ENVIRONMENTAL EDUCATION

(A MANDATORY COURSE TO ALL UG STUDENTS)

SECOND YEAR B.A. / B.Com. / BBA Programme

Semester – 3

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B.A. / B.Com . / BBA SECOND YEAR Semester - 3

Mandatory Course : ENVIRONMENTAL EDUCATION

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FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining a 'A' Grade from the NAAC in the year 2014, the Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from over 285 affiliated colleges spread over the two districts of Guntur and Prakasam.

The University has also started the Centre for Distance Education with the aim to bring higher education within reach of all. The centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even housewives desirous of pursuing higher studies. With the goal of bringing education in the door step of all such people. Acharya Nagarjuna University has started offering B.A, and B, Com courses at the Degree level and M.A, M.Com., L.L.M., courses at the PG level from the academic year 2021-22 on the basis of Semester system.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise in the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers invited respectively. Such ideas will be incorporated for the greater efficacy of this distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is aim that students getting higher education through the Centre for Distance Education should improve their qualification, have better employment opportunities and in turn facilitate the country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will go from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Coordinators, Editors and Lesson -writers of the Centre who have helped in these endeavours.

Prof. P.Rajasekhar
Vice –Chancellor,
Acharya Nagarjuna University

AP State Council of Higher Education

B. A., B. Com and BBA Programmes Revised CBCS w. e. f. 2020-21

Syllabus of 304LSD21- ENVIRONMENTAL EDUCATION

(A MANDATORY COURSE TO ALL UG STUDENTS)

Total hours of teaching - 30Hrs @ 0 2hrs per Week

Course objective : A Generic Course intended to create awareness that the life of human beings is an integral part of environment and to inculcate the skills required to protect environment from all sides.

Learning outcomes : On completion of this course the students will be able to .....

1. Understand the nature, components of an ecosystem and that humans are an integral part of nature.
2. Realize the importance of environment, the goods and services of a healthy biodiversity, dependence of humans on environment.
3. Evaluate the ways and ill effects of destruction of environment, population explosion on ecosystems and global problems consequent to anthropogenic activities.
4. Discuss the laws/ acts made by government to prevent pollution, to protect biodiversity and environment as a whole.
5. Acquaint with international agreements and national movements, and realize citizen's role in protecting environment and nature.

Syllabus :

Unit -1 : Environment andNatural Resources 06 Hrs.

1. Multidisciplinary nature of environmental education; scope and importance.
2. Man as an integral product and part of the Nature.
3. A brief account of land, forest and waterresources in India and their importance.
4. Biodiversity : Definition; importance of Biodiversity - ecological, consumptive, productive, social, ethical and moral, aesthetic, and option value.
5. Levels of Biodiversity: genetic, species and ecosystem diversity.

Unit - 2 : Environmental degradation and impacts **10Hrs**

1. Human population growth and its impacts on environment; land use change, land degradation, soil erosion and desertification.
2. Use and over-exploitation of surface and ground water, construction of dams, floods, conflicts over water (within India).
3. Deforestation: Causes and effects due to expansion of agriculture, firewood, mining, forest fires and building of new habitats.
4. Non-renewable energy resources, their utilization and influences.
5. A brief account of air, water, soil and noise pollutions; Biological, industrial and solid wastes in urban areas. Human health and economic risks.
6. Green house effect - global warming; ocean acidification, ozone layer depletion, acid rains and impacts on human communities and agriculture.
7. Threats to biodiversity: Natural calamities, habitat destruction and fragmentation, over exploitation, hunting and poaching, introduction of exotic species, pollution, predator and pest control.

Unit - 3 : Conservation of Environment **10 Hrs**

1. Concept of sustainability and sustainable development with judicious use of land, water and forest resources; afforestation.
2. Control measures for various types of pollution; use of renewable and alternate sources of energy.
3 Solid waste management: Control measures of urban and industrial waste.
4. Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.
5. Environment Laws: Environment Protection Act; Act; Wildlife Protection Act; Forest Conservation Act.
6. International agreements: Montreal and Kyoto protocols; Environmental movements: Bishnois of Rajasthan, Chipko, Silent valley.

Suggested activities to learner : **(4 Hrs)**

1. Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc
2. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural site.
3. Study of common plants, insects, birds and basic principles of identification.

4. Study of simple ecosystems-forest, tank, pond, lake,mangroves etc.
5. Case study of a Forest ecosystem or a pond ecosystem.

Suggested text books :

- ErachBarucha (2004) Text book of Environmental Studies for Undergraduate courses (Prepared for University Grants Commmission) Universities Press.
- PurnimaSmarath (2018) Environmental studies Kalyani Publishers, Ludhiana

Reference books :

- Odum, E.P., Odum, H.T. & Andrews, J. (1971) Fundamentals of Ecology. Philadelphia: Saunders.
- Pepper, I.L., Gerba, C.P. &Brusseau, M.L. (2011). Environmental and Pollution Science. Academic Press.
- Raven, P.H., Hassenzahl, D.M. & Berg, L.R. (2012) Environment. 8th edition. John Wiley & Sons.
- Singh, J.S., Singh, S.P. and Gupta, S.R. (2014) Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
- Sengupta, R. (2003) Ecology and economics: An approach to sustainable development. OUP.
- Wilson, E. O. (2006) The Creation: An appeal to save life on earth. New York: Norton.
- Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll (2006) Principles of Conservation Biology. Sunderland: Sinauer Associates.

MODEL QUESTION PAPER

SECOND YEAR B.A. / B.Com. / BBA Programme

Semester – 3

ENVIRONMENTAL EDUCATION

(Life Skill : Mandatory Course to all UG students)

Time: 1 1/2 hrs (90 Minutes) **Max. Marks: 50**

SECTION A **(4 x 5 = 20 Marks)**

Answer any **FOUR** of the following questions.

1. Explain multidisciplinary nature of environmental education.
2. Explain the levels of biodiversity.
3. Global warming – causes and its impact.
4. Non – renewable enegy sources their utilisation and influences.
5. Montreal and Kyoto protocols ? Explain..
6. Solid state waste management of industrial waste.
7. Soil erosion and desertification; definition, causes and impact.
8. Explain Man as an integral product and parts of nature.

SECTION B **(3 x 10 = 30 Marks)**

Answer any **THREE** of the following questions.

9. Give a brief account of land and water resources in India.
10. Write an essay on threats of biodiversity.
11. Explain the concept of sustainability and sustainable development.
12. Write in detail about environment laws.
13. Write a brief account on air pollution.
14. Define biodiversity and explain the importance of biodiversity.

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CONTENTS

LESSON - 1

NATURE, SCOPE AND IMPORTANCE OF ENVIRONMENTAL EDUCATION

AIMS AND OBJECTIVES :

In this unit, we have presented a global view of multidisciplinary nature of the environmental education and its scope and importance in sustainable development. we have also discussed about the relationship between different subjects and environmental education. various resources and the management and replenishment of these resources. Along with this, we have analysed the impact of environmental education in sustainable development.

At the end of this unit, we will be able to :

- To know basic information about the multidisciplinary nature of the environmental education.
- To know how EE influences Environmental protection.
- To understand environmental education role in sustainable development.
- Finally, the learner acquires a complete outlook on scope and importance of the environmental education and its role in sustainable development.

STRUCTURE OF THE LESSON :

1.1 INTRODUCTION :

Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. Environmental Education (EE) has been developing many years ago. Moreover it was considered as continuous process of outdoor education, and to respond to the world's growing awareness about environmental problems. Thus EE has become an important school curriculum around the globe. EE refers to organized efforts to teach about how natural environments function and, particularly, how human beings can manage their behavior and ecosystems in order to live sustainably. The term is often used to imply education within the school system, from primary to post-secondary. However, EE is sometimes used more broadly to include all efforts to educate the public and other audiences, including print materials, websites, media campaigns, etc. Related disciplines include outdoor education and experiential education.

The components of environmental education are :

- **Awareness and sensitivity** to the environment and environmental challenges
- **Knowledge and understanding** of the environment and environmental challenges
- **Attitudes** of concern for the environment and motivation to improve or maintain environmental quality
- **Skills** to identify and help resolve environmental challenges
- **Participation** in activities that lead to the resolution of environmental challenges

1.2 DEFINITION :

There are many definitions of the term Environmental Education (EE), but the most important one was given by UNESCO :

"Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action".

According to UNESCO, environmental education emphasizes these themes :

- Awareness and sensitivity about the environment and environmental challenges. Knowledge and understanding about the environment and environmental challenges.
- Attitude concern for the environment and help to maintain environmental quality.
- Skills to mitigate the environmental problems.
- Participation for exercising existing knowledge and environmental related programs.

1.3 BELGRADE CHARTER :

The Belgrade Charter was the outcome of the International Workshop on Environmental Education held in Belgrade, The Belgrade Charter was built upon the Stockholm Declaration and adds goals, objectives, and guiding principles of environmental education programs. It defines an audience for environmental education, which includes the general public.

1.3.1 Goals of Environmental Education :

EE goals have received serious consideration from many countries, and international councils, for example the European Resolution on EE set the following goals: “to increase the public awareness of the problems which exist in the field , as well as possible solutions , and to lay the foundations for a fully informed and active participation of the individual in the protection of the environment and the prudent and rational use of natural resources.

Every human on this Earth has a role to play for the environment, and it gives us everything we need- shelter, food, water, recreation, etc.

The points given below will help in understanding the importance of environmental education.

- Environmental education is one of the subjects in the curriculum in schools. When children study the environment and its functions, they develop a sense of understanding of the environment in the early stage of their life.
- It is important to increase the awareness of individuals about the environment. With the help of environmental education, people's knowledge about the environment is instilled into every country's citizens.
- There are a lot of environmental issues that the world is facing. To avoid them in the future, people need to understand the environment and take proper care of it. It can only be done with the help of environmental education.
- Environmental education polishes various other skills of an individual. The ability to make decisions is strengthened with environmental education as people become more responsible and aware.
- Individuals can deal with any environmental problem through environmental education. This, in turn, increases problem-solving skills.
- One develops sensitivity towards the environment because of the environmental issues that have been happening for a long time. In this way, each individual takes any action by keeping in mind the harm it can cause to the environment.

1.4 AIMS AND SIGNIFICANCE OF ENVIRONMENTAL EDUCATION :

The primary aim of environmental education is to make people aware of the environment and its associated problems. The study involves knowledge, skills, motivation, attitude, and commitment to work individually and collectively towards solutions to current problems. There are various objectives that the study of environmental education tends to achieve. Given below are the objectives of environmental education.

- **Awareness :** Awareness is one of the fundamental objectives that any subject of study offers. Through environmental education, awareness about the environment, the issues of the environment, and the solutions for the problems are generated. In addition, there is a proper understanding as to why there are various functions present in the environment.

- **Knowledge :** Environmental education helps a person gain knowledge and information about the current happenings in the environment. There is in-depth and proper education that is provided about the environment and the factors of the environment.

- **Responsibility :** It is only when we understand the reasons behind the disruptions in the environment; we can take proper steps to prevent them. Individuals understand which activities harm the environment, be it small or big, and take necessary precautions to face the adversities. It also helps in taking any future actions and decisions responsibly.

- **Participation :** When we dive deeper into a particular subject, we tend to get more involved in it. The environment concerns us all, so we must save the environment and prevent it from being harmed. Through environmental education, individuals are encouraged to partition in saving and taking care of the environment as they become aware of the harm they can cause to their lives.

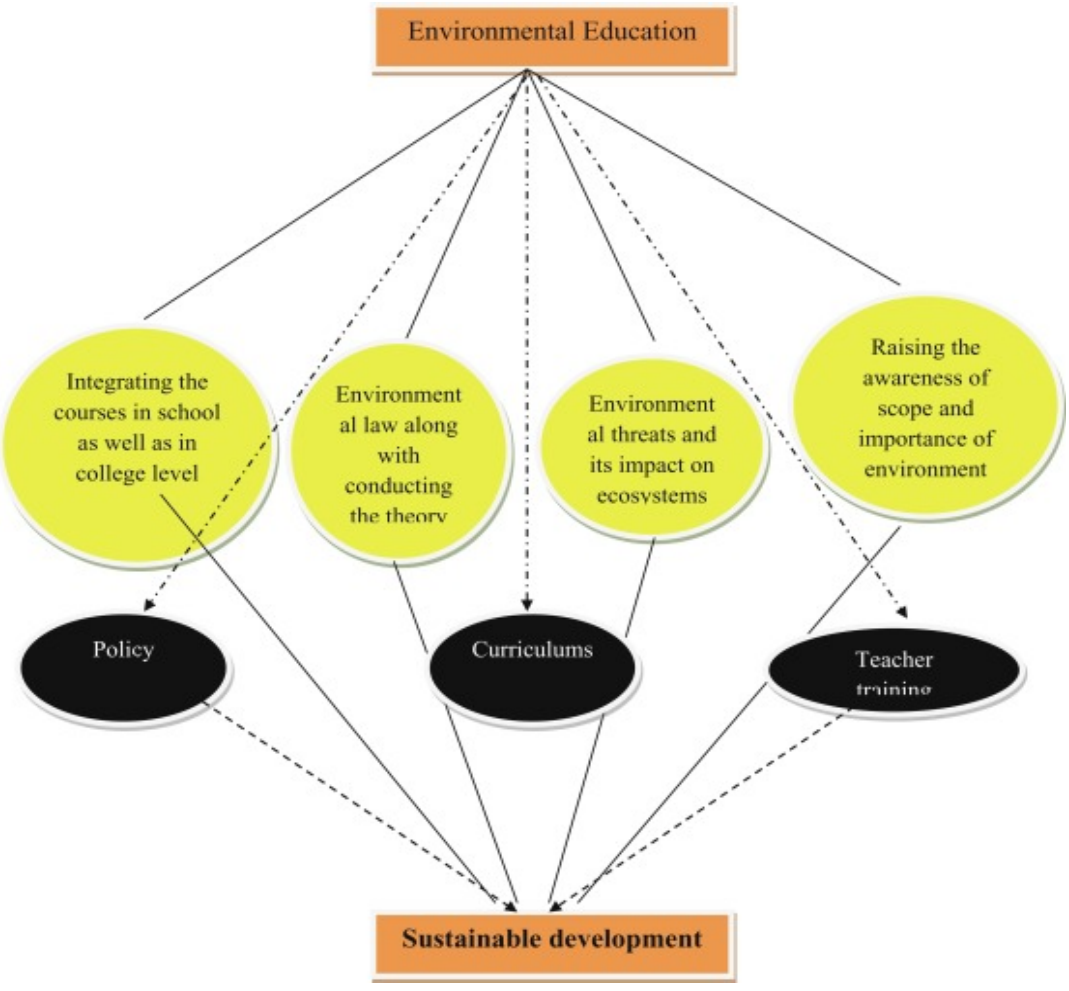
- **Creating New Patterns :** With increased awareness of the harm that man's actions are causing to the environment, environmental education aims to create a new behaviour pattern and attitude towards the environment. These results in less harm as the new pattern is aimed at being environmentally friendly.

- **Understanding the Complexity of Environment :** The environment that we humans live in is complex and involves various activities that happen within it. Environmental education fulfils the aim to make people understand the complexity of working in the environment and the process that occurs in it. By understanding this, people become more indulged in saving and protecting the environment.

1.5 SCOPE OF ENVIRONMENTAL EDUCATION :

Environmental education has a wide scope as it is one of the most important areas of study. People need to understand their duties and responsibilities towards the environment.
The scope of environmental education can be explained with the help of the points given below.

- **Biological Aspect :** The most important aspects of environmental education are biological aspects. The best example is human beings. Other examples of biological aspects include animals, birds, insects, microorganisms, and plants.
- **Physical Aspect :** The physical aspect of environmental education is further divided into natural and man-made aspects. Physical aspects include air, water, land, climate, etc. On the other hand, man-made aspects include roads, highways, airports, railroads, buildings, bridges, dams, and reservoirs, etc., which humans make.
- **Socio-cultural Aspect :** These are the practices, cultures, and traditions which humans make to live in a society. It can include rules, laws, religious beliefs, etc. Human beings, with their efforts, have created these.



Earth Summit produced Agenda 21 which is an international agreement. This agreement develops a more multifunctional mechanism and strategy to achieve the sustainability goals; it is necessary to increase the public participation and community involvement, because environment, social and economic problems affect the community system. So community awareness is very necessary to decrease the social environmental and economic as well as poverty problems. We know that the EE is a component that provides a multifunctional approach and model to achieve SD. Universal supports are very much useful for improving the level of educational opportunity from ground to national level as well as primary and secondary education level. Under such approach, student involvement is very helpful to develop valuable life skills that include communication as well as student's ability of critical and free thinking. At this point, EE provides necessary opportunity to all students to develop skills that are very useful component of academic reform and change education pattern for all sectors. By doing this EE also helps in students' empowerment and learning method. EE seems to the major instrument for achieving SD globally. EE emphasizes to work for present and upcoming generations. EE brings relief for all human being under the crises of natural resource which include coal, petrol, food as well as medicine provided by the nature. At this point we need to identify the drivers of sustainability transitions from sustainable to unsustainable behavior.

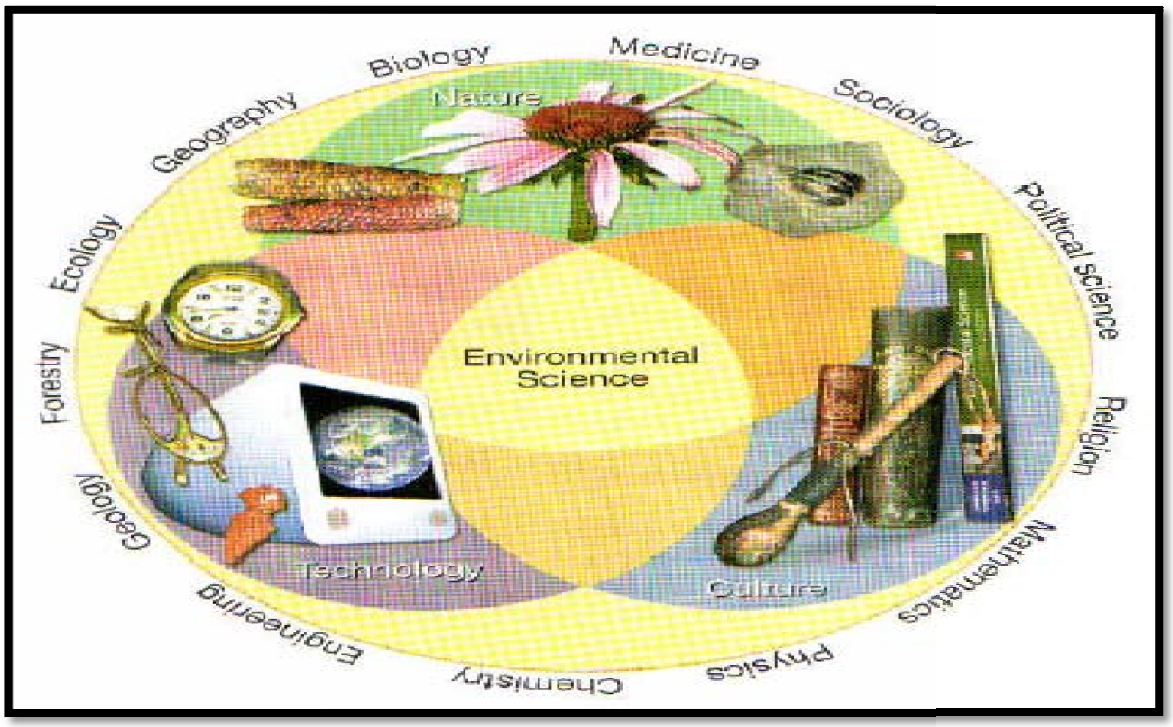
1.6 MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL EDUCATION :

To understand the multidisciplinary nature of environmental studies, we must first comprehend the literal definition of the term multidisciplinary. The phrase is made up of two words: multi and disciplinary. To begin, we define the term disciplinary. Disciplined research in a certain subject is what the term "disciplinary" refers to. Multidisciplinary, on the other hand, refers to the combination of more than one discipline or topic of study. It defines multi-sectoral and multi-dimensional research in a variety of disciplines. For example, a multidisciplinary course of study is one in which you study a variety of disciplines such as Science, Social Science, Mathematics, English, and so on.

Environmental Education is a multidisciplinary academic discipline concerned with the investigation, research, and extension of knowledge about the living and physical environment. It also aids in a better knowledge of environmental natural, political, technical, economic, social, and cultural elements. Environmental Education or EE, can alternatively be defined as the science of physical phenomena in the environment. Environmental Studies is a vast field of study. Not only restricted to **environmental conservation** and management of resources, but it also lays emphasis on understanding. Environmental Education (EE) is made up of several components. They are as follows :

- **Anthropology :** It is the study of human traits, biological and psychological well-being, communities and cultures, and the growth and evolution of humans. EVS is connected to anthropology since it studies humans and their environments throughout place and time.

- **Biology :** It is a field of science that focuses on the study of living creatures. Their physical structure, chemical processes, molecular interactions, development, and evolution are all included. EVS is connected to biology since it is concerned with the natural environment of living creatures.
- **Chemistry :** It is a field of science that examines chemicals and the components that makeup matter. Understanding natural occurrences in EVS necessitates knowledge of chemistry.
- **Computers :** As the world has progressed, computers have become a need for everyone. Computers are used by the Environmental Protection Agency to keep track of pollutants found in soil and water.
- **Geology :** It is the study of physical structures and substances found on Earth, as well as their history and the processes that they go through. EVS is also concerned with the study of the earth and environment.
- **Economics :** It is a field of study concerned with the production, consumption, and distribution of commodities and services. Various economic strategies have been established to preserve the environment from pollution, global warming, and climate change by evaluating and developing answers or cures for environmental concerns.
- **Physics :** It is a field of science that examines energy and matter in space and time, as well as their interactions. Physics is concerned with energy conservation, atmospheric modeling and many environmental concerns.



- **Sociology :** It is the study of social life, change, social causes, and the social repercussions of human action. It also addresses the connection between contemporary society and the environment.
- **Statistics :** It is the study of quantitative data collection, analysis, interpretation, and presentation. It is also used to evaluate data in order to find trends and recommend the optimal environmental growth.

1.7 ENVIRONMENTAL EDUCATION AND SUSTAINABLE DEVELOPMENT :

Environmental Education is closely related to the Sustainable Development. Environmental Education and Sustainable Development relationship develops a multifunctional and sophisticated model through different ways that increases the survivability of all human being for more facilitates without any degeneration. To achieve the sustainability goal, we need to develop this as main objective of Environmental Education that would directly and indirectly lead to Sustainable Development. Environmental Education for Sustainable Development is a term we always use on only for sustainability but many different kinds of aspect should be included under Sustainable Development. Therefore, specific goal should be set in Environmental Education to fulfill the objectives of Sustainable Development. In pursuance of documents introduced by in 1992 through UNESCO at the conference, Environmental Education is one of the subjective educations that can be distributed in all type of education and can also be related to the Sustainable Development.

1.8 SUMMARY AND CONCLUSION :

Environmental education is needed to foster international co-operation and understanding. The developed countries rely on the high technology for the exploitation of natural resources while developing countries like India totally depend on agriculture, forestry and the mineral resources thereby leading to intensive and over-exploitation of the natural resources and these have serious implications on the resources. Public enlightenment on the impact of government policies on local environment should be useful both to the government and the local people. Awareness of such global environmental issues is an essential component of environmental education which ordinary citizen should be aware of. Environmental education for the over-all social and economic emancipation of women and children. These form a substantial percentage in the utilization of natural resources especially at the rural setting. Environmental education is very essential for the lack of it. Environmental Education is virtually a new thing in this part of the world. Environment education is also very essential for our survival on earth. The natural resources and cultural heritage need to be protected not only for this generation but for future generation.

1.9 GLOSSARY / KEY WORDS :

Natural Resources : Materials or substances occurring in nature which can be exploited for economic gain.

Sustainable Development : Economic development that is conducted without depletion of natural resources.

Environmental conservation : Environmental conservation is a practice that paves the way for protecting the environment and natural resources on the individual.

1.10 SELF ASSESSMENT QUESTIONS :

1. Write an essay on multidisciplinary nature of environmental education?
2. Discuss about scope and importance of Environmental Education in Environmental Protection?
3. Give a detailed note on role of environmental education in sustainable development?

1.11 SUGGESTED READINGS :

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press, USA.
3. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA
4. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
5. Kaushik, Anubha and Kaushik, C.P. (2018) Perspectives in Environmental Studies.

Dr. P. Brahmaji Rao

LESSON - 2

MAN AND NATURE

AIMS AND OBJECTIVES :

In this unit, we have presented a global view of how man is related to his environment. To make this interrelationship more clear, we have discussed the ecosystem, various resources and the management and replenishment of these resources. Along with this, we have analysed the impact of over-exploitation of resources and industrialization on the very existence of man.

At the end of this unit, we will be able to :

- To know basic information about the relationship between man and the environment.
- To know how man influences his surroundings with his intelligence.
- To understand natural resources role in human development and aware about the conservation of resources.
- Finally, the learner acquires a complete outlook on how man destroys the environment for his greed.

STRUCTURE OF THE LESSON :

2.1 INTRODUCTION :

Man is an integral part of nature, just like other animals. But with his quick thinking ability about nature, he acquires knowledge of how to manage the surroundings according to the benefits of survival. Early man depended upon nature for all his basic needs like food, clothing and shelter. He enjoyed a dominant position over the other living organisms around him because of his erect posture, hands and intelligence. Man invented and developed many innovative things, they played a significant role in civilization as well as environmental destruction. In the early ages, man invented so many instruments for his comfort, like wheels, fire, and tools and he also practiced new patterns of agriculture and housing for his comfort, which led him to improve the standard of living and make himself superior to other living beings. Thus, modern man modified the environment where he multiplied in numbers to increase population and has always extended his territories, leading to the exploitation of natural resources. This exploitation led to a conflict between man and environment, which grew day by day in an exponential way.

2.2 MAN AND ENVIRONMENT :

The study of relationships between man and environment has always been a focal theme of environmental science and facets of man- environment relationship changed through time with the development of human society and the dimension of environment As man became social, economic and technological, he broadened his environment by creating his own through his design and skill to have provision for better food, shelter, access and comfort. The man environment relationships, thus, can be perceived and evaluated in a variety of ways and approaches as followings :

2.2.1 Deterministic Approach :

This approach is based on the basic tenet of ‘earth made man’ and pays more attention on the complete control of physical environment on man and his activities. In fact, according to deterministic perspectives of man-environment relationships, man is subordinate to natural environment as all aspects of human life viz. physical (health and comfort), social, economic, political, ethical and aesthetic etc. not only depend but are dominantly controlled by physical environment.

2.2.2 Teleological Approach :

The teleological approach is based on the religious faith that man is superior to nature and all other creatures. This ideology of the man-environment/nature relationship fostered the desire in men to exploit natural resources and subdue nature without considering the aftereffects of reckless and uncontrolled plundering of natural resources.

2.2.3 Possibilistic Approach :

A probabilistic approach to the study of man-environment relationships emerged through the criticism of environmental determinism and the overtones of a teleological approach. Right from the very inception of the school of environmental determinism, there was a dissenting voice raised by those who believed that "no doubt the physical environment influences man and his activities, but there is ample scope for man to change the environment so much so that it becomes suitable for man and his society."

2.2.4 Economic Deterministic Approach :

This approach is based on the basic ideology of man's mastery over the environment and continued economic and industrial expansion through the application of modern technologies. The basic thesis of the "growth" (affluence) school is that because economic growth is required for political, social, and economic stability, the "quality of the environment" normally assumes lower priority in formulating planning proposals and in long-term planning because the deterioration of the environment is generally more protracted and socially less oblique than a deterioration in the economy. It may be pointed out that this extreme concept of economic determinism led to rapacious exploitation of natural resources in the western developed countries and thus created most of the environmental and ecological problems of global dimension.

2.2.5 Ecological Approach :

An ecological approach to the study of human-environmental relationships is based on the basic principle of ecology, which is the study of mutual interactions between organisms and their physical environment on the one hand and interactions among the organisms on the other hand in a given ecosystem. Thus, man is considered an integral part of nature and the environment. It is obvious that the relationship between man and the environment is two-directional, as the environment affects and influences man, and in turn, man also influences and modifies the environment. This type of mutual interaction and relationship between man and the environment is symbiotic in nature.

2.3 MAN'S INTERACTION WITH THE ENVIRONMENT THROUGH THE AGES :

"According to the biophilia hypothesis, the human species evolved in the company of other life forms, and we continue to rely—physically, emotionally, and intellectually—on the quality and richness of our affiliations with natural diversity." Healthy and diverse natural environments are necessary pre-conditions for human lives of satisfaction and fulfillment. So, it is the technology of man that has drastically changed the man-environment relationship from the prehistoric period to the present most advanced industrial period. In fact, "the industrial and scientific revolutions" have led to rapid changes in our environment, but all technology, from the most primitive to the most advanced, causes some changes in the environment. The underlying cause of the depletion of natural resources in a large-scale social dilemma is the unrestricted

access that people have to natural resources, either renewable or nonrenewable, such as electricity, water, oil, clean air, etc. Though there is a traditional debate between conservationists and non-conservationists, people in general are still highly concerned with the quality of the environment.

2.4 ROLE OF MAN IN DEVELOPMENT AND DESTRUCTION :

Earth is the only known planet in the solar system that supports life—within its very thin layer called 'Biosphere. The natural resources that provide the base for human sustenance and development by providing ecosystem services are not inexhaustible. Environment does not merely mean landscape, soil, water, deserts, or mountains but is the sum total of living and non-living components; influences, and events surrounding an organism. It also includes the biological, or biotic, influences in the form of microbes and animals. Man has brought changes to the environment by over-exploiting its capacity to meet his needs and demands. While this has improved the standard of living for mankind, the subjugation of nature has done irreparable damage to the environment, which now poses a threat to planet Earth. There has been a substantial decline and degradation of natural resources over the years, and there is an urgent need for sustainable natural resource management.

Humans are mainly responsible for the destruction of the environment. The impacts of human activity on the environment are from the time of our very earliest ancestors. Since then we have all been modifying the environment as per our convenience, and at this point, today, we are losing all the valuable natural resources which cannot be gained back.

The human effects or the factors contributing to the loss of the environment are :

- Pollution
- Deforestation
- Overpopulation
- Disposal of wastes
- Wastage of natural resources

All these factors lead to acid rain, increased carbon dioxide levels in the atmosphere, acidification of lakes, depletion of the ozone layer, climate change, global warming, extinction of species, etc.

Environmentalism describes man as an integral part of the environment. This approach emphasises the need for wise and restrained use of natural resources and the application of appropriate environmental management programmes, policies, and strategies with a view to ensuring that depleted natural resources are replenished while keeping the health and productivity of nature intact. Radioactive hazardous wastes, organic waste from kitchens (crockery, tin and plastic cans, glass bottles, cloth rags, straw, ash slag, lime sludge, brine mud,

scraps of metal, glass, ferrous and non-ferrous metals, wool, thread, and paper; fly ash, plastics, pesticides, and herbicides get mixed in the soil of the fields. Run-off from agricultural lands brings these into water bodies. Irrigation from such bodies of water takes pesticides and herbicides back to the field areas. Spraying and evaporation enable the entry of pesticides into the atmosphere. Rainfall brings these chemicals back onto land and into water bodies. Persistent chemicals and pollutants follow this pathway for a much longer time and enter the food chain. If they are not biodegradable, these pollutants can bioaccumulate and biomagnify at higher levels of the food chain. As a result of chemical reactions between pollutants like sulphur, nitrogen, carbon dioxide, carbon monoxide, hydrocarbons, and particulates released from fuel burning, normal atmospheric compounds under the influence of electromagnetic radiation from the sun spell catastrophe for our environment.

2.5 HUMAN POPULATION AND ENVIRONMENT :

The relationship between population, environment, and quality of life is quite complex, firstly because of the complexity of the characteristics of each, and secondly because of the lack of agreement among experts as to the cause-and-effect relationship between these factors. Unplanned population growth has been recognised by most people as a cause of environmental pollution and a barrier to promoting the quality of life of the people. The relationship between population, environment, and development is highly complex. Unless a value judgment is made as to what a developed society is, it is difficult to determine which changes are part of the development process. The UNESCO declaration that "since wars begin in the minds of men, it is in the minds of men that defenses of peace are to be constructed" is equally relevant to alleviating the problems of population increase, poverty, the environment, and sustainable development. It is in the "minds of men" that radical changes will have to be made in order to ensure sustainable development and maintain optimum quality of life for all without endangering the environment.

