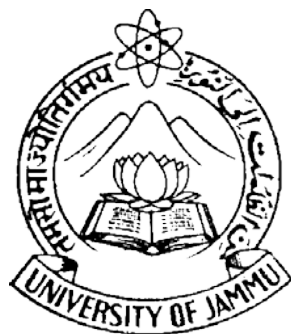


Centre for Distance & Online Education

UNIVERSITY OF JAMMU

JAMMU



SELF LEARNING MATERIAL

B.Ed.

SEMESTER-III

**SUBJECT : ENVIRONMENTAL EDUCATION & DISASTER
MANAGEMENT**

UNIT : I-IV

Course No. : 303

LESSON NO. : 1 to 13

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Printed and Published on behalf of the Centre for Distance & Online Education,
University of Jammu, Jammu by the Director, CD&OE, University of Jammu, Jammu

<http://www.distanceeducationju.in>

ENVIRONMENTAL EDUCATION & DISASTER MANAGEMENT

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**Bachelor of Education (B.Ed) through Open and Distance Learning (ODL)
Semester –III**

(For the examination to held in the year 2025, 2026 & 2027)

Course no. 303	Title: Environment Education & Disaster Management
Credits 4	Total Marks : 100
Maximum Marks Internal : 30	Maximum Marks External : 70
Duration of Exam : 3hrs	

OBJECTIVES:

To enable the pupil- teachers to:

- understand the need of environmental Education.
- develop a sense of Awareness about the environmental pollution and possible hazards and its causes and remedies.
- know various ways and means to create healthy environment.
- acquire knowledge about disaster management.

Unit-I

1. Meaning, need and scope of environmental education.
2. Objectives of environmental education at primary and secondary level.
3. Types of pollution –sources, effects and control of pollutions
4. Evolution and Development of environmental education.

Unit-II

1. Environmental Hazards –causes , effects and its remedies.
2. Acid rains ozone depletion, impact of deforestation and global warming.
3. Population and Ecosystem concepts of ecosystem, components of ecosystem- Abiotic and Biotic

Unit-III

1. Biodiversity, conservation of Genetic diversity.
2. Learning to live in harmony with nature.
3. Miscellaneous Environmental issues:
 - a) Forest and conservations,
 - b) Wild life and its conservation

Unit-IV

Disaster Management : Disaster- Natural and man made: strategies to tackle disaster: Timed and untimed disasters: Role of teachers in the disaster management : the schools and community participation.

Disaster Management and its outcome on education:

Students and their fallout of disaster on education : how to rebuild the educational program and role of management in overcoming the disaster to the system of education – role of students and teachers collaborations, the community supports.

Sessional work

- Work on a project related to any issue of environmental preservation and protection.
- Prepare a scrap file on environmental issues.
- Celebration of various days in relation with environment.
- Tree plantation drive

Note for Paper Setters

The Question paper consists of 9 questions having Q no 1 as Compulsory having four parts spread over the entire Syllabus, with a weightage of 14 marks. The rest of Question paper is divided into four Units and the students are to attend four Questions from these units with the internal choice. The essay type Question carries 14 marks each. Unit IV having the sessional work/field work (section) could also be a part of the theory paper.

Internship/field work Unit IV having the components/activities of the internship are to be developed in the form of the Reflective Journal. All the activities under the internship are to be evaluated for credits and hence all the activities are to be showcased by the trainee and are to be fully recorded with the complete certification of its genuineness.

The Theory paper is to have 70 marks (external) . 30 Marks are for the In House activities

Books recommended

- AGGARWAL, J.C. (2007): *Education for values ,environment and human rights*, Shipra publications, Delhi.
- Dani, H. M. (1996): *Environmental Education*. Publication Bureau, Punjab University, Chandigarh.
- Kohli, V.K. and Kohli, V (2000): *Environmental Pollution and Management*. Vivek Publishers, Ambala.
- Nanda, V.K. (1997): *Environmental Education*, Anmol Publications, New Delhi.
- Reddy, K.P. and Reddy, D.N. (2002): *Environmental Education*. Neelkamal Publications Pvt. Ltd, Hyderabad..
- Sharma, R.C. *Environmental Education*, Metropolitan Book Pvt. Ltd.
- Sungosh, S.M. (2006): *An introduction to Environmental Education*, Akashi Book Depot, Shillong.
- Trivedi, R.N. (1990): *Dimensions of safe environment*, Anmol Publications, New Delhi.

ENVIRONMENTAL EDUCATION & DISASTER MANAGEMENT
COURSE NO. : 303
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	Lesson-2	Objectives of environmental education at primary and secondary level.	Dr Sanjay Sharma
	Lesson-3	Types of pollution, sources, effects and control of pollutions	Dr Rakesh Atri
	Lesson-4	Evolution and Development of environmental education.	Dr Sanjay Sharma
Unit-II	Lesson-5	Environmental Hazards : causes, effects and remedies.	Dr. Mohd. Zia-UI-Haq Razaqi
	Lesson-6	Acid rains, ozone depletion, impact of deforestation and global warming.	Dr. Mohd. Zia-UI-Haq Razaqi
	Lesson-7	Population and Ecosystem concepts of ecosystem, components of ecosystem- Abiotic and Biotic.	Dr. Mohd. Zia-UI-Haq Razaqi
Unit-III	Lesson-8	Biodiversity, conservation of Genetic diversity.	Prof. Piyush Malaviya
	Lesson-9	Learning to live in harmony with nature.	Dr. Rakesh Atri
	Lesson-10	Miscellaneous Environmental issues: a) Forest and conservations, b) Wild life and its conservation	Dr. Deepika Slathia

Unit No	Lesson No	Title of Lesson	Name of the Script Writer
Unit-IV	Lesson-11	Disaster Management: Disaster- Natural and man made: strategies to tackle disaster: Timed and untimed disasters: Role of teachers in the disaster management: the schools and community participation.	Prof. Sudarshana Rana
	Lesson-12	Disaster Management and its outcome on education.	Prof. Sudarshana Rana
	Lesson-13	Students and fallout of disaster on their education: how to rebuild the educational program and role of management in overcoming the disaster to the system of education, role of students' and teachers' collaborations, the community supports.	Prof. Sudarshana Rana

**MEANING, NEED AND SCOPE OF ENVIRONMENTAL
EDUCATION (EE)**

Structure

- 1.1 Introduction
- 1.2 Objectives
- 1.3 Meaning and definitions of Environment and Environmental Education
 - 1.3.1 Concept of environment
 - 1.3.2 Meaning of Environmental Education
 - 1.3.3 Definitions of Environmental Education
- 1.4. Need of environmental education:
 - 1.4.1 Goals of Environmental Education
 - 1.4.2. Classification of environmental education
- 1.5 Scope and importance of environmental education:
 - 1.5.1 Scope of environmental Education
 - 1.5.2 Importance of environmental education
- 1.6 Let Us Sum Up
- 1.7 Lesson End Exercise
- 1.8 Suggested Further Readings
- 1.9 Answers to Check Your Progress

1.1 INTRODUCTION

The deteriorating environment of the earth has prompted us to understand the sources of environmental pollution and in turn their proper management to achieve sustainable environment. To achieve sustainability education especially Environmental Education is one of the major priorities of a country. The rationale behind the concept of environmental education is that we are ourselves a renewable resource and there is a need to train ourselves to restore the degrading environment. The youth in particular is the vital

resource, as the future of the civilization is dependent on them. This lesson is a process to promote among the learners awareness and understanding of the concept of environment and environmental education and aim to develop interest towards environment and work for its maintenance, conservation and improvement.

Environmental education enables learners to develop a structure of knowledge about the world and seek knowledge that they can use and develop throughout their lives. Environmental education also empowers learners by enabling them to participate in a sustainable future. Thus the foundation for a lifelong learning is laid by environmental education. This lesson will enable the students to get well versed with the meaning of environmental education, it's need, role and scope and will make you understand, why environmental education is necessary in the present day scenario along with its scope in the future.

1.2 OBJECTIVES

After going through this lesson, you shall be able to:

- explain the concept of environment and it's components,
- state and define environmental education,
- explain the significance and need of environmental education in present day situation,
- discuss the nature, types, scope and importance of environmental education, and
- create among people the faith in conservation of bio-diversity and describe relationship between population and environment.

1.3 MEANING AND DEFINITION OF ENVIRONMENT AND ENVIRONMENTAL EDUCATION

1.3.1 Concept of environment

Before we discuss the concept of environmental education it is pertinent to first understand the environment. Our concern with regard to environment is for the existence of entire mankind existing on earth and the generations to follow. Environment literally means surrounding, in which we are living. Environment includes all those things on which we are directly or indirectly dependent for our survival, whether it is living component like animals, plants or non living component like soil, air water. According to Boring 'A person's

environment consists of the sum total of the stimulation which he receives from his conception until his death.' It can be concluded from the above definition that Environment comprises various types of forces such as physical, intellectual, economical, political, cultural, social, moral and emotional. Environment is the sum total of all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms.

According to Douglas and Holland: 'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms.'

Environmental Protection Act (1986) defined "Environment as the sum total of water, air and land, their interrelationship among themselves and with the human beings, other living beings and property."

The environment consists of three segments of the earth namely atmosphere, hydrosphere and lithosphere :

1. Atmosphere:

The Atmosphere is a distinctive protective layer of about 100 km thickness around the earth. A blanket of gases known as atmosphere surrounds the earth and protects the surface of earth from the Sun's harmful, ultraviolet rays. It sustains life on the earth. It also regulates temperature, preventing the earth from becoming too hot or too cold and absorbs most of the cosmic rays and filter harmful ultra violet rays. The atmosphere has a marked effect on the energy balance at the surface of the Earth.

2. Hydrosphere:

The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reservoirs, polar icecaps, glaciers, and ground water. Oceans represent 97 percent of the earth's water and about 2 percent of the water resources is locked in the polar icecaps and glaciers. Only about 1 percent is available as fresh water as surface water in rivers, lakes, streams, and as ground water for human use.

3. Lithosphere:

Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil e.g. minerals, organic matter, air and water.

Livable components of atmosphere, hydrosphere and lithosphere is called Biosphere.

The fate of every life that inhabits the planet including that of human beings is linked with environment. The industrialization brought about devastating impacts on the environment and at the end of the nineteenth century, people started to apprehend the susceptibility of the environment and the gravity of the implications if the environment is not saved from it. Nations gathered and issues regarding environment were initiated on priority, hoping to obtain and sustain a better future for our planet. In spite of rapidly changing lifestyles, the traditions of living in harmony with nature and of environmentally sound practices underpin the lives of most people. Education including formal education, public awareness and training are recognized as educational process by which human beings and societies can reach their fullest potential. Education is also critical for promoting sustainable development and improving the capacity of the people to address environmental and developmental issues. Human demands are never ending. It is against this background that the Environmental Education (E.E.) strategy has evolved.

1.3.2 Meaning of Environmental Education

Man is only one of the millions of species existing on earth and at the same time is exploiting nature to an extent that nobody will escape from the harms caused by them. Environmental education is being pushed so that people become aware of the harm they are causing to the mother Earth. Environmental Education is basically an awareness program in which participation of everyone is compulsory. Environmental education is an approach to study of human interactions with the natural environment. It integrates different approaches of the humanities, social sciences, biological sciences and physical sciences and applies these approaches to investigate environmental concerns. Environmental study is a key process for bringing about the changes in the knowledge, values, behaviors and lifestyles of the people, required to achieve sustainability and stability within and among countries. Environmental education also deals with every issue that affects an organism. It is essentially a multidisciplinary approach that brings about an appreciation of our natural world and human impacts on its integrity. Environmental education is an applied approach which seeks practical answers to make human civilization sustainable. Its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health, Anthropology, Economics, Statistics, Philosophy, etc. with the thrust on:

1. To clarify modern environmental concept like how to conserve biodiversity.
2. To know the more sustainable way of living.
3. To use natural resources more efficiently.
4. To know the behaviour of organism under natural conditions.
5. To know the interrelationship between organisms in populations and communities.

6. To aware and educate people regarding environmental issues and problems at local, national and international levels.

Various terms such as Environmental Education (E. E.), Environmental study (E.S.) and Environmental Approach (E.A.) are being used in the literature in the context of environment and education. Although, Environmental Education, Environmental Studies and Environmental Approach have different meanings but these are being used many a time synonymously and interchangeably. In this lesson we will strictly talk of environmental education.

1.3.3 Definitions of Environmental Education

According to the Ministry of Environment and Forest, Government of India (2006), Environmental education can be defined as 'a process of recognizing values and clarifying concepts in order to develop skills and added tools necessary to understand and appreciate the interrelationships among man, his culture and his biophysical surroundings. Environmental education is a process to disseminate awareness and understanding of the environment and its relationship with man and his activities. It is also aimed to develop responsible actions necessary for preservation, conservation and improvement of the environment and its components.

Environment education denotes a study of environment and its dynamics, environmental degradation and its various forms, factors degrading environment and its impact on man's life. Environment education is education 'about' the environment, 'from' the environment and 'for' the environment. According to a report of conference of African Educators at Nairobi (1968) "Environmental Education is to create an awareness and understanding of the evolving social and physical environment as a whole, its natural, man-made, cultural, spiritual resources together with the rational use and conservation of these resources for development."

The IUCN Commission of Education (1970) stated that "Environmental Education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his bio-physical surroundings."

According to Mishra (1993) environmental education appears to be the process that equips human with awareness, knowledge skill, attitudes and commitment to improve environment.

1.4. NEED OF ENVIRONMENTAL EDUCATION

In today's world because of industrialization and increasing population, the natural resources have rapidly been utilised and our environment is being increasingly degraded by human activities, so we need to protect the environment. It is not only the duty of

government but also of the people to take active role for protecting the environment so that protection of our environment is more economical and viable as compared to the damage caused once the action has been taken. National Policy on Education, 1986, has laid great stress on the need for introducing environmental education at all educational levels. It states that, "There is a dire need to create a consciousness of the environment among all the ages and all sections of the society". The need of E.E. can be highlighted through following points:

- The need of environmental education is to provide moral and ethical education to people for changing their attitude.
- to protect children living in polluted regions, environmental education represents a relevant means of prevention.
- it is need of the hour to propose the environmental education with these essential elements of moral philosophy.
- the moral and ethical education for changing people's attitude.
- to protect children living in polluted regions, environmental education represents a relevant means of prevention.

1.4.1 Goals of Environmental Education

Environmental education is a process that equips human beings with goals of inculcating a) awareness and sensitivity about concerns of economic, social, political and ecological interdependence in urban and rural areas b) to provide every person with opportunities to acquire the knowledge and understanding c) promotion of positive attitudes and values, d) commitment and development of skills needed to protect and improve the environment, e) To create new patterns of behavior of individuals, groups and society as a whole towards the environment and f) encompassing, both environmental training and information.

Environmental education is the need of the hour keeping in view that world is facing numerous crisis. Thousands of animals and trees are dying due to human activities. Steps must be taken to preserve our mother earth. When we teach people early on about the importance of the environment, we pave way for a healthier and greener environment.. Environmental Education can bring about much-needed change. To educate people about environment is a comprehensive lifelong education process in response to outcomes of the rapidly changing world. The individuals have to be prepared for life, through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to play a productive role towards improving life and protecting the environment with due regard given to ethical values (UNESCO, 1977).

1.4.2. Classification of environmental education

The major ways to organize environmental education are through

1. Informal Education
2. Formal Education

1. Informal education:

Informal education is a term used for education that takes place outside of a structured curriculum. It works through conversation, and the exploration and enlargement of experience. The process of informal education includes educating people where the target groups are adults, rural youth and non student youth. The activities involved are Eco development camps, public participation, Foundation courses, trained manpower development, development of education material and teaching.

2. Formal education

Formal education is given in schools, colleges and a university, etc., and is limited to a specific period and has a well defined and systematic curriculum. At school level it is at a). Primary School stage b) lower secondary stage, c) Higher Secondary School stage. The other stages are e. college stage and f. University education.

The disciplines included in environmental education are environmental sciences, environmental engineering and environmental management.

1. Environmental studies: This is concerned with environment disturbance and minimization of their impact through change in the society.

2. Environmental Sciences: It deals with the study of environmental system which include the processes in water, air, soil, land and to minimise the pollution and impact of the induced changes which can be considered acceptable clean, safe and healthy for human and natural ecosystem

3. Environmental engineering: It deals with the study of technical processes which are used in the protection of environment from the potentially deleterious effects of human activity and improving the environmental quality for the health and well beings of humans.

4. Environmental Management: It is management of physical, social and economic environment of the enterprise or projects. It encourages planned investment at the start of the production chain rather than forced investment in cleaning up at the end.

Check your Progress -1

Note: (a) Answers the question given below:

(b) Compare your answer with those given at the end of the lesson:

- a. Environment is some total of and factors
- b. Biosphere is:
- (i) The solid shell of inorganic materials on the surface of the Earth
 - (ii) The thin shell of organic matter on the surface of earth comprising of all the living things
 - (iii) The sphere which occupies the livable part of all the spheres
 - (iv) All of the above
- c. Define environmental education.
- d. The classification of environmental education was given by
- e. Which one of the following is an abiotic component of the ecosystem?
- (a) Bacteria
 - (b) Plants
 - (c) Temperature
 - (d) Fungi
- f. Environmental education is important only at
- (a) Primary school stage
 - (b) Secondary school stage
 - (c) Collage stage
 - (d) All stages

1.5 SCOPE AND IMPORTANCE OF ENVIRONMENTAL EDUCATION

1.5.1 Scope of environmental education

Environmental education discipline has multiple and multilevel scopes. This is important and necessary with regard to i) Conservation of natural resources, ii) ecological aspects, iii) pollution of the surrounding natural resources, iv) controlling the pollution, v) social issues connected to it, and vi) impacts of human population on the environment. The scope of environmental education is summarized as follows:

1. The study creates awareness among the people to know about various renewable and nonrenewable resources of the region. The estimates of potential utilization patterns and the available balance of various resources for future use can be assessed. It enables theoretical knowledge into practice and the multiple uses of environment.
2. It teaches the citizens about the need of sustainable utilization of resources as these resources are inherited from our ancestors and have to be passed on to future generations without deteriorating their quality and quantity.

3. The necessary information about biodiversity and the potential threats to plant, animal, species in the environment.
4. The ability to understand the causes and impacts due to natural and manmade disasters and suggest mitigation measures to minimize the effects is enhanced.
5. The evaluation of alternatives can be done before setting up any project or deciding an action.
6. It enables the individuals to acquire knowledge about ecological systems and cause and effect relationships.
7. It teaches the citizens the need for sustainable utilization of resources as these resources are inherited from our ancestors to the younger generation without deteriorating their quality.
8. The ability of citizens to understand the problems of over population, their living quality, health, hygiene, etc. and be solved through environmental education.
9. Through environmental education adoption of green technology and development of appropriate indigenous eco-friendly skills and technologies can be initiated to resolve various environmental issues.
10. The awareness regarding environmental acts, rights, rules, legislations, etc. is created among the citizens to take appropriate decisions for the protection and improvement of environment of the earth.
11. It enables theoretical knowledge into practice and the multiple uses of environment.

The scope of environmental education can be divided into biological, physical and sociological aspects as described below:

Biological aspect: Biological aspect is the most important aspect of environmental education. In this particular aspect living organisms such as human beings, animals, birds, insects, microorganism, plants, are included.

Physical aspect: It refers to natural and manmade aspects which include air, water, land, climate, etc. in natural physical aspects whereas Man made physical aspects cover things such as roads, buildings, bridges, houses, etc. constructed by human.

Sociological and cultural aspect: Socio-cultural aspects are man-made social practices, rules and laws, and religious places, etc. created by them.

1.5.2 Importance of environmental education

The environmental education is important for the following reasons:

1. To understand the trends of increasing World population at an alarming rate, especially in developing countries, and its impacts on environment.

2. As the natural resources endowment in the earth is limited.
3. The methods and techniques of exploiting natural resources have become advanced.
4. The resources are over-exploited and there is no foresight of leaving the resources to the future generations.
5. The unplanned exploitation of natural resources lead to pollution of all types and at all levels.
6. The pollution and degraded environment seriously affect the health of all living things on earth, including man.
7. The people should take a combined responsibility for the deteriorating environment and begin to take appropriate actions to save the earth.
8. Education and trainings are needed to save the biodiversity and species extinction.
9. The urban area, coupled with industries, is major sources of pollution.
10. The number and area extent under protected area should be increased so that the wild life is protected at least in these sites.
11. Environmental study is a key instrument for bringing about the changes in the Knowledge, values, behaviors and lifestyles required to achieve sustainability and stability within and among countries.
12. The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.
13. The study motivates students to get involved in community action, and to participate in various environment and management projects.
14. It is a high time to reorient educational systems and curricula towards these needs.
15. Environmental education takes a multidisciplinary approach to the study of human interactions with the natural environment.

Check your Progress -2

Note: (a) Answers the question given below:

(b) Compare your answer with those given at the end of the lesson:

i) With regards to Scope of environmental education write any four important and necessary aspects

a.

b.

c.

d.

ii) **Biological aspect of environmental education is** _____

- iii) **Sociocultural aspect of environmental education** is _____
- iv) The urban area, coupled with industries, is major source of pollution True/ False
- v) In Sustainable development resources are over-exploited and there is no possibility of leaving the resources for the future generations. True/ False

1.6 LET US SUM UP

Environmental education (E.E.) deals with every issue that affects human and other living organisms. Approaches of teaching environmental education are multidisciplinary and interdisciplinary that induces or inculcates, among the individuals or society as a whole, appreciation for our natural world and to counter the human impacts on its integrity. E. E. is a study of the factors influencing ecosystems, mental and physical health, leaving and working condition, decaying cities and population pressures. Environmental Education is the process of recognizing values and clarifying concepts related to environment and its problems in order to develop skills and attitudes necessary to understand the environment. It makes learners to perceive and understand the concept of environmental protection by creating awareness among the people and incorporate values in their lifestyles. Environmental education is a key to achieve these goals and objectives. E. E. also entails practice in decision making and it aims to make the citizens competent to do scientific work and to find out practical solutions to current environmental problems.

Environmental Education has significance and includes all i.e. from children adults to improve the environment of individuals as well as society. E.E is instrumental in the maintenance of living standards and health of people, preserving and conserving nature, to stimulate concern for environment for the welfare of mankind.

1.7 LESSON END EXERCISE

1. What is Environment? Discuss the scope of Environment.
2. Describe the importance of environment education.
3. Discuss the scope of environment.
5. "The need for public awareness about environment is of vital importance."

Discuss.

6. Discuss the various types of environmental education.

Short Answer Type Questions

1. Define environment.
2. Formal education.

3. Informal education
4. Write a note on the importance of environment studies.
5. Write a note on the need of public awareness about environment.
6. Write a note on physical environment.
7. Write a note on biological environment
8. Write about the types of education

1.8 SUGGESTED FURTHER READINGS

Bharucha, E. (2015). Textbook of Environmental Studies for Undergraduate Courses, 2nd ed. New Delhi: University Grants Commission.

C. E. E. (1994). Essential Learning in Environmental Education. Ahmadabad: C.E.E. Publication.

Nanda, V.K. (2010). Environmental Education. New Delhi: Anmol Publications Pvt. Ltd.

N.C.E.R.T. (1981). Environmental Education of the School Level: A Lead Paper. New Delhi:

NCERT Publication.

Singh, P.S. (2017). Textbook of Environmental Education. New Delhi: Pacific Books International.

Tbilisi UNESCO-UNEP. (1977). First Intergovernmental Conference of Environmental Education, Final Report, USSR.

1.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

- a. Biotic and Abiotic
- b. iii
- c. Environmental education can be defined as 'a process of recognizing values and clarifying concepts in order to develop skills and added tools necessary to understand and appreciate the interrelationships among man, his culture and his biophysical surroundings.
- d. Newman e. c f. d

Check Your Progress 2

- i. a. Sociological b. Physical c. Cultural d. Biological
- ii Environmental education with regards to all living beings
- iii Environmental education with regards to man made norms, values, rules and regulations, etc. devised in the society.
- iv. True
- v. False

**OBJECTIVES OF ENVIRONMENTAL EDUCATION
AT PRIMARY AND SECONDARY LEVEL**

Structure

- 2.1 Introduction.
- 2.2 Objectives
- 2.3 Environment - as a medium of learning.
- 2.4. The guidelines and objectives of Environmental Education.
 - 2.4.1. Broad Guidelines for Environmental Education
 - 2.4.2. The Objectives of Environmental Education
- 2.5 Classification of Environmental Education
- 2.6 Objectives and focus of environmental education at primary and secondary school levelsA
 - 2.6.1 Primary school stage
 - 2.6.1.1. Objectives of Environmental Education at Primary Level
 - 2.6.1.2 . The Focus of environmental education at primary school level
 - 2.6.2 Secondary school stage
 - 2.6.2.1 Objectives of environmental education at secondary level
 - 2.6.2.2 The Focus of environmental education at secondary school level
- 2.7 Curriculum for Environmental Education at school level
- 2.8 Let Us Sum Up
- 2.9 Lesson End Exercise
- 2.10 Suggested Further Readings
- 2.11 Answers to Check Your Progress

2.1 INTRODUCTION

Man and environment are interdependent. Due to various developmental processes the condition of environment is deteriorating day by day. The natural resources are facing irreparable damage. A society cannot survive if its natural resources are rendered unfit for use. Science and technology can help only in a limited way but creating awareness amongst the people and encouraging them to work for conservation and preservation of environment. This is only possible when environmental education is included in the curriculum at various stages of formal education along with non formal environmental education targeting adults,

school dropouts, housewives and others. The present lesson will be instrumental in promoting the understanding of environmental education its aims and objectives, especially formal education at school level i.e at primary and secondary levels. By going through the lesson the learners will be enabled to work as ambassadors of environmental related education to teach students at various levels such as primary and secondary through formal and informal platforms.

2.2 OBJECTIVES

After going through this lesson, you shall be able to:

- explain how we can learn through environment,
- classify the types and levels of environmental education,
- explain and elaborate on the guidelines and objectives of environmental education,
- elaborate on the objectives and focus of environmental education in schools i.e. at primary and secondary school levels,
- identify various aspects on which emphasis has to be given while devising curriculum for environmental education, and
- enumerate some essential tips for using curriculum in the classroom situation.

2.3 ENVIRONMENT - AS A MEDIUM OF LEARNING

Education through the environment implies utilizing the surroundings itself as a resource for the educational purpose. The environment itself is the most effective and readily available tool for environmental education. Activities which take place outdoors are of utmost importance especially with the younger generation which tends to learn more through direct observation and experience. Appreciation of our surroundings is not something that could be learnt merely in a classroom, but requires an investment of time spent in nature. Environmental education is also a part of adult education because it is needed by all citizens at all ages to make their lives better, systematic and prosperous. Environmental education will help to improve the quality of life of the people and will conserve environment.

Environmental education (EE) refers to organized efforts to teach about how natural environments function and, particularly, how human beings can manage their behavior and ecosystems in order to live sustainably. The term is often used to imply education within the school system, from primary to post-secondary. However, it is sometimes used more broadly to include all efforts to educate the public and other audiences, including print

materials, websites, media campaigns, etc. Related disciplines include outdoor education and experimental education.

For this purpose, it is important that environmental themes be integrated to the curricula of general education schools. Legislation and regulations valuing environmental awareness are not enough on their own in order to improve the environmental awareness of the population

2.4. THE GUIDELINES AND OBJECTIVES OF ENVIRONMENTAL EDUCATION

The report of the First-Inter-Governmental Conference on Environmental Education, Tbilisi, USSR (1977) organized by the United Nations Education, Scientific and Cultural Organization (UNESCO) in cooperation with the U.N. Environment Programme (UNEP) provides the following broad guidelines for Environmental Education:

- The Conference recommended the adoption of certain criteria which will help to guide efforts to develop environmental education at the national, regional, and global levels:
- To make an effective contribution towards improving the environment, educational action must be linked with legislation, policies, measures of control, and the decisions that governments may adopt in relation to the human environment.
- The Conference endorses the following goals, objectives and guiding principles for environmental education:

2.4.1. Broad Guidelines for Environmental Education:

Environmental education should:

- i. Be interdisciplinary and multidisciplinary in its approach.
- ii. Consider the holistic view of environment.
- iii. Be continuous, beginning at the pre-school level and continuing through all the formal and non-formal stages.
- iv. Examine the major environmental issues critically from the local, regional, national and international point of view;
- v. Dwell on the current and future environmental trends and scenarios;
- vi. Help learners discover the symptoms and real causes of environmental problems and plan accordingly
- vii. Spread awareness amongst the masses and implement programmes of eco-protection and eco-restoration.

- viii Understand the growth of population and its interpretation for socio-economic development.
- ix. Understand the utilization of physical and human resources and suggest remedial measures for optimum development.
- x. Make aware of the village community about natural aspects of environment and it's restoration.
- xi. Orient the rural community to general rules of hygiene, proper disposal of wastage and other waste products.
- xii. Explain the hazardous effects of environmental pollution and measures to protect them from their fatal effects.
- xiii. Create new patterns of behaviour of individuals, groups and society as a whole towards the environment.
- xiv. Study the impact of environmental pollution and changes on the life of man.
- xv. Evolve population control ideas, devices and measures and to adopt them to deal with environmental degradation and its consequences

2.4.2 The Objectives of Environmental Education:

The basic Objectives of Environmental Education are to create:

- **Awareness:** to help individuals and social groups especially school going children to acquire an awareness and sensitivity to the total environment and its allied problems.
- **Knowledge:** to help children to gain varied experiences to acquire a basic understanding of, the environment and its associated problems. This is most important as the more the youth learn about their surroundings, the more they will tend to care about it.
- **Attitudes:** to help the children to inculcate in them values and consciousness towards the environment and also to motivate them for actively participating in environmental management and protection. Reinforcing this category, the attitudes of school going children is a major focus of many environmental education programmes.
- **Skills:** to help youth acquire the skills for identifying and solving environmental problems.
- **Participation:** to provide an opportunity for children to prepare them for actively involved at all levels of decisions pertaining to solution of environmental problems in future. The serious environmental education aims to motivate them to take responsible actions.

2.5 CLASSIFICATION OF ENVIRONMENTAL EDUCATION

A. Broad classification of environmental education

The environmental education can be broadly classified into two classes

- a. Formal environmental education
- b. Informal environmental education

a. Formal environmental education

Formal environmental education generally means the education we get in schools colleges and this type of education is characterized by classroom teaching and well structured syllabus. The teacher teaches the theoretical as well as practical problems on real life situation. Formal Environmental Education is increasingly a prominent part of primary, secondary and tertiary education now a day. The formal education sector plays a vital role in environmental education and awareness by exposing the younger generation to the information, issues, analyses and interpretations on environment and development.

b. Informal environmental education

Informal environmental education is characterized by no students; instead there are learners or participants; there is no teacher; instead there is a program planner and facilitator; there is no formal curriculum with a set commencing and completion time - but there is a thoughtful approach which is learner motivated, guided by learner interests, voluntary, personal, collaborative and open-ended. In order to be successful, many of the current environmental education takes place in informal settings. Many organizations operate with the goal of fostering personal connections between participants and the environment to encourage pro-environment behaviors and attitudes.

I. Under formal education New Man (1981) gave a three-fold classification i.e.

1. Environmental studies: this is concerned with environment disturbance and minimization of their impact through change in the society.

2. Environmental Sciences: it deals with the study of the process in water, air, soil, etc. which help in establishing a standard which can be considered acceptable clean safe and healthy for human and natural ecosystem

3. Environmental engineering: this is the study of technical process which are used to minimise the pollution and impact of these environment engineering sciences

II. Levels of Formal environmental education in India

The various levels of Formal environmental education in India encompasses

a) School stage

The education system in India had incorporated certain aspects of environment in school curricula as early as 1930. The Kothari commission (1964-66) also suggested that basic education had to offer EE and relate it to the life needs and aspirations of the people and the nation. At the primary stage, the report of Kothari commission recommended that " the aims of teaching science in the primary schools should be to develop proper understanding of the main facts, concepts, principles and processes in physical and biological environment" Environmental education is an essential part of every pupil's learning. It helps to encourage awareness of the environment, leading to informed concern for active participation in resolving environmental problems.

At school level environmental education can be provide at three levels i.e.

- i. Primary School stage
- ii. lower secondary stage
- iii. Higher Secondary School stage

Environmental education at primary, secondary and higher secondary levels is treated in a different way.

b) The other levels at which environmental education is provided are:

- i. College stage
- ii. University stage

At College level in environmental education the emphasis is given on Teaching in four areas which include environmental engineering, conservation engineering, environmental health and ecology and environmental studies. Whereas, at university stage, three main components are considered which are Teaching, Research and Extension. At this level there are some major areas which have been recognised and these are Environmental sciences, Environmental Ecology, Environmental Engineering, Environmental management, etc. and also along with them non formal education which include adult education, rural youth and non student youth The activity involves Eco development camps public representative Foundation courses research and development programme development at trained manpower development of education material.

