ਜਗਤ ਗੁਰੂ ਨਾਨਕ ਦੇਵ
ਪੰਜਾਬ ਸਟੇਟ ਓਪਨ ਯੂਨੀਵਰਸਿਟੀ
ਪਟਿਆਲਾ

JAGAT GURU NANAK DEV
PUNJAB STATE OPEN UNIVERSITY, PATIALA

(Established by Act No. 19 of 2019 of the Legislature of State of Punjab)

The Motto of the University

(SEWA)

SKILL ENHANCEMENT EMPLOYABILITY WISDOM ACCESSIBILITY

Bachelor of Computer Applications (BCA)
Course : Environmental Studies
Course Code: BCA-2-ENVS

ADDRESS: C/28, THE LOWER MALL, PATIALA-147001
WEBSITE: www.psou.ac.in

JAGAT GURU NANAK DEV
PUNJAB STATE OPEN UNIVERSITY PATIALA
(Established by Act No.19 of 2019 of Legislature of the State of Punjab)

PROGRAMME COORDINATOR :
Dr. Monika Pathak
Assistant Professor, School of Sciences and Emerging Technologies
Jagat Guru Nanak Dev Punjab State Open University, Patiala

PROGRAMME CO-COORDINATOR :
Dr. Gaurav Dhiman
Assistant Professor, School of Sciences and Emerging Technologies
Jagat Guru Nanak Dev Punjab State Open University, Patiala

COURSE COORDINATOR :
Dr. Shefali Bedi
Assistant Professor, School of Social Sciences and Liberal Arts
Jagat Guru Nanak Dev Punjab State Open University, Patiala

JAGAT GURU NANAK DEV
PUNJAB STATE OPEN UNIVERSITY PATIALA
(Established by Act No.19 of 2019 of Legislature of the State of Punjab)

PREFACE

Jagat Guru Nanak Dev Punjab State Open University, Patiala was established in Decembas 2019 by Act 19 of the Legislature of State of Punjab. It is the first and only Open Universit of the State, entrusted with the responsibility of making higher education accessible to all especially to those sections of society who do not have the means, time or opportunity to pursue regular education.

In keeping with the nature of an Open University, this University provides a flexible education system to suit every need. The time given to complete a programme is double the duration of a regular mode programme. Well-designed study material has been prepared in consultation with experts in their respective fields.

The University offers programmes which have been designed to provide relevant, skill-based and employability-enhancing education. The study material provided in this booklet is self instructional, with self-assessment exercises, and recommendations for further readings. The syllabus has been divided in sections, and provided as units for simplification.

The Learner Support Centres/Study Centres are located in the Government and Government aided colleges of Punjab, to enable students to make use of reading facilities, and for curriculum-based counselling and practicals. We, at the University, welcome you to be a part of this institution of knowledge.

Prof. G. S. Batra,
Dean Academic Affairs

Bachelor of Computer Applications (BCA)
Environmental Studies

MAX.MARKS:100
EXTERNAL:70
INTERNAL:30
PASS:35%
Credits:4

Objective:

The objective of this paper is to create awareness about environmental problems among learners. The paper imparts basic knowledge about environment and its problems, and attempts to motivate learners to participate improvement.

INSTRUCTIONS FOR THE CANDIDATES:

Candidates are required to attempt any two questions each from the sections A, and B of the question paper, and any ten short answer questions from Section C. They have to attempt questions only at one place and only once. Second or subsequent attempts, unless the earlier ones have been crossed out, shall not be evaluated.

Course Outcomes (COs) After the completion of this course, the students will be able to:	
CO1	Gain a broad understanding of key environmental challenges, such as climate change, pollution, biodiversity loss, and resource depletion.
CO2	Understand the interconnected nature of environmental, social, economic, and political systems, and how they influence each other
CO3	Understand of natural systems, including ecosystems, and how they function, as well as human impacts on these systems.
CO4	Understand of sustainability principles and practices, including the ability to analyze and evaluate sustainability initiatives.
CO5	Knowledge the environmental laws, policies, and governance structures at local, national, and international levels.

SECTION-A

The multidisciplinary nature of environmental studies. Definition, scope and importance. Concept of Biosphere – Lithosphere, Hydrosphere, Atmosphere.

Ecosystem & Biodiversity Conservation

Ecosystem and its components, Types of Ecosystems

Biodiversity - Definition and Value, Threats to biodiversity and its conservation

Level of biological diversity: genetic, species and ecosystem diversity; bio-geographic zonesof India; biodiversity patterns and global biodiversity hot spots.

India as Mega-biodiversity nation; Endangered and endemic species of India. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational value.

Natural Resources–Renewable And Non Renewable Resources: Land resources and land use change; land degradation, soil erosion and desertification. Deforestation: causes and impacts due to mining, dam building on environment, Forests, Biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, Floods, droughts, conflictsover water (international & inter-state)
Energy resources: renewable and nonrenewable energy sources, use of alternate energy sources, growing energy needs, case studies.
Environmental Pollution: Types, causes, effects and controls; Air, Water, Soil and noise pollution. Nuclear hazards and human health risks Solid waste management, Source Segregations : Control measures of urban and Industrial waste. Pollution case studies.

SECTION-B

Environmental Protection Laws In In dia: Environmental protection act for; Air (Prevention and control of pollution), Water (Prevention and Control of pollution), Wild life, Forest Conservation, Issues involved in the enforcement of environmental legislation.Role of an individual in prevention of pollution.
Environmental policies & Practices; Climate change, global warming, ozone layer depletion, acid rain and imapcts on human communities and agriculture.

Human Communities and the Environment
Human population growth: Impacts on environment, human health and welfare, Sanitation & Hygiene. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environment movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation for a Clean-green pollution free state. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi)

Road Safety Awareness: Concept and significance of Road safety, Traffic signs, Traffic rules, Traffic Offences and penalties, How to obtain license, Role of first aid in Road Safety.

Stubble Burning: Meaning of Stubble burning. Impact on health & environment. Management and alternative uses of crop stubble. Environmental Legislations and Policies for Restriction of Agriculture Residue Burning in Punjab.

Suggested Readings:

1. Carson, R.2002. Silent Spring, Houghton Mifflin Harcourt.
2. Gadgil. M., & Guha,R.1993. This Fissured Land : An Ecological History of India.Univ. of California Press.
3. Gleeson, B. and Low, N.(eds.)1999. Global Ethics and Environment, London, Routledge.
4. Gleick,P.H.1993. Water in Crisis.Pacific Institute for Studies in Dev. Environment &Security. Stockholam Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland : Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalays dams.Science,339:36-37.
7. McCully,P.1996. Rivers no more: the environmental effects of dams (pp.29-64). ZedBooks.
8. McNeill, John R. 2000. Something New Under the Sun : An Environmental Historyof the Twentieth Century.
9. Odum, E.P., H.T & Andrews, J.1971. Fundamentals of Ecology. Philadelphia : Saunders.

10. Pepper, I.L., Gerba ,C.P & Brusseau, M.L. 2011. Environmental and Pollution Sciences. Academic Press.
11. Rao, M.N. & Datta, A.K.1987. Waste Water Treatment. Oxford and IBH PublishingCo. Pvt.Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R.2012,Environment. 8Th edition. John Wiles & Sons.
13. Rosencranz, A., Divan, S., & Nobie, M.L. 2001. Environmental law and policy inIndia. Tripathi 1992
14. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development.OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science andConservation. S. Chand Publishing, New Delhi.
16. Sodhi, N.S. Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18. Warren, C.E. 1971. Biology and Water Pollution Control. WB Saunders.
19. Wilson, E.O. 2006. The Creation: An appeal to save life on earth. New York: Norton.
20. World commission on Environment and Development. 1987. Our Common Future.Oxford University Press.

SEMESTER: II

COURSE: ENVIRONMENTAL STUDIES

UNIT – 1: INTRODUCTION TO ENVIRONMENTAL STUDIES

STRUCTURE

1.0 LEARNING OUTCOMES:

After the study of this unit, the learners will be able to:

- Know the concept of environment and understand it from the perspective of the elements that constitute the environment
- Understand the multidisciplinary approach towards the subject of Environmental Studies
- Learn about the scope and importance of the discipline of Environmental Studies
- Acquire a greater understanding of the components of the environment and know more about the thermal stratification of the environment

1.1 INTRODUCTION

The subject of Environment Studies aims at providing a comprehensive understanding of a wide range of environmental concerns through an interdisciplinary approach that combines scientific knowledge with an understanding of the socioeconomic impact of these problems. It focuses on environmental issues such as climate change and global warming, as well as contamination and pollution. It contributes significantly in equipping the students with an analytical skill and critical approach towards the understanding of the important issues

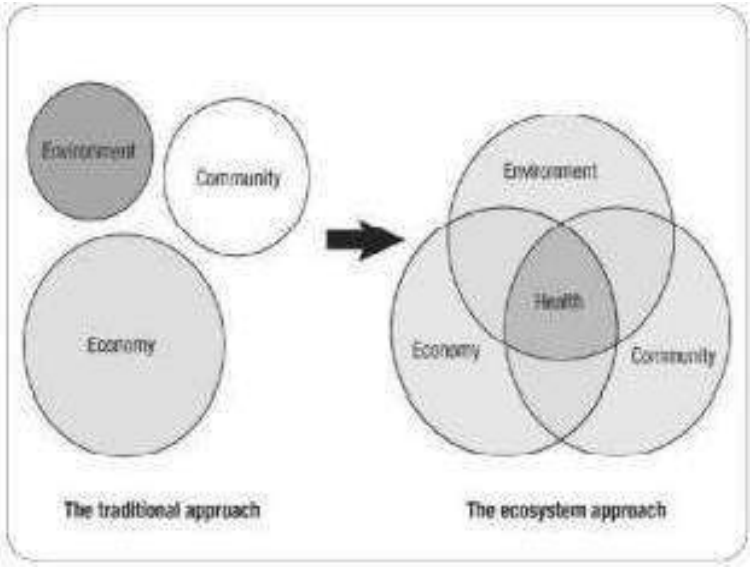
pertaining to the environment and inculcates in them a contextual understanding of major global and regional environmental challenges. The resources available with the Mother earth are dwindling day by day and the human beings have been causing intemperate damage to the environment in an urge to grow and progress in all spheres of their lives. The human beings cannot survive without the environment either but the destruction caused to the quality of environment because of the incessant use of natural resources has almost begun to render survival and sustenance impossible on the Earth. The rise in the global temperature, depletion of the ozone layer, climate changes, increasing incidence of environmental pollution, rising proportion of human population and calamities and disasters are all, the consequences of human interference with the ecological balance.

The subject of environmental studies can help in understanding the problems and concerns relating to the environment from the perspective of physical, biological, chemical and social perspectives. It gives the learners an opportunity to delve deeper into the interface between human beings and nature and understand how human beings and other living organisms depend upon each other. An insight into this discipline will help to develop an awareness of the significance of the renewable sources of energy and the need to cut down on the use of non-renewable sources. The knowledge of the subject can provide the skills that are essentialto find out effective solutions to the problems and encourage the use and development of scientific and conscientious principles to address the issues that have invited a great deal of national and global attention.

1.2 MEANING OF ENVIRONMENT

The word environment finds its origin from the French word ‗environner' which means ‗to encircle' or ‗to surround'. The term ‗environment' was used for the first time by a biologist Jacob Van Uerkal for the subject of ecology in which the interaction between the living organisms and their environment is studied. Thus the term indicates the external conditions or surroundings that support the growth of flora and fauna or even the human beings and their characteristics and also protect all these species from the ill effects of pollution. Douglass and Holland (1947) defined environment as *–a word which describes, in the aggregate, all of the extrinsic (external) forces, influences and conditions which affect the life, nature, behaviour and the growth, development and maturity of living organisms.*‖The Environment Protection Act 1986 defines an environment as the sum total of land, air, water, the interrelationship amongst these components and also their interface with the human beings and other living organisms on the earth. Environment can thus be defined as the aggregate of a complex set of

physical, geographical, biological, social, cultural or political conditions or forces which can potentially affect the individuals or organisms on the earth and can also shape their appearance and determine the conditions of their survival. Of all the planets in the solar system, it is the Earth alone that supports life and provides for all the necessary conditions that are conducive for the survival of various species.



Since an environment constitutes of the interaction of the physical, biological and cultural elements, *inter alia*, the components that broadly define an environment may be categorized as:

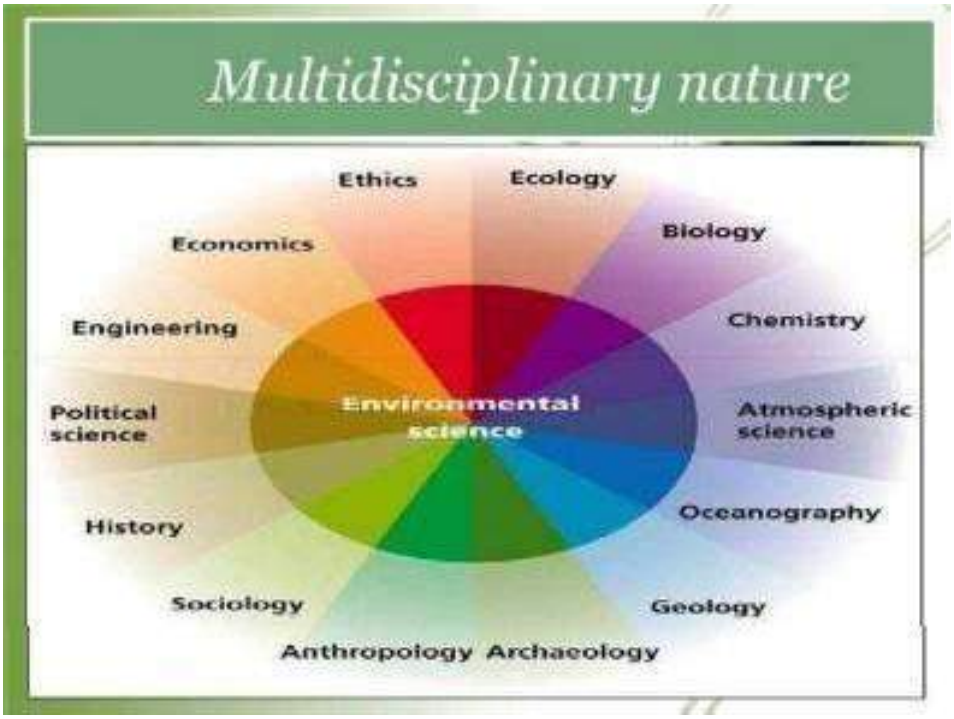
a. Physical elements –The physical elements include the climatic and the physical conditions such as the air, water, sky, vegetation, the elements below the surface of the earth and the organisms that are a part of life on earth. The physical efficiency, appearance, colour of the skin, all depend upon the physical environment. For ex. In cold regions, the human beings usually have a short and a sturdy built-up so that heat is trapped inside their body whereas in the hot areas, people have thin and long limbed structures which allow heat to be released from the body, more quickly.
b. Social and cultural environment –The moral values, cultural ethics and emotional strengths of the individuals contribute towards their social and cultural environment. The social environment is an outcome of the interaction of the political, economic or social conditions in which an individual operates. Such an environment manifests itself in the form of all rituals and customs, legal and behavioural approaches reflected by the society. It comprises of the groups, communities, committees or all such institutions which are established by the individuals to build up human relationships.
c. Psychological environment – All individuals in a society may have a common physical and social environment but each individual is faced by a different psychological environment. The psychological environment is important for the

purpose of understanding the personality and approach of an individual. Such factors influence the nature of an individual and also cast their impact on the way an individual lives his life. For ex. if a person is unable to attain a goal that he sets for himself, he will either become frustrated or will be forced to switch his goal according to his psychological environment.

1.3 MULTIDISCIPLINARY NATURE OF ENVIRONMENT STUDIES

It is a well-known fact that an environment is a complex structure wherein all living organisms interact with their surroundings in a quest to live. In this process, the human beings come either in conflict or in direct correlation with the nature by using the limited and finite resources bestowed by the nature. Environment studies, thus by its multidisciplinary nature, aims and endeavours at finding out and unravelling ways and means so that life can be sustained without drastically affecting the environment. The discipline of environment studies is believed to be multidisciplinary in nature because it is one such subject which has interrelation with several other subjects like physical science, medical science, chemistry, agriculture, economics, statistics, law, public health, biological sciences, geology, sociology, anthropology, political science, engineering, management, technology and even religion. Amongst all these subjects, physics, geography, chemistry and geology are the main streams which help us to understand the environment in its structural and physical form. Apart from these, the subject of statistics and computer applications can be used for data simulation and designing a suitable environmental model. The idea of devising technical solutions or a scientific technique to tackle the problems like pollution, waste management, use of green energy, can be effectively contributed by the fields of engineering and chemical sciences. The subjects like economics and law which are prescriptive in nature, can go a long way in identifying the extent to which damage has been caused to the environment and can thus be used to suggest and recommend legal remedies or policy solutions which can effectively be used to compensate for the harm caused by the human beings to the environment, in their unquenching urge to grow and develop. Similarly, insights on subjects like political science and international relations can help in understanding the relevance of the issue of sustainability attached to the environment; the principles of sustainable development are more associated and intertwined with the elements of international cooperation which are accorded significance while dealing with the global environmental issues such as climate

change, ozone layer depletion, loss of biodiversity, transmission of pollution across the boundaries of the countries etc.



The food that provides energy, water which is crucial for the sustenance of life and air without which life on earth would not have been possible - all form an integral part of the environment and to maintain and sustain these components of environment, the subject of environmental studies has to be approached in a holistic way. Therefore it can be conclusively said that only the use of a multidisciplinary approach towards environmental studies can help in understanding and appreciating the inter linkage between the nature and the human beings. This subject in its practical sense seeks to analyse the problems and concerns related to the environment and eventually find out practical solutions so as to render life on earth more sustainable, keeping in view the limited extent to which environmental resources are available for life.

1.4 SCOPE AND IMPORTANCE OF ENVIRONMENT STUDIES

1.4.1 Scope of Environment Studies

Human development has paced up during the last two and a half centuries and this period has been important from the point of view of environment as well. In an urge to control and use nature for the sake of development, human beings have exploited the resources to an extent of their depletion. The approach of acquiring development at the cost of the natural resources

has not only set into motion complex changes which have not only altered the very basics of nature but has also caused irreparable damages to the environment, a kind of which has never been witnessed before. The scope of the subject of environmental studies is now not only confined to the study of the concepts and components of nature but has also transgressed into social, political and economic dimensions so as to find solutions to the problem related to environmental protection. This calls for greater participation of the individuals at all levels and also an approach which can be used to effectively design solutions and strategies for the problems being faced on the environmental aspect. It is time that human beings accept their responsibility in causing the damage to the environment and start taking immediate steps to reverse the loss. The resources available with the mother earth are finite and enough for meeting the development needs of the human beings but not enough for their greed. So, in this backdrop, it is extremely important that the individuals rise up and realise the need to use environmental resources more rationally and prudently and start leading environmentally responsible and sustainable lifestyles.

1.4.2 Importance of Environment Studies

Environment studies, is a subject that imparts knowledge to the mankind about the need and importance of protecting and conserving the resources available in nature and also provides an idea of the indiscriminate extent of pollution released into the environment. Since recent the problems related to the environment have been growing in size as well as their complexity day by day. This has not only threatened the survival of mankind on earth, but has also raised global concerns for the need to look into environmental protection. Today the human beings have reached that stage where they can reverse some extent of environmental degradation only if they organise and empower the educated communities and seek expert guidance in issues related to sustainable development. Environment studies, has been gaining significance for the following reasons:

1. **International importance attached to environment issues:** It is now being realised that environmental issues like ozone depletions, acid rain, marine pollution, global warming and loss of biodiversity have no more remained issues of national concern but have become global issues which require international efforts and cooperation to tackle them.
2. **Issues concerning development process:** The process of development across nations gave birth to the phenomenon of urbanisation, growth of agriculture, growth of

industrial sectors, development of means of transportation etc. However the countries of the north, i.e. the developed world started cleansing out their own environment by shifting their ‗dirty' factories to the southern nations thus distributing the impact of their development on environment to the other parts of the world.

3. **Discovering sustainable ways of life:** Adopting a sustainable approach to life would mean that the human beings make sure that they not only use the resources for their present needs but also preserve some, for their future generations. If the current rate of exhaustion of the resources continues, the natural resources will be depleted at a rate fast enough and making them unavailable for the future generations. An environmentally sustainable approach advocates for the need to create awareness amongst people about rational consumption of resources and minimise its unnecessary wastage. Thus, environmental education can help in understanding the repercussions that may be caused because of over exploitation of resources and underlines the need to act accordingly.
4. **Knowledge of the contemporary concepts for conservation of biodiversity:** The study of environment studies helps in understanding how the human beings and other organisms get along with the environment and how the two are interdependent. The study of Environment Studies brings with it new concepts like biodiversity; organic food; sustainability; the R's of environment i.e. reduce, reuse and recycle; use of eco-friendly products, etc. With the increase in the concerns pertaining to the environment, new concepts and policy solutions have evolved which have expanded the scope and dimensions of this discipline.
5. **Efficient use of natural resources:** The study of environmental science guides towards utilisation of natural resources lake water, forests, minerals and fossil fuels in an efficient manner. It explains the methods and measures in the form of conservation and recycling strategies so that the environment and its resources can be put use in such a manner that there is maximum utility and minimal wastage.
6. **Creating awareness about the environmental problems at local, national and the international levels:** It has been observed that most problems related to the environment occur because of the lack of awareness and this applies not only to the local or national levels but also to the international regime. Environmental studies as a subject can help to educate and equip the learners with the necessary skills and ability so that the knowledge acquired can be passed on to create awareness amongst the members of the community.

1.5 COMPONENTS OF THE ENVIRONMENT

The environment is divided as a whole into physical and biological components which include man and other living organisms along with the natural and physical factors that surround the various species of living beings. The factors such as soil, air, water, light, temperature, etc. are all called abiotic factors. Apart from these abiotic factors, the environment constitutes of biotic factors as well which include various forms of life like plants, animals, human beings, microorganisms etc. Thus, man is an integral part of the environment and that is why the environment is significantly affected by the activities carried out by the human beings. The environment can thus be divided into four major components namely the Lithosphere, Hydrosphere, Atmosphere and Biosphere.

1. **Biosphere** –It is that part of the global ecosystem which includes living organisms and the non-living factors which work as the source of energy and nutrients to the living organisms. The Biosphere encompasses all the zones of the earth in which life is present, that is the entire bio-resources on the earth. The biosphere evolved almost 4billion years ago through an evolutionary process. Life exists in diverse forms in the top layer of the lithosphere, throughout the hydrosphere and in the lower layers of the atmosphere. Thus, all the biological resources and their surroundings together constitute the biosphere and amongst all the components of the biosphere, human beings are the most evolved species. The layer of the biosphere extends almost over the entire surface of the earth and includes the upper layers of the Earth's crust and the thick layer of the soil which primarily support life. Since life has been observed to exist on the ground, in the air, below the water, so

the biosphere is known to overlap all these spheres. The biosphere extends to about 20 kilometers from top to bottom and almost all living organisms exist end survive between these limits; i.e. about 500 meters below the sea level and about 6 kilometers above the sea level.

About 3 to 30 million species of organisms constitute the biosphere which include plants, animals, fungi, the oldest and the earliest form of life called prokaryotes which included single celled organisms like bacteria that survived without oxygen and single celled eukaryotes which included organisms like protozoa. Of all these species, only about 1.4 million species have been named by the systematists and less than 1% species have been examined for the relationship that they witness with the ecology and the role that they play in the ecosystem. The Biosphere is thus believed to be a large ecosystem – that is a complex community of various living and non-living components which function together as a single unit. However, more often, the biosphere is described to have many ecosystems included in itself.

2. **Lithosphere –** The lithosphere is thought to have evolved around 4.6 billion years ago. It reaches a depth of around 60 miles (100 km).The solid, stony crust that covers the entire surface of the Earth is referred to as the lithosphere. It consists of all hard and solid land masses on the earth's surface, as well as semi-solid rocks (molten minerals) beneath the earth's crust and liquid rocks in the earth's inner core. The lithosphere‘s outer shell is not one continuous piece, but is fragmented into around a dozen main independent hard blocks, or plates, like a slightly cracked eggshell. The lateral movements of the plates are thought to be caused by slow convection currents deep under the mantle, which are caused by radioactive heating of the interior. The lithosphere's surface is uneven, as it is marked by diverse landform features. The liquid, semi-solid, and solid land components in this layer comprise of chemically and physically distinct layers. This is why the lithosphere is separated into sub-spheres such as the crust, mantle, outer core, and inner core.

   The top layer of the Crust, known as the outer crust is made up of rocks and loose soil; it is expected to be around 30 to 40 kms thick and mostly contains Silicon and Aluminium whereas the inner crust which is merely 5 to 10 kms thick comprises of Silicon and Magnesium. The middle layer, i.e. the mantle is composed of dense rock containing nickel and iron in the form of silicate rocks and its lower layer comprises of semi-solid rocks. Liquid (pure molten) rock components make up the outer core of

the Lithosphere. The inner core of the planet is formed entirely of extremely hot and liquid iron and nickel. Almost 10% of this layer is believed to be composed of sulphur and oxygen since these elements are abundantly available in the cosmos and dissolve easily into the molten iron.

Earthquakes, volcanic eruptions, mountain formation, and continental drift all occur in the Lithosphere. It includes continents, oceans, seas, lakes, mountains, plateaus, plains, deltas, beaches, cliffs, and dunes, among other topographical characteristics. It is made up of rocks (igneous, sedimentary, and metamorphic rocks) that contain all minerals(dolomite, magnetite, hematite, etc.) and elements(iron, nickel, nitrogen, hydrogen, oxygen, sulphur, phosphorus, etc.) which are essential for the survival and prosperity of the human beings.

3. **Hydrosphere** –The word Hydrosphere refers to the most important resource, i.e. water and it includes all important forms of water in the form of solid, liquid and gas on the surface of the Earth. The hydrosphere extends to thousands of miles from the Earth's surface into the lithosphere and high above the crust into the atmosphere. The majority of the water in the atmosphere is in a gaseous state, and as it reaches higher in the atmosphere, it condenses into clouds, which fall back to earth as precipitation. Like the gases in the atmosphere, all of the water in the hydrosphere is always in motion. Rivers, streams, lakes, seas, oceans, and water vapour are examples of natural earth characteristics that portray the hydrosphere. Glaciers, which are slow-moving masses of ice, are also a part of the Hydrosphere.

   Since water is a necessity for life, all plants and animals depend upon the Hydrosphere for their survival. The Hydrosphere is the home to various plants and animals and it is estimated that the Hydrosphere stretches across to almost 70% of the surface of the Earth. Moreover, almost 97% of the water available on the earth is saline; oceans carry most of the salty water with themselves whereas the lakes and the rivers carry fresh water. The temperature on the surface of the Earth is also significantly affected by the Hydrosphere. Icebergs, glaciers, and icecaps are associated to extremely cold temperatures; low to moderate temperatures are related to the basic forms of precipitation i.e. the snow, rain, drizzle, sleet, or hail; and high temperatures are generally correlated to dry, hot conditions and evaporation.

Water source	Water volume, in cubic miles	Water volume, in cubic kilometres	Percentage of freshwater	Percentage of total water
Oceans, Seas, & Bays	321,000,000	1,338,000,000	--	96.54
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.7	1.74
Groundwater	5,614,000	23,400,000	--	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	--	0.013
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	--	0.006
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Source: Adapted from Igor Shiklomanov's chapter "**World Fresh Water Resources**" in Peter H. Gleick (ed.), Water in Crisis: A Guide to the World's Fresh Water Resources, copyright 1993, Oxford University Press, New York

Table made available by the United States Geological Survey

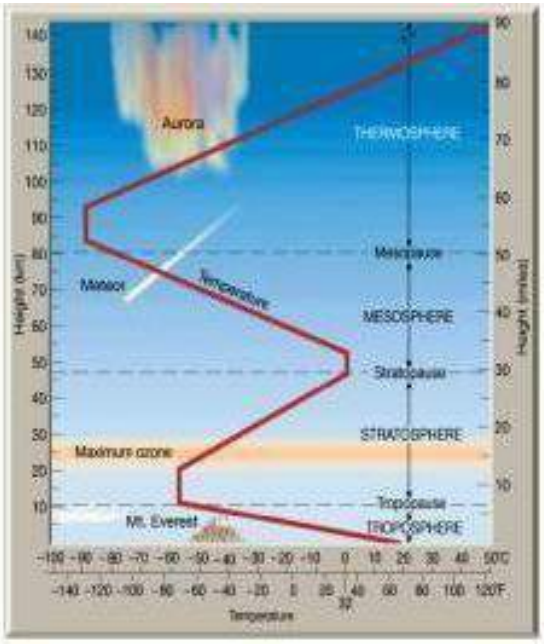
4. **Atmosphere** –The layer of air around the Earth makes the atmosphere which comprises of nitrogen (78%), oxygen (21%), other gases (1%) which includes carbon dioxide (0.039%), argon (0.93%) and remaining trace gases (like krypton, neon, helium and xenon). The atmosphere gets thinner as it rises in altitude, and this characteristic eventually approaches towards space. The atmosphere stretches from the earth's crust to more than 10,000 kilometres above the surface of the planet and into space. The atmosphere is a protective layer of gases that surrounds the Earth and

aids in the survival of life. It shields humans from the harsh conditions of space by absorbing the majority of cosmic rays and damaging UV radiation. It transmits visible light, near-infrared light (300 to 2,500 nm), UV light (primarily UV A), and radio waves.

Based on temperature, the atmosphere is separated into five layers. The troposphere is the layer closest to the Earth's surface, measuring between seven and fifteen kilometres. At the equator, the troposphere is thickest, but at the North and South Poles, it is much thinner. The troposphere contains the majority of the mass of the entire atmosphere—between 75 and 80%. The troposphere contains the majority of the water vapour in the atmosphere, as well as dust and ash particles, which explains why the troposphere is home to the majority of Earth's clouds. Temperatures in the troposphere drop as the altitude increases.

The stratosphere is the next layer above the surface of the Earth. It extends from the tropopause, i.e. the top of the troposphere, to a height of about 50 kilometres. The stratosphere's temperature rises with height. The stratosphere's ozone layer is made up of a high concentration of ozone, a molecule made up of three oxygen atoms. This ozone absorbs some of the incoming solar energy, protecting life on Earth from potentially damaging ultraviolet (UV) light, and is responsible for the rise in altitude temperature.

The stratopause is the top layer of the stratosphere. The mesosphere is above that, reaching up to 85 kilometres above the Earth's surface. With an increase in the altitude in themesosphere, the temperature drops. The coldest temperatures in the atmosphere are found towards the top of the mesosphere, where temperatures are around -90°C. The atmosphere is thin here, but thick enough for meteors to fall



through. The upper layer of the mesosphere is called the mesopause.

Above the mesopause is the thermosphere, which extends for about 600 kilometers. The thermosphere is one such zone of the atmosphere, about which not much is known, except the fact that temperatures rise with height in this layer. Solar radiation heats the thermosphere's top portions, which can raise the temperatures as high as up to 2,000°C.The exosphere is the topmost layer, which merges with what is called outer space. The gravitational attraction of the Earth is so weak here that gas molecules escape into the outer space.

CHECK YOUR PROGRESS

Ques.1 Answer the following Short Answer Type Questions:

i. The solid components of the earth consisting of soil, rocks and mountains is called:
   a. Hydrosphere
   b. Lithosphere
   c. Biosphere
   d. Atmosphere

ii. The major principle of environmental sustainability entails the concept of R‘s which mean……., …… and ……

iii. The reversal of environmental degradation caused by the human beings calls for the need to ..... the educated communities and seek an expertise in issues related to ……

iv. Match the component of Environment (in Column A) with its thickness (Column B)

Column A	Column B
Lithosphere	10,000 km
Biosphere	All over the earth‘s surface
Atmosphere	20 km
Hydrosphere	60 km

v. The layer of the atmosphere that absorbs the ultra violet and other harmful radiations from the Sun and prevents them from reaching the Earth is called
   a. Troposphere
   b. Exosphere
   c. Mesosphere
   d. Stratosphere

1.6 SUMMARY

In this unit, effort was made to understand the meaning, scope and importance of Environment Studies as a discipline and to develop a more cognizant approach towards the issues related to the environment. The learners would have been able to learn that:

- The external conditions or surroundings that support the life of human beings and all others living organisms together constitute the environment
- The environment constitutes of the physical (air, water, sky, etc.) social and cultural (moral, ethical and emotional factors) and psychological (nature or personality of the human beings) elements
- Environment studies, is multidisciplinary in nature and approach because environment as a concept and a problem, can be perceived from the perspective of science as well as the non-science subjects. The interrelationship between environment and other disciplines can help in finding out better policy solutions to the problems pertaining to the environment.
- The study of the environment has now extended its dimensions to the social, political and economic aspects as well because of the urgent need to look into the solutions to the problems related to environmental protection.
- New concepts related to the field of environment, like biodiversity, sustainable development, the three R‘s of environment, i.e. reduce, reuse and recycle, green energy etc. have evolved in the recent year and there is need to look into the concerns arising from the environment from a contemporary perspective.
- It is becoming extremely important day by day to look into and examine various issues that occur because of the irrational behaviour of human beings while using the natural resources for their growth and development.
- The environment is actually divided into four broad components, i.e. the Lithosphere, Hydrosphere, Atmosphere and Biosphere.
- The Biosphere includes all the zones of the Earth in which life exists and it extends across almost the entire surface of the earth and even the upper layers of the Earth‘s crust.
- The rocky layer on the surface of the Earth is called the Lithosphere which is further fragmented into three subzones - the crust, the mantle and the core.

- All the sources of water on the surface of the Earth, whether they are in the form of solid, liquid or gaseous state, constitute the Hydrosphere and it is this hydrosphere which is the main source of supporting life on the Earth.
- The layer of air around the Earth is called the atmosphere which consists of various gases that exist in different proportions and it is this protective layer of gases that helps in the survival of life on the Earth.

1.7 QUESTIONS FOR PRACTICE

Ques. 1 How do you think Environment Studies is a subject with a multidisciplinary approach?

Ques. 2 Discuss how has the scope of Environment Studies changed with the change in the intensity of the issues related to the environment?

Ques. 3 ―Earth provides enough to satisfy every man‘s needs but not every man‘s greed.‖ In the light of this statement, explain why is it important to use resources for need and not for greed?

Ques. 4 Differentiate between Lithosphere and Biosphere. Which of the two has conditions more suitable for supporting life on the earth and why?

Ques. 5 Make a thermal stratification of the atmosphere and explain the features of each layer of the atmosphere in detail.

1.8 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad

SEMESTER: II

COURSE: ENVIRONMENTAL STUDIES

UNIT 2: ECOSYSTEM AND BIODIVERSITY CONSERVATION

STRUCTURE

2.0 LEARNING OUTCOMES

After reading the material, learner shall be able to understand

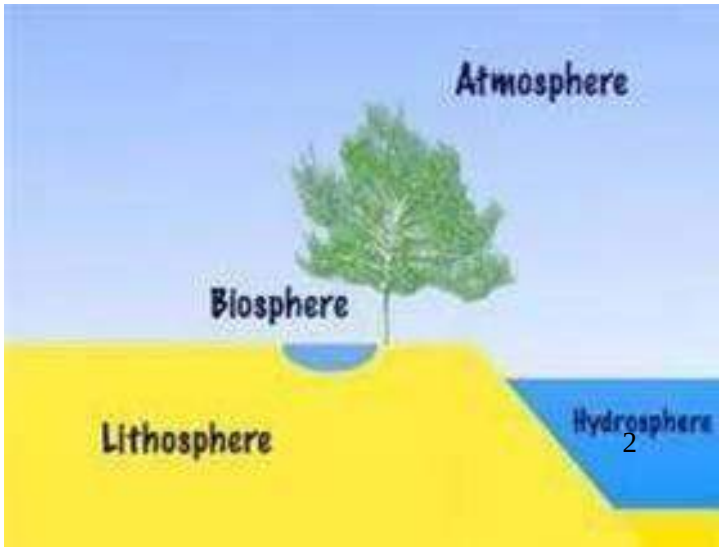
- Meaning of ecosystem and biological diversity
- Importance of Biological diversity and need for protection of biodiversity
- Methods of protecting biodiversity
- Value of biodiversity
- Biodiversity in India

2.1 INTRODUCTION

Environment has received greater attention in the later part of the twentieth century and in twenty first century. Increased exploitation of natural and physical resources without caring for the surrounding environment and increased environmental pollution impacting all living organisms on the planet has received the attention of the masses and policy makers. Environmental studies, therefore, has assumed greater emphasis than ever. However, environmental studies is not restricted to study of what constitutes environment and environmental pollution but also the legal provisions, human actions and other factors which influence the environment. The subject indeed requires a multidisciplinary approach involving study of environmental science, legal provisions and human approach.

Term Environment has been derived from French word _Environia' which implies to surround. Term environment includes both living (biotic) and non-living/physical environment. Therefore, it includes all surrounding in which organisms live. Immediate environment i.e. area near the surface of the earth can be divided into atmosphere, hydrosphere, lithosphere and biosphere.

Atmosphere is composed of various gases surrounding the earth. Atmosphere is in a state of continual change. Atmosphere can be divided into troposphere (lower layer of the atmosphere close to earth), stratosphere (upper layer of the atmosphere where large layer of ozone is there), mesosphere (where water vapors free and create clouds) and thermosphere (the top layer of the atmosphere where satellites circle the earth).



Lithosphere implies rocks and minerals. Lithosphere is believed to have come into existence billions of years ago and it refers to solid rocky crust that covers the entire planet. It includes mountains, valleys, soil, minerals and rocks.

Hydrosphere refers to all forms of water in earth‘s environment. It includes lakes, rivers, oceans, glaciers, ground water etc. About 70% of the earth‘s surface is composed of Hydrosphere.

Biosphere refers to all forms of living organisms existing on the planet. Various forms of life exist in the biosphere including plants, animals and other living organisms.

2.2 ECOSYSTEM

Term ‗eco‘ implies part of the world. It means set of coordinating units. In an environment, various living organisms and their surroundings function together as a unit. These units of ecology are referred to as ‗ecosystem‘. Ecosystem, therefore, implies sum total of living organisms and the surrounding environment i.e. biotic and abiotic environment. It includes living organisms including plants, animals and other living things. This is described as biocoenosis. Nature is a biotope that encompasses the visible environment of life. The term ecosystem first appeared in a book published by British naturalist Arthur Tansley, in 1935. The biological system can have verydifferent sizes. It could be a whole forest, with a small dam. Various natural habitats are often separated by local barriers, such as deserts, mountains or seas, or by other means, such as lakes orrivers. Since these boundaries are never solid, nature often meets.

Ecosystem species are connected with each other, directly or indirectly. There is a diverse relationship between various species in an ecosystem. This relationship is unique as well as delicate. Changes in ecosystem can adversely affect this relationship causing damage to various species thereby affecting the entire ecosystem. For example, if there is increase in temperature in a particular ecosystem, plants and other living organisms will have to adapt to such change and those which are unable adapt would face extinction or migration.

2.2.1 Components of Ecosystem

Ecosystem is composed to two different components i.e. abiotic and biotic components. Biotic components of the ecosystem are living things. As stated earlier, in an ecosystem various species are connected with each other in diverse ways and they influence each other in myriad ways.

Plants, animals, bacteria and fungi all affect each other. Based on their energy requirement source, biotic components are categorized as producers, consumers, and decomposers.

Abiotic components are physical and non-living components. These include rocks, minerals, water, air and other non-living things. These include organic and inorganic compounds. Organic compounds include proteins, carbohydrates, amino acids and lipids. Inorganic compounds, on the other hand, include calcium, nitrogen, phosphate, caron dioxide. These factors influence living organisms.

2.3 TYPES OF ECOSYSTEMS

Depending upon various climates, habitats and life forms, ecosystems can be broadly classified as Aquatic and Terrestrial Ecosystem.

2.3.1 Aquatic Ecosystem

Aquatic ecosystems refer to all such ecosystems that are primarily located on or inside water bodies. The nature and characteristics of all living and non-living organisms in the aquatic system are determined based on the environment surrounding their ecosystem. Organisms in these ecosystems interact with other organisms in aquatic and terrestrial ecosystems. The aquatic ecosystem is mainly sub-divided into the following types:

2.3.1.1 Freshwater Ecosystem

The freshwater ecosystem is one of the essential ecosystems for humans and other organisms living on land. This is because this ecosystem is a source of drinking water. Additionally, it also helps in providing the necessary energy and water for transportation, recreation, etc. Freshwater ecosystems mainly include lentic, lotic, and wetlands.

Lentic: Water bodies that are moving slowly or are still in some places come under lentic. For example, ponds, lakes, pools, etc. Lakes are known as large water bodies and are surrounded by land.

Lotic: Water bodies that are moving at a fast pace fall under a lotic. For example, streams and rivers.

Wetlands: Environments characterized by soils saturated with water for a long time fall under wetlands.