2.6 CONCLUSION :

Man invented and developed many innovative things, they played a significant role in civilization as well as environmental destruction. In the early ages, man invented so many instruments for his comfort, like wheels, fire, and tools and he also practiced new patterns of agriculture and housing for his comfort, which led him to improve the standard of living and make himself superior to other living beings. Thus, modern man modified the environment where he multiplied in numbers to increase population and has always extended his territories, leading to the exploitation of natural resources. This exploitation led to a conflict between man and environment. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change in climate that is attributed directly or indirectly to human activity that alters the composition of the global environment. Human society is standing at the crossroads and searching for better alternatives for a sustainable future Earth. The United Nations' Brundtland Commission rightly propounded in its report the need for sustainable

development to meet the needs of the present generation without compromising the ability of future generations to meet their needs. Albert Einstein had said, "The environment is everything that is not me." Undeniably, there will not be a society if the environment is destroyed.

2.7 GLOSSARY / KEY WORDS :

- **Destruction** : The action or process of causing so much damage to something that it no longer exists or cannot be repaired.
- **Endanger** : Put (someone or something) at risk or in danger.
- **Exploitation** : The action of making use of and benefiting from resources.
- **Bioaccumulation** : Become concentrated inside the bodies of living things.
- **Deterministic** : Relating to the philosophical doctrine that all events, including human action, are ultimately determined by causes regarded as external to the will.

2.8 SELF ASSESSMENT QUESTIONS :

1. Write an essay on role of man in environmental construction and destruction?
2. Explain about understanding approaches of man and environmental relationship?
3. Give a detailed note on population and pollution?

2.9 SUGGESTED READINGS :

1. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
2. Kaushik, Anubha and Kaushik, C.P. (2018)Perspectives in Environmental Studies
3. Bharucha, Erach Textbook of Environmental Studies for Undergraduate Courses(2018)

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LESSON - 3

IMPORTANCE OF LAND, FOREST AND WATER RESOURCES

AIMS & OBJECTIVES :

At the end of lesson the learner would understand

- Knowledge about the Forest Resources and it uses and Economic significance.
- Knowledge about the Forests types and Management.
- Knowledge about the Forest Cover.
- Knowledge about the Water Resources, Indian Water Resources.
- Knowledge about the Land Resources, types of Indian soils, Land Degradation.

STRUCTURE OF THE LESSON :

3.1 FOREST RESOURCES :

3.1.1 Forest Resources - Uses :

Forest resources can be classified as Biotic and Abiotic.

Biotic resources :

Plants are useful in many ways such as food, fodder, firewood as well as medicinal uses. Animal resources in the forest provides the ecological balance and protection of diversity in the forests.

Abiotic resources comprised with various types of rocks, gravel and also fossil fuels that are useful for the mankind in the day to day life.

3.1.2 Importance of Forests : Forests are Important Ecologically and Economically

The functions of a forest may broadly be classified into following three categories :

(i) Protective functions : These include the protective role of forests against soil erosion, droughts, floods, intense radiation.

(ii) Productive functions : Forests are the source of wood and many other products like gums, resins, fibres, medicines, katha, honey, bidi wrappers, pulp, paper.

(iii) Accessory functions : These include the role of forests in recreation, aesthetics, and as habitat of diverse wildlife.

3.1.3 Ecological Importance :

Forests are home to 50-90% of earth's species and are potentially renewable resources if used as per optimum needs and ensuring their security known as sustainability. However, forests- especially tropical forests of United States, southwestern Canada, and Asia are disappearing faster than any other biome as they are cleared for timber, paper pulp, or fuel wood and even for minor forest produce and replaced by cropland, grazing land, mines, reservoirs, and cities. Eco degradation of forests is intense due to urbanization, civilization and even tourism they are also threatened by air pollution and by climate changes.

Forests play crucial role in regulation of global climate and temperature as the forest cover absorbs the solar energy for primary production of food and energy that would otherwise be reflected back into the atmosphere by the bare surface of the earth. It is well known that through the process of photosynthesis in green plants, carbon is taken from the atmosphere, using solar energy and water, produce food and store as energy and released back into the atmosphere due to respiration as a part of a steady-state a cycle known as carbon cycle. But as more forests are destroyed than replaced, there will be a net increase in the concentration of carbon dioxide in the atmosphere contributing to the warming up trend i.e., greenhouse effects. For example, the worlds forest contain about 830 pg C (10^{15} gm) in their vegetation which is 1.5 times more the carbon present in soil. The forest help as sinks for CO_2 during photosynthesis and release O_2 in that process balancing the O_2, in the biosphere.

Forests, wetlands, mangroves and wildlife are some of our major natural renewable resources and their conservation is highly essential for sustainable development. They contribute significantly for economic development by providing goods and services to the people and industry. Further, they also play an important role in enhancing the quality of environment by influencing the life support systems.

Forested watersheds act as giant sponges, slowing down runoff and absorbing and holding water that recharges springs, streams, and groundwater. Thus they regulate the flow of

water from mountain highlands to croplands and urban areas, they act as shields and they reduce the amount of sediment washing into streams, lakes, and reservoirs by restricting soil erosion as the forests enrich soil binding property.

Forests also influence local, regional, and global climate. On a hot day, a large tree may extract from the soil as much as 5.5 metric tons (5 tons) of water and transpire it into the atmosphere to natural rain cloud seeding. Thus 50-80% of the moisture in the air above tropical forests comes from trees via transpiration and evaporation. If large areas of these lush forests are cleared, average annual precipitation drops, the region's climate gets hotter, drier, and soils become depleted of already scarce nutrients, baked, and washed away. This process can eventually convert a diverse tropical forest into a sparse grassland or a desert involving deforestation, devegetation leading to desertification.

They also provide habitats for high wildlife species diversity than any other biome, buffer us against noise, absorb air pollutants, and nourish the human spirit.

As long as the lasting and renewable ecological benefits of complex and diverse forests are undervalued to realize short term gains people will continue to sacrifice these forests and their long-term ecological services for short-term economic gains.

Since agriculture began about 10,000 years ago, human activities gradually reduced earth's forest cover by about one quarter, from about 34% to 26% of the worlds. If used sustainably, if the rate of cutting and degradation does not exceed the rate of regrowth, and if protecting biodiversity is emphasized-forests are renewable resources. However, forests are disappearing or are being fragmented and degraded almost everywhere, especially in tropical countries by the local over exploitation as well as alien illicit traders of forest produce major and minor.

3.1.4 Economic Significance :

Forests are the most valuable natural resources available to the mankind on planet earth. On the one hand, they are the essential source of livelihood and fuel for the poor and marginalised sections of the society; on the other hand they provide wood, timber from which furniture and other items of desire can be prepared for the rich. Wood may also be converted into soild (coke), liquid, and gaseous fuels. Timber is an important material in building construction and day-to-day uses. Forests provides raw material for various wood-based industries, viz., pulp and paper, composite wood, rayon and other man-made fibres, sport goods, furniture, boat building, matches etc., Miscellaneous products, like bamboos, resins, gums, some oils, fibres, medicines, katha, lac, shellac etc., are also obtained from forests. After years of neglect, forestry is acquiring international dimensions. The role of forests in the environmental amelioration and peoples life assumed global significance after the 1992 Rio Summit. The saga of deforestation in the developing countries on account of rising population and consequent poverty has attracted global attention of scientists, resource managers and law makers. To reverse the degradation in

resources, action programmes for conservation and development of forest resources have taken shape in most of the countries.

3.1.5 Forests Types and Management :

Influence of Precipitation and Temperature on Vegetation :

Temperature and moisture are two major factors that influence the kind of vegetation that can occur in an area. Areas with low moisture and low temperatures produce tundra; areas with high moisture and freezing temperatures during part of the year produce deciduous or coniferous forests; dry areas produce deserts; moderate amounts of rainfall or seasonal rainfall support grasslands or savannas; and areas with high rainfall and high temperatures support tropical rain forests. Similarly there is a direct relationship between altitudes, latitudes and vegetation.

Old growth forests also called in succession as climax forests are virgin (uncut) forests and regenerated forests that have not been seriously disturbed for several hundred or even thousands of years. Example include forests of Douglas fir, western hemlock, giant sequoia, and coastal redwoods in the western United States; loblolly pine in the Southeast; and 60% of the world's tropical forests.

Old growth forests provide ecological niches for a variety of wildlife species. These forests also have large numbers of standing dead trees (snags) and fallen logs that are habitats for a variety of species. Decay of this dead vegetation returns plant nutrients to the soil.

Second growth forests are stands of trees resulting from secondary ecological succession after cutting. Most forests in the temperate areas are second-growth forests that grew back after virgin forests were cleared for timber or to create farms that were later abandoned. About 40% of tropical forests are second-growth forests. Some second-growth growing stands have remained undisturbed long enough to be become old-growth forests, but many are not diverse forests at all, but all rather are tree farms managed tracts with emphasis on uniformly aged mono species trees that are harvested by clear-cutting as soon as they become commercially valuable. Commercial Importance of Forests provide lumber for housing, biomass for fuel wood, pulp for paper, crude medicines, and many other products worth more than $300 billion a year. Many forest lands are also used for mining, grazing livestock, and recreation.

3.1.6 World Forest Cover :

3.1.6.1 Global Forest Cover :

According to the State of World Forests 1999 published by FAO (Anonymous, 1999(a)) the position of the various regions of the world regarding percentage of forest cover, per capita forests and annual loss between 1990-1995 is given in following Table.

Table - Details of Forest Cover

S.No.	Region / Country	% of Forest Cover to land area	Per capita Forest ha	Annual change between 1990-1995 (in thousand ha)
1.	World	26.6	0.64	-11269
2.	Asia	16.4	0.1	-2901
3.	Africa	17.7	0.7	-3748
4.	Europe	41.3	1.3	+519
5.	China	14.3	0.1	-87
6.	Pakistan	2.3	Non-significant	-55
7.	Nepal	33.7	0.2	-55
8.	Bangladesh	7.8	Non-significant	-9
9.	Sri Lanka	27.8	Non-significant	-20
10.	Indonesia	60.6	0.6	-1084
11.	Malaysia	47.1	0.8	-400
12.	Philippines	22.7	0.1	-262
13.	Japan	66.8	0.2	-13
14.	USA	23.2	0.8	+589
15.	India	19.27	0.08	+7

India is one of the few developing countries, which has attempted to arrest the loss of forest cover as reflected by the above Figures in the above table.

The extent of world forest cover available in the different types of ecosystem are given in following table, Worldwide, about half of the wood logs cut each year is used as fuel for heating and cooking, especially in developing countries. Some of this fuel is burned directly as firewood, and some is converted into charcoal, which is widely used by urban dwellers and by some industries. One-third of the world's annual harvest is saw logs that are converted into building materials: timber, plywood, hardboard, particleboard, and chipboard. One -sixth is converted into pulp used in a variety of paper products.

Table - Forest Vegetation by Generalized Eco-System type

	Area 10^6 km^2	Total net primary production (10^{15} g C/year)	Total mass of vegetation (10^{15} g C)
Tropical rain forest	17.0	16.8	344
Tropical seasonal forest	7.5	5.4	117
Temperate conifer forest	5.0	2.9	79
Temperate angiosperm forest	7.0	3.8	95
Boreal forest	12.0	4.3	108
Woodland and shrubland	8.5	2.7	22
Savannah	15.0	6.1	27
All other continental vegetation	77.0	10.8	35
Total continental	149	52.8	827
Total marine	361	24.8	1.74
Total global	510	77.6	828

3.1.6.2 Mangrove Forests :

As much as 75 percent of the low-lying tropical coastline with fresh water drainage is dominated by salt-tolerant trees or shrubs known as mangrove forests. An estimated area of 15 mha of mangrove forests are located in tropical Africa, Asia and the Americas. The extent of the mangrove forests are given in the following table.

Table - Area of Mangrove Forests

Country	Area ('000sha)
Indonesia	4,000-6,000
India	1,420
Nigeria	700-1,000
Bangladesh	629
Philippines	4,000
Thailand	313-268
Malaysia	130-150

Mangrove forests are one of the most productive and biological ecosystems in the world providing habitat for more than 2,000 species of fish, invertebrates and epiphytic plants (plants that live on the trunks and branches of plants deriving support as mere space parasites but not

nutrients from their host plants.) Nutrients released through the decomposition of the abundant mangrove leaf and twig litter are an important direct and indirect food source for local aquatic life. Mangroves are also valuable as source of timber, pulpwood, fuel and charcoal and crude drugs. In addition, their extensive root systems act as silt traps, stabilize shorelines and help maintain estuarine coastline water quality.

By the end of the century it is expected that more than half of the world's population with activities like woodcutting, diversion of upland watersheds (through construction of dams), reclamation for agriculture and aquaculture (e.g. Chilika Lake in Orissa) will seriously affect the mangrove ecosystems.

3.2 WATER RESOURCES :

3.2.1 Introduction :

Water is a vital natural resource which forms the basis of all life. Further, water is a key resource in all economic activities ranging from agriculture to industry. With ever increasing pressure of human population, there is severe stress on water resources.

In many places where lack of food threatens human survival, it is the lack of water that limits food production. Water also plays key role in the development of earth's surface, moderating climate and diluting pollutants. Infact, without water, life as we know it, cannot exist as for all the physiological activities of plants, animals and microorganisms, it is essential. It is an essential raw material in the process of photosynthesis of green plants which becomes food used by various living systems in all trophic levels. Atmospheric humidity which constitutes water is highly essential for all terrestrial life to protect from dehydration. Atmospheric water is the key factor in combination with temperature in influencing the global ecology, and as a function of hydrological cycle covering 70% of land surface, it influences weather and global climate and flora and fauna. In view of the above it is significantly linked with social, economic, political and ecological intricacies.

3.2.2 Worldwide supply, Renewal and Distribution :

Only a tiny fraction of the planet's abundant water is available to us as fresh water. About 97% is found in the oceans and is too salty for drinking, irrigation, or industry.

The remaining 3% is fresh water. About 2.997% of it is locked up in ice caps or glaciers or is buried so deep that it costs too much to extract. Only about 0.0035 of Earth's total volume of water is easily available to us as soil moisture, exploitable ground water, water vapor, and lakes and streams. The pattern of distribution of Earth's Water Resources are presented in the following table.

Table - Earth's Water Resources

	Volume (thousands of km^{3+})	% Total water	Average residence time
Total	1,403377	100	2800
Ocean	1370000	97.6	3000 years to 30,000 years
Ice and snow	29,000	2.07	1 to 16,000
Groundwater down to 1 km	4000	0.28	From days to thousands of years
Lakes and reservoirs	125	0.009	1 to 100years
Saline lakes	104	0.007	10 to 1000 years
Soil moisture	65	0.005	2 weeks to a year
Biological moisture in plants and animals	65	0.005	1 week
Atmosphere	13	0.001	8 to 10 days
Swamps and marshes	1.7	0.0001	10 to 30 days
Rivers and streams	1.7	0.0001	10 to 30 days

3.2.3 Indian Water Resources :

In India, out of total rainfall in an area of 3290 lakh hectares, a rainfall of 4000 billion cubic meters annually occurs. Out of the total, 41% is lost-evaporation, 40% is lost-run off, 10% is retained- soil moisture, 9% seeps in for recharging ground water. Of the 40% stream flow water, 8% is used for irrigation, 2% for domestic use, 4% for industry, 12% for electric generation. Out of total available water resource 1869 bcm, the usable, water resources are only 1122 bcm, which consists surface water 690 bcm, ground water 432 bcm which the present per capita available water resources is 1122 cm and by 2050 it is likely to reduce to 748 cm.

When the countries per capita water availability is less than 1700 cm it is considered as water stress country.

3.2.4 Main Rivers in India :

The Rivers in India can be classified as

(a) Himalayan water system (Indus, Ganga /Brahmaputra, Chinab, Jhelum, Ravi and Beas)

(b) Deccan Plateau water system (Narmada, Tapti, Mahanadi, Godavari, Krishna, Periyar)

(c) Coastal water systems and

(d) others including inland water systems.

3.2.5 Water resources of Andhra Pradesh :

Considering that a normal annual rainfall is about 900 mm, the present estimates of the water balance components are as follows :

Total quality of water received through rainfall	24.4 m ha m
Surface run-off (40%)	9.8 m ha m
Percolation to groundwater bodies (9%)	2.2 m ha m
Evapotranspiration (41%)	10.0 m ha m
Retained as soil moisture (10%)	2.4 m ha m

The major water bodies of ecological significance are presented in the given following table.

Table - Major water bodies of ecological significance in Andhra Pradesh

Rivers, canals and distributions	13,891 Km^2
Actual forest cover	44,229 Km^2
Tanks and ponds Total irrigation	79,953
Total irrigation tanks (for which records are available)	73,604b
Abandoned tanks	29,187
Irrigation tanks with > 40 ha command area	13,000
Tanks with Waters Users Association	8,813

3.2.6 Hydrological Cycle :

The available fresh water is continuously collected, purified, and distributed through the hydrologic cycle. In the hydrological cycle, the factors which control the process of evaporation and evapo transpiration are temperature, humidity, and win. It is a continuous process going on day and night from the ocean surface, ground surface, inland waters (like lakes and streams), and plant and animal surfaces. Raising in the atmosphere this water forms clouds that float around in gaseous or droplet form. The atmosphere above the earth to varying heights of 10 to 17 km (depending upon latitude and season) is called the troposphere up to which the clouds float and in which all weather changes take place. Water returns to the earth in the form of precipitation, most of which takes place over the ocean and a little in the land surface. Rainfall in the land surface may have following fates; it may percolate through the soil and become a part of ground

water regime; accumulate in a pond, lake, or reservoir as inland surface water; flow down to the ocean in the form of stream; taken up by plants and animals; or evaporate.

This natural cycling and purification process provides plenty of fresh water so long as it is not interfered by human activities by overloading with slowly degradable and non-degradable wastes or extracted it from underground supplies faster than it is replenished. However, in the process of economic development the above two human activities accompanied with various development programmes are interfering with the natural hydrological cycle and deteriorating the water quality).

3.2.7 Surface Water :

Much of fresh water we use first arrives as the result of precipitation. Precipitation that doesn't seep into the ground or does not return to the atmosphere by evaporation or transpiration is called surface water. It forms streams, lakes, wetlands and artificial reservoirs.

Watersheds, also called drainage basins, are areas of land that drain water into bodies of surface water. Water flowing off the land into these bodies is called surface runoff.

3.2.8 Ground Water :

Groundwater is the source of about 90% country's drinking water. In rural areas, almost all of the water supply comes from groundwater and more than one-third of our 100 largest cities depend on it for at least part of their supply. Historically, groundwater has been considered to be safe to drink. However, of late groundwater is becoming contaminated with industrial effluents discharged on land and septic systems, as well as illegal and uncontrolled hazardous waste sites. Once contaminated, groundwater is difficult, if not impossible, to restore.

Some precipitation infiltrates into the ground and fills the pores in soil and rock. The subsurface area where all available soil and rock pore spaces are filled by water is called the zone of saturation, and the water in these pores is called ground water. The water table is the upper surface of the zone of saturation; it is the poorly demarcated and fluctuating the dividing line between saturated soil and rock (in which every available pore is full) and unsaturated (but still wet) rock and soil in which the pores can absorb more water. The water table falls in dry weather and rises in wet weather.

3.2.9 Aquifers :

Underground water, or subsurface water, occurs in two zones, distinguished by whether or not water fills all of the cracks and pores between particles of soil and rock. The unsaturated zone that lies just beneath the land surface is characterized by crevices that contain both air and water. Water in the unsaturated zone, called yadose water, is essentially unavailable for use. That is, it cannot be pumped, though plants certainly use soil water that lies near the surface. In the saturated zone, all spaces between soil particles are filled with water. Water in the saturated zone is called groundwater, and the upper boundary of the saturated zone is called the water table.

There is a transition region between these two zones called the capillary fringe, where water rises into small cracks as a result of the attraction between water and rock surfaces.

Illustrates an unconfined aquifer situated above a confining bed. An aquifer is a saturated geologic layer that is permeable enough to allow water to flow fairly easily through it, while a confining bed, or, as it is sometimes called, an aquitards or an aquiclude, relatively impermeable layer that greatly restricts the movement of groundwater. The two terms are not precisely defined, and are often used in a relative sense. A well drilled into the saturated zone of an unconfined aquifer will have water at atmospheric pressure at the level of the water table. It is not unusual to have a local impermeable layer in the midst of an unsaturated zone, above the main body of groundwater. Downward percolating water is trapped above this layer, creating a perched water table.

Groundwater also occurs in confined aquifers, which are aquifers sandwiched between two aquitards. Water in a confined aquifer can be under pressure so that a well drilled into it may have water naturally rising above the upper surface of the aquifer, in which case it is called an artesian well. A line drawn at the level to which water would rise in an artesian well defines a surface called the piezometric surface or the potentiometer surface. In some cases, enough pressure may exist to force water to rise above ground level and flow without pumping, in which case it is called flowing artesian well. Figure shows these distinctions.

The amount of water that can be stored in a saturated aquifer depends on the porosity of the soil or rock which makes up the aquifer. Porosity (n) is defined to be the ratio of the volume of voids (openings) to the total volume of material :

Porosity (n) = Volume of voids / Total volume

The gradient is important because groundwater flows - in the direction of the gradient and at a rate proportional to the gradient. To determine the gradient, it is useful to introduce the notion of hydraulic head as shown in Figure. The elevation head at a well, for example, is the vertical distance from some reference datum plane (usually taken to be sea loyal) and the bottom of the well. The pressure head is the bottom of the well to the water level in the well. The sum of the two is the total head and has dimensions of length such as "meters of water" or "feet of water" and the hydraulic gradient.

3.2.10 Ground Water Resource :

The total quantity of groundwater on Earth is estimated at more than 50 million cu.km. Of this, 4 million cu.km. are considered as a reasonable quantity of fresh water that could be exploited, which excludes water that will not drain from small pore spaces, saline water and water lying deep in confined aquifers.

The total groundwater reserves of India upto a depth of 300 metres are estimated to be at 3,700 million hectare metres (mham) and the usable groundwater at around 42 mham, per year.

Out of this, 27.37 percent is exploited. The state of Uttar Pradesh has a usable potential of 9.27 mham/y followed by Madhya Pradesh (5.95 mham/y), Andhra Pradesh (2.21 mham/y) and Gujarat (2.03 mham/y).

Depletion of groundwater sources due to the withdrawal of water at a rate far exceeding the natural recharge rate is currently a matter of global concern.

The groundwater potential of Andhra Pradesh was revised in 2002, by dividing the State into 1,195 assessment units using the 2000-01 database developed by the State-Level Groundwater Estimation Committee constituted in 1999. As per the estimates, the net annual available groundwater is 30.41 bcm (1, 074 tmc), out of which about 12.97 (458 tmc) are currently being utilized.

3.2.11 Water Resources - Indian Scenario :

Need for water conservation

Average annual rainfall 1170 mm

Area 3290 lakh hectares

Out of Total Precipitation

41%(10,02,040 lakh) lost as evaporation and transpiration

40% (9,77,600 lakh) lost as run off,

10% (2,44,400 lakh) is retained as soil moisture

9% (2,19,960 lakh) seeps in for recharging ground water.

India will be requiring about 1,2010,000 lakh cubic metres (cum) of water in the year 2050 AD to cater to the needs of about 150 crores population for food, drinking water, domestic, industrial, navigational, environmental and ecological requirements due to which there is a great need to conserve water.

Table - India's Water Budget

Category	1985		2000		2025	
	Surface water	Ground water	Surface water	Ground water	Surface water	Ground water
Domestic/live stock	16.70		28.70		40.00	
Industries	10.00		30.00		120.00	
Thermal power	2.70		3.30		4.00	
Miscellaneous	40.60		58.00		116.00	
Subtotal	40	30	80	40	1990	90
Irrigation	320	150	420	210	510	260
Sub-Total	360	180	500	250	700	350
Total	540		750		1,050	

Experts opine that there would be no underground water by 2025 in Rajasthan if the present rate of indiscriminate utilization continues. Annually, $1/3^{rd}$ of the area in the country is drought hit while some areas struggle/suffer with natural calamities like flood. Even 30% of the available water is not efficiently used whereas most of the waters are wasted into the sea.

3.3 LAND RESOURCES :

3.3.1 Land as a Resource :

Land and its soils are considered as important resources of earth as these provide essential medium for development of agriculture, vegetation, forestry etc. The percapita land availability in different continents of the world is given in the following table.

S.No.	Continent Land	Availability (Ha/capita)	% of potentially arable land under cultivation
1	North America	1.84	43
2	South America	2.81	12
3	Africa	1.85	22
4	Europe	0.60	54
5	Asia	0.39	77
6	World	0.88	42

3.3.2 Soils :

Soil is an organized mixture of minerals, organic material, living organisms, air and water. Soil formation begins with the breakdown of the parent material by such physical processes as change in temperature, freezing and thawing and movement of particles by glaciers, flowing water or wind. Oxidation and hydrolysis can chemically alter the parent material. Organisms also affect soil budding by burrowing into and mixing the soil, by releasing nutrients, and by their decomposition. Topsoil contains a mixture of humus and inorganic material, both of which supply soil nutrients. Soil fertility is determined by the inorganic matter, organic matter, water and air spaces in the soil. The mineral portion of the soil consists of various mixtures of sand, silt and clay particles.

A soil profile consists of the A horizon, which is rich in organic matter, the B-horizon, which accumulates materials leached from the A horizon and the C horizon which consists of slightly altered parent material. Forest soils typically have a shallow A horizon and a deep nutrient-rich B horizon with much root development. Grassland soils usually have a thick A horizon and very few nutrients in the thin B horizon. Therefore, most of the roots of the grasses will be in the A horizon.

3.3.3 Types of Indian Soils :

Soils of India are classified into six major types based on their nature and composition.

3.3.3.1 Red soils :

They cover large areas in south, and in the north-east of the Peninsula. Such soils occur in Andhra Pradesh, Tamilnadu, and parts of Bihar, Orissa, U.P. and West Bengal. Their color is due to high proportion of iron components. These are mainly sandy to loam in texture, with gravels on upper slopes, sandy soils, deeper loamy soils on lower slopes, and clay in the valley bottoms. In addition, clay of true as well as low laterites also occurs in this zone in Western Ghats and Kerala respectively. Moreover, there are also a number of red, yellowish and whitish clays in some parts of south-west India.

3.3.3.2 Laterite soils (Latosols) :

These are present in the Western Ghats, the northern half of the Eastern Ghats, eastern margins of Chhota Nagpur plateau, Meghalaya, few patches around Kathiawar, and in two areas in the centre of the peninsula north of Bangalore and west Hyderabad. These soils have porous clay rich in hydroxides of iron and aluminium. At low elevations, such soils are suitable for paddy cultivation, whereas those at higher elevations, favour the growth of coffee, rubber, tea and Cinchona.

3.3.3.3 Black soils :

This type of soils are found in the Deccan traps including Maharashtra, Mysore and M.P. The Krishna and Tungabhadra basin Andhra Pradesh also similar types. In western Deccan, these are indeed black cotton soils-regur, whereas in the eastern part these are medium light black type. Soil of Vindhya and adjacent hills are also called brown soils. Black soil and predominantly clay, with patches of loams, loams and sand loams.

3.3.3.4 Skeletal (Mountain) soils :

They occur in north-western hills or the Aravallis, where they are stony sandy hill foot fans and slope colluvium, and in the humid south and east of the Himalayas and in Meghalaya where these are more clayey in texture.

3.3.3.5 Desert soils :

These cover large parts of Rajasthan and the semi-desert areas of the Rann of Kutch.

3.3.3.6 Alluvial soils :

These occur chiefly in the Indo-Gangetic plain covering the states of Punjab and Haryana in the north-west, U.P. and Bihar in the north and Bengal and parts of Meghalaya and Orissa in the north east. Besides plains. These soil are also present in the east coast deltas and terrace, deltaic and lagoon alluvium of peninsular India. The soil is rich in loams and clay components in Punjab and Western Ganga plains, the loam component increasing and sand decreasing in the central Ganga plains, where the much calcareous kankaris common. The soil is

generally alkaline or neutral in reaction. In Ganga and Brahmaputra plains soil contains very fine particles varying from loams to very fine silt clay.

3.3.4 Land Degradation :

Land degradation can be defined as any change in the land that reduces its condition or quality and hence its productivity or productive potential. It occurs whenever the natural balances in the landscape are changed by human activity, through misuse or overuse. It is the result of using land and other resources beyond their capability. The various causes of land degradation are given in the following table.

Table - Major Land Degradation Problems

Water erosion, including gullying, rill and sheet erosion, mass movement of hill slopes
Dry land salinity
Irrigation-induced salinity
Soil surface scalding
Water logging
Soil acidity
Soil structure decline
Soil fertility decline or nutrient loss
Vegetation decline and degradation, such as weed infestation and lack
Tree regeneration
Loss of flora and fauna and hence of biodiversity

Due to population explosion, which demands greater food production the pressure on land resources has also increased. The cropland of the world which was around 210 million hectares in 1900 has increased to 426 to 453 million hectares in 1980-1995.

3.3.5 Soil Degradation :

Soils can degrade without any loss of soil particles, but always due to farming practices. When ploughing, the soil losses organic matter and changes its composition. Valuable soil organisms are lost. When irrigating soils, they can accumulate salts (Salinization), eventually becoming unproductive. In above table , the five most common reasons for soil degradation are given for several areas, and the world. Actual erosion of the soil often follows the initial period of degradation.

3.3.5.1 Causes for Soil Degradation :

The following are the main causes of soil degradation.

(a) Deforestation : Forest soils contain much organic matter, indeed often more than can be converted by the soil organisms. When a forest is cleared, the trees are burnt, which leads to an immediate loss in organic matter, but above the soil. Some of the organic matter in the soil is burnt too. But in the years following, soil organisms become starved of a carbon source and burn the remaining organic soil content. It all leads to massive emissions of carbondioxide. In the wet tropics, forest soils do not contain much fertility. The tropical rains make farming a nightmare.

(b) Fuelwood : Cutting forest for fuelwood is another form of deforestation. Fuelwood is usually converted to charcoal, which burns cleanly. In the process, all hydrogen and oxygen are removed, so that carbon remains. Humans need enough fuelwood for cooking, to be problematic. In arid regions, even the last tree and shrub is used, leaving the landscape barren.

(c) Overgrazing : When insufficient amounts of grass litter are left for the soil, the soil organisms die and the soil loses fertility. Sparse cover lets raindrops erode the surface. It is a common practice that leads to desertification.

(d) Agriculture : Most agricultural practices are harmful to the soil.

(e) Industrialisation : Industries can pollute soils, mining operations do.

Soil is a crucial life-support system since the bulk of all food production depends on it. For each continent the main causes of soil degradation differ: Europe suffers most from deforestation although agriculture is a close contender. In Africa, its cause is overwhelmingly overgrazing, whereas in North America it comes with agriculture. The figures for Oceania are dominated by Australia and New Zealand where overgrazing is by far the largest contributor.

3.3.5.2 Soil Degradation - Indian Scenario :

India out of 329 million hectares of land area has experienced an expansion of degraded land area from 130 million hectares in 1987 to 188 million in 1993.

Soil has never stayed in one place. Running water and wind have moved soils since they a major way. Soil in tropical zones are generally more susceptible to erosion than the temperate were first formed the early rocks. The present agricultural practices aggravated the problem in zone due to the topography of the land, the nature of soil and rainfall. More than half of India, for example, suffers from some form of soil degradation. An estimated 6,000 million tones of soil are lost every year along with more than a million tones of nutrients, more than the amount wich is applied in the form of fertilizers. While the land is becoming degraded, there is also a decline in per capita land availability in India. It was 0.48 ha in 1952, and in 2000 it was 0.15 ha due to

increase of country's population. There is a loss of 15 million ha of land due to spread of urbanization, and there is the demand for more land for housing, industries and communication. It may be noted that the minimum per capita land required in India for ensuring food security and other essential needs is 0.5 ha.

Soil erosion occurs easily when trees are cut or the soil is ploughed. Plant roots bind the soil, and their destruction allows the soil to be readily moved by wind or flowing water. Such destruction, aided by drought, accounted for the formation of the dist bowls. Secondary causes of soil instability include the disturbance of the cycles involving humans and nitrogen. In undisturbed soils, these materials are normally replaced at least at the rate at which they are removed. In disturbed soils, the lack of recycling of organic matter demands that fertilizers rich in nitrogen be used, which greatly increases nitrogen content of soil and adjacent waterways. If fertilizers are not used, soil fertility continues to decline, and in time this is reflected in the crop. Destruction of natural vegetation cover by overfelling and overgrazing is the genesis of soil erosion. Water and wind are the principal causes for the removal of soil from one place to another.