Check your Progress -1

Note: (a) Answers the question given below:

(b) Compare your answer with those given at the end of the lesson:

- i. Environment is a very important educator for human beings . True / False
- ii. Environmental education is not important for all age groups . True / False
- iii. First-Inter-Governmental Conference on Environmental Education was held in

iv. Write five basic objectives of environmental education i.e. development of:

- | | | |
|----|----|----|
| a. | b. | c. |
| d. | e. | |

v. According to Newman (1981) Environmental education can be classified as

- | | | |
|----|----|----|
| a. | b. | c. |
|----|----|----|

2.6 OBJECTIVES OF ENVIRONMENTAL EDUCATION AT PRIMARY AND SECONDARY LEVELS

Environmental education at primary school stage and its objectives is explained as under.

2.6.1 Primary school stage

At primary level environmental education is provided as a compulsory subject, as part of a compulsory subject area (normally science) or as an interdisciplinary theme in primary education. The actual approaches adopted for the teaching of environmental education at this stage differ and there are three main models identified, which are:

- Environmental education as a subject area in its own right;
- Environmental education embedded in specific subjects of the curriculum;
- Environmental education addressed through topics or themes in the curriculum that are addressed in an inter-disciplinary manner.

2.6.1.1 Objectives of Environmental Education at Primary Level

- (a) To make students know and understand the true aspects of the environment in general.
- (b) To make the students know and understand the various interactions between man and its environment which include animals, plants and their physical various elements and components of the environment
- (c) To build understanding, awareness and sensitivity towards causes and effects that continuously take place in society the world around us.
- (d) The development of skills in thinking, reasoning, enquiring, evaluating and making decisions among the students which concern human and the world around them.
- (e) Inculcate in the students attitude in using the knowledge and skills towards problem solving and issues related to individuals, society and the environment as a whole.
- (f) To build the values and attitudes towards the need and necessity to live together in harmony in the context of the heterogeneous society.

2.6.1.2 The Focus of environmental education at primary school level

The Focus of environmental education at primary school level should be kept on that:

1. Human, animal and plants undergo a number of life-processes.
2. The adaptability of Human, animals and plants to the environment is continuous
3. The Human are dependent on environment to fulfill numerous living needs and should alter and modify the environment with great caution.
4. The Identification of various interactions between human and nature and between environmental elements which give rise to various phenomena which affect them.
5. Enough steps will be taken by the society to conserve the environment and the balance of nature through careful plans and processing.

At Primary School stage maximum emphasizes should be on building up awareness and conservation and attempts should be to sensitize the child about environment. The content used for teaching should be the surroundings and situation around home and school. The outdoor teaching strategy including audio visual and field visits should be adopted.

It has been observed that the environmental education curriculum at primary level generally addressed in geography and sciences but it is also addressed in other areas e.g social studies. The important themes which are also emphasized at primary level are ethics, values, attitudes and behavior.

2.6.2 Objectives of environmental education at secondary level

In most of the countries environmental education is either a compulsory subject or part of a compulsory subject area (normally science) or interdisciplinary theme in lower secondary general/academic or compulsory education. At secondary level also the three models identified and mentioned at 2.6.1 are also followed in secondary school level.

At secondary schools, environmental concepts are infused into the courses of physics, chemistry, biology and geography. At the same time, the teachers use local examples to help develop environmental understanding among the students.

2.6.2.1. The Objectives of Environmental Education at Secondary Level

Environmental education is to be taught as integrated science in which environmental education Concepts are included.

1. To emphasize the relevance of science to daily life.
2. To develop a scientific attitude in student.
3. To create an environmental conducive to greater reliance on the use of principles and practices of science.
4. To acquaint the student's with various natural phenomena.
5. To develop an outlook which emphasizes the method employed in different disciplines of science.

2.6.2.2 The Focus of environmental education at Secondary school level

Aspects of Environmental Education on which the emphasis should be given at Secondary Level

(a) Population: Growing population and problems of unplanned population are the prime reasons for the environmental degradation which give rise to disasters, urbanization, migration of people to other areas, land use changes, etc..

(b) Land and its uses: The knowledge with regard to faulty land use practices indiscriminate land use changes lack of proper land use planning, conversion of prime agriculture land to non agriculture use, etc. and laws pertaining to Land use, land reclamation and land and soil conservation.

(c) Types of resources and their uses: The knowledge with regard to various natural resources, their types, resource uses and their conservation, recycling and proper utilization to achieve sustainability.

(d) Food and nutrition: Availability of food for everyone, availability of safe and nutritious food, balance diet, sustainable food production..

(e) Conservation: Conservation of wildlife, plant, soil, water and other non-renewable natural beauty.

(f) Pollution: to provide knowledge and awareness about sources of pollution pollution by insecticide and other chemicals and waste disposals causing air, water, land, soil, etc., their mitigation, use of green technologies to reduce pollution.

(g) Health and Hygiene: Individual, family, country and social health and hygiene, health hazards, etc.

(h) Humans and Nature: People are dependent on environment for procuring various products for domestic use and as raw material for industries. In return human dispose wastes in the form of domestic and industrial waste to the environment. The concept of sustainable development has to be adopted.

2. 7 CURRICULUM FOR ENVIRONMENTAL EDUCATION AT SCHOOL LEVEL

Children are resource of a nation and the future of a civilization is dependent on them. There has been an increased concern and activities for Environmental Education (E.E.) during the last two to three decades. The purpose is to create man's interest in preservation, conservation and improvement of the environment before it is too late and reaches the point of no return. Environmental education has been perceived differently by various educationalist and thinkers. They differ in its objectives, the kinds of activities that

are used to achieve the objectives and resources to attain these ends. It is the vastness and variety of the area of E.E. that necessitates taking holistic view of the various aspects of E.E. This will help us to see its strength and weakness and draw conclusions for the future. It is common to use the term 'environmental education' for different meanings. For the sake of clarity and to avoid ambiguity it is necessary to define Environmental education.

The Government of India announced a National Policy on Education in 1986. While recognizing the guidelines for imparting environment education, it emphasizes that, "there is a paramount need to create an environmental consciousness." The emphasis should be given on conservation, assimilation of knowledge identification of problem and how to act skills. Contents should be science based and action based.

The approach for environmental education should lay emphasis on various aspects, also suggested by NCERT, and some of the important one are discussed under head 2.6.2.1.

Environmental education empowers individuals, groups and institutions to properly explore environmental issues along thoughts and activities for environmental sustainability. It seeks to develop deeper understanding of the environment across divides.

Check your Progress-2

Note: (a) Answers the question given below:

(b) Compare your answer with those given at the end of the lesson:

- i. Which of the models given is not correct
 - a. Environmental education as a subject area in its own right;
 - b. Environmental education only through education institutes
 - d. Environmental education embedded in specific subjects of the curriculum;
 - c. Environmental education addressed through inter-disciplinary curriculum.
- ii. Formal environmental education is provided in classrooms with developed curriculum
True/ False
- iii. In environmental education the emphasis at primary school level is not given on ethics, values, attitudes and behavior.
True/ False
- iv Unplanned population growth is the prime reason for disasters True/ False
- v. Write any five aspects on which emphasis is to be given in curriculum of Environmental education

a. b. c. d. e.

2.8 LET US SUM UP

Formal environmental education is the education we receive in schools, colleges and Universities through classroom teaching and structured syllabi. Formal Environmental Education is a important part of primary, secondary and tertiary education. The students

are taught to protect and conserve their surroundings, human health, nutrition of people, rural development, slum improvement, prevention of food contamination, love for plants and animals, sensitize them towards environmental problems, developing skills for solving environmental problems.

The teachers involved in teaching of environmental education at school level need to be prepared to become environmental education facilitators. For this the guidelines and objectives regarding environmental education at school level should be well defined. It is a fact that teachers are potential change agents and are capable of creating awareness, attitude, knowledge, skills, etc. among the students and generating a workforce of enlightened, skilled and motivated learners. They can empower students with the ability, attitude and values to protect the environment using formal and non formal channels of education. It is essential that teachers themselves need to be trained and equipped with the requisite knowledge skills and values to bring such a change by emphasizing and identifying some focus areas such as growing population, natural resources, land and land use, pollution of air, water, land, etc., health and nutrition of people, conservation of wild life, plants, etc. The formal environmental education at primary and secondary levels needs a well defined curriculum which should dwell upon key areas

The educators involved in Environmental Education should utilize creative teaching methods such as group work, drama, problem solving techniques, outside class observations and investigations, participation by the pupils, games and plays.

2.9 LESSON END EXERCISE

1. Define formal education. How environment can be a medium of learning?
2. Write a note on broad guidelines and objectives for environmental education.
3. Write a note on environmental education and its objectives at primary school stage.
4. Write a note on environmental education and its objectives at secondary school stage.
5. Describe briefly the development of curriculum for environmental education at school level.

2.10 SUGGESTED FURTHER READINGS

Aggarwal, S.K. (1997). Environmental Issues Themes. New Delhi: APH Publishing Corporation.

C.E.E (1994). Essential Learning in Environmental Education. Ahmadabad: C.E.E. Publication.

Nanda. V.K. (2005), Environmental Education. New Delhi: Anmol Publications Pvt. Ltd.

N.C.E.R.T. (1981). Environmental Education of the School Level: A Lead Paper. New Delhi: NCERT Publication.

Singh, P.S. (2017). Textbook of Environmental Education. New Delhi : Pacific Books International.

2.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

i. True; ii. False; iii. Tbilisi USSR; iv. Skill, Attitude, Knowledge, Awareness and Participation v. Environmental studies, Environmental Sciences and Environmental management

Check Your Progress 2

i. b, ii. True, iii. False, iv. True
v. Population, Types of resources and their uses, Food and nutrition, Pollution and Conservation.

TYPES OF POLLUTION, SOURCES, EFFECTS AND CONTROL OF POLLUTIONS

Structure

- 3.1 Introduction
- 3.2 Objectives
- 3.3 Types of Pollution and their Sources
 - 3.3.1 Air Pollution
 - 3.3.2 Water Pollution
 - 3.3.3 Soil Contamination
 - 3.3.4 Radioactive Contamination
 - 3.3.5 Others:
 - 3.3.5.1 Light pollution
 - 3.3.5.2 Invasive Species
 - 3.3.5.3 Radio spectrum pollution
 - 3.3.5.4 E-waste or WEEE
- 3.4 Effects of Pollution
 - 3.4.1 Effects on Human Health
 - 3.4.2 Effects on Plants and Animals
 - 3.4.3 Effects on Environment and Ecosystems
 - 3.4.4 Climatological Effects
- 3.5 Prevention and Control Strategies of Pollution
 - 3.5.1 Waste Minimization
 - 3.5.2 Applying Pollution Control Technologies
 - 3.5.3 Strict Environment Compliance and Enforcement Mechanisms
- 3.6 Let Us Sum Up
- 3.7 Lesson End Exercise
- 3.8 Suggested Further Readings
- 3.9 Answers to Check Your Progress

3.1 INTRODUCTION

Human domination of Earth's ecosystems have altered their structure and functioning, and how they interact with the atmosphere, with aquatic systems, and with surrounding land. Human activities are causing environmental degradation, which is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution. "The rates, scales, kinds, and combinations of changes occurring on Earth now are fundamentally different from those at any other time in history; we are changing Earth more rapidly than we are understanding it. In a very real sense, the world is in our hands and how we handle it will determine its composition and dynamics, and our fate." (Vitousek et al., 1997).

Environmental pollution can be defined as the accumulation and adverse effects of contaminants or pollutants on human health and welfare, and/or the environment. Although the terms pollutant and contaminant both refer to undesirable or unwanted substances or materials, a pollutant is a substance that pollutes the environment, and a contaminant is a substance that contaminates the environment. Keller (1988) defined pollution is "a substance that is in the wrong place in the environment, in the wrong concentrations, or at the wrong time, such that it is damaging to living organisms or disrupts the normal functioning of the environment." Contaminants mostly originate from human activities, but can also result from natural processes such as arsenic dissolution from bedrock into groundwater, or air pollution from natural fires, volcanic eruptions, dust storms etc. Pollutants are also ubiquitous in that they can be in the solid, liquid, or gaseous state. Majority of pollutants predominantly occur directly through activities such as mining or agriculture, industrial and vehicular emissions. Other classes of pollutants can occur due to poor waste management or disposal, which can lead to the presence of pathogenic microorganisms in water. Some pollutants originate due to accidental spillage of organics that can be toxic, such as chlorinated solvents or petroleum hydrocarbons that contaminate groundwater, oil spills in the oceans, accidental damage to nuclear power plants etc. Severity of a pollutant depends on its chemical nature, the concentration, the area affected and the persistence.

3.2 OBJECTIVES

After going through this lesson, you will be able to:

- explain environmental pollution: types and their sources,
- discuss health, ecological and climatological effects of pollution, and
- discuss strategies for prevention and control of pollution

3.3 TYPES OF POLLUTION AND THEIR SOURCES

Pollution does not have to produce physical harm always; pollutants such as noise and heat may cause injury but more often cause psychological distress, and aesthetic pollution such as foul odours and unpleasant sights affects the senses. Pollutants can be classified as biodegradable or non-biodegradable, primary or secondary etc. Based on their origin, sources pollution can be classified as point sources and non-point sources. A point source of pollution is a single identifiable source and has negligible extent e.g. factories, power plants, municipal sewage treatment, forest fire, storm water discharges etc. Nonpoint source (NPS) pollution is pollution resulting from many diffuse sources, e.g. vehicular emissions, atmospheric deposition, drainage, land runoff, etc. Some major categories and types of pollution are listed in Table 3.1 and discussed below along with their sources:

TABLE 3.1 Categories and Types of Pollution

Pollution Categories	Type of Pollution	
Air pollution	Acid rain	Global distillation
	Chlorofluorocarbon	Particulates
	Global warming	Smog
	Global dimming	Ozone depletion
Water pollution	Eutrophication	Surface runoff
	Hypoxia	Thermal pollution
	Marine pollution	Wastewater
	Marine debris	Waterborne diseases
	Ocean acidification	Water quality
	Oil spills	Water stagnation
	Ship pollution	
Soil contamination	Bioremediation	Pesticides
	Electrical resistance heating	Soil Guideline Values (SGVs)
	Herbicides	
	Actinides in the environment	Plutonium in the environment
Radioactive contamination	Environmental radioactivity	Radiation poisoning
	Fission products	Radium in the environment
	Nuclear fallout	Uranium in the environment
	Invasive species	Radio spectrum pollution
Others	Light pollution	Visual pollution
	Noise pollution	

(Source: Spellman, 2017)

3.3.1 Air pollution: Air pollution occurs when harmful or excessive quantities of substances are introduced into Earth's atmosphere mostly from the human activities such as industrial and vehicular emissions, stubble burning, dust from constructions etc. Air pollution is a major environmental problems in the urban centers especially in the developing countries like India and China. According to the 2019 World Air Quality Report published by IQ Air, India accounts for 14 of the top 20 most polluted cities of the world. Air pollution causes the deaths of around 7 million people worldwide each year, and is the world's largest single environmental health risk. In 19th century, episodes of "smog" (a combination of smoke and fog) in cities like New York and London resulted in many deaths. Cities like Delhi are almost inhabitable in winters due to very high pollution loads. Emissions of Sulfur dioxide and Nitrogen oxide into the atmosphere produce acids which precipitate down as acid rains with pH value lower than 5.7. Downwind locations in the industrial area like those in the Scandinavian region have been the most affected from the acid rain. Ozone layer in the stratosphere protect the living world underneath from harmful UV radiation. Its gradual thinning from the release of chlorine or bromine containing gaseous chemical compounds like Chlorofluorocarbons (CFCs) and most pronounced in the Polar Regions was reported in 1969 by Paul Crutzen. CFCs used in refrigeration and in foam industry were the primary cause of ozone depletion. Subsequently with the discovery of ozone depletion, their usage was banned along with other Ozone depleting Substances (ODS) under Montreal Protocol (1988). Latest scientific data have indicated the healing of Ozone hole in the North Pole. Six major air pollutants viz. carbon monoxide, lead, ground-level ozone, nitrogen dioxide, particulate matter, and sulfur dioxide have been classified as criteria pollutants by USEPA under the Clean Air Act. Suspended particulate matter, or fine dust are of particular concern because of their high concentrations in the urban environments. Particulate matter (PM) is further categorized into PM_{10} (particles with diameter upto 10 micrometers) and $PM_{2.5}$ (particles with diameter upto 2.5 micrometers). Worldwide regulatory bodies such as Central Pollution Control Board (CPCB) in India, have devised National Ambient Air Quality Standards (NAAQS) which sets limits on atmospheric concentration of harmful pollutant in the ambient atmospheres.

3.3.2 Water pollution: Water pollution is the contamination of water bodies, such as lakes, rivers, oceans, aquifers and groundwater by the discharge of wastewater from commercial and industrial waste into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; eutrophication and natural contamination from Arsenic, Fluoride etc. Water pollution can be classified as surface water or groundwater pollution. Sources of water pollution are either be point sources or non-point sources. All plants and organisms living in or being exposed to polluted

water bodies can be impacted. Water pollution is the leading worldwide cause of death and disease, e.g. due to water-borne diseases. Elevated temperatures can also lead to polluted water. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. Elevated water temperatures or thermal pollution decrease oxygen levels, which can kill fish and alter food chain composition, reduce species biodiversity, and foster invasion by new thermophilic species. Groundwater supplies are the major source of drinking water in India. However, groundwater aquifers are susceptible to contamination. Pathogens like *Cryptosporidium parvum*, *Giardia lamblia*, *Salmonella*, *Norovirus* and other viruses, Parasitic worms (helminths) cause disease when they are present in public drinking water supplies. Coliform bacteria and faecal matter may also be detected in runoff. These bacteria are a commonly used indicator of water pollution. Pathogens may contaminate runoff due to poorly managed livestock operations, faulty septic systems, improper handling of pet waste, the over application of human sewage sludge, contaminated storm sewers, and sanitary sewer overflows.

Oil spills and disposal of debris has been one of the major problem of Marine pollution thus threatening oceanic biodiversity. Surface run off with rivers carry with them a large mass of waste products such chemicals, organic contaminants, plastic etc. into the marine and coastal environments. The increased concentration of chemicals, such as nitrogen and phosphorus, in the coastal ocean promotes the growth of algal blooms, which can be toxic to wildlife and harmful to humans. Marine oil spills happens when oil is released into the ocean or coastal waters as crude oil leakage from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products and their by-products, heavier fuels used by large ships etc. Such spills may take weeks, months or even years to clean up. Some notable oil spill episodes are Lakeview Gusher in California, USA, Atlantic Empress oil spill in Trinidad and Tobago, Taylor Energy in United States, Gulf of Mexico.

3.3.3 Soil Pollution: The soil is the home for a large part of bacterial biodiversity and other microscopic and macroscopic living organisms. The concern over soil contamination stems primarily from health risks, from direct contact with the contaminated soil, vapours from the contaminants, or from secondary contamination of water supplies within and underlying the soil. Some major causes of soil pollution are discussed below:

- a) **Pesticides and Herbicides:** Pesticides like DDT, aldrin, Dieldrin, carbamates, organophosphates etc. and herbicides like arsenite, sodium chlorate etc. are one of the main causes of soil pollution. Most of these compounds are insoluble in water and non-biodegradable or have longer residence times. These chemicals will not gradually decompose and often bio-accumulate from lower to higher trophic level via the food chain. Hence, it will cause many metabolic and physiological disorders in humans.

- b) **Inorganic Fertilizers and inferior irrigation practices:** Excessive use of inorganic nitrogen fertilizers leads to acidification of soil and contaminate the agricultural soil. Poor irrigation methods increase the soil salinity. Moreover, excess watering, improper maintenance of canals and irrigation channels, lack of crop rotation and intensive farming gradually decreases the quality of soil over time and cause degradation of land.
- c) **Industrial activities:** Dry deposition and the incorrect way of chemical waste disposal from different types of industries can cause contamination of soil. Human activities like this have led to acidification of soil and contamination due to the disposal of industrial waste, heavy metals, toxic chemicals, dumping oil and fuel, etc. Coal mining and power generation produce large amounts of solid waste as coal fly ash and mining tails which are one the biggest reason of soil contamination especially from the heavy metals.
- d) **Vehicular emissions:** Vehicular emissions and wear and tear of machinery and tyres is one of the major cause of heavy metal contamination high traffic density locations. Moreover, oil spills from vehicles contaminates soils in the adjoining region. Tetraethyl lead used as an anti-knocking agent in the petrol had been a major source of lead contamination in the urban top soils and roadside deposited sediments.
- e) **Solid waste:** Disposal of plastics, cans, and other solid waste falls into the category of soil pollution. Disposal of electrical goods such as batteries causes an adverse effect on the soil due to the presence of harmful chemicals. Lack of proper waste disposal, regular constructions can cause excessive damage to the soil due to lack of proper drainage and surface run-off.

3.3.4 Radioactive contamination: Radioactive contamination is the deposition of, or presence of radioactive substances on surfaces or within solids, liquids or gases, where their presence is unintended or undesirable (International Atomic Energy Agency). Such contamination presents a hazard because of the radioactive decay of the contaminants, which produces such harmful effects as ionising radiation (namely and rays) and free neutrons. The degree of hazard is determined by the concentration of the contaminants, the energy of the radiation being emitted, the type of radiation, and the proximity of the contamination to organs of the body. The sources of radioactive pollution can be natural and man-made. Following an atmospheric nuclear weapon discharge or a nuclear reactor containment breach, the air, soil, people, plants, and animals in the vicinity will become contaminated by nuclear fuel and fission products. Cases of widespread radioactive contamination include the Fukushima Daiichi nuclear disaster, the Chernobyl disaster, Three miles island nuclear accident, USA.

3.3.5 Others:

3.3.5.1 Light pollution: Light pollution is the presence of artificial light in otherwise dark conditions. The term is most commonly used in relation to in the outdoor environment, but is also used to refer to artificial light indoors. Light pollution competes with starlight in the night sky for urban residents, interferes with astronomical observatories, and, like any other form of pollution, disrupts ecosystems and has adverse health effects. Its sources include building exterior and interior lighting, advertising, outdoor area lighting (such as car parks), offices, factories, streetlights, and illuminated sporting venues.

3.3.5.2 Invasive Species: An invasive species is a species that is not native to a specific location, and that has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health. Such species may be either plants or animals and may disrupt by dominating a region, wilderness areas, particular habitats, or wild land-urban interface land from loss of natural controls. The movement of people and goods around the world increases the opportunity for introduction of invasive species.

3.3.5.3 Radio spectrum pollution: Radio spectrum pollution is the straying of waves in the radio and electromagnetic spectrums outside their allocations that cause problems for some activities. It is of particular concern to radio astronomers.

3.3.5.4 E-waste or WEEE: E-waste means the "waste electrical and electronic equipment (WEEE)" and includes all types of electronic equipment/ products which have become obsolete, and are at the near end of their useful life by their owners or have been discarded due to rapid advancement in technology. E-waste has been one of the fastest growing waste streams in the world as a variety of harmful substances are contained in E-waste such as Mercury, Lead, Brominated Flame Retardants (BFR), Cadmium etc. are harmful for humans as well as other flora and fauna. Most importantly, E-waste also contains some precious metals like gold, silver, copper etc. which can be extracted economically through scientific disposal of E-waste. India has enacted the E-Waste (Management) Rules, 2016 which were amended in 2018 for the management handling and disposal of E-waste.

Check Your Progress-I

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. What are point sources of pollution?

.....

2. Global warming is caused by?

3. Eutrophication is a type of water/soil/air pollution?
.....
4. What are invasive species?
.....
5. CFC stands for?
6. Ozone layer protects us from radiations?
7. Ozone hole was reported by which scientist?
.....
8. Ozone depleting substance are banned under which protocol?
.....

3.4 EFFECTS OF POLLUTION

Environmental pollution has negative effect on natural elements that are an absolute need for life to exist on earth, such as water and air. Effects of environmental pollution can be broadly classified as

3.4.1 Effects on Human health: Adverse air quality can kill many organisms, including humans. Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water by untreated sewage in developing countries. Over ten million people in India fell ill with waterborne illnesses in 2013, and 1,535 people died, most of them children. The WHO estimated in 2007 that air pollution causes half a million deaths per year in India. Studies have estimated that the number of people killed annually in the United States could be over 50,000. Ozone pollution can cause respiratory disease, cardiovascular disease, throat inflammation, chest pain, and congestion. Nearly 500 million Chinese lack access to safe drinking water. Oil spills can cause skin irritations and rashes. Noise pollution induces hearing loss, high blood pressure, stress, and sleep disturbance. Mercury has been linked to developmental deficits in children and neurologic symptoms. Older people are majorly exposed to diseases induced by air pollution. Those with heart or lung disorders are at additional risk. Children and infants are also at serious risk. Lead and other heavy metals have been shown to cause neurological problems. Chemical and radioactive substances can cause cancer and as well as birth defects.

3.4.2 Effects on Plants and Animals: Environmental pollution mainly affects animal by causing harm to their living environment, making it toxic for them to live in. Acid rains can change the composition of rivers and seas, making them toxic for fishes. Toxic heavy metals are released into the water at lower pH values. Nitrogen and phosphates in water will cause overgrowth of toxic algae, preventing other forms of life to follow their normal

course resulting in eutrophication. Eventually, soil pollution will cause harm and sometimes even the destruction of microorganisms, which can have the dramatic effect of killing the first layers of the primary food chain. As for animals, plants, and especially trees, can be destroyed by acid rains. High ozone in the lower parts of the atmosphere can cause lung problems to all animals. Ozone in the lower atmosphere block the plant respiration, and harmful pollutants can be absorbed from the water or soil. Light pollution poses a serious threat in particular to nocturnal wildlife, having negative impacts on plant and animal physiology. It can confuse the migratory patterns of animals, alter competitive interactions of animals, change predator-prey relations, and cause physiological harm.

3.4.3 Effects on environment and ecosystems: Pollution has been found to be present widely in the environment. There are a number of effects e.g. biomagnifications is the situations where toxins (such as heavy metals) may pass through trophic levels, becoming exponentially more concentrated in the process. Carbon dioxide emissions cause ocean acidification of the oceanic, the ongoing decrease in the pH of the Earth's oceans as carbon dioxide is resulting in bleaching of coral reefs. Invasive species can outcompete native species and reduce biodiversity. Invasive plants can contribute debris and biomolecules that can alter soil and chemical compositions of an environment, often reducing native species competitiveness. Smog and haze can reduce the amount of sunlight received by plants to carry out photosynthesis and leads to the production of tropospheric ozone which damages plants. Soil can become infertile and unsuitable for plants. This will affect other organisms in the food web. Sulfur dioxide and nitrogen oxides can cause acid rain which lowers the pH value of soil. Acid rains can change the composition of rivers and seas, making them toxic for fishes, an important quantity of ozone in the lower parts of the atmosphere can cause lung problems to all animals. Organic pollution of watercourses can deplete oxygen levels and reduce species diversity.

3.4.4 Climatological effects: Carbon dioxide emissions has increased by over 30% since industrial revolution reaching to the present levels of 400 PPM. Carbon dioxide along with other Greenhouse gases (GHGs) is responsible for global warming triggering climate change. Global warming is disastrous for the planet as it affects the natural meteorological conditions and increase the frequency of extreme events such as floods, dry spells, thunder storms, heat waves etc. Moreover increase in carbon dioxide also lowers the pH of oceanic water resulting in acid bleaching of the coral reefs. Fighting climate change is one of the biggest environmental challenge of present generation. Under Paris agreement of 2015, a number of nation states have resolved to decrease their respective GHGs concentration by adopting greener technologies.

Check Your Progress -II

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. NAAQS stands for?

.....

2. Thermal pollution results in increase/decrease in dissolved oxygen in water?

.....

3. Which bacteria is commonly used as an indicator of water quality?

.....

4. Other terms used for E-waste is?

5. Name the latest nuclear disaster triggered by tsunami in Japan?

.....

6. Toxic heavy metals are released into water at high/low pH?

3.5 POLLUTION: PREVENTION AND CONTROL STRATEGIES

Pollution control is an essential task. There are four types of control: legal, social, economic, and technological measures, which help to prevent the pollution by various methods of operations.

3.5.1 Waste Minimization: Waste minimisation is a set of processes and practices intended to Reduce the amount of waste produced. The famous "three R's" of waste management i.e. reduce, Reuse and Recycle provides an important guide towards waste minimization. A small lifestyle change could less the burdens of landfills. Moreover, this could eliminate a number of toxic inorganic and organic pollutants from our environment. Reuse means by taking, but not reprocessing, previously used items, helps save time, money, energy and resources. Recycling is the process of converting waste materials into new materials and objects. Furthermore, the replacement of the non-biodegradable products by biodegradable e.g. replacement of plastic/polythene by paper could be utmost importance for the improvement of ecosystem. In industry, using more efficient manufacturing processes and better materials generally reduces the production of waste. The application of waste minimisation techniques has led to the development of innovative and commercially successful replacement products.

3.5.2 Applying Pollution Control Technologies: Pollution control devices are a series of devices that work to prevent a variety of different pollutants, from entering the environment primarily out of industrial units. Common pollution control devices used to control air pollutants are, Electrostatic precipitators, Fabric filters, Cyclones Cyclonic spray scrubber,

mechanically aided scrubber, Spray tower etc. For sewage treatment, a combination of primary treatment (sedimentation) and secondary treatment (activated sludge biotreaters, aerated lagoons, and constructed wetlands) techniques are employed. Industrial waste water treatment may require more sophisticated techniques using Biofilters, Dissolved air flotation, Powdered activated carbon treatment, Ultrafiltration etc. Another important techniques is Phytoremediation, which is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater.

3.5.3 Strict Environment Compliance and Enforcement Mechanisms: Strengthening enforcement and compliance systems are of particular interest in the context of designing policies that can help minimize and control pollutants. The Government of India has enacted key national laws for the prevention and control of industrial and urban pollution such as Water (Prevention and Control of Pollution) Act of 1974, amended in 1988, Water (Prevention and Control of Pollution) Cess Act of 1977, amended in 1991, Air (Prevention and Control of Pollution) Act of 1981, amended in 1987, Environment (Protection) Act of 1986 (EPA) etc. In addition to the Constitutional mandate, India has a number of national policies governing environmental management, including the National Policy on Pollution Abatement (NPPA, 1992) and the National Conservation Strategy and Policy Statement on Environment and Development (NCS/PSED, 1992) with aims for prevention of pollution at source; adoption of best available technology; the polluter pays principle; and public participation in decision making Building on earlier policies. The Central Pollution Control Board (CPCB) of India established in 1974 is a statutory organisation under the Ministry of Environment, Forest and Climate Change It was under the Water (Prevention and Control of pollution) Act, 1974. The CPCB with oversight powers over state boards has been entrusted with the powers and functions under various acts for the prevention and control of pollution in the country.

Check Your Progress -III

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. What is bio-magnification?

.....

2. Acidification of oceans is caused by high/low levels of dissolved carbon dioxide?

.....

3. Which gaseous pollutants in the atmosphere cause acid rain?

.....

4. Under which agreement in 2015, different nations have resolved to decrease their greenhouse gas emissions?

.....

5. What are the famous "three R's" of waste management?

.....

6. Name some Pollution control devices?

.....

7. CPCB stands for?

3.6 LETS SUM UP

Environmental pollution is an outcome of human arrogance. Anthropogenic activities have disturbed the structure and functioning of Earth's ecosystems. Deterioration of environmental goods have risked humans also. Humans are nowadays surrounded by the different types of pollutants present in varying concentrations. Immediate measures through technological interventions and restorations of natural ecosystems are required to abate the menace the environmental pollution. Sustainable development provides a new paradigm for working and living in harmony with nature through establishment of a balance between the needs of the present generation with the responsibilities owed to future generations. Small lifestyle change could less the burdens of landfills. The famous "three R's" of waste management i.e. reduce, Reuse and Recycle provides an important guide towards waste minimization. The technological intervention like usage of pollution control devices, sewage treatment plants, bio-remediation etc. is vital for the minimization and control of environmental pollutants. Furthermore, strengthening, enforcement and compliance systems are of particular interest in the context of designing policies for prevention of pollution at source; adoption of best available technology; the polluter pays principle; and public participation etc. is an important cornerstone for the dealing with environmental pollutants.

3.7 LESSON END EXERCISE

1. What do you mean by Environmental Pollution? Discuss the various types of pollution?
2. Discuss the sources of Environmental pollution? What is E-waste?
3. Discuss the health and ecological effects of environmental pollutants?
4. What the various measures to control the pollutants? Discuss the role of legal enforcement mechanisms in the control of pollution?