The freshwater ecosystem is the smallest type of ecosystem among the major types of ecosystems. There is usually no salt content in the freshwater ecosystem. Besides, it consists of many insects, small fish, amphibians, and various plant species. Plants help provide oxygen through photosynthesis and also provide food for the organisms living in this ecosystem.

2.3.1.2 Marine Ecosystem

Marine ecosystems are usually characterized by the presence of salt content. These ecosystems have a higher salt content than the freshwater ecosystem. Moreover, they are known as the largest type of ecosystem on Earth. It usually includes all the oceans and their parts. Besides, marine ecosystems have distinctive flora and fauna, which support greater biodiversity than freshwater ecosystems. This type of ecosystem is essential for both marine and terrestrial environments.

In particular, this ecosystem includes salt marshes, lagoons, coral reefs, estuaries, intertidal zones, mangroves, seafloor, and deep seas. Salt marshes, mangrove forests, and sea-grass meadows are said to be among the most productive ecosystems. Coral reefs are known to provide adequate quantities of food and shelter to most marine inhabitants worldwide.

2.3.2 Terrestrial Ecosystem

Terrestrial ecosystem refers to all such ecosystems which are mainly located on land. Although the presence of water in these ecosystems is measured, they are entirely land-based and exist on land. More specifically, a low and sufficiently needed amount of water is located in terrestrial ecosystems. The low amount of water separates these ecosystems from aquatic ecosystems. Besides, terrestrial ecosystems typically have temperature fluctuations in both seasonal and diurnal climates. It is also a specific factor that makes these ecosystems different from aquatic ecosystems in similar environments.

Furthermore, the availability of light is somewhat higher in terrestrial ecosystems than in aquatic ecosystems. The reason for this is that the climate in the land is relatively more transparent than

water. Due to entirely different light availability and temperature in terrestrial ecosystems, they have diverse flora and fauna. Terrestrial ecosystems include various ecosystems distributed around different geological zones. Terrestrial ecosystems are mainly classified into the following types:

2.3.2.1 Forest Ecosystems

A forest ecosystem is an ecosystem where many organisms live together with the environment's abiotic components. There are much different flora and fauna in this ecosystem. This usually means that the forest ecosystem has a high density of living organisms that live with non-living abiotic elements. The forest ecosystem usually includes various plants, microorganisms, animals, and other species.

Forests are significant carbon sinks and participate in controlling and balancing the overall temperature of the Erath. Changes in the forest ecosystem affect the entire ecological balance, and severe changes or destruction of forests can also kill the whole ecosystem. Forests are generally classified into tropical deciduous forests, tropical evergreen forests, temperate deciduous forests, temperate forests, and Taig.

2.3.2.1 Grassland Ecosystems

Grassland ecosystems are referred to as those ecosystems where the number of trees is low. These ecosystems mainly consist of grasses, shrubs, and herbs. That means grasses are the primary vegetation in these ecosystems, along with legumes that typically belong to the composite family.

Grassland ecosystems are commonly situated in both the tropical and temperate regions globally; however, they have distinct variations. Examples of these ecosystems include the savanna grasslands and temperate grasslands. They are home to various grazing animals, insectivores, and herbivores.

2.3.2.2 Mountain Ecosystems

As the name suggests, the mountain ecosystem is characterized by mountainous regions where the climate is usually cold, and rainfall is low. Due to these climate changes, these ecosystems have a wide variety of habitats where various animal and plant species are found.

The high altitude areas of mountainous regions have a cold and harsh climate. This is the reason why only treeless alpine vegetation is found in these ecosystems. Animals found in these ecosystems usually have tick fur coats to protect them from cold climates.

Besides, mainly coniferous trees exist on the lower slopes of the mountains. Examples of mountain ecosystems include mountain tops in Arctic regions. They are covered with snow for most of the year.

2.3.2.3 Desert Ecosystems

Desert ecosystems exist worldwide and cover about 17 per cent of desert areas. These are areas where annual rainfall is usually measured less than 25 mm. Due to fewer trees and land of sand, sunlight intensifies in these ecosystems. This is why these ecosystems have incredibly high temperatures and low availability of water. However, the nights are quite cold.

The Desert ecosystem has unique flora and fauna. Plants grow with small amounts of water and conserve water's possible amount in their leaves and stems. For example, the spiny-leafed cactus is a type of desert plant that has the characteristic of storing water using a stem. Similarly, animals are also adapted to the condition of desert ecosystems. Some common animals are camels, reptiles, a diverse range of insects and birds.

2.4 BIODIVERSITY : MEANING AND DEFINITION

Biodiversity refers to all the species of living things on Earth or to a particular ecosystem. Biodiversity is the variety of the species of plants, animals, fungi and living things including the diverse ecosystems in which they live.

Natural resources from biodiversity and ecosystems are important at the global, regional and local levels. The world now acknowledges that the loss of biodiversity is contributing to global climate change. Forests are a major means of converting carbon dioxide into oxygen. Loss of forest cover, coupled with increased release of carbon dioxide and other gases through industrial use contributes to the _thermal effect‘ causing global warming. Global warming is melting glaciers, leading to

rising sea levels which will slowly drown the low lying coastal areas. It causes dramatic changes in the atmosphere, resulting in rising temperatures, severe droughts in some areas, and unexpected floods in others areas. Value of biodiversity can be measured in terms of direct value like use of plants, herbs for medicinal, human consumption or other productive uses. Apart from economic value, biodiversityhelps in sustenance of the environment and thus is essential for our sustenance and survival.

2.5 THREATS TO BIODIVERSITY AND ITS CONSERVATION

2.5.1 Threats to Biodiversity

There are various threats to biodiversity primarily owing to human activities. The underlying causes of biodiversity loss are growing human population and overconsumption. These factors are often complex and stem from many interrelated factors. Some of these threats are discussed hereinafter:

2.5.1.1 Human Population

Population explosion is one of the biggest challenges to biodiversity protection. Population explosion has led to severe strain on natural resources leading to over exploitation of natural resources. From 1 billion people in 1800, population has increased to around 6.8 billion in around 200 years. Increasing demand for food, clothes, necessities and luxuries of life leading to deforestation and large exploitation of natural resources pose a serious threat to biodiversity.

2.5.1.2 Pollution

Environmental pollution is a big threat to survival of many species. Various facets of environment be it air, water, soil or noise have been immensely polluted due to irresponsible behavior of mankind. Rapid industrialization, increased construction activities, mass scale deforestation to meet human needs, vehicular emissions, household emissions, discharge of industrial affluents into water bodies, stubble burning, massive waste generation and its unscientific disposal pose serious threat to the environment and sustenance of various organisms. All these factors individually and jointly have a serious adverse impact on biodiversity.

Bioaccumulation is another facet which requires special mention. Bioaccumulation refers to the process wherein chemicals released by humans get concentrated in animal tissues and they enter

the food chain. These chemicals invade into the nervous systems of the predators and cause serious ailments thereby endangering the entire population of the predating specie.

2.5.1.3 Habitat Loss

One of the major threats to biodiversity is habitat loss often caused due to anthropogenic reasons. Increasing population, increasing demand for food supplies and forest produce led to large scale deforestation thereby causing serious habitat loss endangering flora and fona found at such places.

2.5.1.4 Invasive Species

Movement of species and living organisms from one place to another place can affect resident species of that place sometimes endangering the original inhabitants. Such invasive species can predate original resident species, disrupt their habitat or be the cause of some diseases. All these factors taken together can lead to loss of biodiversity of the area.

2.5.1.5 Overharvesting

Overfishing includes targeted hunting, gathering, or fishing for a particular type of harvest and harvesting associated with the decline of marine fisheries. An example of the extinction of megafauna in the past was the example of over-harvesting causing environmental loss.

Marine fisheries are at high risk of over harvest especially during the second post-war period due to technological advances such as refrigerator, sonar, processing board etc. a few decades of great harvest using this new technology in the late twentieth century led to the collapse of the human race. The population is declining by more than 90%, and species fishing was banned in Canada and the United States. The loss of high-quality animal such as cod, as well as the decline of other predators such as haddock and flounder, has led to the explosion of large numbers of fish such as herring, capelin, shrimp. Cod people have not yet been found, although fishing pressures have stopped, and these observations have led researchers to speculate that the ecosystem may now be in a stable state that will prevent cod recovery

2.5.1.6 Climate Change and Biodiversity Loss

Climate change affects the environment in many ways, including changes in temperature. These

mutations make it difficult or impossible for many species to survive. As the climate changes more and more, biodiversity will face ever-increasing threats. Likewise, efforts to conserve biodiversity will face challenges. Conservationists may be faced with the challenge of deciding which species

should be protected.

2.5.2 Conservation of Biodiversity

Conservation of biodiversity is of crucial importance for survival of various life forms including humans. The primary aim of conservation of biodiversity is to ensure sustainable utilization of species and ecosystem thereby maintaining essential ecological processes. There are two methods of two methods of biodiversity i.e. in-situ conservation and ex-situ conservation.

Endangered species may be protected by protecting its habitat. This method is known as in-situ conservation and is one of the commonly adopted measures to protect the endangered specie in its own habitat. Various countries have adopted this method and created National Parks, Wildlife Sanctuaries, protected areas etc.

Sometimes, it may not be feasible to protect endangered species by protecting their habitat alone. For example, the specie may be close to extinction. Therefore, alternative measures may be required to protect the specie from becoming extinct. In such cases, ex-situ conservation may be adopted, i.e. conserving the specie outside its natural habitat in an artificially created habitat wherein humankind can control the circumstances and can help the specie multiply using human intelligence.

2.5.2.1 Strategies for Biodiversity Conservation

There are various ways in which biodiversity can be preserved including :

- Development of national parks, wildlife sanctuaries etc
- Identification and conservation of economically important organisms
- Preservation of unique ecosystems.
- Efficient and effective utilization of resources
- Enforcing an effective ban on poaching and hunting of wild animals
- Strict enforcement of environment legislation
- Control over environmental pollution
- Identification and conservation of endangered species both in situ and ex situ
- Creation of public awareness

2.6 LEVEL OF BIOLOGICAL DIVERSITY: GENETIC, SPECIES ANDECOSYSTEM DIVERSITY

Biodiversity is categorized as Genetic Diversity, species diversity and ecological diversity.

2.6.1 Genetic Diversity

All species on Earth have genetic connections with other species. Through the process of evolution, species have evolved into their present-day shape and form. And when one species is related to another, they will share additional genetic information. These types will also look very similar. The closest physical contact is with members of its genus. Members of a particular gene share genes. Genetics are fragments of information about chemicals that partially determine how the body looks, behaves, and lives. Almost all species have the same and closely related species in the neighborhood. In addition, all species have other closely related species. These two types share common features.

2.6.2 Species Diversity

Biodiversity refers to the diversity of species that exist in an area. It determines the level of biodiversity. Species are a common form of biodiversity because they are the basic units of biodiversity. It is estimated that there are some 10 million species in the world, with only 1.75 million species being able to name them.

Some regions are more diverse. Tropical North and South America, for example, have about 85,000 flowering plants. Tropical and Tropical Asia has at least 50,000 while tropical and tropical Africa has 35,000.

Europe has about 11,300 artificial plants. Some areas, such as the polluted stream, have a surprisingly low percentage of species.

2.6.3 Ecological Biodiversity

Ecological Biodiversity refers to ecosystem diversity in the area. It includes a complex network of diverse species that exist in living environments and strong connections between them. An ecosystem is made up of materials from a variety of species that live together in an environment and their interactions through the flow of nutrients, energy, and matter.

An ecosystem can cover a small area, such as a lake, or a large area, such as the entire forest. The main source of energy for almost all of nature is the sun's radiant energy being converted into chemical energy by plants.

Animals eat plants, allowing energy to flow through systems. Animals are eaten by other animals. Fungi decomposes organic matter to gain energy and in the process of regeneration the nutrients return to the soil.

Thus, an ecosystem is a collection of living things and inanimate objects connected by energy flow. It is difficult to measure biological diversity because every living thing on earth is connected to the surrounding environment.

2.7 BIO-GEOGRAPHIC ZONES OF INDIA

Biogeography is the study of the distribution of species and nature in geographic space and geological period. India has a rich heritage of biodiversity. India ranks fourth in Asia and tenth in the world among the 17 most diverse countries in the world. India accounts for about 11% of the world's flower species including more than 17500 flowering plants, 6200 endemic species, 7500 medicinal plants and only 246 threatened species worldwide in only 2.4% of the world's soil.

India also has some of the most diverse landscapes - the Andaman & Nicobar Islands, the Eastern Himalayas, the Indo-Burma region, and the Western Ghats.

Attempts have been made to divide India zoogeographically since 1988. India's Forest Survey published an atlas of forest species in 2011. However, there is no official plan approved by the Government of India, as issued by the European Environment Agency to conserve biodiversity.

2.7.1 Biogeographic Zones

As stated earlier, attempt have been made to divide India zoogeographically while planning a network of protected areas of India. The system has divided India into 10 biogeographic segments, and each area is further subdivided into biogeographic provinces, numbering 27 in total.

2.7.1.1. Ten Biogeographic Segments

- Trans Himalayan zone.

- Himalayan zone
- Desert zone.
- Semiarid zone.
- Western ghat zone.
- Deccan plateau zone.
- Gangetic plain zone.
- Northeast zone.
- Coastal zone.
- Islands

2.8 BIODIVERSITY PATTERNS AND GLOBAL BIODIVERSITY HOT SPOTS

As stated earlier biodiversity is the richness of species and degree of variation of life and other living organisms including genetic diversity, species diversity, or biodiversity within the area, biome, or planet. Diversity is the work of two things: the number of species (Species Richness) and the number of specimen of these species (Evenness). Multiple indices for measuring diversity have been suggested, which give more or less weight to the two.

Introduction of species in new areas have led to new distribution patterns. For example, Macropus eugenii was thought to be extinct in Australia for 100 years but was rediscovered on an island in New Zealand (2000 species) where it was introduced in 1862. Migration creates a special kind of diversity pattern.

If we examine biodiversity patterns, we find that Tropical areas have the highest diversity of species due to various reasons including High productivity and food availability; high biomass; past patterns of evolution etc. The patterns of a variety of species in a place or at any one time are set by a combination of three elements i.e. Chance, History and Necessity.

2.8.1 Biodiversity Hotspots

The term biodiversity hotspot was coined by Norman Myers. It refers to regions known for their high diversity richness and endemism. According to Conservation International, in order to qualify as a biodiversity hotspot, the region must meet the following two criteria:

- ✓ The region should have at least 1500 species of vascular plants i.e., should have a high rate of endemism.
- ✓ Region Must contain 30% (or less) of its original species, i.e. species must be threatened.

In India, following major biodiversity hotspots have been identified:

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

2.8.1.1 The Himalayas

Himalayas is located in northeastern India, Bhutan, central and eastern parts of Nepal. The region (NE-Himalayan) has a record of 163 endangered species including Wild Asian Water Buffalo, 1-horned rhino; and some 10,000 species of plants, 3160 of which are extinct.

2.8.1.2 Indo - Burmese region

The Indo-Burma region extends over 2,373,000 km². Over the past 12 years, six species of mammals have been identified in the region.

The tropics are also known for the tortoise species of freshwater, many of which are at risk of extinction, due to over harvest and large-scale losses. There are also 1,300 different species of birds, including the threatened White-eared Night-heron, the gray-headed Crocias, and the Orange-neck Partridge.

2.8.1.3 Western Ghats

The Western Ghats are located on the western edge of the Indian subcontinent and include most of the refreshing forests and rain forests. According to UNESCO, it is home to at least 325

endangered species that are endangered, animals, birds, amphibians, reptiles and fish. Initially, vegetation in the region was distributed over 190,000 km2 but has now been reduced to 43,000 km2. The region is also known for the world's endangered species of plants and animals represented by 229 species of animals, 31 species of mammals, 15 species of birds, 43 species of amphibians, 5 species of reptiles and 1 species of fish. According to UNESCO, –of the 325 species threatened in the Western Ghats, 129 are considered endangered, 145 are endangered and 51 are at risk of Extinction.‖

2.8.1.4 Sundaland

Nicobar Island form part of the Sundaland. It is a biological diversity hotspot. It extends to the tectonic plates under Indian ocean. Various species like Orangutans, Javan and Sumitran Rhinos, pig-tailed langurs etc are found in this hotspot. It is home to world‘s largest fowers measuring upto one meter.

2.8.1.5 Terrai-Duar Savannah

The region falls within a narrow stretch at the base of Himalayas in Indo-Gangetic plains in India,, Nepal and Bhutan. These are the world‘s tallest grasslands. These are rare elephant grasslands grown by silt deposited by monsoon floods. These are home to one-horned rhinoceros, sloth bears and Asian elephants.

2.8.1.6 Sunderbans

Sunderbans is the largest mangrove forest in the world consisting of set of 104 island formed by Ganga-Brahmaputra Delta. Sunderbans are home to Royal Bengal Tiger, Gangetic Dophins and estuarine crocodiles. Sunderbans have immense biological diversity but are endangered by rising sea level caused by global warming.

2.9 INDIA AS MEGA-BIODIVERSITY NATION

India is one of the 12 mega biodiversity countries of the world. Various factors have contributed in making India as a mega biodiversity nation including physical and geographical factors and climatic conditions. Biogeographically, India is located at a tri-junction of three realms - the Afro-

tropical, Indo-Malayan and Paleo-Arctic regions. Consequently, India has certain features of all these regions. This is one of the important factors for rich biodiversity in India. India is home to 167 important crops of millets, cereals, condiments, fruits, vegetables, pulses, fiber plants and oilseeds, and 114 species of domestic animals. About 4,900 species of flowering plants are found in the country. Western Ghats and North East India are home to rich biodiversity. It is claimed that India is home to around 62% of the amphibians.

Conservation of biological diversity and respect for environmental sustainability was deep rooted in Indian tradition and culture. Many tribes in India worship facets of environment and work towards sustenance of biological diversity. Owing to rich biodiversity and traditional knowledge of the medicinal therapeutic use of herbs, many alternative systems of medicines viz., Ayurveda, Unani and Homeopathy are practiced in India making use of biodiversity.

2.10 ENDANGERED AND ENDEMIC SPECIES OF INDIA

Endangered species are those species whose sustenance is endangered i.e. whose population is declining owing to various natural and anthropogenic reasons. These species may become extinct, if efforts are not made to protect them. In India, around 450 plant species, 100 mammals and around 150 types of birds are considered as endangered.

Endemic species, on the other hand, are those plants or animals which exist in a particular area only and nowhere else e.g. Bengal Tiger.

Critically Endangered animals

1. Jenkin's Shrew
2. Malabar Large Spotted Civet
3. Namdapha Flying Squirrel
4. Pygmy Hog
5. Salim Ali's Fruit Bat
6. Sumatran Rhinoceros
7. Wroughton's Free-Tailed Bat

Endangered animals

1. Asiatic Lion
2. Asiatic Black Bear
3. Desert Cat
4. Great Indian Rhinoceros
5. Indian Elephant or Asian Elephant
6. Blue Whale
7. Capped Leaf Monkey
8. Fin Whale
9. Ganges River Dolphin
10. Hispid Hare
11. Indus River Dolphin
12. Red Panda

Vulnerable Species

1. Asiatic Wild Dogs
2. Banteng
3. Brown Bear
4. Clouded Leopard
5. Ganges River Dolphin
6. Himalayan Musk Dear
7. Jackal
8. Asiatic Golden Cat
9. Barasingha
10. Blackbuck
11. Fishing Cat
12. Royal Bengal Tiger
13. Sloth Bear
14. Wild Goat
15. Wild Yak

Threatened Species

1. Indian Wild Ass
2. Leopard
3. Red Fox

Endemic animals

Endemic species are animals or plants that exist only in some particular areas and nowhere else in the world. In India, endemic species are mostly in the Himalayas and the Western Ghats. The endemic animals in India are :

1. Lion-tailed Macaque
2. Nilgiri Langur
3. Brown Palm Civet
4. Nilgiri Tahr

2.11 ECOSYSTEM AND BIODIVERSITY SERVICES: ECOLOGICAL, ECONOMIC,SOCIAL, ETHICAL, AESTHETIC AND INFORMATIONAL VALUE

Biodiversity has great social, economic, information, ethical and aesthetic value. Though it is not possible to exactly quantify the value of biodiversity yet an attempt is made to explain the value of biodiversity in economic, social, ethical, moral and information terms.

2.11.1 Social Value

Social value of biodiversity is reflected in cultural, medicinal, aesthetic, recreational and spiritual value to the society at large. Biodiversity is part of cultural heritage and the lifestyles. Governments of welfare state are keen on protecting the biodiversity and are spending on green vegetation and on Coral Reef Island for tourism and for preserving their identity associated with biodiversity.

2.11.2 Ethical and Moral Values

Every society has its own ethical and moral values. Every specie has a right to life and to preserve the life. Various communities attach great significance to biodiversity and they worship components of ecosystem, worship rivers, trees, plants and animals as part of their culture and heritage. There are various cultural and ethical considerations associated with conservation of

biodiversity. We have a number of sacred places, sanctuaries of rivers which have been preserved by tribal people. These places are infact genetic banks for wild plants. Tribals view biodiversity as part of their culture and their ethical and social norms.

2.11.3 Economic Value

Biological diversity and its sustenance help us in sustainable use of biological resources which can be used for making various products. These products be it agricultural products, extracts from plants, animals or their use in various ways have immense economic value. Various plants have medicinal value; extracts from animals are used for cure of various diseases; biodiversity provide raw material to various industries. Thus, biodiversity has vast economic value.

2.11.4 Aesthetic Value

Aesthetic value of biodiversity is known to all of us. All of us seek beauty in mountains, rivers, water bodies, snow covered peaks, animals, flowers etc. World without these is unimaginable and would be devoid of aesthetic value. Thus, biodiversity has great aesthetic value.

2.11.5 Ecological Value

Every species plays a unique role in nature and helps in maintaining natural balance ensuring that the environment is not disturbed. Therefore, even if we do not use a plant or animal yet it has an important place in food chain and in preserving the ecology. One creature becomes food for another creature and nothing goes waste. Forests are sinks of carbon dioxide and are lungs of this planet earth providing oxygen to humans which is essential for our survival. Forests and oceans absorb global warming and therefore protect us from the evils of global warming. Thus, various components of biological organisms contribute in maintaining ecological balance.

2.11.6 Educational Value and/or Scientific Value

Biodiversity has immense scientific value. Plants and animals are subject matter of research and help us in understanding our ecosystem. They are the source of scientific and medical information and are useful for educational, scientific and medical purposes. Even our day to day use products are made or influenced by biological organisms. For example, Velcro design is obtained from cockle-burrs that quickly attach to clothing as we walk through the woods.

2.11.7 Cultural and Spiritual Value

Many societies worship plants and animals. For example, Hindus worship owls as the vehicle of Goddess Lakshmi, elephant, monkeys, snakes etc. Many religions identify themselves with pants and animals and as such, those plants and animals have cultural and religious importance.

2.11.8 Option Value

Option value refers to the undiscovered potential of plants or animals or other living organisms. With advancements in technology and research, plants and animals have been found to be useful in treatment of various diseases. Snake venom is used in medical treatment. Option value refers to untapped potential of biodiversity which is unknown today but there is a possibility of discovery in future. But if the biodiversity is destroyed, the untapped potential would be lost.

CHECK YOUR PROGRESS

Which of the following is correct?

1) Preservation of specie in its own habitat is known as
    a. In-situ preservation
    b. Ex-situ preservation
    c. Bio preservation
    d. All of these
2) The top most layer of atmosphere is knows as
    a. Lithosphere
    b. Biosphere
    c. Mesosphere
    d. Thermosphere
3) Which of the following is a major threat to biodiversity
    a. Increasing population and over exploitation of resources
    b. Invasive species
    c. Natural calamities
    d. All of the above
4) Which of the following is a Biodiversity hotspot in India
    a. Himalayas

b. Western Ghats

c. Indo Burmese Region

d. All of these

5) Which of the following is a critically endangered specie in India

a. Asiatic Lion

b. Sumatran Rhinoceros

c. Desert Cat

d. Jackal

2.12 SUMMARY

2.12.1 Term Environment has been derived from French word _Environia' which implies to surround. Term environment includes both living (biotic) and non-living/physical environment.

2.12.2 Ecosystem is the sum total of living organisms and the surrounding environment i.e. biotic and abiotic environment. It includes living organisms including plants, animals and other living things.

2.12.3 Ecosystem includes Aquatic ecosystems and terrestrial ecosystem. Aquatic ecosystem refers to all such ecosystems that are primarily located on or inside water bodies and include Marine ecosystem, freshwater ecosystem. Terrestrial ecosystem refers to all such ecosystems which are mainly located on land and includes Forest ecosystem, desert ecosystem, mountain ecosystem and grassland ecosystem.

2.12.4 Biodiversity refers to all the species of living things on Earth or to a particular ecosystem. Biodiversity is the variety of the species of plants, animals, fungi and living things including the diverse ecosystems in which they live.

2.12.5 Preservation of ecosystem and biodiversity is important for survival and wellbeing of human race.

2.12.6 Ecosystem and biodiversity are threatened by non-sustainable exploitation of natural resources, increased population, rapid industrialization, deforestation, environmental pollution, global warming and the like.

2.12.7 India is a mega biodiversity nation and it can be divided into 10 biogeographical zones.

2.12.8 Biodiversity hotspot is a region which has rich biological diversity and some or other species are endangered

2.12.9 India is home to 167 important crops of millets, cereals, condiments, fruits, vegetables,

pulses, fiber plants and oilseeds, and 114 species of domestic animals. About 4,900 species of flowering plants are found in the country. Western Ghats and North East India are home to rich biodiversity. It is claimed that India is home to around 62% of the amphibians.

2.12.10 Despite mega biodiversity, India also has biodiversity hotspots and many animals, plants are declared as endangered or critically endangered species.

2.12.11 Biodiversity is not only essential for wellbeing of all living organism on this planet earth but it also has economic, medicinal, scientific, educational, social and cultural value

2.13 QUESTIONS FOR PRACTICE

1) Discuss whether India has rich biological diversity? What are the biodiversity hotspots in India?
2) What is biodiversity conservation? What measures can be taken for biodiversity conservation?
3) What is ecosystem? What are the components of ecosystem?
4) Discuss major threats to biological diversity.
5) Write a note on the value of biological diversity to mankind.

2.14 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad

SEMESTER-II

COURSE: ENVIRONMENTAL STUDIES

UNIT – 3: NATURAL RESOURCES – RENEWABLE AND NON-RENEWABLE

STRUCTURE

3.0 LEARNING OUTCOMES

After the study of this unit, the learners will be able to:

- Understand the concept of Renewable and Non Renewable Resources
- Know about the issues and challenges associated to the use of Land Resource
- Develop an insight into the issues pertaining to Deforestation and its impact on the environment and the lives of the communities dependent upon the forests

- Learn about the use and exploitation of water resources and know more about some Water Resource conflicts
- Acquire a knowledge about the Renewable and Non-Renewable Sources of Energy and also gauge the significance and need for alternate sources of energy in the light of growing energy needs.

3.1 INTRODUCTION

The biosphere of the Earth is home to a wide range of ecosystems that give a bounty of products and services to humanity. A natural resource is any component of the natural environment that can be used by man to enhance his well-being. A substance, an energy unit, or a natural process or phenomena can all be considered natural resources. These are resources that are found in the environment and developed without human involvement. Air, sunlight, water, soil, stone, plants, animals, and fossil fuels are all examples of natural resources. Some of the resources (such as soil and water) are critical elements of the life-sustaining system. Natural resources provide recreational opportunities, solace, and even inspiration to people, apart from providing food, fodder, and shelter. Humans have been exploiting natural resources since the dawn of civilization, if not earlier. However, because the resources were ample in comparison to the human population at that time, no severe depletion occurred. Natural resources are naturally occurring items that are beneficial to man or could be useful in possible technological, economic, or social circumstances, as well as supplies derived from the ground, such as food, building and clothing materials, fertilisers, metals, water, and geothermal energy. Natural resources were once the purview of the natural sciences.

The human population has grown dramatically during the previous millennium, causing significant damage to the destruction of natural resources. The location, quantum, and quality of natural resources vary widely. For example, a specific forest type may only be found in a few nations. In addition, the geographical area covered by forest and the nature of the wood available, may vary greatly between countries. After being utilised once, some resources can be reused. The exhaustibility and renewability of resources provide a useful classification system, i.e. Renewable and Non - Renewable Resources

3.2 RENEWABLE AND NON RENEWABLE RESOURCES

3.2.1 Renewable Resources

Renewable resources are those that are always available, no matter how they are used. After use, they can be fairly restored or replaced. However, if the rate of consumption of these resources continues to outpace their rate of replenishment, not only will their quality suffer, but they may also become completely depleted. Some of the important renewable resources include:

(1) Forests, which produce timber and other plant products, (2) Rangelands, which support grazing animals for milk, meat, and wool production, (3) Wildlife, which maintains the food chain, (4) Agricultural systems, which produce food and fibre, and (5) Marine and fresh water systems, which produce a variety of foods from plants and animals Other renewable resources include soil and water. Animals are also renewable resources since they may be reared and bred to generate offspring to replace older animals.

Even though these resources are renewable, replacing them could take tens to hundreds of years. Organic renewable resources are those that come from living things such as animals and plants, whereas inorganic renewable resources are those that come from non-living things such as the sun, water, and wind.

3.2.2 Non - Renewable Resources

Non-renewable resources are those that can't be easily replaced or recovered once they've been used or destroyed. Biological species that have evolved over millions of years in nature are termed non-renewable. Man cannot recreate a biological species that have become extinct on the planet. Minerals and fossil fuels are examples of such natural resources. Minerals are classified as non-renewable because, while they form naturally through the geological cycle, they require thousands of years to create. Because they are on the point of extinction, some animals, especially endangered species, are classified as non-renewable. It highlights the several reasons why endangered species must be safeguarded at all costs.

Organic non-renewable resources are non-renewable materials that arise from living creatures, such as fossil fuels while those that come from non-living substances like rocks and dirt are

called inorganic non-renewable resources. The natural resources can be of four types - Land Resources; Water Resources; Forest Resources and Energy Resources

3.3 LAND RESOURCE

3.3.1 Land as a Resource

Hills, valleys, plains, river basins, and wetlands are examples of landforms that comprise of multiple resource-generating areas on which the people living therein, depend. Many traditional farming communities had appropriate mechanisms to protect the regions that possessed the resources that they used. For example, in the Western Ghats, _sacred groves,' requests to the spirit of the Grove for permission to cut a tree or extract a resource were accompanied by simple rituals.

Land can be considered a renewable resource if it is used efficiently. The soil is bound by the roots of trees and grasses. When forests are depleted or grasslands are overgrazed, the land becomes unproductive, resulting in the formation of wasteland. Irrigation that is too intensive results in water logging and salinization, preventing crops from growing. When highly hazardous industrial and nuclear wastes are placed on land, it becomes a non-renewable resource. Land, like all of our other natural resources, is limited. While humanity has learned to adapt its lifestyle to many ecosystems around the world, he will not be able to live comfortably on polar ice caps, under the sea, or in space in the near future.

Land is required by man for the construction of homes, the cultivation of food, the maintenance of pastures for domestic animals, the development of industries to provide goods, and the support of the industry through the creation of towns and cities. To safeguard our very rich biodiversity, man must also protect wilderness areas in forests, grasslands, marshes, mountains, and coasts, among other places. As a result, rational land use necessitates meticulous planning. Most of these distinct forms of land uses can be developed virtually everywhere. However, Protected Areas (National Parks and Wildlife Sanctuaries) can only be established when some natural ecosystems remain undisturbed. These Protected Areas are critical components of effective land use planning.

3.3.2 Land Use Change

The speed with which forests have disappeared in recent years, both in India and around the world, demonstrates the most devastating change in landuse. Forests offer a variety of services to mankind. These processes include things like regulating oxygen levels in the atmosphere, removing carbon dioxide, controlling water regimes, and reducing erosion, as well as producing things like food, fuel, timber, fodder, medicinal plants, and so on. The loss of these is significantly greater in the long run than the short-term profits from converting forest lands to other uses.

3.4 LAND DEGRADATION, SOIL EROSION AND DESERTIFICATION

3.4.1 Land Degradation

Land degradation is the loss of soil fertility or the deterioration of soil. Due to increasing intensification of use, farmland is under danger. The demand for arable land to produce food, fibre, and fuel wood is increasing as the world's population grows. As a result, there is increasing pressure on scarce land resources, which are degrading as a result of over-exploitation. The degradation of land resources affects around 56 percent of the country's overall geographical area. Every year, 5 to 7 million hectares of land are added to the world's already damaged agricultural area. Wind and rain erode soil more quickly when it is used more extensively for farming. Salinization is caused by over-irrigating fields, as evaporation of water pushes salts to the top of the soil, where crops cannot grow. Excessive irrigation also causes topsoil water logging, which affects agricultural roots and causes the crop to degrade. As more chemical fertilizers are used, the soil becomes poisoned, and the land becomes unproductive. Agricultural land and woods are shrinking as urban centers and industrial growth expand. This is a significant loss with long-term consequences for human civilization. Water logging and salinity affect 3.4 million hectares of canal irrigated land, out of a total area of 17 million hectares.

3.4.2 Soil Erosion

The nature of soil determines the characteristics of natural ecosystems such as forests and grasslands. Various types of soil support a wide range of crops. The process by which the superficial layer of soil is lost or removed due to the impact of wind, water, and human influences is called soil erosion. The abuse of an ecosystem results in the loss of essential soil due to monsoon rains and, to a lesser extent, wind erosion. The soil is held by the roots of the

trees in the forest. As a result, deforestation causes considerable soil erosion. In other terms, it can be characterized as the transfer of soil components from one place to another, particularly surface litter and top soil. More than 5000 million tonnes of topsoil are predicted to be eroded each year, with 30% of the total eroded mass ending up in the sea.Soil is washed into streams, carried downstream by rivers, and eventually washed into the sea. The process is more visible in places like the Himalayas and the Western Ghats, where deforestation has resulted in erosion on steep hill slopes. These places are known as ESAs (ecologically sensitive areas). To avoid the annual loss of millions of tons of the essential soil, it is critical to conserve what remains. It is indeed crucial to reforest the deforested areas. The physical soil binding function of forests is not the only link between their existence and the presence of soil. The leaf litter of the forest enriches the soil. Soil microorganisms, fungi, worms, and insects break down this waste, which helps to recycle nutrients in the system. Further depletion of our soil wealth will drain the resource base of our country and impair the ability to produce enough food in the future.

3.4.3 Desertification

The term Desertification refers to an irreversible change in a land resource. Desertification is the loss of ten percent or more of the productive potential of arid or semiarid regions. Desertification is marked by deforestation, groundwater depletion, salinization, and significant soil erosion. If it would take more than a decade to recover from damage, it is deemed to be irreversible. There are various types of desertification that can be observed.

- Loss of economic capacity to manufacture goods and services involving direct human utility
- Loss of ecological functions required to maintain ecosystem processes
- Loss of biodiversity at the ecological or genetic level
- To detect new and difficult-to-reverse forms of deterioration, persistent national land monitoring systems are required.
- The current socio-economic systems and management technologies should be the subject of research.
- Policy approaches must account for local heterogeneity and complexity.

- In the absence of global or regional solutions to the majority of savanna and dry land degradation issues, progress must be made.
- Because of the failure and large expense of traditional initiatives, it is evident that focusing on enabling incentives that foster spontaneous response across the entire community will result in more progress. Land tenure, taxation, and marketing are the three key policy issues.
- Many successful techniques will have a high geographical dimension and include cross-national and ecological boundary movement.

Monitoring and evaluation are critical for the formulation of an action plan to halt the desertification process. This necessitates the use of a consistent mapping methodology.

3.5 DEFORESTATION: CAUSES AND IMPACT

Forests comprise over a third of the earth's land surface and provide numerous environmental benefits, including a critical role in the hydrologic cycle, soil conservation, climate change mitigation, and biodiversity protection. Deforestation is the process of converting forestland to a non-forested land use such as agriculture, grazing, or urban development. Deforestation is primarily a challenge for tropical developing countries since it leads to depletion of the tropical forest areas, resulting in biodiversity loss and increasing the greenhouse impact. Forests cover 30% of the earth's geographical surface, or around 3.9 billion hectares. It was estimated that the ancient forest covered an area of 1,500 acres.

The loss of various plant, animal, and microbial species in the recent years has been an outcome of deforestation. This phenomenon also poses a threat to indigenous people, whose culture and physical well-being is dependent on the forests. Regional and global climate changes are also caused by deforestation. Droughts become more likely in deforested areas because of the decline in rainfall. Deforestation contributes to global warming by releasing stored carbon as carbon dioxide, a greenhouse gas, into the atmosphere.

3.5.1 Causes of Deforestation

The fight to save the world's rainforests and other forests continues, and global consciousness about the issue is growing day by day. To save forests, we must understand the causes behind

their destruction. In order to understand the major factors of deforestation, it is critical to distinguish between the agents of deforestation and the causes of deforestation.

1. Shifting Cultivation or Jhum Cultivation - Shifting cultivation means that the people in the tribal areas clear the forest lands to grow subsistence crops. It has been observed that the major cause of deforestation in regions like Africa, Asia and tropical America has been estimated to be around 70, 50 and 35% respectively. Shifting cultivation is a process of slash and burn agriculture in which it is estimated that more than 5 lakh hectares of land is cleared annually. In countries like India, shifting cultivation is more popular in the north eastern States and to some extent in states like Bihar, Madhya Pradesh and Andhra Pradesh where the phenomenon contributes significantly to the process of deforestation.
2. Commercial logging - Commercial logging is also an important agent of deforestation stop although it might not be the primary cause of forest clearing but is certainly a secondary cause of deforestation because new logging definitely permits shifting cultivation and the fuelwood gathers access to the new logged areas.
3. Need for fuelwood – With an increase in the population, the demand for fuel would also increase which persistently becomes an impelling factor for deforestation especially in the dry forest areas.
4. Overgrazing - The dry regions of the tropical areas are more prone to overgrazing where soil pastures are degraded because of overgrazing which further becomes a cause for soil erosion. Also, the felling of trees is a common feature in the dry areas where the cleared land is used for providing fodder for the grazing animals. When animals that are brought for grazing, remove the vegetation from the land, the remaining task is finished up by the winds which blow away the top layer of the soil, thus transforming the grasslands into a desert. It has been primarily overgrazing, which was a major cause of converting the grasslands in the north of Beijing and Inner Mongolia into desert lands.
5. Expansion of the farming land - With the addition of cash crops and the increased earnings from such crops, the demand for cultivation of plants like oil palm, rubber, fruits and other ornamental plants has considerably increased. This has also exerted pressure on the need to expand the area for the cultivation of agri-business products and this is what leads to an increase in deforestation.

6. Urbanization - Developing cities and towns necessitate land to build the infrastructure required to support a growing population, which is accomplished through clearing forests. Tropical forests are a significant target for infrastructure development for oil extraction, logging concessions, and hydropower dam construction, which ultimately leads to the growth of the road network and the construction of roads in otherwise virgin areas. Roads, railways, bridges, and airports offer additional territory for development, bringing a growing number of people to the forest frontier. These immigrants have colonized the forests by exploiting logging routes or new roads to enter the forest for subsistence land, whether or not they were supported by government programming.

7. Fires - Fires are a common method of clearing forest for shifting and permanent agriculture, as well as the development of pastures. When used responsibly, fire can be a helpful tool in agricultural and forest management, but when used inappropriately, it can result in severe deforestation. Forest fires were reported to affect an average of 19.8 million hectares or 1% of all forests per year, according to statistics from 118 countries covering 65% of the global forest area. In Brazil, deforestation due to road paving has resulted in an increase in forest fires.
8. Tourism - Undoubtedly, national parks and sanctuaries safeguard trees, but the unregulated and irresponsible opening of such regions to the public for tourism is detrimental. Unfortunately, national governments in tropical and sub-tropical nations use tourism as a quick source of revenue, abandoning strict management techniques in the process. Furthermore, many organizations and resorts that represent themselves as eco-tourist destinations are actually profiting off the trees.

9. Exploitation by industrialized nations - Wealthy countries or former colonial powers who lack their own natural resources rely heavily on the resources of financially impoverished countries that are often wealthy in natural resources. Only 20% of the world's population consumes 80% of the world's resources. Unfortunately, the governments of these poor resource-rich countries had adopted the same growth-syndrome as their western neighbours, focusing on maximizing exports, income, and exploiting their vast natural resources for short-term profits. The problem is further exacerbated by the low price of most Third World exports realized in the international market.
10. Overpopulation and Poverty - The influence of population density on deforestation has long been a source of debate. According to international organizations such as the FAO and intergovernmental bodies, poverty and overpopulation are the primary drivers of forest loss. These organizations often assume that fostering development and attempting to minimize population increase will address the problem. Rapid population expansion, on the other hand, appears to be a key indirect and overarching source of deforestation. More people necessitate more food and space, which necessitates more agricultural and habitation land. As a result, additional woods have to be cleared.