An additional problem, chemical deterioration in the form of nutrient loss and leaching, is the result of shortened fallow periods, which have decreased from 20 years to only a few years over a short five decades. Only 37 percent of Indian land area can be said to be largely free from degradation of any kind, and degraded land will continue its growth in years to come.

3.4 CONCLUSION :

In this lesson we know the importance if the land, water forests resources in India. Degradation of the land & soil and their courses. Ecological importance of the forest resources. Now days all the resources undergoing the degradation. We are the citizens of India we may protects our Natural Resources like Land, Soil and Water, Forests if may give the best gift to our future generations.

3.5 GLOSSARY / KEYWORDS :

1. **Soil degradation** : Decline of soil fertility due to N – P – K present in the soil.
2. **Forest cover** : The land occupied with plant canopy on which the rain fall depends.
3. **Hydrological cycle** : Cycling of water from surface to atmosphere and distribution of rain fall depends on hydrological cycle.

3.6 SELF ASSESSMENT QUESTIONS :

1. Importance of Forests and their resources?
2. What are the different types of forests and management?

3. Brief account of World Forest Cover and short note on Mangrove Forests?
4. Water Resources in Indian, Mini River in India?

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3.7 SUGGESTED BOOKS :

1. Managing Natural Resources Focus Land and Water by Harikesh N. Mila.
2. Geography of Water Resources by R.K. Gurlar, B.C. Jat.
3. Water Resource Management by R.B. Mandal.
4. Land and Water Resources by Bell. A.
5. Introduction to Forests and Renewable Resources by Chad P. Dawson, John C. Hendee.
6. Encyclopedia of Natural Resources by Yeqiao Wang.

Dr. Ch. Sunitha

LESSON - 4

BIODIVERSITY AND IT'S USES

AIMS AND OBJECTIVES :

After going through the lesson the student will be able to :

1. Identify the goods, resources and services that you receive from biodiversity on a day to day basis; the human activities that are causing large scale loss of biodiversity across the world.
2. Understand how an individual, a community, a society and a nation benefits from biodiversity; how biodiversity is an integral part our culture and tradition; how indigenouscommunities have played a major role in preserving biodiversity in India; how your practices, habits, behaviour and perception can impact biodiversity and are resulting in a sixth mass extinction crisis.

STRUCTURE OF THE LESSON :

4.1 INTRODUCTION :

Biodiversity has a very fundamental value to human and our very existence is intricately linked to it. On one hand, we are dependent on biodiversity for our very basic necessities and everyday sustenance; while on the other hand, we are also dependent on it for economic, cultural and environmental well-being. As the biotic component of any ecosystem, biodiversity forms the backbone for ecosystems to thrive and function efficiently. The three components or levels of biodiversity – genes , species and ecosystems – are collectively called as biological resources. All three components provide humans with a wide range of goods and services which together constitute the value of biodiversity. No wonder, that for any nation, their greatest wealth is contained within forests, wetlands, grasslands, mountains, freshwater and marine habitats. All these ecosystems provide invaluable and irreplaceable benefits to humankind.

4.2 DEFINITION :

"Biodiversity is the variation among living organisms from different sources including terrestrial, marine and desert ecosystems, and the ecological complexes of which they are a part." In a detailed version: '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.

Biological diversity means the variability among living organisms from all sources including, inter alia (among other things), terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems. ……. Convention on Biological Diversity, 1992

4.3 IMPORTANCE OF BIODIVERSITY :

Biodiversity describes the richness and variety of life on earth. It is the most complex and important feature of our planet. Without biodiversity, life would not sustain. The term biodiversity was coined in 1985. It is important in natural as well as artificial ecosystems. It deals with nature's variety, the biosphere. It refers to variability's among plants, animals and microorganism species. Biodiversity includes the number of different organisms and their relative frequencies in an ecosystem. It also reflects the organization of organisms at different levels. Biodiversity holds ecological and economic significance. It provides us with nourishment, housing, fuel, clothing and several other resources. It also extracts monetary benefits through tourism. Therefore, it is very important to have a good knowledge of biodiversity for a sustainable livelihood.

4.4 VALUE OF BIODIVERSITY :

The value of biodiversity can be broadly divided into two categories- a) direct values and b) indirect values.

- **Direct values** are the benefits obtained through the *goods* provided by biodiversity. Examples of such direct values include food, timber, fuel wood, medicines, linen, wool etc. These goods can be used by humans for their own consumptive needs as well as for generation of revenue through trade and research.
- **Indirect values** are those benefits which correspond to the *services* obtained from biodiversity and which is of much significance to society at large rather than to individuals or corporate. Examples of indirect values include services like pollination by bees, maintenance of water and oxygen cycles by plants, decomposition of dead material by bacteria and fungi, worshipping various animals and plants, sacred groves, aesthetic beauty of fauna and flora etc. It must be indeed clear that these indirect values are as important, if not more, as the direct values. Let us now discuss these various values of biodiversity in detail.

4.4.1 Consumptive value :

Consumptive value refers to tangible resources obtained from biodiversity that are used by humans for their sustenance, day to day activities and other necessities. In other words, these goods are not used for any market value. Such resources include various kind of edible items like fruits, berries, meat, medicinal plants, firewood, timber, wool, linen etc. Such resources are extremely important for communities that live in or near various kinds of forest areas and wetlands as these people directly consume these them. It has been reported that about 80,000 edible plant species are obtained from the wild, 90% of present-day food crops have been domesticated from wild tropical plants and 75% of the world's medicinal demands aredependent upon plants or plant extracts.

4.4.2 Economic (Productive) value :

Economic value of biodiversity comprises of all tangible resources that are used for market purpose. These products are sold for profit value and help in generating revenue for individuals, organizations and countries. The economic value of biodiversity helps in providing employment to millions of people. A number of industries like food industry, wood industry, paper industry, silk industry, textile industry, leather industry, pharmaceutical industry etc are dependent on the products obtained from biodiversity. Animal products like tusks, silk, wool, musk, fur, lac, honey are all traded in the market. Scientists and researchers play an important role in utilizing the economic value of biodiversity as they manipulate genes of wild varieties of plants and animals and introduce desirable traits into crops and domesticated animals. An important area of research that has emerged in the last 50 years is that of bio prospecting, which is defined as systematic and organized search for useful products derived from micro-organisms, plants and animals, which can be further developed for commercialization and the overall benefit of society. In this respect, traditional knowledge gathered by local communities and people who have been living in forest areas and wild habitats for centuries, also play a vital role.

4.4.3 Ecological value :

Perhaps the most significant, yet underrated value of biodiversity is related to the ecological services that it provides. These refer to the various processes occurring in an ecosystem that is being contributed, maintained and regulated by biodiversity or the biotic component. Moreover these processes or ecosystem services are extremely vital for the very existence of human society. Ecological services can be generally divided into the following categories

a. **Regulation and Stabilization**: These include services like climate regulation, mitigation of storms and floods, erosion control, pest and disease control, regulation of rainfall and underground water recharge.

b. **Purification and Detoxification:** These services comprise of filtration, purification and detoxification of air, water and soils.

c. **Cycling Processes**: These include basic ecosystem processes like nutrient cycling, soil formation, nitrogen fixation, carbon sequestration etc.

d. **Habitat maintenance and interactions**: Vegetation supports all the fauna in this world, which in turn are useful to us in myriad ways. Biodiversity is also a storehouse of genetic material that are essential for human sustenance. A number of native insects, birds and other animals help in pollination of agricultural crops, forest trees and native flowering plants through their interactions with flora.

4.4.4 Social Value :

The social value of biodiversity includes cultural and spiritual values that have long influenced the existence of human societies. Many of the beliefs, rituals and customs have passed on through a number of generations and is an indication of how ancient people were closely interwoven with their surrounding environment. The religious texts of all religions emphasize the need for humans to value the environment, to protect, preserve and sustain it. In almost every religion, there are rituals involving animal and plant worship and also glorification of animals and animal related deities.

Furthermore, the life of the indigenous tribes and local communities in many parts of the world, especially in developing nations, still revolves around the forests and other ecosystems where they dwell. In India, we have the Bishnoi community as the best example for their intense connects and devotion to nature and towards its protection. Thus biodiversity has always helped communities in finding a spiritual solace in nature and has kept societies united through the cultural and spiritual value it provides. One major benefit of such traditional beliefs and rituals is that it has led to preservation of biodiversity in different parts of the world by local communities. An example of such preservation is the case of sacred groves which will be discussed in detail towards the end of this section.

4.4.5 Aesthetic Value :

Biodiversity provides a rare beauty aspect to our planet that differentiates Earth from all other planets and stars of the universe, all of which are barren. Biodiversity enhances the beauty of any landscape and adds immensely to the quality of life through scenic enjoyment and outdoor recreation. Each ecosystem and every species adds to the richness and beauty of life on this planet. They provide opportunities for recreational activities such as bird watching, river rafting, hiking, rock climbing, and nature and wildlife photography. Areas such as national parks, sanctuaries, zoological and botanical gardens, butterfly parks, nurseries are all a source of pleasure and aesthetic satisfaction and keep us closer to the rich biodiversity around us. In urban areas, establishment of biodiversity parks is gaining much importance today due to the various benefits that it provides. If not nearby, then people are willing to go far off places to enjoy nature and wildlife. This type of tourism, which is famously referred toas eco-tourism, is gaining much relevance today and has now become a major source of income in many countries which are blessed with immense biological resources, and this includes India as well, which is one of the seventeen mega diverse countries of world. It is also providing employment to thousands of people belonging to indigenous communities living in biodiversity areas. Natural ecosystems, once destroyed, are extremely difficult to re-establish, and a species that becomes extinct, is gone forever, thereby damagingthe aesthetic beauty. It is therefore imperative that biodiversity be protected for its aesthetic value as well.

4.4.6 Ethical Value :

The world today faces a serious ethical challenge in protecting and preserving Earth's biodiversity. Ethical values related to biodiversity conservation highlights the importance of protecting all forms of life, since every species and individual has the right to exist on earth and no organism should be harmed unnecessarily. The most fundamental ethical principle to followed here is '*to live and let others live'*. Today, human beings are too much focused on themselves, using and exploiting the natural resources for our own betterment and development, resulting in irreversible loss of biodiversity. Another ethical principle concerning biodiversity is that every species on this earth has an 'intrinsic value to the ecosystem'. The challenge for humanity is to move from a predominantly anthropocentric (human oriented) perspective to a more eco-centric (ecosystem oriented) perspective, and try to reach a balance between the two, in order to counter the current environmental crisis. Achieving this balance also forms the basis for the much endorsed global sustainable development efforts.

Ethical values also include human rights. This is especially important when we take into consideration the millions of indigenous tribes and local communities living in biodiversity rich areas across the world. These indigenous people face exploitation and injustice when their forest areas are destroyed due to activities like deforestation, animal poaching commercial forestry, pollution and mining. They are not given sufficient compensation for their land being used and any monetary benefits generated from the

products obtained from these biodiversity rich areas are not equitably shared with them. Many of these people are not allowed any kind of ownership to their ancestral lands. As a result, these communities feel violated and isolated. Taken as a whole, this results in more damage to biodiversity and considerably lowers the success of conservation efforts. The challenge today is to ensure that these communities, their traditions and knowledge are valued as indispensable in biodiversity protection and preservation.

Ethical value of biodiversity, therefore, helps us to realize our co-dependence with nature, which in turn brings about a sense of appreciation for and generosity towards the natural world. Both these virtues are essential if we have to protect, preserve and sustain biodiversity and all its values for future generations.

4.5 SACRED GROVES AND THEIR IMPORTANCE :

The worship of Mother Earth is a universal phenomenon in many cultures across the world and especially in India, where living in harmony with nature has been an integral part of our culture. The large variety of traditional practices, religious beliefs, rituals and folklore are an evidence of the close association of local communities with the nature. One of the benefits of this close association has been the protection and preservation of biodiversity as discussed above in the social values sub-section.

Among the finest examples of cultural practices in India that has contributed significantly to nature conservation has been the maintenance of certain patches of land or forest areas as 'sacred groves'. The sacred groves are patches of land, mainly forests areas having rich biodiversity, which have been protected by the local people for centuries, as part of their cultural and religious beliefs. Such beliefs can take the form of taboos or as a mark of reverence to deities believed to be residing in these forest patches. As a result, sacred groves have been zealously protected and maintained by the indigenous communities for centuries.

Scientists believe that sacred groves have been a very effective way of preserving tropical biological diversity in India. These areas are considered a reservoir of biodiversity, and a number of new species have been discovered in these groves. A number ofendangered species remain protected in these areas. Many medicinal plants are preserved in these areas that are not found anywhere else in the wild. There are also examples of sacred ponds attached to temples in many parts of India that have helped in protection of endangered species of certain amphibians, turtles, lizards, snakes, insects, fresh water sponge etc. These groves also provide invaluable ecological services like recharge of underground water, watershed areas for streams and rivers, prevention of soil erosion and air purification. Sacred groves, if present in urban landscapes, provide much needed vegetation cover and also act as 'lungs' to the city. Today these sacred groves face threats of urbanization, overexploitation for resources (like excessive firewood collection, overgrazing), environmental destruction due to religious tourism and invasive species that have penetrated into these areas. Despite the destruction of forests in many parts of India, some sacred groves still remain intact that aid in conservingthe rich biological diversity.

4.6 CONCLUSION :

Biodiversity is fundamentally important. It is considered by many to have intrinsic value: each species has a value and a right to exist, whether or not it is known to have value to humans. All species, including humans, rely on many other species to live. Many of us were taught about the web of life at school. We need varieties of healthy and well-functioning ecosystems to support the life of all species, including humans. Biodiversity is considered by many to have intrinsic value: each species has a value and a right to exist, whether or not it is known to have value to humans. Biodiversity is also important for people and the survival of humanity.

4.7 GLOSSARY / KEYWORDS :

- **Direct values of biodiversity :**

  These are the benefits obtained through the *goods* provided bybiodiversity.

- **Indirect values of biodiversity :**

  These are the benefits which correspond to the *services* obtained from biodiversity and which is of ecological, social, cultural, ethical and aesthetic significance to individual and society at large.

- **Bio prospecting :**

  It defined as systematic and organized search for useful products derived from micro-organisms, plants and animals, which can be further developed for commercialization and the overall benefit of society.

- **Sacred groves :**

  These are patches of land, mainly forests areas, having rich biodiversity that have been protected by the local people for centuries, as part of their cultural and religious beliefs.

4.8 SELF ASSESSMENT QUESTIONS :

1. Briefly discuss the values of biodiversity to humankind.
2. What are sacred groves? Explain their importance to biodiversity
3. Discuss the ecological value of biodiversity and its importance to mankind.

4.9 SUGGESTED READINGS :

1. Ecology Environmental Science and Conservation, JP Singh, S.P. Singh, S.R.Gupta, S.Chand and Company Limited.

2. Principals of Environmental Science – inquiry and applications, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Environmental Science Towards A Sustainable Future, Richard T. Wright, PHI Learning Pvt. Ltd.
4. Biodiversity, Edward O. Wilson, Frances M. Peter, National Academies 1988

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LESSON - 5

LEVELS OF BIODIVERSITY

AIMS AND OBJECTIVES :

At the end of this unit, the Learners will be able to understand

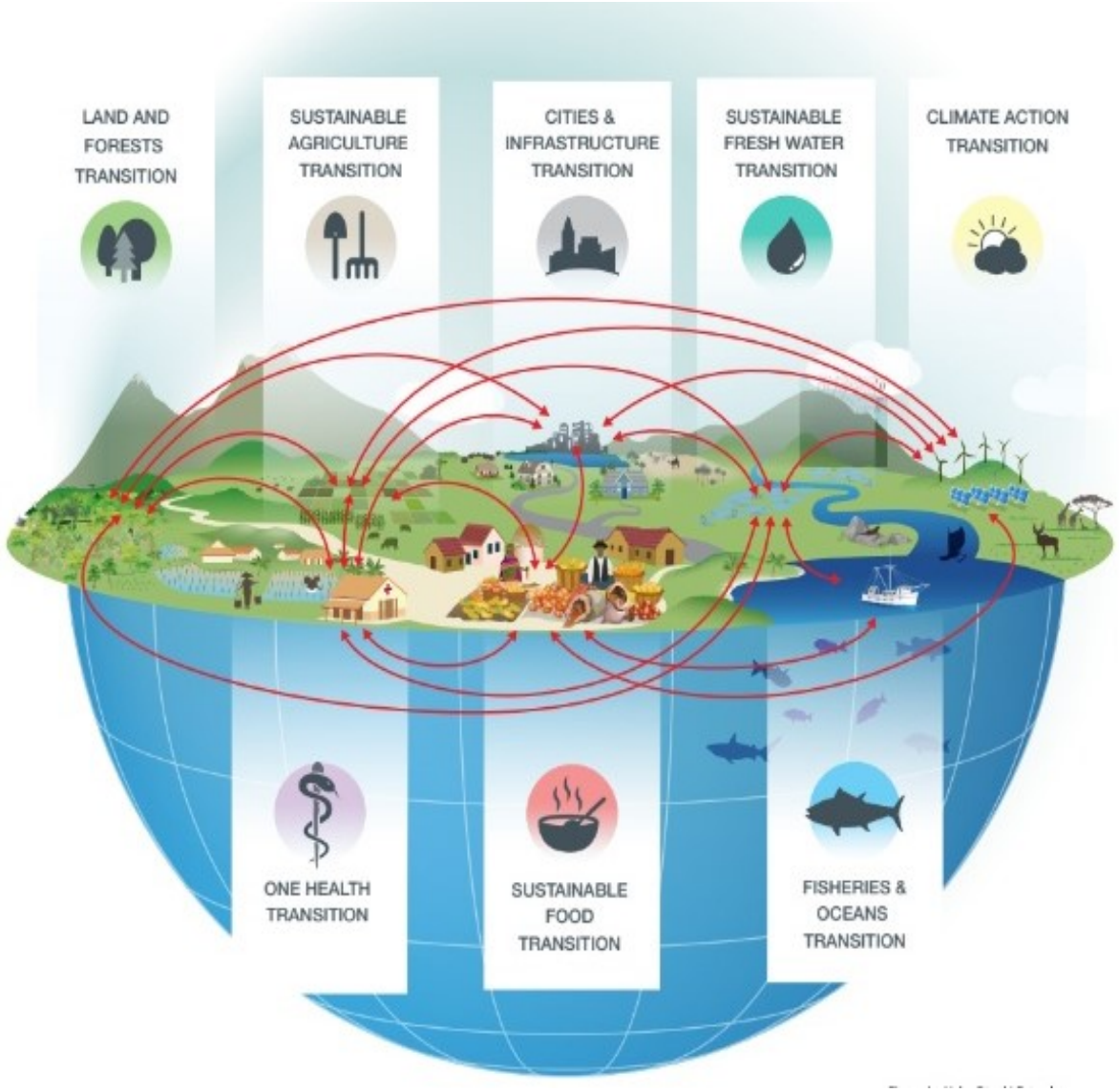
- About the basic information about the different levels of biodiversity will be very useful for a clear understanding of diversity and its importance.
- To know the significance of genetic, species and ecosystem diversities and their role in the existence of life on earth.
- To understand natural resources' role in human development and be aware of the conservation of resources.
- Finally, the learner acquires a complete outlook on the role of biodiversity in human existence.

STRUCTURE OF THE LESSON :

5.1 INTRODUCTION :

Biodiversity refers to all the different kinds of living organisms within a given area. Biodiversity includes plants, animals, fungi, and other living things. Biodiversity can include everything from towering redwood trees to tiny, single-cell algae that are impossible to see without a microscope. A common way to measure biodiversity is to count the total number of species living within a particular area. Tropical regions, areas that are warm year-round, have the most biodiversity. Temperate regions, which have warm summers and cold winters, have less biodiversity. Regions with cold or dry conditions, such as mountaintops and deserts, have even less. Generally, the closer a region is to the Equator, the greater the biodiversity. At least 40,000 different plant species live in the Amazon rainforest of South America, one of the most biologically diverse regions on the planet. Only about 2,800 live in Canada's Quebec province. The warm waters of the western Pacific and Indian Oceans tend to be the most diverse marine environments. The Bird's Head Seascape in Indonesia is home to more than 1,200 species of fish and 600 species of coral. Many of the corals build coral reefs, which are home to hundreds more species, from tiny seaweeds to large sharks. Some places in the world have a large number of endemic species—species that exist only in that place. The Cape Floristic Region in South Africa is home to about 6,200 plant species found nowhere else in the world. Areas with high numbers of endemic species are called biodiversity hotspots. Scientists and communities are making a special effort to preserve biodiversity in these regions.

Biodiversity can also refer to the variety of ecosystems—communities of living things and their environments. Ecosystems include deserts, grasslands, and rainforests. The continent of Africa is home to tropical rainforests, alpine mountains, and dry deserts. It enjoys a high level of biodiversity. Antarctica, covered almost entirely by an ice sheet, has low biodiversity. Another way to measure biodiversity is genetic diversity. Genes are the basic units of biological information passed on when living things reproduce. Some species have as many as 400,000 genes. (Human beings have about 25,000 genes, while rice has more than 56,000.) Some of these genes are the same for all individuals within a species—they're what make a daisy a daisy and a dog a dog. But some genes within a species are different. This genetic variation is why some dogs are poodles and some are pit bulls. It's why some people have brown eyes and some people have blue eyes.



5.2 ELEMENTS OF BIODIVERSITY :

Three groups of basic building blocks of biodiversity, viz., genetic diversity, organismal diversity and ecological diversity have been recognized. Genetic diversity encompasses the components of the genetic coding that structures organisms (nucleotides, genes, chromosomes) and variation in the genetic make-up between individuals within a population and between populations, organismal diversity encompasses the full taxonomic hierarchy and its components, from individuals upwards to populations, subspecies and species genera, families, phyla and beyond to kingdoms and domains, and ecological diversity encompasses the scales of ecological differences from populations, through habitats, to ecosystems, ecoregions, provinces and on up to biomes and biogeographic realms. (Table.1)

Ecological diversity		**Organismal diversity**
Biogeographic realms		Domains of Kingdom
Biomes		Phyla
Provinces		Families
Ecoregions		Genes
Ecosystems		Species
Habitats	**Genetic Diversity**	Subspecies
Populations	Populations	Populations
	Individual	Individual
	Chromosomes	
	Genes	
	Nucleotides	

Tabile.1: Elements of biodiversity, focusing on those levels that are most commonly used.

5.3 LEVELS OF BIODIVERSITY :

Biological diversity includes three hierarchical levels :

- Genetic Diversity
- Species Diversity
- Ecosystem Diversity.

These levels of biodiversity are interrelated, yet distinct enough to be studies separately to understand the interconnections that support life of earth.

5.3.1 Genetic diversity :

Genetic diversity refers to the variation in the genetic composition of individuals within or among species. Genetic diversity enables the population to adapt to its environment and respond to natural selection. The amount of genetic variation is the basis of speciation. Genetic diversity occurs at several levels of organization, such as among higher taxonomic categories such as kingdoms, phyla and families, among species and among populations. Most genetic diversity can be observed between organisms of two kingdoms (such as plants versus animals), between phyla (such as arthropods versus chordates), between classes (such as birds versus reptiles) and so on. The genetic diversity enables a population to adapt to its environment and to respond to natural selection. If a species has more genetic diversity, it can adapt better to the changed environmental conditions. Lower genetic diversity in a species leads to uniformity, as is the case with large monocultures of genetically similar crop plants. This has advantage when increased crop production is a consideration, but can be a problem when an insect or a fungal disease attacks the field and poses a threat to the whole crop.

The amount of genetic variation is the basis of speciation (evolution or new species). It has a key role in the maintenance of diversity at species and community levels, the total genetic diversity of a community will be greater if there are many species as compared to a situation where there are only a few species. Genetic diversity within a species often increases with environmental variability. We know that each species, varying from bacteria to higher plants and animals, stores in immense amount of genetic information. For example, the number of genes is about 450-700 in Mycoplasma, 4000 in Escherichia coli, 13000 in Drosophila melanogaster, 32000-50000 in Oryza sativa and 35000 to 45000 in Homo sapiens.

5.3.2 Species Diversity :

Species diversity refers to the variety of species within a community or a region. Simplest measure of species diversity is a count of the number of species present in an area i.e. species richness. Number of species often increases with the area of the site leading to different species-area relationships. Relative commonness and rarity of the individual species, i.e. equitability (species evenness), is another important aspect of species diversity. In nature, the number and kind of species as well as the number of individuals per species vary, leading to greater diversity. Further, not all species of a community are equally different. It is possible to classify species on the basis of their functions. Functional types are those species which perform different ecological functions; and functional analogues represent distinct taxa performing the same or very similar ecological functions. According to the biological species concept, species are groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups. Species diversity refers to the variety of species within a region i.e. species richness. However, in the broad sense, species diversity includes species richness as well as species evenness. Taxonomic (or phylogenetic) diversity also falls under species diversity.

5.3.3 Ecosystem Diversity :

Ecosystems include all the species, plus all the abiotic factors characteristic of a region. For example, a desert ecosystem has soil, temperature, rainfall patterns, and solar radiation that affect not only what species occur there, but also the morphology, behavior and the interactions among those species. Ecosystem diversity describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food webs and the recycling of nutrients. Ecosystem diversity describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food webs, and the recycling of nutrients. It has a focus on various biotic interactions and the role and function of keystone species. The number of habitats/ecosystems present in a region is also a measure of biodiversity.

5.4 WHITTAKER CLASSIFICATION OF BIODIVERSITY :

Whittaker proposed three types of diversity to explain community and ecosystem diversity, namely, alpha (), beta (β) and gamma (γ) diversity.

5.4.1 Alpha diversity (α- index diversity) :

Alpha diversity is the diversity within community and refers to the species diversity in a given community or habitat. Alpha diversity is represented by the two indices i.e., species richness and species evenness, in the combination.

5.4.2 Beta diversity (β- index diversity) :

Beta diversity is the diversity between the communities and appears in a range of communities due to replacement of species along the complex-gradient of ecosystem or habitats within a given geographical region. It is due to the presence of different microhabitats, niches and differences in environmental conditions. The β- diversity is observed along altitude gradient, moisture gradient or gradient of any other environmental factors. Greater the heterogeneity in the habitats or between communities, there will be greater β-diversity.

5.4.3 Gamma diversity (γ- index diversity) :

Gamma diversity refers to diversity present in range of communities and is represented by diversity of habitats or ecosystems over a total landscape or geographical area. Whittaker[23] proposed that γ- diversity can be measured as the ratio between regional diversity or γ-diversity and the average α- diversity such that β= γ/±.

5.5 HOT SPOTS OF BIODIVERSITY :

Biodiversity hotspots are areas that support natural ecosystems that are largely intact and communities associated with these ecosystems are well represented. They are also areas with high species endemism which are not found outside the hotspot. Norman Myers has introduced the concept of Hot Spots and presently there are 34 such hot spots of biodiversity at a global level. Hot spots once covered 15.7% earths land surface but today total hot spot cover is 2.3% Reptiles and Amphibians are more prone to hot spot endemism.

There are two criteria for determining hot spots

1. It must contain at least 1500 species as endemics (>0.5% of worlds total)
2. It has to have lost at least 70 percent of its original habitat (Under Severe threat)

5.6 HOT SPOTS IN INDIA :

India is known for its rich biodiversity and has around 24.46% of the geographical area covered by forests and trees. There are major four biodiversity hotspots in India :

- The Himalayas
- Indo-Burma Region
- The Western Ghats
- Sundaland

5.6.1 The Himalayas :

Considered the highest in the world, the Himalayas (overall) comprises North-East India, Bhutan, Central and Eastern parts of Nepal. This region (NE Himalayas) holds a record of having 163 endangered species which includes the Wild Asian Water Buffalo, One-horned Rhino; and as many as 10,000 plant species, of which 3160 are endemic. This mountain range covers nearly 750,000 km2.

5.6.2 Indo – Burma Region :

The Indo-Burma Region is stretched over a distance of 2,373,000 km². In the last 12 years, 6 large mammal species have been discovered in this region: the Large-antlered Muntjac, the Annamite Muntjac, the Grey-shanked Douc, the Annamite Striped Rabbit, the Leaf Deer, and the Saola. This hotspot is also known for the endemic freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss. There are also 1,300 different bird species, including the threatened White-eared Night-heron, the Grey-crowned Crocias, and the Orange-necked Partridge.

5.6.3 The Western Ghats :

The Western Ghats are present along the western edge of peninsular India and covers most of the deciduous forests and rain forests. As per UNESCO, it is home to at least 325 globally threatened flora, fauna, bird, amphibian, reptile and fish species. Originally, the vegetation in this region was spread over 190,000 km2 but has been now reduced to 43,000 km2. The region is also known for the globally threatened flora and fauna represented by 229 plant species, 31 mammal species, 15 bird species, 43 amphibian species, 5 reptile species and 1 fish species. UNESCO mentions that “Of the total 325 globally threatened species in the Western Ghats, 129 are classified as Vulnerable, 145 as Endangered and 51 as Critically Endangered.”

5.6.4 SUNDALAND :

The Sundaland hotspot lies in South-East Asia and covers Singapore, Thailand, Indonesia, Brunei, and Malaysia. In the year 2013, the Sundaland was declared as a World Biosphere Reserve by the United Nations. This region is famous for its rich terrestrial and marine ecosystem. Sundaland is one of the biologically richest hotspots in the world which comprises 25,000 species of vascular plants, of which 15,000 are found only in this region.

5.7 BIODIVERSITY IN INDIA :

India is famous for its rich flora and fauna. India houses over 500 species of mammals, more than 200 species of birds, and 30,000 different species of insects. The Zoological Survey of India which is headquartered in Kolkata is responsible for surveying the faunal resources of India. India has a diverse climate, topology, and habitat are known to have the richest flora in the world with over 18000 species of flowering plants. These plant species constitute 6-7% of the

world's plant species. There are 8 main floristic regions in India- the Western and the Eastern Himalayas, Indus and Ganges, Assam, the Deccan, Malabar, and the Andaman Islands which is home to 3000 Indian plant species. The forests in India cover ranges from the tropical rainforest including Andaman, Western Ghats, and northeast India to the coniferous forests of the Himalayas. The deciduous forests can be found in the eastern, central, and southern parts of India.

5.8 ENDANGERED SPECIES OF INDIA :

According to the International Union for Conservation of Nature, "India accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals. But with the rapid loss of biodiversity, many species are becoming extinct or at risk of becoming critically endangered. The species that are at risk of extinction due to the sudden decrease in their population and habitat are known as endangered species.

5.9 CONCLUSION :

There is no single overarching influence of diversity on either productivity or stability, and it is essential that the phenomenon of biodiversity is very large, complex, and interrelated. The actual consequences will be greatly influenced by the environmental setting and the study's time horizon. Although the proportional contributions of diversity and composition are still unknown, it is now recognized that biodiversity is crucial for both managed and natural ecosystems. Human is only one more of natural creatures and should not be alien to the other life-forms. We have no moral right to destroy nature and other beings that dwell on earth. We should treat all animals and plants with compassion. Every individual can make a small and yet significant effort in the race to save our planet and conserve biodiversity

5.10 GLOSSARY/ KEYWORDS :

- **Biodiversity Hot Spot :** A biodiversity hotspot is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans.
- **Habitat :** The natural home or environment of an animal, plant, or other organism.
- **Food Web :** A system of interlocking and interdependent food chains.
- **Endangered :** Seriously at risk of extinction

5.11 SELF ASSESSMENT QUESTIONS :

1. Give a detailed note on Levels of Biodiversity
2. Write a note on Ecosystems Biodiversity and its significance.

3. Write an essay on types of biodiversity and its role in human sustenance.
4. Draw a detailed sketch on the Biodiversity of India and its hotspots.

5.12 SUGGESTED READINGS :

1. **Ecology Environmental Science and Conservation**, JP Singh, S.P. Singh, S.R.Gupta, S.Chand and Company Limited.
2. **Biodiversity,** Edward O. Wilson, Frances M. Peter, National Academies 1988

Dr. K. Sasidhar

LESSON - 6

HUMAN POPULATION AND ITS IMPACT ON ENVIRONMENT

AIMS & OBJECTIVES :

At the end of lesson the learner would understand

- Knowledge about the Human population and the environment.
- Knowledge about India's Population.
- Knowledge about Impact of population growth and environment.

STRUCTURE OF THE LESSON :

6.1 HUMAN POPULATION AND THE ENVIRONMENT :

6.1.1 Meaning of Population :

The word 'Population' has been derived from the Latin word 'Populus' meaning 'people'. 'Population' refers to number of people living in a geographical area at a given time. Human population all over the world belongs to single species, "Home Sapiens". Modern humans appeared around fifty thousand years ago. Initially, the human population was small hence human interference with nature was minimal.