3.8 SUGGESTED FURTHER READINGS

Hill, M.K. (2010). Understanding Environmental Pollution. United Kingdom: Cambridge University Press.

Khopkar, S. M. (2018). Environmental Pollution Monitoring and Control. New Delhi: New Age International Private Limited.

Narayanan, P. (2014). Environmental Pollution: Principles, Analysis & Control. New Delhi: CBS Publishers and Distributors Pvt. Ltd.

Rao, C.S. (2018). Environmental Pollution Control Engineering. New Delhi: New Age International Publishers.

3.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress -I

- (1) A point source of pollution is a single identifiable source and has negligible extent
- (2) Greenhouse gases
- (3) Water
- (4) An invasive species is a species that is not native to a specific location
- (5) Chlorofluorocarbons
- (6) Ultraviolet
- (7) Paul Crutzen
- (8) Montreal Protocol

Check Your Progress -II

- (1) National Ambient Air Quality Standards
- (2) Decrease
- (3) Coliform bacteria
- (4) WEEE
- (5) Fukushima Daiichi nuclear disaster
- (6) Low

Check Your Progress -III

- (1) Biomagnification is the situations where toxins (such as heavy metals) may pass through trophic levels, becoming exponentially more concentrated in the process.
- (2) High
- (3) Sulphur dioxide and Nitrogen dioxide
- (4) Paris agreement
- (5) Reduce, Reuse and Recycle
- (6) Electrostatic precipitators, Fabric filters, Cyclones Cyclonic spray scrubber, mechanically aided scrubber, Spray tower etc.
- (7) Central Pollution Control Board

EVOLUTION AND DEVELOPMENT OF ENVIRONMENTAL EDUCATION

Structure

- 4.1 Introduction
- 4.2 Objectives
- 4.3. Concept of Environmental Education
- 4.4 Evolution of environmental education
- 4.5 Development of environmental education:
 - 4.5.1 Major Developments in Environmental Education
 - 4.5.1.1 . The Stockholm declaration:
 - 4.5.1.2. The International Workshop on Environmental Education (1975)
 - 4.5.1.3. Inter-governmental Conference on Environmental Education (Tbilisi)
 - 4.5.1.4. World Commission on Environment and Development (WCED)
 - 4.5.1.5. United Nations Conference on Environment and Development (Earth Summit)
 - 4.5.1.6. Agenda 21 (1992)
 - 4.5.1.7. UNESCO Thessaloniki Declaration (1997)
- 4.6 Development of environmental education in India
- 4.7. Let Us Sum Up
- 4.8 Lesson End Exercise
- 4.9 Suggested Further Readings
- 4.10. Answers to Check Your Progress

4.1. INTRODUCTION

This chapter focuses on the history and development of Environmental Education in the world with special reference to India. Environmental Education has a rich and varied past with range of multi- disciplines. The presentation in this lesson is primarily chronological. The present lesson emphasize on some contextual and sequential aspects with an objective to provide readers with a clear overview of the background and power of Environmental Education.

4.2. OBJECTIVES

After going through this lesson, you shall be able to:

- understand the concept of environmental education,
- have a grasp over the concept and significance of environmental education,
- understand how the concept of environmental education evolved over the years,
- understand the process of development and the efforts put in to promote environmental education,
- explain the role of various conferences in development of environmental education, and
- analyse the role of international organizations in promotion of environmental education.

4.3. CONCEPT OF ENVIRONMENTAL EDUCATION

Environment is derived from a French word Environ, which mean encircle or surrounding. The environment encompasses all the living and non-living things that occur on Earth. The fate of the environment is attached with every life that inhabits the planet including human beings. The industrialization era brought about devastating impacts on the environment and at the end of the nineteenth century, people started to apprehend the susceptibleness of the environment and the gravity of the implications nations gathered and issues regarding environment were initiated on priority with a hope to obtain and sustain a better future for our planet.

Environmental education describes the inter-relationships among organisms with their abiotic (Physical) environment. These include atmospheric conditions, food chains, the water cycle, etc. It is a basic science, which is an amalgamation of various subjects deal with earth and various activities taking place on it. Therefore, environmental science is important for one and all. Environmental education is a process that enables individuals to explore environmental issues, engage in problem solving and take action to improve the environment. The environmental education inculcates deeper understanding of environmental and environment related issues amongst the people and offer individuals with the skills, experience and knowledge that are necessary to make them responsible decisions makers and community leaders. Environmental education is considered to be a global process which is continuous and lifelong process.

The five important areas which should be given priority in environmental education are that:

- Environmental education should be valued in a society.
- The emphasis on environmental education changes according to need through legislation, strategic documents and budgets.
- Acquiring and providing environmental education should be in compliance to internationally assumed responsibilities, strategies and legislation.
- Every age group should be open to get environmental education needed and to develop the skills, attitudes and behaviour necessary for the development of a sustainable environment and lifestyle.
- Environment and sustainable development are an obligatory part of all levels of education. Education that supports sustainable development is a system of knowledge, skills, attitudes and value orientations, which enables making people conscious of the relations of the natural, economic, and socio-cultural environment, focusing thereby on the idea of sustainable development.

Environmental education is directed towards shaping environmental awareness at local as well as global context. The educational system has the best possibilities for shaping people's value orientations, both through formal education, informal education and indirect shaping (from child to parent, etc).

4. 4 EVOLUTION OF ENVIRONMENTAL EDUCATION

The origin of the term 'Environmental Education' has always remained an issue and it is claimed that it was used for the first time in Paris in the year 1948. However, the formal beginning of discipline of Environmental Education is marked by the organization of International Union for Conservation of Nature (IUCN) and Natural Resources Conference held in Paris in the year 1948, where the term was used widely as one of the central themes of the conference. After the conference, a formal body named, International Union for Conservation of Nature or IUCN was established in 1949.

Environmental education is not a contemporary subject matter. According to Palmer (1998), who is considered as one of the prime advocates of environmentalism, the words 'environment' and 'education' did not use together until mid 1960s. The evolution of environmental education can be credited to significant role of some of the great 18th and 19th century writers and educators, of which some of the notable are Dewey, Goethe, Rousseau, Haeckel, Humboldt, Froebel, and Montesson. In eighteenth century Jean-Jacques Rousseau stressed on the value of education that takes into consideration the environment. After that the Swiss-born naturalist, Louis Agassiz, promoted Rousseau's philosophy. These influential pioneers clearly contributed to the environmental thought and practice. In UK many writers attributed the founding of environmental education to a Scottish Professor of Botany Sir Patrick Geddes (1854-1933), who was considered as

an originator of town and country planning. He was regarded as the first to establish an important link between the quality of the environment and the quality of education. Louis Agassiz and Sir Patrick Geddes were the two influential scholars of that time who laid the foundation for a real environmental education program, known as "the Nature Study", which took place between the late 19th century and early 20th century.

The School of Nature Study Union was formed in the year 1902. During 1940s the area of nature study broadened to rural studies with formation of local associations. From this movement the term 'environmental studies' evolved and was frequently in use consisting of a mixture of teaching elements of geography, history and nature study. Simultaneously the teaching of history, geography and biology also gained momentum with the establishment of Council for the Promotion of Field Studies. The concept of Nature Conservation also played a significant role for the ongoing development of environmental teaching in 1949.

The first recorded use of the term environmental education in Britain is traced back to a conference held in 1965 at Keele University, Staffordshire, with the purpose of conservation of the countryside and its implications for education. This conference was significant for UK, as it marked the first occasion where educationists and conservationists came together, and led to the establishment of the Council for Environmental Education (CEE), which met for the first time in July 1968. Since then there is a long history of the development of Environmental Education accounting for more than seven decades.

Check Your Progress-1

Note: (a) Answers the question given below:

(b) Compare your answer with those given at the end of the lesson:

- i. Environmental education describe the inter-relationships among organisms with their abiotic (Physical) environment. True/ False
- ii. In eighteenth century stressed upon the value of education that takes into consideration the environment.
- iii. The discipline of Environmental Education is marked by the organization of(IUCN) andconference held in Paris in the year 1948.
- iv. The first recorded use of the term environmental education in Britain is traced back to a conference held in the year at University.
- v. —and — were the two influential scholars of that time who laid the foundation for a concrete environmental education program, known as "the Nature Study"

4.5 DEVELOPMENT OF ENVIRONMENTAL EDUCATION

The concept of environmental education emerged only in the seventies and the period was called as the decade of environmental education. During this period the world realized that environmental concerns and awareness could be spread only through a mass environment education program. The concept of environment education emerged from the Stockholm Conference organized by the United Nation in 1972. Recommendations of the conference emphasized on the conduct of 'formal' and 'mass' environmental education programs. Educate masses about environment and its components, is supposed to develop critical thinking, analytical and problem solving skills in human. It is also instrumental in developing knowledge and insights in human to improve their living quality on earth.

With the great efforts of many naturalists, April 22nd, 1970, was declared as the first Earth Day. This event paved the way for the current environmental education movement. In the latter months, US President Nixon passed the National Environmental Education Act, which intended to incorporate environmental education into K-12 schools. In the years to follow, the North American Association for Environmental Education (NAAEE), formally known as National Association for Environmental Education, was established to improve the environmental literacy, by providing resources to teachers in order to promote environmental education programs. The year was then declared by the European Council as the "Year of the Environment".

Efforts to define environmental education as a specific endeavor began in the 1960s. International support at the United Nations Conference on Human Environment, held in Stockholm in 1972, set the stage for the need to promote Environmental Education internationally. In the conference participating governments recommended that environmental education be recognised and promoted at international scale under the umbrella of the United Nations. The greatest landmark in the history to define the term 'environmental education' was an IUCN/UNESCO International Working Meeting on Environmental Education in the School Curriculum' held in 1970 at the Foresta Institute, Carson City, Nevada, USA. A classic definition of Environmental Education was formulated and adopted there "Environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulation of a code of behaviour about issues concerning environmental quality" (IUCN, 1970)

4.5.1 Major Developments in Environmental Education

World over The United Nations Education Scientific and Cultural Organization (UNESCO) and the United Nations Environment Program (UNEP) were credited with three major declarations that have guided the development of environmental education. These three are:

4.5.1.1 The Stockholm declaration:

Environmental education was globally acknowledged when the UN Conference on the Human Environment held in 1972, in Stockholm, Sweden, affirmed that environmental education must be utilized as the key to address environmental issues all around the world. The Declaration of the United Nations Conference on the Human Environment took place between June 5th and June 16th of the year 1972. In this conference it was declared that-"Education in environmental matters for the younger generation as well as adults giving due consideration for the underprivileged is essential" The document, consisting of 7 proclamations and 26 principles, was created in order "to inspire and guide the people of the world in the preservation and enhancement of the human environment."

4.5.1.2 The International Workshop on Environmental Education (1975)

The International Workshop on Environmental Education, held in Belgrade, Yugoslavia in October of 1975 resulted in what became known as The Belgrade Charter. The Belgrade Charter built on the framework of Stockholm and described the goals, objectives, audiences, and guiding principles of EE and proposed what has become the most widely accepted definition of Environmental Education which is "Environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments, and skills to work individually and collectively toward solutions of current problems and the prevention of new ones". (UNESCO-UNEP 1976)

4.5.1.3 Intergovernmental Conference on Environmental Education held in Tbilisi

The definitive codification of Environmental Education as an international enterprise ultimately came out of the world's first Intergovernmental Conference on Environmental Education held in Tbilisi, Georgia, USSR, in October of 1977. The document known as The Tbilisi Declaration was formulated during this conference and in many quarters remains the definitive statement on what EE is and ought to be. These goals provide the foundation for much of what has been done in the field since 1978:

In 1987 UNESCO and UNEP jointly organised Educational Congress on Environmental Education and Training, called as 'Tbilisi Plus Ten Conference', was held in Moscow. This was the tenth anniversary of the first 'Tbilisi Conference'. A number of major themes emerged from the deliberations of this event, including the vital importance of environmental education as summed up was "In the long run, nothing significant will happen to reduce local and international threats to the environment unless widespread public awareness is aroused concerning the essential links between environmental quality and the continued satisfaction of human needs. Human action depends upon motivation, which depends upon widespread understanding. This is why we feel it is so important that everyone becomes environmentally conscious through proper environmental education" (UNESCO-1987) (Palmer, 1998,)

The other endeavours followed for the development of Environmental Education were

4.5.1.4. World Commission on Environment and Development (WCED)

The IUCN World Conservation Strategy (1980) suggested requirements for human survival and prosperity, putting forward the conservationist concept of sustainable development. The importance of sustainable development was established in the year 1987, when the World Commission on Environment and Development published the Brundtland Report. This report, also known as 'Our Common Future', enlightened the concept of sustainable development in which the protection of the environment and the economic growth were regarded as interdependent notions as well as the concept of social equity. According to the Brundtland Report, sustainable development implies "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Our Common Future (1988) was the name of the report published by the World Commission on Environment and Development, chaired by the Prime Minister of Norway, Mrs Brundtland. It emphasised the relationship between the under-developed nature of parts of the world, and existing social and environmental problems. The report is a survey of the planet's health, presenting the problems of atmospheric pollution, desertification, over-population, over-consumption, water shortages, poverty and under-development.

4.5.1.5. United Nations Conference on Environment and Development (Earth Summit)

In 1992, the United Nations Conference on Environment and Development which took place in Rio de Janeiro, Brazil, supported and embellished the goal of obtaining sustainability. This was achieved by means of international agreements made on climate variation, woodland and biodiversity. One of the most significant aspects of the Rio Earth Summit, was Chapter 36 of Agenda 21; the fulcrum of our current environmental sustainable development. Agenda 21 focused on "reorienting education towards sustainable development; increasing public awareness; and promoting training."

4.5.1.6 Agenda 21 (1992)

The United Nations Conference on Environment and Development in Rio de Janeiro established further strategies for a sustainable future. Chapter 36 of the action plan adopted by the Conference, Agenda 21, focused on public education, awareness and training, which confirms the role of education and the importance of positioning environmental education in the perspective of sustainable development.

4.5.1.7. UNESCO Thessaloniki Declaration (1997),:

In UNESCO Thessaloniki Declaration (1997), 'Educating for a Viable Future' a multidisciplinary vision for concerted action was sought to further clarify the concept of education for sustainable development. It presented sustainability as an ethical and moral imperative and the objective to which education should devote itself as an instrument of choice. Education is considered as an ongoing process aimed at developing the capability of adapting to rapid changes in the world, but first and foremost as a process of transmitting

knowledge and information to make the public understand the problems and to stimulate awareness.

During the same period, individuals and groups, both within and outside formal education systems and agencies, began to generate new emphases in their educational work, finding and expressing different focal points and relationships as well as a new urgency in their treatment.

4.6 DEVELOPMENT OF ENVIRONMENTAL EDUCATION IN INDIA

The United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, and has drawn the attention of the global community to discuss problems concerning environment and development. In order to achieve the goals of sustainable development, people need to become aware of the environmental issues and acquire background knowledge to enable them to make and influence decisions. The education system in India had incorporated certain aspects of environment in school curricula as early as 1930. The Kothari commission (1964-66) also suggested that basic education had to offer EE and relate it to the life needs and aspirations of the people and the nation. At the primary stage, the report recommended that " the aims of teaching science in the primary schools should be to develop proper understanding of the main facts, concepts, principles and processes in physical and biological environment" Environmental education at primary, secondary, higher secondary levels was treated in a different way. Environmental education is an essential part of every pupil's learning. It helps to encourage awareness of the environment, leading to informed concern for active participation in resolving environmental problems. It was introduced without any delay from class First as EVS, as a subject so that right from their childhood, the right attitudes towards environment will be nurtured in the young minds.

Recognizing the importance of environmental education at all levels, the Hon'ble Supreme Court of India ruled that a course on Environment be made mandatory at the undergraduate level to sensitize the youth to environmental issues and concerns. As per the Supreme Court direction, the University Grants Commission introduced six months compulsory environmental course in all the Universities and Colleges during the academic year 2004-05. Two face-to-face National Consultations on Environmental Education in Schools were organized to supplement the analysis of individual and institutional consultations. The First Consultation on the academic aspects of Environmental Education in schools was organised by NCERT on 13-14, February, 2004 in New Delhi. Seventy participants comprising eminent scientists, environmentalists, officials of government departments concerned with environment, academicians dealing with fields of environmental sciences, environmental

studies, ecology, etc. belonging to different universities, teacher educators, principals of teacher training colleges, prominent NGOs and NCERT faculty took part in deliberations. The second consultation on the implementation of EE in schools was held on 13th March 2004. Seventy-two officials comprising Presidents/Chairpersons of Boards/Councils of school education, Directors of Education in the states, Directors of State Councils of Educational Research and Training (SCERTs), eminent scientists, environmentalists and NCERT faculty participated.

The declaration of the decade for Education for Sustainable Development (ESD) in 2005, by the United Nations has provided further impetus to the promotion of environmental education. The goal is to create a sustainable world through active participation of citizens. Thus, ESD is seen as a process that develops vision, builds capacity, and empowers to make changes in human societies. The ideology needed to learn and teach sustainability need to have orientation which emphasize on conserving cultural values, beliefs, and practices that contribute to sustainable relationship with the environment. All the citizens must be environmentally literate.

Check Your Progress 2

Note: (a) Answers the question given below:

(b) Compare your answer with those given at the end of the lesson:

- i. United Nations Conference on the Human Environment was organized by the United Nation at in the year
- ii. United Nations Conference on Environment and Development was held in the year at
- iii. The full form of IUCN is
- iv. The full form of UNESCO is
- v. Which declaration framed a view 'Educating for a Viable Future'.....
- vi. The First Consultation on academic aspects of Environmental Education in schools of India was organised by
- vii. Define sustainable development:.....

4.7 LET US SUM UP

The environmental education inculcates deeper understanding of environmental and environment related issues amongst the people and offer individuals with the skills, experience and knowledge that are necessary to make them responsible decisions makers and community leaders.

Formally the discipline of Environmental Education initiated with the organization of International Union for Conservation of Nature (IUCN) and Natural Resources Conference held in Paris in the year 1948. The evolution of environmental education can be credited to the role of some writers and educators during 18th and 19th century. In eighteenth century Jean-Jacques Rousseau advocated to the value of education that considers environment. Later on Rousseau's philosophy was promoted by the Swiss-born naturalist, Louis Agassiz. Louis Agassiz and Sir Patrick Geddes were the two influential scholars of that time who laid the foundation for a real environmental education program, known as "the Nature Study".

Environmental education was globally acknowledged when United Nations Conference on the Human Environment held in 1972, in Stockholm, Sweden, affirmed that environmental education must be utilized as the key to address environmental issues all around the world. Later on the International events namely the Belgrade charter and the Tbilisi declaration were the trend setter in favour of environmental education. The importance of sustainable development was established in the year 1987, when the World Commission on Environment and Development published the Brundtland Report named 'Our Common Future'.

In 1992, the United Nations Conference on Environment and Development which took place in Rio de Janeiro, Brazil, supported and embellished the goal of obtaining sustainability. One of the most significant aspects of the Rio Earth Summit, was Chapter 36 of Agenda 21; the fulcrum of our current environmental sustainable development. Agenda 21 focused on "reorienting education towards sustainable development; increasing public awareness; and promoting training."

In India Environmental Education became an integral part of education since 1986 and from 2004 it was introduced for all undergraduate courses. Y.K. Sabharwal, Chief Justice of India at the conference on "Environment Awareness-Enforcement" held in 2006 at Delhi remarked "Though environmental education has been integrated into the National Curriculum Frame Work, and as a result of directions issued by the Supreme Court, Environmental Science was made mandatory for undergraduates and Environmental Studies was introduced as a subject for students of Class I to V, environmental education problems are still far from over.

4.8 LESSON END EXERCISE

Answer the following questions

1. What are the important areas which should be given priority in environmental education?
2. Write in detail how environmental education evolved?

3. Write about the development process of Environmental Education.
4. Write about the role of various International Conferences in development of environmental education.
5. Elaborate on the development of environmental education in India.

4.9 SUGGESTED FURTHER READINGS

Ahluwalia, S.P., & Bals, H.S. (1992). Environmental Education: Concepts and Contours, Education: Issues and Challenges. New Delhi: Ashish Publishing House.

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UNESCO. (1988). Environmental Education in Light of Tbilisi Conference. Paris: UNESCO.

UNESCO. (1997). Educating for a sustainable future: a trans-disciplinary vision for concerted action. Paris: UNESCO

4.10. ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress- 1

- | | | |
|-----------------|---|--------------------------------|
| i. True | ii. Jean-Jacques Rousseau | iii. IUCN and Natural Resource |
| iv. 1965; Keele | v. Louis Agassiz and Sir Patrick Geddes | |

Answers to Check Your Progress- 2

- | | |
|---|--------------------------|
| i. Stockholm; 1972 | ii. 1992; Rio de Janeiro |
| iii. International Union for Conservation of Nature | |

ENVIRONMENTAL HAZARDS CAUSES : EFFECTS AND REMEDIES

Structure

- 5.1 Introduction
- 5.2 Objectives
- 5.3 Environmental Hazards
 - 5.3.1 Types of Environmental Hazards
- 5.4 Causes of Environmental Hazards
- 5.5 Effects of Environmental hazards
- 5.6 Remedies of environmental hazards
- 5.7 Let Us Sum Up
- 5.8 Lesson End Exercise
- 5.9 Suggested Further Readings
- 5.10 Answer to Check Your Progress

5.1 INTRODUCTION

It is a known fact that out of all the creatures present on our planet only human beings are having the higher thinking capacity and do possess the ability of altering their environment. Our environment consists of physical, chemical and biological factors which are always in an interactive relationship with us, meaning that we affect our environment and consequently our environment affects us. These interactions may expose us to many environmental hazards. A hazard is something which is recognized to cause harm, that is, a source of danger. Initially hazards were known to have only natural origin and were believed to be the "act of God" or the result of some external powers. Later on it was found that there is no doubt that humans affect natural processes in many ways and so often lead to hazards. Many physical aspects of natural hazards, however, are out of their control. This does not imply that people are just passive in facing hazards; they can and do construct defences against and implement measures to mitigate the impacts of hazards. Here in this lesson we are going to learn about the causes and consequences of environmental hazards and will also highlight the role of man in originating, controlling and mitigating the environmental hazards.

5.2 OBJECTIVES

After going through the lesson, you shall be able to:

- explain the meaning of environmental hazards,
- identify the natural and manmade hazards,
- distinguish the role of nature and man in causing the hazards and
- discuss various causes and remedies of environmental hazards.

5.3. ENVIRONMENTAL HAZARDS

An environmental hazard is a threat posed by natural or built by the environment, to humans and the things that are valued in human society. Alexander (2000) defines environmental hazard as "an extreme geophysical event that is capable of causing a disaster." Burton and Kates (1964) maintain that natural hazards are those elements of the physical environment that are harmful to humans and caused by forces extraneous to them. Cutter (1993) defines hazards as the threats to people and the things they value such as their homes and belongings and environment. All these definitions are correct in the sense that hazards are harmful to people, but fails to acknowledge the role of humans in causing these hazards. There is no question that humans affect natural processes in many ways and thus often contribute to hazards. Keeping the anthropogenic role in mind United Nations define the hazard, as "A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation" (UNISDR, 2004). This definition directly acknowledges the role of humans in causing/exacerbating hazards. In the next section we are going to know about the classification of environmental hazards.

5.3.1 Classification or Types of Environmental Hazards

Many efforts have been made to classify the ever increasing list of hazards. Classifications of hazards usually provide us with a useful framework for identifying similarities, differences, making generalizations and setting up a sound management practice about the hazardous events. Most of the existing hazard typologies use the causes or origins of hazard events as the classifying principle. United Nations International Strategy for Disaster Reduction (UNISDR) classified the hazards into two families: natural and anthropogenic (man-made). The anthropogenic hazard family is sub-divided into three sub-families, Technological Hazards (hazards, such as fire, explosion, and power outage, as well one location for a hazard, Mine Disaster, and a hazard entitled, Industrial Disaster), Chemical and Radiological Hazards (Chemical Spill, Oil Spill, Radiation Contamination, Nuclear Incident) and the Transportation Accident hazards (includes the media through which objects are transported,

Rail Accident, Road Accident, Space Accident, Aviation Accident etc.). In the following section we are going to discuss each one of them in detail:

Natural Environmental Hazards

Natural hazards are those components of the physical environment, harmful to man and are induced by some extraneous forces. A natural hazard can be specified as an unexpected or uncontrollable phenomenon of rare magnitude that creates a threat to people, structure and economic assets caused by geological, seismic, hydrological and biological conditions. Earthquakes, volcanic eruptions, hurricanes, tsunamis, blizzards, and tornadoes that originate in the lithosphere, hydrosphere, or atmosphere are all natural hazards and are exclusively of natural origin. On the other hand landslides, flood, droughts and fires are termed as socio-natural hazards, since their causes are natural as well as manmade e.g. landslides may cause flooding and in the same way groundwater extraction or drainage may contribute to droughts. Tobin and Montz (1997) classified natural hazards into four categories: (1) meteorological (tropical cyclones/hurricanes, thunderstorms, tornadoes, lightning, hailstorms, windstorms, ice storms, snowstorms, blizzards, cold waves, heat waves, avalanches, fog, and frost), (2) geological (earthquakes, volcanoes, tsunamis, landslides, subsidence, mudflows, and sinkholes), (3) hydrological (floods, droughts, and wildfires), and (4) extraterrestrial (meteorites).

Anthropogenic Environmental Hazards

An Anthropogenic hazard (Man-made) also experienced as human induced disasters cover a broad range of events created largely due to accidents, negligence or sometimes even by human inventions, which result in huge loss of lives and property every year. These include road, rail, river, marine and aviation accidents, oil spill, building and bridge collapse, bomb blast, industrial and chemical accidents etc. These also include the threats of nuclear, biological and chemical disasters. This type of hazards may result from industrial accidents or deliberate as well as inadvertent action of individual or groups. India has experienced several man-made disasters. One among them is the 'Bhopal Gas Tragedy' it happened in the early hours of December 3, 1984, a highly toxic cloud of methyl isocyanate leaked from Tank - E610 engulfing the city of Bhopal resulting as many as 10,000 deaths. The anthropogenic hazards are further sub-divided into three sub-families, 'Technological Hazards', 'Chemical and Radiological Hazards', and the 'Transportation Accidents'.

A. Technological Hazards: Technological hazards originate from the interaction of society, technology, and natural systems and constitute a relatively new form of threat. Technological hazards are the hazards which are caused due to mishandling, mismanagement or due to maladministration of technology. Technological hazards can affect localized or widespread areas. They are frequently unpredictable, can cause property damage, loss of life, and can significantly affect infrastructure. Hazards caused by incidents like dam failures (that cause downstream flooding), Fires, (burning in residential, commercial, industrial or

other properties), uncontrolled releases of hazardous materials from fixed sites or during transport like uncontrolled releases of radioactive materials at commercial power plants or other nuclear reactor, power failures and telecommunications failures are some of the examples of technological hazards. One of the most devastating technological environmental hazards occurred in 1986, when a nuclear reactor in Ukraine, which at the time was part of the former Soviet Union, exploded. The explosion sent a huge cloud of radioactive particles into the air. The cloud drifted over Europe, contaminating millions of acres in Ukraine, Belarus, and Russia. Hundreds of thousands of people had to leave their homes. Many people suffered various illnesses because of their exposure to the radiation.

B. Chemical and Radiological Hazards: Chemical and radiological hazards are those hazards that are caused by some chemical, biological, radiological or nuclear component, commonly known as CBRN. All these hazards agents (Chemical, biological, radiological or nuclear (CBRN)) are retained under this classification because there are distinct similarities in building some of the emergency preparedness and response measures for all of them. Chemical emergencies can happen in a number of different situations where hazardous chemicals are discharged into the environment. These chemicals can be in the form of gases, solids or liquids and can be either chemical elements, compounds in a natural or processed state or their by-products. Exposure by inhalation, ingestion or to the skin may result in illness or injury to human health depending on the chemical substance, the amount of the dose and the duration of exposure.

Biological hazards make up another type of environmental hazard; sources of biological hazards include pathogens like bacteria, viruses, parasites, insects, birds, and toxins or poisons that are produced by them. Animals and plants that appear in a place that is not their natural habitat can be environmental hazards. Exposure in sufficient quantities and over a given duration may result in illness or injury to human health, and this can happen through natural exposure or release (intentional or unintentional) of these biological agents. For example, bacteria cause cholera, tuberculosis, leprosy, relapsing fever and many diarrhoeal diseases; viruses are responsible for hepatitis B and C, HIV, measles, polio, corona etc.; and there are many diseases caused by parasites like malaria, filarial, leishmaniasis, ascariasis, dracunculiasis (guinea worm), filariasis, onchocerciasis etc. Biological hazards arise from working with infected people or animals, or handling infectious waste and body fluids, as well as contact with unsafe water, food and waste.

Radioactive chemicals emit harmful radiations that have harmful impact on the environment. Nuclear and radiological hazards are related to ionizing radiation (the ability of particles to release ionizing radiation) from radioactive sources which in sufficiently high doses are hazardous to humans, animals and also cause an adverse impact on the surroundings.

Nuclear emergencies involve or emerge from nuclear chain reactions while as radiological emergencies can affect all other situations involving radioactive sources, for instance, those employed in radiological devices for medical, industrial or research applications. Radioactive chemicals include: radioactive isotopes, radioactive elements, radionuclides, radioactive cesium, uranium, strontium etc. A radiation incident can create public panic and potentially result in a large displaced population seeking alternate shelter and health cover for possible exposure, which may produce an additional health care burden on the local mental health and public health resources. Long-term effects could include ecological damage, loss of food and agricultural output, and human resettlement.

C. Transportation Accidents: The third sub-family of anthropogenic hazards is the Transportation Accidents which occur along roads, railways, air, or water bodies. A transport accident is any accident or incident that happens during any type of transportation, including accidents occurring during road transport, rail transport, maritime transport and air transport. It can refer to a road traffic accident including vehicle collision, pedestrian-bicycle collisions, pedestrian-pedestrian collisions and so on, a marine accident like sailing ship accident, including man overboard, railroad accidents including train wreck, an aviation accident and incident. Such risks may result from adverse weather conditions, human fault, and/or mechanical failure. In other words accidents caused by the media of transportation like rail, road, space and aviation etc., Such risks may result from adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. From adverse weather conditions, human fault, and/or mechanical failure. Transit arrangements are projected to displace people, commodities and services efficiently, economically and safely from one spot to some other. Despite this broad goal, there are many environmental hazards that commonly disrupt or damage these systems in a variety of spatial and temporal scales. Referable to the potential for tragedy, various state and federal agencies have been established to regulate transportation methods and to minimize the number of automobile collisions, airplane accidents, train crashes and other types of transportation accidents. Safety boards and other agencies analyse and investigate accidents involving trains, planes and automobiles. Additionally, inspectors investigate trucking incidences and other transportation issues. However, industrial and transportation-related accidents and progressive or precipitous destruction of ecosystems reflect failures or side-effects of human-devised technologies, failures of judgment, or even flagrant human neglect.

Check Your Progress-I

Note: (a) Answer the questions given below

(b) Compare your answer with those given at the end of this lesson

- i. UNISDR stands for.....
- ii. UNISDR was created in.....
- iii. Environmental hazards are classified as..... and..... hazards
- iv. Anthropogenic environmental hazards are also known as..... hazards
- v. The three examples of natural hazards are..... and.....

5.4. CAUSES OF ENVIRONMENTAL HAZARDS

Most people dwell along the boundary of an environmental hazard-whether they recognize it or not. Some environmental hazards, such as a rising flood or a smoking volcano, are easy to recognize, while as others are not so easy to detect, whereas some environmental threats, such as earthquakes, can occur quickly, with short notice, other environmental hazards might take long time to become recognised, such as the influence of the pesticide DDT on wildlife and human tissue. Anything that affects the environmental health of humans, plants, and animals in a negative way is an environmental hazard. Air contamination, contaminated food, and water pollution are all models of the environmental hazards Earth's population faces. United Nations international strategy for disaster reduction (UNISDR) has divided hazards into two families: natural and anthropogenic. Natural hazards are naturally occurring physical phenomena having atmospheric, geologic or hydrologic origin like tornadoes, hurricanes, earthquakes, landslides, floods, droughts etc. while as anthropogenic or man-made hazards are the hazards caused by human action or inaction like fire, explosion, Mine Disaster, Chemical Spill, Radiation Contamination, Nuclear Incident and even transportation accidents are all included in anthropogenic hazards. All these hazards may directly or indirectly bear on living organisms, biomes and ecosystem. The severities of these hazards are the key elements in the risk analysis. These hazards affect physical, mental and social welfare of people and may occur intentionally or unintentionally. Hazards lead to loss of life, damage of economy, social disruptions and have adverse long term effects. There are a number of environmental hazards that occur every year and have an adverse impact on the human population and other components essential for their survival. Here we are going to discuss some important causes of the popular hazards.