3.5.2 Impact of Deforestation

Deforestation has a number of negative repercussions; it directly and adversely affects the environment. It affects the lives of human beings and hampers the ecological balance to quite an extent; so much so that hundreds of thousands of species are killed each year as their habitats are destroyed by forest fires and tree cutting. Moreover, deforestation also exacerbates the pace of global warming, thus making life unsustainable for all species on the Earth. The major implications of the problem of deforestation are:

1. Impact on Productivity - Soil, water, and wind erosion are among the catastrophic effects of deforestation in India, with an annual cost of approximately 16,400 crores. Deforestation has a two-fold effect on farmland productivity: it increases soil erosion by a considerable proportion; deforestation forces people to utilize cow-dung and crop wastes as fuel, primarily for cooking, because the soil has been swept away, resulting in an exacerbated cycle of floods and drought.

2. Land Erosion and Landslides - Land erosion and landslides have been caused by deforestation. In the situation of lack of trees, data shows that around 6,000 million tonnes of topsoil is lost annually due to water erosion. In 1973, topsoil erosion loss resulted into a worth of almost Rs 700 crores. In 1976, 1977, and 1978, the values were Rs. 889 crore, Rs. 1,200 crore, and Rs. 1,091 crore, respectively.
3. Reduction in Agricultural Production - Forest trees help to ensure long-term agricultural output by providing environmental protection. They improve the fertility and texture of forest soils, as well as production, by protecting agricultural land from deterioration. The presence of trees on farmlands in portions of the sudano-sahelian region lowers the drying effect of the prevailing wind on the soil, preserving the soil moisture essential for healthy agricultural growth and development. Wind speed and sand movement over planted crops are reduced by trees. Already planted seeds may be lost if there are no wind breaks. In terms of seed and labour expenses, supplying or replanting seedlings is a financial loss. In extreme circumstances, late planting can result in crop failure.
4. Loss of Income Generation - Forest resources bring prosperity to the people of the communities, where they are used. The forests are vital to the livelihood of rural people. Rural people process and trade forest products to supplement their household income and, in certain cases, to set aside money for future needs. To create additional cash, the forest sells wild life, fruit, medicinal herbs, and fuel wood. Furthermore, many rural and urban residents profit from forestry. However, it is an irony that today, as a result of deforestation, the amount of cash generated from the forest has been substantially reduced.
5. Loss of Biodiversity and Habitats - Deforestation, fragmentation, and degradation of forests, particularly those in the tropical areas, harm biodiversity as a whole and habitat for migratory species, including endangered species, some of which have yet to be identified. Tropical forests are home to almost two-thirds of all known species and 65 percent of the world's 10,000 threatened species. The biodiversity of forested regions should be preserved as a type of capital until further research is carried out to determine the relative significance of diverse plant and animal species.

3.5.3 Impact of Deforestation due to Mining

Mining affects the forests and lives of tribal people in number of ways:

- Surface mining is used to mine shallow deposits, while subsurface mining is used to mine deep deposits. It causes land deterioration and the loss of top soil. In India, mining activities are believed to be putting around 80,000 hectares of land under danger.
- Mining and other related activities remove flora as well as the underlying soil mantle, resulting in topography and landscape degradation in mountainous areas. Due to indiscriminate mining, large-scale deforestation has been recorded in the Mussoorie and Dehradun valleys.
- In hilly areas, mining causes perennial water sources such as springs and streams to dry up.
- The extent of forested land has decreased by 33% on average, and the rise in non-forest land owing to mining activities has resulted in relatively unstable zones that have resulted in landslides.
- Since 1961, unregulated mining in Goa's forests has devastated more than 50000 acres of forest area. Coal mining in the Jharia, Raniganj, and Singrauli areas has resulted in considerable deforestation in Jharkhand, while magnetite and soapstone mining in the mountainous slopes of Khirakot, Kosi valley, and Almora has destroyed 14 hectares of forest.
- The lush forests of the Western Ghats are also under threat from mining projects for copper, chromites, bauxite, and magnetite in Kerala, Tamil Nadu, and Karnataka.
- Mining is both intensive and a devastating activity. Because the land area involved is so little, it is not considered a major cause of primary deforestation. Mining is a lucrative industry that promotes development booms, which can lead to population increase and deforestation.
- Furthermore, roads built to assist the mining operations will allow agriculturists, permanent farmers, ranchers, land speculators, and infrastructure developers to access the area. For example, infrastructure development projects like as highways allowing access to frontier regions, mining areas, and big hydropower reservoirs were at the heart of Brazil's Amazon development strategy.
- Roads, railways, bridges, and airports open up the land for development, bringing an increasing number of people to the forest frontier. If wood is utilized as a fuel in mining operations and comes from plantations set up for that purpose, it might result in significant deforestation in the region.

3.5.4 Impact of Dam Building on Environment

Dam and valley projects were called as "Temples of Modern India" by Pandit Jawaharlal Nehru.

These large dams and river valley projects serve a variety of purposes. These dams, on one hand, are responsible for the degradation of forests and on the other hand, they are to be blamed for the degradation of catchment areas, the extinction of flora and wildlife, the spread of water-borne diseases, the disruption of forest ecosystems, and the rehabilitation and resettlement of tribal people. Ironically, woodlands are found in locations with abundant mineral resources. Forests also cover the steep river valley embankments, which are perfect for developing hydropower and irrigation projects. As a result, there is a perpetual conflict of interest between environmental scientists' conservation concerns and the Mining and Irrigation Departments'.

Dams provide a year-round supply of water for domestic purposes, as well as additional water for agriculture, industry, and hydropower generation, but they also have a number of major environmental concerns. They disrupt river flows, alter natural flood control mechanisms like wetlands and flood plains, and destroy local people's lifestyles as well as wild plant and animal habitats. The lives, livelihoods, customs, and spiritual existence of indigenous and tribal people have all been negatively impacted by large dams. Dams have unduly harmed them, and they are usually left deprived of the advantages. In India, tribal people accounted for 40 to 50 percent of the 16 to 18 million people displaced by dams, despite being only 8% of the country's population of one billion.

3.6 WATER RESOURCES: USE AND OVER-EXPLOITATION, FLOODS AND DROUGHTS

3.6.1 Use of Water Resources

Water is utilised for agricultural, industrial, household, recreational, and other purposes, in addition to environmental initiatives. The majority of the operations necessitate the usage of fresh water. However, salt water makes up around 97 percent of all water on the planet, with fresh water accounting for barely 3%. Glaciers and polar ice caps hold a bit more than two-thirds of the accessible fresh water. The remaining freshwater is mostly found as groundwater, with only a small amount present on the ground or in the air. Water is a critical element in all aspects of the ecosystem. Water resources are distinct from other natural resources. It is the world's most abundant and extensively distributed element. It covers almost three-quarters of the earth's

surface (70 percent). It can be found in every part of the environment, including the oceans as a massive saltwater reservoir, on land as surface water in lakes and rivers, underground as groundwater, in the atmosphere as water vapour, and in the polar icecaps as solid ice. This equates to 1400 million cubic kilometres, or enough to cover the world with a 3000 metre thick layer. This apparent abundance, however, is deceptive, as it conceals an ironic reality that a massive 97.5 percent of the amount contained in the world's oceans and seas is saline and so unfit for human consumption. We, like many other organisms, require fresh water to thrive, but only around 2.5 percent of the entire amount is available as fresh water. Approximately 68.9% of the water resources are inaccessible due to ice fields and glaciers, while the remaining 29.9% is present as groundwater. In fact, just one-hundredth of one percent (0.03%) of the world's total supply of 14 billion cubic metres is deemed readily available for human consumption on a regular basis.

The following is a quick rundown of how water is used in various industries.

i. Agricultural Use: In agricultural economies like India, agriculture accounts for 69 percent of total water usage. As a result, agriculture is the world's largest consumer of accessible freshwater.

   Agriculture's global water demand is expected to rise by 19 percent by 2050 due to irrigational needs. Increased irrigation demand is projected to place undue strain on water reserves. It's also unclear whether further irrigation development, as well as increased water withdrawals from rivers and groundwater, will be sustainable or not.

ii. Industrial Use: Water is used in industry since it is the lifeblood of the industry. It is utilised as a coolant for raw materials, a solvent, a transport agent, and an energy source. Manufacturing accounts for a significant proportion of total industrial water usage. Chemicals and key metals, in addition to paper and related goods, are major industrial uses of water.

   The industry accounts for 19% of overall consumption worldwide. Industry, on the other hand, consumes more than half of the water available for human use in developed countries.

iii. Domestic Use: It encompasses drinking, cleaning, personal hygiene, gardening, cooking, clothing, dishwashing, and vehicle maintenance, among other things. People have been moving out of the countryside and into ever-expanding cities since the end of World War II. This trend has major 15 consequences for our water resources.

To distribute water to expanding populations and industry, the government and towns have had to start developing major water-supply systems. Domestic water use accounts for around 12% of global water consumption.

iv. Use for Hydropower generation: Hydropower is electricity generated by water. Hydropower is the world's most widely used renewable energy source. It generates around 16 percent of the world's total electricity. There are several hydropower development prospects all throughout the world. China, the United States, Brazil, Canada, India, and Russia are the world's top hydropower producers now.

v. Use for Navigation and Recreation: Watercourses that have been or may be used for interstate or international commerce are known as navigable waterways. In many parts of the world, agricultural and commercial items are transported by water on a vast scale.

Recreational activities such as boating, swimming and sporting activities are all done on the water. These activities degrade the water's quality and pollute it. While allowing such operations in reservoirs, lakes, and rivers, the highest priority should be given to public health and drinking water quality.

3.6.2 Over-Exploitation of Water Resources

Water scarcity has become a worldwide concern. In recent decades, the United Nations has convened several water conventions. Continuous overuse of surface and ground water has resulted in today's world experiencing virtual water scarcity.

Water scarcity has arisen as a result of dwindling resources due to high human population growth over the centuries, as well as rising man-made water pollution around the world. As a result of the massive rise in the world population, existing water supplies have been continuously overused. In many places of the world, groundwater is the primary source of water. However, due to overexploitation by an ever-increasing human population and the rapid rise in global temperatures, this resource has been steadily depleted.

In recent times, there has been a lot of industrialization and urbanization. By 2025, India is predicted to be under severe water stress. At the global level, 31 nations are now experiencing water shortages, and by 2025, 48 countries will be experiencing severe water shortages. Water shortages are expected to affect 4 billion people by 2050, according to the United Nations. This will result in a slew of water-related conflicts between countries. Around 20 of India's main cities are experiencing chronic or intermittent water shortages. The waters of 13 main rivers and

lakes are shared by 100 countries. Upstream countries may starve downstream countries, resulting in political instability around the world.

3.6.2.1 Surface Water

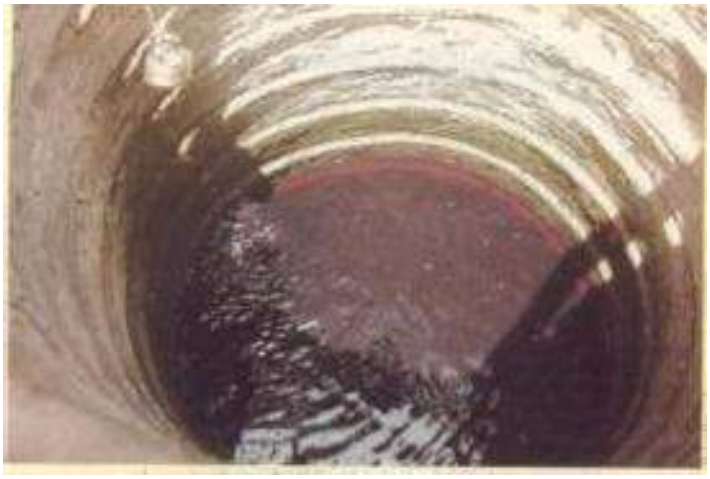
Rain and snow cover are the prime sources of surface water. Natural lakes and ponds, rivers and streams, and constructed reservoirs are all examples of surface sources. The country's economy is determined by the availability of surface water. Surface water availability affects production on one hand, while water sources can also produce floods and drought on the other. Water may cause national (interstate) or international issues as a result of unequal distribution. Due to these issues, the sharing of surface water is harming the productivity of several agro eco-zones and causing challenges for the government.

3.6.2.2 Ground Water

In many places of the world, groundwater is the primary source of water. However, due to overexploitation by a growing human population and the rapid development in industrialization and urbanisation in contemporary times, this resource has been continuously depleted. Groundwater accounts for around 9.86 percent of total fresh water resources, and it is 35-50 times larger than surface water supplies. So far, about 32% of the groundwater resources have been exploited.

Groundwater extraction is increasing day by day in order to cater to the growing agricultural demands, particularly for the production of water-intensive crops like sugarcane. 90% of the groundwater that is extracted is used for irrigation. In most states, over 8.5 million electric and diesel pumps are used to remove groundwater, resulting in declining water tables. Only the northern and coastal plains have abundant groundwater supplies. In some areas, the supply is insufficient. The volume of groundwater is around 210 million cubic metres. Infiltration, seepage, and evaporation all contribute to this amount. The country's total replenishable ground water resources have been assessed to be 45.23 million hectares metres per year. 6.93 million hectares metres are used for drinking, industrial, and other purposes, leaving 38.34 million hectares metres available for irrigation. Even now, our country is unable to offer safe drinking water to all of its villages and cities. The dissolved minerals in ground water come from the soil layers through which it flows. As water seeps through the layers of the earth, it is drained of most of the microorganisms originally present in the surface water. Though the salt concentration can

be overwhelming at times, it is generally superior as a source of domestic water. The organic materials and mineral nutrients in surface water support algae and huge bacteria populations.



3.6.2.3 Overutilization

With the increase in human population, bigger volumes of water are required to meet a range of fundamental demands. This standard is currently unattainable in many regions. Water overuse occurs on a variety of levels. Most people consume far more water than they require. Most of us waste water while bathing, showering, or washing our clothes. Many farmers use more water than is required to cultivate crops. Farmers may use less water without compromising yields in a variety of methods, including the use of drip irrigation technology.

The world's freshwater resources have been stressed by years of fast population increase and rising water usage. Water demand has already surpassed natural availability in some locations, and an increasing number of countries are anticipated to experience water shortages in the near future. At 6.1 billion people, the world's population is increasing by roughly 80 million people per year. This figure translates to a 64 billion cubic metre increase in annual freshwater demand. When annual water supplies fall below 1,700 cubic metres per person, a country is said to be experiencing water stress. A country is said to be facing water scarcity if water availability is less than 1,000 cubic metres per person. When a country faces water scarcity, it should expect persistent freshwater shortages that jeopardise food production, stifle economic growth and development, and harm the environment.

In 1995, 31 countries with a population of 458 million people faced water scarcity or stress. According to Population Action International's forecasts, more than 2.8 billion people in 48 countries would face water stress or scarcity by 2025. By 2050, there will be 54 countries without enough water, affecting 4 billion people, or 40% of the estimated global population. The Middle East, North Africa, and Sub-Saharan Africa have been impacted the hardest. More than 200 million people in Sub-Saharan Africa already live in water scarce countries.

The can be depicted through the following table.

Table 3.1 World"s Water Demand Per Year

Year	Demand for Water per Year (in cubic kilometers)
1940	1000
1990	4130
2000	5000
2002	6650

Water scarcity is becoming the single greatest threat to food production, since groundwater levels are dropping and rivers are receding, leaving less water available for cultivation.

According to the United Nations Environment Programme, India will be water-stressed by 2025, with average annual water availability ranging from 1000 to 1700 cubic metres per person.

Agriculture sector is shown to be the largest user of water. Water usage for irrigation increased from roughly 40% two decades ago to 73 percent by the year 2000 A.D. The usage of irrigation is inefficient. As a result, 25-30% efficiency and watering methods will be dramatically altered. The data on water consumption displayed in the table below shows that irrigation, including livestock and electricity use, accounts for 79.6% and 13.7 percent of total water use, respectively.

Table 3.2 Water Use (India) 2000 A.D.

Use	Taken	Consumed	Returned
Irrigation	869	783	86
Livestock	150	5	145
Industry	35	10	25
Domestic	38	8	30
Total	1092	806	286

3.6.3 Floods

For ages, floods have been a severe environmental concern. However, as people have deforested catchments and increased their usage of river flood plains that originally served as safety valves, the destruction wreaked by rivers overflowing their banks has become increasingly devastating. Wetlands in flood plains are natural flood control systems into which overflowing rivers can spill and act as a temporary buffer, soaking up the water and keeping it from destroying the

surrounding land. Water levels in rivers, seas, and oceans rise as a result of heavy rains. Flooding occurs when water accumulates along the coastline. Floods wreak havoc on crops, domestic animals, property, and people's lives. Many animals are carried away by the power of the water during floods and die as a result.

Floods in the Ganges and its tributaries, as well as the Bramhaputra, are caused by deforestation in the Himalayas, which kill people, damage the crops, and destroy homes year after year. During floods, rivers alter the direction of their flow, and tonnes of rich soil is lost to the sea. Rainwater no longer seeps into the subsurface when forests decline, but instead flows down the mountainside, carrying vast volumes of topsoil. This momentarily blocks rivers, but as pressure builds, it gives way, allowing massive amounts of water to wash down into the plains below. Rivers surge, burst their banks, and flood waters engulf people's crops and homes there.

3.6.4 Droughts

Drought has been a serious issue in our country, particularly in the dry areas. Droughts occur when an area goes without rain for an extended length of time. In the meantime, evaporation and transpiration will continue to drain groundwater from the soil. The land gets incredibly dry since this water is not returned to the earth in the form of rain; the water level in ponds and rivers drops and in rare cases, water bodies totally dry up. Droughts occur when groundwater becomes scarce. It is extremely difficult to obtain food and fodder in drought circumstances. Life becomes difficult, and many animals perish as a result. It is a climatic situation that develops as a result of the failure of one or more monsoons. It occurs at different times in different places of our country. While it is impossible to prevent the monsoon from failing, careful environmental management can mitigate its negative consequences. During drought years, water shortage has an impact on houses, agriculture, and business. It also causes food shortages and malnutrition, which has a particularly negative impact on children.

Rainfall in most parched places of the world is unpredictable. This results in periods of severe water scarcity for drinking, farming, and providing for urban and industrial use. Drought-prone areas are consequently subjected to periodic hunger. Agriculturists have no income in these terrible years, and because they don't have a consistent source of income, they are constantly concerned about droughts. Drought-prone areas in India have 'Drought Prone Areas Development Programs,' which are intended to mitigate the consequences of droughts. People

are paid in bad years to build roads, minor irrigation projects, and plantation initiatives under these programs. There are several steps that can be taken to reduce the severity of a drought's effects. However, this must be done as a precautionary measure so that the impact on local people's life is minimized if the monsoons fail. When the monsoon is nice, we use up the plentiful quantity of water without attempting to save it or use it wisely. In the drought area, there is no water even for drinking during a year when the rains are scarce.

Deforestation is one element that exacerbates the effects of drought. Rainwater rushes down rivers and is lost once hill slopes are cleared of forest cover. Water is kept in the area by the forest cover, which allows it to seep into the earth. This increases the amount of water stored underground in natural aquifers. If the stocks have been replenished during a good monsoon, this can be utilized in dry years. Overuse of subsurface storage water causes the water table to drop and vegetation to suffer. Drought-resilient soil and water management, as well as afforestation, are long-term solutions.

3.7 CONFLICTS OVER WATER

Water conflict is a term that describes a dispute over water resources between countries, states, or groups.

3.7.1 Inter-state Water Conflict

Agriculture is India's primary source of income. For the effective supply of water for agricultural uses, multi-purpose projects and irrigation projects have been built across rivers. As a result, the equitable distribution of river water resources is critical to people's well-being. Inter-state water disputes arose as a result of states sharing river water. Since India's independence, there have been numerous river water disputes. When a water dispute emerges between two or more State governments, the Central Government receives a request under Section 3 of the Inter-State River Water Disputes Act, 1956 (ISRWD Act, 1956) from any of the basis States regarding the existence of a water dispute.

Kaveri River Dispute

The origins of this war may be traced back to two agreements made between the ancient Madras Presidency and the Princely State of Mysore in 1892 and 1924. Karnataka claims that the river does not provide it with its fair share of water. It contends that the accords were severely skewed

in favour of the Madras Presidency, and it has asked a renegotiated deal based on equitable water sharing. On the other hand, Tamil Nadu claims that it has already developed about 3,000,000 acres of land and has come to rely substantially on the current pattern of use. Any change will have a negative impact on the livelihoods of millions of families in the states.

On February 5, 2007, the Indian government issued a final decision allocating 419 billion cubic feet of water to Tamil Nadu and 270 billion cubic feet to Karnataka, as well as 30 billion cubic feet of Kaveri river water to Kerala and 7 billion cubic feet to Puducherry. All four states have decided to file review petitions in order to obtain clarifications and maybe renegotiate the ruling. The Indian Government notified the final award of the Cauvery Water Disputes Tribunal on February 20, 2013, in accordance with Supreme Court orders (CWDT). On May 10, 2013, the Supreme Court of India issued an interim order directing the Government of India to establish a temporary Supervisory Committee to administer the Cauvery Tribunal order.

3.7.2 International Water Conflict

Tsangpo-Brahmaputra (Indo – China conflict)

The two lower riparian countries, India and Bangladesh, are concerned about China's huge intentions to harness the Brahmaputra River's waters. Dam development in China, as well as the anticipated diversion of the Brahmaputra‘s waters, is likely to have an impact on water flow, agriculture, environment, and downstream lives and livelihoods. Hydropower projects along the Brahmaputra have been approved by the Chinese government. It claims that all of these projects are run-of-the-river, with no storage or diversion, and that they will have no impact on the river's downstream flow into northeast India. Nonetheless, its ambitions have caused concern in India's northeast and Bangladesh, where the Brahmaputra is a lifeline. The anticipated northward rerouting of the Brahmaputra's waters is more concerning than China's construction of hydropower dams on the river. The river's water level would drop significantly as it entered India as a result of the diversion. The increased salinity of the water will have a significant impact on agriculture and fisheries in downstream locations. The issue's lack of communication is fueling distrust and tension. This emphasizes the importance of a multi-country discourse involving all riparian countries. China must share information about its dam development and other plans with the rest of the world.

3.8 ENERGY RESOURCES

Energy is a critical component of economic growth, and the availability of energy is closely linked to a country's future prosperity. The production of electricity and the consumption of energy are both critical to economic progress. Energy is consumed in India in a variety of ways, including through the use of fuel wood, animal dung, and agricultural wastes. Commercial fuels, such as coal, petroleum products, natural gas, and electricity, are gradually replacing these noncommercial fuels. Commercial fuels contribute for 60% of total energy, whereas non-commercial fuels account for 40%.

In our lives, the sun is our primary source of energy. We use it directly for warmth, as well as indirectly through natural processes that offer us with food, water, fuel, and shelter. The sun's rays fuel the growth of plants, which provide us with food, produce oxygen, which we breathe in, and absorb carbon dioxide that we exhale. The sun's energy evaporates water from seas, rivers, and lakes, forming clouds that eventually transform into rain. Fossil fuels were originally forests that grew in prehistoric times owing to the sun's light. The exploitation of most energy sources will be required to meet the future energy needs of a rapidly growing human population. Energy resources can be classified as either non-renewable or renewable.

3.8.1 Renewable Sources

Natural processes rejuvenate renewable energy resources, allowing them to be used continuously. In comparison to fossil fuels or nuclear energy, renewable energy has a far lower negative environmental impact. Renewable energy generation is often more expensive than energy produced by fossil fuels or nuclear energy at this time in technology; but, as technology progresses, renewable energy costs are predicted to fall. Solar energy is the most important of the renewable energy sources. Hydropower, wind, geothermal energy, ocean waves, and tidal energy are some of the other sustainable energy sources.

Plants (crops and forests) and animals that are periodically replaced because they have the ability to reproduce and maintain life cycles are examples of renewable resources. Wood and wood products, pulp products, natural rubber, fibres (e.g. cotton, jute, animal wool, silk and synthetic fibres), and leather are examples of renewable resources that do not have a life cycle but can be recycled.

Water and soil, in addition to these resources, are considered as renewable resources. Solar energy, despite having a finite life, is seen as a renewable resource in the sense that solar stores are limitless on a human scale.

3.8.2 Non – Renewable Sources

Nonrenewable sources are resources that cannot be replaced by natural processes. There are only a limited number of such resources available, and they cannot be raised. Fossil fuels (petrol, coal, etc.) and nuclear energy sources are among these resources (e.g. uranium, thorium, etc). Moreover, minerals, salts, and metals (iron, copper, gold, silver, lead, zinc, and so on) (carbonates, phosphates, nitrates etc.) are also all forms of non-renewable energy resources. Once a non-renewable resource is depleted, it is no longer available. Then we must either locate a replacement or do without it. Non-renewable resources can further be divided into two categories, viz. Recyclable and non-recyclable.

(1) Recyclable resources: These are non-renewable materials that can be gathered and repurposed after they have been utilised. These are primarily non-energy mineral resources found in the earth's crust (e.g. aluminium, copper, mercury, etc.) and fertiliser nutrient reserves (e.g. phosphate sock and potassium, as well as minerals used in their natural state) (asbestos, clay, mica etc.)

(2) Non – Recyclable resources: These are nonrenewable resources that are incapable of being recycled in any way. Fossil fuels and nuclear energy sources (e.g. uranium, etc.) are examples of these, which provide 90% of our energy needs.

3.9 USE OF ALTERNATE ENERGY SOURCES

There is a need to develop renewable energy sources that are already accessible and can be used (such as solar or wind), as well as sources that can be generated and used (bio-mass). Solar, wind, hydel, waste, and bio-mass are India's primary renewable energy sources. Bio-mass refers to agricultural resources such as wood, bagasse, cow manure, seeds, and so on.

3.9.1 Solar Energy

Solar energy can be used for human welfare in both direct and indirect ways. The radiant energy of the sun is direct solar energy, whereas indirect solar energy is acquired from things that have previously absorbed the sun's radiant energy. Direct heating using solar energy is possible, or the

heat can be transformed into power (thermal electric generation). Direct solar energy is converted into electricity using photovoltaic cells. When solar power is unavailable at night or on overcast days, a backup system is required to store and create electricity.

India, as a tropical country, has the potential to commercialize solar energy. As per the findings of various studies, one sq. kms of land might create 35 MW of power. With such potential, solar energy has a bright future as a source of energy for the country's development. The most significant constraint is the initial investment, which has resulted in a poor utilization of its potential. Solar energy will require a lot of research, low-cost technologies, and minimal expenditure to become one of the front runners

3.9.2 Biomass Energy

Biomass energy is the most important of the different energy resources where solar energy is used indirectly. Live plant material and dried residues, fresh water and marine algae, agricultural and forest residues (e.g. straw, husks, maize cobs, bark, sawdust, roots, animal wastes), and other materials whose origin can be attributed to photosynthesis provide biomass energy. Biomass also includes biodegradable organic waste from sugar mills, breweries, and other businesses. Biomass is the primary source of energy for at least half of the world's population. In India's rural areas, fuel wood is still an important source of energy for domestic use. To release its energy, biomass fuel, which can be solid, liquid, or gas, is burned. Wood, charcoal, animal dung and peat are examples of solid biomass. Biomass can be turned to liquid fuels, particularly methanol and ethanol, for use in internal combustion engines. Microbial decomposition can also be used to convert biomass, notably animal waste, into biogas in biogas digesters. Biogas is a clean fuel that emits fewer pollutants than other combustible energy sources when burned. It is made up of a mixture of gases that can be conveniently stored and transferred.

Biomass energy production necessitates a sufficient amount of land and water.

3.9.3 Biogas Energy

Organic waste, such as dead plant and animal material, animal dung, and kitchen garbage, can be transformed into a gaseous fuel called biogas by anaerobic digestion or fermentation. Biogas is composed primarily of methane (CH_4) and carbon dioxide (CO_2), with minor amounts of hydrogen sulphide (H_2S), moisture, and siloxanes. It is a biomass-based renewable energy source. Biogas is a fuel that can be utilized in any country for any type of heating, including

cooking. It can also be found in anaerobic digesters, where it is used in a gas engine to convert gas energy into electricity and heat. Biogas, like natural gas, may be compressed and utilized to power vehicles.

Denmark produces a considerable amount of biogas from wastes and 15 farmer cooperatives produce 15,000 megawatts of electricity. A factory in London produces 30 megawatts of electricity per year from 420,000 tonnes of municipal refuse, enough to power 50,000 households. In Germany, biogas is used to generate electricity in 25% of waste landfills. Japan recycles 85 percent of its waste whereas, France recycles 50 percent. In India's rural sector, biogas plants are becoming increasingly popular. Cowdung is utilised in biogas plants, which is transformed into a gas that is used as a fuel. It can also be utilised to power dual-fuel engines. Using biogas to minimise cooking smoke has helped thousands of people breathe easier.

3.9.4 Hydropower

To create electric energy, water is made to fall from a height which further turns turbines at the dam's bottom. Hydropower generates around a quarter of the world's electricity and is typically less expensive than electricity generated by thermal power facilities. Building a dam to keep the water, on the other hand, causes a slew of environmental issues, including the submergence of plant and animal habitats and the relocation of people. Hydropower generation globally grew sevenfold between 1950 and 1970. Some of its advantages include the long life of hydropower plants, the renewable nature of the energy source, very cheap operating and maintenance costs, and the absence of inflationary pressures as with fossil fuels.

Although hydroelectric power has aided global economic development, it has also exacerbated significant environmental issues. Large amounts of forest and agricultural land are submerged to generate hydroelectric electricity. Local tribal people and farmers have long relied on these areas for their livelihood. Land use conflicts are unavoidable. Reservoir silting (particularly as a result of deforestation) shortens the life of hydroelectric power plants. Aside from electricity generation, water is necessary for a variety of other functions. Domestic needs, agricultural crop production, and industrial needs are among them. As a result, conflicts arise.

When rivers are dammed for electricity generation, they become difficult to be utilised for navigation and fishing. The problem of displaced persons' resettlement is one for which there is no simple solution. As most dam projects have failed to rehabilitate those who have been displaced, yet many large hydroelectric initiatives are still being opposed.

3.9.5 Growing Energy Needs

Energy has always been inextricably related to man's economic progress and advancement. Energy usage has been regarded as an indicator of economic progress in current development models that have concentrated on measuring the extent of economic expansion. This measure, on the other hand, ignores the long-term negative repercussions of high energy consumption on society. The world's energy demands quadrupled between 1950 and 1990. Over the previous 22 years, the global demand for power has doubled. In the year 2000, the global primary energy consumption was 9096 million tonnes of oil. This equates to 1.5 tonnes of oil per capita on a worldwide scale. Electricity is currently the world's fastest increasing kind of end-use energy. By 2005, Asia-Pacific is predicted to overtake North America in terms of energy consumption, and by 2020, it will consume 40% more energy than North America.

Coal was the major source of energy for the industrial revolution in the nineteenth century for about 200 years. Oil accounted for 39% of global commercial energy use at the end of the twentieth century, followed by coal (24%) and natural gas (24%), with nuclear (7%) and hydro/renewable sources (6%) accounting for the remainder. Coal is the most common commercial energy source in India, accounting for 55 percent of total energy consumption in 2001, followed by oil (31%), natural gas (8%), hydro (5%), and nuclear energy (1%). Biomass (mostly wood and dung) provides for over 40% of India's primary source of energy. While coal remains the most common fuel for electricity generation, nuclear power has grown in popularity during the 1970s and 1980s, and the demand for natural gas has surged in the 1980s and 1990s.

3.10 CASE STUDIES

The importance of energy resources in today's economy and as a foundation for our future may be seen in recent clashes between some of the world's most powerful nations, which have mostly been attributed to the goal of securing their energy supply. The two Gulf Wars are significant examples of this. Energy security has been acknowledged by defence experts as the driving force for Iraq's invasion over Kuwait, as well as the rationale for the second Gulf war. The globe has recently witnessed a conflict in the South China Sea between India, Vietnam, and China over the subject of prospecting for natural gas and petroleum beneath the seabed and these days, it is the tussle between Russia, China and the U.S. making claims over the Arctic region, which highlights their expanding demand and urgent need to augment their sources of energy.

3.10.1 India and Pakistan : The Indus Water Treaty

About the Indus River Basin: The Indus River originates in China (Tibet) and Afghanistan and runs 3,100 kilometres to the Arabian Sea through India and Pakistan. Three western rivers (the Indus, Jhelum, and Chenab) and three eastern rivers (the Sutlej, the Beas, and the Ravi) make up the Indus River system. In terms of agriculture, the Indus is one of the world's most developed rivers, having huge irrigation facilities in both Pakistan and India. The partition of India and Pakistan in 1947 separated the Indus basin's water resources, resulting in disputes over water allocation between the two countries.

Conflict: The Indus River has long been a source of contention between India and Pakistan, two countries with a history of mistrust and antagonism in their relationship. During the 1940s, large irrigation projects were undertaken in a section of the basin (Punjab) that was to be partitioned between the two countries. On five of the six rivers in the Indus basin, the 1947 split established India as the upstream riparian and Pakistan as the downstream riparian. Water allocation disputes emerged almost immediately. In December 1947, a brief standstill agreement was reached, which kept the status quo in place until March 1948. In the spring of 1948, when the agreement expired, numerous water supplies from India to Pakistan were cut off. Attempts to resolve the dispute failed in producing a long-term solution.

Resolution: David E. Lilienthal, an external expert, suggested a cooperative approach to water management in the 1950s, with the goal of boosting available water supply through infrastructure development and controlling the Indus basin as a single entity. He recommended a technical and collaborative approach to issue solving and management, as well as the establishment of the Indus Engineering Corporation with World Bank funding and support. Following his evaluation of the report, World Bank President Jim Yong Kim called Pakistan and India's prime ministers to gauge their interest in engaging in a new dispute settlement procedure mediated by the bank's "good offices." The prime ministers agreed, and the mediation process began.

- A mediation process design was agreed upon, comprising fundamental concepts and a representation technique to steer the negotiations. Both governments agreed to take a cooperative approach to water management, to negotiate on a functional rather than political basis, and to appoint engineers from their respective countries to participate in the talks. The construction of a shared information base on water resources and infrastructure development choices was agreed upon, with a commitment to share data.

- Both India and Pakistan submitted a series of suggestions and counterproposals for water use and allocation plans at the request of the World Bank. While the respective models shared supply assumptions, they differed considerably in terms of water allocation. The two parties were unable to reach an agreement on a collaborative approach to developing the Indus basin's waters, leaving only a quantitative split of the waters as a viable alternative. The World Bank proposed allocating the vast majority of the water supplies from eastern tributaries to India and from western tributaries to Pakistan once the idea of joint development was abandoned.
- The World Bank's proposal was approved by India as the basis for an agreement. Given the inadequate storage facilities, Pakistan regarded the flow of western rivers insufficient to replace their existing supplies from eastern rivers. As a result, Pakistan only offered a conditional consent. The World Bank replied by recommending that India should construct larger storage facilities, which India declined due to financial constraints. The concerns of how much India would contribute to the development of extra storage and where the finances for the remaining construction would come from, were essential to resolve this deadlock.
- Separate talks with India and Pakistan were held by the Bank president, who also sought financing from the world community. India agreed to give $174 million, with the rest of the world chipping in another $900 million. Both Pakistan and India consented to the package, which was formally drafted as the Indus Treaty in January 1961 and ratified by both the nations.

3.10.2 South China Sea Conflict

About the South China Sea: The South China Sea is a huge tropical ocean expanse that spans over 3 million square kilometres and is located between Asia's mainland coast and the island groupings of the Philippines, Borneo, and Indonesia. Because it connects the Indian and Pacific Oceans, it is critical to the flow of world maritime trade. Approximately 90% of the world's commercial goods are transported by water. Many of the countries in this region lack natural resources but have robust, industrialised economies that rely on importing raw materials and shipping manufactured goods across the sea.

Ships operating through the South China Sea are expected to transport more than $5 trillion in annual trade. This includes around a quarter of all oil transported by sea (about 15 million barrels per day) and more than half of all global liquefied natural gas trade (LNG). The South China Sea

is also an internationally important biodiversity hotspot. It has coral reef environments that sustain at least 3,365 recognised marine fish species. The South China Sea, despite being a small area of the oceans, produces an incredible amount of fish, accounting for 12 percent of global fishing catch and valued about US$21 billion per year. These live assets are more valuable than money. They employ at least 3.7 million people and are critical to the region's food security for hundreds of millions of people.

Conflict: The South China Sea disputes mainly revolve around the islands. The area's coastal geography is complicated, with several small islands, rocks, and coral reef features, the vast majority of which are subject to opposing sovereignty claims. Two archipelagos — the Paracel Islands in the northwest and the Spratly Islands in the south — as well as the isolated Pratas Island and Scarborough Reef (or Shoal) in the northeast and east of the South China Sea are among the territories of conflict. Over 120 small islands, islets, rocks, and reefs dot the 240,000 square km of maritime space that make up the Spratly Islands. The 12 largest Spratly Islands have a total land area of less than 2 square kilometres, with the largest, Itu Aba, measuring only 1.4 kilometres long and 370 metres wide. Despite their apparent insignificance, China, Taiwan, the Philippines, Malaysia, Brunei, and Vietnam all claim these islands small whole or in part. With the exception of Brunei, all claimants have occupied and stationed garrisons on at least one of the disputed islands, demonstrating the significance of the conflicts.

Competing Claims: Another facet of these issues is that the South China Sea is becoming a more competitive, and potentially conflict-prone, battleground for China, its neighbours, and the United States. China has attempted to stretch its defensive perimeter offshore in recent decades. The People's Liberation Army Navy (PLAN) of China has been developing and modernising its navy, adding powerful submarines, frigates, destroyers, and long-range maritime patrol aircraft. Despite the fact that China is now Asia's most powerful naval power, it still falls behind in comparison to the US Navy in terms of size and capacity. The United States has increased its naval presence in the South China Sea in response to China's growing aggressiveness, as part of a so-called "pivot to Asia."

To make matters even more complicated, all of the South China Sea states claim coastal zones offshore that include important marine resources. These countries' maritime claims tend to converge as they border the South China Sea. They also make claims from contested islands, which will invariably clash. As a result, a complex, web-like network of claim lines emerges. In

the South China Sea, China also claims a so-called "nine-dash line." If these disconnected lines were connected, they would encircle around 80% of the South China Sea. Although China has never explained this 'nine-dash line' concept, yet it is presumed to be a historical claim to the islands and waterways in question.

Further Complications: This South China Sea dynamic of contending geographies is frightening. It sets the stage for future war as China strives to exercise its "historic rights" and other coastal states want to exploit resources such as oil and seafood found within "their" waters. This has serious consequences for the region's valuable marine biodiversity and fisheries management. It also jeopardises regional security and freedom of travel along globally significant rivers. China is expected to assert its sovereignty not only over the disputed South China Sea islands, but also over marine areas inside the nine-dash line as well and the issue is likely to continue further.

CHECK YOUR PROGRESS

Ques. 1 Answer the following Short Answer Type Questions:

i. What does recycling mean?
   a) To use a natural resource to make something new.
   b) To use less of a natural resource than is possible.
   c) To reuse natural resources or old products to make new things
   d) To put old products in the trash.

ii. Total earth‘s surface covered by water is
   a) 75%
   b) 60%
   c) 85%
   d) 50%

iii. The primary cause of Deforestation is …….. and it leads to a fall in …….

iv. The main activity largely responsible for the damage of Indian forests is ……..

v. What happens when rain falls on soil without vegetation cover?
   a) Rain water percolates in soil efficiently
   b) Rain water causes loss of surface soil

c) Rain water leads to fertility of the soil

d) Rain water does not cause any change in soil

3.11 SUMMARY

The effects of natural calamities and disasters, population explosion, deforestation, increased transportation, and eviction of fumes and poisonous gases from industries have all contributed to the depletion of natural resources and environmental degradation, across all parts of the world. The present chapter was an endeavour to understand the following points:

- Natural resources which may be further classified as Renewable and Non-Renewable are subject to over-utilization because of the increasing demand by the human population, worldwide. However, there is a greater need to minimize the use of Non-Renewable Resources and increase the use of Renewable Resources.
- Although land is a renewable resource, it ought to be used efficiently and efforts need to be made to prevent activities which bring about a change in the pattern of use of land as a resource.
- Consistent efforts need to be made to prevent degradation of land, soil erosion and desertification of land.
- Forests constitute a significant resource which can help in maintaining the ecological balance but the unregulated felling of trees and increasing deforestation tendencies by the human beings so as to augment their incomes and acquire more development, affect adversely the lives of various species and even the tribal communities who are dependent upon these resources for their livelihood.
- Water, in recent years has acquired a critical significance, owing to its depleting levels especially in terms of groundwater. If the scantily available water resources are not conserved and water is not used cautiously and judiciously, most nations of the world will soon become water scarce countries. This will not only affect the lives of the people in the developed world but also the prospects of development in the less developed nations.
- Realizing the significance of the inadequacy of water resources, the states inside a country and even countries at the international level land up into disputes over water resources, which not only generates tension between two nations but also limits the movement by other countries across the disputed waters.