Men certainly have the most power. Men have the power to destroy the planet or to help it return to a natural paradise. Our choices have more impact than the choices of animals, so in some ways homo sapiens is the most important species on earth.

6.2 SURGES OF POPULATION :

The population has increased in three surges brought about the three technological revolutions :

6.2.1 The first population surge - Tool making revolutions :

After leaving the tree (arboreal) life, ancestral man got exposed to the dangers of terrestrial existence - sun, rain and storms. These forced him to take shelter in the caves. The attacks of the carnivores that roamed on the land made the men to devise stone tools originally used for self-defense and later as a means to hunt animals for food. The advent of tool making some 600,000 years before the birth of Christ changed the primitive man from a gatherer of roots and seeds to an efficient hunter. The tools afforded him greater security against his human and non-human enemies. By 10,000 B.C., the earth probably supported 5 million people.

6.2.2 The Second Population Surge - Agricultural Revolution :

The second population surge occurred about 8-10 thousand years ago with the discovery and development of agriculture and domestication of animals. Planting of crops and domestication of animals assured larger source of food for human population than hunting. The storage of surplus food helped them to remain at one place and set up dwellings. Thus arose the early villages or settlements. Food sufficiency increased nutrition and decreased mortality and the human population kept growing. By the time of Christ, it reached about 250 millions from the 5 millions in the beginning of agricultural revolution.

6.2.3 The Third Population Surge - Industrial Revolution :

The third surge began in Europe in the mid - 17^{th} century, after the decline of plague. By the 19^{th} century, public sanitation programmes had begun, vaccines were developed and rapid advances in food storage and transportation technologies led to marked increase in food supplies.

The population increased continued into modern times, the time of industrial revolution. Industrial Revolution set up a period of population growth that is still continuing as shown in the table.

Human Population over the Ages (after Keyfitz, 1966)

Date	Estimated World Population
10,000 - 8,000 B.C.	5 millions
1650. A.D.	500 millions
1850 A.D.	1,000 millions (1 billion)
1930 A.D.	2,000 millions (2 billions)
1975 A.D.	4,000 millions (4 billions)
2010 A.D.	8 billions
2040 A.D.	16 billions

Population Growth : Variation Among Nations

The 20th century has witnessed an extraordinary growth of the world Copulation from 1.65 billion to 6 billion people by 1999, Rapid growth was gered by drammatic reductions in mortality.

Currently, one billion people are added every 12 or 13 years to the the world population will continue to grow in this century also with less intensity. In a nutshell, 5 persons are added every two seconds, i.e., every year one Germany is added to the world in terms of world population. population is expected to continue growing. Based on the medium, fertility variant, which assumes replacement level of fertility, global population is projected to reach 9.5 billion in 2050, peaking at 15 billion in 2200.

Population estimates from 1950 to 2050 for major areas and regions of the world
(Population in millions)

Area/ Region	1950	1980	1985	1990	1995	2000	2025	2050
World 2520	4453	4842	5248	5677	6067	7810	9039	
Africa 221	476	553	645	753	800	1258	1804	
North America	172	252	263	275	287	306	374	444
Latin America	167	362	406	453	501	482	657	772
East Asia	645	1182	1252	1317	1390	1493	1669	1585
South Asia	782	1408	1752	1740	1909	2003	2754	3287
Europe358	484	492	499	505	728	714	658	
Oceanial 3	23	25	27	29	31	39	44	

Africa is the region with the highest rates of population growth, while Europe has the lowest rates. Africa's population would increase from 792 million in 2000 to about 2 billion in 2050, and its share of the world population will pass from 13 to 20 per cent. During the same period, the European population is projected to decline from 728 million to 632 million and its share of the world population will drop from 12 to 7 percent. So, while the population of the Europe has more than double that of Africa in 1950, the population of Africa is expected to be more than triple that of the Europe in 2050. Europe and India together will account for about one third of the world population. Europe and North America taken together will account one-tenth.

The most glaring and disturbing fact is the stark difference in the population growth pattern between developing and industrialized nations. Nearly 99 percent of all pollution increase takes place in developing countries, while population size is static or declining in industrialized nations. Among the major industrialized nations, only the US has significant population growth, mainly because of immigration,

By 2050 industrialised countries are expected to increase their population by about 4 percent. In contrast, the population of developing countries is likely to go up by about 55 percent. For example, even as Western European populations decrease, West Asian countries are expected to have about 186 million more people by 2050.

The ten most populous countries: 2004 status and 2050 estimates

Country	2004 Status		2050 Estimates	
	Population (millions)	Rank	Population (millions)	Rank
China	1300	1	1437	2
India	1087	2	1628	1
USA	294	3	420	3
Indonesia	219	4	308	4
Brazil	179	5	221	8
Pakistan	159	6	295	6
Russia	144	7	128	13
Bangladesh	141	8	280	7
Nigeria	137	9	307	5
Japan	128	10	110	15
D.R. Congo	-	-	181	9
Ethiopia	-	-	173	10

Note that, by 2050, India is expected to be well ahead of China -in terms of the size of its population. In the case of China, although the people will increase, its share of the world population will decline from 21 percent in 2000 to 16 percent in 2050. Obviously, China is doing a better job of controlling its population. Even so there are questions about China's ability to grow enough food for its people, given the environmental problems it faces. The world of 2050 is likely to be one in which China and India together will account for about one-third of the world population. Of the three industrialized countries (i.e., USA, Russia & Japan) only the US is expected to remain there 2050. Russia and Japan are likely to be replaced by the Democratic Republic of Congo and Ethiopia. The population of Pakistan and Bangladesh are likely to double by 2050. Thus, China and the Indian subcontinent could together have about 40 percent of the world's population. Nigeria is the most populous country in Africa and it has a huge reproductive potential since 44 percent of the population is less than 15 years old. That is why it is likely to move to the fifth place in the list of the 10 most populous countries by 2050.

Every second, on an average 4-5 children are born and 2 people die, thus we are growing nearly 2.5 person every second. As a result human population is growing by about 9,000 people per hour and by about 214,000 people per day.

6.3 LAND USE- LAND DEGRADATION :

Land is an essential building block of civilization, it is essential for growing most of the food that the world's ever-growing population needs, and yet its contribution to our quality of life is perceived and valued in starkly different and often incompatible ways. A minority has grown rich from the unsustainable use and large scale exploitation of land resources, with related conflicts intensifying in many countries. The world has reached a point where we must reconcile these differences and rethink the way in which we plan, use, and manage the land.

1. Land Degradation -

Land degradation is caused by multiple forces, including extreme weather conditions, particularly drought. It is also caused by human activities that pollute or degrade the quality of soils and land utility.

Land degradation is a process in which the value of the biophysical environment is affected by a combination of human-induced processes acting upon the land. It is viewed as any change or disturbance to the land perceived to be deleterious or undesirable. Natural hazards are excluded as a cause; however human activities can indirectly affect phenomena such as floods and bush fires. While land degradation is a global problem, it takes place locally and requires local solutions.

Greater commitment and more effective cooperation at the local level are necessary to stop land degradation and loss of biodiversity. Our ability to manage trade-offs at a landscape scale will ultimately decide the future of land resources – soil, water, and biodiversity – and

determine success or failure in delivering poverty reduction, food and water security, and climate change mitigation and adaptation. Indeed, integrated land and water management is recognized as an accelerator for achieving most of the 17 Sustainable Development Goals (SDGs). Further agricultural expansion, one of the main causes of land degradation, could be limited by increasing yields on existing farmland, shifting to plant-based diets, consuming animal proteins from sustainable sources, and reducing food loss and waste.

While we are at a critical juncture, fast approaching and in some cases surpassing planetary boundaries, the evidence presented in this first edition of the Global Land Outlook 2017 (GLO) demonstrates that informed and responsible decision making, improved land management policies and practices, and simple changes in our everyday lives, can, if widely adopted, help to reverse the current worrying trends in the state of our land resources. The United Nations estimate that about 30% of land is degraded worldwide, and about 3.2 billion people reside in these degrading areas.

Bringing together a diverse group of international experts and partners, the GLO provides the first in-depth analysis of the multiple functions of the land viewed from a wide range of interrelated sectors and thematic areas, such as the food-water-land interactions, as well as less obvious drivers of land use, notably the nature of economic growth, consumer choices and global trade patterns. It addresses the future challenges and opportunities for the management and restoration of land resources in the context of sustainable development, including :

- Food, water and energy security;
- Climate change and biodiversity conservation;
- Urban, peri-urban and infrastructure development;
- Land tenure, governance and gender; and
- Migration, conflict and human security.

While at global level desertification is addressed by the United Nations Convention to Combat Desertification (UNCCD), land degradation is a problem that also concerns the United Nations Framework Convention on Combating Climate Change and the Convention on Biodiversity.

Land degradation also decreases resilience to environmental stresses: increased vulnerability, especially of the poor, women and children, can intensify competition for scarce natural resources and result in migration, instability, and conflict. About 1.3 billion people are trapped on degrading agricultural land: farmers on marginal land, especially in the drylands, have limited options for alternative livelihoods and are often excluded from wider infrastructure and economic development, and desertification is often the consequence. The main concerns are the declining productivity on 20 % of the world's arable land in the last two decades with losses per year estimated to USD 6 –10 trillion. Areas with high poverty rate represent 40% of the

world's degraded land while 80% of the worldwide poor live in rural areas and 64% work in agriculture.

2. Sustainable Land Management -

Sustainable Land Management (SLM) was defined at the Rio Earth Summit in 1992 as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions". Such SLM represents a holistic approach to preserve all ecosystem services in long- term productive ecosystems by integrating economic, sociocultural and biophysical needs and values. Scientific evidence increasingly highlights the advantages of adopting SLM practices as land-based solutions that have the potential to simultaneously address Desertification, Land Degradation and Drought (DLDD), climate change adaptation and mitigation, while often achieving other co-benefits, such as protection of biodiversity. SLM represents a wide range of agronomic, vegetative, management and structural technologies, policies and activities in agricultural and natural land, based on the key principles of maintaining and enhancing the productivity and protection of natural resources, while being economically viable and socially acceptable. The concept of SLM is thus applicable to any ecosystem and land-use type.

Globally, SLM forms one of the main mechanisms to achieve Land Degradation Neutrality (LDN) and strongly supports the objectives of the three Environmental Rio Conventions through its positive impacts on productivity, an increased resilience to climate change, reduced greenhouse gas emissions and better protection of biodiversity. SLM contributes directly to achieving several of the 17 Sustainable Development Goals (SDGs) set by the United Nations, such as life on land (SDG 15), which focuses on the achievement of Land Degradation Neutrality by introducing land management practices that prevent the loss of healthy land and maintain or improve the land's productivity.

Here are four main ways of looking at land degradation and its impact on the environment around it :

1. A temporary or permanent decline in the productive capacity of the land. This can be seen through a loss of biomass, a loss of actual productivity or in potential productivity, or a loss or change in vegetative cover and soil nutrients.
2. Action in the land's capacity to provide resources for human livelihoods. This can be measured from a base line of past land use.
3. Loss of biodiversity: A loss of range of species or ecosystem complexity as a decline in the environmental quality.
4. Shifting ecological risk: increased vulnerability of the environment or people to destruction or crisis. This is measured through a base line in the form of pre-existing risk of crisis or destruction.

6.4 IMPACT OF POPULATION GROWTH OF ENVIRONMENT :

Environmental impact of population is equal to the number of people multiplied by unit of resources consumed per capita. The capacity of an area to support human population depends not only on the number of people but also on the needs and lifestyle of the people living there. If the needs of the people are few and their lifestyles simple, an area can support a large number of people than if the needs and desires of the people are many.

The population growth depletes the environmental resources that support life and more wastes than the earth's natural processes can handle are added to the environment. This can happen when there are too many people trying to meet their basic needs.

All people want to be fed, clothed, housed, and have access to clean water. To meet these requirements, water, land, forests, and other natural resources must be exploited to some degree. As population increases, more resources are needed to meet basic requirements. More forest must be cut down to provide wood for housing and fuel. More cleared land is needed for agriculture and development. All of these resources are finite. More than 99% of the world's food supply comes from the land, while less than 1 percent is from oceans and other aquatic habitats. The continued production of an adequate food supply is directly dependent on ample fertile land, forest water, energy, plus the maintenance of biodiversity. As the human population grows, the requirements for these resources also grow. Even if these resources are never depleted, on a per capita basis they will decline significantly because they must be divided among more people.

At the same time as people consume these resources, they produce waste that is put back into the air, land and water. The greater amount of waste from larger population puts more stress on ecosystems. Even if markets function with perfect efficiency, and the best technology is always used, it will take more resources to support a larger population than a small one, and the environmental costs of doing so will probably be higher as well. The world food production cannot keep pace with the world's current annual growth rate of 2.5% as it has been for the past 20 years.

The impacts of population and consumption on the environment can be seen as under :

6.4.1 Deforestation :

With the increase in population, food requirement also increases. To supply food, more land is required for agriculture. More fire wood is required to cook their food. To meet the demand of the increased population, deforestation takes place. According to estimates of Harrison (1992), population growth in developing countries has accounted for 79 per cent of the tropical deforestation suffered during 1973 - 88.

As long as the population of fire wood gatherers in a local community does not exceed the capacity of the local tree stock to replenish itself through true growth, the community can exploit the resource indefinitely. But as the population increases, so does the number of fuel

wood gatherers. When firewood collection exceeds the self-renewing capacity of the trees, there comes a stage when the tree stock starts depleting and the tree cover starts disappearing. It was estimated that in 2000, about 2.4 billion people met their wood requirements by cutting fuel wood faster than it could regenerate through natural growth. Unless populations are controlled, deforestation may one day become the Waterloo of the human race.

6.4.2 Soil Erosion :

Increasing populations put pressure on land for housing, agricultural fields, etc., which, in turn, puts pressure on forest cover. Agriculture, deforestation, overgrazing, and other human activities increase the chances of soil being eroded. Today, all around the world, soil is being eroded at a rate much faster than the rate at which it forms. Shifting cultivation leads to soil erosion. Further, original prime topsoil has found its way into streams, lakes and oceans, mostly as a result of over-cultivation, overgrazing and deforestation. About 86% of the soil eroded in the USA comes from land used to graze cattle or to raise crops to feed cattle.

Another 14 percent of eroded soil in the USA comes from land used to raise crops for human consumption.

Climatic Change: The global climate is under threat from increasing population of the atmosphere by gases that heat up the earth, such as carbon dioxide, methane, chlorofluorocarbons, nitrous oxide and nitrogen oxides. An increase in population is associated with a growth in the demand for food supplies. As humans try to expand food production to meet the needs of growing populations, the resulting increase in land cleared for food and pasture in livestock, and is fossil fuel use would release more greenhouse gases. Population growth will also mean more organic wastes. The putrefaction of these wastes also releases methane, a greenhouse gas which contributes to global warming.

6.4.3 Water Pollution :

Increase in populations demands intensive cultivation and the use of chemical fertilizers and pesticides. The over use of these chemicals leads for pollution of ground water and river water.

Thus, deforestation, soil erosion, climatic change and water pollution are just four environmental issues discussed here to illustrate the impact of population growth and environment. People and their lifestyle obviously have a role in almost every environ mental threat known today biodiversity loss, ozone-layer depletion, desertification, etc.

6.5 POPULATION (GROWTH) CONTROL AND FAMILY WELFARE PROGRAMME :

Slowing population growth by reducing fertility can reduce pressure on the environment. This is vital for the socio-economic development and to protect the productivity of the environment, particularly in developing countries. It is now universally accepted that planning of

families not only enhances individuals' health and welfare but also controls the population growth or explosion. Family planning allows couples to decide their family size and also the time spacing of their offspring. Besides family planning, late marriages help in controlling the population explosion.

6.6 CONCLUSION :

Increasing population growth depletes the environmental resources all people want to beds, clothes houses and lake access to clean water to meet their requirements water, land, forests and other natural resources must be exploited.

6.7 GLOSSARY :

1. **Population** : The total number of any single species.
2. **Carnivores** : Those who eat secondary consumers and tertiary consumers.
3. **Soil Erosion** : Removal of fertile soil layer.

6.8 SELF ASSESSMENT QUESTIONS :

1. How did you describe human population and the environment.population?
2. Describe the surges of population?
3. Discuss about Impact of population growth on environment?

6.9 SUGGESTED BOOKS :

1. Environmental Studies by Dr. S.R. Myneni
2. Introduction of Environmental Sciences by Y. Anjaneyulu.
3. Population Environment and Health. by R.B. Bhagat.
4. Population, Economic growth and Environmental Pollution by Amit Kumar Rai & Dr. V.K. Tripathi.
5. Population, Development & Environment by C.M. Lakshamana (Ed.)
6. Human Population and the Environment by Mallikarjuna Raju.

Dr. Ch. Sunitha

LESSON - 7

USAGE AND EXPLOITATION OF SURFACE AND GROUND WATER

AIMS AND OBJECTIVES :

At the end of lesson, the learners would understand

1. Knowledge about the water resources
2. Knowledge about the construction of Dams, floods, conflicts over water
3. Students acquire knowledge, scope and applications about the topic and learn more about the subject is useful in their career and job opportunities.

STRUCTURE OF THE LESSON :

7.1 INTRODUCTION :

The rapid increase in population and industrial growth led to severe demand on water resources. After using all available surface water resources to the maximum, human beings began using groundwater to meet their needs.

1. The increased extraction of groundwater far in excess of the natural recharge led to decreased groundwater level. The erratic and inadequate rainfall caused reduction in storage of water in reservoirs. This also led to decrease of groundwater.

2. Building construction activities seal permeable soil zone and reduce the area for percolation of rainwater thereby increasing surface runoff.

3. If groundwater withdrawal rate is higher than recharge rate, sediments in aquifers get compacted resulting in sinking of overlaying land surface. This is called land subsidence which leads to structural damage in buildings, fracture in pipes and reverses the flow of canals leading to tidal flooding.

4. Over-utilization of groundwater in arid and semi-arid regions for agriculture disturbs equilibrium of reservoir in the region causing problems like lowering of water table and decreased pressure in aquifers coupled with changes in speed and direction of water flow.
5. Over utilization of groundwater in coastal areas leads to rapid intrusion of salt water from the sea thereby rendering it unusable for drinking and agriculture.
6. Over-utilization of groundwater lads to decrease in water level thereby causing earthquake, landslides and famine.
7. Over-utilization of groundwater leads to drying-up of dug wells as well as bore wells.
8. Due to excess use of groundwater near agricultural fields, agricultural water that contains nitrogen as a fertilizer percolate rapidly and pollutes the groundwater thereby rendering the water unfit for potable use by infants. (Nitrate concentration exceeding 45 mg/L).

7.2 FLOODS :

Flooding is an overflowing of water onto land that is normally dry. Floods can happen during heavy rains, when ocean waves come on shore, when snow melts too fast, or when dams or levees break. Flooding may happen with only a few inches of water, or it may cover a house to the rooftop. They can occur quickly or over a long period and may last days, weeks, or longer. Floods are the most common and widespread of all weather-related natural disasters. Flash floods are the most dangerous kind of floods, because they combine the destructive power of a flood with incredible speed and unpredictability. Flash floods occur when excessive water fills normally dry creeks or river beds along with currently flowing creeks and rivers, causing rapid rises of water in a short amount of time. They can happen with little or no warning.

Reasons of Floods :

Rains :

Each time there are more rains than the drainage system can take, there can be floods. Sometimes, there is heavy rain for a very short period that results in floods. In other times, there may be light rain for many days and weeks and can also result in floods.

River overflow :

Rivers can overflow their banks to cause flooding. This happens when there is more water upstream than usual, and as it flows downstream to the adjacent low-lying areas (also called a floodplain), there is a burst and water gets into the land.

Strong winds in coastal areas: Sea water can be carried by massive winds and hurricanes onto dry coastal lands and cause flooding. Sometimes this is made worse if the winds carry rains them. Sometimes water from the sea resulting from a tsunami can flow inland to cause damage.

Dam breaking :

Dams are built along the side of a river and are used to prevent high water from flooding bordering land. Sometimes, too much water held up in the dam can cause it to break and overflow the area. Excess water can also be intentionally released from the dam to prevent it from breaking and that can also cause floods.

Snow - melts :

In many cold regions, heavy snow over the winter usually stays un-melted for some time. There are also mountains that have ice on top of them. Sometimes the ice suddenly melts when the temperature rises, resulting in massive movement of water into places that are usually dry. This is usually called a snowmelt flood. A flood occurs when water overflows or inundates land that's normally dry. This can happen in a multitude of ways. Most common is when rivers or streams overflow their banks. ... Coastal flooding occurs when a large storm or tsunami causes the sea to surge inland.

7.2.1 Effects of Floods :

Floods can have devastating consequences and can have effects on the economy, environment and people. During floods roads, bridges, farms, houses and automobiles are destroyed. People become homeless. Floods can have devastating consequences and can have effects on the economy, environment and people.

Economy :

During floods (especially flash floods), roads, bridges, farms, houses and automobiles are destroyed. People become homeless. Additionally, the government deploys firemen, police and other emergency apparatuses to help the affected. All these come at a heavy cost to people and the government. It usually takes years for affected communities to be re-built and business to come back to normalcy.

Environment :

The environment also suffers when floods happen. Chemicals and other hazardous substances end up in the water and eventually contaminate the water bodies that floods end up in. In 2011, a huge tsunami hit Japan, and sea water flooded a part of the coastline. The flooding caused massive leakage in nuclear plants and has since caused high radiation in that area. Authorities in Japan fear that Fukushima radiation levels are 18 times higher than even thought.

People and Animals :

Many people and animals have died in flash floods. Many more are injured and others made homeless. Water supply and electricity are disrupted and people struggle and suffer as a result. In addition to this, flooding brings a lot of diseases and infections including military fever, pneumonic plague, dermatopathia and dysentery. Sometimes insects and snakes make their ways to the area and cause a lot of havoc.

Prevention of Floods :

Humans cannot stop the rains from falling or stop flowing surface water from bursting its banks. These are natural events, but we can do something to prevent them from having great impact. Here are a few. Sea walls and tide gates have been built in some places to prevent tidal waves from pushing the waters up ashore. In some areas too, sand bags are made and placed in strategic areas to retain floodwaters.

Retaining walls :

In some places, retaining walls levees, lakes, dams, reservoirs or retention ponds have been constructed to hold extra water during times of flooding.

Town planning :

It is important that builders acquire permission before buildings are erected. This will ensure that waterways are not blocked. Also, drainage systems must be covered and kept free from objects that chock them. This way, water can quickly run through if it rains and minimize any chance of town flooding. Drainage systems should also be covered to prevent litter from getting into them.

Vegetation :

Trees, shrubs and grass help protect the land from erosion by moving water. People in low-lying areas must be encouraged to use a lot of vegetation to help break the power of moving flood water and also help reduce erosion.

Education :

In many developing countries, drainage systems are chocked with litter and people have little knowledge of the effects that can have during a rain. Education is therefore very important, to inform and caution people about the dangers of floods, what causes floods, and what can be done to minimise its impact.

7.3 CONFLICTS OVER WATER :

Rivers are also used for industrial purposes. They act as reservoirs for supply of fresh water and also a receptor of waste water and rubbish from the industry. Water crossing borders that has been polluted by wastes from one country develops into an international conflict.

Management of water conflicts :

1. Concerted efforts are required to enforce laws that check these practices to control water pollution.
2. In order to overcome the problem of sharing river water in a country, the concept of interlinking of rivers has been suggested.

3. Rivers should be nationalized; the National Water Authority and River Basin Authority should be given powers to ensure equitable distribution of basin water.

7.4. GLOSSARY / KEY WORDS :

1. **Floods** : During natural calamities the overflowing of water.
2. **Exploitation** : Over utilization of resources.

7.5. SELF ASSESSMENT QUESTIONS :

1. Write about the sources of Ground water?
2. Effects of over utilization of Water resources?

7.6. SUGGESTED READINGS :

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LESSON - 8

DEFORESTATION AND ITS IMPACT ON ENVIRONMENT

AIMS AND OBJECTIVES :

At the end of lesson, the learners would understand

1. Knowledge about the deforestation: causes and effects
2. Students acquire knowledge, scope and applications about the topic and learn more about the subject is useful in their career and job opportunities.

STRUCTURE OF THE LESSON :

8.1 INTRODUCTION :

Deforestation, means the felling and clearing of forest cover or tree plantations to accommodate agricultural, industrial or urban use. Deforestation refers to the decrease in forest areas across the world that are lost for other uses such as agricultural croplands, urbanization, unsustainable forest management, mining activities, infrastructure projects and increased fire incidence and intensity. It involves the permanent end of forest cover to make that land available for residential, commercial or industrial purposes. Deforestation can involve conversion of forest land to farms, ranches, or urban use.

Greatly accelerated by human activities deforestation has been negatively affecting natural ecosystems, biodiversity, and the climate. The United Nations Food and Agriculture Organization estimates the annual rate of deforestation to be around 1.3 million km^2 per decade. Poor forest management and unsustainable fuel wood collection degrade forests, form of deforestation. Forests cover more than 30% of the Earth's land surface, according to the World Wildlife Fund (WWF). These forested areas produce oxygen and absorb carbon

dioxide (CO_2), and are home to an estimated 80% of Earth's terrestrial species. Forests also are a source of food, medicine and fuel for more than a billion people. Worldwide, forests provide 13.4 million people with jobs in the forest sector, and another 41 million people have jobs related to forests. The most concentrated deforestation occurs in tropical rainforests." Forests are an important natural resource, but humans have destroyed substantial quantities of forested land.

Today, most deforestation is happening in the tropics. Areas that were inaccessible in the past are now within reach as people build new roads through the dense forests. The world has lost about 10% of its tropical tree cover since 2000, and nearly 47,000 square miles were destroyed in 2019. The World Bank estimates that about 3.9 million square miles of forest have been lost since the beginning of the 20th century.

Forests can be found from the tropics to high-latitude areas and contain a wide array of trees, plants, animals, fungi and microbes, according to WWF. When forests are destroyed, complex ecosystems are disrupted or perish. Human communities that depend on forests also suffer the consequences of widespread deforestation. In countries like Uganda, people rely on trees for firewood, timber and charcoal. From 2000 to 2020, Uganda lost more than 3,500 square miles of its forest cover,

According to the United Nation's 2020 State of the World's Forests report, three-quarters of Earth's freshwater comes from forested watersheds, and the loss of trees can worsen water quality. The report also found that over half the global population relies on forested watersheds for their drinking water as well as water used for agriculture and industry. A 2019 study published in the journal Ecohydrology, showed that parts of the Amazon rainforest that were converted to agricultural land had higher soil and air temperatures, which can exacerbate drought conditions.

Trees also absorb carbon dioxide, mitigating the emission of greenhouse gases produced by human activity. As climate change continues, trees play an important role in carbon sequestration, or the capture and storage of excess carbon dioxide. Tropical trees alone are estimated to provide about 23% of the climate mitigation that's needed to offset climate change, according to the World Resources Institute, a non-profit global research institute.

Deforestation not only eliminates vegetation that is important for removing carbon dioxide from the air, but the act of clearing the forests also produces greenhouse gas emissions. The Food and Agriculture Organization of the United Nations says that deforestation is the second-leading cause of climate change. In fact, deforestation accounts for nearly 20% of greenhouse gas emissions.

8.2 CAUSES :

Multiple factors, either of human or natural origin, cause deforestation. Natural factors include natural forest fires or parasite-caused diseases which can result in deforestation. Nevertheless, human activities are among the main causes of global deforestation. According to the Food and Agriculture Organization (FAO), the

expansion of agriculture caused nearly 80% of global deforestation, with the construction of infrastructures such as roads or dams, together with mining activities and urbanization, making up the remaining causes of deforestation. The loss of forests also contributes between 12% and 17% to the annual global Green House Gas emissions.

8.2.1 Primary Causes of Deforestation :

1. Agricultural Activities :

As earlier mentioned, agricultural activities are one of the significant factors affecting deforestation. According to the FAO, agriculture leads to around 80% of deforestation. Due to the overgrowing demand for food products, a huge amount of trees are felled to grow crops, and 33% of agriculture-caused deforestation is because of subsistence agriculture.

2. Livestock Ranching :

Livestock is believed to be responsible for about 14% of global deforestation. Farmers often clear the land by cutting down trees and burning them to raise livestock and grow food. They continue to use the property until the soil is completely degraded and repeat the same process on new woodland.

Eventually, it'll reforest, but it will take many years to return to its original condition. Surprisingly, over the past 40 years, the forest area has reduced by almost 40 percent, and during the same period, pasture regions and cattle populations have grown significantly and rapidly.

3. Illegal Mining :

Now-a-days the mining activity taking place in the forest areas is going beyond the limits permitted by the mining department. This illegal mining activity leads to deforestation.

4. Urbanization :

Further, to gain access to these forests, the construction of roads is undertaken; here again, trees are chopped to build roads. Overpopulation too directly affects forest covers, as with the expansion of cities, more land is needed to establish housing and settlements. Therefore forest land is reclaimed.

5. Desertification of Land :

The other factors that lead to deforestation are also partly natural and partly anthropogenic, like desertification of land. It occurs due to land abuse, making it unfit for the growth of trees.

6. Mining :

Oil and coal mining requires a considerable amount of forest land. Apart from this, roads and highways have to be built to make way for trucks and other equipment. The waste that comes out from mining pollutes the environment and affects the nearby species.

7. Forest Fires :

Another valid example would be forest blazes, hundreds of trees are lost each year due to forest fires in various portions of the world. It happens due to extreme warm summers and milder winters. Fires, whether caused by man or nature, results in a massive loss of forest cover.

8. Paper :

According to the Environment Paper Network, the paper that's thrown away each year accounts for approximately 640 million trees. America, China, Canada, Japan, constitute more than that of the world's paper production, and that is 400 million tons a year.

9. Overpopulation :

The overpopulation requires more land to establish housing and settlements. It generates a significant need for food and farmland to grow food and raise livestock. It automatically requires many more roads and highways for transport and communication—all these results in deforestation. Logging industries cut down trees for furniture, paper, building materials, and many more products. The growing human population is directly linked to deforestation.

8.2.2 Control of Deforestation :

Our society is over consuming. We are demanding too much from our planet and having an unsustainable ecological footprint. The UN Food and Agriculture Organization (FAO) also estimates that roughly one-third of the food produced in the world for human consumption every year is wasted or lost. So if we start consuming less, we'll be contributing to lower the demand, therefore, the production of goods is likely to slow down.

But there is one special thing we need to be aware - consume less : meat and dairy.

According to the WWF, it's estimated that deforestation caused by livestock is responsible for the discharge of 3.4% of current global emissions of carbon to the atmosphere every year. The whole industry, in fact, contributes to around 14% of the global anthropogenic greenhouse emissions.

8.3 EFFECTS OF DEFORESTATION :

1. Climate Imbalance and Climate Change :

Deforestation also affects the climate in many ways. Forests are the lungs of our planet. Trees take in carbon dioxide and release oxygen and water vapor in the air, and that is why tropical rainforests are extremely humid. Trees also provide shade that keeps the soil moist. All these are compromised with the lack of trees. It leads to the imbalance in the atmospheric temperature, drier climate, further making conditions for the ecology difficult that leads to climate change.

Several animals and plant species that form the flora and fauna across the world are vastly accustomed to their natural habitat. Therefore, haphazard clearance of forests would make it very difficult for them to survive or to shift from their native environment or adapt to new habitats. When a forest is cut down, the humidity levels come down and cause the remaining plants to dry out. The drying out tropical rainforests increases fire damage that destroys forests rapidly and harms wild animals as well as humans.

Forests and climate are linked intrinsically. Forest loss and degradation are both a cause and an effect of our changing climate. Several animals and plant species that form the flora and fauna across the world are vastly accustomed to their natural habitat. Therefore, haphazard clearance of forests would make it very difficult for them to survive or to shift from their native environment or adapt to new habitats.

When a forest is cut down, the humidity levels come down and cause the remaining plants to dry out. The drying out tropical rainforests increases fire damage that destroys forests rapidly and harms wild animals as well as humans. Forests and climate are linked intrinsically. Forest loss and degradation are both a cause and an effect of our changing climate. At the same time, deforestation is self-perpetuating.

2. Increase in Global Warming :

Trees play a major role in controlling global warming. The trees utilize greenhouse gases, restoring the balance in the atmosphere. With constant deforestation, the ratio of greenhouse gases in the atmosphere has increased, adding to our global warming woes.

3. Increase in Greenhouse Gas Emissions :

Forests help to mitigate carbon dioxide and other toxic greenhouse gas emissions. However, once they're cut, burned, or otherwise removed, they become carbon sources. It's estimated that deforestation is responsible for around 20 percent of greenhouse gas emissions, and due to tropical deforestation, 1.5 billion tons of carbon is released every year in the atmosphere.