1. Land Degradation: Land degradation generally signifies the temporary or permanent decline in the productive capacity of the land. It is also defined as the long-term

loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided. The most frequently recognized causes of land degradation include; overgrazing of rangeland; over-cultivation of cropland; water logging and salinization of irrigated land; deforestation; pollution and industrial causes. Land degradation adversely affects people's livelihoods and occurs over a 10 quarter of the Earth's land area. Land degradation affects humans in multiple ways, interacting with social, political, cultural and economic aspects, including marketing, technology, inequality and demographic change. Land degradation impacts extend beyond the land surface itself, affecting marine and freshwater systems, as well as people and ecosystems far away from the local sites of degradation. Land degradation is currently a huge challenge for the sustainable development. This problem is more acute in the areas where the environment is intrinsically vulnerable and the population is losing control over its resources.

2. Pollution: any unfavourable alteration in the physical, chemical or biological characteristics of air, water and land may or will adversely affect human life. Industrial life, industrial progress, living conditions and cultural assets are all classified as pollution, which is recognized to exert a negative stress on the positive health of the ecosystem. The substances that cause the undesirable changes in the air, water and land are referred to as the pollutants which can be a substance (e.g., dust, smoke), chemicals (e.g., SO₂ or Methyl mercury) or factor (like heat, noise etc.) whose introduction into the environment has an actual or probable adverse effect on human interests. The rapid industrial growth and urbanization has led to atmospheric pollution. Industrial pollution is acute in areas where petroleum refineries, chemicals, iron and steel, non-metallic products, pulp and paper and textile industries are located. Dirt, dust and solid waste propelled in the air are also harmful for humans, animals and plants. Acid rain destroys the forests and water bodies, gases like CFC's damage the ozone in the atmosphere, while as gases like carbon dioxide, which is directly poisonous are all produced by the anthropogenic activities. The primary sources of water pollution are flushing domestic and industrial seepages containing organic pollutants, wastes of chemicals, heavy metals etc. into lakes, canals, rivers, coastal areas and underground water sources. These pollutions can become one of the major reasons for both natural and man-made hazards.

3. Overpopulation or Overcrowding: Overpopulation refers to a population which exceeds its sustainable size within a particular environment or habitat. Overpopulation is a consequence of various factors like increased birth rate, decreased death rate, better medical facilities, depletion of precious resources, immigration to a new ecological niche with fewer predators and so on. It is possible for a sparsely populated area to become densely populated if it is not capable to sustain life. Growth in population puts strain on natural resources which results in environmental hazards. Overpopulation means more demand for food, clothes and shelter, more space to cultivate food and provide more

homes to people, resulting in deforestation which is a prime factor that led to environmental hazards. Overcrowding is the major cause of many man-made hazards. The Tsunami in the Cuddalore district of Tamil Nadu occurred on 26 Dec 2004 causing massive loss of life and devastation of property, overcrowding was one great reason of it. The untoward effect of over exploitation of resources due to huge population size was one big reason pointed out by geologists for the occurrence of this hazard.

4. Deforestation: Deforestation is simply the conversion of forested tracts to barren lands usually done by clear-cutting trees and removing the wood or vegetation for agricultural operations or to harvest wood as a fuel or for wooden products. The whole of Europe was once thickly forested, but the trees were cut down to provide wood and for agriculture. Today, rapid deforestation is taking place in the tropics, where rainforests in South America, Africa, and Asia are being cleared for agriculture. In India some 3.4 million hectares of forest land were lost during the initial three decades of planning. Deforestation is still ongoing at a rapid rate in the name of river valley projects, urban settlement, industrialization, roads, communication etc. The issue of deforestation has reached to such a level that it has totally disturbed the ecological balance. The process of deforestation results in many undesirable environmental impacts at multiple scales. Local impacts include decreasing soil stability, increasing erosion and transporting sediments into streams, reduction in biodiversity through loss of habitat, and alterations to microclimates that typically increase local temperatures because of loss of vegetation and increased numbers of heat islands. Deforestation can also produce impacts on a global scale. Research over the past decade has represented that the cutting and burning of large forest tracts is quickly liberating large amounts of carbon and increasing levels of the greenhouse gas, carbon dioxide, in the atmosphere. Removing forest vegetation further disrupts the global carbon balance by eliminating the living trees that served as a sink for carbon dioxide.

5. Ozone Depletion, Greenhouse effect and Global warming: All these three physical phenomena (Ozone Depletion, Greenhouse effect and Global warming) are connected to one another to a major extent. Ozone depletion and global warming are linked with industrial development and energy use especially fossil fuels. Near the earth's surface, ozone is a troublesome pollutant but its presence in stratosphere is as important to life as oxygen. If the stratospheric layer of ozone disappears or thins, all the terrestrial life will be annihilated. This depletion of ozone layer is linked to both 'greenhouse effect' and global warming. The greenhouse effect occurs due to the emission of certain gaseous pollutants like methane, CFCs, water vapor and carbon dioxide in the air, which after the warming of the atmosphere causes the average global temperature to rise known as global warming, which also imposes devastating and disturbing results on the biosphere. A rise of 5°C temperature would affect all the components of the local, regional and global ecosystems. It results in the increase in the sea levels and ocean currents, prevailing winds, fresh water

supplies, agriculture, forests, fisheries, industry, transport, urban planning, demographics, human health etc. It also results in the melting of glaciers at the poles which makes the cities that lie near the coasts or in low-lying areas prone to flood and landslides.

6. Faulty Mining Practice: Mining is the extraction of economically valuable minerals or other geological materials from the surface of the earth (ore body, lode, vein, seam, reef or placer deposits). Mining is a hazardous operation and consists of considerable environmental, health and safety risk to miners. Unsafe conditions in mines lead to a number of accidents and cause loss and harm to human lives, damage to property, interruption in production etc. Extraction of minerals on a large scale has created a grave problem in ruining the land, water, forest and air. Huge mining has resulted in the conversion of agricultural and forest land into roads, railway lines and removal of vegetation and top soil. Most of the people working in these industries suffer from several respiratory and skin diseases. The dust and various fumes inhaled by miners make them vulnerable to pulmonary diseases. The danger of collapsing mine roofs, inundation and fires in coal mines are a perpetual threat to miners. Dumping of waste and slurry leads to the degradation of land, soil and increase the water contamination in stream and river.

7. Disposal of Wastes: waste is any unusable or unwanted substance or material produced during manufacturing or as a consequence of a process. Waste products may be in the form of fruit and vegetable peels, leftover food, packing material, old and unwanted plastic objects, old clothes, etc. or in the form of medicine, chemical or nuclear and radioactive substance. A hazardous waste is a waste with a chemical composition or other properties that make it capable of causing illness, death, or some other harm to humans and other life forms when mismanaged or released into the environment. Some hazardous substances show their toxic effects (humans or environment) after a single, episodic release while as others produce their toxic effects after extended exposure to the substance, the former is known as acute toxicity while as the latter is known as chronic toxicity. There are many hazardous chemicals which are toxic in very small amounts, whereas others can have large volumes of exposure before there is a reaction. Having hazardous chemicals in the human body causes adverse reactions to fetuses, children, adolescents, adults and the elderly but the reaction each may have varies. A fetus and young child are more susceptible to adverse reactions than an adult because their developing organs may be permanently damaged. Some potential health conditions in people of all ages include: behavior abnormalities, cancer, physiological malfunctions (e.g., kidney failure, reproductive impairment) genetic mutations, physical deformations, birth defects and so on.

5.5. EFFECTS OF ENVIRONMENTAL HAZARDS

The impacts of environmental hazards vary in their severity and are measured through analysis of the interaction between the hazard (natural or man-made) and the receptors

(people, properties, infrastructure or environment). Different hazards affect different receptors to different extents. Hazards become less important when the receptors are other than humans or when humans are not directly impacted. The involvement of populations depends upon population density, magnitude of the hazard, frequency or how often hazard occur, development, preparations, accessibility, etc. The effects can be acute, meaning that the injury or harm can occur or be felt as soon as a person comes in contact with the hazardous agent and sometimes it may be chronic or delayed. Once the hazard is removed or eliminated, the effects may be reversible or irreversible (permanent). Wealth and development plays an important role in retrieval from hazards, for example an economically developed country can prepare for and predict hazards more effectively and they have many resources to support a faster recovery than an underdeveloped country. All types of environmental hazards can have primary, secondary, and tertiary effects. Primary Effects occur as a result of the process itself. For example collapse of buildings during an earthquake, landslide, or hurricane. Secondary effects are originated from a primary effect. For example, fires ignited as a result of earthquakes, disruption of electrical power and water service as a result of an earthquake, flood, or hurricane, or flooding caused by a landslide into a lake or river. Tertiary Effects are long-term effects that are set forth as a result of a primary event. These include things like loss of habitat caused by a flood, permanent changes in the position of river channel caused by flood, crop failure caused by a volcanic eruption etc. Here we are going to discuss in brief some of the major effects of hazards:

1. Loss of life and property: the loss of life and property due to natural disasters like tropical cyclones, floods, droughts, tornadoes, earthquakes, volcanic eruptions etc, is enormous. Cities and towns are worst affected due to large concentration of human population, commercial complexes and residential areas. Due to collapse of large buildings there is greater loss of life and property. The worst damage a hazard can cause is the loss of human life as property loss can be engrossed with the passage of time but a loss of life is irretrievable. Losing a family member has far more lasting impact than any other loss. Loss of family member leads to social and psychological disturbance that affects the recovery phase and also lengthens the rehabilitation period. Another major effect of the environmental hazard is the loss of livelihood. The earning of whole life is distracted in a moment, which can cause a grief and other psychological traumas.

2. Social impact: Man's social environment is developed in a family and family is the basic unit of a society. Natural or manmade hazard badly hampers the social life of the victim. Alteration or disturbance in the social life increases mental health issues, alcohol misuse, domestic violence, chronic disease etc. The acute impact of hazards is that people may be killed or injured, but the long term effect is that diseases are spread; people are

sheltered in refugee camps. Living in refugee camps or hospitals with temporary or permanent disability has a number of social ill effects. Upbringing in these camps is linked with social stigma and adjustment in community in normal manner becomes very difficult.

3. Economic impact: Hazards also have adverse longer-term consequences on economic growth, development and poverty reduction. Hazards deteriorate the economy badly by putting down the valuable assets such as buildings, equipment, human capital, etc., which consequently hamper their production capacity and sometimes lead to forced close down. The economy of these places would be stuck by the devastation caused by these hazards and the cost of restructuring settlement would be difficult. The focus and priority will shift from prosperity to recovery and importance will be given to provide immediate assistance to victims. Japan's economy was jolted (cost \$360 billion) by an earthquake and tsunami that hit the country on March 11, 2011. On an estimate 28,000 people died and more than 500,000 people were displaced.

4. Health impact: Health of all living organism, including humans might be at the receiving end as a result of the environmental hazards. Lack of basic necessities is a significant cause of human fatality rate. Environmental hazards increase the risk of cancer, heart disease, asthma, and many other illnesses. These hazards can be physical, such as pollution, toxic chemicals, and food contaminants, or they can be social, such as unsafework, poor housing conditions, urban sprawl, and poverty. The basic infrastructure of health care is destroyed at the time of natural hazard occupied with poor hygiene and lack of access to basic need adversely affecting the victim. Leakage of toxic chemicals from industries and accidents has both short term and long term effects on the health. Blindness, cancer, paralysis, heart trouble, gastric and respiratory abnormalities are the short term effects of the these hazards while as genetic imbalances in humans and its impingement on the future generations are the long term consequences of the biological and chemical hazards. Radiation is a major health concern; humans exposed to diversedegrees of radiation can cause uncontrolled growth of malignant neoplastic cells. Radiations can also alter the hereditary composition of an organism.

5. Change in Temperature: The global (Earth's surface, oceans and atmosphere) temperature is rising with every passing year due to human activities, primarily due to the combustion of fossil fuels that pump carbon dioxide (CO₂), methane and other greenhouse gases into the atmosphere. According to the National Oceanic and Atmospheric Administration (NOAA) the average global temperature has increased by about 1.4 degrees Fahrenheit (0.8 degrees Celsius) over the past 100 years, which leads to climate change and increases the likelihood of weather-related natural disasters. If global climate change causes the global average temperature to rise; frequencies of extreme weather events such

as floods, droughts and heat waves are expected to increase in the future.

6. Loss of Tourism: The environmental hazards can be a huge setback for tourism sector that rely on tourists for their daily livelihood. These hazards make huge damage in the form of loss of green cover, loss of biodiversity, huge landfills, increased air and water pollution can be a big turn off for most of the tourists.

5.6 REMEDIES OF ENVIRONMENTAL HAZARDS

Humans are subordinate to nature despite the fact that we have excelled in science and technology these hazards do not recognize man-made borders and threatens the environment every time. Therefore, it is the demand of hour that the international organizations and communities should operate together to diminish the danger of natural and manmade hazards. Here in this section we are going to discuss some of the important measures to be taken by various stakeholders that can help us either in controlling or in minimising the damage caused by these hazards.

1. Education and awareness: widespread public awareness and educating about the hazards will help in reducing the loss of life, personal injuries, and damage introduced through hazards. In today's world, with the help of technological advancement, acquiring knowledge and its application in the realm of action is regarded as the only effective means for preventing disasters or reducing its effects. People must be made aware of what natural hazards they are probable to face in their own communities and should know in advance what specific preparations is to be made before the occurrence of a hazard. Media plays a significant role in educating the population about disaster and its management, without which we could not aware people about disaster in remote areas of the country. Public officials and the media (television, radio, and newspapers) must be fully prepared to respond effectively, responsibly, and speedily to large-scale natural emergencies. Community-wide planning and education should be encouraged, schools, government organizations, community and church groups, business and neighbourhood organizations, hospital and medical groups, and the news media should all be involved.

2. Monitoring and control : Environmental Monitoring is a process of understanding the level of harmful pollutants present in atmosphere and examining their effect on environment, human life, animals and trees. The monitoring and control of environmental hazards involve a broad range of actions, each personalized to the particular hazard. Monitoring implies the use of routine measurements to observe changes in the environment, based on data from a wide diversity of sources, used to distinguish the critical agents, pathways and populations at risk. Such considerations will guide the methods to be utilised for monitoring and regular surveillance. Emissions inventories, Environmental data, bio-monitoring data and health data are various measures that could be applied for examining the environmental hazards. Setting of guidelines and criteria pertaining to environmental

levels may be implemented by voluntary agreement, balance of penalties and benefits to encourage good practice and dissuade bad, legal mandate. Measures which entail licensing, emissions control, or health and safety protection, can be enforced on individuals or individual companies violating the set protocol.

3. Environmentalism: This means building up good habits towards environment and refraining from inappropriate act against environment. Some of the major safety measures include: cultivation of maximum number of trees, using ozone friendly motors, keeping toxic wastes separated, cleaning of water reservoirs from time to time, refraining from synthetic fertilizers, recycling of various materials, using bio degradable products, using cloth bags instead of plastic are few of the measures that could help in protecting the environment.

4. Use of Personal Protective Equipment: Monitoring and protection against harmful chemicals or radiation risks covers various significant areas. Workers in high radiation areas should have radiation monitoring tests carried out frequently. There are various technological solutions available to reduce radiation levels if found to be above the limit. Workers in the nuclear industry or in other fields where there is exposure to ionizing radiations should wear radiation badges to monitor personal exposure. For non-ionizing radiation sources, there are published guidelines on exposure limits from static magnetic fields, to time-varying electric, magnetic and electromagnetic fields. The guidelines advise basic restrictions to provide protection against the established adverse health effects of exposure, e.g. shielding or limiting frequent use.

5. Hazard Communication and Training Programme: A Successful hazard prevention and control programme should involve communication and training for workers, supervisors and all other persons working in hazardous areas or people living in places where hazards are prone. In order to make this programme effective proper awareness and motivation should be integrated. Employees should be made aware of any sort of suspected or potential risk associated with their work. People residing at flood prone areas or earthquake zone areas should be made aware about these hazards beforehand so that they either plan to migrate to other areas or are aware of basic precautions to be taken while living there. People should also be informed on the best available means for prevention and control, and on how they can contribute to their implementation. This information should be associated with the proper utilisation of any control system, be it based on engineering controls, employment pattern or personal security. Persons involved with prevention and control should have opportunities to continually update their knowledge, skills and should be alert to new guidelines and new standards which may be applicable.

6. Health Surveillance: Health surveillance of employee includes pre-employment, periodic and special health examinations, which include clinical observations, screening

tests or investigations, and early detection of health impairment. Such surveillance should also be carried out in case of accidents, or those who have faced natural hazards as people after survival through hazards also faces various diseases, anxiety and depression which deteriorate their health. Health surveillance can never be replaced by primary hazard prevention; however, it is an essential complement, as it contributes in many ways to preventive strategies. This health surveillance may serve as useful indicators for controlling measures by detecting problems or failures in the system.

Check Your Progress : 2

Note : (a) Write your answers in the space given below.

(b) Compare your answers with those given at the end of the lesson

1. Anything that affects the environmental health of humans, plants and animals in a negative way is an _____.
2. UNISDR has divided hazards into two families: _____
3. Hazards caused by human action or inaction are _____ hazards.
4. Enlist important causes of hazards.

5. ____ and ____ will help in reducing the effects of environmental hazards.
6. What is the full form of NOAA

7. Enlist any four relevant remedies of environmental hazards.

5.7 LET US SUM UP

In the conclusion of this lesson we have gone through a detailed description of various environmental hazards. We have also learnt how different hazards effect our environment and what steps should be taken to handle or control the ill effects caused by the hazards. As discussed earlier a hazard is an agent, which possesses the potential to cause harm to a vulnerable target. In other words a hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impact, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. The hazard may also cause social and economic disruption or environmental

degradation. The hazards are classified into two families: natural and anthropogenic (man-made). Natural hazards are naturally occurring physical phenomena having atmospheric, geologic or hydrologic origin like tornadoes, hurricanes, earthquakes, landslides, floods, droughts etc. while as anthropogenic or man-made hazards are the hazards caused by human action or inaction like fire, explosion, Mine Disaster, Chemical Spill, Radiation Contamination, Nuclear Incident and even transportation accidents are all included in anthropogenic hazards. The anthropogenic hazards are further divided into three sub-families, Technological Hazards (hazards, such as fire, explosion, and power outage, as well one location for a hazard, Mine Disaster, and a hazard entitled, Industrial Disaster), Chemical and Radiological Hazards (Chemical Spill, Oil Spill, Radiation Contamination, Nuclear Incident) and the Transportation Accident hazards (includes the media through which objects are transported, Rail Accident, Road Accident, Space Accident, Aviation Accident etc.). All these hazards may directly or indirectly affect living organisms, biomes and ecosystem. Hazards lead to loss of life, damage of economy, social disruptions and have adverse long term effects.

5.8 LESSON END EXERCISE

- Q1. What do you understand by environmental hazards? How these hazards effect our environment?
- Q2. Write a short note on natural and anthropogenic environmental hazards?
- Q3. Describe the role of human beings in propelling the environmental hazards?
- Q4. How environmental hazard effect our social life?
- Q5. What remedies should be adopted to secure our-self from environmental hazards?

5.9 SUGGESTED FURTHER READINGS

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5.10. ANSWER TO CHECK YOUR PROGRESS

Check Your Progress-I

(i). United Nations International Strategy for Disaster Reduction. (ii). December 1999
(iii). Natural and anthropogenic (iv). Man-made (v) Earthquakes, Volcanic eruption and hurricanes.

Check Your Progress-2

1. Environmental education 2. Natural and Anthropogenic
3. Anthropogenic
4. (i) Land degradation (ii) Pollution (iii) Over Population (iv) Deforestation
(v) Ozone depletion (vi) Disposal of Wastes
5. Education and Awareness
6. National Oceanic and Atmospheric Administration
7. (i) Education and Awareness (ii) Monitoring and Control
(iii) Environmentalism (iv) Training Programmes

**ACID RAINS, OZONE DEPLETION, IMPACT OF DEFORESTATION AND
GLOBAL WARMING**

Structure

- 6.1 Introduction
- 6.2 Objectives
- 6.3 Acid Rains
 - 6.3.1 Types of acid rain
 - 6.3.2 Effects of acid rain
 - 6.3.3 Preventive measures
- 6.4 Ozone depletion
 - 6.4.1 Formation of Ozone
 - 6.4.2 Importance of ozone layer
 - 6.4.3 The Phenomenon of Ozone depletion
 - 6.4.4 Impact of Ozone Depletion
 - 6.4.5 Measure to prevent ozone depletion
- 6.5 Impact of deforestation
 - 6.5.1 Causes of deforestation
 - 6.5.2 Consequences or effects of deforestation
 - 6.5.3 Control of deforestation
- 6.6 Global Warming
 - 6.6.1 Impact of global warming
 - 6.6.2 Preventive measures
- 6.7 Let Us Sum Up
- 6.8 Lesson End Exercise
- 6.9 Suggested Further Readings
- 6.10 Answer to check your progress

6.1 INTRODUCTION

Environmental education increases the human capability to take part in the environmental management and assist in resolving the environmental crisis and challenges, which could be accomplished by increasing awareness and effectively modifying the individual outlook on the environment. In the previous lesson we have acquired knowledge about various environmental hazards and have already talked about their causes, effects and remedies. In this lesson we will focus our discussion on four important environmental hazards-acid rains, ozone depletion, deforestation and the global warming. These four environmental hazards are frequent and common now-a-days and information about them is utmost important. Because of the industrialisation, development in science and technology, urbanisation and overpopulation the frequency of acid rains, deforestation, global warming and the ozone depletion increases. So, here we are going to discuss these four environmental hazards in detail.

6.2 OBJECTIVES

After going through this lesson, you shall be able to:

- describe the concept of acid rains,
- explain the causes of formation of acid rains and impact of acid rains,
- delineate the phenomenon of ozone depletion,
- discuss the meaning, causes and consequences of deforestation, and
- describe the concept of global warming.

6.3 ACID RAINS : MEANING

The term acid rain is a comprehensive term that includes any form of precipitation that contains acidic components, such as sulphuric acid or nitric acid. In simple words, it is a precipitation having a pH of less than 5.6 (Pure water pH = 7.0 (neutral); unpolluted rainwater pH of about 5.6 acidic). Atmospheric pollutants, particularly oxides of sulphur (SO_2) and nitrogen (NO_2), can cause precipitation to turn more acidic when converted to sulphuric (H_2SO_4) and nitric (HNO_3) acids. Acid deposition, acid rain and acid precipitation all relate to the chemistry of air pollution and moisture in the atmosphere. Scientists generally use the term acid deposition, but all three terms refer to the same subject. The term acid rain was first used by Robert Angus Smith, a scientist working in Manchester in the 1870s. The problem of acid rain is hence not a new one, but the nature of the problem has varied

from being a local problem for towns and cities with being an international problem. The process that results in the formation of acid rain generally begins with the emissions of sulphur dioxide and nitrogen oxide into the atmosphere either from automobiles, or through certain industrial operations (e.g. smelting and refining) or by electric power plants that burn fossil fuels such as coal and petroleum. These gases combine with water vapour in clouds to form sulphuric and nitric acids and retrieve back as acid rain.

6.3.1 Types of Acid Rains:

Depending upon the nature of precipitation acid rain is of two types

1. Wet deposition
2. Dry deposition

Wet Deposition: If the acid chemicals in the air are blown into areas where the weather is wet, the acids can go down in the shape of rain, snow, haze, or mist and is termed as wet deposition.

Dry Deposition: In areas where the weather is dry, the acid chemicals may get incorporated into dust or smoke and comes down as dry deposition, sticking to the ground, buildings, homes, automobiles, and trees and washed from these surfaces by rainstorms, leading to increased runoff.

6.3.2 Effects of Acid Rains:

Acid rain and the air pollution that causes it can severely damage the ecosystem. Every ecosystem is interconnected, and the beings that live there rely heavily on each other. Acid rain may only damage a few organisms in an ecosystem, but everything else is indirectly involved. The damage acid rain causes can also take years, or even decades to reverse. Acid rain not only affects the ecosystems but also bears upon human health and other man made materials. Acid rain has broad economic, social and medical impacts and has been called an unseen plague of the industrial age. Let us highlight some of the effect of acid rain on our ecosystem.

1. Acid rain has many ecological effects, especially in lakes, streams, rivers, bays, ponds, and other bodies of water. Acid rain either falls directly on aquatic bodies or gets run off the forests, roads and fields to flow into streams, rivers and lakes. Over a period of time, acids get accumulated in the water and lower the overall pH of the water body. Aquatic plants grow best between pH 7.0 and 9.0. As the acidity increases, submerged plants, freshwater shrimp, bacterial decomposers, and plankton die off, and below pH 4.5 all the fish perish out.
2. Acid rain harms the surface vegetation. Research has verified that acid rain damages leaves' protective coating, allowing penetration of acids, which disrupts water

evaporation and gas exchange to the point that the plant can no longer breathe, convert nutrients, or take up water, henceforth wither off.

3. Acid rain also leaches essential nutrients like calcium, magnesium, and potassium from the land and increases the absorption of toxic metals such as lead, zinc, copper, chromium, and aluminium, which makes it hard for trees to take up water. Thus, stunts the growth of tree, plant, along with mosses, algae, nitrogen-fixing bacteria, and fungi.
4. The effects of acid rain combined with other environmental stressors make trees and plants less healthy, more vulnerable to cold temperatures, insects, diseases and also inhibit the tree's ability to procreate. Some soil is able to neutralise acids better than others, however, in areas where the buffering capacity of soil is low, the harmful effects of acid rain are seen much greater.
5. When acid rain falls on limestone statues, monuments, and gravestones, it dissolves, discolours, and/or disfigures the surfaces by reacting with the rock, known as dissolution. Statues, modern buildings, automobiles, airplanes, steel bridges and pipes are all affected by acid rain; irreplaceable damage can be caused to the old heritage buildings.
6. The toxic metals discharged due to acid rain when mixes with water and absorbed by crops, or animals that human consumes or directly used up by humans cause severe nerve damage, lung problems (asthma and bronchitis), brain damage, kidney problems, cancer, and Alzheimer's disease, that may cause even death.
7. Sometimes the concentration of particulate matter derivatives like sulphates and nitrates degrades the visibility, which can cause accidents leading to serious injuries or even deaths.

6.3.3 Preventive Measures:

There are number of potential solutions available to deal with air contamination and the resultant acid rain. Still, what matters more is to consciously apply these solutions on a broad plate. The foremost and the most significant thing is to educate people all over the world, and create awareness, about the causes and effects of acid rains. A second path to fight acid rain is to inhibit the release of the pollutants that cause it and for that the following measures should be taken.

1. One of the most fundamental solutions is to utilize fuels that burn cleaner, or to burn coal or other fuels more efficiently. This will greatly cut down the quantity of acids released into the atmosphere. Governments need to invest in exploring different ways of creating alternate energy sources that produce less pollution.
2. As far as industrial power plants are concerned, the best resolution is to fix devices commonly known as scrubbers in their chimneys, which help to reduce the quantity of sulphur released through the smoke by 90-95%.

3. Cars and vehicles are potential contributors of environmental contamination and acid rain. Using public transport, resorting to carpool, walking down to nearby places instead of driving, and so on, will help in saving fuel and reducing their adverse effects.
4. All types of vehicles must be equipped with catalytic converters to their exhaust pipes which help in the reduction of sulphur dioxide.
5. We can also help by adopting small habits in our daily routine life. Step like turning off our lights, computers, and other electrical appliances, when not in use, while purchasing any electric appliances, we should always buy energy efficient appliances, which consumes less energy. Adopting these energy saving steps can support to a great extent.
6. We should resist the use of non-renewable fuels and switch over to renewable sources of energy like solar energy, wind energy, and hydro energy.
7. Damaged lakes and other water bodies can be rejuvenated by adding certain chemicals that are popular for neutralising the acidity caused by acid rains. Chemicals like calcium oxide, caustic soda, sodium carbonate, slaked lime and lime stone are popularly utilised for this purpose.

All these solutions will be pointless unless people are informed and educated about the ill-effect(s) and harm caused by acid rain. A widespread and nationwide effort must be made to make people aware of the hazardous effects caused by acid rain. Only after then all other solution will make a difference.

Check Your Progress-1

Note: (a) Answer the questions given below

(b) Compare your answer with those given at the end of this lesson

- i. Oxides of & causes Acid rain.
- ii. & depositions are the two types of Acid rain.
- iii. Acid rain is having a pH of less than.....
- iv. Acid rain was discovered by
- v. The chemical formula of Sulphuric & Nitric acid is and

6.4 OZONE DEPLETION : MEANING

Ozone is a naturally occurring gas present in our atmosphere, which was first discovered by German-Swiss chemist C. F. Schnbein in 1839. Each ozone molecule contains three atoms of oxygen chemically denoted as O_3 and is chiefly found in two regions of the

atmosphere. Approximately 10% of atmospheric ozone is present in the troposphere and the remaining 90% is present in stratosphere. The troposphere is close to earth approximately 10-16 kilometres and the stratosphere about 50 kilometres above the surface. This large quantity of stratospheric ozone is often referred to as the ozone layer. The word ozone is derived from the Greek word ozein meaning "to smell. It is an irritating, pale-blue gas that is explosive and toxic, even at low concentration. Its pungent odour allows it to be detected even at very low amounts. Ozone reacts rapidly with many chemical compounds and is explosive in concentrated quantities. The ozone layer extends over the entire globe with some variation in altitude and thickness. The most common stratospheric ozone measurement unit is the Dobson Unit (DU) named after the atmospheric ozone pioneer G.M.B. Dobson. A Dobson Unit measures the total quantity of ozone in an overhead column of the aura. Dobson Units are assessed by how compact the layer of ozone would be if it were compressed into single layer at 0 degrees Celsius and with a pressure of one atmosphere above it.

6.4.1. Formation of Ozone

As discussed above ozone is found in two regions of the atmosphere, therefore here we can explain its formation with regard to its existence:

- a. **Formation of Stratospheric ozone:** - Stratospheric ozone is formed naturally by chemical reactions involving solar ultraviolet radiation (sunlight) and oxygen molecules. In the first step, solar ultraviolet radiation breaks apart one oxygen molecule (O_2) to produce two oxygen atoms ($2O$). In the second step, each of these highly reactive atoms combines with an oxygen molecule to produce an ozone molecule (O_3). These reactions occur continually whenever solar ultraviolet radiation is present in the stratosphere. As a consequence, the largest ozone production occurs in the tropical stratosphere.
- b. **Formation of Tropospheric ozone:** - Fossil fuel combustion is a main source of pollutant gases that contribute to tropospheric ozone production. Near the Earth's surface, ozone is produced by chemical reactions involving naturally occurring gases and gases from pollution sources. Ozone production reactions primarily involve hydrocarbon and nitrogen oxide gases, as well as ozone itself, and all require sunlight for completion.

6.4.2. Importance of Ozone layer:

Ozone may be either hazardous or beneficial, depending largely on its presence. For example, stratospheric ozone is thought safe for human and other forms of life because it absorbs UV-B radiation from the Sun, which otherwise would reach Earth's surface and will cause harm to all forms of life. Increased exposure to UV-B radiation increases the

risks of skin cancer, cataracts, and a suppressed immune system and can also damage terrestrial plant life, single-cell organisms, and aquatic ecosystems. Other UV radiation, UV-A, which is not absorbed significantly by ozone, causes premature aging of the skin. On the other hand, Ozone near the Earth's surface in excess quantities is thought as bad ozone, which is hazardous as an oxidant in smog (smog ozone). Smog ozone reduces the normal operation of the lungs because it inflames the cells that line the respiratory tract. Other health effects include increased incidence of asthma attacks, increased danger of infection, and reduced heart and circulatory functions. Smog Ozone also damages plant foliage and reduces their production or yield.