- In the contemporary times, energy has also assumed critical importance in terms of the development and prosperity of the nations. That is why it is becoming increasingly important to strike a balance between the renewable and non renewable sources of energy. Since the non renewable sources are available only to a limited extent, the need to develop alternate renewable energy sources has increased overtime.
- The increasing demand for energy resources across the world has culminated into disputes and conflicts between various nations over water resources, oil resources and land resources which possess the potential of catering to the supplementary energy resource needs of the progressing countries.

3.12 QUESTIONS FOR PRACTICE

Ques. 1 Differentiate between the Renewable and Non-Renewable Sources of Energy. Explain the various alternative sources of Renewable Energy that can be used effectively in the low income countries of the world.

Ques. 2 Explain in detail the case of any one dispute at the international level which indicates the increasing hunger of the nations to acquire an additional source of natural resources.

Ques. 3 Explain the various avenues of use of water resources by the human beings across the globe. How can the over-exploitation of water resources be minimized?

Ques. 4 What is meant by Deforestation? Explain the prime causes of deforestation. How does Mining impact the lives of the tribal people dependent upon the use of forest resources?

Ques. 5 Make an account of the ill-effects caused by the change in the land use pattern and land degradation on the environment.

3.13 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad

SEMESTER: II

COURSE: ENVIRONMENTAL STUDIES

UNIT 4: ENVIRONMENTAL POLLUTION

STRUCTURE

4.0 LEARNING OUTCOMES

The learner will be able to understand

- Meaning and causes of environmental pollution
- The impact of environmental pollution on human health and environment
- Types of environmental pollution and measures undertaken to control pollution
- Health hazards of radioactive wastes
- Policy and measures for management of waste
- Role of individual and society in environmental protection

4.1 INTRODUCTION

Protection and preservation of environment is essential for survival of various living organisms including mankind. Environment pollution is referred to the adverse alteration or contamination of physical or biological components of the environment. It may be in the form of alteration of properties/quality of air, water, soil or the climate due to anthropogenic reasons like emissions or natural reasons like volcano eruptions, forest fires etc. Environmental pollution is primarily the

adverse impact of human activities on our surroundings viz., land, air, water etc.

World is witnessing unprecedented deterioration of the environment owing to unregulated activities of humans including deterioration of air quality, pollution of water bodies, contamination of soil, water bodies, depletion of forest cover, loss of biodiversity, depletion of ozone layer, hostile climatic conditions etc. These adverse impacts on environment are primarily due to anthropogenic reasons. However, the problem of environment degradation is neither new or unique to India. This problem has confronted the mankind for decades and centuries altogether to varying degrees. The entire globe is afflicted by environmental pollution and India is no exception to this.

4.2 ENVIRONMENTAL POLLUTION :TYPES, CAUSES, EFFECTS ANDCONTROL MEASURES

Environmental pollution can be described as adverse impact of human activities on our surrounding depleting the quality of air, water, soil or other surroundings. Typically environmental pollution can be categorized as Air Pollution, Water Pollution, Soil Pollution, Noise Pollution etc.

4.2.1 Air Pollution

Air, and in particular good quality air, is essential for the survival of mankind and other living organism on this planet earth. Air is a gift to all living organism by the mother-nature and is the mixture of gases forming earth‘s atmosphere. Natural air in the earth‘s atmosphere contains molecules of different gases i.e. around 78% Nitrogen, 21% Oxygen and around 1% molecules of other gases like Carbon dioxide, argon and other components. It also includes water vapours. If this composition is disturbed by additional presence of carbon dioxide or ozone molecules or other gases, the air is said to be polluted. The entry of additional hazardous gases in disproportionate numbers in air or disturbance of the natural composition of air can have disastrous consequences.

Air pollution may occur due to entry of air pollutants in air disturbing the natural composition of the air. Various factors contributing to air pollution have been identified by environmentalists, scientists and experts including but not limited to, rapid industrialization, power plants, burning of fossil fuels, dust and fumes emitted by vehicles, deforestation, mining, agricultural activities, stubble burning, burning of municipal solid waste, construction activities, emission from stone crushers and hot-mix plants, smoke, fire and other human and natural

activities.

4.2.1.1. Causes of Air Pollution

4.2.1.1.1Industrial Emission

Rapid and unregulated industrialization has seriously impacted the environment and in particular air, water and soil. Untreated industrial emissions and discharge of toxic gases in air is a big source of air pollution. Industries, industrial products and industrial wastes emit various gases including carbon dioxide, carbon monoxide and other toxic gases.

- Burning of Fossil Fuels

Increasing number of automobiles and use of non-renewable forms of energy has immensely deteriorated the quality of air. Ever increasing burning of fossil fuels and vehicular emissions is a major source of greenhouse gases.

- Mining and Agricultural Activities

Rampant use of fertilizers, insecticides, pesticides etc in agriculture have not only adverse impact on the quality of soil but these chemicals also percolate in food chain. This apart, part of these chemicals become air borne either at the time of spray or in the form of vapors and therefore, degrade the quality of air.

Similarly, unregulated mining activities lead to dust and fumes being released in air polluting the air and surroundings and have adverse impact on the health of workers.

- Stubble Burning

Burning of crop residue after harvesting has become a big challenge in India and other developing countries. After the crop is harvested, farmers resort to stubble burning being cost effective, easy and fast method to clear the fields and to prepare them quickly for the next crop. Mass scale stubble burning pollutes the air and in some areas, air quality becomes toxic and dangerous.

- Burning of Municipal Solid Waste

Unscientific waste management is another reason for worsening quality of air. Sometimes, municipal solid waste is burnt in open. Scenes of rubber tyres being burnt are common. Burning of such waste releases toxic gases in air polluting the environment.

- Other Factors

There are various other factors causing air pollution like construction activities, unscientific management of household waste, emissions from hot mix plants, stone crushing units, dumping of toxic waste etc.

4.2.1.2. Effects of Air Pollution

Air pollution has reached alarming proportions around the globe and India has also been severely afflicted by air pollution.

- Adverse Health Impacts

Greenpeace India, in its report published in 2020 has reported that around 120000 people died in six metropolitan cities in India on account of air pollution related diseases. As per the report, cost of air pollution costs was around 120000 crores in six metropolitans. It is estimated in 2017 report of Greenpeace India that the cost of air pollution is around 3% of India‘s Gross Domestic Product. Assessment by Greenpeace of India‘s 168 cities across 24 states shows that none of the cities in India can claim to have clean air by WHO standards.

- Global Warming and Climate Change

One of the most serious issues caused by environmental degradation is climate change which has a very serious effect on human beings, ecosystems and other living organisms. Climate Change implies changes in the usual weather found at a particular place over a period of time i.e. the rainfall spells, rainfall quantum, duration, timing, dry spells, changes in temperature, changes in winter season etc. It implies changes in earth‘s climate in totality. Climate change was considered to be a rhetoric by majority of the people around the world but now it has been scientifically established that earth‘s climate is actually changing.

It has been reported that annual average surface air temperature of the earth has increased by 1.8 degree Fahrenheit during the last 115 years i.e. from 1901-2016. Climate change manifests in various forms including in the form of global temperature rise and the resultant effects of the same i.e. shrinking of ice sheets at the poles; melting of glaciers and glacier retreat around the globe i.e. in Himalayas, Alaska, Alps etc.; rise in sea level and the threat to survival of coastal cities/nations etc.

- Ocean Acidification

Ocean acidification is another cause of concern in international environmental governance.

Oceans are sinks of carbon dioxide and have been absorbing excess heat caused by GHG emissions. More than quarter of the CO2 emitted in the atmosphere is absorbed by the oceans leading to warming of ocean waters at almost all levels and acidification of the oceans which is detrimental to marine ecosystems. Since the onset of industrial revolution, acidity of surface waters have increased by 30% (NASA) which is attributable to CO2 emissions which are being absorbed by the oceans. The absorption of CO2 by oceans is increasing every year making them more acidic. Absorption of CO2 by oceans is increasing by 2 billion tons per annum.

4.2.1.3. Control of Air Pollution

To prevent and control Air Pollution, India enacted *Air (Prevention and Control of Pollution) Act*, 1981. The Act was enacted to make legal provisions for prevention, control and abatement of air pollution and to preserve quality of air. The Act provided for establishment of regulatory mechanism in the form of Central and State Pollution Control Boards for carrying out the objectives of the Act. The Act came into force on 16th May 1981 and it applies to whole of India. Act has empowered the Boards to lay down standards for quality control and to regulate release of gases in air. The industrial establishments are required to comply with the norms laid down by the Pollution Control Boards. Board can also ban use of particular type of fuels to prevent air pollution. However, enactment of law alone can not serve the purpose. Therefore, various other measures at individual, institutional and societal level are required to be undertaken to check the menace of air pollution. These include:

- Shifting from fossil fuels to renewable resources of energy
- Using clean energy sources
- Reducing vehicular emissions
- Energy conservation
- Proper and scientific waste management
- Prevention and prohibition on stubble burning and burning of municipal solid waste
- Avoiding traffic jams

4.3.2 Water Pollution

Water pollution is another issue which is facing the humankind at global level. Discharge of untreated sewage, industrial affluent and other discharges into water bodies has polluted major rivers across the globe and this is more so in developing countries. As per the report of UNEP,

Water pollution has worsened since 1990s in the majority of rivers in Latin America, Africa and Asia (UNEP, Snapshot of World's Water Quality, 2016). UNEP reports that around 1/3rd of all river stretches in Latin America, Asia and Africa are severely affected by pathogen pollution and it presents a serious health hazard posed not only by drinking contaminated water but also by using the same for bathing or other human purposes. The increase in pathogen and organic pollution is more than 50% in these regions and Asia is most severely hit by it. More than 323 million people living on these continents run the risk of water borne diseases. However, the menace is not confined to these continents alone or to developing countries alone even the developed countries are facing the same. For instance, water pollution causing severe water borne diseases has been reported in countries like Canada (John Vidal, Cleaning the World's Water). Contamination of water not only presents health hazards but also affects food production and economies of the nations.

4.3.2.1. Causes of Water Pollution

There are multiple causes of water pollution including discharge of untreated industrial affluents in water bodies; discharge of untreated sewage; discharge of religious material in water bodies; dumping of industrial and other wastes in water bodies; contamination of water by pesticides, insecticides and fertilizers and; contamination of ground water table by seepage of chemicals in water table.

4.3.2.2. Effects of Water Pollution

Water pollution can have deleterious effect on the health of humans and various other living organisms. The effect of contamination of water depends upon the type of pollutants and their concentration in water. Polluted water can have deleterious effect on human effect and the concentration of chemicals in animals can enter the food chain and affect health severely. Not only it can have direct effect on humans and food chain, it can also affect aquatic life adversely affecting the metabolism, behavior, reproduction etc.

The effect of water pollution can have a huge impact on the food chain. It disrupts the food chain. Cadmium and lead are some toxic substances, these pollutants upon entering the food chain through animals (fish when consumed by animals, humans) can continue to disrupt at higher levels. Increasing incidence of water borne diseases like diarrhea, hepatitis etc. are the direct impact of water pollution.

4.3.2.3. Control Measures for Prevention and Abatement of Water Pollution

To control and prevent water pollution, *Water (Prevention and Control of Pollution) Act*, 1974 was enacted in pursuance of resolutions passed by State legislatures under Article 252 of the Constitution of India. The Act was first in the series of laws dealing with pollution in India. The principal aim of the Act was to lay down legal regime for prevention, control and abatement of water pollution and to provide regulatory mechanism for the purpose. The Act is applicable throughout the territory of India. Act has laid provided for sleuth of measures for preventing water pollution by industrial affluents. Industries are required to take prior permission before commencing operations and are required to treat the industrial affluents before they are discharged. Violation of rules laid down under the Act has been penalized and offender can be prosecuted and punished.

However, enacting laws alone can not serve the purpose and efforts are required to be undertakenat individual, institutional and societal level. Some of the control measures are:

- Treatment of affluents and sewage before discharge in water bodies
- Reuse of water after treatment
- Use of organic methods for detoxification of water like use of Water Hyacinth
- Scientific disposal of affluents and sewage.

4.3.3 Soil Pollution

Soil degradation is yet another serious environmental challenge being faced by the modern world. Soil pollution means the presence of chemicals in excess of natural compositions on the soil which degrade the soil. Soil pollution and soil degradation is the result of various human activities like use of excessive fertilizers, pesticides, herbicides, insecticides, agricultural practices, antibiotics contained in animal manure, sewage, waste dumping and industrial and mining activities leading to seepage of chemicals into the soil. As per Food and Agriculture Organization of the United Nations, around 1/3rd of the world‘s soils are degraded and billions of tonnes of soil are lost to farming each year. It has seriously affected farmlands. The problem has affected various nations of the world. For example, the joint study conducted by Yale Environment and China dialogue reported in 2014 that 16.1% of the China‘s soil are polluted and the figure for farmlands was higher. The main contaminants are cadmium, lead, nickel and arsenic. As per the report of Food and Agricultural Organization (FAO) of UN, 40% of the African continent‘s soils are degraded (FAO, Status of the World‘s Soil Resources, 2015). So far as India is concerned, it has also been

facing this problem at a large scale. State of India‘ Environment, 2017 has reported that around 40% to 70% of land in India has undergone desertification. Further, India is one of the four major countries affected by soil salination.

4.3.3.1. Causes of Soil Pollution

There are various sources and causes of soil pollution. Some of them are:

- Discharge of untreated industrial affluents in water bodies
- Discharge of untreated sewage in water bodies
- Dumping of wastes in rivers and oceans
- Industrial accidents
- Oil spills
- Ocean acidification caused by excessive release of CO2
- Seepage of chemicals in ground water table
- Seepage of fertilizers, chemicals, pesticides and insecticides in water bodies

4.3.3.2 Effects of Soil Pollution

Soil pollution has various adverse impacts on humans, ecosystem and biodiversity. Soil pollution initiates a chain reaction. It can adversely affect soil biodiversity and the capacity of the soil to act as a filter thereby leading to contamination of ground water table. The study of water table near the dumping sites at New Delhi has revealed that ground water table is dangerously contaminated. Contaminated water can accumulate in plant tissues, animal tissues and can thus enter the food chain of humans and animals. Such chain reaction can lead to multiple diseases and increase morbidity in humans apart from adversely affecting the health. Soil pollution has high economic costs. It reduces fertility of the soil thereby leading to lesser productivity.

4.3.3. 3 Control Measures

To control pollution including soil pollution, India enacted Environment (Protection) Act, 1986. The Act empowered the appropriate governments to take measures for prevention, control and abatement of environmental pollution including formulation of rules for scientific management of wastes. Consequently, Government of India has notified various rules for prevention of pollution. Some of the rules are as under:

- Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987

- The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989
- The Manufacture, Use, Import, Export and Storage of Hazardous Micro-Organisms/Genetically Engineered Organisms or Cells Rules, 1989
- The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- Ozone Depleting Substances (Regulation and Control) Rules, 2000
- Batteries (Management and Handling) Rules, 2001
- Atomic Energy (Radiation Protection) Rules, 2004
- Atomic Energy (Radiation Processing of Food and Allied Products) Rules, 2012
- Bio-Medical Waste Management Rules, 2016
- Solid Waste Management Rules, 2016
- E-Waste (Management) Rules, 2016
- Plastic Waste Management Rules, 2016
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- Construction and Demolition Waste Management Rules, 2016

4.3.4 Noise Pollution

Word noise is derived from Latin word ‗Nausea' which means sickness leading to vomiting sensation. Noise pollution is also presenting as a significant environmental concern in the recent years.

4.3.4.1. Causes of Noise Pollution

There are various causes of noise pollution including the following:

- Vehicular noise
- Industrial noise
- Household/domestic noise
- Neighborhood noise
- Noise caused by natural resources like streams, falls etc.
- Construction and demolition activities
- Playing loud music in open in functions and elsewhere
- Use of loud fire-crackers, bugels etc.

4.3.4.2. Effects of Noise Pollution

Noise pollution has significant impact on human health and recently data has shown the proportionate hearing loss attributable to noise pollution (Alex Grey, 2017). As per the recent study in 2017, where noise pollution levels in 50 cities across the globe was measured, it was found that the Guangzhou in China is worst affected city followed by New Delhi, India. Mumbai ranks 4th worst city in noise pollution. The studies have found that excessive noise pollution is not only causing discomfort and other related diseases but is also responsible for hearing loss. As per WHO more than 360 million people are afflicted by hearing loss and of these, around 32 million are children. The average city dweller is found to be having hearing loss equivalent to 10-20 years older than his actual age. Unfortunately, in the hearing loss rank, New Delhi tops the global list followed by Mumbai wherein maximum hearing loss of 20 years than the actual age is reported (World Hearing Loss City Ranking, 2017).

Apart from hearing loss, excessive noise can lead to hypertension, sleeping disorders and cardiovascular issues.

4.3.4.3 Control Measures

With a view to prevent noise pollution, Noise Pollution (Regulation and Control) Rules 2000 have been notified by the Union Government under Environment (Protection) Act, 1986. Under these rules, restrictions on use of loud speakers, public address systems, DJ music systems beyond permitted hours can be placed. For example, use of DJ music systems after 10 pm has been restricted under Noise Pollution Rules. Areas can be classified as residential and silence zones and prohibitions can accordingly be placed.

However, enactment of laws can never be successful unless they are accepted and endorsed by the public at large. Therefore, it is of utmost importance that individuals and society at large take measures like

- Avoiding unnecessary honking at public places
- Avoiding loud music systems in residential areas
- Use of sound proof systems in commercial areas, silent zones like hospitals and schools
- Regulation of industrial noise.

4.4 NUCLEAR HAZARDS AND HUMAN HEALTH RISKS

Nuclear hazards are threats posed by invisible and odorless pollutants in the form of radioactive substances such as radio-nuclides in the air, water, or soil. These radio-nuclides emit high-energy particles (alpha and beta rays) and electromagnetic radiation (gamma rays). The automatic release of particles and radiation by an unstable nucleus is called Radioactivity and the pollution from these radiations is called Nuclear pollution. Therefore, radiation or Nuclear pollution can be defined as the release of radioactive material or particles of high energy into atmospheric water, or to the earth primarily as a result of human activity, either by accident or construction. Sources of nuclear pollution include natural and man-made natural resources. The human environment has been emitting radiation and making up 85% of man's annual radiation output. Radiation from human activities usually accounts for up to 15% of public exposure each year.

4.4.1 Causes of Nuclear Pollution

Radiation substances when released into the environment are dispersed or concentrated in living organisms through a food chain. In addition to naturally occurring radioisotopes, large numbers are produced by human activities, including the operation of nuclear power plants, the development of nuclear weapons, and the testing of atomic bombs. Explosions at Three Mile Island 1979 and Chernobyl 1986 nuclear power plant are glaring examples of radioactive contamination. This apart, even the radioactive medical waste can have health effects on workers.

4.4.1.1. Nuclear Waste management and Disposal

It can produce low to medium radiation over a long period of time. Radioactivity can pollute and disperse air, water, and soil. Therefore, their effects may not be easily distinguished and difficult to predict. The biggest problem with radioactive waste is the fact that it cannot be degraded or chemically or biologically treated. Therefore, the only option is to contain waste by storing it in tightly sealed containers protected by radioactive material, Debris can also be stored in remote areas with little or no life.

4.4.1.2. Radiation isotope used for medical, industrial and research applications

The greatest exposure to humans stems from the use of X-ray diagnosis, radioactive isotopes used as a follow-up and treatment of cancer and other diseases.

4.4.1.3. Nuclear explosion and nuclear weapons

The highest rate of man-made radioactive fallout has been made around the middle of the 20th century through various nuclear deterrent methods, which ended World War II. Use of radioactive material in the production of Defense weapons can also emit radiation from radioactive material.

4.4.1.4. Mining and Processing of Radioactive Ores

Crushing and processing of radioactive ores and the production of radioactive products can also produce radioactive waste, similar to the extraction of phosphate ores, contaminating the environment.

4.4.2 Human Health Risks

Nuclear pollution can have adverse effect on human health. The health risks of exposure to radioactivity may be DNA mutation, psychological effects, damage to vital organs and tissues, damage to the immune system, cancer cell production or biomagnification. These include Somatic effects and Genetic Effects.

4.4.2.1. Somatic Effects

Somatic affects the function of cells and organs of the exposed person. It causes damage to cell membranes, mitochondria and cell nuclei leading to abnormal cell function, cell division, growth and death. Radiation causes severe damage to cells throughout the body. Radiation damage can cause headaches, nausea, vomiting, diarrhea, and even death, depending on the amount of radiation you receive. While the remaining effects can last for days or years and can lead to death. All creatures are susceptible to radiation pollution, and the effects can range from mild to severe depending on a variety of factors such as volume, duration, and type of radiation.

4.4.2.2. Genetic Effects

Radiation exposure can lead to genetic mutations, i.e. changes in the genetic makeup of cells affecting future generations. These effects are mainly due to damage to DNA molecules. People suffer from leukemia and cancer of the bone when exposed to high doses radiation.

4 . 4 . 3 Control Measures

Union of India has enacted Atomic Energy Act, 1962 and thereunder Atomic Energy (Radiation Protection) Rules, 2004 have been formulated. This part, Atomic Energy (Safe Disposal of Radioactive Waste) Rules, 1987; The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989; The Manufacture, Use, Import, Export and Storage of Hazardous Micro-

Organisms/Genetically Engineered Organisms or Cells Rules, 1989; The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 have been formulated.

4.5 SOLID WASTE MANAGEMENT

Solid Waste Management is a major administrative and environmental hazard in all major cities of India. In-fact Solid Waste Management or Municipal Solid Waste Management is a serious problem everywhere especially in all developing countries. Rapid population growth, increasing industrialization and large scale migration from rural areas to cities has led to tremendous increase in waste generation and its disposal in cities and towns. Generation of large scale waste in cities has put tremendous strain on the already limited resources of modern cities. To add to this, unscientific disposal of the waste poses serious environmental and health hazard. The problem is further accentuated by the fact that urban solid waste contains not only household waste but it also contains hazardous waste, construction and demolition waste, plastic waste and electronic waste etc.

Waste can be categorized into Municipal Solid Waste, Construction and Demolition Waste, Plastic Waste, E-Waste, Hazardous Waste, Bio Medical Waste etc. In order to ensure proper and scientific management of waste generated in India, Union government has notified following rules under Environment (Protection) Act 1986

- Bio-Medical Waste Management Rules, 2016
- Solid Waste Management Rules, 2016
- E-Waste (Management) Rules, 2016
- Plastic Waste Management Rules, 2016
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- Construction and Demolition Waste Management Rules, 2016

Separate detailed rules have been put in place for management of various categories of waste including for Lead Acid Batteries (Management and Handling). Responsibilities of individuals, Municipalities, institutions and industry have been fixed under these rules.

4.6 SOURCE SEGREGATIONS: CONTROL MEASURES OF URBAN AND INDUSTRIAL WASTE

The above rules have laid down detailed framework for bifurcation of various categories of waste. Institutions, producers have a responsibility under E-Waste Management Rules to bifurcate electronic waste and dispose off the same to an authorized recycler or refurbisher only and maintain adequate records. Provisions for extended Producer responsibility for collection of electronic waste have been made.

Municipal Solid Waste is required to be segregated at the stage where the waste is generated. Rules provide for segregation and storage of waste in three separate bins

- Bio-degradable waste– any organic material which can be degraded by micro-organisms into simpler stable compounds
- Non bio-degradable waste– to contain dry waste including recyclable and non-recyclable waste, combustible waste, sanitary napkins and diapers etc.
- Domestic Hazardous waste – CFL bulbs, expired medicines, broken mercury thermometers, pesticide cans, discarded paint drums, used needles and syringes, contaminated gauge, used batteries etc

- Segregated waste is required to be handed over to authorized waste collectors/waste pickers
- Used sanitarypads, diapers etc. to be packed/wrapped safely either in the pouches provided by manufacturers or in other prescribed suitable material
- Construction and demolition waste to be separately stored and disposed off as per Construction and Demolition Waste Management Rules, 2016
- Horticulture and garden waste to be separately stored in the premises
- No littering of solid waste on streets, public spaces roads etc
- Solid Waste not to be burnt/buried in streets or open public spaces
- Solid Waste not to be thrown in drains or water bodies

4.6.1 Disposal of Industrial and Urban Waste

The segregated waste, thus, collected can be disposed off in various ways i.e. Sanitary Landfills, incineration, recycling, recovery, pyrolysis, composting and use in energy generation and road making.

4.6.1.1 Sanitary Landfill

This is the most popular waste disposal method used today. Garbage is spread out in small layers, pressed and covered with soil or plastic foam. Modern garbage dumps are constructed in such a

way that the concrete floor is covered with an impenetrable line, often made of several layers of plastic and thick sand. This liner protects groundwater from contamination due to leakage or decay. When the landfill is full, it is covered with layers of sand, clay, topsoil and dust to prevent water accumulation. Arrangements are being made to rediscover recycling facilities.

4.6.1.2 Incineration

This process involves the burning of solid waste at high temperatures until the waste is reduced to ashes. Heats are made in such a way that they do not emit excess heat when solid debris burns. The things that recycle heat by kitchens and boilers are called waste plants. These waste energy systems are more expensive to set up and operate compared to empty heaters because they require special equipment and controls, skilled technical personnel, and auxiliary fuel systems.This method of solid waste management can be done by individuals, municipalities and even institutions.

4.6.1.3. Recovery

Resource recovery is one of the hallmarks in waste management. Many important metals go waste and create pollution unless they are recovered in a scientific manner. For example, precious metals used in electronic items can be recovered and reused which will not only lead to resource recovery and savings but will also avoid pollution.

4.6.1.4. Recycling

Certain waste like plastic bags, paper, tins, glass and containers can be recycled and reused. This reduces waste and thus reduces the burden on landfill sites and also leads to resource recovery. Process of recycling is aimed at reducing energy loss, reducing wastes and thereby reducing burden on landfills. Thus it avoids soil pollution.

4.6.1.5. Pyrolysis

Pyrolysis refers to decomposition of the solid waste using heat generated by chemicals without use of oxygen. The process is undertaken at high temperatures.

4.6.1.6. Composting

Biodegradable waste including wastes from trees, gardens etc. is segregated and used to make compost. Rules enacted by Union government require that the compost so generated shall be used as manure at the site of generation. New residential colonies have been mandated to make

provisions for compost making thereby reducing burden on landfill sites. Only bio-degradable waste is used in composting. It is a biological process which converts the waste into organic fertilizer which is high in carbon and nitrogen.

4.7 POLLUTION CASE STUDY

4.7.1 Delhi Pollution Case Study

Around the first week of November, almost every year, the capital city of India i.e. New Delhi gets clogged with dense layer of smoke. The smoke set down on the lower sky of the city and chokes the entire National Capital Region. Children, elderly people and persons afflicted with chest diseases find it difficult to breathe. Many people complain of chest congestion and breathlessness. Reports suggest that about 54000 people die of diseases related to air pollution every year in New Delhi. Cost of combating air pollution related ailments comes around 58000 crores in New Delhi.

It is claimed by government of Delhi that the primary cause of choking of New Delhi is stubble burning in the neighboring states of Punjab and Haryana.

Conflict: Claims and Counter Claims

Government of National Capital Territory of Delhi claim that the cause of smoke engulfing Delhi is stubble burning in the States of Haryana and Punjab. Whereas States of Punjab and Haryana claim that it is the increased vehicular pollution in Delhi coupled with industrial pollution and pollution caused by fire-crackers are the root cause of air pollution in New Delhi. Both the States deny stubble burning as the root cause of choking of Delhi in NCR region near Diwali. Both the states claim that there is very little stubble burning in their states. It is claimed that since the wind is not blowing that is why Delhi has turned into gas chamber.

Resolution

The solution to the problem of NCR lies in adopting a multipronged strategy. Stubble burning does contribute in choking of Delhi but other factors like pollution caused by fire-crackers burnt near Diwali significantly increase the smoke cover. Further, very low pressure of winds aggravates the problem and the smoke is not diluted and carried further. This apart, vehicular emissions, construction activities and industrial discharges into air also contribute significantly in deterioration of air quality of Delhi. The solution, therefore, lies in

- Encouraging and adopting the use public transport system and decreasing the use of

vehicles to reduce vehicular emissions by adopting odd-even formula.

- Strictly enforcing prohibition on burning of fire-crackers around that part of the year.
- Enforcing prohibition on stubble burning and by providing alternate and effective means of stubble disposal
- Temporaryban on construction and demolition activities when the air pressure is extremely low.
- Temporary ban on industrial activities when the air pressure is low and smoke starts engulfing the region.
- Use of scientific methods like air purifiers, sprays etc to improve the air quality
- Continuous monitoring of air quality levels.

CHECK YOUR PROGRESS

Answer the following:

1) _____and _____natural sinks of carbon dioxide

2) _____waste is used for composting

3) According to Food and Agricultural Organization (FAO) of UN, how much percentage of soil of African continent‘s soils are degraded?

   a) 20%
   b) 30%
   c) 40%
   d) 50%

4) Which of the following is unscientific and unacceptable method of waste disposal

   a) burning of rubber tyres in open
   b) Dumping at landfill sites
   c) Recycle and recovery
   d) All of these

5) CFL and LED lights, Thermometer etc are

a) Bio-degradable waste

b) Hazardous waste

c) Bio-degradable but hazardous waste

None of these

4.8 SUMMARY

- Environmental pollution is contamination of physical and biological components of environment.
- Environmental pollution is caused by various anthropogenic factors like discharge of industrial gases in air, smoke, vehicular emissions, stubble burning, burning of waste, dumping of wastes in open, contamination of soil, noise etc.
- Environmental pollution can be broadly classified as air pollution, soil pollution, noise pollution, water pollution
- Environmental pollution whether air pollution, water pollution, soil pollution or noise pollution has various adverse impacts on health, biodiversity, genetic mutations, habitat etc
- Government has enacted various laws and rules for prevention, control and abatement of air pollution yet the pollution is continuing unabated.
- Apart from pollution caused by emissions from vehicles and industries, handling and use of radioactive materials also expose humans and other living organisms to radiations which have harmful effect on humans and other living organisms.
- Municipalities, institutions, individuals and society have a responsibility to ensure that environment is protected and preserved and the waste generated by us is disposed off in an environmentally sound manner.

4.9 QUESTIONS FOR PRACTICE

1) Write detailed note on solid municipal waste and its disposal methods.
2) Explain pollution caused by radioactive material and the health hazards involved while dealing with radioactive waste.
3) What are the causes of water pollution? How it can be prevented?
4) Discuss the causes and effects of air pollution.

5) Discuss control measures for prevention of environmental pollution.

4.10 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad

COURSE: ENVIRONMENTAL STUDIES

UNIT 5: ENVIRONMENT PROTECTION LAW IN INDIA

STRUCTURE

5.0 LEARNING OUTCOMES

Learning outcomes of this chapter are as follows:

- To apprise the learner about important environmental laws enacted in India
- To make learner understand the importance of environmental laws
- To apprise the learner about environmental offences
- To inform the learner about major environmental issues

- To make learner understand the individual role in preservation and protection of environment

5.1 INTRODUCTION

Traditional Indian society always respected and worshipped various constituents of environment and environment ethics formed part of Indian religious philosophy. Traditional inhabitants of this sacred land worshipped nature – Sun, Moon, Earth, Air and water. They perhaps knew that eco-system is delicate and has a very fine balance which is required to be preserved and any tangible changes in eco-system can have disastrous consequences. The reverence of nature in reflected in the teachings of Jagat Guru Nanak Dev Ji - _Pawan Guru, Pani Pita Mata Dhart Mahat, Divis Raat Doi Daia, Khele Sagal Jagat‘ (Air is like God, Water is father and Earth is the mother. It is through the harmonious interaction of all these three vital ingredients that the whole universe is being sustained). However, with the passage of time, human race started ignoring the environmental ethos and values and increasing human greed led to increasing exploitation of natural resources without caring for the need to preserve and protect the environment. Rapid industrialization, urbanization, societal degradation and increased greed to exploit resources led to environmental pollution and environmental degradation necessitating enactment of laws to preserve and protect the environment.

5.1 ENVIRONMENT PROTECTION LAWS IN INDIA

UN Conference on Human Environment (June 1972) is catalyst in development of environmental law across the globe. India also participated in the conference wherein it was decided to take appropriate measures for protection of natural resources and to prevent air pollution. Accordingly, India amended the constitution to include some provisions pertaining to environment. The constitutional amendment paved the way for development of environment protection laws in India.

a. Indian Constitution and Environment Protection

There was no express provision in the Constitution of India relating to Environment protection. Constitution (Forty-Second Amendment) Act, 1976 inserted Article 48A in Part IV of the Indian Constitution (i.e. Directive Principles of State Policy). Article 48A read as under:

> *The State shall endeavour to protect and improve the environment and to safeguard the forests and wild life of the country.*

Though Part IV of the Constitution is not justiciable i.e. it can-not be enforced in a court of law, yet it is fundamental in the governance of the country. Insertion of express provision in the Constitution of India, coupled with other national and international developments, lead to development of environmental protection law in India. As stated earlier directive principles are fundamental in the governance of the country. This apart, Part IVA i.e. Fundamental duties was also inserted in the Constitution of India. Article 51A(g), contained in Part IVA, casts a duty on every citizen of India:

> *To protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures*

Constitution of India did not provide express provisions for enforcement of fundamental duties. However, High Court of Rajasthan in L.K. Koolwal v. State of Rajasthan(AIR 1982 Raj. 2)stated that rights and duties co-exist and there can-not be any right without any duty and there can-not be duty without any right. Hence, the duty of one is the right of another. With passage of time, Right to clean environment has been recognized, by the Supreme Court of India, as a fundamental right explicit in Right to Life and Personal Liberty (Article 21 of the Constitution of India). Constitution (Forty-second Amendment) Act, 1976 also inserted entries 17A and 17B relating to Forests and Protection of Wild Animals and birds respectivelyin the Concurrent List. This apart, there are provisions in Article 252 and 253 of the Constitution of India. Article 252 enables the Parliament of India to enact laws, when so required by two or more states, on a subject on which Parliament has no power to make laws. Article 253 enables the Parliament to make laws to give effect to international treaties and agreements which include treaties and agreements relating to environment protection.

Therefore, it is clear that there are provisions in the constitution for enactment of laws relating to protection of environment. In accordance with constitutional mandate, India has enacted various laws for protection of the environment.

- The Wild Life (Protection) Act, 1972

- Water (Prevention and Control of Pollution) Act, 1974
- Forest Conservation Act, 1980
- Air (Prevention and Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Public Liability Insurance Act, 1991
- The Biological Diversity Act, 2002
- National Green Tribunal Act, 2010

b. Wild Life (Protection) Act, 1972

Elites of Indian subcontinent were fond of hunting wild animals since times immemorial and therefore, concern for wild life protection was raised far back in 3rd Century BC and accordingly, laws were enacted for

Indian legislature has made various laws for protection and preservation of wild life and forests viz.,

- Elephants Preservation Act, 1879
- The Wild Birds Protection Act, 1887
- The Wild Birds and Animal Protection Act, 1912
- The Indian Forest Act, 1927
- The Prevention of Cruelty to Animals Act, 1960
- The Wild Life (Protection) Act, 1972

Objectives of The Wild Life (Protection) Act, 1972

As is apparent from the tile itself, The Wildlife (Protection) Act, 1972 was enacted to protect, preserve and improve wild life in India. The Act has been enacted with the following objectives:

- To ensure protection of wild animals, birds and plants
- To ensure ecological and environmental security of the country

Overview of the Wild Life (Protection) Act, 1972

- The Act facilitated the preparation of list of endangered species of wild life and it prohibited hunting of endangered species
- Act banned trading in Endangered species except as provided in the law.
- Wild Life Act has six schedules. Depending upon the threat to survival of species, species have been classified into various schedules. Animals, birds, reptiles etc mentioned in Schedule I, can-not be hunted except by an order in writing when such specie has become dangerous to humans etc.
- Law enabled setting up of Protected Areas i.e. Sanctuaries, National Parks etc.
- It regulated trade in prescribed species of wild life.
- Act provided for constitution of National Board for Wild life which is the highest authority. The Board lays down the policy and reviews the matters related to wild life preservation, national parks, sanctuaries etc.
- Central Zoo Authority has been established under the Act to supervise zoos in India.
- National Tiger Conservation Authority has been established to protect Tigers and to increase the population of Tigers.
- Tiger and other Endangered Species Crime Control Bureau has been established to curb poaching and trade in Tiger and other Endangered Species.

After Enactment of Wild Life (Protection) Act, 1972 India signed UN multilateral treaty aimed at protecting endangered animals and plants i.e. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which entered into force on 01st July 1975.

c. Water (Prevention and Control of Pollution) Act, 1974

We all know that clean drinking water is essential for survival of human race and other species. That is why Supreme Court of India has recognized right to clean water as part of fundamental right to life (Narmada Bachao Andolan v Union of India, AIR 2000 SC 3751). Water Pollution amounts to violation of Right to Life enshrined in Article 21 of the Indian Constitution (State of M.P. v. Kedia Leather and Liquor Ltd, AIR 2003 SC 3236).

Objectives of Water Act

Water (Prevention and Control of Pollution) Act, 1974 has been enacted with the following objectives:

- To provide legal rules for prevention and control of water pollution
- To provide legal mechanism for implementation of the provisions of the Water Act
- To provide legal mechanism for maintaining wholesomeness of water of reservoirs etc.

Overview of the Act

- Water Act mandates setting up of Central Pollution Control Board and State Pollution Control Boards for carrying out various functions under the Water Act and for taking appropriate measures for prevention and control of water pollution.
- Water Act contains detailed provisions for prevention and control of Water Pollution. Water Act prohibits establishment of any industry etc which would discharge sewage or trade effluent into a stream without the permission of Pollution Control Board. Board is required to examine the application with regard to pollution control measures and is competent to impose requisite conditions for ensuring compliance with legal norms. Permission of the Board is required to be renewed periodically. If the industry does not comply with the conditions imposed by the Board, it may withdraw the permission and industry can-not continue its operations. Board has the power to inspect the premises of any industry and take appropriate measures.
- To regulate use of water, Board has the power to seek information regarding abstraction of water from a stream or well. Similarly, Board has the power to seek information regarding discharge of sewage or effluents into water bodies and issue appropriate directions. Non compliance with the directions can attract imprisonment upto 3 months or fine which can extend upto 10000 (Ten thousand) Rupee. In case of continuing defaults, fine upto Rs. 5000 per day during can be imposed.
- Water Act also bars discharge of any poisonous, obnoxious or polluting matter into a stream or water resource.
- Water Act prohibits obstruction in the free flow of a water body which is likely to increase pollution. It must, however, be remembered that Act does not bar construction of

dams, bridges, building, dock, drain or sewer which any person has right to construct. Similarly, the natural deposits, sand or gravel which have flown from the stream can be put back into the stream.

- Board is authorized to collect water samples from streams, wells and sample of sewage etc. being discharged into stream or well to ensure that untreated effluents are not discharged into water bodies. The officer is required so serve immediate notice upon the occupier or his agent stating the intention to take sample and to get it analysed.
- Pollution Control Board has the power to take appropriate measures in case of any accident or to meet emergencies and it can appropriate orders restraining discharge of pollutants into water streams or well. Non compliance with such orders is punishable with minimum mandatory imprisonment of one and half year extendable upto six years with fine.

d. Air (Prevention and Control of Pollution) Act, 1981

Clean air is required for the survival of not only the humans but also for survival of various other living organisms. Air pollution has been defined to mean presence of any solid, gaseous or other substance in air, including noise, beyond defined limits which is likely to adversely affects humans and other living organisms. Natural air in the earth‘s atmosphere contains around 78% Nitrogen, 21% Oxygen and around 1% molecules of other gases like Carbon dioxide, argon and other components including water vapours. However, if the composition of the natural air is altered owing to natural or man-made reasons, it would adversely affect various living organisms.

Objectives of the Air Act

Air Act has been enacted with the following objectives:

- To lay down rules for the prevention, control and abatement of air pollution;
- To preserve the quality of the air and take appropriate measures to maintain the same;
- To establish mechanism for implementation of the provisions of the Act by establishing Central and State Pollution Boards;

- To confer powers upon Central and State Boards for carrying out the functions assigned by the Act.