4. Soil Erosion :

Trees are also crucial for our local water cycles as they keep on returning water vapor to the atmosphere. The soil remains moist as the rainwater percolates within the soil. The fertile soil is held in place by intricate root structures of many layers of trees. With the clearance of tree cover, the land is directly exposed to the sun, making it dry. Without trees, erosion often occurs and sweeps the land into nearby rivers and streams. Forests serve as nature's water purification plants. Soil erosion makes soil exposed to contaminants that leach into the water supply, which damages the quality of our drinking water.

5. Floods :

When it rains, trees absorb and store a large amount of water with the help of their roots. When they are cut down, the flow of water is disrupted, and the soil loses its ability to retain water. It leads to floods in some areas and droughts in others.

6. Wildlife Extinction & Habitat Loss :

Due to the massive felling down of trees, various animal species are lost. They lose their habitat and also forced to move to a new location. Many of them are even pushed to extinction. Our world has lost innumerable species of plants and animals in the last couple of decades. A study of the Brazilian Amazon forecasts that up to 90% of predicted extinctions will occur until the next 40 years.

7. Acidic Oceans :

The increased levels of carbon dioxide in the atmosphere due to deforestation and burning fossil fuels make our oceans more acidic. Since the Industrial Revolution, beaches are already 30 percent more acidic, posing ocean species and ecosystems at extreme risk.

8. The Decline in Life Quality of People :

People in millions all over the world depend on forests for hunting, small-scale agriculture, gathering, and medicine. Everyday materials we use, such as latex, cork, fruit, nuts, natural oils, and resins are found in the tropical forests. Deforestation disrupts the lives of millions of people.

9. Food Insecurity in the Future :

Deforestation for food may result in food insecurity in the future. Currently, 52% of all the land used for food production is moderately or severely impacted by soil erosion. In the long term, the lack of fertile soil can lead to low yields and food insecurity.

10. Loss of Biodiversity

Deforestation leads to a huge loss of biodiversity. About 80% of the global biodiversity is located in tropical rainforests. Forests not only provide habitats for wildlife but also foster medicinal conservation. The forest acts as a critical medium to preserve the wide variety of species. It also destroys the microbial community that is responsible for the production of clean water, the removal of pollutants and the recycling of nutrients.

8.4 SOLUTIONS TO DEFORESTATION :

1. Government Regulations :

The best solution to deforestation is to curb the felling of trees by enforcing a series of rules and laws to govern it. Deforestation in the current scenario may have reduced; however, it would be too early to assume. The money-churner nature of forest resources can be tempting enough for deforestation to continue.

2. Banning Clear-Cutting of Forests :

This will curb the total depletion of the forest cover. It is a practical solution and is very feasible.

3. Reforestation and Afforestation :

Land skinned of its tree cover for urban settlements should be urged to plant trees in the vicinity and replace the cut trees. Also, the cutting must be replaced by planting young trees to replace the older ones that were cut. Trees are being planted under several initiatives every year, but they still don't match the numbers of the ones we've already lost.

4. Reduce Consumption of Paper :

Your daily consumption of paper includes printing paper, notebooks, napkins, toilet paper, etc. Try to reduce consumption, reduce waste of paper and also opt for recycled paper products. Make life simple such as printing/writing on both sides of the paper, using less toilet paper, avoiding paper plates, and napkins and wherever possible, go paperless.

5. Educate Others :

Still, many are entirely unaware of the global warming problem we're facing. Educate your friends, family, and community by sharing the deforestation facts, and its causes and effects. You can make an impact!

8. Reduce Consumption of Deforestation Prone Products :

Palm oil is a common ingredient in absolutely everything we see around us. Make it a simple habit to get a quick peek at the ingredients. Soybeans are another deforestation hotspot.

9. Spread Awareness and Raise Consciousness :

Teach your family, friends or colleagues about the issues around deforestation. Let them know about the consequences of deforestation. And empower them about how they can also use their consumer role to make a difference. At the same time, as a citizen, use your voting power and your local network and let the people in power know what type of changes you'd like to see in your condominium, in your neighbourhood, city or district.

Apart from people's individual contributions to stop deforestation, from a political and systemic perspective, other more direct and hands-on actions approaches can be taken:

1. Fighting illegal logging and limiting logging in old-growth forests;
2. Protecting forested areas by creating laws and policies that ensure forests are kept protected and restored and betting on land practices such as wildfire corridors;
3. Reforming trade agreements, starting to value differently products obtained through deforestation, and creating incentives for the use of sustainable forestry certifications
4. Educating local communities and tourists about the need to protect forests and develop and enrol in ecotourism activities.

8. 5 GLOSSARY / KEY WORDS :

Deforestation : Clearing a wide area of trees.

Desertification : The process by which fertile land becomes desert.

8.6 SELF ASSESSMENT QUESTIONS :

1. What are causes of Deforestation?
2. Write about the effects and control of deforestation?

8.7 SUGGESTED READINGS :

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LESSON - 9

NON - RENEWABLE ENERGY RESOURCES

AIMS AND OBJECTIVES :

At the end of lesson, the learners would understand

1. Knowledge about the ideas of Non- Renewable Energy Resources
2. Students acquire knowledge, scope and applications about the topic and learn more about the subject is useful in their career and job opportunities.

STRUCTURE OF THE LESSON :

9.1 INTRODUCTION :

A non-renewable resource refers to a natural resource that is found beneath the earth, which when consumed, does not replenish at the same speed at which it is used up. The resources typically take millions of years to develop. The main examples of non-renewable resources are fuels such as oil, coal, and natural gas, which humans regularly draw to produce energy. A non-renewable resource is a natural resource that cannot be readily replaced by natural means at a pace quick enough to keep up with consumption. An example is carbon-based fossil fuels. The original organic matter, with the aid of heat and pressure, becomes a fuel such as oil or gas. Earth minerals and metal ores, fossil fuels (coal, petroleum, natural gas) and groundwater in certain aquifers are all considered non-renewable resources.

Earth minerals and metal ores are examples of non-renewable resources. The metals themselves are present in vast amounts in Earth's crust, and their extraction by humans only occurs where they are concentrated by natural geological processes enough to become economically viable to extract. These processes generally take from tens of thousands to millions of years, through plate tectonics, tectonic subsidence and crustal recycling. The localized deposits of metal ores near the surface which can be extracted economically by humans are non-renewable in human time-frames. There are certain rare earth minerals and elements that are more scarce and exhaustible than others. These are in high demand in manufacturing, particularly for the electronics industry.

9.2 TYPES OF NON-RENEWABLE RESOURCES :

The two broad categories of non-renewable resources are fossil fuels and nuclear energy.

Fossil fuels :

Fossil fuels are formed due to the continuous heating and compressing of organic matter buried beneath the earth's surface. The organic matter mainly comprises of plant and animal remains that have decomposed, heated, and compressed over millions of years to form fossil deposits. The deposits are extracted through drilling or mining, and they can be in liquid, gas, or solid form. Fossil fuels are highly combustible, making them a rich source of energy.

Fossil fuels include :

Crude oil :

Crude oil, also referred to as petroleum oil, is the only non-renewable resource that is extracted in liquid form. It is found between the layers of the earth's crust, or between the rocks, and it is retrieved by drilling a vertical well into the ground and ocean floor.

The crude oil is then pumped out to the surface, taken through a refinery, and then used to create different products. It used to produce gasoline and diesel to power motor vehicles and manufacture plastics, heating oil, propane, and jet fuel, as well as artificial food flavours.

With oil reserves being used up more quickly than new oil fields are discovered, scientists predict that the current oil reserves may not last beyond the middle of the 21^{st} century.

Natural gas :

Natural gas is a gaseous non-renewable resource that is found below the earth's crust but near crude oil deposits in the subsurface. Natural gas primarily consists of methane, but may also contain other forms of natural gas such as propane, ethane, and butane.

Methane is odourless, and it is mixed with a special additive to give it an odor for easy detection in case there is gas leakage. Once natural gas is extracted, it is sent to processing plants to remove propane and butane, which are used as liquefied petroleum gas (LPG). Natural gas is used for heating homes, as well as for cooking in gas ovens, stoves, and grills.

Coal :

Coal is created by compressed organic matter, and it contains carbon and hydrocarbon matter. It is formed from plant-filled swamps that have been covered by sediments for millions of years. Coal is extracted by digging up the ground and taking out the coal solids for processing into energy. The main types of coal are anthracite, lignite, bituminous coal,

and sub-bituminous coal. Bituminous is found in the United States. It contains 45% to 86% of carbon. It has a high heat content and is used in generating energy and in making steel and iron. Anthracite contains 86% to 97% carbon, and it has the highest heating value. It is much harder to find than the other types of coal and is used in the metal industry.

Nuclear energy :

Apart from fossil fuels, the other category of non-renewable resources is nuclear fuels. It is primarily obtained through the mining and refining of uranium ore, a naturally occurring radioactive element below the earth's surface. Uranium is found in small quantities, and miners often gather the uranium deposits for refining and purification. The mineral generates power through a process known as nuclear fusion, which creates enough pressure to run turbines and generate nuclear power.

Natural resources such as coal, petroleum (crude oil) and natural gas take thousands of years to form naturally and cannot be replaced as fast as they are being consumed. Eventually it is considered that fossil-based resources will become too costly to harvest and humanity will need to shift its reliance to other sources of energy such as solar or wind power, see renewable energy. An alternative hypothesis is that carbon based fuel is virtually inexhaustible in human terms, if one includes all sources of carbon-based energy such as methane hydrates on the sea floor, which are vastly greater than all other carbon based fossil fuel resources combined. These sources of carbon are also considered non-renewable, although their rate of formation/replenishment on the sea floor is not known. However their extraction at economically viable costs and rates has yet to be determined. At present, the main energy source used by humans is non-renewable fossil fuels.

9.3 RENEWABLE ENERGY RESOURCES :

1. These types of resources have the ability to regenerate themselves easily.
2. The process of regeneration of renewable energy involves ecological processes for a specific time period.
3. If renewable energy is utilized at a very high speed that is higher than the environment's ability to refill it, then it may become non-renewable energy in the near future.

Non-Renewable Energy Resources :

1. They are also termed as a stock resource as they are not available in high quantities.
2. These substances can be again used after recycling.
3. Non-renewable energy is available in the form of minerals which are generally present in the lithosphere of the earth in various forms.
4. The non-renewable resources can be present in all three states of matter namely solids, liquids or gases.

5. The solid form of non-renewable resources includes coal, ignite, minerals, etc. while its liquid form includes petroleum, and its gaseous form includes resources such as natural gas etc.

Natural resources, known as renewable resources, are replaced by natural processes and forces persistent in the natural environment. There are intermittent and reoccurring renewable, and recyclable materials, which are utilized during a cycle across a certain amount of time, and can be harnessed for any number of cycles. The production of goods and services by manufacturing products in economic systems creates many types of waste during production and after the consumer has made use of it. The material is then either incinerated, buried in a landfill or recycled for reuse. Recycling turns materials of value that would otherwise become waste into valuable resources again.

In the natural environment water, forests, plants and animals are all renewable resources, as long as they are adequately monitored, protected and conserved. Sustainable agriculture is the cultivation of plant and animal materials in a manner that preserves plant and animal ecosystems and that can improve soil health and soil fertility over the long term. The overfishing of the oceans is one example of where an industry practice or method can threaten an ecosystem, endanger species and possibly even determine whether or not a fishery is sustainable for use by humans. An unregulated industry practice or method can lead to a complete resource depletion.

The renewable energy from the sun, wind, wave, biomass and geothermal energies are based on renewable resources. Renewable resources such as the movement of water (hydropower, tidal power and wave energy) wind and radiant energy from geothermal heat and solar energy (used for solar energy) are practically infinite and cannot be depleted, unlike their non-renewable counterparts, which are likely to run out if not used sparingly.

The potential wave energy on coastlines can provide 1/5 of world demand. Hydroelectric power can supply 1/3 of our total energy global needs. Geothermal energy can provide 1.5 more times the energy we need. There is enough wind to power the planet 30 times over, wind power could power all of humanity's needs alone. Solar currently supplies only 0.1% of our world energy needs, but there is enough out there to power humanity's needs 4,000 times over, the entire global projected energy demand by 2050.

Renewable energy and energy efficiency are no longer niche sectors that are promoted only by governments and environmentalists. The increasing levels of investment and that more of the capital is from conventional financial actors, both suggest that sustainable energy has become mainstream and the future of energy production, as non-renewable resources decline. This is reinforced by climate change concerns, nuclear dangers and accumulating radioactive waste, high oil prices, peak oil and increasing government support for renewable energy. These factors are commercializing renewable energy, enlarging the market and growing demand, the adoption of new products to replace obsolete technology and the conversion of existing infrastructure to a renewable standard.

9.4 NON-RENEWABLE ENERGY- ADVANTAGES :

1. Non-renewable resources are high in energy. Resources such as coal and oil tend to provide us more energy in comparison to renewable energy like solar or wind energy.
2. Huge profits can be generated in the mining of coal, selling of oil or the construction of natural gas pipelines.
3. These resources are easy to use whether in a home or anywhere else.
4. Consumers can find non-renewable resources at a very cost-effective price.
5. For some people, new machines and other energy sources cannot replace their traditional minerals like coal and oil. So, it is also known as traditional energy.
6. Non-renewable energy is easily found anywhere and everywhere. This implies that they can be conveniently moved across the world. People living in areas that are not easily approachable can make use of non-renewable energy as well.
7. Most importantly, non-renewable recourses are job-creating. Extracting, transporting and refining are the parts of non-renewable sources that provide employment.
8. Most of the non-renewable sources are also quite easy to store.

9.5 NON-RENEWABLE ENERGY – DISADVANTAGES :

Though they have a number of advantages, non-renewable resources have many disadvantages as well. These include :

1. One of the major disadvantages of non-renewable energy is that it is time-consuming. Mining of coal, searching for oil, installing oil drills, building oil rigs, inserting pipes to extract and transporting natural gases are very time-consuming processes. It also takes a lot of effort.
2. Since non-renewable energy takes billions of years to form, they are slowly but gradually vanishing from the earth. Using non-renewable resources indiscriminately without thinking for our future generations could be selfish.
3. Non-renewable energy can be dangerous and can cause respiratory problems in humans because sources like fossil fuels emit gases such as carbon monoxide.
4. The workers working in coal mines or oil drills are more prone to a number of health risks. As a result, there are a large number of diseases, injuries and even deaths.
5. Sources like coal, oil and natural gas release a large amount of carbon dioxide when burnt. As a result of these chemicals, they are rapidly destroying the ozone layer.
6. Oxides like sulphur oxide and others released while burning fossil fuels convert the rain into acidic rain, which is harmful to wildlife as well as human beings.

7. Many non-renewable sources release smog which envelopes the buildings. Mostly in modern cities, people complain about the same. Over time, black smog can make your building and other property appear dark and dirty.

9. 6 GLOSSARY / KEY WORDS :

1. **Energy Resources** : Materials or elements that can be used to produce energy.
2. **Fossil fuels** : Any of a class of hydrocarbon containing materials of biological origin
3. **Renewable resources** : A renewable resource is a resource that can be replenished naturally.

9.7 SELF ASSESSMENT QUESTIONS :

1. Explain about Non-renewable Energy Resources?
2. Write about advantages and disadvantages of Non-renewable Energy Resources?

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LESSON - 10

ENVIRONMENTAL POLLUTION AND IMPACT ON ENVIRONMENT

AIMS & OBJECTIVES :

At the end of lesson the learner would understand

- Knowledge about the environmental pollution and causing pollutants.
- Knowledge about the different types of environmental pollutions.
- Knowledge about the causes of Air, Water, Noise and Soil pollutions.
- Knowledge about the effects of pollutions on environment and human health.

STRUCTURE OF THE LESSON :

10.1 ENVIRONMENTAL POLLUTION :

10.1.1 DEFINITION OF ENVIRONMENTAL POLLUTION AND POLLUTANTS :

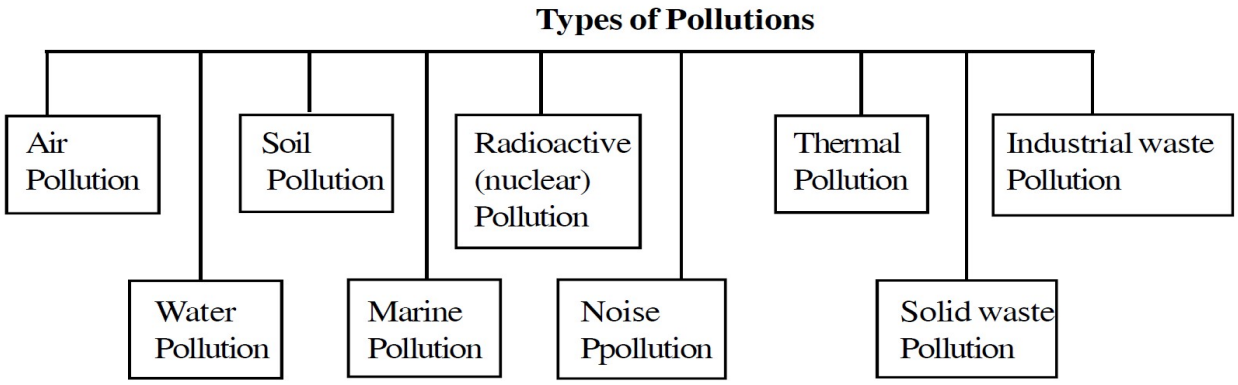
The unthoughtful race for industrial development and unlimited exploitation of natural resources has adversely affected all forms of life in the biosphere. This has threatened the survival of all living organisms. Air has become dangerous to breathe, water is unfit to drink, soil is unsuitable for crops, aquatic ecosystems antagonized marine creatures. The industrialization has given us radioactivity, dangerous effluents, poisonous gases, heavy metals etc. in our environment. Thanks to pollutions, all these are the gifts of industrialization to modern civilization.

Pollution is defined as an undesirable change in chemical, physical and/or biological characteristics of air, water and soil which creates a potential health hazard to living organism and/or harmfully affects the life. Pollution is caused by pollutants.

Pollutants may be defined as the substances that cause pollution. It may be solid liquid or gaseous. It includes any chemical or geochemical substance such as grit, sediment, dust etc.; biotic components and their products. Physical factors such as hear which is deliberately released by man into the environment is also a pochis.

10.2 DIFFERENT TYPES OF POLLUTIONS AND THEIR SOURCES :

There are several kinds of pollutions now-a-days. Main among them are the following.



These pollutions are caused mainly due to following reasons.

10.2.1 Natural sources :

(i) smoke and trace gases produced from forest fires

(ii) gases released from volcanic eruptions

(iii) volcanic ash

(iv) dust from dust-storms

(v) marsh gas such as methane (CH_4) released from the decay of organic matter

(vi) bacterias, cysts, pollens, spores etc.

10.2.2 Man-made (or anthropogenic) sources :

(i) smoke and dust particles from industries

(ii) smoke and dust particles from thermal power plants

(iii) smoke and dust particles from automobile exhausts

(iv) smoke and dust particles from marine exhausts

(v) smoke and dust particles from aircrafts exhausts

(vi) nuclear explosione

(vii) explosives, fertilizers, pesticides etc..

(viii) solid wastes due to over-urbanization and over-population

(x) deforestation and destruction of natural habitat

(xi) quarrying, mining, and construction of dams etc.

(xii) construction of roads, buildings etc.

Some recent additions in this list are the following.

(xiii) medical waste and garbage

(xiv) micro-particles of automobile tyres.

Amongst the above, the man-made sources are more dangerous and have caused serious detriment to the environment.

10.3 DIFFERENT TYPES OF ENVIRONMENTAL POLLUTANTS :

Major pollutants that are responsible for different kinds of pollutions are listed as follows :

1. Gases e.g. NO, NO_2, SO_2, CO, CO_2, halogens, (chlorine, bromine, iodine).
2. Deposited matter-soot, smoke, tar, dust, grit etc.
3. Metals e.g. mercury, lead, iron, zinc, nickel, tin, cadmium, chromium etc.
4. Acid droplets-e.g. sulphuric acid, nitric acid etc.
5. Fluorides
6. Agrochemicals e.g. pesticides, herbicides, fungicides, nematicides, bactericides, weedicides and fertilizers
7. Radioactive waste e.g. nuclear ash from reactor
8. Noise
9. Solid wastes e.g. industrial ash, garbage, rubbish
10. Complex organic substances e.g. benzene, ether, acetic acid, benzpyrenes etc.
11. Photochemical oxidants e.g. photochemical smog, ozone, peroxyacetyl nitrate (PAN), peroxybenzoil nitrate (PB_2N), nitrogen oxides, aldehydes, ethylene etc.

10.4 AIR POLLUTION :

10.4.1 Definition and Introduction :

While the greenhouse gases and the CFCs may be considered as global pollutants (because they potentially harm the climate system and the stratospheric ozone layer worldwide), the term "air pollution" generally refers to substances that on local and regional scales directly harm animals, plants, and people and their artifacts. There have been complaints about air quality for centuries, especially in cities. But the steady expansion of population and industrial civilization has changed the nature of air pollution, now. The pervasive effects of emissions are increasingly manifest, and the need to control them is influencing to a greater degree for the development of technology, particularly in the energy and transportation sectors.

10.4.2 Causes of Air Pollution :

A wide range of chemicals can pollute the air, but the ones generally viewed as needing control measures are carbon monoxide, sulphur dioxide, toxic organics particulates, nitrogen oxides, and volatile organic compounds Whereas the first four directly harm the human welfare, the last two are ingredients of photochemical smog, whose harmful effects are due to the production of ozone and other "oxidant" molecules.

From different sources of air pollution, a variety of pollutants are released into atmosphere. Main among them are as follows :

1. **Carbon Compounds :** These are mainly CO_2 and CO. The CO_2 is released by complete combustion of fossil fuels and CO by automobile exhausts CO is a poisonous gas.
2. **Sulphur Compounds:** These include SO_2, H_2S and H_2SO_4; and are mostly released by fossil fuels (coal etc.) based at thermal power plants and industrial units such as oil refineries.
3. **Nitrogen Oxides:** These include chiefly NO, NO_2, and HNO_3. These are mostly released by automobiles, power plants and industries.
4. **Ozone (O_3):** Its level may rise in atmosphere due to human activities.
5. **Fluorides:** These come from industries insecticides spray etc.
6. **Hydrocarbons:** These are chiefly benzene, benzpyrene etc. which are mostly discharged by automobiles and industries,
7. **Metals:** These mainly include lead, nickel, arsenic, beryllium, tin, vanadium, titanium, cadmium etc. which are present in air as solid particles liquid droplets or gases. They are produced mostly by metallurgical processes, automobiles, spray etc.
8. **Photochemical Products:** These are the photochemical smog such as PAN, PB_2N etc. and released mostly by automobiles
9. **Particulate Matter:** These are fly ash, dust, grit and other suspended particulate matter (SPM) released from power plants and industries like stone crushers etc.
10. **Biological Particulate Pollutants:** There are also bacterial cells, fungal spores and pollens in air as biological particulate pollutants.
11. **Toxicants other than Heavy Metals:** These are complex chemical substances released during manufacture of other goods.

10.4.3 Effects of Air Pollution :

Air pollution affects everyone: human beings, plants animals, materials etc. It also affects the aesthetic beauty of nature and the climate. A brief account of all these effects is enumerated as following.

10.4.3.1 Effects of air pollution on human health :

Air pollutants have many effects on human health. These are :

i. Irritation of eye, nose and throat.
ii. Irritation of the respiratory system.
iii. Nickel particulates in tobacco smoke result in respiratory damage.
iv. Lead particulates from automobile exhausts cause lead-poisoning resulting in convulsions, delirium, coma and even death.
v. Cadmium particulates through cigarette smoking cause cardio vascular diseases, kidney and liver damage, and even death.
vi. Radioactive fallout has somatic* and genetic effects on future generations.
vii. Mercury from combustion of fossil fuels and plants result in nerve, brain and kidney damage.

10.4.3.2 Effects of pollutants on plants :

Spraying of pesticides, and other agricultural practices cause exposure of the plants to a large number of air pollutants. These adversely affect their growth and metabolism by destroying chlorophyll and disrupting photosynthesis. For example

i. Ozone causes necrosis (i.e. dead areas on a leaf structure) and damages me the leaves.
ii. NO_2 causes premature leaf fall (i.e. abscission) and suppressed growth of plants resulting in reduced yields of crop plants.
iii. SO_2 bleaches the leaf surfaces and causes chlorosis (i.e. loss of chlorophyll and yellowing of the leaf), especially in leafy vegetables.
iv. PAN (peroxyacylnitrate) damages leafy vegetables causing their premature fall, discolouration and curling of sepals.

10.4.3.3 Effects of pollutants on animals :

When the animals feed on the particulate coated plants (especially with Fluorine, Lead,

Arsenic), they get affected with Arsenic poisoning (cattle and sheep are main victims). Lead poisoning results in bronchitis and lack of appetite in pet animals.

10.4.3.4 Effects of air pollution on materials :

Materials are affected by air pollutants due to the following phenomenon.

(i) Chemical attack.

(ii) Abrasion.

(iii) Corrosion.

(iv) Deposition and removal of materials.

The damages caused are in the following manner.

(a) Ozone, SO_2, NO_2, and acid gases discolour, deteriorate and reduce the tensile strength of textiles.

(b) SO_2 acid rains and aerosols damage the building materials.

(c) Paper becomes brittle and leather undergoes disintegration by SO_2 and acid gases.

(d) Paints are discoloured by SO_2, H_2S and particulates.

10.4.3.5 Effect of air pollution on aesthetic beauty :

The aesthetic beauty of nature is visible [Reduction in visibility results from scattering of light by air borne particulates (0.1 to 1 mm size). This also leads to safety hazards] in the haze formed by dust and smoke in the air.

Industries, automobiles, sewage and garbage heaps emit foul odours causing further loss of aesthetic beauty.

10.4.3.6 Effect of air pollution on climate :

Due to deforestation and fuel combustion in industries and automobiles, the CO_2 content of the atmosphere is expected to double by the year 2020.

This increase may change the climate of earth by changing the factors controlling the climate e.g. Composition gases. This increase in CO_2 will enhance the atmospheric temperature of earth, resulting in the melting of polar ice, glaciers etc. Consequently, it will cause flooding of coastal areas. Pattern of rainfall, if changed, will affect the agricultural output.

The thinning of the ozone layer in stratosphere by the action of aerosols will increase the penetration of harmful ultraviolet rays to earth. This will cause blindness, sunburn, Onactivation of proteins, RNA and DNA etc.

10.5 WATER POLLUTION :

10.5.1 Definition and Introduction :

Water pollution may be defined as 'the presence of impurities and foreign substances in water in such a quantity that lowers its quality, makes unfit for use and becomes a health hazard'.

The water quality for human consumption should be pure i.e. without impurities. It needs to have some minerals in order to give it some taste. Pure water should conform to the water quality standards set for human consumption.

These are

(i) It should be odourless.

(ii) It should be free of pathogenic organisms.

(iii) The dissolved inorganic solids should be in moderate quantities.

(iv) It should be free of suspended solids and turbidity.

(v) Drinking water should be moderately soft (50-100 ppm), even slight hardness of 100 to 150 ppm is acceptable put excessive hardness above this level is unacceptable.

(vi) It should be free of toxic substances that may have serious long term effects.

(vii) It should be non-corrosive.

(viii) The pH value should be preferably between 7 and 8.5.

10.5.2 Causes (or Sources) of Water Pollution :

Major sources of water pollution are the following.

1. Sewage and other wastes. It comes from home, animals and food processing plants. It includes human and animal excreta, paper, soap, detergents, dust, dirts oils, clothes, rotten vegetables etc.
2. Industrial effluents
3. Agricultural discharges
   (i) artificial fertilizers
   (ii) pesticides
   (iii) herbicides
   (iv) toxicants, etc.

4. Industrial wastes. These come from chemical industries, petrochemical industries, tannaries, thermal power plants, nuclear power plants etc. Besides other things, these also include
   (i) mercury
   (ii) lead
   (iii) other metals

Sewage and other wastes. Sewage is the waterborne waste derived from home animal, and food processing plants. It includes human excreta, paper, cloth, soap detergents etc. These constitute a major proportion of water pollutants. There is uncontrolled dumping of wastes of rural areas, towns and cities into ponds, lakes, stream or rivers. Due to accumulation of sewage and other wastes in these bodies, they are not able to recycle them and their self- regulatory capability is lost. The decomposition of these wastes by aerobic microbes decreases due to higher levels of pollution. The self-purifying ability of the water is lost and water becomes unfit for drinking and other domestic uses. Since decomposition of sewage and other wastes is largely an aerobic process, accumulation of these in water increases its oxygen requirements (BOD).

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

Industrial effluents. A wide variety of inorganic and organic pollutants remain present in effluents from breweries, tanneries, dying textiles, paper and pulp mills, steel industries, mining operations etc. These include oils, greases, plastics, plasticizers, metallic wastes, suspended solids, phenols, toxins, acids, salts, dyes, cyanides, DDT etc. Many of these are not readily susceptible to degradation and thus cause serious pollution that increases the hardness of water. It has disastrous effect on live organisms and corrodes concrete etc. Na, Cu, Cr, Cd, Hg, Pb, etc. are the heavy metal effluents that are discharged from industries.

Agricultural discharges. Modern agriculture rely heavily on synthetic chemicals which include different types of fertilizers, pesticides and herbicides or weedicides. These chemicals along with waste are washed off lands through irrigation, rainfall, drainage etc. reaching into the rivers, lakes, streams etc. where they disturb the natural ecosystem.

Fertilizers (phosphates, nitrates etc.) along with domestic waste (sewage) make water bodies nutrients rich. These become more productive, a phenomenon called eutrophication. Due to this, oxygen level of water decreases and CO_2 level increases. It causes death of fish and other animals, due to which clean water body turns into a stinking drain.

Pesticides are the chemicals used for killing the plant and animal pests. It is a general term that includes bactericides. fungicides, nematicides, insecticides and also the herbicides or weedicides. Since weeds (herbs) are not pests like bacteria, fungi, nematodes, insects, the spectrum of activity of these chemicals is extended beyond the pests: some authors use a broader term-biocide to include also herbicides etc.

There is a wide range of chemicals used as pesticides and herbicides. But the most harmful are those which either do not degrade or degrade very slowly in nature. We prefer to distinguish such chemical substances as hazardous substances or toxicants. These are highly potent chemicals that enter our food chain and then begin to increase in their concentrations at successive trophic levels in the food chain. Equally hazardous substances are the radio nuclides. The hazardous biocides cause considerable harm since their effects are cumulative. Most nations have banned the use of some of these chemicals.

Besides DDT there are also heavy metals like lead, mercury, copper which also show similar behaviour in a food chain. Similarly the radionuclides as strontium 90 follows biological magnification. The outcome of such criminal and indiscriminate use may be acute (immediate) or chronic poisoning. The danger of long term consumption of pestic de residues in food is far more serious than acute poisoning from the point of view of national health. Children born today have to start life with a body burden of pesticides which increases with age. There is evidence that such chronic accumulation of pesticides played a role in kidney malfunctioning, excess of amino acids in blood and urine, electroencephalogram abnormalities of brain tissue, blood abnormalities etc.

Industrial Wastes : Fluoride pollution. Fluorine is regularly present in water and soil besides air. In nature it is found as fluoride. The crop plants grown in high-fluoride soils in agricultural, non industrial areas had a fluoride content as high as 300 ppm. Consumption of fluoride-rich water from wells caused endemic fluorisis. Fluoride content water caused dental fluorisis. Prolonged intake of fluoride containing water stiffens the bone joints, particularly of spinal cord. Fluoride is not absorbed in the blood stream. It has an affinity with Calcium and thus gets accumulated in bones, resulting in the mottling of teeth, pain in the bones and joint and outward bending of legs from the knees-knock- knee syndrome. Fluoride levels more than 0.5 ppm over a period of 5-10 years results in fluorisis terminating in crippling, or paralysis. In water of most villages of Rajasthan, fluoride level is higher than permissible limit of 1 mg/litre of water.

Cattle grazing around fluoride sources, as ceramic rocks, phosphate fertilizer plants and aluminium factories often develop fluorisis. The toxic effects are staining, mottling and abrasion of teeth, high fluoride levels in bone and urine, decreased milk production, and lameness.

Lead Pollution : Lead poisoning is common in adults. The chief source of lead to water are the effluents of lead and lead processing industries Lead toys may be chewed by children Painters also have a risk of lead consumption. In some plastic pipes lead is used as stabilizer. The water

may become contaminated in these pipes. Lead is also used in insecticides, food, beverages, ointments and medicinal concoctions for flavouring and sweetenting.