6.4.3. The Phenomenon of Ozone depletion:

Ozone hole or Ozone layer depletion, is simply the wearing out (reduction or thinning) of the amount of ozone in the stratosphere. The loss of ozone layer occurs when more ozone is being destroyed than being created. The ozone layer is being ruined by a group of manufactured chemicals that are known as Ozone-Depleting Substances (ODS). In the 1970s, scientists from the British Antarctic Service first noticed an evident diminution in the quantity of ozone in the stratosphere above the Antarctic in winter. It was first proposed by M. Molina and S. Rowland in 1974 that a man-made group of compounds known as the chlorofluorocarbons (CFCs, extremely long-lived, stable, non-flammable, not too toxic) were likely to be the main source of ozone depletion. CFC's are used in air conditioning systems, refrigerants, solvents, foam blowing agents and as propellants for aerosol spray cans. Chlorofluorocarbons are not "washed" back to Earth by rain or destroyed in reactions with other chemicals. These compounds merely do not break down in the lower atmosphere and they can remain there from 20 to 120 years or more. As a result of their relative stability, CFCs are transported into the stratosphere where they are finally worn down by ultraviolet (UV) rays from the Sun, releasing free chlorine which actively gets involved in the destruction of ozone. Scientists have found that 1 atom of chlorine can destroy over 100,000 ozone molecules. Researchers have found ozone also thinned over North America, Europe, Asia, Australia, South America, and Africa.

6.4.4. Impact of Ozone depletion:

As discussed earlier, the stratospheric ozone plays an important role in protecting surface life forms from exposure to harmful UV-B radiation. This 'good ozone' typically absorbs 97-99 percent of incoming UV-B radiation. If these radiations enter into our atmosphere they adversely effect on each and every component of our ecosystem (directly or indirectly). Here in this section we are going to talk about some of the adverse effects of Ozone

depletion on our ecosystem.

A. Human and Animal Health: Increased penetration of solar UV-B radiation to earth is likely to induce a profound impact on human health with potential risks of eye diseases, skin cancer and various other infectious diseases. UV radiation can damage the cornea and lens of the eye; it could lead to cataract. Experiments have shown that UV exposure adversely affects the immune response to skin cancers, infectious agents and other antigens making them prone to many infectious diseases.

B. Terrestrial Plants: The Physiological and developmental processes of plants are also affected by UV-B radiation leading to change the species composition by mutation, which strongly changes the bio-diversity of different ecosystems. UV-B could involve the plant community indirectly resulting in alteration of plant form, secondary metabolism, etc. These alterations can have significant implications for plant competitive balance, plant pathogens and bio-geochemical cycles.

C. Effects on Aquatic Ecosystems: More than 30 percent of the world's animal protein for human consumption comes from the sea alone, it is feared that increased levels of UV exposure can have adverse impacts on the productivity of aquatic ecosystem system. Higher levels of vulnerability in the tropics and subtropics may affect the distribution of phytoplankton's which form the base of aquatic food webs. UV-B can also cause damage to early development stages of fish, prawn, crab, amphibians and other animals and can also decrease the reproductive capacity of many aquatic animals.

D. Effects on Air Quality: Decline in stratospheric ozone increases the penetration of UV-B radiation that results in higher photo dissociation rates of key trace gases that support the chemical reactivity of the troposphere. This can increase both production and destruction of ozone and related oxidants such as hydrogen peroxide which are experienced to cause adverse effects on human health, terrestrial plants and outdoor materials.

E. Effects on Materials: increased level of solar UV radiation is known to have adverse effects on synthetic polymers, and some other materials of commercial interest. These radiations accelerate the photo degradation rates of these materials, thus limiting their life. Typical damages range from discoloration to loss of mechanical integrity.

F. Effects on Climate Change: Ozone depletion and climate change are linked in a number of ways, but ozone depletion is not a major causal agent of climate change. Atmospheric ozone affects the temperature balance of the Earth, as it absorbs solar ultraviolet radiation, which heats the stratosphere. Heating of stratosphere will lead to various climatic changes which vary with the altitude.

6.4.5. Measures to prevent Ozone depletion:

The Vienna Convention for the protection of the Ozone layer in 1985 and the Montreal Protocol on substances that deplete the ozone layer in 1987 were the starting points of global cooperation for protection of the ozone layer in the stratosphere. Depletion of the ozone layer is a serious issue and various programmes had been set up by the government of various countries to forbid it. But, steps should be taken both at individual as well as at community level to prevent the depletion of ozone layer. Here we are going to highlight some of the steps that would directly or indirectly assist in the prevention of Ozone depletion at individual as well as at global level.

1. We should avoid the consumption of those gases which are hazardous to the ozone layer. Some of the most dangerous gases are CFCs (chlorofluorocarbons), halogenated hydrocarbon, methyl bromide and nitrous oxide.
2. We should minimise the usage of vehicles as they rent out large amount of greenhouse gases that contribute to global heating as well as ozone depletion. Therefore, the utilisation of vehicles should be minimised as a good deal as possible.
3. We should not use cleaning products that are harmful to the environment. Many cleaning products contain solvents and substances that are harmful. We can replace these dangerous substances with non-toxic products such as vinegar or bicarbonate.
4. We should maintain air conditioners, as their malfunctions cause CFC to runaway into the atmosphere.
5. We should ensure that existing restrictions on ozone-depleting substances are properly implemented and global economic consumption of ozone-depleting substances continues to be cut.
6. We should ensure that banks of ozone-depleting substances (both in storage and contained in existing equipment) are dispensed within an environment-friendly manner and are replaced with climate-friendly alternatives.
7. We should attempt to reduce the utilisation of ozone-depleting substances in applications that are not enumerated under the Montreal Protocol.
8. We should ensure that no new chemicals or technologies emerge that could pose new threats to the ozone layer (e.g. very short-lived substances).
9. We should avoid using pesticides, and should switch to use the natural methods to get rid of pests and weeds instead of using chemicals. One can use eco-friendly chemicals to remove the pests or remove the weeds manually.

10. We should attempt to apply eco-friendly cleaning products as most of the cleaning products have chlorine and bromine releasing chemicals that gets liberated into the atmosphere and affect the ozone layer. These should be substituted with natural products to protect the environment.
11. Government should act and prohibit the use of harmful nitrous oxide containing substances that are adversely affecting the ozone layer. The people should be made aware of the harmful effects of nitrous oxide and the products emitting the gas so that its use is minimised at the individual level as well.

Check Your Progress-II

Note: (a) Answer the questions given below

(b) compare your answer with those given at the end of this lesson

- i. The chemical formula of ozone is
- ii. CFC stands for.....
- iii. In the atmosphere good ozone is found in the
- iv. In Vienna Convention for the protection of the Ozone layer was held
- v. Ozone depletion was first proposed by In 1974
- vi. The word ozone is derived from a Greek word

6.5. DEFORESTATION MEANING

The term deforestation means the aggregate sum of activities that lead to the removal of vegetative cover in the forests. It can be either by anthropogenic (man) activity or by a natural (wildfire caused by lightning) phenomenal. It also covers all other activities that cause the temporal removal of forest cover such as slashing and burning technique, shifting cultivation, and clear cutting. Deforestation is the conversion of forest to an alternative permanent non-forested land use such as agriculture, grazing or urban development. **The definition used by UN agencies is "the temporary or permanent clearance of forest for agriculture or other purposes"**. Deforestation is the permanent removal of trees to create room for something besides forest. This can include gaining the ground for farming or grazing, or utilizing the timber for fuel, or for construction or manufacturing. Deforestation is thus a process of cutting down trees and clearing land. In many countries, people clear land to use it for other purposes, such as agriculture, pasture land, urban development etc. Deforestation can also occur to produce the wood and organic materials needed for a variety of industries. Forests cover about 30 percent of the total surface of the Earth. These forested areas supply food, medication and fuel for more than a billion

people. Scientists find that forests provide 13.4 million people with jobs in the forest sector, and another 41 million people hold jobs related to forests.

6.5.1 Causes of Deforestation:

There are many factors that contribute to deforestation, each with its own causes and negative environmental consequences. Here we are going to highlight some of the major factors responsible of deforestation.

- 1. Population growth and Deforestation:** One of the chief causes of deforestation is overpopulation in cities and developing nations. Population and per capita income frequently grow in the third world which increases the need for wood products. This increasing demand leads to overexploitation of forests and promotes deforestation i.e., conversion of forestlands to agriculture and other form of development.
- 2. Agriculture:** Due to overpopulation the agriculture area has increased from 118 million hectares in 1951 to 142 million hectares in 1999 and is still increasing. Agriculture is one of the most significant causes of deforestation. One of the most common forms of deforestation is slash-and-burn agriculture which refers to the cutting and burning of forests or woodlands to create fields for agriculture or pasture for livestock or for a variety of purposes. Slash-and-burn agriculture is responsible for the loss of around 50 acres of land every hour worldwide. One of the issues with slash and burn is that fires intentionally set can unintentionally spread throughout the forest. When fire spreads to unintended areas, the protective forest canopy is adversely destroyed.
- 3. Housing:** Housing, also called "urban sprawl" is the major leading cause of deforestation. Urban sprawl is one of the most difficult deforestation-related issues to resolve. This is due to the fact that, at its base, urban sprawl is driven by overpopulation. In fact, overpopulation is one the most complex and pressing issues at the beginning of many environmental problems. With the worldwide growth in population, land to build houses for people to live in is very much called for.
- 4. Cattle Grazing** Another force that operates deforestation is a cattle grazing. Cattle ranching have a monumental impact on forests around the world, especially tropical rainforests like the Amazon. Many farmers use deforested areas of land to raise cattle; however, it might surprise you to learn that corporations do this on a much larger scale. Fast food companies have been contributing to deforestation in order to raise cattle for their hamburgers.
- 5. Hydro-electric projects and Dams.** Hydroelectric projects, dams, reservoirs submerge large forest tracts. They uproot thousands of forest dwellers from their area of residence much before the construction of a dam. A great deal of earth is cleared for

providing a residence for the workers for which wood and other wood products are used up. While constructing huge dam's vast area of forests and human colonies has been destroyed, this initiated many social problems.

6. Wild Fire A wildfire, also known as a wild land fire, vegetation fire, grass fire, bush fire or hill fire is an uncontrolled fire often occurring in wild land areas, but which can also consume houses or agricultural resources. Common causes are lightening, human carelessness, arson and volcano eruption. Heat waves, droughts and cyclical climate changes can also possess a striking consequence on the hazard of wildfires.

7. Acid Rain: Acid rain occurs when sulphur dioxide and nitrogen oxides are emitted into the atmosphere undergo chemical transformation and are absorbed by water droplets in clouds. The droplets then fall to earth as rain, snow, mist and dry dust, which harms the surface vegetation (plants, trees, grass etc). Scientists think acid rain damages leaves' protective coating, allowing acids to penetrate. This disrupts water evaporation and exchange of gases to the point that the plant can no longer breathe, convert nutrients, or take up water results in wilting or under extreme conditions even death.

8. Quarrying and mining: In forested and hilly areas, mining and quarrying are harmful. They spoil vegetation over large areas due to mine dust, ore and mine wastes. Moreover, the forest terrains are converted to roads for transportation.

6.5.2 Consequences or Effects of Deforestation:

Dear students in this segment we are going to discuss the consequences of deforestation and after going through this section we can also acquire knowledge about the importance of forests in our ecosystem. So, let us begin to understand them in detail.

- 1.** The loss of forests also means the loss of habitats for many species of plants and animals. "Seventy per cent of the world's flora and fauna survive in forests and are losing their habitats to deforestation. The loss of habitat means the loss of species and thus the loss of biodiversity, which has varied negative impacts on environment.
- 2.** The UN's 2018 'State of the World's Forests report' found that over half the global population relies on forested watersheds for their drinking water as well as water used for agriculture and industry purposes. Therefore, the loss of forests can also affect the water quality of the globe.
- 3.** Trees undergo a natural process called 'transpiration' i.e. secretion of water vapours through tiny pores of leaves. These vapours become clouds and come back down as rain. When trees are cut down in a forest, it eliminates or decreases the amount of transpiration, which means that the total rainfall in that region will decrease and can contribute to droughts.

4. The roots of trees hold the particles of soil together, thus, preventing the fertile top soil from being carried away. When trees are cut down, surrounding soil becomes loosened from the ground, and can be blown away by wind, or washed away by rain. Soil erosion leads to loss of productivity of the land due to loss of mineral nutrients and soil microorganisms.
5. Trees also play an important role in carbon sequestration, or the capture and storage of excess carbon dioxide. Accumulation of carbon dioxide in the atmosphere acts as a blanket that traps long wave radiation of heat and prevents them from escaping back into the atmosphere. These trapped radiation increase the temperature of the atmosphere causes global warming.
6. Destruction of forests also causes a modification of the climate of an area more often leading to desertification and aridity.
7. Some trees are used as medicinal herbs, such as the Cinchona which has been utilized for the treatment of Malaria since time immemorial. Demolition of these forests leads to destruction of medicinal plants that could be applied as a treatment for several ailments.
8. One of the vital functions of forests is to absorb and store great amounts of water quickly when it rains heavily. When forests are cut down, this regulation of the flow of water is disrupted, which leads to alternating periods of flood and then drought in the affected area, which, disrupts human settlements and loss of life.
9. Indigenous peoples living in the forests depend on the natural environment for food, shelter, materials for cooking, clothing, etc. If the forests are cut down or if their environment becomes polluted from oil extraction and mining, they are forced to migrate or risk starvation and may become prone to diseases.

6.5.3 Control of Deforestation:

In the previous section we have discussed about the consequences of deforestation, which indirectly provides us a clue about the importance of forests. Although, the process of deforestation is continually going on we can minimise or stop it by assuming some of the below mentioned criteria.

- We should try to develop alternatives to deforestation that can help in diminishing the demand for tree clearing. For instance, it is a well-known fact that agriculture is an attractive reason for deforestation, people should adopt sustainable farming practices or employee new farming technologies and should use high yield crops that will furnish the demand and the need for more land may be diminished.

- To arrest deforestation, it is important to create a network of protected areas where the forests are protected from encroachment.
- Improvements in forest management require sincere commitments on the part of both government and industry to make real changes.
- Encouraging the practice of agro forestry i.e. the exercise of growing trees with agricultural crops or livestock on the same parcel of land.
- Industrial plantation of fast growing trees has a great potential for satisfying much of the requirement for forest products and at the same time, reducing the need to exploit the natural forest.
- Forests can also be rejuvenated, through replanting trees in cleared areas or simply allowing the forest ecosystem to regenerate over time
- Tree planting and the protecting of existing vegetation from fire, grazing and land clearing should be boosted and the appropriate incentives should be provided.
- True participation of all interest groups like communities, companies, local government, and other land users is needed in planning and implementation of policies.
- More support is needed for national and international Research into forestry and other land uses for combating deforestation.
- The highest priority should be given to reforms to natural resource policies and other policies affecting forest lands.
- More support must be given to public education and awareness building campaigns about forest sector issues.

Everyone can contribute their part to curb deforestation by adopting simple steps like purchasing certified wood products, go paperless whenever possible, limit our consumption of products that use palm oil and should plant a tree when possible.

Check Your Progress-III

Note: (a) Answer the questions given below

(b) compare your answer with those given at the end of this lesson

- i. Cutting down the forests is known as
- ii. Planting trees is known as
- iii. Evaporation of water vapours through the leaves is known as
- iv. Chipko movement was launched for the protection of

6.6. GLOBAL WARMING MEANING

Climate scientists are continuously observing various weather phenomena such as temperatures, precipitation, and storms and their influences on climate since a long time. These observations indicate that Earth's climate has shifted dramatically since the start of the Industrial Revolution. Climate change is any significant change in Earth's climate that holds for an extended period of time. Global warming refers to climate change that causes an increment in the mean temperature of the lower atmosphere. Global warming may have many reasons, but is usually linked with human interference, specifically the release of excessive quantities of greenhouse gases. A special report brought out by the Intergovernmental Panel on Climate Change (IPCC) in 2018 observed that human and their activities are responsible for an increase in worldwide average temperature between 0.8 and 1.2 °C of global warming since preindustrial times. It also predicted that the global mean surface temperature would increase between 3 and 4 °C by 2100.

The composition of atmosphere encompasses 78.1 percent nitrogen and 20.9 percent oxygen and all other gases like carbon dioxide (CO₂) 0.035 percent, methane (CH₄) 0.00017 percent, and ozone 0.000002 percent, roughly make up to 1 percent of the total. Gases, such as carbon dioxide, methane, water vapour, and fluorinated gases, are usually known as greenhouse gases as they act like a greenhouse around the earth. These gases form a partial cover over the Earth's atmosphere and do not permit the outgoing infra-red radiations to travel backwards into space. This mechanism of trapping gases is largely adopted in greenhouses to take aid of the warmth generated from such gases in the speedy development of plants present there. Equally the same mechanism involves in the Earth's atmosphere, so it is as well recognized as the 'Greenhouse Effect'.

The emission of the greenhouse gases has been on the rise since pre-industrial times, but such increase have become extensively rapid in recent times with industrialization, advancement of science and technology, overpopulation, land-use change, deforestation, change in lifestyles, and the increase in the burning of fossil-fuels. These anthropogenic activities added a fresh variety of gases to the family of greenhouse gases like chlorofluorocarbons (CFCs), per fluorocarbons (PFCs), hydro-fluorocarbons (HFCs) and sulphur hexafluoride (SF₆) which further enhance the average temperature of the Earth. When the stock of the greenhouse gases goes beyond the assimilative capacity of the Earth, there occur manifestations of the same through changes in the weather regime

and impacts are also observed on the diverse ecosystems of the globe. As a consequence of the greenhouse effect, the global mean temperature of the Earth increases and carries on over a long period of time and is the main cause of extensive warming of the planet, hence, termed as 'Global Warming'.

6.6.1. Effect or Impact of global warming:

The first scientist to propose that increased carbon dioxide could alter the atmosphere was a Swedish chemist named Svante Arrhenius. Predicting the consequences of global warming is one of the most difficult tasks faced by the climate researchers. This is due to the fact that natural processes that cause rain, snowfall, hailstorms, rise in sea levels is reliant on many diverse factors. Moreover, it is very hard to predict the size of emissions of greenhouse gases in the future years as this is determined majorly through technological advancements and political decisions. Global warming produces many negative effects some of which are described as below:

1. Because of global warming the glacier ice sheaths start melting, which leads to the rise of sea level. Rate of increase in sea level is 3.19 mm per year; this causes loss of low lying land, submergence of islands in Indian and Pacific Ocean, loss of valuable habitats and beaches.
2. Global warming is responsible for very destructive storms. The ocean temperature gets increased due to global warming, which subsequently intensify the speed of the wind, resulting in the hurricanes and tornadoes which cause mass destruction to lives, properties and crops.
3. Forest fires can occur either naturally (lightening, volcanic eruptions, spark from rock falls) or by anthropogenic (slash and burn) activity liberating huge amounts of Carbon dioxide, ash and other related materials. It has been estimated between 1850 and 1980 90-120 billion metric tons of CO₂ was released by forest fires which is thought to be the primary cause of global warming.
4. Heat waves which are the consequences of global warming kill more than 184 people in India during 2019. Most affected regions are Andhra Pradesh, Telangana, Punjab, Uttar Pradesh, Odisha and Bihar. It also severely affected cattle and harvest yield
5. Increased temperatures of land and ocean moved the habitat range of many species pole ward or upward from their current location, such movements are also accelerated by droughts and desertification. Species with restricted habitat requirement are more vulnerable to climate change. Species that are already at

risk face extinction, many habitats such as wetlands, beaches, grasslands and sea grass beds disappear. Climatic change associated reduction in Arctic and Antarctic ice alter seasonal distribution, migratory pattern, nutritional and reproductive status of marine mammals, it also affect the plankton distribution which affect or collapses the entire food chain.

6. Increasing temperature causes coral bleaching in various parts of the world and acidification of oceans affect the corals regard to their formation of skeleton, acidified waters cause difficulties in absorbing calcium from the water which is essential for shell formation and it also dissolves the reefs.
7. Epidemics of water born and vector borne diseases occur as flooding increases, the breeding places of mosquito and other vectors also increases.
8. Global warming may also transfer various diseases to other regions as people will shift from regions of higher temperatures to regions of comparatively lower temperatures.
9. Flood and landslides cause large death and injury in human population such events are increasing with the global climatic change in countries like Bangladesh, Khartoum, Netherlands, Egypt and Sudan.

6.6.2. Preventive measures for global warming:

In order to control global warming and climate change, the emission of greenhouse gases into the atmosphere should be drastically reduced. This can be achieved by adopting the following measures:

- Improving energy conservation and efficiency as well as the production and efficient utilization of non-fossil fuels. The use of non-fossil fuels can be greatly improved by unleashing our engineering, economic and political entrepreneurs. This could help us in moving towards greater use of renewable energy resources and non-fossil fuels.
- The production of carbon dioxide should be decreased by decreasing the use of fossil fuels. Other ways to reduce its emission includes the establishment of stringent standards for power plants, development and marketing of high efficiency but cost effective automobiles, and provision of financial incentives for energy efficiency in industries and homes.
- We should grow green plants wherever possible, the planting of more trees is a more direct and practical way of combating global warming and climate change because forests sequester a large amount of carbon dioxide in the leaves and soil.

- Apart from reducing the emission of greenhouse gases, a number of innovative geo-engineering models (e.g. iron fertilization) have been proposed so as to achieve a cooler planet and thereby control climate change and other effects of global warming.
- We can reduce the emission of nitrous oxide by reducing the use of nitrogen fertilizers in agriculture.

Above all the most important is to educate people about the evil and hazardous consequences of global warming. All of us should lend our hand to fight against global warming, healing the planet starts at home-from our garage, kitchen, and from our dining-room table.

Check Your Progress-IV

Note: (a) Answer the questions given below

(b) compare your answer with those given at the end of this lesson

- i. Most abundant greenhouse gas present in the atmosphere is
- ii. is the most abundant gas in the atmosphere is?
- iii. The process of in plants help in the absorption the atmospheric CO_2 .
- iv. Polar ice sheets melt because of
- v. Global warming leads to increase the of earth.

6.7. LET US SUM UP

In this lesson we have discussed in detail the concept of acid rain, Ozone Depletion, deforestation and global warming at the end of this lesson let us recapitulate them:

Acid Rain: Acid rain is any form of precipitation that contains acidic components like sulphuric acid or nitric acid having a pH of less than 5.6. Atmospheric pollutants, particularly oxides of sulphur (SO_2) and nitrogen (NO_2), causes the precipitation to turn more acidic.

Ozone depletion: Ozone is a naturally occurring gas present in our atmosphere. Each ozone molecule contains three atoms of oxygen chemically denoted as O_3 . The ozone layer extends over the entire globe with some variation in altitude and thickness. Ozone hole or Ozone layer depletion is simply the wearing out, reduction or thinning of the amount of ozone in the stratosphere caused by a group of chemicals known as Ozone-Depleting Substances (ODS) like chlorofluorocarbons.

Deforestation: The term deforestation means the aggregate sum of activities that lead to the removal of vegetative cover in the forests. Deforestation is the conversion of forest to an alternative permanent non-forested land use such as agriculture, grazing or urban development.

Global warming: Global warming refers to climate change that causes an increment in the mean temperature of the lower atmosphere. Global warming may have many reasons, but is usually linked with human interference, specifically the release of excessive quantities of greenhouse gases.

6.8. LESSON END EXERCISE

- Q1. Write a brief note on acid rain?
- Q2. Explain in detail the phenomenon of Ozone depletion?
- Q3. What preventive measures can be taken to check the menace of deforestation?
- Q4. What do you understand by the term greenhouse effect?
- Q5. Write a detail note on the consequences of Global warming?

6.9. SUGGESTED FURTHER READING

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6.10. ANSWER TO CHECK YOUR PROGRESS

Answers to Check Your Progress-I

(i). Sulphur and Nitrogen (ii). Dry & wet (iii). 5.6 (iv). Robert Angus Smith (v). H_2SO_4 and HNO_3 .

Answers to Check Your Progress-II

(i). O_3 (ii). Chlorofluorocarbon (iii). Stratosphere (iv). 1985 (v). M. Molina and S. Rowland. (vi). Ozone.

Answers to Check Your Progress-III

(i). deforestation (ii). Afforestation (iii). Transpiration (iv). Forests

Answers to Check Your Progress-IV

(i). Carbon dioxide (ii). Nitrogen (iii). Photosynthesis (iv). Global warming (v). Mean temperature.

**POPULATION AND ECOSYSTEM - CONCEPT OF ECOSYSTEM,
COMPONENTS OF ECOSYSTEM – ABIOTIC AND BIOTIC**

Structure

- 7.1 Introduction
- 7.2 Objectives
- 7.3 Population
 - 7.3.1 Characteristics of Population
- 7.4 Ecosystem
 - 7.4.1 Components of Ecosystem
 - 7.4.2 Abiotic components
 - 7.4.3 Biotic components
- 7.5 Let Us Sum Up
- 7.6 Lesson End Exercise
- 7.7 Suggested Further Readings
- 7.8 Answer to Check Your Progress

7.1 INTRODUCTION

Ecology, (also called as bioecology, bionomics, or environmental biology), is a branch of biology concerned with the study of the relationships between organisms and their biophysical environment, which includes both living and non-living components. The term ecology was coined by a German biologist Ernst Haeckel in 1866 and is derived from two Greek words, Oikos meaning house or dwelling place and logos means study of. Thus, ecology is the study of living organisms (both plants and animals), in natural habitats or homes, which admit both the other organisms and their physical surroundings. There involves an interactions or relationships within a population and between individuals of different populations and their surroundings, which progress to ecological systems or ecosystems. These interactions results in the establishment of grouping of organisms which is called ecological hierarchy or ecological levels of organization or the organizational hierarchy.

Ecological hierarchy therefore describes the organization of biological organisms in relation to one another which begins at the level of an individual and proceeds to greater levels of complexity like ecosystem and finally to the entire biosphere. The first level of the ecological hierarchy is an individual organism which is recognized as the basic unit of the ecological hierarchy. This level of the hierarchy examines how one organism interacts with its environment and their response (biological, morphological and physiological development) to the natural environment. The second level of the ecological hierarchy involves populations which contain a group of individuals belonging to a single species inhabiting in a specific geographical area at a particular time. Populations of the same sort form a species which may represent different populations inhabiting in different geographical areas. Population ecology studies the interactions among the individual members of a population. The third level of the ecological hierarchy is known as community. The organisms of all the species that exist in a specified area and interact in diverse ways with one another to constitute a self-sustained unit is collectively called as biotic community or biocenose. The animal population of a biocenose is known as animal community while as its plant population is known as plant community and its microbial population is known as microbial community. The community level hierarchy focuses on the relationship between different species in a community. Predator and prey relationships play a large role in community-level analyses. The next hierarchical level is an ecosystem, a natural self-sufficient unit of an environment comprising of a biotic and abiotic components. This level of ecological hierarchy focuses on the interaction of living organisms with one another and with the non-living components present in the environment. All the ecosystems of the world together form a biosphere or an ecosphere which forms the top most level of this hierarchy. The biosphere includes climate, geology, the oceans, human pollution and so on. The biosphere includes all ecosystems on Earth and how they interact together. In this lesson we are going to discuss in detail the concept of population, its characteristics and the ecosystem and its types.

7.2 OBJECTIVES

After going through this lesson, you shall be able to:

- know the meaning of population,
- general characteristics of the population,
- know the concept of ecosystem,
- biotic components of ecosystem, and
- abiotic components of ecosystem.

7.3 POPULATION

Dear students whenever there is a talk of population, we generally think of human populations. In order to understand the concept of population, we have to think in terms of groupings. A grouping of individuals of the same species located in the same geographical area is known as a population. Ecologists usually do not study organisms as individuals; rather, they group them together into populations. All the populations of the same sort of organisms form a species. The population consists of only a single species; most species are made up of many populations. Each population occupies the same kind of habitat, spread over a landscape or region. Populations fluctuate based on a number of factors: seasonal and annual changes in the environment, natural disasters such as forest fires and volcanic eruptions, and competition for resources between and within species are some of them. All the individuals of a population belong to one species, which are morphologically genetically and anatomically similar with a free gene flow between individuals of a population. The study of ecology of individuals of the same species is called as population ecology and the study of factors that affect growth, stability, and decline of population is called as population dynamics. Therefore, in simple words, we can define population as a group of same kind of individuals living in a specific geographical area at a particular time.

7.3.1. Characteristics of a Population

Scientists study a population by investigating how individuals in that population interrelate with each other and how the population as a whole interacts with its environment. Population ecologists rely on various statistical measures, known as demographic parameters, to describe a population and the field of science interested in collecting and analyzing these parameters is termed as population demographics, or demography. Therefore, demography is the study of the characteristics of populations. A population displays certain characteristics which can only be expressed at the population level and not shared at the individual level, for example, individual organisms are born, grow and die, but characteristics such as birth rate, death rate, density are only meaningful at the population level not at the individual level. Demography includes any statistical factors that determine population growth or fall and provides a mathematical description of how these characteristics change over time. Here, in this section, we are going to discuss some of the important characteristics of population in detail.

1. Population Size: Population size means the total number of individuals of a species in an area at a specific time. Population size influences the chances of a species survival or extinction. Generally, very small populations are at greatest risk of extinction. However, the size of a population may be less important than its density.

2. Population Density: number of individuals per unit area or volume at a given time e.g. the number of animals per square kilometer or number of trees per acre etc. if the total number of individuals is represented by Capital letter N and the number of unit of space by S, then the population density D can be obtained as $D = N/S$

3. Natality: the birth or Natality rate is the rate of production of new individuals (birth, hatching or germination etc) per unit time, or the rate at which new individuals are added to a population through reproduction. It is usually expressed as the number of births per 1,000 individuals in the population per year.

Birth rate or Natality = Number of births per unit time / Average population

Maximum (absolute or physiological) Natality is the maximum production of new individuals under ideal environmental conditions while as ecological Natality refers to the population increase under natural environmental conditions.

4. Mortality: the death or mortality rate is the rate of loss of individuals (death rate) per unit time due to death or due to the different environmental changes, competition, predation, etc., or the rate at which individuals are lost from a population by death. It is usually expressed as the number of deaths per 1,000 individuals in the population per year.

Death rate or Mortality = Number of deaths per unit time/average population.

Ecological mortality is the loss of individuals under the given environmental conditions. Minimal mortality represents the loss under ideal conditions.

5. Dispersal: the movement of individuals from their immediate environment of parents to an area more or less distant from their parents is known as dispersal. In other words dispersal operates when an individual organism leaves the place in which they were born, and settle in new areas. Dispersal strongly influences the population dynamics of a species and can aid in determining the population size and density. The initial movement of an organism from its birthplace to a place in which it tries to spawn is known as Natal dispersal, while as the movement of an adult to change its location in space is known as adult dispersal. Dispersal in plants is largely limited to natal dispersal, as little or no secondary movement is possible, while as in animals disperse occurs multiple times. Lack of dispersal can lead to high rates of inbreeding, which can lead to decreased fitness in many species.

6. Age structure: It is the total number or percentage of individuals in different age group. Age is usually articulated in days, months or years, but it is likewise shown in other forms such as pre-reproductive, reproductive and post reproductive. Age distribution influences natality, mortality and the ratio of various age groups in a population. Age structure predicts the future of a population i.e., in a population with high reproductive phase

individuals will demonstrate an expanding population, while as a population with even distribution of reproductive and post-reproductive individuals' displays a static population and a population with a heavy ratio of older or post reproductive individuals will demonstrate decline.

7. Dispersion: Organisms are naturally distributed either by movements, migrations, or transport by wind, water, or by other organisms. The act or process of spreading is known as dispersal, and the resulting pattern of distribution is referred as dispersion. Dispersion is a basic characteristic of populations, controlling various features like population density, mean area, frequency, and chance of encountering one or more individuals of the population in a particular area and so on. Individuals of a population can be distributed in one of three basic patterns: they can be more or less equally spaced apart (uniform dispersion), dispersed randomly with no predictable pattern (random dispersion), or clustered in groups (clumped dispersion).

8. Growth form: Population growth form refers to the pattern of population growth, which is defined as the change in the size of the population over time. There are two basic patterns of population growth represented by 'J' & 'S' shaped growth curves. Population growth follows a particular pattern consisting of a lag phase, an exponential growth phase, and a stable equilibrium phase. At the beginning part of the curve the population grows very slowly because the process of procreation and development of offspring takes place and is known as the lag phase. As the first batch of offspring does attain sexual maturity, the parents begin to produce a second set of offspring, increasing the number of reproducing organisms. Therefore, the population begins to increase at an exponential pace and is known as the exponential growth stage of the growth curve. This increase in population will continue as long as the birth rate exceeds the death rate. Finally, reaching a stage where the death and birth rate balance each other and the population will stop growing. This stage is known as the equilibrium phase. Hence, populations cannot grow continuously because of the concept of carrying capacity-the maximum population size that an ecosystem can support under particular environmental conditions.

S-Shaped Growth Curve: S-shaped growth curve or sigmoid growth curve is a pattern of growth in which, the population density of an organism initially increases slowly in a positive acceleration phase; then increases rapidly, approaching an exponential growth rate but then declines in a negative acceleration phase until at zero growth rate the population stabilizes Fig 7.1. This decline reflects increasing environmental resistance factors which becomes proportionately more important at higher population densities.