Overview of the Air Act

- Air Act mandated the establishment of Central Pollution Control Board and State Pollution Control Boards for discharging the functions assigned under Air Act. To avoid duplicacy and to integrate Water Act and Air Act, it has been laid down that the Pollution Control Boards established under Water Act shall also perform the functions under the Act.
- Air Act contains provisions and measures for prevention control and abatement of air pollution. Act contains preventive as well as remedial measures.
- State Government has been empowered to declare certain areas to be air pollution control areas. Act empowers states to prohibit use of any fuel causing air pollution in such areas by notification.
- Burning of any material causing pollution like stubble burning can be prohibited in pollution control areas. Act also empowers for approval of appliances for controlling and regulating air pollution.
- Act enables issuance of emission standards for vehicles for curbing air pollution. Accordingly, pollution emission standards can be fixed which Vehicle Registration Authority is bound to follow. Similarly, section 110 of Motor Vehicles Act also empowers the Central government to issue directions regarding emission of smoke, visible vapour, sparks, ashes, reduction of noise caused by vehicles and standards of emission of air pollutants.
- All industrial plants are required to obtain permission of the Pollution Control Board before commencing operation. Similarly existing units are also required to obtain permission. All industrial plants in air pollution control area are required to comply with emission norms fixed by the Board from time to time.
- Before granting permission, Board may require installation of specified air pollution control equipments so as to prevent and control air pollution. Such equipments are required to be kept in good working condition.

- Board may also require chimney of approved specifications to be erected in industrial plants
- Act also requires remedial actions to be taken when there is apprehension of emission of air pollutants in excess of prescribed limits due to accidents and other unforeseen circumstances.
- It can also apply for injunction from court to restrain emission of air pollutants in excess of prescribed standards.
- To ensure compliance with the provisions of the Act, State Board can seek information from the person occupying industrial plant pertaining to emission of pollutants. To verify the information, Board officers can enter upon the premises and inspect the premises and take samples.
- State Board can issue directions for ensuring prevention and control of air pollution. To enforce provisions of the Air Act, State Board can also order closure, prohibition or regulation of any industry, operation/process or stoppage or regulation of electricity/water supply or other service.
- Act has provided stringent penalties for non compliance with legal provisions pertaining to prevention and control of air pollution. Act provides for mandatory imprisonment for one and half years extendable upto six years and fine, if any person commences or operates any industrial plant without the consent of the State Board or emits air pollutants in excess of the standards laid down by the Board.
- In case of offences committed by Companies, punishment can be imposed not only on the company but also on the officers in charge of the company or responsible for the conduct of the business of the company. Similar provisions have been made in case of offences committed by Government departments.

e. Environment (Protection) Act, 1986

Environment (Protection) Act is an umbrella legislation enacted by Parliament of India to protect the environment. Water Act and Air Act dealt with Water pollution and air pollution, however, provisions relating to soil pollution, noise pollution, waste management, electronic waste, solid waste, bio waste, Ozone Depleting Substances, Lead Batteries etc were missing. Therefore, an umbrella legislation was enacted which empowered Union to enact rules for protecting and

preserving the environment. Enactment of Environment (Protection) Act, 1986 has enabled the Union to frame various rules to prevent pollution and to protect the environment including the following:

This apart, India has enacted various rules and regulatory mechanism for dealing with waste disposal in an environmentally sound manner. These include :

- The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989
- The Manufacture, Use, Import, Export and Storage of Hazardous Micro-Organisms/Genetically Engineered Organisms or Cells Rules, 1989
- The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- Ozone Depleting Substances (Regulation and Control) Rules, 2000
- Batteries (Management and Handling) Rules, 2001
- Coastal Regulation Zone Notification, 2011 etc.
- Bio-Medical Waste Management Rules, 2016
- Solid Waste Management Rules, 2016
- E-Waste (Management) Rules, 2016
- Plastic Waste Management Rules, 2016
- Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016
- Construction and Demolition Waste Management Rules, 2016

5.3 ACID RAIN AND ITS IMPACT ON HUMANS AND AGRICULTURE

Acid rain, as is apparent from the name, implies precipitation of acid in the form of rain. Acid rain contains acidic droplets and can adversely affect plants, trees and agriculture. When Sulphur and Nitrogen particles get mixed with wet components of rain, it causes acid rain. Increased industrial pollution coupled with vehicular emissions can lead to acid rain wherein atmospheric pollutants like oxides of Nitrogen and Sulphur react with rainwater and come down with rain droplets. Acid rain can also result from natural causes like lightning strike which releases Nitrogen ions and release of Sulphur from volcano.

Various studies have shown that acid rain on its own may not have much adverse impact on humans directly. The pH of acid rain does not have enough acid to burn human skin. However, it

can have indirect impact on human health. It does pollute the air and water. Sulphur dioxide in the air can cause lung diseases in humans and animals. Similarly, acidic precipitation at high altitude areas can cause thick acidic fog which can lead to irritation in eyes and nose.

Acid rain, however, has serious impact on plants, trees and agriculture, it changes the composition of soil and depletes minerals and essential elements from the soil thereby affecting productivity and quality of the agricultural produce. Acid rain has also serious adverse impact on marine ecosystem. It can cause death of various marine living organisms disturbing marine ecology.

As stated earlier, various laws have been enacted to curb air pollution and to decrease carbon emissions.

5.4 CLIMATE CHANGE AND GLOBAL WARMING

Climate change implies changes in normal weather of a particular place over longer period of time. As per Intergovernmental Panel on Climate Change (IPCC), Climate Change refers to change in the state of climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change means tangible change in earth‘s climate e.g. change in earth‘s usual temperature.

Climate change has led to global warming. As per the data available, during the last 115 years global average surface air temperature has increased by 1 degree Celsius. Global warming has been attributed to increased carbon emissions. Increased industrialization has led to increase in carbon emissions leading to further rise in average global surface temperature.

Global warming has serious impacts on human race and ecosystem. It leads to ocean acidification adversely affecting marine ecosystem. It causes melting of glaciers, shrinking of ice sheets and rise in sea level. It has already lead to flooding of coastal areas which may ultimately sink in the ocean permanently. Global warming and increasing sea level can lead to intrusion o salt water in fresh water lakes causing shortages in drinking water supply. Extreme weather changes caused by global warming can adversely affect food production. Further, demographic

change caused by Climate change may lead to overheating and related health issues leading to increase in heat related deaths. Overheating is likely to affect human productivity as well.

Efforts have been made at the national and international level to decrease carbon emissions. India has also made a policy to combat climate change i.e. National Action Plan on Climate Change (NAPCC). NAPCC consists of eight national missions i.e. national solar mission, mission for enhanced energy efficiency, sustainable habitat, water mission, mission for sustainable agriculture, mission for sustaining Himalayan Ecosystem, national mission for green India and mission on strategic knowledge on climate change.

5.5 OZONE LAYER DEPLETION

Ozone layer or Ozone shield is concentration of Ozone in earth‘s stratosphere which protects us from harmful effects of solar radiation. It absorbs ultraviolet rays which are harmful to humans and other living organisms. In 1985, it was found that human activities have led to depletion of ozone layer and low concentration of ozone referred to as ozone hole was detected near South Pole. Driven by discovery of hole in ozone layer, Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in 1985 as a supplementary agreement to Vienna Convention 1985. Montreal Protocol, 1987 has been ratified by all countries of the world including India. It was recognized that Chlorofluorocarbons (CFCs) are responsible for depletion of ozone layer. With increased scientific knowledge, various substances causing damage to ozone layer were identified and Montreal Protocol provided for phasing out such controlled substances in a time bound manner. Various substances identified for causing depletion of ozone layer are CFCs (Chlorofluorocarbons), Halons, Fully Halogenated CFCs, Carbon Tetrachloride, Methyl Chloroform, Hydrochlorofluorocarbons (HCFC), Hydrobromofluorocarbons (HBFC), Methyle Bromide and Bromocholoromethane and HFCs.

In compliance of its international obligations under the Montreal Protocol, India has enacted Ozone Depleting Substances (Regulation and Control) Rules, 2000. India has already phased out production and consumption of CFCs , CTC and Halons except for medical purposes. India has also phased out production and consumption of Methyl Chloroform and Methyl Bromide. The Rules of 2000 lay down rules for production, consumption, import and export of Ozone Depleting substances. Rules also provide for monitoring mechanism.

5.6 ROLE OF INDIVIDUAL IN ENVIRONMENTAL PROTECTION

Individuals have a very important role to play in protection and preservation of environment and in preventing and controlling pollution. As stated earlier, right to clean environment has been declared to be a fundamental right in India. Indian constitution casts a duty on every citizen to protect and improve the natural environment. However, fundamental duties remain on paper and we hardly bother for our fundamental duties.

Be it stubble burning, excessive and unjustified use of motor vehicles, high quantum of waste generation (electronic waste, municipal solid waste, plastic waste etc), improper and unscientific management of wastes in homes and in offices, excessive and disproportionate use of water, noise pollution or the like, individual role has not been upto the mark in India.

Therefore, if an individual understand his fundamental duties properly and does its bit in protection of environment like keeping vehicular emissions to the minimum, avoiding fossils fuels, decreasing carbon footprint, avoiding wastage of water and contamination of water bodies, segregating waste and adopting scientific waste management techniques in homes and offices, avoiding or decreasing activities causing air pollution, use of energy efficient equipments, saving energy etc. he can significantly contribute in protection and preservation of environment.

5.7 MAJOR ISSUES IN ENVIRONMENTAL LAW ENFORCEMENT IN INDIA

From the foregoing discussion, it is clear that India has plethora of laws to protect and preserve the environment and for preventing and controlling the pollution. However, despite enactment of several laws and pro-active approach of Indian judiciary in developing environmental jurisprudence, the environmental degradation in India continues unabated.

Untreated trade effluents are being discharged into water bodies polluting water resources and adversely affecting aquatic ecosystem. This apart, due to release of chemicals in soil, heaps of electronic waste and hazardous waste contaminate the soil and chemicals percolate deep down in the water table thereby polluting ground water table.

Air pollution caused by vehicular emissions, industrial emissions and stubble burning have worsened the air quality beyond measurable limits. Each year, near Diwali season, northern India is choked with smog caused by vehicular emissions and stubble burning despite there being ban on stubble burning. Air pollution is causing deep impact on human health. This apart, there are various environmental challenges like waste management, depleting ground water table, desertification, issues caused by climate change, loss of wild life habitat, more species being endangered, loss of Himalayan Ecosystem and other environmental issues.

The question, therefore, arises is why despite enacting various laws, the problem of environmental pollution is still haunting our country. There are various reasons for the same including

- Tardy Implementation of Laws
- Lack of initiative among Individuals and civil society regarding environmental protection
- Judicial system being afflicted by slow motion syndrome
- Non availability of technology and technical know-how at affordable prices to industry and individuals
- Lesser Human resources for implementation of Environmental Laws
- Governmental apathy in implementation of environment protection laws
- Increase in population and increased demand for customer and luxury goods
- Declining social and moral values
- Unemployment and poverty
- Developed countries dumping hazardous waste in developing countries like India

It must also not be lost sight of that India has achieved some success in environment management. We have been able to phase out Ozone Depleting Substances as per the norms applicable under Montreal Protocol. Similarly, we have been able to increase forest cover, provide better norms for waste management, developed environmental jurisprudence on sound judicial principles and the like.

CHECK YOUR PROGRESS

1) Right to Clean environment has been guaranteed in which article of the Indian Constitution
   a. Article 19 b. Article 20 c. Article 21 d. Article 22
2) Fundamental duty of every citizen to protect and improve the natural environment is provided in Article
   a. 51A(d) b. 51A(f) c. 51A(g) d. 51A(h)
3) 78% of the Air is composed of which of the following elements
   a. Nitrogen b. Oxygen c. Carbon dioxide d. Carbon Monoxide
4) Which of the following is cause of air pollution
   a. Burning of Fossil fuels b. Agriculture residue burning
   c. Construction activities d. All of these
5) Which of the following is protected area under Wild Life (Protection) Act
   a. Sanctuaries b. Conservation Reserves
   c. National Parks d. All of these

Answers:

1. C
2. C
3. A
4. D
5. D

5.8 SUMMARY

From the perusal of the foregoing discussion, it is apparent that India has enacted various laws for protection and preservation of environment and for controlling and preventing environmental pollution. Legal provisions have been introduced in the Constitution of India and various laws have been enacted viz. The Wild Life (Protection) Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest Conservation Act, 1980; Air (Prevention and Control of Pollution) Act, 1981; Environment (Protection) Act, 1986; Public Liability Insurance Act, 1991; The Biological Diversity Act, 2002; National Green Tribunal Act, 2010. This apart various rules have been enacted under these statutes for protection of environment.

Indian judiciary have also contributed by developing sound environmental jurisprudence and have declared right to clean environment as a fundamental right being included in right to life and personal liberty guaranteed under Article 21 of the Constitution of India.

However, due to various factors including rapidly increasing population, increased demand for consumer and luxury goods, unavailability of sustainable technology at affordable prices etc, environmental pollution is a major issue confronting our nation. Mere enactment of laws can-not achieve the desired result. The effective implementation of laws is required to be ensured in letter and spirit. This apart, citizenry need to join hands to protect the environment. We must remember that it is not the job of government and its instrumentalities alone but citizens also need to partner the objective of preserving and protecting the environment.

5.9 Questions for Practice

A. Descriptive questions

1) Discuss constitutional provisions for protection and preservation of environment.
2) Explain the legal framework for prevention and control of air pollution.
3) Discuss salient features of Water (Prevention and Control of Pollution) Act, 1974
4) Write a short note on National Action Plan on Climate Change.
5) Elaborate role of individual in protection of environment.

5.10 Suggested Readings

1. Dr. Paramjit S. Jaswal, Dr. Nishtha Jaswal and Vibhuti Jaswal, Envrionmental Law, Allahadbad Law Agency, Faridabad
2. Dr. S.R. Myneni, Environmental Law, Asia Law House, Hyderabad
3. Benimadhab Chatterjee, Environmental Laws: Implementation Problems and Perspectives, Deep & Deep Publications Pvt. Ltd.
4. Gardiner, S.M. et al (eds.) (2010) : Climate Ethics : Essential Readings, Oxford University Press, New York
5. Humphrey, S. (ed.) (2010) : Human Rights and Climate Change, Cambridge University Press, New York

6. Pandve, Harshal T. (2009) : India‘s National Action Plan on Climate Change, Indian Journal of Occupational and Environmental Medicine, Volume 13(1), April
7. Guus J.M. Velders et al (2007) : Importance of Montreal Protocol in Protecting Climate, Proceedings of the National Academy of Sciences of the United States of America, Vol. 104(12), March
8. Forest Survey of India (2015) : India State of Forests Report, 2015 available at http://fsi.nic.in/isfr-2015/isfr-2015-tree-cover.pdf
9. Mishra T K, _Forestry Research in India‘, Economic and Political Weekly, Vol. 34, No. 16-17, 1999, pp.942-944.
10. Kanupriya Gupta (2011), Consumer Responses to Incentives to Reduce Plastic Bag Use : Evidence from a Field Experiment in Urban India, SANDEE Working Paper no. 65-11

COURSE: ENVIRONMENTAL STUDIES

UNIT – 6: HUMAN COMMUNITIES AND THE ENVIRONMENT

STRUCTURE

6.0 LEARNING OBJECTIVES

After the study of this unit, the learners will be able to:

- Understand the concept of Human population growth and evaluate the impact causedby it on the environment and human welfare
- Delve deeper into the need and concerns pertaining to Sanitation and Hygiene
- Gauge the extent of resettlement and rehabilitation that has been possible for theproject affected people
- Acquire an understanding of the concept of Disaster Management with reference tothe problems created by Floods, Earthquakes and Cyclones

- Know about the various important movements attached to the issue of Environment
- Develop an understanding of the concept of Environmental Ethics and know about therole played by various religions and cultures in conservation of the environment
- Learn about the issues of Environmental Communication and Public Awareness

6.1 INTRODUCTION

Human population increase can be modelled using animal population dynamics concepts. Humans aren't the only ones who can change their surroundings. Beaver dams, for example, affect the stream ecology where they are constructed. Humans, on the other hand, have the potential to change their environment in order to enhance carrying capacity, often at the expense of other species. The human population and their usage of resources on Earth are fast increasing, to the point where some people are concerned about the planet's ability to support its human population. Long-term exponential expansion involves the possibility of famine, disease, and mass death, as well as social implications such as overcrowding and increased incidence of crime. Human technology, particularly human use of the energy contained in fossil fuels, has wreaked havoc on the Earth's environment, altering ecosystems to the point where some may be in jeopardy. Human activities are to blame for global changes such as ozone layer depletion, desertification and topsoil loss, and global climate change.

The total number of people living in a specific region at a given moment is referred to as the human population. The rapid growth of the human population over the previous few decades has resulted in a population explosion. The exponential growth of the human population is depleting natural resources and degrading the environment. Land, water, fossil fuels, minerals, and other resources are finite, and owing to overexploitation, these resources are depleting. Forests, grasslands, and other renewable resources are under severe stress. Industrial and economic development improves our standard of living but also introducing harmful contaminants into the air, water, and soil. As a result, environmental life-support systems are threatened.

6.2 HUMAN POPULATION GROWTH

The growth in the number of people in a population is known as population growth.

Global population increase is about 83 million people every year, or 1.1 percent per year. The lower death rate owing to advances in public health and sanitation has been the primary reason of human growth acceleration in the last 200 years. In industrialised countries, access to safe drinking water and appropriate sewage disposal has significantly benefited health. In addition, medical advances such as the use of antibiotics and vaccinations have reduced infectious disease's potential to limit human population increase.

Given present practises, population growth is far exceeding our planet's ability to support it. Overpopulation is linked to a variety of severe environmental and economic consequences, including over-farming, deforestation, and water pollution, as well as eutrophication and global warming.Anthropogenic activities such as urbanisation, industrialisation, deforestation, overpopulation, and the usage of fossil fuels all have an impact on our ecosystem. Natural calamities such as earthquakes, volcanoes, cyclones, landslides, and floods can also cause environmental damage. Some of the key environmental challenges India confronts today include air pollution, inadequate waste management, increasing water shortages, decreasing groundwater tables, water pollution, forest preservation and quality, biodiversity loss, and land/soil degradation. It has an impact on the natural environment as well.

6.2.1 Impacts on environment

Population explosion leads to various environmental problems because of overburdening on natural resources:

1. Worldwide warming: The combustion of fossil fuels has resulted in a rise in carbon dioxide gas emissions on a global scale. Increases in its atmospheric levels, as a GHG (greenhouse gas), have led to a rise in temperature by trapping heat radiation, resulting in the greenhouse effect, resulting in global warming and climate change. Melting polar ice caps contribute to rising sea levels, flooding, and coastal submergence as a result of global warming.
2. Deforestation: Forests must be removed to make more area accessible for agricultural operations and to meet the expanding population's other requirements. It causes soil erosion, destroys ecological equilibrium, and causes

irregular rain and drought-like conditions.

3. Biodiversity loss: Deforestation results in the loss of wild life habitat and biodiversity, disrupting the ecological equilibrium. It leads to the devastation of food chains and food webs, as well as the collapse of ecosystems, which can jeopardise human life on the planet.
4. Pollution: As a result of population pressure, there is a lot of pollution in the water,air, soil, and noise. Overconsumption and indiscriminate exploitation of natural resources are to blame. Pollution poisoning of these natural resources endangers human life by causing diseases such as lung and skin cancer, as well as respiratory and water-borne illnesses.
5. Natural resource stress: As the world's population grows, so does overexploitation and indiscriminate use of non-renewable natural resources such as fossil fuels.
6. Water scarcity: As the world's population grows, so does the need for clean, drinkable water. Water shortage might trigger a third world war.
7. Productivity: Degradation of the environment not only damages human health but also lowers economic productivity. In developing nations like India, dirty water, poor sanitation, air pollution, and soil degradation cause severe illnesses on a massive scale.
8. Urbanization: Rapid population expansion has resulted in urbanisation, which has hada negative impact on the environment. Natural resources in cities are being degradedat an alarming rate as a result of population pressure.

6.2.2 Human Health and Welfare

Economic hardship, environmental degradation, and overexploitation of natural resources are all consequences of population expansion, and the Indian government has launched a number of family welfare programmes to address the problem.India is a welfare state, as evidenced by the Directive Principles of State Policy, which are incorporated in Part IV of the Indian Constitution. The Ministry of Women and Child Development, a department of the Indian government, is responsible for women's and children's welfare as well as the coordination of operations of other ministries and organisations in this area; supports the development and stabilisation of Self Help

Groups (SHGs) as well as awareness campaigns among rural and urban women.

The National Family Welfare Programme (NFWP) was established in 1951 with the goal of stabilising and reducing population increase. The NFWP committee advocated for marriage at a young age, a limited family size, healthy motherhood, and a longer period between childbirths. Several birth control methods have been developed by modern science, including mechanical barriers, surgical procedures, chemical tablets, and physical obstacles to implantation. Methods of family planning are significant because they have resulted in lower birth rates, lower infant death rates, and higher life expectancy rates.

Women's and Children's Welfare: In 1985, the Indian government established the Department of Women and Child Development, which prepares and implements policies, programmes, and assists in the enactment and amendment of legislation for the welfare of women and children. Children and women are particularly vulnerable to exploitation, as they are members of a high-risk category. Many governmental and non-governmental organisations, such as the National Commission for Women (NCW), the National Commission for Children, the National Institute of Public Cooperation and Child Development (NIPCCD), the Rashtriya Mahila Kosh (RMK), UNICEF, and others, work to promote the development, welfare, and protection of women and children.

The Indian government has introduced a slew of social programmes aimed towards the country's overall growth. Antyodaya Anna Yojna, National Gramin Awaas Mission (previously Indira AwasYojna), Bharat Nirman, and other organisations are examples. All of these programmes have been created in order to alleviate poverty and create jobs so that the economy may grow quickly in this competitive world.

Women Welfare Programmes in India:

1. The Swarnajayanti Gram Swarojgar Yojana (SGSY)

2. The Jawahar Gram Samridhi Yojana (JGSY)

3. The Indira Awas Yojana (IAY):

4. The National Social Assistance Programme (NSAP)

5. Under the Accelerated Rural Water Supply Programme (ARWSP)

6. Rashtriya Mahila Kosh (RMK)

7. Development of women and children in Rural Areas (DWCRA):

8. Child Development Services Scheme (CDS)

9. Welfare of Street Children

6.3 SANITATION AND HYGIENE

6.3.1 Swachh Bharat Mission

It is common knowledge that a clean country is a healthy one. Due to the country's huge geographical covering of 3.2 million square kilometres, India's story of cleanliness and sanitation has been one of steady improvement. While regulatory measures can help to provide universal cleanliness, nothing compares to the influence of a cultural shift among the country's population. The Prime Minister of India, Shri Narendra Modi, inaugurated the Swachh Bharat Mission (SBM) on October 2, 2014, with the objective of making India an open defecation-free (ODF) country by October 2, 2019 as a befitting tribute to Mahatma Gandhi on his 150th birth anniversary.

The Department of Drinking Water and Sanitation is in charge of the Swachh Bharat Mission Grameen (SBM-G) rural component of the mission, as well as the broader SBM. India's rural sanitation coverage has improved from 39% in 2014 to over 95% as of June 2019, and the Mission is on target to meet its goal of an ODF India by 2019. The Swachh Bharat Mission was started with the goal of establishing a clean India by 2019 (encompassing over 4,000 cities and towns) through ensuring sanitation and cleanliness (solid and liquid waste management and making Gram panchayats open defecation-free). SBM (Gramin) is one of the two sub-missions of the overall mission.

6.3.2 Impact of Swachh Bharat Misison

- The Indian government has taken immediate steps to expand sanitation coverage across the country. Since its inception, the Swachh Bharat Mission - Grameen has built 81.55 million toilets across India, resulting in a rural sanitation coverage of roughly 90.33 percent, up from 38.7 percent on October 2, 2014.

- In addition, 4,19,391 communities have been proclaimed open defecation-free since the campaign began.
- Around 4.32 million household toilets and 392,817 community toilets have been built as part of the Swachh Bharat (Urban) Mission. Furthermore, 100% door-to-door collection was achieved in 67,085 wards (Solid Waste Management Rules).
- According to the WHO, if the government achieves 100 percent cleanliness implementation by 2019, the country might avoid 300,000 deaths from diarrhoeal illness and protein-energy malnutrition (PEM)

6.4 RESETTLEMENT AND REHABILITATIONOF PROJECT AFFECTED PERSONS

Various development initiatives sometimes result in the eviction of poor and often uneducated local or tribal people. The rehabilitation of these individuals is a serious socioeconomic concern. The purpose of development initiatives is to improve society.

However, over-exploitation of natural resources and environmental damage are common during the development process. The project site's indigenous people are directly impacted. They are the poorest of the poor, the most disadvantaged tribal people. As the local community's socioeconomic and ecological foundation is disrupted, many sorts of projects result in the displacement of native people, who suffer great economic and psychological hardship.

6.4.1 Dam-Related Displacement Issues: Large-scale displacement of local people from their ancestral homes and loss of their customary profession or occupation is one of the most significant socio-economic consequences of the huge river valley projects. India is one of the world's leaders in large dam development, with more than 20 million people believed to have been affected directly or indirectly by these dams over the previous 50 years. More than 20,000 people have been displaced as a result of the Hirakund Dam, who live in 250 communities. The Bhakra Nangal Dam was built in the 1950s, and only half of the displaced people have been rehabilitated to this day.The same may be said about the Tehri Dam on the Bhagirathi River, whose construction was approved following a three- decade struggle headed by

renowned activist and Chipko Movement propagator Sunderlal Bahuguna. The Tehri Dam's immediate impact would be on the 10,000 people of Tehritown.

6.4.1.1 Case Study

The Sardar Sarovar Project, which aims to construct 30 major, 135 medium, and 3000 minor dams on the Narmada River and its tributaries, is expected to engulf nearly as much land as it is intended to irrigate. Due to the flooding, a total of 573 villages with a population of over three lakh people would be impacted. The tribals' communal rights have been violated as a result of the large dams. It is a painful experience to be torn from one's native land, where one's family has lived for centuries, and relocate to a new location as an outsider.The family is frequently disbanded. The tribals are paying a high price for a large dam project that is meant to bring happiness and wealth to the country. The tribals must be adequately compensated in the form of land, jobs, financial compensation, and other forms of recompense in exchange for their great sacrifice, and attention should be taken to improve their quality of life.

6.4.2 Displacement as a result of Mining: Mining is another development activity that causes local people to be displaced. Thousands of hectares of land have been covered by mining operations, and indigenous people have been displaced. Local people are sometimes displaced as a result of accidents that occur in mined regions, such as land subsidence, which frequently results in population shifts.

6.4.2.1 Case Study

Due to subterranean fires, the Jharia coal fields in Jharkhand have become a major source of concern for nearby inhabitants, who have been ordered to leave. The proposed large- scale evacuation of roughly 0.3 million people from Jharia highlights the issue of their relocation and rehabilitation, which would require careful planning. Since 1976, 115 crores of rupees have been spent to put out the flames, yet the problem still exists. The residents of Jharia are being ordered to leave, but no replacement land or rehabilitation plan has been devised as of yet.As a result, the residents of Jharia coalfield have created a "Jharia coalfield Bachao Samiti." According to the latest estimates, the cost of relocating the Jharia people

would be approximately Rs. 18,000 crore, while the cost of putting out the fire will be around Rs. 8,000 crore.

6.4.3 Displacement as a result of the creation of National Parks: When a portion of a forest is designated as a National Park, it is a positive step toward the protection of natural resources. It does, however, have a social element to it that is frequently overlooked. A large section of the forest has been designated as a core-area, making it illegal for locals or tribals to enter. When these people lose their ancestral rights or access to the forests, they typically react by engaging in harmful behaviour. It is necessary to investigate their difficulties and offer them with work.

6.4.3.1 Case Study

Tribals from the Tharu community in 142 villages in Bihar's Valmiki Tiger Reserve region in the West Champaran district believe they have been denied their legal traditional rights to harvest firewood and fodder from the forest. Their jobs have also been lost as a result of the "Project Tiger" programme. The villagers who have lost their jobs are revealed to be destroying the forest and its wealth in collusion with foreign agents who supply them with guns and ammunition for illegal logging and poaching. To prevent local tribals from becoming criminals, planners should prioritise compensating them for their losses by providing them with work opportunities.

The Wayanad Wildlife Sanctuary in Kerala has forced 53,472 tribal households to relocate. It was determined at the time of its inception to give land to these indigenous families in order to settle them. However, only 843 households were able to obtain the land until 2003. As a result, the tribals felt deceived, and in January 2003, they encroached into the forest in large numbers, cutting down trees, erecting houses, and digging wells, resulting in a violent confrontation with forest officials, resulting in injuries and fatalities among the people.

6.5 DISASTER MANAGEMENT

The word "disaster" comes from the French word "disastre," which means "a wicked or evil star." A disaster is an unexpected and unforeseeable tragedy that brings sorrow and

misery to humanity. Human lives, the economy, and the environment have all been severely impactedby the calamities. Natural catastrophes are always unexpected and devastating. A disaster is an unforeseen occurrence that strikes a town with little or no notice, wreaking havoc on people's lives and economies in the area.

Two types of disasters have been identified:

1. Earthquakes, landslides, volcanic eruptions, tsunamis, and cyclones are examples of natural disasters;

2. Man-made disasters include the Bhopal gas tragedy, the Chernobyl accident, dam leakage or collapse, and so on.

India is also vulnerable to natural disasters such as floods, earthquakes, cyclones, and landslides.

Meaning: The effective organisation, guidance, and exploitation of available counter-disaster resources is known as disaster management. For individuals who are unprepared, the events of a tragedy can be highly distressing. Disaster management concepts apply in both normal and emergency scenarios. Disaster mitigation and disaster rebuilding are examples of routine management tasks that take place during non-crisis situations. The term "crisis management" refers to the planning and execution of emergency operations, and it encompasses both the pre-disaster and post-disaster phases.

Post -Disaster management was the focus till now which involved taking care of the situation after its occurrence.

Post- Disaster management involves:

- Evacuation,
- Communication
- Search
- Rescue
- Fire fighting
- Medical
- Food

- Shelter assistance etc.

The need of the hour is to emphasize on Pre-disaster management measures to minimize or prevent the loss. Pre-disaster management strategies involve:

- Disaster-prone regions are identified, and
- Gathering of information about historical dangers, population, and current infrastructure
- Information on the local ecology
- Risk assessment to evaluate the frequency of disasters and the length of time it takes to recover from disasters and return to normality.

Mitigation entails using modern and improved technologies to anticipate, warn, and distribute information fast. GIS (Geographical Information System), GPS (Global Positioning System), and satellite communication are examples of computer and space technologies used in management.

Various national and state-level efforts have been launched with the goal of preventing and mitigating natural catastrophes, as follows:

1. The government has established the National Decades for Disaster Reduction (NDDR). Every year, the Indian government has designated the 29th of October as ―National Day for Disaster Reduction.‖ Its main goal is to raise public awareness about natural catastrophes and to help people prepare for them.

2. Under the chairmanship of Shri J.C. Pant, the High-Power Committee on Disaster Management was established in 1999 at the suggestion of Prime Minister (PM) to create comprehensive model plans for disaster management at the national, state, and district levels.

3. The government established the National Committee for Disaster Management. It proposes the institutional and legal changes that will be required to develop a successful and long-term plan for dealing with severe natural disasters in the near future.

4. Hazard Mapping and Building Vulnerability Assessment- The Ministry of Urban Development created the Vulnerability Atlas of India, which includes maps of earthquake, cyclone, and flood-prone areas.

5. Monitoring and Impact Assessment of Natural Disasters- The Department of Space offered help and support for flood, cyclone, and drought impact monitoring and assessment.

6. The use of contemporary technology, such as remote sensing, the global positioning system (GPS), and database generation through computer modelling, has been popular in recent years. The disaster management control rooms are being actively modernised to make them more effective and community friendly.

6.5.1 Floods

The major environmental mental danger is flooding. The reason for this is due to the vast geographic distribution of river valleys and low-lying coastlines, as well as their long- standing appeal to human habitation. Floods affect every country, and in many cases, the hazard is restricted to floodplains and estuary areas.In Bihar, West Bengal, Uttar Pradesh, Assam, and Orissa, it is a common occurrence. Uttar Pradesh is often regarded as one of India's worst-affected flood-prone states. It covers almost 20% of the country's total 40 million hectares of flood-prone land. Floods are common in rivers such as the Ganga, Yamuna, Brahmaputra, Mahanadi, and Godavari. Human life, livestock, buildings, power supply, agriculture, roads, and water supply are all severely impacted by floods. In such circumstances, an outbreak of a water-borne epidemic illness can develop.

Deforestation plays a significant role in the occurrence of floods. Given that the country's land surface has lost forest cover (including 77 percent of the Himalayan territory), the extraordinary rise in the frequency and intensity of floods, despite no discernible change in rainfall patterns over the previous century, is easy to comprehend. Man's fast urbanisation and building activities have significantly reduced infiltration and increased surface run-off, resulting in local floods in major cities such as Mumbai and Kolkata. Flooding is three times more likely in a city with 40% impervious surface than when urbanisation had not yet taken hold.

Floods are caused by a number of factors, including:

a. Natural (heavy and prolonged rainfall, river passage obstruction, high tides, tsunami, landslide, and volcanic eruption beneath the sea bed) and b. man-made (tsunami, landslide, and volcanic eruption under the sea bed)

b. Created by humans (sudden water release from dam, breakdown of dam or reservoir).

Floods are most commonly caused by excessive rainfall. These can range from semi-predictable seasonal rains across large geographic areas, which cause yearly monsoon floodsin tropical places, to seemingly random conventional storms that cause flash floods in local basins.

Ice jam flooding adds to the severity of spring floods. This happens when huge ice chunks float downstream, temporarily damming waterways. This floating ice solidifies when it comes into contact with a constriction in a waterway, causing flooding. Rapid flooding occurs initially upstream, and when the ice melts, it creates havoc downstream as a result ofits severe impact.

Flood mitigation measures include wetlands preservation, afforestation, flood forecasting, and flood plan management. Construction of reservoirs to regulate monsoon flow and their regulated release after peak flow are structural steps. Flood control techniques include the construction of embankments and flood barriers, as well as anti-erosion measures and better drainage. Flood plains, or low-lying areas that are inundated during floods, aid in flood reduction. Flood control facilities such as flood barriers and river channel deepening have merely shifted the problem downstream.Building barriers keeps flood water from spilling over flood plains, but also increases the velocity of the water, causing it to have a greater impact on communities downstream. Rather of erecting structures on floodplains, it is proposed that floodplains be used for wildlife habitat, parks, recreational spaces, and other uses that are not vulnerable to flooding. To deal with the flood problem, river-networking across the country is also being considered.

Case studies:

a. Kedarnath Disaster in 2013,

b. Jammu floods in 2014,

c. Chennai floods in 2015.

6.5.2 Earthquake

An earthquake is a sudden ground disturbance caused by the abrupt displacement of rock masses, generally in the top 15-50 km of the earth's crust. Earthquakes are vibrations in the earth's crust that shake up a portion of the crust, as well as all structures and everything on it.They are extremely short motions that seldom last more than a minute and are highly varied in strength and duration. Earthquakes are defined as brief tremors in the earth's crust.

The majority of earthquakes are caused by the passage of one rock mass past another due to tectonic pressures. Rocks are pliable and can build strain up to a point when surrounding sections of rocks are subjected to pressures pushing or dragging them. When the tension on a rock surpasses its strength, it fractures along a pre-existing fracture plane called a fault.

The severity of an earthquake is generally measured by its magnitude on Richter Scale, as shown below:

Richter Scale	**Severity of earthquake**
Less than 4	Insignificant
4 - 4.9	Minor
5 - 5.9	Damaging
6 - 6.9	Destructive
7 - 7.9	Major
More than 8	Great

Due to the collapse of high-rise buildings, dams, bridges, and highways, earthquakes have the most devastating consequences in highly populated metropolitan areas. Landslides are caused by earthquakes in mountainous areas, and tsunamis are caused by earthquakes under the sea, such as the Great Tsunami of 2004.

The catastrophic earthquake that struck Bhuj Town in Gujarat caused tremendous devastation, killing 20,000-30,000 people and injuring a large number of others.

Tsunamis, which are caused by earthquakes, may cause significant damage to coastal regions. These massive sea surges may reach speeds of up to 1000 km/hr or even more. They might reach 15 m or even 65 m in height as they approach the seashore, causing tremendous destruction in coastal communities.

Anthropogenic activities can also cause or increase earthquake frequency. Three such operations have been identified:

• Impoundment of massive amounts of water in a lake behind a large dam.
• Nuclear testing underground.
• Liquid waste disposal in deep wells.

Detailed information regarding epicentres and tectonic maps, as well as seismic hazards, are all part of the mitigation procedures taken before an earthquake. Earthquake sensors are being installed to keep track on seismic activity, which can help to prevent loss of life and property.

6.5.2.1 Construction of Earthquake-Resistant Constructions and Buildings

Post-earthquake management entails evacuating people to safe locations as quickly as possible, providing medical care to injured individuals, maintaining law and order, and restoring communication, transportation, and water and food supply lines. Following a disaster, the rebuilding phase entails a survey of the damage, resettlement and rehabilitation of impacted individuals, and the reconstruction of buildings and infrastructure. In earthquake- prone locations such as Japan, wooden homes are recommended.

6.5.2.2 Earthquakes in India

Over 80 earthquakes have struck India's northern, north-western, and north eastern regions in the last two centuries. The worst were those in Assam (1897), Kangra (1905), and Bihar (1907). (1934). The Assam earthquake of 1897 caused catastrophic damage over a 2,800,000- square-kilometer region. Shillong was the hardest hit area. Standing structures were destroyed, the ground was ruptured, the drainage system was dislocated, groundwater erupted, and major landslides were triggered as a result of the earthquake.

On the 15th of August 1950, Assam was struck by another earthquake of comparable magnitude, wreaking havoc. The Kangra earthquake of April 1905, on the other hand, would be known for a long time. It had an 8.9 magnitude and was felt all the way

to Tapti. More than 200,000 people were killed as a result of it. The earthquake in Bihar in January 1934 killed about 12,000 people. It had a magnitude of 8.4 and came from a depth of 20-30 kilometres. It wreaked havoc on nearly all of north Bihar, particularly the Mungher area, and Nepal.

6.5.3 Cyclones

Cyclones are spirally moving storms that form in the Bay of Bengal and Arabian Sea in the tropical belts. Wind vortices the size of spinning tops developed over the sea, spanning horizontally up to 1000 kilometres and vertically up to 12 to 14 kilometres from the surface. They can be found in tropical coastal areas. In other regions of the world, cyclones are knownas hurricanes, typhoons, and willy-Willys. Depending on the pace, cyclones can be mild, severe, or extremely severe. Cyclones are very powerful winds that cause widespread destruction by bringing torrential rainfall and storms that flood coastal regions.

During the months of October, November, and December, the eastern coastal belts of Bangladesh, Bengal, Orissa, Andhra Pradesh, and Tamil Nadu are particularly vulnerable tothe hazards of surging sea waves and heavy downpours that accompany spirally moving fierce winds. The cyclones are endemic in the Andhra Coast, one hitting every second year.

Three to four severe cyclonic storms form on average in the Bay of Bengal, mostly during the pre-monsoon months of April to June and the post-monsoon months of September to December.

Cyclones create a rapid drop in air pressure, as much as 60 to 100 millibars, over the coastal belt, generating storm surges. Floods, which may rise as high as 14 metres and inundate huge areas reaching deep inside the ground through river ways, exacerbate the effects of strong winds and heavy rainfall. Storm surges inflict more than 90% of the damage to coastal towns by flooding the terrain, sweeping away buildings, destroying crops and fields, and causing widespread salinity in the soil and water supplies.

Tsunamis, which are caused by earthquakes in deep sea trenches, are another devastating force alongside cyclones. More than 80% of the world's total seismic energy is concentratedin the pacific belts, which see around 200 earthquakes each year.

Both cyclones and tsunamis leave behind huge storm surges and a significant rise in sea level. They can rise to a height of 5-6 metres above normal sea level, wreaking havoc.

6.5.3.1 Cyclones' Effects

1. Pollution of surface water bodies by salty sea water.

2. Agricultural soils become saline and non-productive.

3. Beach sands overrun coastal belt crops, rendering agricultural lands unusable.

4. Bridges, roads, buildings, and telephone lines are all destroyed in large numbers.

5. Deaths as a result of drowning.

6. As a result of the deluge of huge swaths of land, diseases emerge, resulting in additional deaths.

The storm that hit India's coastal region in November 1970 killed over 2 million people and killed over 800,000 animals, damaging over 200,000 homes, 80 percent of the standing paddy crop, and 65 percent of the fishing capacity in 9000 villages.

6.5.3.2 Strategies for reducing the risk:

• Early warning and cyclone monitoring systems aid in the evacuation of individuals in susceptible regions. Wind tides are forecasted by the Indian Meteorological Department (IMD) and include the location, timing, predicted wind speed, and magnitude.

• The Indian coastal belt has been designated as a cyclone threat zone, preventing the construction of significant residential and industrial structures. It spans from Tamil Nadu to West Bengal via Orissa.

• It's critical to keep communication lines open during rescue efforts. Pocket radios, satellite connections, and Morse Code are all useful tools.

• Mangrove trees planted along coastal belts function as wind and tide blockers.

6.5.4 Landslides

Temporary instability of surface rock formations, whether consolidated or unconsolidated, has long been a serious concern in many parts of the world. These

superficial masses move vertically down after suddenly or gradually leaving their initial location. Such movements are referred to as "Landslides" when they occur on slopes.