Lead pollution causes damage to liver and kidney reduction in haemoglobin formation, mental retardation and abnormalities in fertility and pregnancy. Chronic lead poisoning may cause three general disease syndromes :

(i) Gastrointestinal disorders

(ii) Neuromuscular effects (leadlapsy)-weakness, fatigue, muscular atrophy, and

(iii) Central nervous system effects or CNS syndrome-that may result to coma and death. Lead poisoning also causes constipation, abdominal pain etc. Paper and pulp industries of Japan and Canada also cause mercury pollution. Effluents of industries making switches, batteries, thermometers, fluorescent light tubes and high intensity street lamps also contain mercury.

From the effluents mercury compounds enter the water body and at their bottom these are metabolically converted into methyl mercury compounds by anaerobic microbes. Methyl mercury is highly persistent and thus accumulates in food chain. Methyl mercury is soluble in lipids and thus after being taken by animals it accumulates in fatty tissues.

10.5.3 Effects of Water Pollution :

Pollutants inhibit many physical and chemical changes in water e.g. suspended particles creates turbidity in water; chromium, dyes and iron compounds change the colour of water; phenols, oils, detergents, hydrocarbons, chlorine etc. impart an unpleasant taste to water.

As it is a vital resource essential for sustaining life, contamination of water has immediate as well as far reaching effects on the health and environment of living; organisms. Its major effects are enumerated below.

1. **Industrial effluents** containing poisonous chemicals such as arsenic, mercury, cadmium, lead etc. which kill aquatic organisms and may reach human body through contaminated food such as fishes.
2. **Phosphorus and Nitrates** from fertilizers and detergents contaminate the surface waters where they act as nutrients and promote the growth of oxygen consuming algae which reduce the DO (dissolved oxygen) level of water, killing fish and other aquatic organisms.
3. **Domestic, commercial and industrial effluents** (petroleum refineries, paper mills, breweries, tanneries, slaughter houses) contaminate the water with organic pollutants.

These provide nutrition for micro-organisms which decompose the organic matter and consume oxygen and reduce the DO level of the aquatic system, thereby killing the aquatic organisms.

4. **Waterborne infectious diseases** like typhoid, bacillary dysentry cholera and amoebic dysentery are the predominarit health hazards arising from drinking contaminated water.
5. **Non-biodegradable pesticides** especially organo chlorines travel through food chains and ultimately reach humans where they accumulate in the fatty tissues and affect the nervous system.
6. **Thermal pollution** of water reduces the DO level of the aquatic system making it incapable of supporting life.
7. **Oil pollutants** have been known to be responsible for the death of many water birds and fishes.
8. **Radioactive pollutants** from mining and refining of uranium, thorium and nuclear power plants enter humans through food and water and get accumulated in the blood, thyroid gland, liver bones and muscles.
9. **Fluoride** containing pollutants cause fluorosis i.e. neuromuscular, respiratory, gastro intestinal and dental problems.

10.6 SOIL POLLUTION :

10.6.1 Definition and Introduction :

Soil pollution may be defined as the contamination caused by chemicals and other substances resulting in loss of the productivity (or fertility) of soil. The loss of productivity is in terms of yield of the crops. Besides the damaging contaminants, there are some other types of contaminants also that do not cause any detrimental effect to the plants, but create adverse effect on human beings and the animals who consume such plants.

Organic manure, chemicals, fertilizers, insecticides, pesticides, carcasses, radioactive wastes, discarded food; wastes of clothes, leather goods, paper, plastic goods etc. mainly contribute to solid pollution.

10.6.2 Sources of Soil Pollution :

Soil pollution is caused due to following main reasons/sources.

1. Human and animal excreta

2. Organic insecticides
3. Chemical pollutants such as from following industries
    - Soap • Cement • Drugs • Rubber • Detergents • Dyes
    - Polymer
4. Pesticides etc.
5. Radioactive Substances
    - Nuclear power plants bobb
6. Nitrification
7. Urban Wastes
    - Garbage • Rubbish • Useless Goods
8. Industrial Pollutants
    - Petrochemical industries e.g. fertilizer, oil refinery
    - Mining industries e.g. minerals, coal
    - Metallurgical industries e.g. ore refining, metal manufacturing
    - Thermal power plants
    - Others e.g. breweries, tanneries, sugar factories, textiles etc
9. Other sources such as
    - Absorption of toxic metals
    - Salination

Human and animal excreta used as organic manure to promote crop yield pollute the soil by contaminating the soil and vegetable crops with the pathogens that may be present in the excreta.

Organic insecticides like DDT, aldrin, benzene hexachloride etc. are used against soil borne pests. They accumulate in the soil as they degrade very slowly by soil and water bacteria. Consequently, they have a very deleterious effect on the plant growth-stunting their growth and reducing the yield and size of fruit. Their degradation products may be absorbed by the plants from where they reach the animals and man through the food chains.

Chemicals like iron, lead, mercury, copper, zinc, cadmium, aluminium, cyanides, acids, and alkalies etc. are present in industrial wastes and reach the soil either directly with water or indirectly through air. (e.g. through acid rain). The improper and continuous use of herbicides, pesticides and fungicides to protect the crops from pests, fungi etc. alter the basic composition of the soils and make the soil toxic for plant growth.

Radioactive wastes from mining and nuclear processes may reach the soil via water or as 'fall-out'. From the soil they reach the plants and then into the grazing animals (livestock) which

ultimately reaches man through milk and meat etc, resulting in retarded and abnormal growth of man.

Nitrification, which is the process of forming soluble nitrates from the elemental atmospheric nitrogen or from originally harmless organic materials actually contribute towards water pollution when the nitrates leach out of the soil and accumulate to toxic levels in the water supply.

10.6.3 Causes of Soil Pollution :

The causes (or source) of soil pollution can broadly be classified into two categories, namely direct causes and indirect causes. The direct sources harm the soil much more than the indirect sources. Different sources in each category are the following.

Direct Causes : Various direct causes are :

1. Poor management of solid and liquid waste disposal such as
   - Sewage and sludge
   - Industrial waste
   - Domestic waste
   - Agricultural waste
2. Use of Chemicals to raise the crop yields
3. Amproper sanitation methods
4. Salination
5. Soil erosion
6. Water-logging floods and land undulations etc.
7. Disposal of medical waste
8. Wet lands due to always full irrigational canals

Indirect Causes - These are :

1. Disposal of radioactive substances aulizi off tobom
2. Acid rain

10.6.4 Effects of Soil Pollution :

The injurious effects of soil pollution are listed below.

1. Water mixed with human excretes, sewage and sludge kills the micro-organism and reduces the fertility of soil.

2. Garbage, sludge and dead animals create bad odour which causes chronic diseases
3. Urban solid wastes such as rubbish, broken articles etc, obstruct the public passage (roads, lanes etc.).
4. Pesticides seep gradually through the soil and contaminate the underground drinking water storage.
5. Pesticides affect the normal metabolism and tissues, and also cause dizziness, tremass, weakness etc.
6. Fluorides absorbed by alpaline soils reach to cereal crops (maize, jawar etc.) on consumption which causes fluorosis.

10.6.5 Control Measures for Soil Pollution :

The pollution of soil can be controlled by adopting the following means

1. By minimizing the generation of solid wastes.
2. By reusing and recycling of solid wastes such as
   • Paper • Metal parts • Thermoplast type plastics • Glass articles
3. By employing proper disposal methods such as
   - Incineration of non-biodegradable solids
   - Composting of biodegradeable solids sho
   - Sanitary landfilling
   - Pulverization
4. By treating heavy metals and toxins found in wastes liquid pollutants.
5. By minimizing the use of artificial fertilizers, and increasing the use of biological fertilizer.
6. Faulty sanitation practices should be improved.
7. Soil erosion should be prevented (For details, see chapter 3).
8. Methods should be adopted to reduce the salination of soil (see details in chapter 3)
9. By increasing the infiltration of rain water.
10. By reducing wind erosion by growing vegetation cover.
11. Extensive afforestation and community forestry programmes should be launched to prevent soil erosiion and soil degradation.
12. Formulation of stringent pollution control legislation and their effective implementation.

10.7 NOISE POLLUTION :

10.7.1 Introduction :

Creation of sound is a means of communication. Sound can be of different intensities. A low intensity sound is pleasant, whereas a loud sound is unpleasant. A loud intensity sound is generally referred to as 'noise'. Whether a given sound is pleasant or not, depends on its intensity of loudness, rhythm, duration, and also the mood of the person. It may be a pleasant sound as that of the musical instruments, and unpleasant sound as that of a 'cracker'.

Thus, noise pollution may be defined as 'a sound of unpleasant and annoying nature'. It is a physical form of pollution which is different from the air, water and soil pollutions. Noise pollution is the result of increased industrialization, urbanisation and over-population.

Measurement of intensity of sound/noise. The intensity of sound is measured in the unit of decibel (dB). The decibel scale extends from 0 to 140. A sound of 140 dB is much irksome. Noise level of various sound sources are depicted in the following table.

Table - Noise level of various sources of sound

S.No.	Sources of Sound	Sound Level (dB)
1.	Threshold hearing	≈00
2.	Normal breathing	20
3.	Rustling of leaves due to gentle wind	20
4.	Whispering sound	30
5.	Conversation between two people, one meter apart	40
6.	Normal conversation	50
7.	A small quiet restaurant	60
8.	Traffic on a busy road	70
9.	Small-scale factory e.g. printing press	80
10.	Large-scale factory	90
11.	Jet aircraft upto 300m height	100 to 110
12.	Lightening sounds and thunder	120
13.	Jet aircraft at take off point	150
14.	Rocket engine	180 to 190

10.7.2 Sources of Noise Pollution :

Following are the major sources of noise pollution.

1. Industrial sources such as
   - Steel rolling mills
   - Printing presses
   - Textile mills
2. Transportation sources such as
   - Auto vehicles
   - Trains
   - Aeroplanes
3. Household sources such as
   (i) Indoor noises e.g. of playing children, T.V. and radio, loud conversation, crying of infants, collision of utensils, banging of doors etc.
   (ii) Domestic gadgets e.g. fans, washing machines, desert coolers, mixer-grinder etc.
4. Public address system sources such as
   (i) loud speaker at the occasion of a festival, religious function, marriage function, demonstration. etc.
5. Agricultural machines sources such as
   - Threshers
   - Tractors
   - Tubewells
   - Other farm machineries
6. Defence equipment sources such as
   - Military battle tanks
   - Bomb explosion
   - Exercise of military aeroplanes
   - Shooting practices etc.
7. Other miscellaneous sources such as
   (i) Commercial advertisement
   (ii) Scientific testing e.g. in rocket launching offs
   (iii) Road construction machineries
   (iv) Stone crushers
   (v) Civil engineering construction works etc.

10.7.3 Effects of Noise Pollution :

The effect of noise has far-reaching consequences. It has physical, physiological and psycological effects. The noise is generally harmful and poses serious health problems. Main effects of noise are the following.

1. Physical effects such as
   - Temporary impairment of hearing
   - Permanent deafness
   - Damage to tympanic membrane
   - Damage to ear drum
2. Physiological effects such as
   - Headache
   - Narrowing of arteries
   - Pain in heart
   - Reduced right vision
   - Muscular strain
   - Reduced concentration of memory
3. Psychological effects such as
   - Depression
   - Fatigue
   - Disturbed sleep
   - Emotional disturbance

Human ears have sensor cells for hearing. If these cells are subjected to repeated sounds of high intensity, they can become permanently damaged and may lead to impairment of hearing. Besides the sensory cells, the delicate tympanic membrane or the ear durm can also be permanently damaged by a sudden loud noise such as an explosion. Noise pollution level and its harmfuls effects are displayed in the following table.

Table - Noise pollution level and its harmful effects

Noise level (in dB)	**Effects**
upto 30	Almost no disturbance
30-60	Tension, psychological effects illness, heart problems
60-90	Disturbance in stomach, gall function, pain in muscles, high blood pressure, disturbed sleep
60-120	Severe health problems and diseases
Above 120	Painful effects in long run.

10.8 CONCLUSION :

This lesson may gives the different types of pollution and their courses and what are the effects of the pollution on human health and as well as environment and also about to know the controlling measures.

10.9 GLOSSARY / KEY WORDS :

1. **DDT** : Dichloro diphenyl trichloro ethane (DDT) is an insecticide used in agriculture.

2. **Pollutant :** A substance that pollutes something, especially water or the atmosphere. Ex. "chemical pollutants"
3. **Pulverization :** The process of applying an external force to a (solid) material of a certain size to destroy it and reduce it into pieces that are smaller than the original size.

10.10 SELF ASSEMENT QUESTIONS :

1. What is Environmental Pollution? What are the different types of pollution?
2. Define Air Pollution and it sources, courses, effects on environment?
3. Define Water Pollution and it sources, causes, effects?
4. Define the Soil Pollution and it sources, courses, effects and controlling measures?
5. Define the Noise Pollution as it sources, causes and effects?

10.11 SUGGESTED READINGS :

1. Environment Pollution & Protection - Dr. Prem Lata Meena, Dr. Chandra Mohan, Mr. Kauahal Kumar, Dr. Amit Kumar Rawat.
2. Environmental Pollution - N. Manivasakan.
3. Environmental Pollution Analysis - S.M. Khopkar
4. Elements of Environmental Pollution Control - O.P. Gupta.

Dr. Ch. Sunitha

LESSON - 11

GREEN HOUSE EFFECT AND GLOBAL WARMING

AIMS AND OBJECTIVES :

At the end of this unit, the Learners will be able to understand :

- To know what the "green house effect" is and its impact on natural ecosystems.
- Describe how the Earth's natural greenhouse effect works.
- To understand global warming's effects on the sea and other natural resources.
- Understand methods of increasing and decreasing the greenhouse effect as well as global warming.
- Finally, the learner acquires a complete outlook on the global warming, how it will effect life of the nature and human beings also.

STRUCTURE OF THE LESSON :

11.1 INTRODUCTION :

The greenhouse effect and global warming are two of the major threats the world is facing today. The greenhouse effect is the way in which heat is trapped close to Earth's surface by "greenhouse gases." These heat-trapping gases can be thought of as a blanket wrapped around Earth, keeping the planet toastier than it would be without them. Greenhouse gases include carbon dioxide, methane, nitrous oxides, and water vapor. (Water vapor, which responds physically or chemically to changes in temperature. Global warming refers to the increasing temperature of the Earth's climate system and its related effects. Scientific evidence has conclusively proven that the Earth's temperature is in fact rising and has risen by 0.85oC. This has an impact that has affected different regions differently. The effects include rising sea levels, retreating glaciers, loss of sea ice in the poles, warming global temperatures, changing precipitation, expansion of deserts, etc. In the 21st century, these have been the hottest years on record, with constant occurrences of extreme weather, cyclones, droughts, floods, etc. All these events in some way or another have an association with the greenhouse effect and global warming.

11.2 GREENHOUSE EFFECT :

The trapping and emission of radiation by the greenhouse gases present in the atmosphere is known as the Greenhouse effect. Without this process, Earth will either be very cold or very hot, which will make life impossible on Earth. The greenhouse effect is a natural phenomenon. Due to wrong human activities such as clearing forests, burning fossil fuels, releasing industrial gas in the atmosphere, etc., the emission of greenhouse gases is increasing. Thus, this has, in turn, resulted in global warming. We can see the effects due to these like extreme droughts, floods, hurricanes, landslides, rise in sea levels, etc. Global warming is adversely affecting our biodiversity, ecosystem and the life of the people. Also, the Himalayan glaciers are melting due to this.

11.3 CAUSES OF GREENHOUSE EFFECT :

There are broadly two causes of the greenhouse effect :

1. Natural Causes :

Some components that are present on the Earth naturally produce greenhouse gases. For example, carbon dioxide is present in the oceans, decaying of plants due to forest fires and the manure of some animals produces methane, and nitrogen oxide is present in water and soil. Water Vapour raises the temperature by absorbing energy when there is a rise in the humidity. Humans and animals breathe oxygen and release carbon dioxide in the atmosphere.

2. Man-made Causes :

Burning of fossil fuels such as oil and coal emits carbon dioxide in the atmosphere which causes an excessive greenhouse effect. Also, while digging a coal mine or an oil well, methane is released from the Earth, which pollutes it.

- **Fossil fuel burning :** Coal, oil and natural gas are fossil fuel which is utilized for transportation and electricity generation among others. Burning of fossil fuels releases enormous amounts of carbon dioxide into the air.
- **Farming :** Fertilizers' used during farming releases greenhouse gas nitrous oxide. It is a major cause of global warming.
- **Deforestation :** Rampant deforestation is a common cause of greenhouse effect owing to reduction of oxygen release and absorption of carbon dioxide by plants. Moreover, when wood is burnt, the stored carbon is further released into the environment.
- **Population increase :** Population explosion in different parts of the world has caused enormous pressure on existing resources, which is finite. Higher demand has caused a substantial increase in manufacturing, causing greater emission of harmful gases.
- **Landfill and industrial waste :** Landfill of industrial produce and industrial waste emanating from coal mining activities, cement production, and oil extraction among others lead to the generation of harmful greenhouse gases.

11.4 CONSEQUENCES OF GREENHOUSE EFFECT :

The major consequences of Greenhouse Effect are –

- Ozone layer depletion
- Global warming
- Environmental degradation
- Extinction of species

11.5 PREVENTION MEASURES OF GREENHOUSE EFFECT :

1. Conservation of Energy :

Conservation of energy can substantially cut down emission of greenhouse gases. It is due to the fact that maximum industrial process and electricity production is dependent on consumption of fossil fuel. Increased usage of alternative or renewable energy will facilitate energy conservation.

2. Afforestation :

Planned afforestation on a large scale will help in higher absorption of carbon dioxide from the atmosphere. Barring at night, green plants absorb carbon dioxide and release oxygen into air.

3. Public Transportation :

Close to 30% of greenhouse gases are emitted by various modes of transport. Developed public transportation system helps to reduce number of automobiles that run of regular basis, eventually cutting down harmful gases emission.

4. Policy Intervention :

There is a greater need for policy intervention by government both in terms of framing appropriate regulations and enforcement. International cooperation is important to make such policies a success.

All the countries of the world are facing the ill effects of global warming. The Government and non-governmental organizations need to take appropriate and concrete measures to control the emission of toxic greenhouse gases. They need to promote the greater use of renewable energy and forestation. Also, it is the duty of every individual to protect the environment and not use such means that harm the atmosphere. It is the need of the hour to protect our environment else that day is not far away when life on Earth will also become difficult.

11.6 GLOBAL WARMING :

From the beginning of the Industrial Revolution, the global annual temperature has increased in total by a little more than 1 degree Celsius, or about 2 degrees Fahrenheit. Between 1880—the year that accurate recordkeeping began—and 1980, it rose on average by 0.07 degrees Celsius (0.13 degrees Fahrenheit) every 10 years. Since 1981, however, the rate of increase has more than doubled: For the last 40 years, we've seen the global annual temperature rise by 0.18 degrees Celsius, or 0.32 degrees Fahrenheit, per decade.

11.6.1 Causes of Global Warming :

Global warming occurs when carbon dioxide (CO_2) and other air pollutants collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface. Normally this radiation would escape into space, but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter. These heat-trapping pollutants specifically carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorinated gases are known as greenhouse gases, and their impact is called the greenhouse effect. Though natural cycles and fluctuations have caused the earth's climate to change several

times over the last 800,000 years, our current era of global warming is directly attributable to human activity specifically to our burning of fossil fuels such as coal, oil, gasoline, and natural gas, which results in the greenhouse effect. In the United States, the largest source of greenhouse gases is transportation (29 percent), followed closely by electricity production (28 percent) and industrial activity (22 percent).

Curbing dangerous climate change requires very deep cuts in emissions, as well as the use of alternatives to fossil fuels worldwide. The good news is that countries around the globe have formally committed as part of the 2015 Paris Climate Agreement to lower their emissions by setting new standards and crafting new policies to meet or even exceed those standards. The not-so-good news is that we're not working fast enough. To avoid the worst impacts of climate change, scientists tell us that we need to reduce global carbon emissions by as much as 40 percent by 2030. For that to happen, the global community must take immediate, concrete steps: to decarbonize electricity generation by equitably transitioning from fossil fuel–based production to renewable energy sources like wind and solar; to electrify our cars and trucks; and to maximize energy efficiency in our buildings, appliances, and industries.

11.6.2 Impact of Global Warming :

The impacts of global warming are being felt everywhere. Extreme heat waves have caused tens of thousands of deaths around the world in recent years. And in an alarming sign of events to come, Antarctica has lost nearly four trillion metric tons of ice since the 1990s. The rate of loss could speed up if we keep burning fossil fuels at our current pace, some experts say, causing sea levels to rise several meters in the next 50 to 150 years and wreaking havoc on coastal communities worldwide.

- Disappearing glaciers, early snowmelt, and severe droughts will cause more dramatic water shortages and continue to increase the risk of wildfires in the American West.
- Rising sea levels will lead to even more coastal flooding on the Eastern Seaboard, especially in Florida, and in other areas such as the Gulf of Mexico.
- Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All of these can 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 ragweed, higher levels of air pollution, and the spread of conditions favorable to pathogens and mosquitoes.

In recent years, China has taken the lead in global-warming pollution, producing about 26 percent of all CO2 emissions. The United States comes in second. Despite making up just 4 percent of the world's population, our nation produces a sobering 13 percent of all global CO2

emissions nearly as much as the European Union and India (third and fourth place) combined. And America is still number one, by far, in cumulative emissions over the past 150 years. As a top contributor to global warming, the United States has an obligation to help propel the world to a cleaner, safer, and more equitable future. Our responsibility matters to other countries, and it should matter to us, too.

11.7 OCEAN ACIDIFICATION :

Ocean acidification refers to a reduction in the pH of the ocean over an extended period of time, caused primarily by uptake of carbon dioxide (CO2) from the atmosphere. For more than 200 years, or since the industrial revolution, the concentration of carbon dioxide (CO2) in the atmosphere has increased due to the burning of fossil fuels and land use change. The ocean absorbs about 30 percent of the CO2 that is released in the atmosphere, and as levels of atmospheric CO2 increase, so do the levels in the ocean. When CO2 is absorbed by seawater, a series of chemical reactions occur resulting in the increased concentration of hydrogen ions. This increase causes the seawater to become more acidic and causes carbonate ions to be relatively less abundant.

Carbonate ions are an important building block of structures such as sea shells and coral skeletons. Decreases in carbonate ions can make building and maintaining shells and other calcium carbonate structures difficult for calcifying organisms such as oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton. These changes in ocean chemistry can affect the behavior of non-calcifying organisms as well.

11.8 OZONE LAYER DEPLETION :

The ozone layer is mainly found in the lower portion of the earth's atmosphere. It has the potential to absorb around 97-99% of the harmful ultraviolet radiations coming from the sun that can damage life on earth. If the ozone layer was absent, millions of people would develop skin diseases and may have weakened immune systems. However, scientists have discovered a hole in the ozone layer over Antarctica. This has focused their concern on various environmental issues and steps to control them. The main reasons for the ozone hole are chlorofluorocarbons, carbon tetrachloride, methyl bromide and hydro chlorofluorocarbons.

"Ozone layer depletion is the gradual thinning of the earth's ozone layer in the upper atmosphere caused due to the release of chemical compounds containing gaseous bromine or chlorine from industries or other human activities." This happens when the chlorine and bromine atoms in the atmosphere come in contact with ozone and destroy the ozone molecules. One chlorine can destroy 100,000 molecules of ozone. It is destroyed more quickly than it is created. Some compounds release chlorine and bromine on exposure to high ultraviolet light, which then contributes to ozone layer depletion. Such compounds are known as Ozone Depleting Substances (ODS).

The ozone-depleting substances that contain chlorine include chlorofluorocarbon, carbon tetrachloride, hydro chlorofluorocarbons, and methyl chloroform. Whereas, the ozone-depleting substances that contain bromine are halons, methyl bromide, and hydro bromo fluorocarbons. Chlorofluorocarbons are the most abundant ozone-depleting substance. It is only when the chlorine atom reacts with some other molecule; it does not react with ozone. Montreal Protocol was proposed in 1987 to stop the use, production and import of ozone-depleting substances and minimize their concentration in the atmosphere to protect the ozone layer of the earth.

11.9 ACID RAINS :

Acid rain is the most serious environmental problems emerged due to air pollution. Acid rain is particularly damaging to lakes, streams and forests, and the plants and animals that live in these ecosystems. Rain is one of the most essential ingredients for human and animal life. The water provided by rain allows all life on Earth to survive. Although rain is naturally acidic, it is being increasingly acidified by pollution from homes, factories, power stations and cars. The term used to describe this problem is “acid rain”. Acid rain hasn’t just occurred in the last twenty to thirty years. This was over 100 years ago. For years ever since most of the world has been industrialized, the effects of pollution have plagued nations alike. Acid rain is one of the largest contributors to this industrialized form of pollution.

11.10 CONCLUSION :

The major climate change due to global warming is definitely a significant increase in global temperature. Moreover, the rise in temperature is the reason behind many deaths. It is also the cause of the increase in the incidence rate of some diseases such as dengue, malaria, etc. Global warming is a threat to animals and plants. It is disturbing the entire ecological balance of the environment. Melting of polar ice caps and glaciers is increasing the rise in the water levels (sea and ocean) all around the globe. Furthermore, freshwater resources are reducing day by day. According to scientific organizations like NASA, WHO and such, global warming is responsible for extreme weather incidences, ocean acidification, and many other similar impacts that are affecting the society and nature. However, it is possible to cease these drastic problems by adopting proper changes to our very own lifestyle. Regulatory bodies and the governments across the globe should enforce proper policies to decrease the release of greenhouse gases in the atmosphere. Government and regulatory bodies like United Nations are actively trying to enforce policies to stop the effect**.** Therefore, it is very important to participate in strong international agreements by countries across the globe and together work to save the planet and change the environment.

11.11 GLOSSARY / KEYWORDS :

- **Hurricanes :** Tropical cyclones
- **Depletion :** Reduction in the number or quantity of something

- **Extinction :** The dying out or extermination of a species.
- **Fossil fuel :** Formed from the fossilized, buried remains of plants and animals that lived millions of years ago.
- **Acidification :** The action or process of making or becoming acidic.

11.12 SELF ASSESSMENT QUESTIONS :

1. Write an essay on green house effect and Global warming.
2. Give a detailed note on effects of green house gases on animals and human beings.
3. What is the relation between green house gases and global warming.

11.13 SUGGESTED READINGS :

1. Environmental Science Towards A Sustainable Future, Richard T. Wright, PHI Learning Pvt. Ltd.
2. Environmental Management (Text and Cases), Bala Krishnamoorthy, PHI Learning Pvt. Ltd.
3. Environmental Chemistry, A.K.De, New Age International (P) Limited, Publisheres, New Delhi.

Dr. P. Brahmaji Rao

LESSON - 12

THREATS TO BIODIVERSITY

AIMS AND OBJECTIVES :

In this unit, we will first discuss in detail the various values that biodiversity provides to us humans. This will help us understand and realize the immense importance of biodiversity for our survival and sustenance. Following this, the major anthropogenic threats on biodiversity will be discussed in detail, which will help understand the major reasons for the ongoing sixth mass extinction crisis that earth faces today.

At the end of this unit, we will be able to :

- To know basic information about the relationship between man and the environment.
- To know how man influences his surroundings with his intelligence.
- To understand major threats of biodiversity and its role in environmental destruction.
- Finally, the learner acquires a complete outlook role of biodiversity in human welfare and how biodiversity effected by human activities.

STRUCTURE OF THE LESSON :

12.1 INTRODUCTION :

Biodiversity has a very fundamental value to human and our very existence is intricately linked to it. On one hand, we are dependent on biodiversity for our very basic necessities and everyday sustenance, while on the other hand, we are also dependent on it for

economic, cultural and environmental well-being. As the biotic component of any ecosystem, biodiversity forms the backbone for ecosystems to thrive and function efficiently. The three components or levels of biodiversity – genes , species and ecosystems – are collectively called as biological resources. All three components provide humans with a wide range of goods and services which together constitute the value of biodiversity. No wonder, that for any nation, their greatest wealth is contained within forests, wetlands, grasslands, mountains, freshwater and marine habitats. All these ecosystems provide invaluable and irreplaceable benefits to humankind. Biological diversity is threatened with extinction crisis due to unregulated exploitation by humans. The threat of a sixth mass extinction seems a reality, that is driven mainly by human activities, with thousands of species facing a bleak future. Habitat loss, degradation and fragmentation, overharvesting and overconsumption, poaching, animal trade, human wildlife conflict and invasive species are the major threats endangering numerous species. Human beings are intricately linked to biodiversity, and the loss of biodiversity is going to have devastating consequences with respect to our very own survival.

12.2 CURRENT MASS EXTINCTION CRISIS :

The rapid and large scale loss of biodiversity has led scientists to predict that earth today is facing the imminent threat of a sixth mass extinction. A **mass extinction** is usually defined asa loss of about three quarters of all species in existence across the entire Earth over a "short" geological period of time. Considering that the age of earth is about 4.5 billion years and life first evolved about 3.5 billion years ago, "short" is defined as anything less than 2.8 million years. There have been five mass extinctions till date, the first one occurring about 540million years ago and the fifth one occurring about 60 million years ago. All these five mass extinctions were a result of drastic, but completely natural, alterations in the environment during the respective time periods. However, according to scientists the current (sixth) mass extinction is different from the previous ones in two aspects: a) the rate of extinction of species is much higher, and b) the current extinction is entirely due to anthropogenic reasons. It has been predicted that more than 1 million species are on track for extinction in the coming decades. Two in five amphibian species one-third of reef-forming corals, one in ten species of insects and close to one-third of other marine species are at risk of extinction. Our planet indeed faces a global extinction crisis that has never been witnessed and the ultimate reason can be attributed to human overpopulation and overconsumption. What is more worrying is that It would likely take earth several million years of evolution to restore the biodiversity that is being rapidly lost due to human actions. It is therefore imperative that we try to understand the biggest anthropogenic threats that biodiversity faces today. These are habitat loss, poaching of wildlife, overharvesting, invasive species and human wildlife conflicts. A proper understanding of these threats is important for everyone to contribute towards the goal of protecting and preserving the precious biodiversityof this earth.

12.3 THREATS TO BIODIVERSITY :

Biodiversity today is facing an extinction crisis. The world’s flora and fauna is under serious threat from anthropogenic (human) activities. From rainforests to savannahs, from

coniferous forests to corals beneath the oceans, millions of species are at risk of extinction. The health of ecosystems is deteriorating rapidly which, in turn, is impacting the very species that depend on them, all of which is largely a result of human actions. This large scale biodiversity loss is gradually having detrimental impacts on livelihoods, economies, food security health and overall quality of life.

12.3.1 Habitat Loss :

Habitat loss is one of the biggest threats to biodiversity and the major reason for species going extinct. **Habitat** generally refers to the part of the ecosystem required by a particular species for food, shelter, protection and mates for reproduction. Human destruction of habitats has exponentially increased since the beginning of twentieth century. Cutting down forests for agriculture, plantations, urbanization and mining, levelling wetlands to build houses and other infrastructure, and creating dams that impact the flow of rivers, forest fires are all examples of habitat destruction. It has been estimated that about 18 million acres of forest are destroyed each year, due to various anthropogenic practices, thereby damaging the ecosystems on which many species depend. The impact is particularly severe in tropical rainforests, which hold a high percentage of the world's known species. For example, the Amazon rainforests have lost 750,000 square kilometers across Brazil, Peru, Colombia, Bolivia, Venezuela, Suriname, Guyana, and French Guiana; in west Africa, 90 percent of the coastal rainforest has already been destroyed while in Congo Basin (Cameroon, Central African Republic (CAR), Democratic Republic of Congo (DRC), Republic of the Congo, Equatorial Guinea and Gabon) deforestation has doubled since 1990; the Western Ghats in India has lost about 33,579 sq km or 35.3 percent of the total forest over the last nine decades; while in Southeast Asia, about 80 million hectares of forest have been destroyed between 2005 and 2015.