J Shaped: When the environmental resistance factors do not check population growth then a J-shaped curve is obtained Fig. 7.2. J-shaped growth curve is a curve that records the situation in which, the population density of an organism increases rapidly in an

exponential (logarithmic) form, but then stops abruptly as environmental resistance (e.g. seasonality) or some other factor (e.g. the end of the breeding phase) suddenly becomes effective.

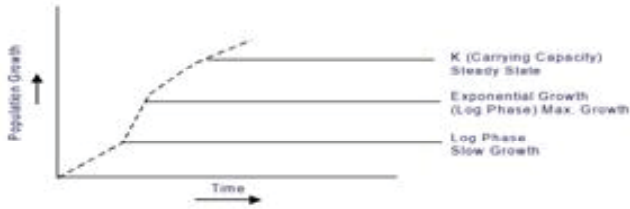


Figure 7.1: S-Shaped Curve

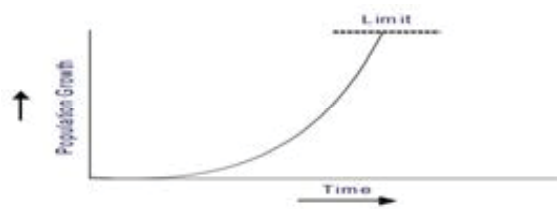


Figure 7.2: J-Shaped Curve

Understanding how population characteristics such as size, spatial distribution, age structure, or the birth and death rates change over time can help scientists or governments make decisions. For example, knowing how the deer populations have increased or decreased over a period of time can help conservationists understand if their protection efforts are effective.

Check Your Progress-I

Note: (a) Answer the questions given below

(b) compare your answer with those given at the end of this lesson

- i. The term ecology was coined by in
- ii. Grouping of individuals of the same species located in the same geographical area is known as
- iii. Birth Rate is also called as.....
- iv. Number of individuals per unit area at a given time is known as
- v. Movement of individuals from their birth place to other place is called as.....

7.4. ECOSYSTEM

The term 'ecosystem' was coined by a British botanist Arthur Tansley in 1935 and defines it as the "system resulting from the integration of all living and non-living factors of the environment". Etymologically the term ecosystem comprises of two words eco meaning environment and system meaning interaction. Therefore ecosystem can also be specified as the interaction and interrelationship between the living community (plants, animals, and organisms) in relation to each other and with other non-living community (soil, air, and water). **An ecosystem can be visualised as a functional unit of nature, where living organisms (producers, consumers, and decomposers) interact among themselves**

and also with the surrounding physical environment. Nutrient cycles and energy flows, keep these living and non-living components connected in an ecosystem. If one part of an ecosystem is damaged or disappears, it causes an impact on everything else. Ecosystem can also be defined as a natural functional ecological unit comprising of living organisms (biotic community) and their non-living (abiotic or physiochemical) environment that interact to form a stable self-supporting system. Ecosystems can be recognized as self-regulating (own control of activities) and self-sustaining (able to persist by itself) units of landscape. An ecosystem can be of any size varying from a drop to ocean, encompasses specific and limited species. In nature two major categories of ecosystems may be distinguished: terrestrial and aquatic. Forests, grasslands, meadows, deserts are examples of terrestrial ecosystems and the aquatic ecosystems can be either fresh water (e.g. ponds, lakes, streams), or salt water (e.g. marine, estuaries).

7.4.1. Components of Ecosystem

Recalling the definition of an ecosystem from section 7.3 we can say that ecosystem includes the biotic as well as the abiotic components and the interaction between the two. Each living organism has to depend and also has to interact with different non-living and living components of the environment for various basic requirements. From a structural perspective, all ecosystems consist of two basic components-abiotic or non-living and biotic or living components which are in constant communication with each other. It should be kept in mind that the components of the ecosystem and environment are the same. Let us try to understand these two structural components of ecosystem in detail.

7.4.2 Abiotic or non-living components of the ecosystem:

Abiotic components are the dead organic (proteins, carbohydrates, lipids, humic substances, etc.), the inorganic material (e.g. carbon, nitrogen, oxygen, CO₂, water, etc.) and all the non-living parts which act as major limiting factors. Abiotic substances are present in soil, water and air. The climatic parameters like solar radiation and temperature determine the abiotic conditions within which the organisms carry out life functions. They can set conditions like how tall trees grow, where animals and plants are found, and why birds migrate and so on. The abiotic factors vary from ecosystem to ecosystem, in an aquatic ecosystem the abiotic factors may include water pH, sunlight, turbidity, water depth, salinity, available nutrients, dissolved oxygen etc., while as in a terrestrial ecosystems, abiotic factors can include soil, soil types, temperature, rain, altitude, wind, nutrients, sunlight etc. Here in this section we are going to discuss some important abiotic factors:

- 1. Energy:** the fundamental source of energy is the sun, which is essential for maintenance of life. The intensity, duration and wavelength of the light are vital factors that

determine the life activities of many living things. Plants utilise solar energy directly and transforms it to other forms of energy resources via photosynthesis. Animals, on the other hand cannot use solar energy directly, they obtain energy indirectly by consuming plants or animals or both. The quantum of energy determines the distribution of organisms in an ecosystem.

2. Materials: these constitute the organic and inorganic compounds, compound like proteins, carbohydrates, lipids etc. belong to organic group which are formed from inorganic substances and are reconverted into them on decomposition and are essential for the transfer of energy in the living world. The inorganic compounds comprise of oxygen, nitrogen carbon, carbon dioxide, water, sulphur, nitrates, phosphates, and ions of various metals which are very essential for organisms to survive.

3. Edaphic factors: Botanists have long recognized that the distribution, habit, and composition of vegetation are greatly determined by the edaphic factor. The edaphic factor pertains to the physical, chemical, and biological properties of soil resulting from geologic phenomena. The importance of the edaphic factor in the distribution of plant species was keenly observed and recorded by many 18th and 19th century plant ecologists, who considered edaphic factors as one of the important ecological determinants of plant distribution. It was in the twentieth century that ecologists fully cherished the importance of the edaphic factor in generating habitats within which plants and their associated organisms live, interact, reproduce, and diverge over time.

4. Weather and Climate: Weather and Climate have profound effects on ecosystems and the habitats that support life on earth. The fluctuations in temperature, humidity, precipitation, quality of water, soil, air etc., will directly influence the growth and composition flora and fauna. The timing of many natural events, such as blooming, migrations, courtship, breeding etc., is linked to many climate factors such as radiation, temperature, precipitation, soil moisture, amount of daylight etc. Changes in weather patterns and extreme events related with climate change can disrupt these natural patterns which in turn, can affect seasonal behaviour and interactions among species. Although species have adjusted to environmental change for millions of years, an abruptly changing climate could require adaptation on larger and faster scales than in the past. Species that cannot adapt are at risk of extinction. Even the loss of a single species can have cascading effects because organisms are connected through food webs and other interactions

5. Temperature: Temperature has a potent influence on the living organisms, a few organisms can tolerate and thrive in a broad range of temperatures known as eurythermal and majority of them are limited to a fine range of temperatures known as stenothermal. High temperature interrupts the balance between respiration and photosynthesis which results in withering of plant tissues and depletion of moisture. Some organisms, such as

thermophilic bacteria, are especially adapted to live in environments experiencing extreme heat and cold, while as most of the organisms are mesophiles, growing best in moderate temperatures between 25 and 40°C. Seasonal changes in temperature often influence the growth patterns and reproduction of organisms like alteration in the flower timing in plants, breeding in animals, seeds germinate and also alteration in animal hibernate.

6. Water: Water is an important abiotic factor commonly known as "universal solvent" for biochemical reactions and also essential to all living organisms. Water links and maintains all ecosystems on the planet. Water propels plant growth, provides a permanent or temporary dwelling or breeding ground for multiple amphibians, insects and other waterborne organisms. Water also helps in the transportation of oxygen, minerals, nutrients and helps in the elimination of waste products to and from the cells. Plants would wilt and their cells would die in a process called plasmolysis. Primary consumers (herbivores) would suffer two fold as their prey (the plants) dies and their water source disappeared. Scarcity of water would adversely affect the hunting region and alteration in hunting regions will lead to relocation of many species.

It is because of these abiotic components, the biotic organisms i.e. plants, animals and microbes survive and interact with each other.

7.4.3 Biotic or living components of the ecosystem

Etymologically, the term 'biotic' is derived from two words, 'bio' meaning life and 'ic' meaning like, stands for all living components of an ecosystem from microscopic organisms to humans. These living or biotic components of the ecosystem are made of many different populations of species, which are interdependent upon each other in the ecosystem. These biotic factors **largely depend** on the abiotic factors for their growth, development and survival. Their presence and their biological by-products affect the composition of an ecosystem. Biotic resources include all living organisms-animals, humans, plants, fungi, bacteria etc. The interactions between various biotic factors are necessary for the survival and reproduction of each species. They interact in a fundamentally energy-dependent fashion and can be classified as producers and consumers. Consumers are further classified as Macro and Micro consumers. Let us now discuss each of them in detail.

1. Producers or Autotrophs: Producers also known as self-feeders are those living components of an ecosystem which are capable of producing their own food. Autotrophs are all the chlorophyll containing plants, certain bacteria and algae, which synthesise carbohydrates from simple inorganic raw materials like carbon dioxide and water in the presence of sunlight by a process known as photosynthesis for them, and indirectly for other non-producers. Autotrophs can be either Phototrophs or Chemotrophs. Most Phototrophs are autotrophs which directly utilises the solar energy, while as Chemotrophs

utilises the energy obtained by oxidize inorganic compounds or organic compounds to produce their food.

2. Heterotrophs or Consumers or Phagotrophs: Heterotrophs comprise all living organisms of ecosystem which are unable to synthesise their own food, and depends on producers for their nourishment. They are also known as consumers, as they consume autotrophic organisms like plants, bacteria, algae etc. as their food. The total energy producers' capture sets the limit on the availability of energy for an ecosystem. Thus, when an autotroph captures energy from sunlight, it is supposed to have produced the energy for the ecosystem. Consumers are broadly divided into two groups, namely macro-consumers and micro-consumers.

i. Macroconsumers: these organisms digest their food inside their body i.e. first they ingest their food and then digestion it. Depending on their food habits, can be further classified into three types as herbivores, carnivores and omnivores.

a) Herbivores are such living organisms which obtain their food directly from the producers or plants e.g. Cow, deer, rabbits, grazing cattle, etc., are all plant eaters and they feed directly on producers. In a food chain, they are recognised as the primary consumers or secondary producers.

b) Carnivores: secondary consumers or primary carnivores are the animals which feed upon primary consumers to obtain their food. The carnivores kill and eat the herbivores and are called as predators e.g. dog, cat, snake. The organisms which completely depend on dead animals are known as scavengers or detritivores e.g. vulture, crow, fox etc. As they feed on the secondary producers they are also known as secondary consumers. Animals which kill other animals and eat them, but are not killed and eaten by other animals in the nature e.g. lion, man, hawk peacock are called as top consumers.

c) Omnivores: An omnivore is an organism that consumes a variety of material, including plants, animals, insects, eggs, algae, and fungi. Some of the omnivores will hunt and eat their food like carnivores and are also capable of eating plants or autotrophs, while as some are scavengers and will eat dead matter, many will eat eggs from other animals. In simple words we can say that carnivorous rely on both vegetation and animal protein to remain healthy. Their size ranges from tiny insects like ants to large creatures-like Bear, man, pig, etc.

ii. Micro consumers or decomposers or Saprotrophs/Osmotrophs: those organisms which break down the complex organic molecules present in dead organic matter (detritus) into simpler inorganic compounds and absorb the soluble nutrients as

their food. Some of the products of decomposition such as inorganic nutrients are released in the ecosystem making them available again to the producers, thus are recycled. Bacteria, fungi, mites, earthworm and certain other soil organisms such as nematodes, and arthropods are also detritus feeders and help in the decomposition of organic matter and are also known as detritivores.

Check Your Progress-II

Note: (a) Answer the questions given below

(b) compare your answer with those given at the end of this lesson

- i. The term Ecosystem was coined by in
- ii.&..... components are the two components of the Ecosystem
- iii. Biotic components include all the components of the ecosystem.
- iv. Air, water and soil are the components of the ecosystem.
- v. Autotrophs are also known as
- vi. Living organisms which can't make their own food are called as

7.5. LET US SUM UP

In this lesson we have learnt a lot of thing related to our environment, initial we have gone through the term population which means a grouping of individuals of the same species located in the same geographical area. Following that we have gone through various characteristics of population like population size, population density, natality, mortality dispersion etc. In the next segment we have learnt that the environment is the sum total of living and the non-living components that surround and influence each other. The living components are called as the biotic components while as the non-living components are known as the abiotic components. The living components include autotrophs and heterotrophs while as the non-living components include, temperature, climate water, land etc.

7.6 LESSON END EXERCISE

- Q1. Define the term population and write a detailed note on the various characteristics of population?
- Q2. Explain in detail the biotic and abiotic components of the environment?
- Q3. Write a detailed note on Autotrophs and heterotrophs?
- Q4. Write a short note on
(a). Herbivores, (b). Carnivores, (c) Omnivorous.

7.7. SUGGESTED FURTHER READINGS

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7.8. ANSWER TO CHECK YOUR PROGRESS

Answers to Check Your Progress-I

(i). Ernst Haeckel, 1866 (ii). Population (iii). Natality (iv). Population Density (v) Dispersion

Answers to Check Your Progress-II

(i). Arthur Tansley in 1935. (ii). Biotic & Abiotic (iii). Living (iv). Abiotic (v) Producers
(vi). Heterotrophs

Structure

- 8.1 Introduction
- 8.2 Objectives
- 8.3 Levels of Biodiversity
 - 8.3.1 Genetic diversity
 - 8.3.2 Species diversity
 - 8.3.3 Ecosystem diversity
- 8.4 Value of Biodiversity
 - 8.4.1 Direct use value
 - 8.4.2 Indirect use value
- 8.5 Threats to Biodiversity
 - 8.5.1 Poaching of wildlife
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 - 8.5.3 Exotic species
 - 8.5.4 Genetic pollution
 - 8.5.5 Environmental pollution
 - 8.5.6 Hybridization and genetics
 - 8.5.7 Climate change
 - 8.5.8 Man-wildlife conflict
- 8.6 Biodiversity Conservation
 - 8.6.1 In-situ conservation
 - 8.6.2 Ex-situ conservation
- 8.7 Let Us Sum Up
- 8.8 Lesson End Exercise
- 8.9 Suggested Further Readings
- 8.10 Answers to Check Your Progress

8.1 INTRODUCTION

The word 'Biodiversity' explains "the variety and variability of biological organisms". On the same line, the Convention on Biological Diversity defines biodiversity as the "variability among living organisms from all sources". In popular usage, the word biodiversity is often used to describe all the species living in a particular area. However, scientists use a broader definition of biodiversity, designed to include not only living organisms and their complex interactions, but also interactions with the abiotic (non-living) aspects of their environment. Biodiversity is the variation of life forms within a given ecosystem, biome, or for the entire Earth. Biodiversity is often used as a measure of the health of biological systems. The present-day biodiversity found on earth consists of many millions of distinct biological species, which is the product of nearly 3.5 billion years of evolution. Biodiversity can be defined as "The variety of life on Earth at all its levels, from genes to ecosystems, and the ecological and evolutionary processes that sustain it".

Over the last century, a great deal of damage has been made to the biodiversity existing on the earth. Increasing human population and consumption of resources along with decreasing efficiency to regenerate resources are some of the causes that have led to overexploitation and manipulation of ecosystems. Trade in wildlife, such as rhino horn, has led to the extinction of species. Consequences of biodiversity loss can be great as any disturbance to one species gives rise to imbalance in others. The decline in biodiversity has been more rapid in the past fifty years than ever before in human history and human activities are causing increased extinction rates. In this lesson, we shall briefly discuss various levels of biodiversity, the threats which are responsible for loss of biodiversity and biodiversity conservation methods.

8.2 OBJECTIVES

After going through this lesson, you shall be able to:

- understand the concept of biodiversity,
- delineate various levels of biodiversity,
- importance of direct and indirect use values of biodiversity,
- recognize various threats to biodiversity, and
- explain biodiversity conservation strategies.

8.3 LEVELS OF BIODIVERSITY

Biodiversity refers to the inter-relatedness of genes, species, and ecosystems and their interactions with the environment. There are three levels of biodiversity i.e. genetic, species, and ecosystem diversity.

8.3.1 Genetic diversity

Genetic diversity refers to the total number of genetic characteristics in the genetic makeup of a species. Genetic diversity is the building block of life and responsible for the variability among individuals within any species, based on variations in genes.

Genetic variability increases the chance that a species will adapt to changing environmental conditions or impacts, since some individuals will be able to handle the change better than others. The more individuals there are, the greater the chance of genetic variation. Species with a small population of individuals have limited variability and therefore, have limited ability to respond to change. Genetic diversity involves processes such as mutations, gene exchanges, and genome dynamics that occur at the DNA level and cause evolution. There are different ways to measure genetic diversity. Genetic diversity plays a major role in survival and adaptability of a species against environmental changes or other stresses. Slight variations at genetic level are necessary for adaptation and survival. A species that has a large degree of genetic diversity, can adopt easily in unfavorable conditions, while the species that have very little genetic variation are at a great risk. Selective breeding leads to monocultures and makes crops extremely susceptible to widespread disease. A high level of genetic diversity in a population is generally considered a desirable attribute. With greater genetic diversity, populations are more likely to have resistance to new diseases and to be more adaptable to environmental variations.

Cheetahs are a threatened species, having extremely low genetic diversity and resulting poor sperm quality has made breeding and survivorship difficult for cheetahs, only about 5% of cheetahs survive to adulthood. About 10,000 years ago, all except the jubatus species of cheetahs died out. The species encountered a population bottleneck and close family relatives were forced to mate with each other, or inbreed. However, it has been recently discovered that female cheetahs can mate with more than one male per litter of cubs. They undergo induced ovulation, which means that a new egg is produced every time a female mates. By mating with multiple males, the mother increases the genetic diversity within a single litter of cubs.

8.3.2 Species diversity

Species diversity is an index that incorporates the number of species in an area and also their relative abundance. It is the number of different species in a particular area determined by some measure of abundance (species richness) such as number of individuals or biomass. Another measure of species diversity, the species evenness, can be defined as the relative abundance with which each species is represented in an area. An ecosystem where all the

species are represented by the same number of individuals has high species evenness and where some species are represented by large number of individuals while other species are represented by few individuals has low species evenness.

Biological diversity can be quantified in many different ways. Whittaker described three common metrics used to measure species-level biodiversity viz. species richness or species evenness; Simpson index and Shannon-Wiener index. The most common index of species diversity is Simpson's Diversity Index. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

The number of species per sample is a measure of richness. Richness is a measure of the number of different kinds of organisms present in a particular area. However, diversity depends not only on richness, but also on evenness. Evenness compares the similarity of the population size of each of the species present. Evenness measures the relative abundance of the different species making up the richness of an area.

A community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. An increase in species richness and evenness give rise to the diversity of the area.

8.3.3 Ecosystem diversity

Ecosystem diversity includes all the different habitats, biological communities, and ecological processes, as well as variation within individual ecosystems. The diversity of an ecosystem is dependent on the physical characteristics of the environment, the diversity of species present, and the interactions that the species have with each other and with the environment. The physical characteristics of an environment that affect ecosystem diversity are quite complex. These characteristics include temperature, precipitation and topography of the ecosystem. Therefore, there is a general trend for warm tropical ecosystems to be richer in species than cold temperate ecosystems. The energy flux in the environment can also significantly affect the ecosystem. An exposed coastline with high wave energy will have a considerably different type of ecosystem than a low-energy environment such as a sheltered salt marsh. Likewise, an exposed mountainside is likely to have stunted vegetation and low species diversity compared to more prolific vegetation and high species diversity in sheltered valleys.

Environmental disturbance on a variety of temporal and spatial scales can affect the species richness and consequently, the diversity of an ecosystem. However, moderate levels of occasional disturbance can also increase the species richness of an ecosystem by creating spatial heterogeneity in the ecosystem, and also by preventing certain species from dominating

the ecosystem. Ecosystems may be classified according to the dominant type of environment, or dominant type of species present; e.g., a rocky shore intertidal ecosystem, a salt marsh ecosystem, a mangrove swamp ecosystem. Because temperature is an important aspect in shaping ecosystem diversity, it is also used in ecosystem classification (e.g., cold winter deserts versus warm deserts). While the physical characteristics of an area will significantly influence the diversity of the species within a community, the organisms can also modify the physical characteristics of the ecosystem, e.g., stony corals are responsible for building the extensive calcareous structures that are the basis for coral reef ecosystems that can extend thousands of kilometers (e.g. Great Barrier Reef). There are less extensive ways in which organisms can modify their ecosystems. For example, trees can modify the microclimate and the structure and chemical composition of the soil around them.

Check Your Progress-1

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

- i. Biodiversity refers to the.....of genes, species, and ecosystems and their interactions with the environment.
- ii. There are three levels of biodiversity i.e. genetic, species, anddiversity.
- iii. Genetic diversity refers to the total number ofin the genetic makeup of a species.
- iv.....leads to monocultures and makes crops extremely susceptible to widespread disease.
- v. Only aboutof cheetahs survive to adulthood.
- vi. The species evenness, can be defined as thewith which each species is represented in an area.
- vii. The diversity of an ecosystem is dependent on theof the environment, the diversity of species present, and thethat the species have with each other and with the environment.

8.4 VALUE OF BIODIVERSITY

The diversity of life provides a foundation for the continued existence of a healthy planet and well-being to live. Ecosystems rich in diversity gain greater resilience and are therefore, able to recover more readily from stresses such as drought or habitat degradation due to anthropogenic activities. In a diverse ecosystem, there is a range of pathways for primary

production and ecological processes such as nutrient recycling, so that if one is damaged or destroyed, an alternative pathway may be used and the ecosystem can continue functioning at its normal level. If biological diversity is greatly diminished, the functioning of ecosystems is put at risk. The greatest value of the variety of life may be the opportunities for adapting to change. The unknown potential of genes, species and ecosystems is certainly of high value. The many values of biological diversity and its importance for development indicate why biological diversity conservation differs from traditional nature conservation.

Biological diversity conservation entails a shift from a reactive posture, protecting nature from the impacts of development, to a proactive effort seeking to meet the needs from biological resources while ensuring the long-term ecological sustainability of Earth's biotic wealth. On a global level it thus involves not only the protection of wild species and their habitats but also the safeguarding of the genetic diversity of cultivated and domesticated species and their wild relatives. The conservation of biological diversity seeks to maintain the life-support system provided by nature in all its variety, and the living resources essential for ecologically sustainable development. Biodiversity performs a number of ecological services for mankind that have economic, aesthetic and/or recreational value. The value of biodiversity can be grouped into two main categories with several sub-categories. These categories are direct and indirect use values of biodiversity.

8.4.1 Direct use value

The direct value include food resources like grains, vegetables, fruits which are obtained from plant resources and meat, fish, egg, milk and milk products from animal resources. These also include other values like medicine, fuel, timber, fiber, wool, wax, resin, rubber, silk and decorative items.

The direct values are of two types (i) Consumptive use value and (ii) Productive use value.

(a) Consumptive use value

These are direct use values where the products of biodiversity can be harvested and consumed directly. Various species provide a variety of goods and/or products, many of which play important roles in human economies, e.g. food, medicine, timber, fiber, etc.

Food

Human and other organism's existence is heavily dependent on plants. Five thousand plant species have been used as food by humans, but less than twenty now feed the majority of the world's population and just three or four carbohydrate crops are staples for the immense majority. One of the important benefits of conservation of biodiversity is the wild plant gene pool which is available to augment the narrow genetic base of these established food

crops, providing disease resistance, improved productivity and different environmental tolerances. The short and long-term values of these genetic resources are enormous and most improvements in agriculture and silviculture depend on their preservation.

Drugs and medicines

People used have long biological resources for medicinal purposes. About 75% World's population depends upon plant or plant extracts for medicines. A few medicines have been widely used, such as the ubiquitous eucalyptus oil for relief of respiratory tract infections, but many more are now being investigated. Likewise, Quinine, the anti-malaria drug is obtained from the bark of Cinchona tree. Wild plant, animal and microbial resources are also of great importance in the search for new medically active compounds to contribute to modern medicine has scarcely begun to be realized. Many of the drugs presently used are derived from plants; many medicines, in particular antibiotics, are derived from microorganisms.

Wood

Wood is a basic commodity used worldwide, and is still largely harvested from the wild. It is a primary source of fuel, used in construction, and forms the basis for paper production. Fossil fuels, coal, petroleum and natural gas are also product of fossilized biodiversity. Firewood collected by individuals is usually not marketed and are directly consumed by tribes and rural people.

(b) Productive use value

These are commercially usable values, where the product is marketed and sold. A wide range of industrial materials are derived directly from biological resources. These include building materials, fibers, dyes, resirubber and oil. There is enormous potential for further research into sustainably utilizing materials from a wider diversity of organisms. Animal products like tusks of elephant, musk from musk deer, silk from silk worm, wool from sheep, fir of many animals, lac from lac insects supports a large number of industries. Biodiversity products are also used in industries like pulp and paper mill, plywood industry, railways, silk, textile, ivory works, leather, pearls, etc.

8.4.2 Indirect values

Biodiversity provides indirect benefits to human beings which support the existence of biological life and other benefits which are difficult to quantify. These include social values, ethical values, aesthetic values, option values, cultural values and ecosystem service values.

Social value

Value associated with the social life, customs, religions, psycho-spiritual aspects of the people. Tulsi, peepal, mango, lotus, bael are considered as holy plants. In general, leaves,

fruits or flowers are used for worship. Social life, songs, dances and customs of tribal people are related with wild life. Some animals like cow, snake, bull peacock and owl also have social importance.

Ethical value

It is also known as existence value. It involves ethical values like "all life form must be preserved". It is based on the concept of live and let live. There is a necessity to protect all biodiversity for survival of human race.

Aesthetic value

Natural and wild landscapes are aesthetically pleasing and provide opportunities to get away from landscapes. They also provide opportunities for recreational activities such as hiking, canoeing, bird watching and nature photography. In North America, protected wild areas where indigenous organisms live undisturbed, give people a sense of satisfaction in knowing that there are bears and wolves and rare plants and insects that still exist on their continent. The tourism promoting such activities is known as Eco-tourism.

Option value

These values include the potentials of biodiversity that are currently unknown and necessitate exploration. For example, there is a possibility that we may have some potential cure of AIDS or other incurable diseases in the diverse environment. Thus, the option value of biodiversity suggests that any species may prove to be a wonder or of great use some day.

Cultural and Spiritual values

The identity of human cultures around the world is attached to varying degrees to wild species. Wild species are often referred to in the religious texts. Outside of formal religion, many people feel connected to species for reasons that can be hard to explain. Some may be inspired by the intrinsic beauty of the species, worship it for its strength, or admire it for its cleverness. In all cases, cultural diversity is closely linked to wild species.

Ecosystem service values

Biodiversity provides many ecological services that are critical to the stability and integrity of ecosystems as well as the welfare of humans. They include nutrient cycling, biological productivity, control of erosion, provision of oxygen, and removal of carbon dioxide and its storage. All of these services are critical to the welfare of people and other species, but they are not usually assigned economic value due to insufficient understanding about importance of ecological services in terms of economics.

Maintaining the climate stability

Vegetation influences climate at the macro and micro levels. Growing evidence suggests that undisturbed forest helps to maintain the rainfall in its immediate vicinity by recycling

water vapour at a steady rate back into the atmosphere and through the canopy's effect in promoting atmospheric turbulence. At smaller scales, vegetation has a moderating influence on local climates and may create quite specific micro-climates. Many organisms are dependent on such micro-climates for their existence.

Balancing the ecosystems

Ecosystem relationships resemble a web of connections from one living thing to many other living and non-living things. They not only allow survival, but also maintain a balance between living things and the resources required to survive. Vegetation is integral to the maintenance of water and humidity levels and is essential for the maintenance of the oxygen/carbon dioxide balance of the atmosphere. Due to the complex nature of ecosystem relationships, the removal or disturbance of one part of the ecosystem could affect the functioning of many other components of the ecosystem. Maintaining natural habitats helps ecosystem functions over a wider area.

Ecological Value

Population of every species is part of an ecosystem of interacting populations and environment and thus has an ecological role to play. There are producers, consumers, decomposers, and many variations of these roles and others competitors, dispersers and pollinators, and more. Some species play ecological roles that are of great importance than we would predict from their abundance; these are called keystone species. All species are supported by the interactions among other species and ecosystems, each providing an ecological value to one another. Loss of species makes ecosystems less resilient and often less productive. Biodiversity also supports a number of natural ecosystem processes and services. Some ecosystem services that benefit society are air water purification, climate, pest and disease control, pollination and prevention of erosion. Biodiversity is also believed to create stability in ecosystems, allowing these ecosystems to continue providing services aligned with disturbances.

Pollution removal

Ecosystems and ecological processes play an important role in the breakdown and absorption of many pollutants created by natural and anthropogenic activities. Components of ecosystems from bacteria to higher life forms are involved in these breakdown and assimilative processes. Some ecosystems, especially wetlands have qualities that are particularly well suited to breaking down and absorbing pollutants. Natural and artificial wetlands are being used to filter effluents to remove nutrients, heavy metals and suspended solids, reduce the biochemical oxygen demand and destroy potentially harmful microorganisms.

Nutrient storage and cycling

Ecosystems perform the vital function of recycling nutrients. These nutrients include the elements of the atmosphere as well as those found in the soil, which are necessary for the maintenance of life and soil health. Biological diversity is essential in this process. Plants are able to take up nutrients from the soil, and these nutrients can then form the base of food chains. The nutrient status of soil is replenished by dead or waste matter which is transformed by microorganisms; this may then feed other species such as earthworms which also mix and aerate the soil and make nutrients in the more readily available form for the plants.

Soil formation and protection

Biological diversity helps in the formation and maintenance of soil structure and the retention of moisture and nutrient levels. The loss of biological diversity through clearing of vegetation has contributed to the salinisation of soils, leaching of nutrients, and accelerated erosion of topsoil, reducing the soil fertility. Soil protection by maintenance of biological diversity can preserve the productive capacity of the soil, prevent landslides, safeguard coastlines and riverbanks, and prevent the degradation of coral reefs and riverine and coastal fisheries by siltation. Trees and other vegetation also assist in soil formation. A significant contribution is the introduction of organic matter through litter formation and the decay and regeneration of tiny fibrous roots, both of which facilitate microbial activity. Root systems also bring mineral nutrients to the surface through root uptake.

Check Your Progress-2

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

- i. The conservation of biological diversity seeks to maintain theprovided by nature in all its variety, and theresources essential for ecologically sustainable development.
- ii. The value of biodiversity can be grouped intoanduse values of biodiversity.
- iii. The direct values are of two types. These areand.....
- iv.....include the potentials of biodiversity that are currently unknown and necessitate exploration.
- v. Some species play ecological roles that are of great importance than we would predict from their abundance, these are called.....

8.5 THREATS OF BIODIVERSITY

During the last century, biodiversity loss has been increasingly observed. One eighth of known plant species are threatened with extinction. Some estimates put the loss at up to 140000 species. This figure indicates unsustainable ecological practices. The rate of species loss is greater now than earlier. Various threats which are responsible for loss of biodiversity are discussed below.

8.5.1 Poaching of wildlife

Poaching has been a significant cause for the extinction of hundreds of species and the endangerment of many more. Most extinction over past several hundred years is mainly due to over-harvesting for food, fashion and profit. Commercial hunting, both legal and illegal is the principal threat.

8.5.2 Habitat loss

Most of the species extinctions from 1000 AD to 2000 AD are due to human activities, in particular destruction of plant and animal habitats. Raised rates of extinction are being driven by human consumption of organic resources, especially related to tropical forest destruction. While most of the species that are becoming extinct are not food species, their biomass is converted into human food when their habitat is transformed into pasture, cropland and orchards. It is estimated that more than one third of the Earth's biomass is tied up in only the few species that represent humans, livestock and crops. Factors contributing to loss of biodiversity include overpopulation, deforestation, air pollution, water pollution, soil contamination and global warming, climate change, etc. Habitat fragmentation is a further aspect of habitat loss. The forest, meadow, or other habitat that remains generally is in small, isolated bits rather than in large, intact units. Each is a tiny island that can at best maintain a very small population. Environmental fluctuations, disease and other factors make such small isolates highly vulnerable to extinction.