The word landslide refers to the _rapid downslope movement' of soil or rocks in general. Gravity continuously pushes the material down, resulting in a process known as "mass waste." Although the movement is gradual and delicate, some slope processes, such as rock slides and avalanches, may be deadly and quick.Landslides are common in mountainous areas. Landslides are common in India's Himalayan and Western Ghats areas. Landslides cause economic damage by blocking roads, disrupting commerce and obstructing people's movement, as well as biodiversity loss.

Landslides can occur as a result of local features, climatic rock degradation, and natural earthquakes. In steep areas, man-made activities such as deforestation, land use change, androad building cause landslides.

Landslides are caused by a variety of activities.

1) Construction of roads in steep regions
2) Mineral and coal extraction (mining operations)
3) Forest removal on hill slopes
4) Cultivation techniques on slopes in agriculture
5) Constructing a home on a slope that is unstable
6) Explosions in the earth for rock blasting,

etc. Mitigation of disasters entails:

• Landslide predictions based on soil properties, rainfall, seismic activity, and man-made structures; • an effective warning system is essential.

• Overuse of natural resources should be avoided in development projects, and changes in the balance burden on the mountains should be avoided.

• People should be rehabilitated and relocated to safer locations.

• Landslides can be avoided through proper drainage during rainstorms and the adoption ofsoil erosion management measures such as grass plantation, masonry wall building, and afforestation.

6.6 ENVIRONMENT MOVEMENTS

Environmental and ecological movements are key instances of several social groupings acting collectively. These movements are concerned with the protection and

recognition of constitutional and democratic rights, which are not defined by law but are an important part of the subaltern masses' day-to-day lives, such as control over their resources, indigenous people's right to preserve their culture, environmental protection, and ecological balance.Within the wider framework of the development debate, the environmental movement is a broad word that is used to define and explain various forms of local struggles and conflicts involving livelihood concerns and ecological security. In reality, these battles questioned and criticised the Indian state's and officials' pursuit of development and conservation ecological from colonial times.

6.6.1 Chipko Movement

The Chipko movement in the central Himalayan area in the early 1970s is credited with establishing contemporary environmentalism and environmental movements in India. The Chipko movement, which was started to safeguard Himalayan forests from destruction before independence, has its origins in the pre-independence era. During the early decades of the twentieth century, several protests against colonial forest policies were organised. People's major demand during these rallies was that the forest's advantages, particularly the right to fodder, be distributed to locals. These conflicts have persisted in the post-independence era, as independent India's forest laws remain identical to those of colonial India.

During the year 1973, _Chipko' [chipak jayenge - to hug] was born. The forest department declined to give ash trees to the Dashauli Gram Swarajya Sangha (DGSS), a local cooperative centred in Chamoli regions, for the purpose of producing agricultural tools in early 1973. The forest department, on the other hand, assigned ash trees to Symonds Co., a private enterprise. The DGSS was prompted by this occurrence to protest the injustice by lying down in front of lumber trucks and burning resin and timber warehouses, as was done during the Quit India campaign.When these measures were ineffective, one of the leaders, Chandi Prasad Bhat, proposed embracing the trees, and so _Chipko' was created (for further information, see Bahuguna, 1990 and Guha, 1989). This type of protest was crucial in convincing the private firm not to cut down the ash trees. As a result of its success, the movement expanded to other nearby places, and the movement became known as the Chipko movement globally. From the outset, the Chipko movement focused on environmental concerns such as forest

depletion and soil erosion.

The Chipko movement's success was due to three important factors. First, the tight ties between the livelihoods of the local people and the character of the movement. Chipko is seen by the locals as a battle for fundamental survival, which has been denied to them by the state's institutions and policies. In addition, peculiarity of the location where Chipko movement took place; engagement of women in the contribution to households‘ subsistence and the overwhelming support to anti-alcohol campaign have contributed to the overwhelming support of women which is unique to the Chipko movement.The kind of agitation is the second point to consider. Chipko, unlike other environmental groups, has closely adhered to Gandhi's nonviolent liberation fight tradition. Third, the simplicity and sincerity of leaders such as Sunderlal Bahuguna, as well as their connections to national leaders such as Mrs. Indira Gandhi, other politicians, and bureaucrats, contributed significantly to the movement's success.

The Chipko movement's demands were as follows:

i) A full halt to tree cutting for commercial interests;

ii) Traditional rights should be recognised in accordance with people's basic requirements;

iii) Bringing the dry forest back to life by encouraging people to plant trees;

iv) The establishment of local committees to oversee forest management;

v) The development of forest-related home-based enterprises and the provision of rawmaterials, funds, and technology; and

vi) Putting afforestation first, taking into account local circumstances, needs, and varieties.

6.6.2 Silent Valley Movement

Palghat is a district in Kerala, India, that is 3000 feet above sea level. The district's geographical area is 8950 hectares. Because of the high altitude and abundant rainfall, this area has developed into an equatorial thick forest zone. This is a distant location that is currently devoid of human activity. The building of a hydropower plant sparked this movement. This project was launched due to irrigation and power. When the real building work began, various NGOs stepped out to voice their opposition to the proposal. Because of the thick forest, this area is rich in wildlife. There are several uncommon flora and animals, as well as birds.

The struggle over the now-famous Silent Valley lasted for more than ten years,

involving thousands of individuals who did not even reside in the region that was to be demolished. Despite the lack of unified organisation, the campaign was extremely successful. Citizens placed persistent pressure on the government, using all available measures at the time – letters to newspaper editors, seminars, extensive awareness programmes, and finally petitions and appeals in court and other high offices – which ultimately proved effective. Silent Valley was designated as a National Park in 1986, a powerful testament to the power of people's activism.

6.6.3 Bishnois of Rajasthan

A similar but less fortunate deed of Bishnois in the early 18th century inspired the first ever recorded environmental revolt, the Chipko movement of 1973. When the royal authorities instructed by the then Maharaja of Jodhpur went to her native hamlet Khejarli to cut down the lush Khejarli trees for the gathering of lumber, an outstanding Bishnoi woman named Amrita Devi took the initiative. To keep the trees from being cut, she and the other 84 villagers clutched them to their bosoms.

Unfortunately, the authorities mistook it for a bluff and chopped several peasants who were hugging the trees in their haste, and the slaughter continued until the King himself arrived to put an end to it. 363 Bishnois had died in that tragic struggle to defend their holy trees and beliefs. However, it was precisely this movement that brought Bishnois to the attention of the state, which then issued a royal edict restricting hunting and wood-cutting operations in Bishnoi-populated regions.

6.7 ENVIRONMENTAL ETHICS: ROLE OF INDIAN AND OTHER RELIGIONS AND CULTURES IN ENVIRONMENTAL CONSERVATION FOR A CLEAN- GREEN POLLUTION FREE STATE

In ancient Indian tradition, people have always valued mountain, river, forest, trees and several animals. As a result, much of the natural world has been preserved. Both in Hindu religion and tribal culture, forests have been associated with the names of forest gods and goddesses. The goddesses of the trees have been linked to certain plants. Tulsi is a plant that may be found in almost every home. The elephant is linked with Bhangwan Ganesha in Indian mythology. Tulsi is associated with Lakshmi and Krushna. Amalaki, mango, and Tulsi shrub are among the trees connected with

Goddess Laxmi. Our traditional culture and religion provide us with environmental education.

The environmental ethics are listed below.

1. Relationship and contact with the environment
2. The variety of the environment
3. Human health and spirit are created by the quality and beauty of nature.
4. Does not wreak havoc on the environment
5. We believe in long-term growth.

6.7.1 Human Ethics

The following are examples of human ethics: environmental protection.

1. The pattern of resource usage and the requirement for equitable utilisation
2. Inequity - the divide between northern and southern countries
3. Issues of urban-rural equality
4. The need of gender equality 5. Animal rights
6. Environmental education and awareness must be based on ethical principles.
7. India's traditional value system and conservation ethics.

6.7.2 Role of Religions and Cultures in Environment Protection and Conservation

All religions and cultures have something to offer in terms of environmental protection and conservation. Several injunctions or exhortations from each faith can be combined to build a guideline for environmentally sustainable development. This is abundantly and comprehensively illustrated in the various religions' codes.

6.7.2.1 Environment and Hinduism

Hinduism is deeply rooted in the sanctity of all life on this earth and elsewhere. All creatures, including humans, are under the Supreme God's total authority. All lives have the same right to exist, according to Hindu texts. Humans have no authority over other living things. Theyare discouraged from exploiting nature and are advised instead to seek peace and live in harmony with it. To maintain and protect the harmonious harmony of God and nature, the Hindu faith demands devotion, respect, and obedience. The doctrine of Ahimsa (nonviolence) is founded on Hindu philosophy, which implies the doctrines of karma and reincarnation. The Hindu belief in the cycle of life and

reincarnation, in which a person may reincarnate as an animal or a bird, means that Hindus appreciate and revere other animals. This offers a firm foundation for the Hindu idea of ahimsa, or non- violence (or non-injury) against both animals and humans, which Hindus hold dear. Becausethe soul may return in other living forms, there is a strong resistance to the institutionalised slaughter of animals, birds, and fish for human food. Hinduism is a religion that originated in India. Nature is referred to in Hinduism as "God's body." Different Gods and Goddesses are associated with different birds and animals, and they are worshipped or their protection and preservation is emphasised. Finally, Hinduism offers a moral framework for environmental protection and conservation. Nature abuse and exploitation are seen as unjust and sacrilegious.

Man, Nature, and The God all have an inherent equilibrium, according to Vedic literature (about 1500 BC). Natural forces were seen to be venerable realities and representations of the Lord Himself. The Vedas envision a lovely natural ecosystem on Earth and forbid man from polluting it. The wise are commanded by Veda to keep the environment free of all pollutants, which can be accomplished through Yagnas or sacrificial fire. Yagnas are thought to be the link between humans and the Devatas. These Devatas are the natural forces that must be pampered. Yagnas are performed to honour the deity as well as to purify the air and maintaina healthy environment.

6.7.2.2 Environment and Buddhism

Buddhism is a religion based on love, understanding, and compassion, as well as nonviolent beliefs. Buddhism's essential teachings are simplicity and ahimsa. Man should not overexploit natural resources, according to the idea of simplicity based on sustainability. The ahimsa (nonviolence) philosophy of not killing animals demonstrates a love for biodiversity. The doctrine of Karma and the philosophy of cause and consequence have been central to Buddhist teachings. They show how a willful disregard for these principles of ethical living can result in anarchy and, as a result, environmental disaster. Rivers, forests, and mountains are revered and regarded as bliss providers in Buddhism and the buddhist followers had great respect for the Sun, Moon and other planets.

In Sutta-Nipata, Buddha also established regulations prohibiting contamination of

rivers, ponds, and wells. "Recognize the grasses and trees... Then know the worms and the various types of ants... Know also the four-footed animals, both tiny and large... the serpents... the fish that swim in the water... the birds that fly through the air on their wings."

The Dalai Lama put it succinctly in the following way: "As a Buddhist, I believe in the interdependence of all things, in the interrelationships throughout the entire spectrum of plant and animal life, including natural components such as mountains, valleys, rivers, sky, and sunshine."

6.7.2.3 Environment and Jainism

The notion of refraining from preventable activities that are damaging to oneself or others is highly valued in Jainism. The essential pillar of the Jain way of life is ahimsa (nonviolence), a concept that is clearly associated with realism, common sense, personal value, and responsibility. Environmental harmony through spirituality should be pursued by all,according to the Jains. This can be accomplished by following three principles: correct belief, correct knowledge, and correct behaviour. Everyone should be kind to all living things, compassionate to the weak, tolerant of the insolent, and happy for the good. This is how theJain approach to environmental harmony works.

6.7.2.4 Environment and Sikhism

Nature was given divine traits by Guru Nanak, the founder of the Sikh religion. People should respect God's creations and understand the ultimate truth about their place in the cosmos, according to Sikhism. The human race is an inseparable part of nature, bound by inextricable ties to the rest of creation. God's glory is revealed in nature and the environment, according to the Guru Granth Sahib. Sikhs believe that the Almighty God created the universe. For the universe to continue, there must be a balance between all of nature's constituents. Any disturbance in the balance results in distress and calamity.

Many stories about the gurus' love and particular interaction with the natural environment, including animals, birds, flora, the land, rivers, mountains, and the sky, can be found in their history. As a result, Sikhism teaches that the natural environment and the survival of all living things are inextricably intertwined in nature's rhythm.

Many stories about the gurus' love and particular interaction with the natural environment - with animals, birds, flora, earth, rivers, mountains, and the sky - can be found in their history.

6.7.2.5 Environment and Christianity

According to Christianity, there is a harmonious triadic relationship between the divine and mankind, as well as between humans and nature, and failing to maintain this harmony may cause humanity to be alienated from its creator as well as from nature. "I am the Alpha andthe Omega, the first and the last, the beginning and the end," the Lord declared. As a result, He has a divine hand in every aspect of creation, and no human creature has the absolute authority to destroy it. "All human endeavour in the world must consequently lead to mutual enrichment of man and creatures," remarked Rev. Father Lanfranco Serrihi (Minister General, Order Friars Minor Conventual, Rome).

In his message to the United Nations Conference on Human Environment in Stockholm in 1972, Pope John Paul VI stated that the environment and resources belong to everyone: they are inalienable property of everyone, and there is no discretionary sovereignty over this universal prosperity exempting from responsibility towards humanity today and tomorrow. 12 This message from Pope John Paul VI makes it abundantly obvious that Christianity andthe environment are inextricably linked, and the emphasis is on sustainable development. As a result, the fundamental spirit of Christianity, which is to keep the environment in ideal shape, is heavily emphasised.

6.7.3 Environment and Indian Culture

India's cultural heritage has a strong commitment to environmental protection and preservation. The earth was regarded as 'Mother' in Indian culture. Lokamata describes rivers. India is a country steeped with rites and traditions. For the survival of life on Earth, Indians have defined the necessity to protect and enhance natural ecological balances through sacred incarnations and systematised rituals. Because almost all of the world's main religions are represented on Indian land, and their religions, in turn, recognised mankind's proximity to nature, they regulated mankind's behaviour in a way that was environmentally friendly.

Indian culture demonstrates an ecological shift toward peace. All aspects of nature

and humans are at peace, and there is harmony between them. The culture lessons were applied on two levels by the Indians. The first is at the level of society's relationship with nature, and the second is at the level of people inside society. Ecocultural socialisation was practised in Indian society. The second lesson was about sustainability and renewable energy. It is founded on the understanding that food comes from the forest, not from man-made towns; food comes from the fields, not from factories. As a result, _environmentalism' is an integral component of Indian culture.

6.8 ENVIRONMENTAL COMMUNICATION AND PUBLIC AWARENESS

The mass media is a medium that is frequently used to provide information to the general audience. It's also viewed as a technique for influencing public opinion on topics or organisations. The capacity to grasp the surrounding world, including all environmental changes, cause-and-effect linkages between environmental quality and human behaviour, and a sense of responsibility for maintaining them, is referred to as public awareness of the environment. Environmental education plays an important role in raising healthy consciousness and establishing a conducive atmosphere for the growth and preservation of human brains. Environmental education encompasses both formal and informal education and training that improves people's capacity to engage in environmental management and the resolution of environmental crises and issues. This might be accomplished through raising awareness and altering people's attitudes about the environment. We require awareness in our actions, as well as ethical principles, in order to maintain and conserve the environment and improve human life quality.

Citizens influencing political decision-making via action are known as public involvement. Demonstrations, protest gatherings, letters to the editor of publications and to politicians, as well as the distribution of information through flyers, newsletters, and the media, might be used to carry out this activity. Participating in consultation sessions with local governments and working groups formulating laws are examples. Finally, individuals might demonstrate actual instances of alternative behaviour and practises, such as recycling and low-impact agriculture approaches.In the

context of the environment, these activities are intended to influence public policy on issues such as water and air pollution, endangered species protection, and the negative consequences of natural resource extraction. These efforts may push politicians to consider public opinion, politicising environmental issues and eventually leading to the passage of laws and policies that reduce the negative environmental effects of growth. It can also compel firms and industries to adopt more environmentally friendly practises, such as reducing car emissions and industrial pollution.

Methods to create environmental awareness:

i) .In schools and colleges
ii) Through mass – media
iii) Non – government organizations
iv) Audio - Visual media
v) Voluntary organizations
vi) Traditional techniques
vii) Cinema
viii) Newspapers
ix) Arranging competitions

6.8.1 Compressed Natural Gas (CNG) Vehicles in Delhi:

In 1998, three years after a lawyer filed his complaint and as a direct result of it, the Supreme Court issued a Directive setting April 2001 as the deadline for replacing or converting all buses, three-wheelers, and taxis to compressed natural gas (CNG). In addition, the Directive mandated the construction of a 70-station CNG refuelling infrastructure as well as financial incentives for fleet conversions.The National Capital Region of Delhi established a Commission in January 1998 to investigate, produce, and publish a report on the city's air pollution problem. This Commission included CSE as a member.

The government was required by the Supreme Court in 1999 to implement the EUR II standard for gasoline engines by the year 2000 for all new automobile sales. The Court ordered sulphur levels below 30 ppm, as well as particle filters for diesel engines, in response to the diesel vehicle marketing. This reignited the debate about CNG. Cleaner diesel was now available, and the car industry and the Delhi government

argued against CNG using scientific evidence.

In reality, the government and the automobile industry were battling diesel's negative reputation. The question of equal rights between public transportation and private automobiles was also at risk. The government had traditionally preferred diesel as a fuel. It was subsidised at first, then taxed less than gasoline. Despite the Supreme Court's decision from 1998, the government nonetheless permitted 6,000 new diesel buses to enter service in 2000. By April 2001, the initial date, nothing had been accomplished in fulfilling the Supreme Court Directive of 1998.

The automobile industry was opposed to CNG, primarily because any local legislation would threaten worldwide mass manufacturing. It continues to fight for the Supreme Court order to be repealed. Finally, in April 2002, the Supreme Court issued a direction imposing a penalty on the government for wasting the court's time, as well as a daily penalty of 1,000 Rupee per day (about 20 US$) for each diesel bus still in use. One of the projects was to switch to compressed natural gas for public transportation, which has been in use in Delhi since April 2001.Compressed Natural Gas was found in roughly 2200 buses, 25,000 three-wheelers, 6000 taxis, and 10,000 automobiles in Delhi. More than half of the cars, however, have notyet been converted to compressed natural gas.

According to a study conducted by the World Wide Fund for Nature (WWF) and E3G, the government earned recognition for drafting one of the top 12 best policies in the world once it began preparing a comprehensive action plan by passing the necessary legislation and establishing the infrastructure required for such a transition.

Due to a lack of cooperation from other government agencies in Delhi, the Indian Supreme Court's decision to switch to CNG was difficult to implement and took considerably longer than it should have. But, in the end, all diesel buses were phased out, and air quality improved. However, daily ambient air quality statistics from Delhi's busiest crossing fromJune 1999 to September 2003 show no overall increase in ambient quality due to point sources of pollution that contribute to SO_2 and mobile sources that contribute to NO_2 concentrations. After the conversion, NO_2 levels increased, but SPM and PM-10 levels decreased very little; CO levels decreased significantly.

CHECK YOUR PROGRESS

Ques. 1 Answer the following Short Answer Questions:

i. The..... movement, which was started to safeguard Himalayan forests fromdestruction before independence, has its origins in the pre-independence era.

ii. An earthquake is a sudden ground disturbance caused by the abrupt displacement of ……, generally in the top .....km of the earth's crust.

iii. State whether the statement is true or false. Give the correct answer in case of a wrongstatement

The Ministry of Youth Welfare and Sports supports the development and stabilisation of SelfHelp Groups (SHGs) as well as awareness campaigns among rural and urban women.

iv. Match the following Richter Scales (Column A) with the severity of the Earthquakes (Column B)

Richter Scales (Column A)	**Severity of the Earthquakes (Column B)**
More than 8	Insignificant
5 - 5.9	Great
Less than 4	Destructive
6 - 6.9	Damaging

v. The major Women Welfare programmes introduced in India are:

a. Development of women and children in Rural Areas (DWCRA):
b. Child Development Services Scheme (CDS)
c. Swaranjayanti Rozgar Yojna (SRY)
d. All of the above

6.9 SUMMARY

In this unit, effort had been made to understand the concept of human population and the impact of its growth on the environment. It has been observed that:

- Our planet's ability to support population expansion is far outstripping its ability to support it. Overcrowding, deforestation, and water pollution, as well as eutrophicationand global warming, are all linked to overpopulation.

- To promote the objective of sanitation and hygiene in India, the government of India launched the Swachh Bharat Mission on October 2, 2014 with an objective of making India Open defecation Free by October 2, 2019.
    - The development of various river valley projects has caused a large scale displacement of various people from their ancestral homes and other socio-economic consequences.
    - Similarly development of Mining sites and creation of National Parks also inhibit the prospects of the tribal people to dwell in areas which are otherwise considered important from the point of view of protection of natural resources.
    - The major natural disasters like earthquakes, floods, cyclones, landslide, etc potentially cause damage to the human population as well as the Environment and so appropriate Disaster Management strategies ought to be applied so as to mitigate the damage caused by them.
    - Historically, various environmental and ecological movements had been carried out to promote the cause of environmental protection and conservation. Chipko movementand Silent Valley were some of the popular movements that aided the objective.
    - Apart from the effect of ecological movements on environmental protection, various religions and cultures like the Indian culture have had a significant impact on environment protection.
    - Various religions like Hinduism, Sikhism, Buddhism, Jainism and Christianity have always upheld the objective of environment protection in relation to the use of resources for community development.
    - Conclusively, it has been realized that it is indeed very important to spread more awareness about the environment.
    - Educating people and masses about the need to protect and conserve the environment is becoming increasingly important, especially in the wake of increasing incidence of accidents and disasters that harm the environment as well as the human communities.

6.10 QUESTIONS FOR PRATICE

Ques. 1 Highlight the main issues and concerns of the Environment Movements in India?

Ques. 2 How far have the religions and cultures contributed positively in protecting the Environment?

Ques. 3 Highlight the extent of displacement caused to the tribal communities in an attempt to develop resources for development of the country. Mention two important case studies to support your answer.

Ques. 4 In your opinion, how are the environmental and ecological rights related to democracy and development in India? Explain.

Ques. 5 Using reference from the case of CNG vehicles in Delhi, discuss how and why is the need for environmental education and public awareness so critical to the objective of environmental protection in India?

6.11 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses,2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad

COURSE: ENVIRONMENTAL STUDIES

UNIT – 7: ROAD SAFETY AWARENESS

STRUCTURE

7.0 LEARNING OUTCOMES

After the study of this unit, the learners will be able to:

- Understand the meaning and importance of the concept of Road safety
- Identify the important signs that are used on roads
- Develop a proper understanding of the significance of the traffic signs
- Acquire knowledge about the various traffic rules that ought to be followed on theroad, to ensure safety
- Know about the various types of Traffic offences and penalties that are attached to theviolation of various traffic rules
- Gather an insight on the procedure that has to be followed to obtain a licence
- Understand the critical importance and role of First aid in the field of Road Safety

7.1 INTRODUCTION

When it comes to the amount of traffic accidents, India ranks the highest. However, there has been progress in this area in recent years. The traffic conditions are under a lot of strain due to the significant increase in the number of vehicles on the road. As a result, one of the mostsevere public health challenges in our country is road safety. It affects everyone, whether they drive a car, walk, or ride a bicycle.

Road safety is a multi-faceted and multi-sectoral problem. It encompasses road infrastructure construction and management, the provision of safer cars, legislation and law enforcement, mobility planning, health and hospital services, child safety, and urban land use planning, among other things. In other worlds, its scope includes road and vehicle engineering on the one hand, and health and hospital services for trauma cases (in a post-crash scenario) on the other. The government and a variety of civil society stakeholders share a multi-dimensional responsibility for road safety.

In order for road safety initiatives to be successful in all nations, they must have widespread support and coordinated effort from all stakeholders. The United Nations General Assembly has designated 2011-2020 as the Decade of Action for Road Safety, with an aim of halvingroad accident mortality by half over that time period, acknowledging the devastating impact of road accidents on global health. Every year, over 1.2 million people die and 50 million are injured in traffic accidents around the world, costing the global economy 1.2 trillion dollars. Road traffic injuries are anticipated to become the fifth biggest cause of mortality in the world by 2030, according to the World Health Organization, unless coordinated action is taken.

7.2 CONCEPT AND SIGNIFICANCE OF ROAD SAFETY

Road safety means to safely drive on road to ensure that there is no harm or the driver of the vehicle does not cause any harm to any other vehicle moving nearby it. In other words we can say that road safety means to reduce accident causes on the road for proper driving.

Imparting Road Safety Education to Road users specially the vulnerable ones is a high priority area. Prosecuting the errant and undisciplined road users through focused

and concentrated enforcement action and improving the standard of safety on roads remains our priority. To familiarise the people how to remain safe on roads and to respect the rights of others, a small guide to road safety has been compiled for the benefit of the road users, suchas the car drivers, the commercial vehicle drivers, the two wheeler riders, the pedestrians etc.

It contains useful information on road safety, which teaches the citizens the safe and secureuse of roads.

In the ancient times, there was no transport system. With the passage of time human beings tamed animals and used them as mode of transportation. Invention of wheel marked the turning point in human civilization. Carriages that could carry three -four passengers, driven by animals, came into usage. In the 16th century invention of automatic mechanism and vehicles helped people travel from one place to another faster. The world‘s first car was invented in 1769 by Nicholas Joseph Cugnot. After that, there was no turning back, vehicles of different shapes and sizes began to be developed and introduced. All this brought with them a new threat to human life i.e. roadside accident. Ways and means were introduced for safety and smoothness of traffic on roads. Several rules were introduced to make the road safe and reduce the number of accidents. Even Manusmriti and Kautilya‗s Arthashastra contains road rules and regulations in great detail.

The rules have been modified from time to time, keeping in view the local needs and requirements .New regulations have been laid down for different categories of road users.

As wheel got invented in the Mesopotamian Civilization, our own civilization was set to motion, for it wheeled our imagination. In 1645 a sort of cycle was invented by Jean Theson but it had no brakes, pedal for steering and needed feet motion. Laufmachine cycle was then created by Karl Von (1817). Soon this was made into the regal Dandy Horse by Dennis Johnson. In 1839 the proper cycle was shaped by K. Macmillan. It had iron wheels and wooden frame. The manifestation of automobile horse-power was taught in 1769 by Nicolas Joseph Cugnot, who invented the first 'Steam Truck' which the French army thought was useful.

Then after, automobiles enveloped our life and culture. But the notion called –accident‖ endangered our future. The first accident of the Steam Truck in 1771 was the eye opener. During 1899 the first fatal accident took place with the death of a driver. Then onward, the world coined several road safety measures. Still today, 12 lakh people are killed and 50 millions get seriously injured all over the world every year. This accident menace makes our citizens an endangered species of the future. So we msut follow the road safety culture and be cautious about traffic rules. Today‘s informed child can only ensure a safe future.

India has the second largest road network in the world with over 3 million km of roads of which 60% are paved. These roads make a vital contribution to the India‘s economy. On the whole the facilities for the road users are not up to the mark leading to a high toll of deathvictims.

7.2.1 Brief History

7.2.1.1 The First Accident: In 1771 the first accident involving a motor vehicle took place in Paris when Cugnot‘s steam tractor hit a low wall in the grounds of the Paris arsenal.

7.2.1.2 The First Act: The Locomotive and Highway Act was the first piece of British motoring legislation. This was also known as the Red flag act of 1865 .The act required three persons in one attendance, one to steer, one to stock and one to walk 60 yards ahead with a Red flag to warn the oncoming traffic.

7.2.1.3 First man to be challenged: In 1895, John Henry Knight was convicted and fined for using a motor tricycle on the highway. He was probably the first motorist to appear in court.

7.2.1.4 First fatal car accident: The first motor car accident in Britain resulting in the death of the driver occurred in Grive Hill, Harrow-on-the Hill, London on 25th February 1899.

7.2.1.5 Dusty Road to Tar surface: In 1902 Tar was first used on a macadam surface to prevent dust in Monte Carlo. It was the idea of Dr. Guglieminetti, a Swiss. At first Tar was brushed on cold, but soon it was applied hot.

7.2.1.6 The First number plate of London: The Motor car Act of Britain came into force on1st January 1904. It required that all cars be registered and carry a number plate, and all motorists to have a driving licence. But there was no driving test to pass and the licence was obtained by filling up a form and paying the fee at a post office. The act made dangerous driving an indictable offence.

7.2.1.7 The First petrol pump: The first petrol pump was installed in USA in 1906.

7.2.1.8 The First traffic light of the world: The world's first traffic lights were installed in Detroit, USA in 1919. The first traffic lights in Britain were installed in Wolverhampton during 1928. However they did not come to London till 1932.

7.2.1.9 Pedestrian crossing: the pedestrian crossing was instituted in Britain in 1934. The roads were marked by dotted lines.On the pavements there were striped Belisha beacon light polls named after Britain's minister of transport L.Hore-Belisha .The zebra crossing with black and white stripes was developed after the Second World War.

7.2.1.10 First Traffic police woman: Police women were employed for traffic control duties for the first time in Paris, in 1964. In Delhi we introduced women traffic police in 1989.

7.2.1.11 First box junction: Box junctions, marked with yellow cross-hatching were introduced in London during 1964. The aim was to prevent traffic blocking junctions when it could not proceed and this was successful.

7.2.2 Basic Principles of Road Side Safety

7.2.2.1 Respect traffic rules/regulations and signs/symbols: As a road user our act should be governed by an inborn, will to be safe and let others be safe on roads. This would comeonly when we respect the traffic rules and regulations. We must lookout for road signs and symbols and follow them.

7.2.2.2 Maintain cool even when in adverse situations: We might be burdened with an unending number of problems at the home or office, but we must keep them aside before we venture on the roads. It is important to keep ourselves fresh and cool.

7.2.2.3 Care and concern for others: We must keep in mind that we are not the sole

ownerof roads and others have similar rights on it. It should be remembered that road is not a placeto show anger. Prevention of accidents should be a major concern of road users.

7.2.2.4 We must be prepared for or any kind of eventuality: The drivers and pedestrians may behave in an unpredictable manner. As a road user we should judge the situation correctly and act accordingly.

7.2.3 Need for Road Safety

Modern metropolitan living is getting more and more associated with traffic hazards. This can be attributed to complex and complicated road structures as well as increasing human and vehicular population. Enhanced life style and increase in the number of privately owned vehicles especially two wheelers have made traveling on roads the most dangerous tasks to be undertaken. Globalisation, free market economy and free trade policies have had a direct impact on the increase of automobiles on roads, which in turn have led to vehicular congestion. Though the number of vehicles increased, the length and breadth of roads remain static. The only way left with the authorities to cope up with the problem was to make improvisation on the already existing structures. All such hi-tech construction works involved engineering scale of a higher order and traversing on them requires driving skills of the higher border, which only a few road users have.Though this has eased congestion, chances of accidents have increased, and in maximum cases, accidents occurred because of human folly. Free flow of traffic has resulted in increase in speed of vehicles, which in turn has resulted in maximum number of accidents on flyovers because of driver‘s inability or incompetence to manipulate the speed properly. Most of the drivers lack intuitive judgement and defensive driving skills, the necessary qualities that a driver must possess.

Most of the road users are unaware of road realities and are ignorant about road signs and markings. They have the least hint of things to come by the way they behave. Some such callous behaviour includes improper parking, improper maintenance of vehicle which results in both air and noise pollution causing inconvenience to others, over speeding, rash driving, crossing the road at wrong places ,and many more. Any one such act on the part of any one road user may be the cause of chaos and confusion on roads.

And most of the people are either blind or inconsiderate about this and do things according to their whims. In face of all these, road safety education has become an essential aspect of road management. Making people aware of the road situations and giving them precautionary tips would be of great helpto redeem the situation.

An ideal road safety education program should be able to:

1. Inculcate a sense of road discipline in the mind of every road user
2. Develop a wilful respect for road rules
3. Help a road user tide over any adverse situation on roads
4. Instil in the minds of road users a sense of fellow feeling.

7.2.4 Specific Road Awareness Programmes

Specific Road awareness programs can be undertaken regarding:

1. Knowledge of road rules
2. An understanding of why road rules are broken and why doing so is dangerous
3. Enrolling students in Road Safety Patrol so that they get a feel of the road and itsrules.

7.2.5 Correct Road Attitude Programmes

An understanding that orderliness on roads has nothing to do with low traffic density (many notions like Japan have high density of traffic yet road rules are crupulously followed). It is important and worthwhile to wait for your turn, on the roads. Rules have to be followed in letter and spirit. Road users have to understand the value of _Live and Let Live' rather than _Live and Let Die'!

The art of time management is vital while taking to the roads. Much of the stress is due to having insufficient time to reach the intended destination, which is compounded by the confusion on the roads.

7.2.6 Programmes for Creating Integrated Minds and Sound Value Systems

Specific programs to develop self awareness, self confidence, collective consciousnes, critical reasoning, distinguishing right from wrong, a sound value system that steers clear of superficial material values and false sense of worth must

be evolved. Through curricular and co-curricular activities, efforts should be made to inculcate a strong moraland ethical base, a sense of social responsibility, a belief that individual goals are not different from social goals and deep rooted social sensitivity.

7.3 TRAFFIC SIGNS

Traffic signs are very helpful, as they give important information. The proper knowledge of road signs is essential to avoid the risk of accidents. Road signs , markings,traffic signals and other traffic devices are there to guide the road users and hence are the languages of the road. Every road user whether a pedestrian, two wheeler rider, driver of four wheeled vehicle should have knowledge regarding these traffic controlling devices and should be aware of what they signify. Traffic signs are there to regulate traffic, warn about hazards and to guide the road user.

There are three types of traffic signs:

i. **Mandatory:** Mandatory road signs are the ones that give order regarding do's anddon'ts and are to be followed strictly.

ii. **Cautionary:** Cautionary road signs are the ones that warn the road users regarding theroad situation ahead. Cautionary signs are generally in triangular shape.

iii. **Informatory:** Informatory road signs are the ones that give information regardingdirections, destinations etc. Informatory signs are generally rectangular in shape.

7.3.1 Mandatory Signs

1. Straight Prohibited or No Entry

These signs are located at places where the vehicles are not allowed to enter. It is generally erected at the end of one way road to prohibit traffic entering the Roadway in the wrong direction and also to each intersection along the one way road.

2. One Way Sign

These signs are located at the entry to the one-way street and repeated at intermediate intersections on that street.

3. Vehicles Prohibited In Both Directions:

This sign is used at the approach and off the roads where entry to all types of vehicular trafficis prohibited, especially in areas which have been designed as pedestrian malls.

4. Horn Prohibited:

This sign is used on stretches of the road where sounding of horn is not allowed, near hospitals and in silence zones.

5. Pedestrian Prohibited:

This sign is erected on each entry to the road where pedestrians are to be prohibited.

6. Cycle Prohibited:

This sign is erected on each entry to the road where cycles are to be prohibited.

7. U-Turn Prohibited:

This sign is used at places where vehicles are forbidden to make a turn to the reverse directionof travel between the sign and the next intersection beyond it.

8. Overtaking Prohibited:

This sign is erected at the beginning of such sections of highways where sight distance is restricted and overtaking will be dangerous.

9. Right/Left Turn Prohibited:

These signs are used at places where vehicles are not allowed to make a turn to the right orleft. The signs are also used at the intersection of one- way street to supplement the one -way sign.

10. All Motor Vehicles Prohibited:

This sign is used at places where entry to all types of motor vehicles is prohibited.

11. Trucks Prohibited:

This sign is used at the entrance to the road where movement of trucks is prohibited.

12. Hand Cart Prohibited:

This sign is erected on each entry to the road where hand carts are to be prohibited.

13. Bullock Cart Prohibited:

This sign is erected on each entry to the road where bullock carts are to be prohibited.

14. Tonga Prohibited:

This sign is erected on each entry to the road where tongas are to be prohibited.

15. No Parking:

This sign is erected where parking is not allowed but vehicles can stop for short duration to allow passengers to get into or get out of the vehicle. The sign should be accompanied by suitable kerb or carriageway markings.

16. No Parking Or Standing:

This sign is erected where vehicles are prohibited to stop even temporarily.

17. Speed Limit:

This sign is erected at the beginning of the section of the road or area covered by a speedrestriction, with numerals indicating the speed limit in km per hour.

18. Width Limit:

This sign it is used where entry of vehicles exceeding a particular width is prohibited.

19. Height Limit:

This sign is erected in advance of an overhead structure where entry is prohibited for vehicleswhose height exceeds a certain limit.

20. Length Limit:

This sign it is used where entry of vehicles exceeding a particular length is prohibited.

21. Load Limit:

This sign is used where entry of vehicles is prohibited for vehicles whose laden weight exceeds a certain limit.

22. Axle Limit:

This sign is used where entry of vehicles is prohibited for vehicles whose axle load exceeds a certain limit.

23. Stop Sign :

This sign is used on roadways where traffic is required to stop before entering a major Road. The vehicle shall proceed past the stop line only after ascertaining that this will not cause any damage to traffic on the main road.

24. Give Way Sign:

This sign is used to assign right -of- way to Traffic on certain roadways and intersections, the intention being that the vehicles controlled by the sign must give way to the other traffichaving the right-of-way.

25. Restriction Ends Sign:

This sign indicates the point at which all prohibitions notified by prohibitory signs for moving of vehicles cease to apply.

26. Compulsory Turn Left/Right:

These signs indicate the appropriate direction in which the vehicles are permitted to proceed Compulsory Ahead Or Turn Left /Right :

These signs indicate the appropriate directions in which the vehicles are permitted to proceed. Vehicles are supposed to move either of the given to directions.

27. Compulsory Ahead:

This sign indicates that the vehicle is only permitted to proceed ahead.

28. Compulsory Keep Left:

This sign is most frequently used on Islands and refuges in the middle of the carriageway and at the beginning of Central reserves of dual carriageway. The vehicles are allowed to keep left only.

29. Compulsory Cycle Rickshaw Track:

This sign means only cycles and rickshaws are allowed on this road/ carriageway.

30. Compulsory Sound Horn :

This sign means the motor vehicles shall compulsorily sound horn at the location where thesign is placed. This sign is mostly put at sharp curves on hill roads.

31. Slip Road Ahead:

This sign means the vehicles can either go straight or turn left.

32. Main Road Ahead:

This sign means the vehicles can either go straight or turn right.

33. Pedestrians Only:

This sign means only pedestrians are allowed and traffic is not allowed on this road /carriageway.

34. Buses Only :

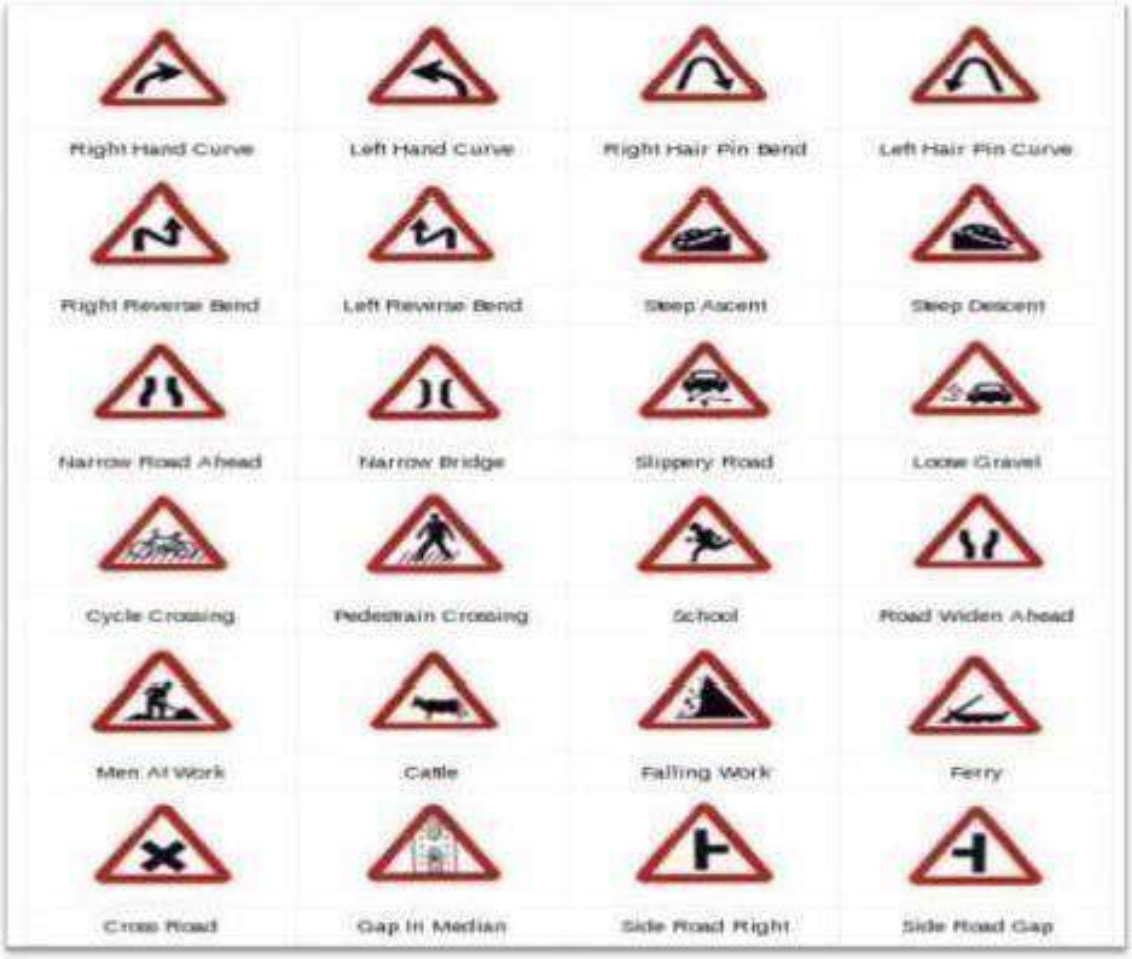
This sign means that only buses are allowed and the traffic is not allowed on this road/carriageway.