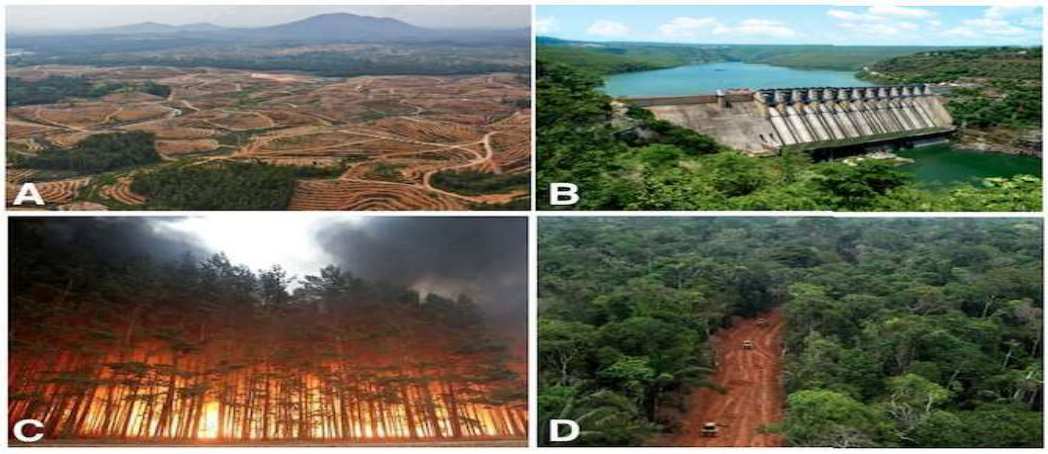


Fig 1. Anthropogenic activities resulting in habitat loss are the most significant threat to biodiversity.

A) Habitat loss due to deforestation, B) Habitat alteration due to dam construction,
C) Habitatdegradation and loss due to forest fires, and
D) Habitat fragmentation due to road construction.

Habitat loss is not just restricted to tropical forests. Large areas of temperate forests, grasslands, wetlands, coral reefs (which are also called the "rainforests of the sea") and marine ecosystem have been demolished for developmental activities, meeting various human needs and have been degraded due to pollution. Rivers and streams, which are vital freshwater ecosystems harbouring unique biodiversity have been impacted due to habitat modification. Constructing dams over rivers affects the water flow and modifies the habitat. Altering a flow regime can reduce or eliminate populations that are adapted to seasonal changes in flow. Furthermore, pollution of freshwater and marine water sources due to sewage and industrial discharge, dumping of waste, mining, oil spills etc degrades the habitat of aquatic organisms to a very harmful extent.

12.3.2 Poaching of Wildlife :

Poaching, the illegal hunting or capture of wildlife for trade and commercial activities, has been on the rise for the last many decades. Poaching has been a significant cause of the extinction of hundreds of plant and animal species and many more becoming endangered. Although poaching is illegal, the huge demand for body parts of specific animals, or need of animals for pet trade and even as source of food has led to growth of this illegal activity. Scientists and conservationists consider that poaching is detrimental to biodiversity both within and outside protected areas. And as biodiversity declines, it will ultimately affect theproper functioning of ecosystems.

Fig 2. Elephant tusk products are illegally sold for very high prices in many countries of the world resulting in large scale elephant poaching.
Reference:*www.express.co.uk/news/nature/705713*

Globally, illegal wildlife trade is estimated to be between $7 billion and $23 billion annually. Elephants are killed for ivory; rhinos for their horns, pangolins for meat and scales; tigers andleopards for their skin and for use in medicine; Elk, musk deer, wolves, and bears are traded regularly since they are used as trophies and in Asian medicine markets; migratory

birds are hunted for meat; polar bears are killed by indigenous communities as a source of food; and rare timber is targeted for hardwood furniture. All this has resulted in massive decline of species' populations, especially large charismatic mammal species which are the ones that aremost often hunted.

12.3.2.1 Impacts of Poaching on Biodiversity :

Poaching, as mentioned earlier, has profound impact on biodiversity. These include :

a. **Loss of population :** A number of mammal, reptile and bird species are already in threatened categories (IUCN category CR, EN and VU) and poaching is a constant threat that decreases their numbers steadily. In combination with the threat of habitat loss and human wildlife conflicts, many of these populations can become locally extinct. Thus animal populations in the wild face the threat of possible extinction.

b. **Impact on food chain :** Since poaching results in decrease in population size of species, italters the delicate balance of food chains in an ecosystem. Many of the species which are killed are apex predators (an animal at the top of a food chain, which has no natural predators) or keystone species, due to which there is drastic change numbers of organisms below them in the food chain, which ultimately creates an imbalance in the ecosystem. This can have catastrophic impact on the ecosystem.

c. **Increasing cases of Zoonotic diseases :** Zoonotic diseases or **Zoonoses** are diseases caused by micro-organisms that are passed between animals and people. These diseases originate in animals and then shift to humans. Zoonotic diseases can be caused by viruses, bacteria, parasites or fungi and occur throughout the world. It may cause mild or severe illness or even death in some cases. Once in humans, the disease may first become a local outbreak, and then subsequently become an **epidemic** (a disease that affects a large number of people within a community, population or a region) and in some case it can become a **pandemic** (a disease that spreads over multiple countries and infects a very high proportion of the world's population). The recent incidences of SARS, Ebola fever, Swine flu and COVID 19 are examples of zoonotic diseases. Scientists believe the major reasons for increase in incidences of zoonotic diseases is increasing invasion of animal habitats by people, poaching activities and trade of animals, all of which results in more interactions between humans and animals.

d. **Decline in wildlife tourism :** Areas that are famous for wildlife tourism face a negative publicity due to poaching as the chances of encountering a charismatic animal in these areas decrease. The tourists also face facing security issues and other restrictions. Thus there is a decrease in the tourism based income and job opportunities for local people.

12.3.3 Overharvesting :

Overharvesting, also called overexploitation, refers to harvesting a renewable resource at an unsustainable rate, to the extent that it gradually becomes non-renewable. It is a serious

threat to biodiversity as it leads to elimination of plants, animals, and other organisms thereby degrading ecosystems. Overharvesting is particularly damaging to aquatic species. Overfishing and overhunting have been major reasons for loss of biodiversity, killing off numerous species over the past several hundred years.

For example, fishing industry has been a very productive industry for the a very long time. However, the introduction of modern factory trawlers in the 1980s and the pressure on fishery industry due to increasing population and demand has led to fishing becoming unsustainable. Further, the fact that fishing grounds are considered a common resource where anybody can capture fishes, there is no regulation on the amount of fishing. With advanced technology available now, fishermen and companies involved harvest huge number of fishes leading to overexploitation.

Fig 3. Harvesting of plants and animals for human consumption in an unsustainable manner is rapidlydeclining population of a large number of species and leading them to extinction.

Ref*: A) nz.pfolsen.com/market-info-news. B) www.zo.utexas.edu/faculty/sjasper/images*

Another example is the case of **bush meat** which is a general term used for wild animals killed for food in many of the African countries. Traditionally, bush meat were hunted by rural families directly. Among indigenous communities in Africa and China, consuming specific wild animal meat is associated with traditional beliefs that it improves health and cures certain diseases. However, recent commercialization of the practice and affordability of the meat, has led to bush meat being available in stores and meat markets in these countries.

12.3.4 Invasive species :

Before we assess the impact of invasive species on the biodiversity, let us first understand what exactly is introduced species. **Introduced species**, also called as **Exotic species**, are species that have been intentionally or unintentionally introduced by humans into an ecosystem or region in which they were not naturally present previously. Such introductions are always mediated by humans. In cases where species are introduced intentionally, the reasons can include population control of some native species, for boosting agriculture and fisheries, for conservation efforts, for ornamental value or for some economic value.

In many cases, exotic species fail to adapt to the new ecosystem and die off. In some cases, they successfully adapt and serve the purpose for which they were introduced. However in few cases, exotic species not just adapt in the new region, but also undergo extensive population expansion. This leads to alteration of the ecological conditions of that ecosystem, to an extent that the exotic species becomes threatening for the native species. In such a scenario, the exotic species is now termed as an invasive species. Invasive species can harm native species through competition for resources, predation or by causing diseases. The introduction and establishment of a species beyond its natural range, where it thrives and expands considerably is called as Biological invasion. Such invasions can harm native species, alter ecological interactions within an ecosystem and even affect socioeconomic conditions of a community or a region.

Impact of Invasive species :

Invasive species have some unique characteristics or traits that enable them to become invasive in the environment where it is introduced. These include, fast growth, rapid reproduction rate, high dispersal ability, tolerate a wide range of environmental conditions and some of them produce toxic secretions which keep away any predators. Invasive species cause harm to biodiversity in many ways. Invasive species often do not have any natural predators in the new environment. The invasive species can out compete native species for food, habitat or other resources, can cause them diseases, prevent native species from reproducing or in some cases, can prey upon the native species. Invasive species can alter the food web in an ecosystem by destroying or replacing native food sources. These species themselves are of little food value for wildlife as they are not the natural preference for native wild species. In such cases, the native species look for easy food options in human habitations, thereby increasing chances of human wildlife conflict. Some invasive species can change conditions in an ecosystem, such as soil chemistry or can increase the intensity of wildfires.

12.4 HUMAN WILDLIFE CONFLICTS :

Human-wildlife conflict refers to the interaction between and humans and wild animals, which results in a negative impact on peoples, animals, resources and habitats. This growing conflict is one of the main threats affecting not just the survival of many species but also the life and livelihood of local human populations. Human wildlife conflicts take place when the ever increasing human populations encroach and invade established wil life areas, creating competition for space and resources. Human-wildlife conflict is a global issue occurring in urban as well as rural landscapes leading to injury to humans and wild animals, loss of livestock and crops, loss of property and at times loss of lives. In India, human wildlife conflicts involving leopards, snow leopards, tigers, lions, elephants, snakes, monkeys, wild boars, nilgai are quite common. The animals, many of which are already threatened or endangered, are often killed in retaliation or to 'prevent' future conflicts.

Fig 4. Human leopard encounters in rural as well as urban areas are becoming in India, due to depleting forest cover suitable habitat for the species.

Ref: www.dailymail.co.uk/indiahome/indianews.

12.5 CONCLUSION :

The major threats to biodiversity are human population growth and unsustainable resource use. To date, the most significant causes of extinctions are habitat loss, introduction of exotic species, and overharvesting. Climate change is predicted to be a significant cause of extinctions in the coming century. Habitat loss occurs through deforestation, damming of rivers, and other activities. Overharvesting is a threat particularly to aquatic species, while the taking of bush meat in the humid tropics threatens many species in Asia, Africa, and the Americas. Exotic species have been the cause of a number of extinctions and are especially damaging to islands and lakes. Exotic species' introductions are increasing because of the increased mobility of human populations and growing global trade and transportation. Climate change is forcing range changes that may lead to extinction. It is also affecting adaptations to the timing of resource availability that negatively affects species in seasonal environments.

12.6 GLOSSARY / KEY WORDS :

- **Mass extinction** : It is usually defined as a loss of about three quarters of all species in existence across the entire earth over a "short" geological period of time (roughly corresponding to 2.8 million years).
- **Poaching** : It is the illegal hunting or capture of wildlife for trade and commercial activities.
- **Epidemic** : It is a disease that affects a large number of people within a community, population or a region.

- **Invasive species :** These are species that are introduced into a new ecosystem or region by humans, and which can harm native species through competition for resources, predation or by causing diseases.
- **Biological invasion :** The introduction and establishment of a species beyond its natural range, where it thrives and expands considerably is called as Biological invasion.

12.7 SELF ASSESSMENT QUESTIONS :

1. Briefly describe the sixth mass extinction crisis.
2. Explain why habitat loss is the biggest threat to biodiversity.
3. Enlist the major reasons that result in human wildlife conflict in India.

12.8 SUGGESTED READINGS :

1. Essentials of Ecology and Environmental Sciences, SVS Rana, PHI Learning Pvt. Ltd.
2. Environmental Studies from Crisis to Cure, Rajagopalan, Oxford University Press, New Delhi.
3. Biodiversity, Edward O. Wilson, Frances M. Peter, National Academies 1988

Dr. K. Sasidhar

LESSON - 13

SOLID WASTE MANAGEMENT

AIMS & OBJECTIVES :

At the end of lesson the learner would understand

- To gain the knowledge about Solid Waste Management.
- Knowledge about the types of Solid Waste.
- Knowledge about the Solid Waste Management problem in Urban areas.
- Knowledge about how to manage Solid Wastes.

STRUCTURE OF THE LESSON :

13.1 INTRODUCTION :

Human activity, either domestic or industrial, produces waste materiais to greater or lesser extent always. These wastes can be liquid wastes or gaseous wastes or solid wastes. Nature also has many solid wastes that have to be taken care of during the functioning of natural

systems. In almost all natural activities involved, any waste produced by any individual species is taken care of by other organisms, since much of the solid waste is of organic nature, and hence gets into food cycle. The ecological cycles are such that organic matter is mineralized by decomposers and thus connect the abiotic and biotic systems. The rate of conversion of some compounds like the cellulose, tannins and lignin etc., may be slow but active always. Some of the plant materials that get buried, travel deep down into bowls of earth and get carbonized forming the fossil fuels over a period of thousands of years.

Problems of wastes are generated from human activity. The more advanced is the society economically, the more complex wastes are generated because of the use of synthetics. Rural practices developed using natural materials for human use and it is the advancement of technology aiming at permanency and better efficiency that produce exotic waste materials challenging the engineer to find safe solutions for disposal. In addition to the quality changes in the waste materials, quantities per capita also increased over recent years. One can see the heaps, nay, the mountains of garbage dumps in most of the cities around us. Irrespective of its fate, man wants the waste to be out of his sight. Even though water supply started with the main idea of safe drinking water supply, soon demand on the quantity of water increased, both due to cultural developments and increase in populations. The story of solid wastes is no different. The solid waste problem is much more severe in urban environments.

13.2 TYPES OF SOLID WASTES :

Most offensive, extremely infective, unpleasant solid waste produced by human communities is the fecal matter, produced at an average rate of 500 g per capita per day wet weight. Developed countries use water carriage system to carry away the offensive material from their places of dwelling. A semi solid waste becomes a suspended liquid waste material utilizing almost 20-30 liters of good water, just for transport. When unlimited quantities of fresh water were available nobody bothered about the use of water for such purpose. Prior to water carriage system was the conservancy system which was to collect the fecal material from house to house by workers. This is considered to be a mean job below the dignity of man. Even today many cities and towns in almost all developing countries have this kind of situation with a few changes in collection mechanism. Today people are advocating either septic tanks (which are not functioning and are of highly limited use) or compost pits. Disposal of human excreta is of primary importance in solid waste disposal but mostly considered under environmental sanitation subject in many books and institutions. Diverging from that concept, solid waste disposal is discussed here from the basic needs of the community, before taking up the refuse, garbage and other solid wastes of importance of today.

13.3 DOMESTIC SOLID WASTE PRODUCTION :

Day to day activities in the home, offices, commercial establishments and industries produce kind of solid wastes. Everyday sweeping of floors, getting rid of used waste food

materials, cleaning the cooking vessels, news paper, torn clothes, plastic bags broken glass are some of these. Depending on the economic condition people either throw away materials or sell them to waste material buyers, in our country. In many middle-income group families, reuse of many materials is a common practice. This habit reduces the waste volume.

The following may be in urban domestic wastes :

- Kitchen wastes containing.
- Paper waste
- Metals
- Glass
- Leather / rubber
- Plastics
- Ashes & inert matter

The mixed solid waste other than fecal matter is thrown out in a dump to be collected by municipal workers. The house refuge consists of ashes, cinders, rubbish, debris from demolition of structures, vegetable peels, seeds bad vegetables and rotting food materials, wastes of animal origin feathers, bones, flesh, egg shells, and others. The wastes from kitchen is called garbage. The street refuse includes the road sweepings, leaves, materials thrown away by people like cigarette buts/match boxes, fruit peels, ground nut shells, paper envelopes, waste materials thrown away as useless. Industrial wastes normally are not to be included in domestic wastes. The solid wastes from commercial buildings like offices, hotels, business establishments produce a wide variety of substances. Hospitals have wastes from used needles to surgically removed fleshy materials, some of which are dangerous contaminants.

13.4 DOMESTIC WASTES HAVE THREE MAIN CHARACTERISTICS :

Weight generated density and constituents. These vary according to country and even towns within a country, depending on the extent of industrialization. The range of weight generated per person per day varies between 250 to 1000 g, worldwide. Density varies from 100 kg/cubic meter to 600 kg/cubic meter. Volume also, therefore, varies from 1/2 liter to 10 liters per person per day.

The important constituents of domestic wastes are :

Vegetable putrescible matter	20% -75%
Inert matter	5 % - 40%
Paper	2% - 60%
Glass	0% - 10%
Metals	0% - 15%

The method and capacity of storage, the correct type of collection vehicle, the optimum size of the crew and frequency of collection depend mainly on volume and density of the wastes and climate. There are potential health risks from improper handling of solid wastes, mainly to the workers. Breeding of disease vectors like flies and rats are causes of indirect risks to community. Due to leaching of water from the stored heap, surface water as well as ground water also may get contaminated. Solid waste management services are expensive because of transport costs. At least one heavy vehicle is required for every 15,000 population in a city. Salvageable materials must be identified in city refuse, since garbage is not seen as a problem but as a resource. The increase in total urban population is and solid waste generation is estimated as follows :

Table - Projection of Urban Solid Wastes

	Total population in Millions	Quantity of waste generated in million tonnes
1991	217	20.71
2001	295	39.38
2011	395	56.33
from A.D.Bhinde; 1999, Strategies for improvement of Urban Solid Waste Management in India; Touchstone Publishers and Printers, New Delhi.		

Solid waste management is not just limited to the cities. Solid Waste Management (SWM) involves managing activities associated with generation, collection transport and disposal of solid waste in an environmentally-compatible manner, adopting principles of economy, aesthetics, energy and conservation.

13.5 SOLID WASTE MANAGEMENT PROBLEM IN URBAN AREAS :

With the increasing population, migration and the rising standard of living the problem of solid waste is attaining larger and complex dimensions, requiring integrated and sophisticated interventions in terms of policies/rules and regulations and technologies.

However, this aspect has not been able to get the necessary attention in overall urban planning/management.

It is estimated that 291 Class I, and 345 Class II towns together generate 52,000 tonnes of MSW/day, which corresponds to a per capita generation of 0.346 kg/day. Out of this only about 2832 tonnes/day of MSW gets properly treated.

Due to increased pace of urbanization and industrialization, the environmental pollution problems discussed above are becoming more complex and diverse requiring innovative technologies and management plans for remediation.

With adoption of advanced process technologies under industrialization programme release of toxic and hazardous wastes have also increased due to which thrust on end on pipe treatment has now shifted to waste minimization, waste utilization, recovery of resources from wastes, cleaner process technologies and assessment of health aspects of pollution problem.

13.6 TRANSPORT OF SOLID WASTE :

The most expensive item in solid waste disposal is the costs incurred in transporting the wastes from the streets to dumping or disposal grounds. Diesel trucks, and open lorries are used in cities. Bullock/buffalo carts were used earlier but in many places these are replaced with lorries. An animal drawn cart is least polluting but is slow. At this time of energy saving plans, and reducing automobile pollution, it is worth considering improving the bullock-cart, with better mechanical efficiency, rubber tires and mechanical tippers. The animals once trained for a route perform their task of drawing the cart on the streets without much aid from the driver. Cattle numbers are also dwindling and using animals for energy may be a worthwhile suggestion. Most of the time the economics plans of solid waste disposal are upset due to the high transport costs. This can be modified with animal carts.

There are different types of lorries-petrol as well as diesel; with mechanisms to tip the carrier, or to compress the waste as it is being collected by hydraulic ram. The maintenance of the vehicles is important since corrosion is common in garbage carrying trucks. Unhygienic transport, due to the negligence of the works, by over loading the lorry and the material getting scattered along the truck route is a very common sight.

13.7 MANAGEMENT OF SOLID WASTES :

Basically there are three types of disposal techniques practiced in domestic solid wastes. Other than hospital wastes, a city normally does not have hazardous wastes mixed up in the city garbage. Even though in India, because of poverty, illiteracy and unhygienic habits fecal matter often finds its way into solid wastes and contaminates the material, in most of the other countries, where adequate disposal methods are practiced, the three main practical methods used are (1) Sanitary Land Disposal; (2) Composting, and (3) Incineration. All the three are practiced in India from olden times. Composting is common with farmers and villagers, sanitary land disposal with towns and cities, incineration with individuals and farmers in the field regarding agricultural wastes. Villagers are used to composting the animal dung mixing it with soil. Cow dung itself was used as plastering material for floors and walls and the frontage of the of a house. Excess cow dung is never wasted, but made into dry cakes and burnt as fuel. Many of old habits are replaced today. Cow dung digesters have become popular in some places when gober-gas is used as fuel and the sludge as fertilizer. Incineration as a disposal for city solid wastes is more expensive and requires more control over the operation because of air pollution. To day incineration is suggested for few hazardous wastes from community or industry.

13.8 METHODS OF LAND DISPOSAL :

Simple dumping the solid waste at the out-skirts of the city, in low lying areas, or on either side of the road at the out-skirts is very common. Uncontrolled tipping is the word used for such kind of disposal. The heap attracts rats, snakes and other seekers of hide outs. The rotting organic matter emits stinking smells. Flies and other insects breed with complete freedom. Prior to any treatment, recovery of materials that have resale value or materials that can be converted to some useful materials should be done. Actually this process goes on in our country because of earning needs of the poor. Collection of plastic bags is already mentioned. Glass bottles, good or broken are made into glass powder to be used as abrasive on the sides of match boxes. Some glass materials can be melted and made again into glass bottles. Rubber tyres are used to make crude shoes/chappals or made into granules to be mixed in making roads. Fuel gas is generated from some rubber materials. Tin and iron have re-sale value. Paper is reused by making it into pulp and handmade card-boards or handmade paper. Papiermache is a man made paper pulp from which beautiful statues and art objects are made. Putting lacquer paint on the materials, excellent art forms are made by some artists.

13.9 SANITARY LANDFILL :

Sanitary landfill can be defined as the use of solid wastes for land-reclamation. In mineral excavations, granite quarries, or soil excavation for brick making, low lying areas are created. Restoration to original level with solid wastes is a good example for sanitary landfill. Low lying areas can also be used to raise the level so that cultivation can be conducted or industrial development can take place in that area. Many solid wastes are of offensive nature, attracting disease vectors like flies and rodents. Sites for sanitary landfill are chosen for improving that environment, but for further degrading that place. Simple engineering techniques are used so that the landfill does not pose dangers to public health and environment. The wastes must be deposited and leveled in layers not exceeding about 2 meters in depth. The whole of the surface of each layer of wastes is covered with soil or other suitable material to a depth of 15-25cms on the same day as the wastes are delivered to the site. The depth of the layer is limited because of the instability of newly deposited wastes over which vehicles must pass and minimize the fire risks. Covering the wastes denies access to flies, any attempts to penetrate the waste material by rats will be immediately visible and remedies can be taken, odors are avoided, and the heat generated during the decomposition of organic matter is retained, assisting the destruction of fly larvae and pathogenic organisms in the wastes. By far, sanitary landfill is the cheapest method. Most of the solid wastes around the world are disposed of by uncontrolled dumping which spoils the land and causes serious health risks and ground water contamination. The land values of reclaimed land and its surroundings are low and hence many builders do not prefer this sanitary landfill. Crude dumping is the most common practice leading to the following hazards :

- Fly generation
- Encouragement of rodents

- Static water pollution and aerial nuisance Surface water pollution
- Fire and smoke pollution.

Decomposition in a sanitary landfill arises from chemical changes brought about by bacteria present in the organic content of the wastes. Saprophytic bacteria, fermenters and pathogenic bacteria constitute the microorganisms. During the first stage of decomposition, aerobic bacteria are dominant. Later, as oxygen declines, anaerobic bacteria take over. Facultative anaerobes are always present. Considerable temperature changes take place within the landfill. Gases like carbon monoxide, carbon dioxide, methane, hydrogen and hydrogen sulfide are produced. Organic and inorganic matter present in crude refuse and the products of decomposition can by leached by water, either rainfall or sometimes groundwater if it passes through the landfill. The leachate can be 20 to 30 times stronger than settled sewage, having a BOD of 6,000 to 7,000 mg/l. Original site where a hard road is prepared for trucks for sanitary landfill.

The heaps of wastes are leveled every day and the sides are covered by 15 to 25cms soil, sand ash or previously composted waste. In course of time all that area can be recovered.

13.10 COMPOSITING :

Under natural conditions dead vegetable and animal materials decompose under the influence of bacteria and fungi, where ever they fall and add to the fertility of the soil. In many places farmers have depended on organic manure derived from animal excreta, agricultural wastes and vegetation. Kitchen wastes and garden wastes in domestic solid wastes is of biodegradable nature. Urban areas generate domestic and commercial wastes on large scale around 300 to 800 gms/person/day. A city with a population of 1 million may generate almost 500 tonnes per day. Between 25-75 percent of this may be vegetable and putrescible matter. Composting is biological process. Just as the microorganisms in water take up biodegradable organic matter as their food, similarly microorganisms in soil also use biodegradable organic matter as food. This process can be either aerobic or anaerobic. Composting has three products; compost as an organic fertilizer, salvaged materials for resale and non-compostables as land fill materials. The aim of composting is to convert a major portion of solid wastes into marketable product.

Compost is brownish, peaty material, the main constituent of which is humus. When compost is applied to soil it lightens heavy soil, improves the texture of light sandy soil, increases water retention, and enlarges root systems of plants. It makes available additional plant nutrients since it contains N, P and K, typical percentages being N = 1.2%; P = 0.7%; and K This composition varies with material that is used for composting. When compost is used with artificial fertilizers it makes the phosphorus more readily available and prolongs the period over which the nitrogen is available, thus improves nutrient take-up by plants. All trace elements

needed by plants (micro-nutrients) are available in compost. The environment gets enriched for plant growth.

Composting needs proper control to make the process proceed without production of odors, propagation of insects, destroy pathogens present in the original wastes, destroy weed seeds, retain maximum nutrient content of N, P and K, minimize time required to complete the process and minimize the land requirement required for the process. There are two main groups of bacteria i.e. anaerobic bacteria which function in the absence of oxygen and aerobic bacteria which require oxygen. There are also some facultative organisms that can adapt to either of environment.

13.11 INCINERATION :

The third method of practice in solid waste disposal is incineration. In many places both in cities and villages, in the agricultural farms, small scale incineration takes place. It is a common sight to see small fires of burning dry leaves, paper etc., on the sides of roads. Such fires produce considerable smoke and air pollution. Even though these fires are small, a number of such fires add up to the total air pollution. Any city refuse cannot be economically subjected to incineration since the combustion has to be maintained by the amount volatile organic matter. In many cases fuel may have to be subsidized and the operation becomes expensive. Using the heat generated to produce steam leads to energy recovery. Incinerators need to have air pollution control measures to day. Certain wastes like hospital wastes must be incinerated only to avoid environmental contamination. Ultimately the ashes which may contain heavy metals have to be disposed of safely. This topic is elaborated in the handling of hazardous wastes.

13.12 CONCLUSION :

Now-a-days the major problem that we facing is the increasing of waste mostly solid waste. We are protecting our environment so we may follow the solid waste management. This solid waste management may both the Urban and Rural areas. We may folllow all the steps of solid waste management that are transport, management that are transport, management, method of land disposal, sanitary land fill and competing. Finals the competing material can be useful to our agriculture fields and also is regulates the biological cycles of N, P and K.

13.13 GLOSSARY / KEY WORDS :

1. **Leaching** : Drain away from soil, ash, or similar material by the action of percolating liquid, especially rainwater.
2. **Incineration** : The destruction of something, especially waste material, by burning. "waste disposal by incineration"

3. **Composting :** A controlled, aerobic (oxygen-required) process that converts organic materials into a nutrient-rich soil amendment or mulch through natural decomposition.
4. **Goober gas :** Biogas or **gober gas** is a clean, unpolluted and cheap source of energy in rural areas. It consists of 55−70% methane which is inflammable.

13.14 SELF ASSEMENT QUESTIONS :

1. What is Solid Waste Management?
2. Discuss types of Solid Wastes?
3. What is Domestic Solid Waste Production?
4. Discuss about Solid Waste Management Problem in Urban Areas?
5. Discuss about Management of Solid Wastes?

13.15 SUGGESTED READINGS :

1. Introduction Environmental Sciences - Y. Anjaneyulu.
2. Environmental Studies - K.MN. Gupta.
3. Environmental Studies - Dr. S. R. Myneni.
4. Solid Waste Management - Dr. K. Sasi Kumar, Sanoop Gopi Krishna.
5. Integrated Solid Waste Management - Forbes R. McDougall.

Dr. Ch. Sunitha

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LESSON - 14

ENVIRONMENTAL LAWS

AIMS AND OBJECTIVES :

At the end of lesson, the learners would understand

- Knowledge about Environmental laws in India.
- Students acquire knowledge, scope and applications about the topic and learn more about the subject is useful in their career and job opportunities.

STRUCTURE OF THE LESSON :

14.1 ENVIRONMENTAL PROTECTION ACT, 1986 - INTRODUCTION :

Environmental Protection Act, 1986 is an Act of the Parliament of India. It was enacted in May 1986 and came into force on 19 November 1986. It has 26 sections and 4 chapters. The Act is widely considered to have been a response to the Bhopal gas leak. The Act was passed by the Government of India under the Article 253 of the Constitution of India, which empowers to union government to enact laws to give effect to international

agreements signed by the country. 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 Act is an "umbrella" legislation that has provided a framework for the environmental regulation regime in India, which covers all major industrial and infrastructure activities and prohibits and regulates specific activities in coastal areas and eco-sensitive areas. The Act also provides for coordination of the activities of various central and state authorities established under other environment-related laws, such as the Water Act and the Air Act.

The original constitution of India did not have any provisions related to natural environment conservation. However, by the 42nd amendment to the constitution, fundamental duties were added describing the protection of the natural environment including the protection of lakes, forests, wildlife, and rivers as the fundamental duty of all citizens.

- This act was launched in 1986 with the objective of preserving the environment and protecting it.
- After the United Nations Conference on the Human Environment was held in Stockholm, in 1972, measures were taken for improving the environmental condition.
- The Wildlife Protection Act 1972, the Water (Prevention and Control of Pollution) Act 1974, and the Air (Prevention and Control of Pollution) Act 1981 were enacted followed by the 1986 Environment Protection Act 1986.
- It was passed by the Indian government for safeguarding the environment after the Bhopal Gas Tragedy on 2 December 1984, which emphasized on the need and measures for the protection of the environment.

14.2 OBJECTIVES OF THE ENVIRONMENTAL PROTECTION ACT :

The Environment Protection Act was passed with the following objectives :

1. To protect the environment from degradation and take actions to improve the current condition.
2. To implement the decisions made at the UN Conference on the Human Environment held in Stockholm in 1972.
3. To set up a government body to look after the industries and regulate the effect they have on the environment, and also issue direct orders such as for closure of industries.
4. To punish and penalize those posing a danger to the environment, health, and safety. For each failure, a fine of up to 1 Lakh, a prison term of five years, or both can be included. In certain cases, the term can be extended up to seven years.

5. To coordinate the work of the agencies for the protection of the environment under existing laws.
6. To enforce this law in all regions, including the places earlier exempted under previous laws.
7. To encourage and work towards sustainable development of the environment.

The Environment Protection Act was passed in 1986 to improve the current environmental condition and safeguard it from further deterioration. The EPA promotes sustainable development by encouraging the use of renewable energy sources. To regulate the pollutants released by industries and manage waste to protect the environment according to the safety standards set by the act. Any individual or organization posing a threat or danger to the environment is liable to be punished under the law.

14.3 NEED FOR AN ENVIRONMENTAL PROTECTION ACT :

- India previously had some environmental legislation, but there was a need for comprehensive legislation that covered the gaps in the current laws.
- As a result, it was passed to bring broad law in environmental protection and cover other significant areas of previously revealed environmental concerns.
- The Stockholm Conference, which brought to international attention the impact of human activities on the environment was also one of the reasons for this act.
- Development and the environment were at a crossroads, and the conference highlighted the importance of reconciling them for the good of people and the earth as a whole.
- The Bhopal Gas Tragedy was another reason. It was about an oleum gas leak from an industry that proved disastrous to the people and the environment.
- This instance highlighted the significance of regulating enterprises so that they may not simply escape penalty for inflicting environmental harm.
- Furthermore, the need was recognised because, while India had various environmental laws, such as the Air Act and Water Act, there was no overall legislation that integrated and coordinated their activities and duties.

14.4 ENVIRONMENT (PROTECTION) ACT, 1986 - SALIENT FEATURES :

- The Environmental (Protection) Act, 1986 has its origins in the Indian Constitution's Article 48A (Directive Principles of State Policy) and Article 51A (g) (Fundamental Duties).