8.5.3 Exotic species

The widespread introduction of exotic species is a forceful threat to biodiversity. When exotic species are introduced to ecosystems and establish self sustaining populations, the endemic species in that ecosystem that have not evolved to cope with the exotic species, resulting which endemic species may not survive by introducing exotic ones. The exotic organisms may be either predators or parasites or simply aggressive species that deprive indigenous species, of nutrients, water and light.

8.5.4 Genetic pollution

Purebred wild species can be threatened with extinction through the process of genetic pollution e.g., uncontrolled hybridization which leads to homogenization or replacement of

local genotypes as a result of either a numerical and/or fitness advantage of introduced plant or animal. Non-native species can bring about a form of extinction of native plants and animals by hybridization either through purposeful introduction by humans or through habitat modification, bringing previously isolated species into contact. These phenomena can be especially detrimental for rare species coming into contact with more abundant ones.

8.5.5 Environmental pollution

Pollution from chemical contaminants poses a great threat to species and ecosystems. While not commonly a cause of extinction, it likely can be harmful for species whose range is extremely small, and which are threatened by contamination.

8.5.6 Hybridization and genetics

Local governments and industries have been pushing hybridization which has resulted in several of the indigenous breeds becoming extinct or threatened. A genetically modified organism (GMO) is an organism whose genetic material has been altered using the genetic engineering techniques generally known as recombinant DNA technology. Genetically Modified (GM) crops today have become a common source for genetic pollution, not only of wild varieties but also of other domesticated varieties derived from relatively natural hybridization. Genetic erosion coupled with genetic pollution may be destroying unique genotypes, thereby creating a hidden crisis which could result in a severe threat to our food security.

8.5.7 Climate change

The phenomenon of global warming is also considered to be a major threat to global biodiversity. For example coral reefs, which are biodiversity hotspots, will be lost in 20 to 40 years if global warming continues at the current trend. Climate change is affecting the habitats of several species, which must either adapt or migrate to areas with more favourable conditions. Even small changes in average temperatures can have a significant effect upon biodiversity at every level.

8.5.8 Man-wildlife conflict

The instances of man-animal interface have grown in recent years, particularly in respect of wild elephants and bear. There are cases of human kill, human injury, cattle kill, house damage and crop damage by wild animals; and also penalizing killing of wild animals. Growing anthropogenic pressure exerted on wildlife habitats is the main reason for conflict with wildlife. The other reason is fragmentation of wild animal habitats, loss of corridors and migratory routes of long ranging animals.

8.6 BIODIVERSITY OF CONSERVATION

Biodiversity conservation focuses on the sustainable management of wealth of biological diversity, comprising land and marine ecosystem, agroecosystems and production areas and ex-situ conservation. These conservation efforts must safeguard traditional knowledge systems and develop biodiversity utilization systems based on equitable sharing of benefits. Conservation of biodiversity can be achieved in a number of ways. These methods can be broadly classified as in-situ and ex-situ conservation. In-situ conservation includes conservation of plants and animals in their native ecosystems or in man-made ecosystems, where they naturally occur. Ex-situ conservation is the conservation of samples of genetic diversity (particularly representing endangered species) away from their natural habitats.

8.6.1 In-situ conservation

The word in-situ refers for 'on-site conservation', it is the process of protecting an endangered plant or animal species in their natural habitat, either by protecting or cleaning up the habitat by defending the species from predators. The in-situ conservation maintains recovering populations in the surrounding where they have developed their distinctive properties and helps to ensure the ongoing processes of evolution and adaptation within their environments. The population size must be sufficient to enable the necessary genetic diversity to survive within the population, so that it has a good chance of continuing to adapt and evolve over time. The main examples of such reserves are national parks, biosphere reserves and wild life sanctuaries.

National parks

A national park is a large reserve of natural or semi-natural land, declared by a national government, set aside for its features of predominantly unspoiled landscape, flora and fauna, permanently dedicated for public enjoyment, education and inspiration, and protected from all interferences other than essential management practices, so that its natural attributes are preserved. Depending on the area and terrain, national parks provide number of opportunities to the visitors to have a close encounters with the wild life. The wildlife national parks in India spread across the country offer a fascinating diversity of terrain, flora and fauna, e.g. Kaziranga national park in east famous for one horned rhino, Kanha national park in the centre, Nagarhole national park in south, Corbett national park in north and Sundarbans national park in the west part of India.

Biosphere reserves

Biosphere reserves are areas of protected ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under independent jurisdiction of the located states. Biosphere reserves serve as living laboratories for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a world network and known as the World Network of Biosphere Reserves (WNBR).

Within this network, exchanges of information, experience and personnel are facilitated. There are 701 biosphere reserves in 124 countries.

Wildlife sanctuaries

Wildlife sanctuary refers to the zoned area set aside by law for the preservation of wildlife where hunting is strictly prohibited and wildlife to be reproduced naturally. The wildlife sanctuaries in India are home to around 2000 bird species, 3500 mammal species, nearly 30000 species of insects and more than 15000 varieties of plants. In India over 550 wildlife sanctuaries are established, which are scattered all across the country. These sanctuaries attract the tourists with their beautiful landscapes, amazing rock formation and diverse range of flora and fauna. These sanctuaries are home to several endangered species of animals and birds like the Asiatic Elephant, the Royal Bengal tiger, the Snow Leopard and the Siberian Crane. The wildlife sanctuaries of India also include the bird sanctuaries. The Bharatpur bird sanctuary known as largest bird sanctuary in Asia, which is much more famous as a refuge of many migratory birds.

8.6.2 Ex-situ conservation

Ex-situ conservation refers to 'off-site conservation'. It is the process of conserving genetic resources by protecting an endangered species of plant or animal by removing a part of the population from a threatened habitat and placing it in a new location, e.g. Zoos, botanical gardens and seed banks.

Colony relocation

In ex-situ conservation techniques, the best method of maximizing a species chance of survival is by relocating part of the population to a less threatened location. It is extremely difficult to mimic the environment of the original colony location given the large number of variables defining the original colony. It is also technically challenging to uproot or trap the required organisms without undue harm.

Human care methods

Zoos, botanical gardens, seed banks, etc. are the most conventional methods of ex-situ conservation. These are protected houses of specimens for breeding and reintroduction into the wild. Endangered plants may also be preserved in part through seedbanks or germplasm banks. The term seedbank sometimes refers to a cryogenic laboratory facility in which the seeds of certain species can be preserved for up to a century or more without losing their fertility. The role of zoos in conservation is very limited by space and by expense. It has been estimated that world zoos could sustain roughly 900 species at population sizes of about 100-150 individuals per species. This population is just large enough to avoid inbreeding effects. Genetic management of captive populations is essential to ensure that genetic diversity is preserved as far as possible. Research has led to great advances in

technologies for captive breeding. This includes techniques such as artificial insemination, embryo transfer and long-term cryogenic storage of embryos. These techniques are all valuable because they allow new genetic lines to be introduced without having to transport the adults to new locations.

The aquaria has largely been used for display and educational facilities. However, they are assuming new importance in captive breeding programmes. Populations of plant species are much easier than animals to maintain artificially. They require less care and their requirements for particular habitat conditions can be provided more readily. It is also much easier to breed and propagate plant species in captivity. Plant genetic diversity can be preserved ex-situ through the use of seed banks. Seeds are small but tough and have evolved to survive all manner of adverse conditions. The result of storing seeds under frozen conditions is to slow down the rate at which they lose their ability to germinate.

Check Your Progress-3

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

- i. Growing.....pressure exerted on wildlife habitats is the main reason for conflict with wildlife.
- ii. The word in-situ refers to.....conservation.
- iii.....refers to the zoned area set aside by law for the preservation of wildlife where hunting is strictly prohibited and wildlife to be reproduced naturally.
- iv. Collectively, biosphere reserves form a world network and known as the.....
- v.....conservation is the process of conserving genetic resources by protecting an endangered species by removing a part of the population from a threatened habitat and placing it in a new location, e.g. Zoos, botanical gardens etc.
- vi. Plant genetic diversity can be preserved ex-situ through the use of.....

8.7 LET US SUM UP

Biodiversity is the variation of life forms within a given ecosystem, biome, or for the entire Earth. Biodiversity refers to the interrelatedness of genes, species, and ecosystems and their interactions with the environment. Usually three levels of biodiversity are discussed; i.e. genetic, species, and ecosystem diversity. Genetic diversity is a level of biodiversity that refers to the total number of genetic characteristics in the genetic makeup of a species. Species diversity is an index that incorporates the number of species in an area and also

their relative abundance. Ecosystem diversity includes all the different habitats, biological communities, and ecological processes, as well as variation within individual ecosystems.

The value of biodiversity in terms of its commercial utility, ecological services, social and aesthetic value is enormous. Biodiversity has an intrinsic value that is worth protecting regardless of its value to humans. Biodiversity performs a number of ecological services for humankind that have economic, aesthetic or recreational value. The value of biodiversity can be grouped into several categories, e.g. direct use values (food, medicine, timber, fiber, etc.), ecological values, cultural and spiritual values, social values, ethical values, etc.

During the last century, biodiversity loss has been increasingly observed. One eighth of known plant species are threatened with extinction. Generally, the acronym HIPPO is used which stands for Habitat destruction, Invasive species, Pollution, Human Overpopulation, and Overharvesting. The main causes of threats to biodiversity includes over hunting, destruction of habitat, introduction of exotic species, genetic and environmental pollution, climate change and some times man-animal conflict. Biodiversity conservation focuses on the sustainable management of wealth of biological diversity, comprising land and marine ecosystem, agroecosystems and production areas and ex-situ conservation. In-situ conservation includes conservation of plants and animals in their native ecosystems or in man-made ecosystems, where they naturally occur. Ex-situ conservation is the conservation of samples of genetic diversity (particularly representing endangered species) away from their natural habitats. Biosphere reserves are areas of prevented ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. The Biosphere Reserves protect larger areas of natural habitat than a national park and often include one or more national parks along buffer zones that are open to some economic uses. Wildlife Sanctuary refers to the zoned area set aside by law for the preservation of wildlife where hunting is strictly prohibited and wildlife to be reproduced naturally. Ex-situ conservation refers to 'off-site conservation'. It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location, e.g. Zoos, botanical gardens and seed banks.

8.8 LESSON AND EXERCISE

1. Elaborate upon the concept of biodiversity. Explain the three hierarchical levels of biodiversity.
2. Explain genetic, species and ecosystem diversity. Discuss the consumptive and productive values of biodiversity.
3. What do you mean by consumptive use value, productive use value, social value, ethical value and option value of biodiversity?

4. Write an explanatory note on threats of biodiversity with the suitable example, explain how poaching and human wildlife conflict are responsible for biodiversity loss.
5. Explain in-situ and ex-situ approaches of conservation of biodiversity. Compare their advantages and limitations.

8.9 SUGGESTED FURTHER READINGS

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Negi, S.S. (1992). Himalayan Wildlife, Habitat and Conservation. New Delhi : Indus Publishing Company.

8.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress-1

- | | |
|------------------------------|---|
| i. Inter-relatedness | v. 5% |
| ii. Ecosystem | vi. Relative abundance |
| iii. Genetic characteristics | vii. Physical characteristics, interactions |
| iv. Selective breeding | |

Check Your Progress-2

- | | |
|--|---------------------|
| i. The life-support system, living | iv. Option values |
| ii. Direct, indirect | v. Keystone species |
| iii. Consumptive use value, productive use value | |

Check Your Progress-3

- | | |
|-------------------------|---|
| i. Anthropogenic | iv. World Network of Biosphere Reserves |
| ii. On-site | v. Ex-situ |
| iii. Wildlife sanctuary | vi. Seed banks |

LEARNING TO LIVE IN HARMONY WITH NATURE

Structure

- 9.1 Introduction
- 9.2 Objectives
- 9.3 Disequilibrium between Modern Man and Nature
 - 9.3.1 Affluence - Endless Modernization
 - 9.3.2 Isolation - Living
 - 9.3.3 Spiritual Disconnection
- 9.4 Nature as a Reliable Benefactor
 - 9.4.1 Raw Products
 - 9.4.2 Bioindicator
 - 9.4.3 Aesthetic and healing value
- 9.5 Sustainable Development : A Paradigm Shift.
 - 9.5.1 Sustainable Industry and Infrastructure
 - 9.5.2 Sustainable Agriculture
 - 9.5.3 Renewable Energy
 - 9.5.4 Conservation
- 9.6 Challenges and Opportunities of Going Green
- 9.7 Let Us Sum Up
- 9.8 Lesson End Exercise
- 9.9 Suggested Further Readings
- 9.10 Answers to Check Your Progress

9.1 INTRODUCTION

Human civilization though a very recent event in Earth's geological history has made enormous progress in such areas as life expectancy, economic prosperity, arts, science, and civic comfort, to name but a few. But the enormity of this

advancement has come at the cost of environmental externalities such as urban pollution, biodiversity loss, land degradation and desertification, ozone depletion, climate change etc. Humans are intimately tied to their natural environment right from the dawn of their existence on this planet. But with their ability to modulate the environment through technological interventions, humans have slowly drifted away from nature into a time of unprecedented separation. "There is nearly total disequilibrium between modern man and nature as attested by nearly every expression of modern civilization which seeks to offer a challenge to nature rather than to co-operate with it" wrote Seyyed Hossein Nasr in his famous book "Man and Nature". In the past, humans feared the forces of nature wild beasts, floods, pestilence, and disease. The modern scientific and technological tools have however have helped conquer nature, kill the wild beasts, build dams to stop flooding, find medicines to fight disease, and use chemicals to control the pests. In this struggle, humans are winning battle after battle, but actually the war is being lost.

"We recognize that planet Earth and its ecosystems are our home and that Mother Earth is a common expression in a number of countries and regions, and we note that some countries recognize the rights of nature in the context of the promotion of sustainable development." United Nations Conference on Sustainable Development (2012).

In 2009, the United Nations General Assembly proclaimed 22 April as International Mother Earth Day. In so doing, Member States acknowledged that the Earth and its ecosystems are our common home, and expressed their conviction that it is necessary to promote Harmony with Nature in order to achieve a just balance among the economic, social and environmental needs of present and future generations. The same year, the General Assembly adopted its first resolution on Harmony with Nature. The General Assembly has widely acknowledged that the world's depletion of natural resources and rapid environmental degradation are the result of unsustainable consumption and production patterns which have led to adverse consequences for both the Earth and the health and overall well-being of humanity.

9.2 OBJECTIVES

After going through this lesson, you shall be able to:

- critically analyse the reasons for disequilibrium between modern man and nature,
- explain the role of nature as a reliable benefactor,
- ascertain the relevance of eco-spirituality as a guiding principle for establishing harmony between man and nature,

- describe the challenges and opportunities of going green, and
- discuss sustainable development a new paradigm shift towards nature

9.3 DISEQUILIBRIUM BETWEEN MODERN MAN AND NATURE

Populations of non-human species have been dwindling, the chemicals sprayed around are getting into the food chains, and atmosphere once been the protective shield from harmful extra-terrestrial radiations has thinned enough to let them pass. We may have developed vaccines for many diseases that has threatened humankind, but new, more sophisticated diseases always seem to come on the scene as soon as the old ones are brought under control. And the time around this chapter is being conceptualized, the COVID-19 virus has already brought the world under lockdown, the scale of what has never ever witnessed by the human civilization. All these experiences advocates that every time we think we have won a battle, nature counterattacks.

9.3.1 Affluence - Endless modernization

The scientific community has well documented evidence that our present way of life, in particular our consumption and production patterns, has severely affected the Earth's carrying capacity. Experts across the discipline are now uncovering the vital importance of our relationship with nature and reinventing ways to get back into the close proximity of nature. "The journey of a thousand miles begins with a single step" a famous saying invokes a realization that in reality, *a person can live in a bustling New Delhi apartment building and be in tune with nature. Increasing consumption and especially its environmental impacts are becoming all the more important now that the 850 million long-established consumers in rich countries have recently been joined by almost 1.1 billion new consumers in 17 developing countries and transition economies.* Modernization in and of itself is not a bad thing. But the collateral effects can be and have been detrimental to humanity. It is the result of misuse and a lack of societal understanding. Over time the face of modernization has changed. The aspect that remains constant is the development of increased productivity, based on technological advancement. With this has come leisure, life style improvements, culture, science and the list goes on. What is often overlooked is the environmental ramifications of uncontrolled, thoughtless development, especially when the benefits are obvious and the costs are hidden and only revealed over time and with considerable investigation and I might add met with strenuous resistance by vested interests. Pollution and climate change are the clearest negatives of modernization.

9.3.2 Isolation - living

Modern cities have almost assumed the roles of horrible monstrous creatures killing our wildlife, polluting the air, over consuming water, swallows up natural areas and cuts people off from natural surroundings is typically responsible for the weakening human connection to nature. Despite their horribleness, we love our cities. An ever increasing number of aspiring men and women are pouring into the various urban centres of the world. Large town and cities are being built to accommodate the increasing population load. Developing world has made a huge leap in urbanization and been the hotspot of urbanization over the past decades. In the last 100 years, the urban population has increased from 13 percent of the world population in 1900 to over 54 percent today. The United Nations projected that by 2050 about 64% of the developing world and 86% of the developed world will be urbanized. Today, in Asia the urban agglomerations of Osaka, Tokyo, Mumbai, Dhaka, Karachi, Jakarta, Shanghai, Chongqing, Guangzhou, Manila, Seoul, and Beijing are each already home to over 20 million people, while Delhi is forecast to approach or exceed 40 million people in the year 2035. Cities such as Tehran, Istanbul, Mexico City, São Paulo, London, Moscow, New York City, Lagos, Los Angeles, and Cairo are, or soon will be, home to over 15 million people each.

9.3.3 Spiritual disconnection: the Missing Dimension

"Living in peace with nature" translates to adapting ourselves and living in harmony with environment and nature. Human activities have always tried to overpower the environment and has destroyed nature by creating its own system. Nature takes corrective action in the form of natural disaster now and then. It is never late to try and make peace with nature and build our future cities environment friendly. Many have become disconnected from the mother earth, not thinking of her as their home, but merely a place to hang their hat. As Humanity becomes unbalanced, so too does Earth. Reconnection of spiritual relationship with nature, a missing dimension of so called "modern world" could assist in the transformation to a more sustainable world, it seems that it is not so much a relationship, but a deep understanding and conscious awareness or knowing of the interconnectedness and interdependence between human beings and nature.

9.4 NATURE AS A RELIABLE BENEFACTOR

Nature presents us a wide variety of products, which the technological knowhow may not be able to attain, at least till the near future. Birds that flock around us are natural cultivators, they consume the fruits and drop the seeds in different places. Who can forget the tragedy of Calveria tree and Dodo bird, the famous extinct flightless bird from Mauritius. The extinction of Dodo bird from human interferences led the extinction of Calveria tree too.

Birds like crow, eagle, and vultures are scavengers and helps disposing dead animal corpse which could cause epidemic. It is hard to believe that widespread use of chemicals and encroachment of their habitat are heading these birds towards extinction.

9.4.1 Raw products

Nature provides mankind a variety of raw materials for its livelihood needs and leisure as well. For example, Bees plays main role in pollination and pollination leads to trees bearing fruits. Bees are fast disappearing and in the near future human being shall take the role of bees and hop from tree to tree and flower to flower. Besides, trees and plants provide shelter for birds, shade for us, pure air and water, and provide livelihood to many. Land and soil itself are essential but finite resources. Bioenergy derived from plants, but also from agricultural and urban waste, is sustainable and does not increase pressures on the land. Besides, there is long list of "raw material" in unprocessed or minimally processed states; e.g., raw latex, crude oil, cotton, coal, raw biomass, iron ore, air, logs, water, forestry, fishing etc. derived from nature's basket

9.4.2 Bioindicator

Many species, or communities and are used to assess the quality of the environment and how it changes over time. Naturally occurring Bioindicators are used to assess the health of the environment and are also an important tool for detecting changes in the environment, either positive or negative, and their subsequent effects on human society. Changes in the environment are often attributed to anthropogenic disturbances (e.g., pollution, land use changes) or natural stressors (e.g., drought, late spring freeze). For example, frogs are also Bioindicators of quality of environment and changes in environment. Frogs are basically influenced by changes that take place in their freshwater and terrestrial habitats. This makes them important Bioindicators of ecological quality and change. Zooplanktons like Alonaguttata, Mesocyclopsedax, Cyclops, Aheyella are zone-based indicators of pollution. Invertebrates can also be Bioindicators; aquatic invertebrates tend to be bottom feeders (also known as Benthos or macro invertebrates), living near the bottom of water bodies. These types of Bioindicators may be particularly powerful indicators of watershed health. Microorganisms are often used as health indicators of aquatic and terrestrial ecosystems. Due to their abundance, they are easy to test and readily available.

9.4.3 Aesthetic and healing value

Our lives are intimately linked to our surroundings in ways that we are not normally conscious of. Nature possess great aesthetic values. Mere walking around an area with lots of green foliage, like a garden or park, helps boost one's mood and memory. Greener environments help improve our immune system and enable us to have more intense levels of physical activities. Greener environments also help you recover quickly from sickness. Large number

of tourists visit every year into the wilderness areas such as national parks and wildlife sanctuaries. This is not just a great source of leisure for the tourists but also provide employment to large number of people engaged in tourism industry.

9.5 SUSTAINABLE DEVELOPMENT: A NEW PARADIGM SHIFT

A new paradigm for working and living in harmony with nature is arising under the conceptual umbrella of sustainability. The Brundtland Commission's in their report "Our Common Future" definition of sustainable development asked for a balance to be struck between the needs of the present with the responsibilities owed to future generations. In this century, the two central challenges of sustainable development are to overcome poverty and inequality, and to re-establish balance within the Earth system. Both objectives are intrinsically linked, and one cannot be achieved without the other. The pursuit of unending development on a finite planet is unsustainable and impossible. It is unsustainable and impossible. The limit to development is defined by the regenerative capacity of the Earth's vital cycles. When growth begins to break that balance, as we see with global warming, we can no longer speak of it as development, but rather, the deterioration and destruction of our home.

9.5.1 Sustainable Industry and Infrastructure

A certain level of growth and industrialization is needed to satisfy basic needs and guarantee the human rights of a population, but this level of "necessary development" is not about permanent growth, but rather, balance among humans and with nature. Sustainable development seeks to eradicate poverty in order to live well, not generate wealthy people who live at the expense of the poor. The goal is the satisfaction of basic human needs in order to allow for the development of human capabilities and human happiness, strengthening community among human beings and with Mother Earth. Sustainable development cannot be attained only at the national level. The wellbeing of a country is only sustainable if it contributes to the wellbeing of the entire system. The pillar of sustainable development can only be achieved from a global perspective. The so-called developed countries are still far from reaching sustainable development.

9.5.2 Sustainable agriculture

Sustainable agriculture movement is but one small part of a far larger movement that is transforming the whole of human society and their relation to environment. Slowly but steadily, agriculture in many parts of the world is moving through a great transformation from the technology-based, industrial era of the past to a knowledge-based, "sustainable" era of the future. An agriculture that uses up or degrades its natural resource base, or

pollutes the natural environment, eventually will lose its ability to produce. It's not sustainable. An agriculture that isn't profitable, at least over time, will not allow its farmers to stay in business. A shift to sustainable agriculture practices that must be ecologically sound, economically viable, and socially responsible is a must to harmonize human-environment relationship.

9.5.3 Renewable Energy

Renewable energy have received tremendous impetus in the last decade. Societies around the world are on the verge of a profound and urgently necessary transformation in the way they produce and use energy. The rapid deployment of renewable energy resources and energy efficiency technologies is resulting in significant energy security, climate change mitigation, and economic benefits. This shift is moving the world away from the consumption of fossil fuels toward cleaner, renewable forms of energy. Millions of people around the world already use renewable energy to generate electricity, heat and cool buildings, cook and provide mobility. By definition "Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat". Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural energy services. India is one of the countries with large production of energy from renewable sources. As of 31 March 2020, 35.86% of India's installed electricity generation capacity is from renewable sources, generating 21.22% of total utility electricity in the country. In the Paris Agreement India has committed to an Intended Nationally Determined Contributions target of achieving 40% of its total electricity generation from non-fossil fuel sources by 2030. World over, National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond.

9.5.4 Conservation

Mainstreaming biodiversity into national development plans should be made a principle, a cross-cutting issue, and must be considered during implementation of the biodiversity framework. Global cooperation among states to conserve, protect and restore the health and integrity of the earth's ecosystem. There is a need to strengthen coherence, synergies and governance, legal frameworks and enforcement of the rule of law. This could be achieved by: strengthening cooperation with and among developing countries to resolve issues of conflict and migration pressures on biodiversity; addressing human rights issues in relation to indigenous and local communities (including women). Forests are essential to the balance and integrity of planet Earth and a key element in the proper functioning of its ecosystems and the broader system of which we are a part. Thus we cannot consider them as simple providers of goods and services for human beings. It is also essential to

guarantee a real and effective reduction of greenhouse gases, particularly on the part of the developed countries historically responsible for climate change, in order to stabilize the increase in temperature.

Check Your Progress-I

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. International Mother Earth Day is celebrated on?
2. Earth's carrying capacity is severely affected by our
3. Name some raw material received from nature?

4. What are bio indicators?

5. Sustainable development asks for striking a balance between the needs of _____ with the responsibilities owed to _____
6. Which are two central challenges of sustainable development in the present century

7. The pursuit of unending development on a finite planet is sustainable and possible. True/False.
8. List the areas in which renewable energy provides energy

9. Increase in green house gases is likely to stabilize the increase in temperature. True/False.

9.6 CHALLENGES AND AN OPPURTUNITIES OF GOING GREEN

Eco-Activism

Despite the deterioration of the environment, the silver lining to the dark cloud is the emergence of Environmental Consciousness both in developed and developing world. Thousands of people take on to the streets to compel their governments on environmental

issues. Declaration of climate emergency in 2019 in several parts of the developed world is a proof of this. Rachel Carson's finest work "Silent Spring", published in 1962, was a landmark in the history of environmental activism, raised the consciousness of a generation. Rachel Carson may be credited for her efforts to capture the public imagination and to forge environmental consciousness. Though the picture may not be gloomy at this point of the time, but nonetheless efforts towards creating a world over organic revolution cannot be undermined. World has made tremendous efforts towards combatting climate change. Landmark "Paris agreement" has been signed to check the future greenhouse gas emissions, by improving the efficiency of the present energy installations, and shift towards non-polluting renewable energy sources. As of 2017, renewables contributed 19.3% to humans' global energy consumption and 24.5% to their generation of electricity in 2015 and 2016, respectively. India is one of the countries with large production of energy from renewable sources. As of 31 March 2020, 35.86% of India's installed electricity generation capacity is from renewable sources, generating 21.22% of total utility electricity in the country. In the Paris Agreement India has committed to an Intended Nationally Determined Contributions (INDC) target of achieving 40% of its total electricity generation from non-fossil fuel sources by 2030.

Eco-Spirituality- The Guiding Principle

Our cultural and spiritual heritage is rich enough to strike a balance between developmental activities and environmental equilibrium. Let no one species encroach over the rights and privileges of other species. Human-beings are superior of all creatures and should owe the responsibility to protect Mother Nature. One can enjoy the bounties of nature only by giving up greed, avarice, arrogance and exploitation. The materiality of the modern world causing eco-crisis can be conquered only through discarding lust for amassing inordinate wealth and riches, banishing hatred and ugly competition and adopting love and compassion instead, by doing good to others including nature. All religions of the world give messages of love, compassion and sympathy for all creatures. We must become sane and develop a new concept of eco-spirituality (not only eco-friendliness). To achieve sustainable economy, we have to build a new relationship with the mother earth by slowing down population growth by using our resources most frugally and more efficiently. Einstein says, 'True religion is concerned with man's attitude towards nature at large with establishing ideals for the individual and communal life and with mutual human relations. Religion exists in nature and nature sustains human life; both religion and nature should be unescapable parts of human

existence. Life is unnavigable without the soul and flag of religion and as life depends on environmental equilibrium, the teachings of religions can be fairly used for developing a concept of eco-spirituality graded by various religious faith of the world. The emergence of a global ecospirituality arises as a response to three deep realizations about humanity's relationship with creation that have become part of our consciousness. A time has come to define man not by his ability to hurt nature but by his ability to heal the wounds caused to nature by his insatiable greed, avarice and lust for dominion over nature and not by his ability to destroy but by his ability to build nature-friendly universe. The pollution of human mind prejudicial to nature can go only by embedding the eternal precepts of religion; for religion is nothing but a symbolic relationship between man and his environments promising a homogenised and congenial ambience. So, it would be true to say that all technologies should be presumed to be guilty until proved innocent."

Religion has a great impact on the human psyche, so, it is necessary to draw upon the wisdom of religion to instil in man the importance of ecology. All religions of the world unanimously declare that so long as man lived in harmony with nature, he was happy and contented. They warn man that he should not flout the laws of nature. But if he turns a deaf ear to these wise precepts of the enlightened persons, he invites calamities for himself. Humans must learn the perennial wisdom to love all living creatures, preserve the beauty of the earth by living in

harmony with the forces of nature without violating her laws, without polluting the environment and thus disturbing the rhythm of nature. Humans have to behave eco-friendly, eco-spiritually, for his own survival on the planet earth.

Check Your Progress-2

Note (a) Answer the questions given below

(b) Compare your answers with those given at the end of the lesson

1. "Salient Spring", a famous book was written by_____.

2. Define Renewable Energy

- | | |
|----|---|
| 3. | Pans agreement has been signed in 2015 to check the emission of _____gases. |
| 4. | INDC stands for _____ |
| 5. | As on 31st March 2020, what percentage of India's installed electricity generation capacity is based on renewable sources. () |
| 6. | _____ is the title of the report submitted by the Brundtland Commission |

9.7 LET US SUM UP

"Living in peace with nature" translates to adapting ourselves and living in harmony with environment and nature. Human's interventions into the natural system have always tried to overpower the environment, and has led to the deterioration of nature by creating its own system. Nature in turn takes corrective measures in the form of natural disasters, climatic extreme events etc. now and then. Humans must reinvent new ways to get back into the close proximity of nature again. "The journey of a thousand miles begins with a single step", it is never late to try and make peace with nature and build our future cities environment friendly and be in tune with nature. Nations of the world must unite like the members of a global family and help the have-nots by eradicating poverty, jealousy, greed and thus help establishing a happy world-order by arousing in them eternal, spiritual values like love and compassion, beauty and peace. This is indeed the sublime environment for mankind.

9.8 LESSON END EXERCISE

- 1 Explain why human actions are deteriorating nature? Give suitable reasons for disequilibrium between man and nature?
- 2 What are the challenges and opportunities of going green? Discuss the importance of renewable energy?
- 3 Elucidate upon how sustainable development is a way ahead in making harmony with nature?
- 4 Explain the role of Eco-spirituality in establishi

9.9 SUGGESTED FURTHER READINGS

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Nasr, S.H. (1968). Man and Nature, The Spiritual Crisis of Modern Man. London: Unwin Paperbacks.

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9.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress-I

1. 22nd April
2. Consumption and production patterns
3. Raw latex, crude oil, cotton, coal, raw biomass, iron ore, air, logs, water, forestry, fishing etc
4. Many species, or communities and are used to assess the quality of the environment and how it changes over time.
5. The present, future generations.
6. Eco-activitism and Eco-spirituality.
7. true
8. Electricity generation, air and water heating/ cooling, transporation and rural energy services.
9. False

Check Your Progress-II

1. Rachel Carson
2. Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat
3. Greenhouse gas emissions
4. Intended Nationally Determined Contributions
5. 35.86%
6. Our Common Future

ENVIRONMENTAL ISSUES

STRUCTURE

- 10.1 Introduction
- 10.2 Objectives
- 10.3 Forests: Introduction
 - 10.3.1 Importance of Forests
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10.1 INTRODUCTION

Forest and wildlife resources are of immense importance to humanity. Man depends on various forest and wildlife species for food, fuel, fodder, medicines, drugs, raw materials for industrial purposes and manufacturing technologies. Besides, forests provide indirect benefits like cycling of nutrients, combating erosion, regulating and recharging water flow,

improving the soil, trapping the sediments, and controlling the pest population. The productivity of agricultural system is a result of continuous alteration of wild plants and animal germplasms. Despite the enormous role of forest and wildlife resources in serving as a foundation for sustainable development, these resources are under tremendous threat. The threats range from reduction in intrinsic quality to decline or complete extinction of species resulting from a causative factor or a combination of factors. To address these multifarious and complex threats, a wide range of conservation actions become imperative. The conservation of forest and wildlife is one aspect of environmental issues that has recently attained global attention. The first section of this chapter provides information regarding the benefits of forests, causes of forest degradation, and the measures that can be taken to conserve the forests. The second section deals with wildlife, its importance, causes of dwindling, and various wildlife conservation measures and approaches.