7.3.2 Cautionary Signs

1. Right/Left Hand Curve: This sign is used where the direction of alignment changes. The sign forewarns the driver to reduce the speed and proceed cautiously along the road.

2. Right /Left Hair Pin Bend: This sign is used where the change in direction is so considerable that it amounts to reversal of action. The symbol bends to right or left

depending upon the road alignment.



3. Narrow Bridge: This sign is erected on roads in advance of bridges where the clear widthbetween the kerbs or wheel guards is less than normal width of carriageway.

4. Gap in Median: This gap is installed ahead of a gap in the median of a divided carriageway other than an intersection.

5. Narrow Road: This sign is normally found in rural areas where a sudden reduction inwidth of pavement causes a danger to traffic.

6. Road Widens: This sign is normally found in rural areas where a sudden widening of roadcauses a danger to traffic such as, a two-lane road suddenly widening to a dual carriageway.

7. Cycle Crossing: This sign is erected in advance of all uncontrolled cycle crossings.

8. Pedestrian Crossing: This sign is erected in advance of both approaches to uncontrolledpedestrian crossings.

9. School: This sign is elected where school buildings or grounds are adjacent to

the roadwhere the traffic creates a hazard to children.

10. Men at Work: This sign is displayed only when men and machines are working on the road or adjacent to it or on overhead lines or poles. This sign is removed when the work is completed.

11. Side Road Left /Right: This sign is displayed in advance of the side road intersections where a large volume of entering traffic together with restricted site distance is likely to constitute a hazard. The driver is warned of the existence of a junction.

12. Major Road: These signs are displayed in advance of crossing with the major road, where a sufficiently large volume of traffic together with the restricted sight is likely to causea hazard.

13. Y-Intersection: These signs are displayed on the approach to a bifurcation of any road. This sign warns of the existence of a junction and no other indication is given.

14. T-Intersection: This sign is displayed in advance of T- junctions where the nature of intersection is not obviousof approaching traffic. This sign is used to warn the driver of the existence of a junction.

15. Roundabout: This sign is used where it is necessary to indicate the approach to a roundabout.

16. Start of Dual Carriageway: This sign is displayed when a single carriageway ends into a dual carriageway.

17. End of Dual Carriageway: This sign is displayed when a dual carriageway is ending and a single carriageway is starting.

i. Reduced Carriageway: These signs caution the driver of the reduction in the width of the carriage way ahead. This is displayed on undivided carriageway as when some portion of the carriage way is closed or reduced for repair.

ii. Two Way Operation: This sign is used to caution the driver of a changed pattern of traffic operation of the carriageway expected to carry traffic in one direction only.

iii. Cross Road: This sign is displayed in advance of the cross road where a sufficiently large volume of crossing or entering traffic with restricted sight distance is likely to constitute a hazard.

18. Public Telephone: This sign is displayed on long stretches of road in rural areas

indicating the distance to the nearest public telephone on supplementary plate, where it is in inconspicuous position.

19. Filling Station: This sign is displayed on long stretches of roads in rural areas at the entry to the road leading to the facility.

20. Hospital: This sign is used to notify drivers of vehicles that they should take the precautions required near medical establishments and in particular that they should not make any unnecessary noise.

21. First Aid Post: This sign is used to notify drivers on long stretches of roads in rural areas of the first aid facility which may be helpful in case of emergency.

22. Eating Place: This sign is used to indicate where a regular eating place is located.

23. Resting Place: This sign is used to indicate where facilities for resting and lodging are available. It is normally combined with a separate definition plate, indicating whether the place is a Rest House, Motel, and Hotel etc.

24. Airport: This sign is installed where the Airport is situated nearby.

25. Repair Facility: This sign is installed at the places where repair facility is situated.

26. Police Station: This sign is installed at the places where the Police Station is situatednearby.

27. Railway Station: This sign is installed at the places where the Railway Station is situatednearby.

28. Bus Stop: This sign is installed at the places where buses are designated to stop.

29. Taxi Stand: This sign is installed at the places where the taxis are expected to wait whennot hired.

30. Cycle Rickshaw Stand: This sign is installed at the places where cycle-rickshaws are towait.

31. No Thorough Road: This sign is used at the entrance to a road from where there is noexit.

7.3.3 Traffic Lights

The traffic signal passes information using a universal colour code.

i. Red- To stop the traffic

Bring your vehicle to a complete halt behind the stop line cross walk. Wait until the light turns green.

ii. Amber-Caution

If you have entered the intersection and the light turn to amber, move on very carefully. Ifyou see the amber light before entering the crossing, stop the vehicle behind the stop line or cross walk.

iii. Green-Go on

Go through the crossing carefully. You can turn in the direction of the arrow by giving an indicator.

7.3.4 Flashing Signal

A flashing red signal is provided at level crossing, airfield, fire stations, minor roads, bridgesetc. It means you must come to a full stop and proceed cautiously after making a safety check on all approaching traffic.

A flashing yellow light is provided where major road meets minor roads. You must slow down and proceed with caution, giving due attention to other traffic and pedestrians.

7.3.5 Pedestrian Signals

These signals help pedestrians cross intersection safely. If we face a steady red human figure, we should not enter the road. If the signal starts flashing, we can cross the road quickly. If we are already on the road, we should stop if we are about to join the road. We must walk ahead cautiously if we face a steady green human figure.

7.4 TRAFFIC RULES

Various traffic rules have been put in force to reduce the incidents of accidents. The general road safety rules are discussed as below:

7.4.1 Negotiating an Intersection Judiciously

- Almost 50% of all city driving collisions occur at intersections.
- We must choose the left lane if we want to turn left, the middle lane if we want to gostraight, and the right lane if turning right, at least 100 metres in advance.
- We must give proper indication before we turn.
- While approaching an unmanned intersection, we must cover the brake and be prepared to stop.
- We should slowdown while approaching an intersection.
- Stopping before stop line at red light is advisable.

- Even if the signal allows us to go, we must proceed slowly and cautiously

7.4.2 Negotiating a Round About

- Choose your lane as per your exit, at least 100m in advance.
- Slow down while approaching a roundabout.
- Enter the roundabout at an angle.
- Give way to Traffic on your right.
- Merge slowly with the traffic inside the roundabout.
- Move towards your exit gradually giving proper indications.
- Be watchful of a pedestrian or an animal that may suddenly appear.

7.4.3 While Overtaking

- Never overtake from left, always overtake from right.
- Show your intentions of over taking clearly to your fellow drivers.
- Give proper indications, before overtaking.
- Be watchful of a pedestrian or an animal that may suddenly appearin front of thevehicle you are overtaking.
- On roads having two- way traffic, overtake only when the oncoming vehicle is at asafe distance.

7.4.4 While Turning

- Give proper indications.
- Start changing lane only when the vehicles behind you have understood your intentions.
- Turn only when the vehicle coming from the opposite direction is at safe distance.
- The vehicle coming from the opposite direction has the right of way.
- Watch out for pedestrians as well as vehicles coming from your right side.
- Slow down while approaching the turning point.

7.4.5 Right of Way

- The children and the disabled have the right of way.
- Pedestrians have the first right of way at unmanned intersections.
- At an unmanned intersection traffic on your right has the right of way.
- At a roundabout, pick on your right has the right of way.
- Traffic on major Road has the right of way.
- On hilly and steep roads vehicles going uphill have the right of way.

- Emergency vehicles like fire brigade, ambulance, police have the right of way.
- These vehicles, during emergency, can jump a red light, drive in non entry areas or onwrong side.
- These vehicles should be given priority and clear passage.

7.4.6 Keep Left:

The driver of a motor vehicle shall drive the vehicle as close as to the left hand side of the road as may be expedient and shall allow all the traffic which is proceeding in the direction to pass on his right hand side.

7.4.7 Turning To Left and Right:

Whether you are going to make a left or right turn, you should be in the correct lane well before reaching the intersection. You should be in the lane closest to the direction in whichyou are going to turn. Never turn from the wrong lane across another lane of traffic. This unexpected move can be dangerous.

7.4.8 Passing To The Right:

The driver of a motor vehicle shall pass to the right of all traffic proceeding in the same direction as himself.

7.4.9 Passing To The Left:

The driver of a motor vehicle may pass to the left of a vehicle, the driver of which having inducted an intention to turn to the right has drawn to the centre to the road and may pass on either side.

7.4.10 Overtaking Prohibited In Certain Cases :

The driver of a motor vehicle shall not pass a vehicle traveling in the same direction as himself.

7.4.11 Overtaking Not To Be Obstructed:

The driver of a motor vehicle shall not, when being overtaken or being passed by another vehicle, increase speed or do anything in any way to prevent the other vehicle from passing him.

7.4.12 Caution Road Junction:

The driver of motor vehicle shall slow down when approaching such intersection, junction at which traffic is not being regulated, if the road entered is a main road designated as such, give way to the vehicles proceeding along the road, and in any other case give way to all traffic approaching intersection on his right hand.

7.4.13 Giving Way to Traffic At Road Junction:

The driver of a motor vehicle shall, on entering a road intersection, at which traffic is notbeing regulated, if the road entered is a main road designated as such, give way to the vehicles proceeding along that road, and in any other case give way to all traffic approaching the intersection on his right hand.

7.4.14 Fire Service Vehicles and Ambulance to Be Given Free Passage:

Every driver shall on the approach of a fire service vehicle or of an ambulance allow free passage by drawing to the side of the road.

7.4.15 Right to Way:

The pedestrians have the right of way a at uncontrolled pedestrian crossings. When any road is provided with footpath or cycle tracks specially for other traffic, except with permission ofa police officer in uniform, a driver shall not drive as such on footpath or track.

7.4.16 Taking "U" Turn:

No driver shall take a ‒U‖ turn where ‒U‖ turn is specially prohibited and on busy traffic road. If a ‒U‖ turn is allowed, the driver shall show signal by hand as for a right turn, watchin the rear view when safe to do so.

7.4.17 Parking of the Vehicles:

Every driver of a motor vehicle parking on any road shall park in such a way that it does not cause or is not likely to cause danger, obstruction or undue inconvenience to other road users and if the manner of parking is indicated by any sign board or markings on the roadside, he shall park his vehicle in such manner.

7.4.18 One Way Traffic:

A driver shall not drive a motor vehicle on the roads declared _ONE WAY' except in the direction specified by sign boards. Drive a vehicle in a reverse direction into a road designated _ONE WAY'.

7.4.19 Driving On Channelized Roads (Lane Traffic)

Where any load is marked by lanes for movement of traffic, the driver of a motor vehicle shall drive within the lane and change the lane only after giving proper signal.

7.4.20 Stop Sign on Road Surface:

When any line is painted on or inlaid in to the surface of any road at the approach to the road junction or to a pedestrian crossing or otherwise, no driver shall drive a motor vehicle so thatany part of thereof projects beyond that line at any time when a signal

to stop is being given by a police officer or by means of traffic control light or by display of any traffic sign.

7.4.21 Towing:

No vehicle other than a mechanically disabled motor vehicle or incompletely assessed motor vehicle, a registered trailer for a sidecar, shall be drawn or towed by any other motor vehicle, except for the purpose of delivery and to the nearest filling station or garage.

7.4.22 Use of Horns and Silence Zones:

A driver of a vehicle shall not:

1. Sound a horn needlessly or continuously or more than necessary to ensure safety.
2. Sound the horn in silence zones.

7.4.23 Traffic Sign and Traffic Police:

A driver of a vehicle and every other person using the road shall obey every direction given whether by signal or otherwise a police officer, or by notice, Traffic sign or signal fixed or operated.

7.4.24 Distance from Vehicles in Front:

A driver of a motor vehicle moving behind another vehicle shall keep at a sufficient distance from that other vehicle to avoid collision if the vehicle in front should suddenly slow down or stop.

7.4.25 Abrupt Brake:

No driver of a vehicle shall apply break abruptly unless it is necessary to do so for safety reasons.

7.4.26 Vehicles Going Uphill To Be Given Precedence:

On mountain roads and steep roads, the driver of a motor vehicle traveling down hill shall give precedence to vehicle going uphill wherever the road is not sufficiently wide to allow the vehicle to pass each other freely without danger, and stop the vehicle to the side of the road in order to allow any vehicle proceed in uphill to pass.

7.4.27 Obstruction of Driver:

A driver of a motor vehicle shall not allow any person to stand or anything to be placed in such manner or position as to hamper his control of the vehicle.

7.4.28 Speed To Be Restricted:

The driver of a motor vehicle shall, when passing or meeting procession or a body of

troops or police on the march or when passing workmen engaged on road repairs, drive at a speednot exceeding 25 kilometre an hour.

Speed is a relative term. You must aim at a a good average speed of travel.Over speeding with reference to a driver control, circumstances and violation of law is dangerous. Speeding with negligence is the direct cause of most road accidents leading to injury and death. Driving at a high speed does not give you sufficient reaction time to observe hazards. Other Road users too, get less time to react. The higher the speed, the greater the stopping distance and larger the chances of an accident. So make sure and drive within the stipulated speed limits. However, speed limit does not mean that it is safe to drive at that speed.

7.4.29 Always drive keeping the following conditions in mind:

- Condition of the road
- Traffic
- Weather and vision
- Type of vehicle
- Restricted areas
- Your own skills and concentration

7.4. 30 Driving Of Tractors and Goods Vehicles:

A driver when driving a tractor shall not carry or allow any person to be carried on tractor. A driver of goods carriage shall not carry more numbers of persons than that is mentioned in the registration certificate and shall not carry passengers for fare.

7.4.31 Projection of loads:

No person shall drive in any public place any motor vehicle which is loaded in a manner likely to cause danger to any person in such a manner that the load or any part thereof of anything extends laterally beyond the body or to the rear or in height beyond the permissible limit.

7.4.32 Restriction to Carriage Of Dangerous Substances:

Except for the fuel and lubricants necessary for the use of the vehicle, no explosive highly inflammable or otherwise dangerous substance, shall be carried on any public service vehicle.

7.4.33 Restriction on Driving Backwards:

No driver of a motor vehicle shall cause the vehicle to be driven backward without first

satisfying himself that he will not hereby cause danger or undue inconvenience to any person or in any circumstances, of any greater distance or period of time than maybe reasonably necessary in order to turn the vehicle round.

7.4.34 Production of Documents:

A person driving a vehicle shall always carry with him his driving licence, certificate of restoration, certificates of taxation and certificate of insurance of the vehicle and in case of transport vehicle the permit and fitness certificate, also, shall on demand by police officer in uniform or any officer of the Motor Vehicles Department in uniform or any other officer authorised by the government, produce the document for inspection.

7.4.35 Driving in dangerous conditions:

Driving at Night

- Be alert: pedestrians, bicycles, animals and hand drawn vehicles that travel withoutlight are difficult to see.
- Drive at a slow speed to get a safe reaction and stoppage time.
- Turn on the headlights when darkness falls.
- Drive with dipped headlights in places where the roads are amply lit.
- Keep your windscreen clean because dirty windscreen can impair your vision.
- The headlights clear and clean and check them frequently. Also carry spare bulbs.
- Avoid looking to the dazzling light if an oncoming vehicle is driving in high beam andgradually slow down your speed.
- To reduce the glare of lights following you, switch your interior rear view mirror tothe night position or slightly tilt it or tilt the exterior rear view mirrors.
- Before overtaking ensure that the oncoming vehicle is at a safe distance.

Driving in rain

- Check the working of wipers, windscreen washing fluid system, all vehicle lights, tyres, exhaust pipe.
- Be careful and reduce your speed as people may run across the roads in panic.
- Keep slow or away from water logged areas as water may enter the carburetor, ignition, muffler or distributor causing the vehicle to stop.
- Be considerate of other road users, avoid splashing of water.
- On slippery roads drive carefully and slowly.In case the vehicle slips,stop acceleration and press the clutch, hold the steering in a straight position

and do not break. Wait till you regain the grip.

Driving in foggy conditions

- Drive slow but not so slow that it becomes a hazard to others.
- Distances are hard to judge and low visibility decreases your reaction time.
- Give yourself extra time to respond to any road hazards.
- Do not hit your breaks in panic, you may get hit from the back.
- Turn on your wipers and defroster and turn off the music.
- Drive with dipped headlights, high beams produce too much glare in fog.
- Use the central verge of the road to guide you.
- Never attempt overtaking.
- Honk your horns periodically to let other drivers know you are there.

Don‟t Drive When Drunk

- Alcohol slows down the mental process.
- It increases confidence but decreases performance.
- It affects brains ability to control and coordinate body movements.
- It slows down the reflex and hence the reaction time increases.
- It impairs vision and hearing.
- It impairs the ability to judge speed and distance.

Seatbelt Saves

- Seat belt saves life and reduces the severity of injuries.
- With belt tied around, become a part of the vehicle, rather than a loose object thatcan be tossed around inside in a crash or thrown outside.
- If you are thrown out of a vehicle in a crash, your chances of being killed are 25times greater than if you stay inside.
- If your vehicle goes out of control, with your seatbelt on you may be able toregain control. Without it, you may not even be able to stay in the driver‘s seat.

7.4.4 Coexisting Peacefully On Road

7.4.4.1 When confronted by an aggressive driver

- Avoid eye contact.
- Stay calm and relaxed.
- Make every attempt to get out of the way safely.

- Avoid confrontation.
- Do not take other driver‘s behaviour personally, he might have some reasonto drive erratically.
- If you feel you are being followed to closely, signal and pull over to allow theother driver to go by.
- Ignore harassing gestures and name calling, and do not return them.

7.4.4.2 Avoid becoming an aggressive driver

- Allow enough travel time to reach the destination on schedule.
- Alter your schedule to avoid driving during peak congestion periods.
- Do not drive when you are angry, upset or overly tired.
- Make your vehicle comfortable and avoid situations that raise your anxiety
- Do not make gestures that may offend others.
- Remember, driving is not a contest. Hence, forget about winning.
- Do not follow too closely. Allow at least a 3 second space between the vehicle ahead.
- If you commit any driving error, apologize by simply waving your hand.
- Give others the benefit of doubt; be polite, courteous and forgiving.
- When driving, relax and remain aware of your posture. Sit back in your seatand losing your grip on the steering wheel.

7.4.5 How to React in Case of an Accident

- Always carry a basic emergency kit in your vehicle, containing flayers andfirst aid supplies.
- If involved in a crash you must stop, regardless of the extent of damage.
- It is a criminal offence to leave the scene of an accident involving a fatality ofa personal injury.
- Exchange information with other drivers involved. Give your name, address, etc. to the other drivers and police on the scene.
- If a parked vehicle or property other than a vehicle is damaged or if a domestic animal is injured, try to locate the owner or notify the police.
- Do not stop at an accident scene unless you are involved or emergency help is needed. Otherwise, keep your attention on driving and the directions givenby traffic police.

- Shift the injured immediately to the hospital in any vehicle available.

7.5 TRAFFIC OFFENCES AND PENALTIES

Indian Road rules, titled ―Rules Of The Road Regulation‖, were brought into effect since July 1989.These rules are germane to the Indian drivers (all inclusive of 2, 3 and 4 wheelers), while on the road to ensure an orderly traffic and a safer journey. Violation of these rules is a punishable transgression as per the city specific traffic police rules of the ―Motor Vehicles Act‖.

Enforcement of these traffic laws, rules regulations and acts can bear out the road accidents. These laws are enforced by issuing ―challans‖ in the name of the offenders and teaching them a lesson by making them pay penalties.

The rules and fines were last revised a few months back and have gotten more stringent than ever before. Basically, there has been a steep increase in the punishments both in monetaryand imprisonment terms.

For example, in case you are caught driving without a valid insurance for your motor vehicle, the earlier penalty of Rs 1,000 and/or imprisonment of up to 3 months has been changed to a fine of Rs 2,000 and/or imprisonment of up to Rs 3 months for the first-time offence. Subsequently, the punishment is increased to a fine of Rs 4,000 and/or imprisonment of 3 months. A similar increase in severity has been witnessed even with other penalties as per the new Traffic Rules and Fines for violating them. Here is a table of all the required details:

Offence	**New Penalty (From September 2019)**	**Old Penalty**
General Offence	First-Time- Rs.500 Second-Time- Rs.1,500	First-Time- Rs.100 Second Time – Rs 300
Road Rules Violation	Rs.500 to Rs.1,000	Nil
Travel without ticket	Rs.500	Rs.200
Disobeying orders of Authorities/Refusing to Share Demanded Information	Rs.2,000	Rs.500
Driving an Unauthorized	Rs.5,000	Rs.1,000

Vehicle without License		
Driving Without License	Rs.5,000	Rs.500
Driving With Disqualified License	Rs.10,000	Rs.500
Over speeding	Light Motor Vehicle: Rs. 1000 to Rs 2000	Rs 400
Medium Passenger orGoods Vehicle	Rs.2,000 to Rs.4,000 and impounding of DL for the Subsequent or Second-Time Offence	Rs.400
Rash Driving	**First-Time Offence**: Imprisonment of 6 Months to 1 Year and/or Fine of Rs.1,000 to Rs.5,000 **Second-Time Offence**: Imprisonment of up to 2 years and/or Fine up to Rs.10,000	Nil
Driving Under Influence of Alcohol or Intoxicating Substance	**First-Time Offence**: Rs.10,000 and/or Imprisonment of up to6 months. **Second-Time Offence**: Rs.15,000 and/or Imprisonment of up to2 years	Rs.2,000
Driving Oversized Vehicles withou tpermission	Rs.5,000	Nil
Driving Whe nMentally/Physically Unfit	**First-Time Offence**: Rs.1,000 **Second-Time Offence**: Rs.2,000	**First Time Offence**:Rs.200 **Second Time Offence** : Rs.500
Accident Relate dOffences	**First-Time Offence:** Rs.5,000 and/or Imprisonment of up to6 months **Second-Time Offence:**	Nil
	Rs,10,000 and/or Imprisonment of up to 1 Year	
Driving Uninsure d Vehicle (without valid Insurance)	**First-Time Offence**: Rs.2,000 and/or Imprisonment of up to 3 months **Second-Time Offence:** Rs.4,000 and/or Imprisonment of up to 3 months	Rs.1,000 and/o rImprisonment of up to 3 months

Racing and Speed-testing	**First-Time Offence:** Rs.5,000 and/or Imprisonment of up to3 months **Second-Time Offence:** Rs.10,000 and/or Imprisonment of up to 1 year	Rs 500
Vehicle Without Permit	Rs.10,000 and/or Imprisonment of up to 6 months	Up to Rs.5,000
Aggregators (Violations of Licensing Conditions)	Rs.25,000 to Rs.1 lakh	Nil
Overloading	Rs.20,000 and Rs.2,000 per extra tonne	Rs.2,000 and Rs.1,000 per extra tonne
Overloading of Passengers	Rs.1,000 per extra passenger	Nil
Not Wearing Seatbelt	Rs.1,000	Rs.100
Overloading of Two-Wheelers	Rs.2,000 and Disqualification of License for 3 months	Rs.100
Not Wearing Helmet	Rs.1,000 and Disqualification of License for 3 months	Rs.100
Not Providing Way for Emergency Vehicles	Rs.10,000 and/or Imprisonment of 6 months	Nil
Offences by Juveniles	Rs.25,000 with Imprisonment of 3 years for which the Guardian / Owner shall bedeemed to be guilty	Nil
Power of Officers to Impound Documents	Suspension of DL under Section 183, 184, 185, 189, 190, 194C, 194D, 194E	Nil
Offences Committed by Enforcing Officers	Double the Penalty under Relevant Section	Nil

.

7.5.1 Highlights of the New Traffic Fines for Violations – (From Sep 2019)

Regardless to say, driving under the influence of alcohol or substance is a serious offence as it poses a threat to the safety of self and that of other road users. This is due to the fact that chances of a mishap increase by many times in case the driver is not alert due to the intoxication. Hence, as per the new traffic rules and fines, the offender is liable to some serious punishment, which varies as per the alcohol level found in

the blood. Similarly, there has been a higher penalty for most other serious offences. The details have been listed outbelow:

i. Driving Without License:

In case you are caught driving without licence, you can be fined for Rs 5,000. This is a ten-fold increase from the earlier fine of Rs 500

ii. Driving Without Insurance:

As per the new traffic rules and fines, which came into action through the amendment of motor vehicle act 2019, the penalty for driving without insurance for the motor vehicle has been increased from Rs 1,000 and /or imprisonment of up to 3 months to Rs 2,000 and/or imprisonment of up to 3 months for the first-time offenders and Rs 4,000 and/orimprisonment of up to 3 months for the second-time offenders.

iii. Driving With Disqualified DL:

In case your driving license has been disqualified and you are caught driving, you will have to pay a fine of Rs 10,000. This has been hiked fro Rs 500 previously.

iv. Driving Under the Influence of Alcohol or Intoxicating Substance:

Regardless to say, driving under the influence of alcohol or substance is a serious offence as it poses a threat to the safety of self and that of other road users. This is due to the fact that chances of a mishap increase by many times in case the driver is not alert due to the intoxication. Hence, as per the new traffic rules and fines, the offender is liable to some serious punishment, which varies as per the alcohol level found in the blood.

v. Not Wearing a Helmet:

The traffic fine for riding a two-wheeler without wearing a helmet has been increased fromRs 100 to Rs.1,000.

vi. Racing and Speed Testing:

Racing and speed-testing on public roads is a publishable offence and its fine has been increased from Rs.500 to Rs.5,000 and/or imprisonment of up to 3 months for the first-time offence and Rs.10,000 and/or imprisonment of up to 1 year for repeat offenders.

vii. Offences by Juveniles:

There is no punishment to the juvenile for this but the owner of the vehicle or the guardianhas to pay a fine of Rs.25,000 with imprisonment of 3 years.

viii. Offences Committed by Enforcing Officers:

While there was no penalty for this offence, the new fine is double the penalty under the relevant section.

ix. Having Two Driving Licences:

In case you are found having two or more driving licenses, you can be penalized. Also, from now, all driving licences that are to be issued will have a smart chip that can be accessed bythe traffic police through a QR code.

7.6 HOW TO OBTAIN LICENSE

Driving license is an official document certifying that the holder is suitably qualified to drive a motor vehicle or vehicles. Under the provision of the motor vehicles Act 1988, in India no person can drive a motor vehicle in any public place unless he holds a valid driving licence issued to him, authorising him to drive a vehicle of that particular category.

In India, 2 kinds of driving licence are issued that is learners licence and permanent licence.

Learners licence is valid only for 6 months. Permanent licence can be availed only after the expiry of 1 month from the date of issuance of learners licence.

7.6.1 What do we need to do to obtain a driving licence?

A learner's licence is essential for obtaining a permanent licence. The eligibility for obtaining a learner's licence for a private motor vehicle for a vehicle of 50CC engine capacity and without any gear, is 16 years (if the applicant‘s parents or guardians give their consent). Minimum age to apply for a permanent licence to drive a private motor vehicle is 18 years.

A person who is at least 20 years old and possesses a learner‘s licence can obtain a licence for driving a commercial vehicle. Also one has to be conversant with the traffic

rules and regulations in all the cases.

For obtaining learner‘s licence you will need to apply in the prescribed format to the Local Transport Office in your region, along with your passport size photographs, proof of your age and residence, declaration of medical fitness and the required fee. After verification of your documents, you will have to go through the learner‘s test. Usually a handbook of traffic rules, signs and regulations is provided with the application form. On passing the learner‘s test, you will be issued a learner‘s licence. If you fail the test, you will be given a chance to take thetest again.

For obtaining a permanent licence, you must have a valid learner‘s licence and must apply after 30 days and within 180 days of issue of the learner‘s licence. You should be conversant about vehicle systems, driving, traffic rules and regulations. You will be put through a driving test, for which you must bring a vehicle with you. On passing the test, you will be issued a permanent driving licence.

7.6.2 How to get a driving licence?

There are two stages to get a permanent driving licence:

Stage 1:- Obtaining a Learner‟s licence

Applicant for a learner‘s licence should appear personally before the licensing authority with the following:-

- Application form (available with the department)
- Fees of Rs. 30 for each of the vehicle
- Proof of age
- Proof of residence
- Medical certificate
- Three recent passport size photographs of the applicant.
- Applicants for transport vehicle licence must produce a permanent driving licence for light motor vehicle held by him at least for one year, medical certificate in form andhe should a attain the age of 20 years.

  Applicants for learner‘s licence shall pass a test regarding basic traffic signs and driver‘s responsibilities.

The learners licence so issued is valid for a period of six months from the date of issue and is renewable for another period of 6 months, during its validity.

Every applicant for the issue of a learner‘s licence or permanent licence or an endorsement shall produce as evidence of his address and age any one or more of the following documents in original or relevant extracts thereof duly attested by a Gazetted Officer of the Central government or of a State government or an officer of a local body who is equivalent in rank to a Gazetted officer of the government or VillageAdministration officer or Municipal Corporation Councillor or PanchayatPresident, namely:

1. Ration Card
2. Electoral Roll
3. Life Insurance Policy
4. Passport
5. Electricity or telephone bill
6. Pay slip issued by any office of the central government or State government or local body
7. House Tax Receipt
8. School certificate
9. Birth Certificate
10. Certificate granted by a registered medical practitioner not below the rank of a Civil surgeon, as to the age of the applicant.

Provided that where the applicant is not able to produce any of the above mentioned documents for sufficient reason, the licensing authority may accept any affidavit sworn by the applicant before an Executive Magistrate, or a First Class Judicial Magistrate or a Notary Public as evidence of age and address.

Stage 2 : Obtaining a permanent licence:

An application for a driving licence shall be made in Form 4 and shall be accompanied by:-

- An effective learner‘s licence to drive the vehicle of the type to which the applicationrelates.
- Appropriate fee as specified in Rule 32(CMV RULES), for the test of competence todrive and issue of licence.
- Three copies of the applicant‘s recent passport size photographs.

- Medical certificate in form 1A where ever applicable.An application for a medicalcertificate (Form-1A) shall contain a declaration in Form 1.
- Driving certificate in Form 5 in case of transport Licence.

For obtaining a fresh driving licence one has to undergo driving test of the relevantvehicle for which he has applied for and pass the test of competence to drive.

7.6.3 Is there a need to produce a Medical Certificate?

Applicants for the non transport licences, under the age of 50 years do not require a medical certificate. However, those applicants who are over 50 years of age must produce a medical certificate. All applicants for Transport vehicle licence must produce a medical certificate, irrespective of their age.

7.6.4 How do we obtain a learner‟s licence?

Applicants for learner‘s licence should appear personally before the licensing authority with the following:-

- Application in Form No.2
- Fees of rupees 30 for each of the vehicle
- User charge of rupees 30
- Proof of age, appropriate for relevant class of vehicle
- Proof of residence like Ration card, electoral roll, electricity telephone bill etc. showing the name of the person.
- Application cum declaration as to the physical fitness in Form 1
- Medical certificate in form No. 1A wherever applicable.
- Three recent passport size photographs of the applicant.
- Applicants for Transport vehicle licence must produce a permanent driving licence forLight motor vehicle held by him, at least for one year.

The Learner‘s licence so issued is valid for a period of six months from the date of issue.

7.6.5 How do we obtain a permanent licence?

The applicant should appear in person along with a registered motor vehicle of the relevantcategory before the licensing authority with the following:-

- Application in Form No.4 (available with the department)

- Fees of rupees 35 for test and licence
- Valid learner‘s licence held by the applicant for the relevant class, which is older than30 days.
- 4 recent passport size photographs of the applicant

Applicants for Transport vehicle licence should enclose a Training Certificate in Form No. 5issued by a recognised Driving school.

The applicant shall pass a driving test on a vehicle of the type he has applied for. Licence to drive a non transport vehicle is valid for 20 years from the date of issue or until the holder attains the age of 50 years, whichever is earlier. After that, the licence is renewed every 5 years.

7.6.6 Renewal of driving licence:

An application for renewal of driving licence shall be made in Form No.9 to the licence authority having jurisdiction over the area in which the applicant ordinarily resides or carries on business and shall be accompanied by:-

- Appropriate fee Renewal as specified in Rule 32 CMV RULES (in Form6 Rs.15 and inForm7 Rs.40 , Late Renewal Fee Rs.10 after grace period of 30 days for every year)
- Three copies of the applicant's recent passport size photograph, if renewal is made in Form 6
- The driving licence
- The medical certificate in Form 1-a wherever applicable.An application for a medicalcertificate (Form 1A) shall contain a declaration in Form 1.

7.6.7 Issue of duplicate driving licence:

An application for issue of duplicate driving licence shall be made in form LLD to thelicensing authority where the licence is obtained or last renewed.

- Appropriate fee as specified in Rule 18 of APMV RULES (RS.15)
- If the duplicate licence made in Form 7, then fees is rupees 40
- 3 copies of the applicant‘s recent passport size photographs.

7.6.8 International driving licence/permit:

An application for international driving licence shall be made to the licensing authority having jurisdiction over the area in which the holder of driving licence

ordinarily resides or carries on business along with the following documents:-

- Fees Rs.500
- Attested photocopy of passport
- Valid Indian driving licence
- Copy of valid Visa
- Three recent passport size photographs
- Attested copy of birth Certificate

7.7 Role of First Aid In Road Safety

Many deaths and impact of injuries can be prevented with First aid if casualties are treatedimmediately.

First Aid is the initial care given to an injured person. Mostly, this timely care prior to thearrival of the medical help means the difference between life and death.

It must start immediately when the injury or illness occurs and continue until the medical help arrives on the casualty recovers.

The basic aims of first aid are:

- To save life
- To protect the casualty from getting more harm
- To reduce pain and priorities of casualty treatment

7.7.1 Priorities of Casualty Treatment

- Asphyxia
- Shock
- Cardiac arrest
- Severe Haemorrhage
- Other injuries/Illness

7.7.2 Immediate Requirement

i. **Critical four minutes:** One of the most common causes of a road accident death is due to loss of oxygen supply. This is mostly caused by a blocked airway. Normally it takes less than four minutes for a blocked airway to cause death.

ii. **The „Golden Hour":** The first hour after the trauma is called the ‒Golden hour‖. If proper first aid is given, road accident victims have a greater chance of

survival and a reduction in the severity of their injuries.

iii. **In case of Wound:** The job of first aider is to remove or reduce the problems that hamper healing such as dirt, infection, movement etc. Leave the wound undisturbed. Clean the wound by washing them with running water. If there are splinters, thornsand pieces of glass inside the wound, remove them with the pair of tweezers so as to avoid infection.

iv. **In case of Profuse Bleeding:** The easiest way to stop bleeding is to apply direct pressure on the wound. This can be done with any clean folded cloth. Lean on the wound with the heel of the hand instead of your fingers.

v. **In case of a Fracture:** In case of a fracture do not apply direct pressure; instead use a splint, combined with a gentle pressure bandage. It is safer not to give the patient anything to eat and drink. This is to protect the patient from vomiting in case he needs anaesthesia and surgery, or has a head injury.

If the wound on the arm or the leg is bleeding profusely, it can be raised. This reduces the blood flow to the wounded area.

vi. **In case of Chest or Abdomen injury:** In abdominal wounds the intestine may come out. The only thing you can do as a first aider is to cover the wound with a very wet clean cloth and get the patient quickly to a hospital. The wet cloth will keep the intestine from drying out, and will stick to the intestine.

Open wounds of the chest could be sucking in the air, making it hard for the patient to breathe. Covering and putting a bandage on the top of this may help to reduce air being sucked into the chest. Get the patient quickly to hospital.

vii. **In case part of a Limb is cut off:** If a part of the limb has been cut off it may be possible to reattach it to the body. Put it inside a clean polythene bag and place thisbag in another bag with cold water. If you can easily get ice, put some in the water to keep it cool. Make sure that the limb does not get soaked in water. If nothing else is available carry the amputated part in a clean cloth quickly to hospital.

In large crush injuries or in amputation avoidwashing the wounds, as it will lead to more blood loss. Just cover the wound with a clean cloth and tie a pressure bandage quickly. If possible keep the limp raised. Avoid using raw cotton wool

to cover a wound as it gets stuck to the wound, and it is difficult to remove and delayed healing.

viii. **In case of an Eye wound:** Do not attempt any cleaning or washing of an open eye injury. Cover the eye with the clean soft; place a stiff covering on top to prevent any pressure coming on the eye. This is important because the contents can be squeezedout even through a very small wound.

ix. **In case of bleeding from Ear:** Bleeding from ears mean either injury to the ear alone, or serious head injury. Avoid putting anything in the ears to stop bleeding as it could further damage the eardrum. The patient be asked to lie down with the injured ear facing down.

x. **In case of bleeding from Nose:** Bleeding from nose could also mean a head injury. If the patient is conscious and can sit up, ask him to pinch his nose and breathe throughhis mouth. If he can lean forward, then that could prevent blood from going to his wind pipe choking him.If the patient is unconscious, he should lie with face to oneside, for the blood to come out easily, so there is no choking.

xi. **In case of Injuries to Muscles, Bones and Joints:** When muscles joints or bones get injured, blood collects over the area, and a swelling appears. You can reduce the swelling by bringing down the bleeding. Apply cold water or ice packs if available. It reduces local blood flow and this brings down the internal bleeding and swelling. But remember not to keep ice packs on more than 10 minutes at a stretch as this will leadto something like frostbite, and not to place ice directly on skin. Always wrap it in a cloth first. A muscle injury can be made less painful by putting a splint on the injured limb.

xii. **In case of Broken Bones and Dislocated Joints:** A fracture for dislocation can be confirmed if there is obvious deformity, abnormal mobility, if the limb cannot be moved at all and if a grating feeling is there. First aid for all fractures and dislocations must aim to reduce movement, which will give relief from pain. Splinting should be done with caution.

7.7.3 Shifting the injured to the Hospital

1. Ensure that he is not hurt more.

2. The patient should be carried on firm board of stretcher so that spine remains stable.
3. While shifting the patient's back, neck and airway need to be protected from further injury. So always take help of another person.
4. If the patient is unconscious, place a large folded cloth or towel gently under the neck so that the neck doesn't sag against the ground.
5. The vehicle used to carry the patient to the hospital should have enough space to keep the patient's back straight and the person a company should be able to care for and resuscitate the patients if necessary.
6. During transportation keep a watch on whether the patient‘s airway is clear, whetherthe patient is breathing and whether you can feel the pulse in the patient.

If there is only one limb injury the patient can be safely taken to the hospital on a chair in a sitting position. Take care to splint or protect limb injuries or bleeding.

CHECK YOUR PROGRESS

Ques.1 Answer the following Short Answer Type Questions**:**

i. You should use your right hand indicator when:
   a. You intend to slow down
   b. You intend to move to the right, at any time
   c. You are about to stop
   d. None of these

ii. What is the minimum age for obtaining a Learner's licence for geared light motor vehicle?
   a) 18 years
   b) 17 years
   c) 20 years
   d) 19 years

iii. Except for …… and..... necessary for the use of the vehicle, no explosive highly.....or otherwise dangerous substance, shall be carried on any public service vehicle.

iv. Match the component in Column A with Column B

Column A Column

B

Overtaking	turn the headlights on
Driving in rain	not to be obstructed
Confrontation with aggressive driver	severity of injury
reducesSeatbelt	avoid eye contact

v. The basic aim of first aid is to:
   a. Save life
   b. Reduce pain
   c. Protect the casualty from getting more harm
   d. All of the above

7.8 SUMMARY

After explaining the meaning and the concept of Road safety, the unit identifies and explains important signs that are used on roads. The significance of the traffic signs cannot be over looked as they are intrinsic for your own safety on the road. Knowledge about the various traffic rules that ought to be followed on the road, to ensure safety have been discussed in detail. Beside the unit familiarises the reader about the various types of traffic offences and penalties that are attached to the violation of various traffic rules. The procedure to obtain a driving licence has also been discussed as it gives citizens the permission to drive and at the same time acts as a valid identity proof. Apart from this the critical importance and role of First aid in the field of Road Safety has also been brought forth.