- The Act empowers the Central Government to take all appropriate measures to prevent and control pollution, as well as to establish effective machinery for the purpose of protecting, improving, and controlling environmental pollution.
- The Act specifies a special procedure for handling hazardous substances, and the person in question is required to follow the Act's procedure.
- The Environmental (Protection) Act of 1986 relaxed the rule of "Locus Standi," and as a result, even a common citizen can approach the Court if he gives a sixty-day notice of the alleged offence and his intention to file a complaint with the Central Government or any other competent authority.
- The Environment (Protection) Act of 1986 provides immunity to government officers for any act performed under the provisions of this Act or under the powers vested in them or functions assigned to them by this Act.
- The Act prohibits Civil Courts from hearing any suit or proceeding based on an action, direction, or order issued by the Central Government or another statutory authority under this Act.
- The provisions of this Act, as well as any rules or orders issued under it, take precedence over anything inconsistent in any other enactment.

14.5 Bodies Related to Environment (Protection) Act :

National Environment Appellate Authority (NEAA)

- The Central Government formed it under the National Environment Appellate Authority Act of 1997.
- Under the Environment (Protection) Act of 1986, the NEAA was formed to hear appeals on the restriction of areas in which certain industries, activities, or operations shall be/must not be carried out subject to specified safeguards.

National Green Tribunal (NGT)

- The NEEA (together with the National Environment Tribunal) was determined to be insufficient, resulting in a need for a new organisation to handle environmental disputes more efficiently and effectively.
- As a result, the National Green Tribunal (NGT) was formed in 2010 under the National Green Tribunal Act 2010 for the effective and timely resolution of environmental protection matters.

- In addition to the Environment (Protection) Act of 1986, the NGT hears civil disputes under six additional statutes.

14.6 Genetic Engineering Appraisal Committee :

- The Genetic Engineering Appraisal Committee was formed under the Environmental Protection Act of 1986.
- The nodal ministry is the Ministry of Environment and Forests.
- Its principal function is to grant permission for operations involving the widespread use of hazardous chemicals and recombinants in industrial production.
- It is also responsible for authorising applications for genetically modified species and items to be released into the environment.
- Field testing is done before releasing any genetically altered organism into the environment.

The Environment (Protection) Act was passed with the primary purpose of conserving and enhancing the environment and associated issues. The Act empowers the Central Government to make all necessary efforts to avoid and control pollution, as well as to construct effective machinery to protect, improve, and regulate environmental pollution.

14.7 FOREST CONSERVATION ACT - INTRODUCTION :

Conservation of forest is the practice of planting more trees and maintaining the forested areas for the sustainability for future generations. Forests are an important natural resource and are beneficial to humans in several ways. But due to increasing deforestation activities, it has become essential to conserve forests throughout the world. Deforestation is the permanent destruction or loss of forests for the expansion of lands for agriculture, livestock, etc. The process of destructing forests for the expansion of agricultural land is referred to as shifting cultivation.

Following are some of the major steps for conservation of forest :

1. With the advent of industrialization, several trees have been cut at an alarming rate for raw materials and various other purposes. This felling of trees can be regulated by selective cutting, clear-cutting and shelterwood cutting.

2. Forest fires are one of the common causes of loss of forests. Sometimes the forest land is set on fire to make the land available for commercial purposes. Once cleared, there can be no vegetation. Natural forest fires are also responsible for the destruction of huge forest covers. Latest fire fighting techniques should be adopted to conserve the forest. However, forest fires are an important part of the ecosystem and it helps replenish nutrients in the soil from dead and decaying matter.

3. More trees should be planted to increase the forest cover. Trees should be selected according to the geographical conditions of a particular region and proper care should be taken during the growth of trees.
4. Prevention of exploitation of forestry and forest products is necessary for the conservation of forest.
5. The existing forests should be protected from diseases by spraying chemicals, antibiotics or development of pest-resistant strains of trees.

The adverse consequences of this have resulted into various environmental issues that are now coming into existence like Global warming, Pollution etc. So there is immediate need of forest conservation.

14.8 FOLLOWING ARE SOME STEPS IN THIS REGARD :

1. National Forest Policy :

In this policy Joint Forest management and local villages worked together to manage forest. For this local villages were credited with 25% of the income of that particular forest area.

2. Conservation of Reserve Forest :

Reserve forests are mainly located in Himalayan, Eastern Ghats and Western Ghats together with national parks and sanctuaries. In all these areas, commercial exploitation should be banned.

3. Local People Involvement :

Common people can play an important role for forest conservation. But the need is that there should be awareness among peoples. Public support must be generated to achieve the goal of forest production. One of the movements was Chipko Movement (1972).

4. Adopting afforestation Scheme :

Forest serves as a source of raw material for commercial sector of the country. So to fulfil this need for forest based industries for longer time, plantation should be promoted in the barren or fallow land.

5. Increasing Forest Productivity :

The productivity of forest can be enhanced by :

(a) Proper Forest Management

b) Supplying proper nutritional demand to the plants by inorganic and organic fertilizer.

(c) Controlling disease, pests and weed by adequate insecticides, pesticides and weedicides.

(d) Use of advanced technique for forest tree breeding and tissue culture method.

Forest Conservation : Forest Conservation in India

1. National Forest Policy: In this policy Joint Forest management and local villages worked together to manage forest.
2. Conservation of Reserve Forest: Reserve forests are mainly located in Himalayan, Eastern Ghats and Western Ghats together with national parks and sanctuaries.
3. Local People Involvement:
4. Adopting afforestation Scheme
5. Increasing Forest Productivity

14.9 ARRANGEMENT OF SECTIONS :

1. Short title, extent and commencement.
2. Restriction on the dereservation of forests or use of forest land for non-forest purpose.
3. Constitution of Advisory Committee.
4. Power to make rules.
5. Repeal and saving

An Act to provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto. BE it enacted by Parliament in the Thirty-first Year of the Republic of India as follows :

1. Short title, extent and commencement.

(a) This Act may be called the Forest (Conservation) Act, 1980.

(b) It extends to the whole of India except the State of Jammu and Kashmir.

(c) It shall be deemed to have come into force on the 25th day of October, 1980.

2. Restriction on the dereservation of forests or use of forest land for non-forest purpose :

Notwithstanding anything contained in any other law for the time being in force in a State, no State Government or other authority shall make, except with the prior approval of the Central Government, any order directing –

(i) that any reserved forest (within the meaning of the expression “reserved forest” in any law for the time being in force in that State) or any portion thereof, shall cease to be reserved;

(ii) that any forest land or any portion thereof may be used for any non-forest purpose.

3. Constitution of Advisory Committee.

The Central Government may constitute a Committee consisting of such number of persons as it may deem fit to advise that Government with regard to —

(i) the grant of approval under section 2; and

(ii) any other matter connected with the conservation of forests which may be referred to it by the Central Government.

4. Power to make rules.

(1) The Central Government may, by notification in the Official Gazette, make rules for carrying out the provisions of this Act.

(2) Every rule made under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

5. Repeal and saving —

(1) The Forest (Conservation) Ordinance, 1980 (17 of 1980) is hereby repealed.

(2) Notwithstanding such repeal, anything done or any action taken under the provisions of the said Ordinance shall be deemed to have been done or taken under the corresponding provisions of this Act

14.10 THE WILDLIFE PROTECTION ACT – INTRODUCTION :

An Act to provide for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensuring the ecological and environmental security of the country.

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 scheduled protected plant and hunting certain animal species or harvesting these species was largely outlawed.[1] The Act provides for the protection of wild animals, birds and plants; and for matters connected therewith or ancillary or incidental thereto. It extends to the whole of India.

It has six schedules which give varying degrees of protection. Schedule I and part II of Schedule II provide absolute protection - offences under these are prescribed the highest penalties. Species listed in Schedule III and Schedule IV are also protected, but the penalties are much lower. Animals under Schedule V, e.g. common crows, fruit bats, rats and mice, are legally considered vermin and may be hunted freely. The specified endemic plants in Schedule VI are prohibited from cultivation and planting. The hunting to the Enforcement

authorities have the power to compound offences under this Schedule. Up to April 2010 there have been 16 convictions under this act relating to the death of tigers.

The Government enacted Wildlife (Protection) Act 1972 with the objective of effectively protecting the wildlife of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent.

14.11 WILDLIFE - THE CRIMES :

Activities that revolve around harassing, causing immense pain to flora and fauna of a region falls under the term, Wildlife crimes. Such acts are against the law, thereby pushing these living beings to the edge of extinction.

Safeguarding the Wildlife :

The Wildlife protection act comes into play, aiming solely to protect these four-legged beings and 6to o deal with wildlife crimes.

The Wildlife Protection act got created in 1972, which got amended six times. And the last amendment was done in 2006. With the help of the judgements passed by the High Courts and Supreme courts, the act has only become more assertive, and the process is still ongoing.

The powers granted under the Wildlife protection act :

As per the statute, the central government post their permission from the parliament. And can give an authorisation right to either a director or any officer above the Assistant Director of the Wildlife preservation. Regarding the State government, as aforementioned, they can grant an authorisation right to either the Chief wildlife warden or any other officer above the rank of a Deputy conservator of Forest.

As per the statute, the state government has the authority to appoint

- Chief Wildlife Warden
- Wildlife warden
- Honorary wildlife warden
- Other officers/employees of the same field

Develop policies and provisions with regards to the protection and conservation of the wildlife and specific floras. Deal with matters about amendments of any provision/schedule. Manage cases that are directly linked to the protection of wildlife as per told by the state government.

14.12 ANIMAL WELFARE BOARD - THE CREATION :

As per the prevention of the cruelty to animals act, the central government is responsible for creating the animal welfare board, which protects animals against cruelty and welfare.
The board must consist of the following authorities:

1. The inspector general of forests
2. The animal husbandry officer
3. Two people representing the Union ministers of the Home Affairs and Education sector, to be appointed by the central government
4. One person representing the Indian board for wildlife, to be appointed by the Union government
5. Three people who are either currently or actively involved in animal welfare/ are renowned humanitarians appointed by the Union government.
6. One person representing any veterinary organisation
7. One person representing each of 2 municipal corporations
8. One person representing each of three organisations in the field of animal welfare
9. One person representing each of 3 such societies who are dealing with the prevention of cruelty to animals
10. Three people to get nominated by the central government
11. Six parliamentary members of which four must belong from Lok Sabha and the two from Rajyasabha

For the chairmanship, the Union government can nominate anyone of the board members to be so and one more to fill the position of the vice president.

Protecting the animals in India- The laws :

Under sections 428 and 429 of the Indian Penal Code, killing/maiming/poisoning an animal is criminal. The punishment includes imprisonment of a maximum of two years or payment of sum as fine or both.

For Wild animals :

As mentioned before in the article, the Wildlife protection act, 1972 deals with safeguarding the wildlife in India. The statute primarily focuses on prohibiting killing, trapping or any kind of harming to wild animals.

For Aquatic animals :

The Wildlife protection act, 1972 also extends to aquatic animals and their protection which are as follows :

Schedule 1 to 4 of the statute lists the protected marine species such as :

- Seahorses
- Giant grouper
- Hermatypic corals
- Organ pipe

- Fire coral
- Sea fans
- Species of Sponges
- Mollusks
- Dolphins

This Act provides for the protection of the country's wild animals, birds, and plant species, in order to ensure environmental and ecological security.

14.13 CONSTITUTIONAL PROVISIONS FOR THE WILDLIFE ACT :

Article 48A of the Constitution of India directs the State to protect and improve the environment and safeguard wildlife and forests. This article was added to the Constitution by the 42nd Amendment in 1976. Article 51A imposes certain fundamental duties for the people of India. One of them is to protect and improve the natural environment including forests, lakes, rivers, and wildlife and to have compassion for living creatures.

14.14 SALIENT FEATURES OF WILDLIFE PROTECTION ACT :

This Act provides for the protection of a listed species of animals, birds, and plants, and also for the establishment of a network of ecologically-important protected areas in the country.

1. The Act provides for the formation of wildlife advisory boards, wildlife wardens, specifies their powers and duties, etc. It helped India become a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
2. The Act prohibited the hunting of endangered species. Scheduled animals are prohibited from being traded as per the Act's provisions. The Act provides for licenses for the sale, transfer, and possession of some wildlife species. It provides for the establishment of wildlife sanctuaries, national parks, etc. Its provisions paved the way for the formation of the Central Zoo Authority. This is the central body responsible for the oversight of zoos in India. It was established in 1992. The National Board for Wildlife was constituted as a statutory organization under the provisions of this Act.
3. The Act created six schedules which gave varying degrees of protection to classes of flora and fauna. Schedule I and Schedule II (Part II) get absolute protection, and offences under these schedules attract the maximum penalties.

14.15 PROTECTED AREAS UNDER THE WILDLIFE PROTECTION ACT :

The government enacted the Wildlife (Protection) Act in 1972 which laid down a comprehensive set of rules and regulations with respect to the protection of wildlife in India. It laid down the provisions for the setting up of national parks, wildlife sanctuaries, etc. Project Tiger is being implemented which has caused the dwindling tiger population to increase. The country saw a 30% rise in the tiger population from 2010 to 2014.

There are five types of protected areas as provided under the Act. They are described below.

1. Sanctuaries :

Sanctuary is a place of refuge where injured, abandoned, and abused wildlife is allowed to live in peace in their natural environment without any human intervention. They are naturally-occurring areas where endangered species are protected from poaching, hunting, and predation. Examples: Indian Wild Ass Sanctuary (Rann of Kutch, Gujarat); Vedanthangal Bird Sanctuary in Tamil Nadu (oldest bird sanctuary in India); Dandeli Wildlife Sanctuary (Karnataka).

2. National Parks :

National Parks are the areas that are set by the government to conserve the natural environment. A national park has more restrictions as compared to a wildlife sanctuary. National parks can be declared by the State government by Notification. No alteration of the boundaries of a national park shall be made except on a resolution passed by the State Legislature.The main objective of a national park is to protect the natural environment of the area and biodiversity conservation. Examples: Bandipur National Park in Karnataka; Hemis National Park in Jammu & Kashmir; Kaziranga National Park in Assam. See more on List of National Parks in India.

3. Conservation Reserves :

The State government may declare an area (particularly those adjacent to sanctuaries or parks) as conservation reserves after consulting with local communities.

4. Community Reserves :

The State government may declare any private or community land as a community reserve after consultation with the local community or an individual who has volunteered to conserve the wildlife.

5. Tiger Reserves :

These areas are reserved for the protection and conservation of tigers in India. They are declared on the recommendations of the National Tiger Conservation Authority.

14.16 GLOSSARY / KEY WORDS :

Environment : The totality of surrounding conditions.

Wildlife : A group of local or native animals is referred to as wildlife.

Conservation	**:**	Prevention of wasteful use of resources
Sanctuaries	**:**	A place of refuge and protection
National Park	**:**	A national park is a natural park in use or conservation purposes, created and protected by national governments.

14.17 SELF ASSESSMENT QUESTIONS :

1. Write about salient features of Environmental protection Act, 1986?
2. Write about Forest conservation Act?
3. Explain about Wildlife (Protection) Act, 1972?

14.18 SUGGESTED READINGS :

1. Odum, E.P., Odum, H. T. & Andrews, J. (1971) Fundamentals of Ecology. Philadelphia: Saunders.
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3. Raven, P.H., Hassenzahl, D. M.& Berg , L.R.(2012). Environment. 8th Edition, John Wiley& Sons.
4. Wilson, E. O. (2006) The Creation: An appeal to save life on the Earth. Newyork: Norton.

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LESSON - 15

INTERNATIONAL AGREEMENTS AND ENVIRONMENTAL MOVEMENTS

AIMS AND OBJECTIVES :

- About the basic information and significance of international environmental agreements in environmental protection.
- To know ozone depletion controlling measures and how role of monitorial protocol in ozone protection.
- To understand environmental movements and its role in conservation of natural resources..
- Finally, the learner acquires a complete outlook on the environmental activism in India.

STRUCTURE OF THE LESSON :

15.1 INTRODUCTION :

International environmental agreement or environmental protocol, is a type of treaty binding in international law, allowing them to reach an environmental protection goals. In other words, it is "an intergovernmental document intended as legally binding with a primary stated purpose of preventing or managing human impacts on natural resources." An agreement

between two nations is known as a bilateral environmental agreement. If the agreement is made among three or more nations, it is called a multilateral environmental agreement (MEA). Such agreements, primarily produced by the United Nations, cover subjects such as atmospheric policies, freshwater policies, hazardous waste and substance policies, the marine environment, nature conservation policies, noise pollution and nuclear safety. Such agreements include important inter-governmental policies, initiatives and measures taken collectively on global environmental issues. The state's efforts to achieve rapid industrialization and modernization have caused numerous environmental problems such as global warming, deterioration of the ozone layer, resource depletion, industrial pollution, deforestation, air pollution, and ocean pollution among others. These issues are not local or national in nature but global, transnational, and trans boundary which demands collective actions by all countries to achieve desired common objectives.

Countries including developed ones cannot effectively cope with major environmental problems by acting alone, and this fact has been well acknowledged by all countries. Hence, international environmental agreements are significant since they enable countries, belonging to different contexts, to come together on common platform and work collectively to deal with complex ecological issues. In other words, the countries (including developed) have soon recognised the fact that environment issues are transnational in nature, and, therefore, they are to be addressed collectively. The international forums provide a platform to all the countries where they can deliberate and discuss on environmental issues and decide the common action programme through multinational agreements. The beginning of international agreements on ecological issues can be traced back to the latter half of 20th century, when they primarily focused on two issues: presentation of natural resources and impacts of pollution on environment and human health. In this regard, the international community attempted to regulate and control the limitless exploitation of maritime resources.

15.2 MONTREAL PROTOCOL :

Montreal Protocol is an essential multilateral agreement that is introduced concerning the Depleting ozone layer. There are many man-made substances and chemicals that are known as ozone-depleting substances (ODS). The Montreal Protocol agreement regulates the production, consumption, and emission of such substances that are responsible for ozone depletion in the stratosphere. Montreal Protocol (1987) The Montreal Protocol entitled as _the Montreal Protocol on Substances that Deplete the Ozone Layer', was initially signed in 1987 by the twenty-four countries and the European Community at the Headquarters of the International Civil Aviation Organization in Montreal, Canada. Later, the same treaty was ratified by more than 180 countries. This global agreement is the first of its kinds in the history of environmental protection which was designed to protect the stratospheric ozone layer by reducing the global production, emission and usage of ozone-depleting chemical substances within the stipulated time period. However the Vienna Convention for the Protection of the Ozone Layer (1985)—that recognizes the responsibility of states to protect the environment and human health from the

adverse effects of ozone depletion—set out the framework under which the Montreal Protocol was negotiated. The protocol was thus adopted on September 16, 1987 but it came into force on January 1, 1989 and subsequently amended many times.

The Montreal Protocol recognized the worldwide emission of certain chemical substances that could deplete or substantially modify the earth‘s ozone layer in a way that was assessed to adversely impact the environment and human health. Hence, it was aimed at regulating the production and consumption of Ozone-Depleting Substances (ODSs) such as chlorofluorocarbons (CFCs), carbon tetrachloride, halons and methyl chloroform among others. The Parties to the Protocol agreed to reduce the manufacture and usage of CFCs by half of their baseline by 1998 and to phase-out usage of Halon by 1992. However, ten years of relaxation was granted to the developing countries, unlike developed countries, in order to comply with the Protocol phase-out targets. The Protocol also delimited trade of controlled substances (ODSs) in the countries not party to the protocol. Moreover, a unique adjustment provision is also included in the protocol which enables the Parties (signatory countries of the protocol) to quickly respond to new scientific information in an effort to ―accelerate the reductions required on chemicals already covered by the Protocol. These adjustments are then automatically applicable to all countries that ratified the Protocol‖ (EPA 2017).

Since the enactment of Montreal Protocol, the Parties adjusted and amended the Protocol not just to regulate the ODSs, but also to provide finance resources to help developing countries in complying with the Protocol‘s provisions. In addition to the adjustment provision, the signatory counties meet to share important scientific information and monitor the implementation of phase-out resolutions.

15.3 KYOTO PROTOCOL :

The Kyoto Protocol, the first international treaty to set legally binding targets to cut greenhouse gas emissions, was adopted 25 years ago, on 11 December 1997, in Kyoto, Japan. The agreement, which entered into force in 2005 and was ratified by 192 Parties, has since been superseded by the Paris Agreement but remains a historic landmark in the international fight against climate change. It is an addendum to the United Nations Framework Convention on Climate Change (UNFCCC), a global environmental agreement whose objective is to “stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” Kyoto Protocol is based on the principle of common but differentiated responsibilities, keeping in mind the socio-economic development of the concerned countries and the polluter pays principle. It is one of the important international environment protocols. The protocol’s first commitment period started in 2008 and ended in 2012. 36 countries had participated in the first commitment period. 9 countries opted for flexibility mechanisms since their national emissions were greater than their targets. Hence these countries funded emissions reductions in other countries.

The Kyoto Protocol was an agreement among developed nations to reduce carbon dioxide (CO_2) emissions and greenhouse gases (GHG) to minimize the impacts of climate change. The Protocol applied to 6 greenhouse gases :

1. Carbon dioxide
2. Methane
3. Nitrous oxide
4. Hydrofluorocarbons
5. Perfluorocarbons
6. Sulfur hexafluoride.

Due to a complex ratification process, it entered into force on 16 February 2005. Currently, there are 192 Parties to the Kyoto Protocol. One important element of the Kyoto Protocol was the establishment of flexible market mechanisms, which are based on the trade of emissions permits. Under the Protocol, countries must meet their targets primarily through national measures. After the first commitment period of the Kyoto Protocol ended, an amendment i.e. changes was carried out to the Kyoto Protocol. This amendment talks about emission reduction targets for the second commitment period. The 2nd commitment period ranges from 2012-2020. As of 2022, there remain 192 signatories.

15.4 INDIA AND THE DOHA AMENDMENT :

Parties to the Kyoto Protocol adopted an amendment to the Kyoto Protocol by decision in accordance with Articles 20 and 21 of the Kyoto Protocol, at the eighth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) held in Doha, Qatar, on 8 December 2012. After becoming a signatory in 2013, Afghanistan became the 192nd and last signatory of the Kyoto Protocol. As of 28 October 2020, 147 Parties have deposited their instrument of acceptance; therefore the threshold for entry into force of the Doha Amendment has been met. As of 2022, there remain 192 signatories. India has ratified the second commitment period of the Kyoto Protocol i.e. meet the emission targets for the time period 2012-2020. India was the 80th country to accept the amendment.

15.5 MAJOR ENVIRONMENTAL MOVEMENTS IN INDIA :

The environmental movement is a broad generic term which is generally used to describe and understand different types of local struggles and conflicts concerned with livelihood issues and ecological security within the larger context of the development debate. These struggles in fact critiqued and questioned the notion of development and conservation ecology pursued by the Indian state and its officials since colonial time. The genesis of the environmental movement in India can be traced to the Chipko movement (1973) in Garhwal region in the new state of Uttranchal. In fact, between 1970s and 1980s there were several struggles in India around issues

of rights to forest and water which raised larger ecological concerns like rights of communities in forest resources, sustainability of large scale environmental projects like dams, issues of displacement and rehabilitation etc.

The Indian environmental movement is critical of the colonial model of development pursued by the post–colonial state. The post–independent state failed to build up a development agenda based on the needs of the people and continued to advocate the modern capitalist agenda which led to the destruction of environment, poverty and marginalisation of rural communities. Formation of national parks, sanctuaries, protected areas in India, in fact represents the conventional environmentalism which the Indian state advocated with the aim of preserving wildlife and biodiversity by pushing people out of these areas. In response to this conventional environmentalism which considered the Indian state to be the custodian of natural resources, the environmental movement in India advocated the ideology of 'environmentalism of the poor'. The growth of environmental movements is not limited to one region of the country. Bishnoi movement, Chipko movement, Save Silent Valley movement,

15.5.1 Bishnoi Movement :

The Bishnois living in western Rajasthan on the fringe of the Thar desert, for centuries, have been conserving the flora and fauna. For them nature-loving people, protection of the environment, wildlife, and plants is a part and parcel of their sacred traditions. In the fifteenth century, Jambhoji, a resident of a village near Jodhpur, had a vision that the cause of the drought that had hit the area and hardship that followed was caused by people's interference with nature. Thereafter, he became a 'sanyasi' and came to be known as Swami Jambeshwar Maharaj. This was the beginning of the Bishnoi sect. He laid down 29 tenets for his followers which included Jeev Daya Palani – Be compassionate to all living beings and Runkh Lila Nahi Ghave – Do not cut green trees. Nature protection was given foremost importance in these tenets. The sacrifice made by Amrita Devi and over 350 others is a heart-rending example of their devotion.

The Maharaja Abhay Singh of Jodhpur wanted to build a new palace and required wood for it. To procure this his men went to the area around the village of Jalnadi to fell the trees.

When Amrita Devi saw this she rushed out to prevent the men and hugged the first tree, but the axe fell on her and she died on the spot. Before dying she uttered a couplet, 'A chopped head is cheaper than a felled tree'. People from 83 surrounding villages rushed to prevent the men from felling the trees and by the end of the day more than 363 had lost their lives. When the king heard about this, he felt remorseful and personally came to village to apologize to the people. He promised them that they would never be asked to provide timber to the ruler, no khejri tree would be cut and hunting would be banned near the Bishnoi villages. The village of Jalnadi thus came to be called Khejarli. The Bishnois will go to any extent to protect the wildlife and the forests around them.

Recently this sect was in the news due to the hunting of Black buck by some Mumbai film group. The heartland of the Bishnois in the forests near Jodhpur is abundant in trees and wildlife. The landscape here is greener than elsewhere and the animals mainly antelopes, particularly the blackbuck and the chinkara, in these forests are not afraid of humans and are often seen near the villages eating out of the villagers' hands. The Bishnois have indeed proved that human lives are a small price to pay to protect the wildlife and the forests around them. Though they are staunch Hindus but they do not cremate their dead but bury them, as they are not permitted to use wood for the cremation. There is a saying that goes "Sir santhe rooke rahe to bhi sasto jaan" this means that if a tree is saved from felling at the cost of one's head, it should be considered as a good deed.

15.5.2 Chipko Movement :

The origin of modern environmentalism and environmental movements in India can be ascribed to the Chipko movement in the central Himalayan region in the early 1970s. Chipko movement, launched to protect the Himalayan forests from destruction, has its' roots in the pre-independence days. Many struggles were organised to protest against the colonial forest policy during the early decades of 20th century. Peoples' main demand in these protests was that the benefits of the forest, especially the right to fodder, should go to local people. These struggles have continued in the post-independent era as the forest policies of independent India are no different from that of colonial ones.

The origin of 'Chipko' [to hug] took place during 1973. In the early 1973 the forest department refused to allot ash trees to the Dashauli Gram Swarajya Sangha (DGSS), a local cooperative organisation based in Chamoli districts, for making agricultural implements. On the other hand, the forest department allotted ash trees to a private company, i.e., Symonds Co. This incident provoked the DGSS to fight against this injustice through lying down in front of timber trucks and burning resin and timber depots as was done in Quit India movement. When these methods were found unsatisfactory, Chandi Prasad Bhat - one of the leaders,

suggested of embracing the trees and thus 'Chipko' was born. This form of protest was instrumental in driving away the private company from felling the ash trees. With its success the movement spread to other neighbouring areas and subsequently the movement came to be popularly known as Chipko movement internationally.

From its beginning the Chipko movement concentrated on ecological issues such as depletion of forest cover and soil erosion. Three important aspects were responsible for the success of Chipko movement. First, the close links between the livelihoods of the local people and the nature of the movement. The local people consider Chipko as a fight for basic subsistence which have been denied to them by the institutions and policies of the State (Guha, 1989). In addition, specificity of the area where Chipko movement took place; involvement of women in the contribution to households' subsistence and the overwhelming support to anti-alcohol campaign have led to the overwhelming support of women which is unique to the Chipko movement. The second aspect is with regard to the nature of agitation. Unlike other environmental movements Chipko has strictly adhered to the Gandhian tradition of freedom struggle, i.e., non–violence. Third, the simplicity and sincerity of the leaders like Sunderlal Bahuguna and their access to national leaders like Mrs. Indira Gandhi, other politicians and officials also helped to the success of the movement to a large extent.

The demands of the Chipko movement were as follows :

i) Complete stoppage of cutting trees for commercial purposes;

ii) The traditional rights should be recognised on the basis of minimum needs of the people;

iii) Making the arid forest green by increasing people's participation in tree cultivation;

iv) Formation of village committees to manage forests;

v) Development of the forest related home-based industries and making available the raw materials, money and technique for it;

vi) Giving priority to afforestation in the light of local conditions, requirements and varieties. What is distinctive about Chipko movement is that it was the forerunner as well 'as direct inspiration for a series of popular movements in defense of community rights to natural resources. Sometimes these struggles revolved around forests, in other instances, around control and use of pasture, mineral or fish resources.

15.5.3 Silent valley Movement :

Silent valley was named by English man during colonial rule, who found that there was no noise of cicadas after dark. It is one of rich bio diverse areas of India. It has a triangular

shape. On two sides are the Kozhikode and Palghat cities in Kerala and on the other side is located the Coimbatore city in neighboring Tamil Nadu. Kunthipuza is a major river that flows 15 km southwest from silent valley. The idea of a dam was first proposed in 1920s by British technical expert. The first survey on this project was carried out in 1958. In 1970, the Kerala State Electricity Board (KSEB) proposed a hydroelectric dam across the Kunthipuzha river that would have submerged 8.3 sq km of untouched moist evergreen forest. Steven Green in 1972, expressed his concerns about the possible threats to the rare lion-tailed macaque from the project. Around the same time, herpetologist Romulus Whitaker wrote to the Bombay Natural History Society about the need to conserve the Valley. Reports like these alert other naturalists. But, the Planning Commission approved this project in 1973. The project planned to generate 120 megawatt of electricity initially and 240 megawatt subsequently. However, due to lack of sufficient funds, implementation was delayed. There was not much protest initially.

In 1976, the project attracted the attention of some environmentalists. A task-force was formed under the chairmanship of the Zafar Futehally. This task Force recommended that scrapping of project, with a loophole that, if abandoning the project was not possible, a series of safeguards should be implemented. The Kerala government decided to proceed with safeguards. In the same year, M.K Prasad wrote an article about the disastrous effect of project on silent valley in Kerala Sasthra Sahitya Parishad (KSSP). His article got huge response.

The General Assembly of the IUCN, many eminent people like Salim Ali, Madhav Gadgil, CV Radhakrishnan, MS Swaminathan, Subramaniam Swamy, etc. also wrote to central government not to sanction the project. However, then Prime Minister Morarji Desai rejected all the appeals and recommended the proposal. A public interest litigation was filed in the High Court in 1979. The Silent Valley Samrakshana Samiti and Kerala Sastra Sahitya Parishad started awareness campaigns, held protest meetings, rallies and debates all over the state, turning the campaign into a mass people's movement. Famous writers from Kerala also joined the movement. The then PM Charan Singh instituted a Central Committee to re-investigate the issue, headed by M.S. Swaminathan. In 1980, the High Court rejected plea. Then, a small group of campaigners met the Kerala Governor and requested her to issue a stay order untill Committees' report was issued. Work was halted once again. But the awareness campaigns continue. PM Charan Singh was replaced by Indira Gandhi.She took active interest in silent valley project. She constituted M.G.K. Menon Committee in 1983 to re-examine the project, which recommended abandoning of the project. Prime Minister Rajiv Gandhi formally inaugurated Silent Valley National Park in 1985. The silent valley movement saw many twists and turns in politics but it gave birth to the idea of environment impact assessment of every project before its initiation.

15.6 CONCLUSION :

As climate change continues to worsen, and the margins for error in addressing it further narrow, the effectiveness of international environmental agreements and the regimes that administer them will only become more important. This review offers significant conclusions

about definitions of effectiveness and the methods by which it can be increased. Ultimately, the environmental problems of the 21st century can only be confronted by thoroughly studying past IEAs and crafting new ones that wield the best available tools to maximize effectiveness.

15.7 GLOSSARY / KEYWORDS :

Green House Gases : Gases in the earth's atmosphere that trap heat.

Agreement : A negotiated and typically legally binding arrangement between parties as to a course of action.

Protocol : The official procedure or system of rules governing affairs of state or diplomatic occasions

Convention : An agreement between states covering particular matters, especially one less formal than a treaty.

15.8 SELF ASSESSMENT QUESTIONS :

1. Write about role of International Agreements in Environmental Protection.
2. Discuss about Monitorial Protocol and Kyoto Protocol.

15.9 SUGGESTED READINGS :

1. Environmental Studies from Crisis to Cure, Rajagopalan, Oxford University Press, New Delhi.
2. Environment and Pollution, R.S. Ambasht, P.K. Ambshat, CBS Publishers and Distributors, New Delhi.

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