7.9 QUESTIONS FOR PRACTICE

Ques. 1 What are the key points to be kept in mind while shifting the injured to ahospital?

Ques. 2 How do you obtain a learner‘s licence?

Ques. 3 What precautions are to be taken by the driver while driving in foggy conditions?

Ques. 4 What is the need of road safety?

Ques. 5 What are the two stages to get a permanent driving licence.Explain?

7.10 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses,2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad

COURSE: ENVIRONMENTAL STUDIES

UNIT 8: STUBBLE BURNING

STRUCTURE

8.0 LEARNING OBJECTIVES

After the study of this unit, the learners will be able to:

- Know about the meaning and concept of Stubble Burning
- Examine the impact of Stubble Burning on Health and Environment
- Know how can Crop stubble be managed and what are the alternative uses of CropStubble
- Delve deeper into the Environmental Legislations and Policies for restriction ofAgriculture Residue Burning in Punjab

8.1. INTRODUCTION

The agricultural industry plays a major role in the overall economic growth of the world. However, there is limited discussion on the management of agricultural waste in the published literature. It could be related to the fact that agriculture industry is not regulated as the municipal solid waste (MSW). The MSW is mainly governed by public

entities such as municipalities and hence the generation and management data are collected, recorded, and analyzed in the public domain. Agricultural waste is predominantly handled by the owners of the agricultural land which is predominantly in the private sector, with little public sector involvement.

The growing demand for food in developing countries, has led to tremendous increase in food production around the world. India accounts for about 2.4 % of the world‘s geographical area and 4.2% of its water resources, but supports about 17.6% of its population which highlights the fact that our natural resources are under considerable strain. The need for providing foodgrains for a growing population, while sustaining the natural resource base, has emergedas one of our main challenges. Foodgrains are a major source of energy and are thus vital for food and nutritional security. As such, food grains would continue to be the main pillar offood security and out of various crops grown, rice, wheat, and pulses are still part of the staple diet of most of the rural population. Large stretches of wasteland have been convertedto arable lands due to developments in water management systems, modern agro-technologies and large-scale agrochemical deployment. These measures have resulted in environmental pollution and increased complexity in the disposal of agricultural waste. However, the national agencies are continuously developing policies and possible options to manage these wastes, which include their conversion to reusable resources.

Waste materials derived from various agricultural operations are defined as agricultural wastes. As per the United Nations, agricultural waste usually includes manure and other wastes from farms, poultry houses and slaughterhouses; harvest waste; fertilizer run-off from fields; pesticides that enter water, air or soils; salt and silt drained from fields. The harvest waste, which is more popularly termed as crop residue can contain both the field residues that are left in an agricultural field or orchard after the crop has been harvested and the process residues that are left after the crop is processed into a usable resource. Stalks and stubble (stems), leaves, and seed pods are some common examples for field residues. Sugarcane bagasse and molasses are some good examples for process residue.

The following is a tabular presentation of the Crop Residues produced by major crops

Source	**Composition**

Rice	Husk, bran
Wheat	Bran, straw
Source	**Composition**
Maize	Stover, husk, skins
Millet	Stover
Sugarcane	Sugarcane tops, bagasse, molasses

Waste from the agricultural industry can be beneficially utilized in various agro-based applications and other industrial processing. However, the cost of collection, processing and transportation can be much higher than the revenue from the beneficial use of such waste. According to the Indian Ministry of New and Renewable Energy (MNRE), India generates on an average 500 Million tons (Mt here after) of crop residue per year. The same report shows that a majority of this crop residue is in fact used as fodder, fuel for other domestic and industrial purposes. However, there is still a surplus of 140 Mt out of which 92 Mt is burned each year. India is the second largest producer of rice and wheat in the world, two crops that usually produce large volume of residue.

8. 2. MEANING OF STUBBLE BURNING

Stubble burning is a practice of removing paddy crop residues from the field for sowing next crop viz. wheat. Where ‗combine harvesting' method is applied, there Stubble burning becomes essential because combine harvester leaves crop residue behind. Combines are machines that harvest the crops as well as thresh, means separation of the grain, and it's cleaning together, but it leaves stubble behind because it doesn't cut close enough to the ground. These residues put a burden on the farmer because these residues are not so useful for the farmer and moreover, there is pressure on the farmer to sow the next crop in time. Therefore, they clear the field by burning the stubble. According to different studies, the residues of rice and wheat crops are major contributors to the total stubble loads in India. Research studies have observed that the contribution of rice and wheat stubble loads in the total stubble was 36 and 41 %,

respectively in the year 2000, while the contribution of Punjabin the total burnt stubble of rice and wheat was 11 and 36 %, respectively during the same time period.

India relies largely on its northern states viz. Punjab, Haryana, western Uttar Pradesh and Uttarakhand for wheat production. Now, states in the south are also involved in the wheat production. But the clinching difference is that they don‘t have the urgency to remove the stubble to make it ready for the next crop. There are two main reasons for crop residue burning-First one is that there is a very short window of time between the harvesting of paddy and sowing of wheat, at the end of the Kharif season. To sow wheat right after paddy, the field needs to be harvested and readied for the next crop timely. In the northern states, the crucial time for the wheat crop to mature is in mid-April, when the temperature is about to cross 35 degrees C. The wheat crop requires 140-150 days to reach full maturity and give maximum yield by then; the farmer has no option but to sow the crop latest by 15 November, so that it grows for the full duration. Added to this complication the Punjab Preservation of Subsoil Water Act2009 – Punjab‘s water-saving law, bans sowing of paddy before 15 May and transplanting it before 15 June.Secondly, the removal of the paddy stalk that remains on the field is a labor-intensive process. With labor being unavailable and the time window between the harvesting of paddy and sowing of wheat being limited, the farmer has to burn the residue right on the field to prepare the field for wheat in just about 20 days. So, the farmer is finally left with only one option- Stubble Burning.

8. 3. IMPACT ON HEALTH AND ENVIRONMENT

The burning of crop residues generates numerous environmental problems. The main adverse effects of crop residue burning include the emission of greenhouse gases (GHGs) that contributes to the global warming, increased levels of particulate matter (PM) and smog that cause health hazards, loss of biodiversity of agricultural lands, and the deterioration of soil fertility.Stubble burning is a significant source of air pollutants such as carbon dioxide (CO_2), volatile organic compounds (VOCs), nitrogen oxides (NO_x) and hydrocarbons (HC) accounting for about 10% of the total emissions in the world. The emission contains particulate matter (PM) and harmful gases such as Nitrogen dioxide (NO_2), N_2O (Nitrous oxide), Sulphur dioxide (SO_2), Carbon monoxide (CO), Carbon dioxide (CO_2), and Methane (CH_4), all of which severely affect

human health. This basically accounts for the loss of organic carbon, nitrogen, and other nutrients, which would otherwise have retained in soil. It is reported in a study that burning of 98.4 Mt of crop residue has resulted in emission of nearly 8.57 Mt of CO, 141.15 Mt of CO_2, 0.037 Mt of SO_x, 0.23 Mt of NO_x, 0.12 Mt of NH_3 and 1.46 Mt NMVOC, 0.65 Mt of NMHC, 1.21 Mt of PM during 2008–2009, where CO_2 is 91.6% of the total emissions. Remaining 8.43% consisted of 66% CO, 2.2% NO, 5% NMHC and 11% NMVOC.

The PM emitted from burning of crop residues in Delhi is 17 times that from all other sources such as vehicle emissions, garbage burning and industries. As such the residue burning in the northwest part of India contributes to about 20% of organic carbon and elemental carbon towards the overall national budget of emission from agricultural waste burning. In summary, impacts of burning may be divided into two groups- First, the on-site impact of burning, which includes removal of a large portion of the organic matter, nitrogen, phosphorus, and loss of useful microflora and fauna and second, the off-site impacts are health-related due to general air quality degradation of the region resulting in aggravation of respiratory like a cough, asthma, bronchitis, eye and skin diseases. Chronic heart and lung diseases can also be aggravated by fine particles present in smoke leading to premature deaths of people. The black soot generated during burning also results in poor visibility which could lead to increased incidence of accidents on road.

8. 3.1Impact on Air Quality

Burning of stubble poses a serious threat to the air quality of the exposed environment. Research has pointed out that air quality is considerably affected by agricultural burning due to the emission of aerosols and gaseous pollutants. PM 2.5 and PM 10 are reported to have the highest effect on the health of the exposed population. In 2001, the World Bank conducted a source apportionment study (1st of its kind) on PM 2.5 for several Indian cities. They discovered that biomass burning contributes 9-28 %, 23-29%, 24%, 37-70% to the PM2.5 concentrations in Delhi, Mumbai, Chandigarh, and Kolkata respectively. In 2011, PM2.5 concentration, in Delhi, increased by 78% and 43% during the rice and wheat stubble burning periods, respectively. A comparison of the burning and non-burning periods in Delhi has found a 300 mg/m3 increase in the hourly concentration of PM10 during the burning episodes. In 2015, PM10 and PM2.5 concentrations increased by 86.7% and 53.2% for rice and wheat burning periods

respectively in Mandi-Gobindgarh city, Punjab. A source apportionment study conducted in Patiala city discovered that stubble burning contributes about 100-200 µg/m3 of PM10 to the air pollution of the city.

Despite not being the main source of pollution, stubble burning is a significant source of air pollution in India. A combination of point and nonpoint sources constitutes the composite emissions. These sources include the industries, power plants, vehicles, construction, and indoor emissions and out of these, emissions from industrial sources comprise 15% of CO, 14% of PM2.5 and 23% of SO2, while transportation emissions contain 17% of PM2.5, 13%of PM10, 53% of NOx and 18% of CO. On the other hand, stubble burning emissions are relatively lower comprising of 14% CO and 12% PM2.5.

The air quality becomes austere mostly in November of each year across the north Indian states. The air quality of the urban areas is more affected by stubble burning emissions because of the presence of the accumulated pollutants from vehicular and industrial emissions leading to a severe air quality condition.

The air quality of a region can be categorized in terms of a parameter termed as the air quality index or AQI, which is a range of categorical measurements of the pollution level which helps in interpreting the quality of air in a region on a scale of 0-500 (Central Pollution Control Board, 2014). Most of the regions in North India have AQI beyond the safe limit, especially during the burning episodes. For example, in November 2019, Delhi recorded a peak AQI of 487, Ghaziabad reported an AQI as high as 493, and Greater Noida recorded
480. These AQI values are clearly in the ‒severe‖ region as the CPCB AQI. This promptedthe government of Delhi and other northern states to close schools at primary levels and warned citizens against early morning outdoor exercises.

Table: Central Pollution Control Board, India's AQI and particulate standards (Central Pollution Control Board, 2014)

AQI Ranges	**PM_{10} (24-hr)**	**$PM_{2.5}$ (24-hr)**	**Category**
0-50	0-50	0-30	Good

51-100	51-100	31-60	Satisfactory
101-200	101-250	61-90	Moderate
201-300	251-350	91-120	Poor
301-400	351-430	121-250	Very Poor
AQI Ranges	**PM_{10} (24-hr)**	**$PM_{2.5}$ (24-hr)**	**Category**
401-500	430+	250+	Severe

8.3.2 Impact on Climate

Emissions from stubble fires have a direct effect on weather and climate through the release of greenhouse gases such as carbon dioxide (CO2) and methane (CH4) which may potentially lead to global warming. About 17% to 32% of the total annual greenhouse gas emissions in the world are contributed by the agricultural sector. It has been found that in 2017, crop stubble burning had resulted in the emission of 171.37 Tg of CO2, 0.706 Tg of CH4, and 0.073 Tg of N2O India contributes about 12.2% to the global greenhouse gas emissions, which is about 658.823 Tg CO2 equivalent. It was reported that India lost about 36% of its expected annual wheat yield in 2018, which was linked to the poor quality of air and change in the weather patterns.

8.3.3 Impact on Soil Fertility

Stubble burning also affects soil productivity by burning the essential nutrients inside the soil. It also raises the soil temperature to about 42 °C, thus displacing or killing the important microorganisms in the soil at a depth of about 2.5 cm. This generates an additional expense of regaining back the soil fertility through the application of fertilizer or compost. Stubble burning strips the soil of the essential nutrients, i.e. Nitrogen, Phosphorus, and Potassium (NPK) as well as other micro-nutrients. For instance, the burning of rice stubble leads to aloss of about 0.445 Mt of NPK, 0.144 Mt in the case of wheat stubble burning, and 0.84 Mt in the case of sugarcane waste burning each year. It is estimated that burning of one tonne ofrice straw accounts for loss of 5.5 kg Nitrogen, 2.3 kg phosphorus, 25 kg potassium and 1.2 kg sulphur

besides, organic carbon. Generally crop residues of different crops contain 80% of Nitrogen (N), 25% of Phosphorus (P), 50% of Sulphur (S) and 20% of Potassium(K). If the crop residue is incorporated or retained in the soil itself, it gets enriched, particularly with organic Carbon and Nitrogen.

Nutrient	**N**	**P**	**K**	**C**
Nutrient Content in Stubble (g/kg)	6.5	2.1	17.5	400
Nutrient	**N**	**P**	**K**	**C**
Percentage Lost due to burning (%)	90	25	20	100
Amount lost per hectare (kg/ha)	35	3.2	21	2,400

8.3.4 Impact on Agricultural Productivity

The effects of burning crop stubble extend to the agricultural sector. There is convincing empirical evidence that air pollution affects food production. The pollutants may affect agricultural productivity directly or indirectly. Direct effects entail injury to leaves, grains, or assimilation of heavy metals. For example, Nitrogen oxide can damage the tissue of plantsand cause discoloration. SO_2 may lead to the formation of acid rain which has severe effects on plants and soil, and may lead to plant mortality. Prolonged exposure of plants to particulates pollution may lead to Chlorosis or Bifacial Necrosis. Indirect effects include the provision of favorable conditions for the growth of pests or diseases. For example, the growth of aphid pests is favored by high concentrations of SO_2 and NO_2.

Stubble burning releases VOCs and NO_x which combine to form ground-level ozone. Ozone is formed in the immediate atmosphere by the reaction of nitrogen oxide and volatile organic compounds in the presence of solar radiation. Ground-level ozone affects plant's metabolism, penetrates, and destroys leaves causing serious effects on crops in the northern parts of India. Ozone was reported to greatly affect the performance of some crops such as wheat and soy, while crops like barley were known to possess some resistance to the same. Rice and maize were reported to be moderately affected. Hence, stubble burning negatively impacts agricultural productivity and

economy and needs to be dealt with appropriately to improve agricultural production to meet the increasing food demand.

8.3.5 Impact on the Economic Development

Apart from its effects on health and the environment, air pollution also affects the growth of a country's economy. The effectiveness of air pollution management in a country is dependent on the economic and technological development of the country, which implies that increased pollution affects the country's economy in many ways. In recent years, tourists' inflow has decreased in Delhi by about 25-30% due to the increase in the level of air pollution. Ghosh et al. (2019) inferred that the accumulated effects of air pollution cost the economy of India about 4.5 to 7.7 % of its GDP in 2018, and when projected to 2060, the percentage rose to about 15%. The productivity of workers in different disciplines is also affected by air pollution through sickness and poor visibility. The World Bank reported that air pollution cost the global economy about $225 billion in 2013 most of which came from the developing countries (World Bank, 2016). The Indian government had delineated the cost of air pollution management and welfare to be around $14 billion annually.

The cost of air pollution management and welfare also has an impact on a local scale. For example, the economic benefit of maintaining air quality at a safe limit in a typical household in Kolkata and Delhi was measured to be 950 (about 12.7 USD, assuming 1 USD = 75 rupees) and 2086 rupees (about 27.8 USD) per annum, respectively. A similar study was conducted for the city of Kanpur and the rural areas of Punjab, and economic benefit/loss of about 255 and 76 million rupees were reported, respectively.

8.3.6 Impact on Health

Many studies have established a link between air pollution and the risk of several health problems especially among children, pregnant women, elderly persons, and people with pre- existing health issues. The harmful effects caused because of exposure to air pollution range from skin and eyes irritation to severe neurological, cardiovascular and respiratory diseases. In some cases, it may also lead to lethal effects especially when the exposed victim is having pre-existing respiratory problems. In chronic cases, exposure to a high level of air pollution may cause permanent health injuries such as the development of lung diseases like asthma, Chronic Obstructive Pulmonary Disease

(COPD), bronchitis, lung capacity loss, emphysema, cancer, etc. (Ghosh et al., 2019). Most of the farmers exposed to stubble smoke complain about eye and lung irritation and had spent a considerable amount of money on medical expenses.

Fine particulate matter (PM2.5) has more effects on humans than the larger sizes, for the former can penetrate through the trachea into the lungs and subsequently to the bloodstream. An epidemiologic study conducted by reported a decline of pulmonary and lung function especially in children exposed to a high level of particulate pollution. PM2.5 pollution alone accounts for about 21% of the total deaths in the southern part of Asia. Its effects range froma runny nose, coughing, and difficulty in breathing to chronic effects such as asthma and coronary diseases. A study showed that exposure to a high level of particulate emissions may lead to a decrease in the functionality of the human lungs. The effect is more austere in children as prolonged exposure may lead to asthma or chronic pulmonary diseases. Other effects of exposure to polluted air include; tuberculosis, stroke, lung cancer, cardiac arrest, and acute infections in the respiratory system.The black soot generated during burning also results in poor visibility which could lead to increased road side incidences of accident.

8.3.6.1 Increase in Mortality

The rates of death as a result of air pollution have been gradually increasing over recent years. For example, in South Asia, the number of deaths attributed to air pollution had increased from 1.1 million to 1.2 million between 1990 and 2015. Dwellers of the Indo- Gangetic Plain (IGP) regions were reported to have lesser life expectancy compared to the other Indian regions with about seven years difference. It was reported that air pollution had increased by about 65% from 1998 to 2016 in the IGP, and the particulate matter concentration in the region was also twice the average levels for other regions in the country (Energy Policy Institute at the University of Chicago (EPIC) 2020). Particulate matter especially PM2.5 is reported to be the most lethal of all the pollutants, and about 50% ofIndia's population is exposed to a high level of the PM2.5 with a concentration above the WHO limit (35 $\mu g/m^3$), while about 49% of the exposed population do not have access togood healthcare. This is why the South Asian countries are characterized by the highest number of premature deaths due to prolonged exposure to high concentrations of particulate matter emissions.

The first and primary target of toxic substances inhaled through the air is the respiratory system causing disorders, cancer, or even death in extreme cases. Prolonged exposure to particulate emissions may lead to an elevated rate of cardiovascular mortality.

Estimates on global effects of air pollution have shown that in India, more than 600,000 people die prematurely each year due to exposure to polluted air. The life expectancy of the Delhi inhabitants has decreased by about 6.4 years due to exposure to a high level of pollution. Delhi populace could live 9 more years if the WHO standards are met, and 6 more years if the national ambient air quality standards are met (EPIC, 2020). In Pakistan, the air pollution problem is the leading cause of diseases and premature deaths causing the deaths of nearly 135,000 people each year. In India, air pollution had claimed the lives of about 1.24 million people, in 2017, out of which 0.67 million were attributed to particulate matter emissions. Also, 51% of the total deaths in India were caused by air pollution most of which were people under 70 years of age. It has been strongly stated that the rate of trauma deathincreases by about 2.3% when suspended particulate matter concentration rises by 100 $\mu g/m^3$.

8.4. MANAGEMENT AND ALTERNATIVE USES OF CROP STUBBLE

8.4.1 Steps taken for Management of Crop Stubble

Several efforts have been made to reduce crop residue burning by various state and central administrations and regulatory bodies so far:

1. *Banning Crop Residue Burning:* Crop residue burning has been notified as an offense under the Air Act of 1981, the Code of Criminal Procedure, 1973 and other appropriate Acts. In addition, a penalty is being imposed on any offending farmer. Enforcement is being done by the village and block-level administrative officials.
2. *Detection and prevention:* For detection and prevention of burning in real time, a combination of remote sensing technology—use of satellite imagery—and a team comprising local officials–Sub-Divisional Magistrates (SDM), Tehsildars, Block Development Officers (BDO), Patwaris and village-level workers is effective.
3. *Establishment of a marketplace for crop residue burning:* Efforts have been and are being made to increase the possibilities for the alternate usage of paddy straw and other crop residues. For instance, paddy straw has a considerable calorific

value, so, it can be used as a fuel in biomass-based power plants. Similarly, it can be further utilized for the preparation of biofuels, organic fertilizers and in paper and cardboard making industries. The strategy, behind all of these measures, is to assign a real economic and commercial value to the agricultural residue and making burning it an economic loss to the farmer.

4. *Outreach and public awareness campaigns:* There are ongoing efforts to highlight the health effects of crop residue burning. As has been mentioned earlier, it produces extremely high levels of toxic particulates, which affect the health of the people. Moreover, efforts are also have been and being made through Kisan camps, training and workshops, apart from campaigns through various print media, T.V. shows, and radio jingles, in informing farmers about the alternative usage of crop residue.

5. *Subsidy on agri-implements:* The state governments, in collaboration with the Centre, provides subsidy on mechanical implements that help tillage of the soil, so that the crop residue can be retained in the soil, adding to its fertility, or alternately, a collection of crop residue for putting it to commercial usage. Still, these implements cannot be afforded by the majority of farmers because of high cost only a small number of farmers have access to these implements at the moment.

6. *Crop Diversification:* Cultivation of alternate crops (apart from rice/paddy and wheat) that produce less crop residue and have greater gap periods between cropping cycles, may be prompted. Various efforts are being made for diversification of cropping techniques resulting into prevention of crop residue burning.

8.4.2 Suggested Alternatives for Management of Stubble

Various approaches have been developed for management of rice stubbles but no one alone can substitute stubble burning effectively. Therefore, these all approaches must be used simultaneously and there is strong need for other innovative approaches for the effectivesubstitution of stubble-burning.

1. *In Situ Incorporation:* Incorporation of stubbles into the field is the easiest way to manage it. But, farmers don‘t prefer in-situ incorporation as the stubble takes time to decompose in the soil that may adversely affect the wheat productivity in

various ways such as late sowing of wheat and immobilization of inorganic nitrogen and its adverse effect due to nitrogen deficiency. Incorporation of crop stubble requires more tillage operations than of post burning. It has been observed that the in-situ incorporation is the best alternative available to burning of rice residue. It is believed that if the rice residue is incorporated in the soil 10, 20 or 40 days before sowing the wheat crop, then the productivity of the subsequent wheat and rice crops is not adversely affected.

The incorporation of the straw in the soil has a favorable effect on the soil‘s physical, chemical and biological properties such as Ph, organic carbon, water holding capacity and bulk density of the soil. On a long-term basis it has been seen that it increases the availability of zinc, copper, iron and manganese content in the soil and it also prevents the leaching of nitrates. By increasing organic carbon it increases bacteria and fungi in the soil. In a rice-wheat rotation, it is observed that soil treated with crop residues held 5– 10 times more aerobic bacteria and 1.5–11 times more fungi than soil from which residues were either burnt or removed. Due to increase in microbial population, the activity of soil enzymes responsible for conversion of unavailable to available form of nutrients also increases. Mulching with paddy straw has been shown to have a favorable effect on the yield of maize, soybean and sugarcane crops. It also results in substantial savings in irrigation and fertilizers. It is reported to add 36 kg/ha of nitrogen and

4.8 kg/ha of phosphorous leading to savings of 15–20 % of total fertilizer use.

2. *Happy Seeder:* Happy Seeder is a technique, used for sowing wheat without any burningof rice residue. This technology is eco-friendly with the environment; make the good health of soil as well as it also saves water. Dasmesh Turbo Happy Seeder has been considered as the most successful implement for sowing wheat in rice residue without burning rice residue.
3. *Stubble-burry Scheme:* In order to curb stubble burning, the districts of the Punjab statewith the help of Agriculture Department had started a _stubble-burry‘ scheme for small and marginal farmers. Under the scheme, the farmers can remove paddy stubble from the main field and bury it in a pit either in their own agricultural land or wasteland. The District Administration has a responsibility to provide workers to farmers under the Mahatma Gandhi National Rural Employment

Guarantee Scheme (MGNREGA) to dig up the compost pits. Moreover, under the scheme of MGNREGA, small farmers are also provided job cards for getting compost pits dug up on their land. But this scheme requires at least takes seven to ten days to manage stubble in a pit, so farmers may be unhappy with it.

4. *Straw Decomposing Bacteria and Fungi:* Straw burning can be substituted with efficient decomposition. Microorganisms which are efficient to degrade cellulose and lignin, required for Straw decomposition. This decomposition of rice straw recovers the soil fertility by recycling the carbon, nitrogen and other nutrients back to the soil. Under both aerobic and anaerobic conditions, general microbial processes may take place. But for most soils, the aerobic pathway is of greater importance than the anaerobic one. In addition to rice straw, other agricultural wastes such as coir pith, banana sheath (dried), sugarcane trash, millets and pulse waste, cotton stubbles can be decomposed with white rot fungus (*Pleurotus sp*.). Some widely used species of white rot fungus are *eous, platypus, djamor* or *sajorcaju.*

5. *Use of Rice Residues as Fodder for Animals:* Rice residues can be used as a fodder for animals. But, this is not a very popular practice among farmers in Punjab because of the high silica content in the rice residue. However, almost 40 % of the wheat straw produced in this state is used as dry fodder for animals. However, to encourage the use of rice residue as fodder for animals, a pilot project was taken up by Punjab State Council for Science & Technology PSCST at PAU, Ludhiana. Trials on natural fermentation of paddy straw for use as protein enriched livestock feed was conducted at PAU. The cattle fed with this feed showed improvement in health and milk production.

6. *Use of Crop Residue in Bio Thermal Power Plants:* Rice residue can also be used for generation of electricity. The thermal plant at Jalkheri, District Fatehgarh Sahib is the first Plant in India which is based on the use of Biomass i.e. renewable energy source. This plant can utilize rice husk, waste wood chips, the straw of various plants e.g. paddy, wheat, etc. for the generation of electricity. The project is providing additional income to thousands of farmers from the sale of agricultural waste as well as reducing the release of smoke and other pollutants caused by burning of wastes.

7. *Use of Rice Residue as Bedding Material for Cattle*: Studies on rice residue as

bedding material have been conducted by the Department of Livestock Production and Management, College of Veterinary Sciences, Punjab Agricultural University (now Guru Angad Dev Veterinary And Animal Sciences University) farmers of the state have been advised to use paddy straw as bedding material for crossbred cows during winters. This paddy straw bedding provides comfort, udder health and leg health to the animals resulting the increased quality and quantity of milk. It helps the animals to keep themselves warm and to maintain the reasonable rates of heat loss from the body. It also provides a clean, hygienic, dry, comfortable and non-slippery environment, which prevents the chances of injury. The use of paddy straw as bedding material was also found to result in increased net profit per animal per month from the sale of an additional amount of milk. The PAU has been demonstrating this technology to farmers through training courses, radio/TV talks and by distributing leaflets.

8. *Use of Rice Residues for Mushroom Cultivation:* Paddy straw is also being used for the cultivation of mushrooms such as *Agaricusbisporus*, *Volvariellavolvacea*, and *Pleurotus spp.* One kg of paddy straw yields 300, 120–150 and 600 g of these mushrooms, respectively. Paddy Straw Mushrooms (*Volvariellavolvacea*) also called grass mushrooms are so named for their cultivation on paddy straw. In addition to paddy straw, this mushroom can be grown on a variety of agricultural wastes for preparation of the substrate such as water hyacinth, oil palm bunch waste, dried banana leaves, cotton or wood waste. Paddy straw mushroom accounts for 16 % of total production of cultivated mushroom inthe world.
9. *Use of Rice Residues in Paper Production:* Paddy straw is also used as an ideal raw material for paper and pulp board manufacturing. The paddy straw is also being used in conjunction with wheat straw for paper production. The technology is already operationalin some paper mills, which are meeting 60 % of their energy requirement through this method.
10. *Use of Rice Residues for Making Bio Gas:* Biogas production from agricultural wastes canbe used as an alternative fuel to replace fossil fuels. Agricultural crop residues, such as rice straw is a chief source of lignocellulose which is required for biogas production.
11. *Production of Bio-oil from Straw and Other Agricultural Wastes:* Wheat straw and rice hull-shave been and is being used for the production of Bio-oil. But, the

feasibility of this technology with paddy straw needs to be assessed. Bio-oil is a high-density liquid produced from agricultural biomass through rapid pyrolysis technology. Bio-oil can be stored, pumped and transported like petroleum-based product and can be combusted directly in boilers, gas turbines and slow and medium speed diesel for heat and power applications.

12. *Mixing of Green Waste and Brown Waste for the Production of Bio-Compost:* Initiation of composting process depends upon the carbon and nitrogen ratio (C: N ratio) of 30:1 has been considered ideal for composting. To get a narrow C: N ratio (30:1), carbon and nitrogen-rich material should be mixed together. Nitrogen-rich sources are green colored waste materials like gliricidia leaves, parthenium, freshly harvested weeds; sesbania leaves whereas brown colored waste material like straw, coir dust, dried leaves and dried grassesare rich in carbon. To get a quicker result in composting, alternating layers of carbon-rich material, animal dung, and nitrogen-rich material need to be heaped while making heap formation. Regular addition of bio-compost to the field improves the physical, chemical and biological properties of the soil.

13. *Bio-Char:* PAU, Ludhiana has come up with an innovation to convert stubble into _biochar‘ which would help in reducing the environmental pollution upto a great extent and would also help in increasing the fertility of the soil. Dr. RK Gupta, a senior soil chemist, Department of Soil Sciences at the PAU, said the burning of the rice and wheat stubble leads to a loss of nutrients and the smoke caused by leads to air pollution. "We have been working on this project for the past three years and the experiments conducted have given a positive result. We found that making _biochar' from stubble, instead of burning it will help in reducing the environmental pollution caused by it by 70 percent," said Dr. Gupta. –After successful experimentation for three years now, we will be askingthe KVK of the PAU to make biochar and disseminate knowledge about it to the farmers so that they can also adopt this method,‖ he said. He said apart from curbing the pollution, using biochar as manure would help in improving the soil health, along with 10 percent increase in the grain yield. It also leads to the improvement in the infiltrationrate and water-holding capacity of the soil. Bio-char will help in improving the grain yield indirectly by improving the soil health (infiltration rate and water holding capacity of soil).

8.5 ENVIRONMENTAL LEGISLATIONS AND POLICIES FOR RESTRICTION OFAGRICULTURE RESIDUE BURNING IN PUNJAB

The core administrative bodies regulating emissions and promoting air quality in India are the Ministry of Environment, Forest and Climate Change (MoEF&CC), the Central Pollution Control Board (CPCB), and its subsidiaries at the state level. The board coordinates with the MoEF&CC and other institutions to provide efficient monitoring and control of air pollution- related problems. The major air quality legislation in India is the Air (prevention and control of pollution) Act established in 1982, under which the guidelines for air quality control were clearly outlined. The Air (prevention and control of pollution) Act together with the environmental (protection) Act provides the basis for monitoring air quality across the country. Other guidelines were stated by the Environment (protection) rule, 1986.

The Indian air quality monitoring program was initiated in 1967 and later established as the National Air Quality Monitoring Scheme (NAQMS). Under this scheme, the number of air quality monitoring stations was increased from 28 (in 1985) to 731 (in 2016). The stations were designed to measure sulfur dioxide (SO_2), NO_x, $PM_{2.5}$, PM_{10}, and meteorological parameters such as wind speed, wind direction, ambient temperature, ambient pressure, and relative humidity. Other pollutants like lead, ammonia, CO, H_2S, and aromatic hydrocarbons were later added. The national air quality index AQI in India was established on the 17th of November, 2014 by the MoEF&CC under the Swachh Bharat Abhiyan (Clean Air Campaign). It constituted 8 main criteria pollutants namely; PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3,NH_3, and lead.

The Hon‘ble Delhi High Court, on October 8, 2016, compelled the states of Uttar Pradesh, Delhi, Punjab, Haryana, and Rajasthan to execute an exhaustive policy to curb the issue of outdoor stubble burning at their respective provinces. Following this directive, the above states immediately enacted strict policies including fines on the burning of any stubble in their respective states. For example, in Haryana, on 26th November 2016, 1406 farmers were fined a total of 1.375 million rupees after been caught violating the policy.

In 2014, the Union government released the National Policy for Management of Crop

Residue. Since then, crop residue management has helped make the soil more fertile, thereby resulting in savings of Rs 2,000/hectare from the farmer‘s manure cost.

The Indian government in 2019, established the national clean air program (NCAP) to be implemented in the coming 5 years. The program was focused on bringing down the particulate matter emission to 20-30 % by 2024 taking 2017 as the base year. The program mandates a collaborative and participatory approach between agencies at various levels and all the stakeholders. It was also planned to address the transboundary transport of pollutants, by planting trees, worth 2.3 billion tons of CO_2 equivalent by 2060. Studies have reported that successful implementation of this goal would increase the average life expectancy of the country's populace by up to 2 years for the Northwest India‘s residents.

Male' declaration (1998) was focused on the promotion of clean air through the control and prevention of air pollution especially at the trans-boundary level in the southern part of Asia which covers the countries of India, Pakistan, Bangladesh, Nepal, Iran, Srilanka, Maldives, and Bhutan. After about 22 years of establishment, several policies were made by the Indian government but were, however, ineffective in tackling most of the pollution issues.

8.5.1 Steps taken in Punjab to Restrict Agriculture Residue Burning

In 2017, the Punjab government distributed direct seeders to many farmers which helped in easily incorporating the paddy straws into the soil. The government also proposed to reduce the cultivated area for paddy farming by about 7 Lakh acres by 2020, which is about 10% of the total paddy area cultivated in 2019.

The Ministry of New and Renewable Energy (MNRE), Government of India has installed about 500 power plants across the country fueled either completely or partially by biomass. Agricultural stubbles form a significant portion of the biomass used in many of these plants. For instance, the 10 MW thermal power stationed at Jalkheri, Fatehgarh Sahib District (established in 1992) is India's first plant focused on the use of biomass for power production.

The plant has an estimated total biomass requirement of 82,500 Mt annually at 100% capacity. The farmers (within the plant's vicinity) sell their crop stubble to be used in theplant at 350 rupees/ton (around 5 USD). This plant uses rice husk, waste wood chips, the straw of different plants e.g. paddy, wheat, etc. The project offers additional

revenues, through the sale of biomass stubbles, to thousands of farmers and also lessens the dischargeof particulates and other gases resulting from the waste burning.

Another plant with an installed capacity of 7.5 MW was established by Malwa Power Pvt. Ltd. in 2002 at Gulabewella in district Mukatsar, Punjab. The plant was set up to utilize the crop stubble (available in the area) such as mustard and cotton stalks, rice husk, and sawdust. It was designed with an estimated biomass requirement of 72,270 Mt annually to supply
465.1 GWh to the grid within 10 years (2005-2015).

In Bhatinda district the paddy straw was totally burnt with no other end use. In Amritsar district the use of rice residue for other uses apart from burning is the maximum with 18.2 % being used for fodder, 19.6 % being sold in the market and 9.4 % given to poor landless families. In the Gurdaspur district, 20.6 % of the rice residue is provided to poor landless families, 12.9 % used as fodder almost the rest of the rice stubble burnt. In Patiala district
11.7 % of the rice stubble is used as fodder for animals and 5.9 % sold in the market and the rest 81.5 % being burnt. In the Ferozepur district, 18.8 % of the rice stubble is provided topoor landless families, 8.8 % is incorporated in the soil and the rest 68.1 % is burnt. It can be observed that except Ferozepur district, the rice stubble is hardly incorporated in the soil in rest of the state.

However, for the wheat crop, a significant proportion of the stubble is used as fodder for animals, in 7 districts of Amritsar, Bhatinda, Faridkot, Gurdaspur, Kapoorthala, Ludhiana and Sangrur, the average being 47 %. Only in the Gurdaspur district 2.4 % of the wheat stubble is incorporated in the soil.From the literature it is clear that farmers seldom incorporate rice and wheat stubble in the soil. Wheat stubble is used as fodder for animals, but the usage of rice stubble as fodder for animals is not much. The paper mills procured rice-straw at a rate of Rs. 200–300 t^{-1}. The wheat straw was generally sold after making chaff. The price of chaff varied between Rs. 2,500 and 3,700 ha^{-1}.

Different management techniques for rice and wheat stubble in Punjab, India

Management method	Rice (Percent Total stubble)	Wheat (Percent Total stubble)
Incorporation into soil	1	<1
Fodder	7	45
Rope making	4	0
Burnt	81	48
Miscellaneous	7	7

In cognizance of this fact, Department of Farm Power and Machinery, Punjab Agricultural University has developed Happy Seeder machine to solve the problem of straw management in collaboration with CSIRO Land and Water Resources, Australia, under financial assistance from Australian Centre for International Agricultural Research (ACIAR). The machine is compact and lightweight and is tractor mounted. It consists of two separate units, a straw management unit and a sowing unit. The Happy Seeder can handle the paddy straw and do the sowing job without any tillage. It consists of straw cutting and chopping unit and a sowing drill combined in one machine. It sows the seed of next crop in one operational passof the field, while retaining the rice residue as surface mulch.

Though there are some apprehensions such as increased chances of rodents, etc., the many advantages of adopting the technology are as under:

1. Allows sowing of wheat even when stubble is standing in the field. This is finally incorporated into the soil.
2. Mulching effect of straw causes weed suppression.
3. Possibility of saving first irrigation by sowing wheat in residual moisture.
4. Leads to conservation of water due to moisture retention. There is no loss of nutrients.

This environment friendly technology will prove a boon to the farmer community and the state can help them in making provision of this tool for improving soil health and environment for sustainable agriculture. The Happy Seeder machine has low adoption because of its high price and less popularity among the farmers. The state although is providing subsidy on Happy Seeder but it needs to make the farmers

educated on the various benefits of Happy Seeder machine. The state needs to undertake demonstration of this technology to make the farmers understanding this technology appropriately. There is also need to encourage farmers adopting Happy Seeder by developing cooperatives or farmers groups and provide the facility to the small and marginal farmers through custom hiring bas

CHECK YOUR PROGRESS

Ques. 1 Answer the following Short Answer type Questions:

i. The residues of …….and …… crops are major contributors to the total stubbleloads in India.

ii ..... can damage the tissue of plants and cause discoloration inthem.

iii. The states of India which are the largest producers of wheat are:
   a. Punjab, Haryana, Western U.P and Uttrakhand
   b. Punjab, Uttar Pradesh, Gujarat, Maharasthra
   c. U.P, Uttarakhand, Haryana, parts of Delhi
   d. None of the above

iv. Paddy straw can be used for..... which is another way of wealth generation.

v. The Act that makes it mandatory for farmers in Punjab to transplant paddy lateduring the Kharif season to prevent loss of water is the:
   a. The Punjab Preservation of Subsoil Water Act, 2009
   b. Farmers and Farm Workers Commission Act, 2017
   c. The APMC Act, 1961
   d. None of the above

8.6 SUMMARY

After studying this chapter, it has been observed that:

- Stubble burning is a practice of removing the crop residue from the field for sowingthe next crop.
- Since the combine harvester leaves crop residue behind, so the farmers clear the fieldby burning the stubble.

- The burning of crop residues generates numerous environmental problems likeemission of greenhouse gases (GHGs) that contributes to the global warming,

  increased levels of particulate matter (PM) and smog that cause health hazards, loss of biodiversity of agricultural lands, and the deterioration of soil fertility
- Several steps can be taken to reduce crop residue burning such as finding an alternate usage of paddy straw and other crop residues, providing subsidy on mechanical implements that help tillage of the soil
- Alternatively, the stubble or the crop residue can be managed by in-situ incorporation, i.e. allowing the stubble to decompose in the field itself, using Happy Seeder technique, allowing the decomposition of rice straw, selling off the crop residue for electricity generation by thermal plants, etc.
- Stubble or crop residue can also be used for making paper, bio-gas and bio-oil which can further augment the incomes of the farmers.
- Various regulatory measures and legislations have been adopted by the govt of India to control the level of pollution and gas emissions that are released into the air because of stubble burning.
- However, there is still need for more efforts and support to be provided by the state governments in the form of financial incentives and subsidies so that the farmers are encouraged to either allow their stubble to decompose naturally or are facilitated so as to use their stubble as an additional source of income generation.

8.7 QUESTIONS FOR PRACTICE

Ques 1. Why is the issue of Stubble Burning so significant from the point of view of Environment protection?

Ques. 2 Discuss the impact of crop residue burning on the

environment? Ques 3. How does stubble burning cause health hazards

to the human beings?

Ques. 4 What kind of policy measures should be adopted to prevent stubble

burning?Ques. 5 Examine the main causes of stubble burning in the northern

states of India?

8.8 SUGGESTED READINGS

- R. Rajagopalan, Environmental Studies : From Crisis to Cure, 2015
- Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses,2021
- B.S. Chauhan, Environmental Studies, 2008
- P.S. Jaswal, Environmental Law, 2021
- S.R. Myneni, Environmental Law, Asia Law House, Hyderabad