10.2 OBJECTIVES

After going through this lesson, you shall be able to:

- explain the concept of forests,
- enumerate the importance of forests,
- specify various threats to the forests,
- explain the measures that can be taken for the conservation of the forests.
- describe wildlife and explain its importance,
- enumerate factors responsible for dwindling wildlife, and
- explain measures that can be taken for the conservation of the wildlife.

10.3 FORESTS: INTRODUCTION

The word forest is derived from the Latin word ‘foris’ means ‘outside’. The term originally referred to as any land 'outside of cultivation'. The forest is a complex, self-sustaining ecosystem consisting mainly of trees having an association with other living organisms and abiotic components. Forest is defined as a land area of more than 0.5 ha, with a tree canopy cover of more than 10%, which is not primarily under agricultural or other specific non-forest land use. In the case of young forests or regions where tree growth is climatically suppressed, the trees should be capable of reaching a height of 5m in situ, and of meeting the canopy cover requirement.

Forest cover broadly signifies the expanse of forest resources in a country or region. About 30.72% of the earth’s area is covered by forests. In India, at the beginning of the 20th century, about 30% of the land was covered with forests. But by the year 2019, the forest cover has been reduced to 21.67%. In 2019, of the existing forests, about 3.02% are categorized as very dense forests (canopy cover 70% or more), 9.39% moderately

dense forests (canopy cover 40% or more but less than 70%), 9.26% open forests (canopy cover 10% or more but less than 40%), and 1.41% scrub forests (canopy cover less than 10%). Lakshadweep, with 90.33 % of forest cover has the highest forest cover in percentage terms, followed by Mizoram (85.41%). Madhya Pradesh is having the largest total forest cover (77, 482 km²) in India, followed by Arunachal Pradesh (66,688 km²).

10.3.1 Importance of Forests

Forests provide a multitude of direct and indirect benefits:

- **Direct benefits**
- **Fuelwood:** Wood is used in rural India for cooking purposes.
- **Timber:** Wood is used for making furniture, tool-handles, bridges, boats, railway sleepers, railway compartments, the body of bus, truck, ships, etc.
- **Food:** Fruits, seeds, leaves, roots, and tubers of plants form the food of forest tribes.
- **Fodder:** Grass and leaves of forest trees are used as fodder for animals.
- **Shelter:** Forests provide shelter to various microbes, insects, birds, reptiles, mammals, etc.
- **Raw material for industries:** Forests provide raw material for industries such as matchbox industries, bidi industries, furniture industry, etc.
- **Foreign exchange earnings:** International tourists are attracted to the forest for excursions and trekking. This has become a major source of foreign exchange.
- **Forest Products:** Forest provides products such as gum, honey, bamboo, medicines, hides, etc. Silkmoth are reared upon forest trees. Honeybees also prefer beehives on forest trees.
- **Indirect benefits**
- **Check soil erosion:** Forest prevent soil erosion by binding the soil with the roots of plants and reduce the velocity of wind and rain, which are main agents causing soil erosion.
- **Temperature Control:** Leaves of trees form an umbrella-like canopy. Transpiration of plants increases the atmospheric humidity, affects rainfall, and cools the atmosphere.
- **Increase soil fertility:** Dry fallen leaves of trees called 'litter' undergoes decay on soil and form humus which adds to the fertility of the soil.

- **Regulation of hydrological cycle and groundwater recharge:** Forested watersheds act like giant sponges, absorbing the rainfall, reducing the runoff, and slowly recharging the springs and underground water sources.
- **Purification of air and control of air pollution:** The trees produce oxygen by photosynthesis which is vital for life on earth. These absorb carbon dioxide which is one of the main air pollutants.
- **Gene bank:** Forest plants and animals possess several useful genes that can be used for the benefit of mankind. e.g. blueprint of Aspirin was obtained from the Salix plant and that of Quinine from the Cinchona tree.

10.3.2 Causes of Forest Destruction/Degradation

Various anthropogenic activities have led to significant changes in the Indian forest. These include:

- **Deforestation:** Deforestation is the permanent destruction of indigenous forests and woodlands and is one of the most pressing land-use problems. Vast areas of forest land are being cleared of trees to reclaim land for human settlements and infrastructure development. The destruction of forests due to unscrupulous and indiscriminate felling of trees has led to the overall deterioration of environment and is posing a serious threat to the quality of life.
- **Forest fires:** Forest fires are one of the major causes of loss of forests and can start due to natural causes or by accidents caused by man. In a controlled manner forest fires are important as they help replenish the nutrients in the soil from dead and decaying matter. Sometimes the forest land is set on fire to make the land available for commercial purposes. Each year, fires burn millions of hectares of forest worldwide.
- **Grazing animals:** The increase in livestock population directly dependent on forests for fodder is also responsible for forest degradation. Forest grazing reportedly has negative impacts on forest ecosystems, such as soil erosion, depletion of nutrients, soil compaction, and soil acidification.
- **Conversion of forest land:** Conversion of forest land for non-forest activities like plantations, pastures, settlements, roads, and construction, etc. has ecological as well as socio-economic effects.
- **Fuelwood harvesting:** Over-harvesting for domestic use or for commercial trade in charcoal significantly damages forests.
- **Mining:** The impact of mining on forests is growing due to rising demand and high mineral prices. Mining projects are often accompanied by major infrastructure construction, putting further pressure on forests and freshwater ecosystems.

- **Pest attacks:** Numerous trees and vegetation covers are destroyed by pests and diseases throughout the year. The general outcome is a reduction in the quality of specific aspects of the forests such as biodiversity and food chain relationships because of the death of certain plant and animal species.
- **Shifting cultivation:** Shifting cultivation or Jhum is an important form of primitive agricultural land use practiced along the Eastern Ghats in which forest area is cleared by slash and burn techniques. Various effects of shifting cultivation include large scale deforestation and associated undesirable ecological imbalances. The clearance of forest accelerates soil erosion and accentuates the variability in rainfall distribution.
- **Forest Fragmentation:** Fragmentation pertains to the separation of large forest areas into smaller pieces and destroys healthy ecosystems since large forest animals mostly flourish in large forest regions as opposed to pieces of forests.
- **Illegal and unsustainable logging:** Illegal logging occurs in all types of forests, destroying nature and wildlife, taking away community livelihoods, and distorting trade.
- **Climate Change:** Forest loss is both a cause and an effect of our changing climate. Climate change can damage forests, for instance by drying out tropical rainforests and increasing fire damage in boreal forests. Climate change is a major threat to biodiversity.

10.3.3 Conservation of Forest

The term ‘Conservation’ was coined by Dr. Gifford Pinchot in 1908 from two Latin words-*con*(=together) and *servare* (=guard). Conservation is one of the major applications of ecology to ensure scientific and sustainable utilization of resources and includes preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment.

Van Mahotsava is an annual tree-planting festival in the month of July and is celebrated as a festival of life. It was started by Sh. K.M. Munshi, the first Agriculture Minister of India.

Conservation of forest is the practice of planting more trees and maintaining the forested areas for the sustainability of future generations. Forest conservation is the preservation and the protection of forests and involves the reversal of deforestation and environmental pollution.

Following are some of the measures that can be taken for conservation of forest:

- **Regulated and planned cutting of trees (controlled deforestation):** With the advent of industrialization, several trees have been cut at an alarming rate for raw materials and various other non-forest purposes. **Following cutting methods are suggested:**

- **Clear cutting:** The clear-cutting method is useful for those areas where the same types of trees are available over a large area. Trees of the same age group can be cut down in a selected area and then marked for replantation.
- **Selective cutting:** In selective cutting, only mature trees are selected for cutting and the process is followed in rotation.
- **Shelterwood cutting:** Shelterwood cutting involves cutting of useless trees followed by medium and best quality timber trees. The time gap between these cuttings is helpful in the re-growth of trees.
- **Regulated or/non-conversion of forest land:** Conversion of forest land for non-forest activities should be restricted unless unavoidable.
- **Protection against forest fires:** Measures to control forest fires include making fire lanes, spreading chemicals to control fire, periodical clearing out dry leaves and trees from forest areas, etc. Also, latest firefighting techniques like developing three-meter-wide fire lanes around the periphery of the fire, the arrangement of water spray, fire retardant chemicals sprayed from the back tank, and if possible, by helicopters, should be adopted.
- **Afforestation and Reforestation:** Afforestation is the process to plant more trees in the area to increase the forest cover either by manual transplantation, or fresh plantation of trees. Trees should be selected according to the geographical conditions of a region and proper care should be taken during the growth of trees. Sustained yield concept should be adopted which dictates that whenever timber is removed, the denuded area must be reforested. Similarly, any forested land which has been destroyed by fire or mining activities should be reforested. Also, afforestation programmes should be started to increase the forest cover.
- **Protection against diseases:** The forest diseases resulting from parasitic fungi, rusts, mistletoes, viruses, and nematodes should be prevented either using chemical sprays, antibiotics, or by the development of disease-resistant strains of trees.
- **Proper utilization of forest products:** Prevention of exploitation of forest and forest products is necessary for the conservation of forest. It has been noticed that after logs are cut from the trees in forests, the rest of the tree (stumps, branches, and foliage, etc.) are left out as worthless debris. This waste material can be used for developing products like waterproof glues, board, etc. Forests can be developed

as tourist centers which can help in earning substantial foreign exchange.

- **Better Farming Practices:** Slash and burn farming, overgrazing by cattle, shifting agriculture are all farming practices that are harmful to the environment and particularly to the forests. These practices should be kept under control.
- **Protection by law**
- **Forest (Conservation) Act, 1980:** Government of India enacted the Forest (Conservation) Act, 1980 for the conservation of forests which was amended in 1988 to incorporate strict penalties against the violators of the act.
- **National Forest Policy of India, 1988:** In India, the first forest policy was declared in 1894. The policy was revised in 1952 and again in 1988. The main target of the revised forest policy of 1988 is protection, conservation, and development of forests. A minimum of one-third of the total land area of the country is to be maintained under forest or tree cover. Following are some of the forestry programmes proposed on areas outside the conventional forests to increase and conserve the forests of the country:
 - **Social Forestry:** Social forestry is defined as forestry outside the conventional forests to provide a continuous flow of goods and services for the benefit of people.
 - **Farm Forestry:** Farm forestry is the name given to programmes that promote commercial tree growing by farmers on their own land.
 - **Extension Forestry:** It is the practice of forestry in areas devoid of tree growth and other vegetation situated in places away from the conventional forest areas with the object of increasing the area under tree growth. It includes the following.
 - **Mixed forestry:** Forestry for raising fodder grass with mixing fodder trees, fruit trees, and fuelwood trees on suitable wastelands, panchayat lands, and village commons.
 - **Shelterbelts:** Shelterbelt is defined as a belt of trees and or shrubs maintained for the purpose of shelter from wind, sun, snowdrift, etc.
 - **Linear Strip plantations:** These are the plantations of fast-growing species on linear strips of land.
 - **Recreation Forestry:** Forestry with the object of raising flowering trees and shrubs mainly to serve as recreation forests for the urban and rural population. This type of forestry is also known as **aesthetic forestry** which is defined as the practice of forestry with the object of developing or maintaining a forest of high scenic value.

Check Your Progress-1

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. Reduction in the productivity and diversity of the forests is:
 - a. Deforestation
 - b. Forest restoration
 - c. Forest degradation.
 - d. Forest destruction
2. Jhum is:
 - a. Method of forest conservation
 - b. Method of soil conservation
 - c. Method of land conservation
 - d. Method of cultivation
3. Which one of the following states has the largest area under permanent forest?
 - a. Uttar Pradesh
 - b. Jammu & Kashmir
 - c. Punjab
 - d. Madhya Pradesh
4. How many National Parks were there in India as in the year 2019?
 - a. 120
 - b. 200
 - c. 104
 - d. 151
5. Forest Conservation Act was implemented in the year
 - a. 1992
 - b. 1990
 - c. 1980
 - d. 001

10.4 WILDLIFE: INTRODUCTION

India is one of the world's richest countries in terms of its vast array of biological diversity and has nearly 8 percent of the total number of species in the world (estimated to be 1.6 million). This is possibly twice or thrice the number yet to be discovered. Wildlife refers to the living organisms, i.e. all the plants, animals, and micro-organisms living in their natural habitat in a wild state other than cultivated plants and domesticated animals. They do not have any human control. Wildlife provides great stability to our environment. Each living organism is placed in the food chain and is equally important, be it a producer, a consumer, or a decomposer, all these are interlinked and depend on each other for their survival.

10.4.1 Importance of Wildlife

The conservation of wildlife is of immense importance to the mankind and vital aspect of our ecosystem. Listed below are a few of the reasons stating the importance of wildlife:

- a. **Economic importance:** The products and by-products of different plants and animals are used by humans for various purposes. Many plants have medicinal values. More than one-third of our pharmaceutical needs are catered by wild plants. Similarly, many microorganisms have found their use in the pharmaceutical and food industry. They also serve as decomposers and convert waste into compost which is used by plants. Fossil fuels obtained from forests help in the economic growth of the country.
- b. **Maintain ecological balance:** The living organisms in an ecosystem interact with one another through food chains. The interdependence of plants and animals is very essential to maintain the balance of nature.
- c. **Biodiversity conservation:** There are thousands of species that take shelters in huge forests. Wildlife has a great role to play in the conservation of biodiversity. It must be preserved whether useful or not as wild species having no use at present may possess un-explored value and may turn out to be very useful later.
- d. **Genetic Resource:** Genes from wild plants and animals are used to help in breeding better crop varieties through genetic engineering.
- e. **Scientific value:** Experiments are carried out on wild animals like monkeys, guinea pigs, rats, fruit fly, etc. which have contributed a lot in the field of biology, medicine etc. Wild animals are used to carry out experiments to evolve new surgical methods and for testing the efficiency of new medicines. The sea urchin has helped in the

understanding of human embryology, Rhesus monkeys in the knowledge of human blood groups, deer antlers in determining the degree of radioactive contamination of environment, etc.

- f. **Aesthetic value:** Wildlife is a source of aesthetic value. Green forests, birds, fishes, and beautiful butterflies in fields and grasslands give grace to the biosphere.
- g. **Cultural Value:** Wildlife is a source of inspiration to the poets and artists. In India, the wildlife has close connection with various religions also.
- h. **Recreation and sports:** Wild animals are source of recreation to public in circus shows, zoological parks and sanctuaries. Wild animals also provide good sport to the hunters.
- i. **Keeping the environment healthy:** Microorganisms take part in nitrogen fixation thus, bringing about an increase in the levels of soil fertility.

10.4.2 Causes of Dwindling Wildlife

The level of wildlife is declining incredibly. Animals and plant species are endangered or extinct. Some major factors responsible for this decline are:

- a. **Habitat Destruction:** The destruction of habitat is the most serious threat to wildlife. Habitat destruction is a process in which natural habitat is unable to support species. Deforestation deprives the wildlife of its shelter and food and reduces the area of their movement. Various developmental works like roads, railway lines, industries, human settlements, dams have reduced the natural habitats of the wildlife. Migratory animals are vulnerable to habitat destruction as physical alteration of any site of their migratory route adversely affects them and they may perish due to failure to locate their route.
- b. **Environment Pollution:** Environmental pollution like water, air and noise pollution has led to a decrease in wildlife due to its adverse effects on certain habitats.
- c. **Population growth:** Population growth is one of the major threats to conservation efforts in many developing nations. The population pressures threaten the parks and protected areas. People with traditional rights over the forests continue to destroy the flora and fauna and thus affect the wildlife.
- d. **Human-Wildlife Conflict:** Human-Wildlife Conflict has become a problem for the conservation of wildlife. Conflicts occur when the needs and behaviors of wildlife have a negative impact on human goals or when human goals have negatively impacted the needs of wildlife. The major consequences of these conflicts are injury and loss of life of humans and wildlife, damage to property and crop, livestock depredation, predation of wildlife stock, the collapse of wildlife populations, and reduction of geographic ranges.

- e. **Hunting and poaching activities:** Hunting of animals for food, safety, and pleasure has been in practice ever since the appearance of man. Many species of wildlife have vanished due to hunting of animals. Some people use hunting as their sport while others like tribal use hunting as a means of their livelihood. Poaching is defined as illegal hunting or catching of wild animals. Poaching of excessive numbers of animal species is an important factor leading to decline in their numbers. Poaching is divided into three separate levels.
 - i. **Subsistence Level:** In this, the persons usually hunt for themselves and their families. They often live in the vicinity of their poaching site and know the territory, habitat, infrastructure, routines, and species extremely well.
 - ii. **Commercial Poaching:** Poaching for getting monetary gains like for deriving traditional medicines, narcotics sale, etc.
- f. **Syndicate Poaching:** This is sophisticated organized crime, well-financed, fine networked, and internationally coordinated. Large organizations of individuals, generally local people are hired to do the actual poaching.
- g. **Illegal Wildlife Trade:** Illegal wildlife trade has consistently kept above the major illegal business in the world. In the illegal wildlife business, there is a high mortality rate due to the nature of the trafficking of living species. Wildlife is smuggled for various reasons including alternative medicines, goods or luxury goods, meat, and pet business.
- h. **Forest Fires:** Many times, the forest fires, which may be intentional or by mistake have been responsible for causing the extinction of several wildlife species in the past.

10.4.3 Wildlife Conservation

Wildlife conservation is commonly known as the practice of protecting endangered flora and fauna and their habitat to ensure the existence of wild life and their value for future generations. Wildlife conservation is carried out to study the interrelationships of plants and animals in their natural habitats, to protect and preserve the rare species of plants and animals from extinction, to preserve the breeding stock of wildlife and to prevent deforestation and maintain the balance of nature.

10.4.3.1. Modes of Wildlife Conservation

To preserve the rich wildlife and hotspots of biodiversity, India has adopted a strategy to build networks of protected areas. Measures are being taken to conserve biodiversity including plants and wildlife. There are two distinct modes of conservation viz., in-situ and ex-situ conservation:

- a. ***In-Situ Conservation:*** Conservation of a species (or genetic resource) within their original habitat is termed as in-situ conservation. The word in-situ also refers to 'on-site protection'. The endangered plant or animal species are conserved in their natural habitat, either by protecting itself or by rehabilitation, or by protecting species from predators. In India, in-situ conservation is taking place through the establishment of a
- Such PAs are of various categories viz. species

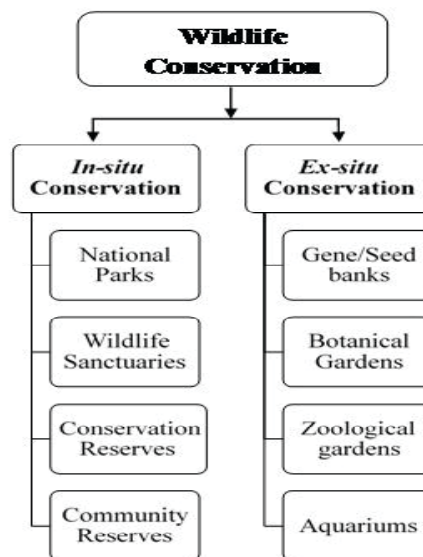


Fig.10.1 Showing different modes of wildlife conservation

parks, biosphere reserves, community reserves, conservation reserves, cultural landscapes, etc. In-situ conservation involves the development of necessary guidelines for the selection, establishment, and management of protected areas. In India, in the year 2019, there were 104 National Parks, 551 wildlife sanctuaries, 127 community reserves and 88 conservation reserves. There is a total of 870 PAs covering about 5.02 percent of the country's area.

Some projects were also started by the Government of India to conserve the endangered species within the natural habitat viz. Project Hangul (1970), Gir Lion Sanctuary Project(1972), Project Tiger(1973), Conservation of Musk Deer(1974), Crocodile Breeding Project(1975), Project Elephant(1992), Project Snow Leopard(2009) and Asiatic Lion Conservation Project(2018).

b. ***Ex-Situ Conservation***

Ex-situ conservation refers to 'off-site conservation'. It is the process of protecting an endangered species of plants or animals outside their natural habitat. The sample population is usually kept in a simulated environment and perpetuated in genetic resource centers, zoological parks, botanical gardens, etc. Besides, gene pools and gametes are stored in germplasm banks for seeds, pollens, semen, ova, cells, tissues, etc. In addition to the protection of a species in captivity, the objective of ex-situ conservation is also to reintroduce the individuals of wild species back to nature. In India, there are 145 recognized zoos and 122 botanical gardens and in some of these ex-situ conservations is practiced mainly through captive breeding of animals and cultures of representative plants.

10.4.3.2 Approaches for Wildlife Conservation

- a. **Habitat restoration and management:** Habitat management is a principal tool that wildlife biologists use to manage, protect, and enhance wildlife populations. Managers may enhance grassland areas by clearing brush and removing trees, and planting with native grassland species to reduce cover used by periphery predators and develop habitat for grassland animals.
- b. **Establishment of Protected areas and buffer zones:** It is essential to establish protected areas like wildlife sanctuaries, national parks, biosphere reserves etc. to protect wildlife. Protected areas will fulfill their conservation goals only if the land around them is managed appropriately. Conservation in forests can be ensured by the creation of substantial areas known as 'buffer zones' for production around them. These zones can support the protected area while, at the same time, provide local people with benefits. Buffer zones are meant to form a physical barrier against human encroachment of the centrally protected area.
- c. **Harvesting:** Harvesting is reducing or maintaining animal populations so there are fewer human-animal conflicts. Controlled hunting is the most effective solution for wildlife management.
- d. **Endangered species management and species re-introduction:** Significant habitat and locations of existing populations of endangered or threatened species are identified and managed on a priority basis. In addition, the lost species can be re-established and re-introduced in suitable habitat.
- e. **Preservation of species:** A habitat or ecosystem can be preserved by following techniques:
 - i. **Manipulative management** involves regulating numbers of animals directly by harvesting or by influencing numbers by altering food, habitat, density of predators etc.
 - ii. **Custodial management** is preventive or protective and minimizes external influences on the population and its habitat.
- f. **Sustainable wildlife management:** Active participation of local communities in decision-making and subsequent benefits sharing helps in sustainable wildlife management.
- g. **Fire Protection:** Although the fire is a natural component of many forest ecosystems, it can damage vegetation and consequently damage the soil erosion and fertility if it is not properly used. Effective fire control with direct control and reaction is a matter of popular education and agricultural policy.
- h. **Prevent deforestation:** Controlling deforestation is the best method to conserve wildlife and defend the rights of forest communities.

- i. **Preservation of breeding stocks:** Major genes can be stored either in pure lines in mixed stocks or in purebred form. The three main methods of conservation are (i) as breeding stocks, (ii) as frozen semen, and (iii) as frozen embryos.
- j. **Periodical census:** Periodical counting of wildlife species in a definite area helps in taking effective measures to conserve wildlife.
- k. **Nature interpretation centers:** Nature interpretation centers may include setting up educational camps or exhibitions in nearby regions of protected areas such as zoological gardens, parks, and wildlife sanctuaries. It is usually taken up by the concerned forest departments and should be handled by qualified and trained staff.
- l. **Protection by Law:** Laws should be enacted to conserve wildlife. Wildlife Protection Act, 1972 is the first act for the conservation of wildlife in the country.
- m. **Public Participation:** It is necessary to make local people understand and acknowledge the initiative and significance of wildlife protection. Public interaction can help in making local people accountable and cooperate in the implementation of wildlife management laws and regulations.
- n. **Public Awareness and education:** People should recognize the concept of conservation of natural resources. The wildlife managers and other eminent persons should hold public discussions, shows, and talks and should make people aware through electronic and print media. The role of education in public awareness programs is very significant. Environmental subjects based on wildlife conservation should be introduced in school and college curricula.

Check Your Progress-2

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. If a person hunts/traps the wildlife for himself and his family, it is called as
 - a. Commercial Poaching
 - b. Subsistence Poaching
 - c. Syndicate Poaching
 - d. None of the above
2. Indian Wildlife (Protection) Act was implemented in the year

- a. 1970
 - b. 1981
 - c. 1972
 - d. 1971
3. Which one of the following was launched in 1992?
- a. Project Tiger
 - b. Project Elephant
 - c. Project Hangul
 - d. Project Snow Leopard
4. Off- Site conservation is In-situ Conservation or Ex-situ Conservation (Tick the correct answer)
5. Illegal hunting is also known as _____.

10.5 LET US SUM UP

Ever since humans evolved, they have changed the land cover of the earth gradually. Consequently, one of the most pressing issues today is the conservation of forests and wildlife. Forest not only provides us with fuelwood, timber, fodder, and non-forest products but also with a wide range of environmental and economic goods and services supporting industrial and commercial activities. Forests are the natural habitat of large-scale wildlife, trees, shrubs, and different variety of plants which, unfortunately, are dwindling every year. Factors responsible for forest destruction and degradation include deforestation, forest fires, overgrazing, overexploitation for forest products, conversion of forest land for non-forest activities, etc. Hence, conservation of forest is an important responsibility that all of us must undertake. Various forest conservation measures include controlled deforestation, protection against forest fires and diseases, afforestation, reforestation of degraded lands, adopting better farming practices, etc.

Wildlife means animals and plants that grow independently of people, usually in natural conditions. Activities such as deforestation, human-wildlife conflicts, hunting, poaching, habitat destruction, and human-induced climate change are some of the factors responsible

for the decline of wildlife. Scientists predict that more than 1 million species are on track for extinction in the coming decades. The extinction of wildlife will ultimately lead to the extinction of human race. It is estimated that by the year 2020, the world will have lost two-thirds of its vertebrate biodiversity. The number of animals living on the land has fallen by 40% since 1970. Conservation of animals and plant species mainly aims to protect the endangered species from becoming extinct because of different human activities. Wildlife conservation is the preservation and protection of animals, plants, and their habitats. Although many efforts have been made around the world to conserve wildlife, so far, the approaches and strategies are not enough to solve the level of loss. Wildlife conservation has become a major area of concern involves both in-situ and ex-situ methods. In-situ conservation involves conservation of species in their natural habitats and is considered the most appropriate way of conserving biodiversity. Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats. Wildlife should be conserved to ensure that the future generations can enjoy the natural world and the incredible species that live within it.

10.5.1 Glossary

Jhum: The sequential system of shifting cultivation where an area of forest is cleared for cultivation by burning to allow the ash to enrich nutrient-poor soils.

National Parks: An area declared by the Central government, set aside for the preservation of the natural landscape, flora, and fauna and protected from all interferences other than essential management practices. A national park may be used for purposes of public recreation and enjoyment or because of its historical or scientific interest.

Wildlife Sanctuaries: Any protected area other than area comprised of any reserve forest or the territorial waters, having adequate ecological, faunal, floral, geomorphological, natural or zoological significance and notified by the State Government for the purpose of protecting, propagating, or developing wildlife or its environment.

Community Reserve: Any private or community land not comprised within a National Park, sanctuary, or a conservation reserve, for protecting fauna, flora, and traditional or cultural conservation values and practices.

Conservation Reserve: Any area owned by the government particularly the areas adjacent to National Parks and sanctuaries and those areas which link one protected area

with another for protecting landscapes, seascapes, flora and fauna, and their habitat.

Gene Banks: A collection of seeds, plants, or animals, maintained as a repository of genetic material, typically to preserve genetic diversity.

Zoo: An establishment that maintains a collection of wild animals, typically in a park or gardens, for study, conservation, or displays to the public.

Aquarium: Artificial habitat for water-dwelling animals. It is a tank, pool, or building housing a collection of aquatic life, as for exhibition and education.

Captive Breeding: Captive breeding, also known as "captive propagation", is the process of maintaining plants or animals in controlled environments, such as wildlife reserves, zoos, botanical gardens, and other conservation facilities.

Botanical gardens: A botanical garden is a garden dedicated to the collection, cultivation, preservation, and display of a wide range of plants labeled with their botanical names.

Cryopreservation: The process of freezing biological material at extremely low temperatures; upto -196°C in liquid nitrogen.

10.6 LESSON END EXERCISE

1. Define Conservation. Write an explanatory note on the causes of forest destruction/degradation.
2. Explain in-situ and ex-situ methods of wildlife conservation.
3. What is the difference between Conservation reserve and Community reserve?
4. Write a note on the importance of forests.
5. Write short notes on:
 - a. Afforestation
 - b. Social Forestry
 - c. Protection of forest by law
 - d. Wildlife Conservation

10.7 SUGGESTED FURTHER READINGS

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Higher Education.

10.8 ANSWERS TO CHECK YOUR PROGRESS

Check your Progress-1

1.c. 2.b. 3.d. 4.c. 5.c.

Check your Progress-2

1.b. 2.c. 3.b. 4.Ex-situ Conservation 5.Poaching

DISASTER MANAGEMENT

Structure

- 11.1 Introduction
- 11.2 Objectives
- 11.3 Understanding the Term Disaster
- 11.4 Classification of Disaster
- 11.5 Strategies to Tackle Disaster
- 11.6 Timed and Untimed Disasters
- 11.7 Disaster Management
- 11.8 Teachers, Schools and Community Activities in Disaster Management
- 11.9 Let Us Sum Up
- 11.10 Lessons End Exercise
- 11.11 Suggested Further Readings
- 11.12 Answers to Check Your Progress

11.1 INTRODUCTION

We live in a world where there are sources of potential happiness and growth on one side and harm or loss on the other. We could be living happily in a town with all basic necessities available around or close to a coastline that is prone to cyclones, tsunami or the mountainous regions vulnerable to earthquakes or an industry which could be dangerous or there maybe communal tension prevailing in the area. It is rightly said that excess of anything is bad. Rainfall is needed but its access leads to flood, heat is needed but excessive heat hurts. A

fine line separates environmental resources and environmental hazards, for example, water under control (reservoir) is a resource, but water out of control (flood) becomes a hazard. Disasters have been mankind's constant companion since time immemorial. They strike unabated and leave a profound trail of deaths, injuries, damage to infrastructure and development causing immense trauma to the affected community.

11.2 OBJECTIVES

After going through this lesson, you shall be able to:

- define the term disaster,
- differentiate between terms disaster and hazard,
- explain different types of disaster,
- enlist various strategies to tackle disaster, and
- elaborate the role of teachers in disaster management.

11.3 UNDERSTANDING THE TERM DISASTER

Hazard or danger or risk can be defined as physical phenomena that pose a threat to the people, structures or economic assets. Generally speaking, there are two types of hazards, namely natural and manmade. When a hazard becomes uncontrolled and damages population and property on large scale, it becomes disaster. A disaster is an occurrence arising with little or no warning. It happens with such a magnitude that it destroys normal life for a long period and requires major effort for the community or country, where it happens, to overcome its effects. It is a serious disruption occurring over a short or long period of time that causes widespread human, material, economic and environmental loss which exceeds the ability of affected community and society to cope using its own resources.

Relationship between hazard, vulnerability and disaster: Hazard is a potentially damaging physical event. Vulnerability refers to susceptibility of a place, the extent to which a community's structure, services or environment are likely to be damaged or disrupted by the impact of a hazard. Risk refers to the probability that loss will occur as the result of an adverse phenomenon happening or the expected losses (of lives, persons injured, property damaged, and economic activities disrupted) due to it. Similarly, disaster is a result of a hazard impacting on a vulnerable population and causing damage, casualties

and disruption, i.e. ***Hazard*** × ***Vulnerability*** = ***Disaster or Risk***.

For example, an earthquake in an uninhabited desert cannot be considered a disaster because there is no loss of man and material there, no matter how strong the intensity might be. An earthquake is disastrous when it affects people, infrastructure and activities. Let us try to understand this concept using following points:

- When extent of hazard and vulnerability is low, the resulting disaster will also be of small magnitude, i.e. ***Hazard (low)*** × ***Vulnerability (low)*** = ***Disaster (less destructive)***.
- When extent of hazard is high but vulnerability is low then the disaster will be of small magnitude, i.e. ***Hazard (high)*** × ***Vulnerability (low)*** = ***Disaster (less destructive)***.
- When extent of hazard is small but vulnerability is high then the resulting disaster will also be of small magnitude, i.e. ***Hazard (low)*** × ***Vulnerability (high)*** = ***Disaster (less destructive)***.
- When extent of hazard is very high and the vulnerability is also high then it will result in a huge disaster, i.e. ***Hazard (high)*** × ***Vulnerability (high)*** = ***Disaster (very destructive)***.

Few definitions of disaster can be stated as:

The word disaster is derived from French word *desastre*, which means badaster or badstar in Greek. The roots of the word disaster came from the astrological theme where they called destruction of a star as a disaster. It was believed an action due to unfavorable position of planets or the act of God

- **According to World Health Organisation (WHO)**, "A disaster can be defined as any occurrence that causes damage, ecological disruption, loss of human life or deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community or area."
- **According to American Red Cross (ARC)**, "A disaster can be defined as an occurrence either nature or manmade that causes human suffering and creates human needs that victims cannot alleviate without assistance"
- **The Oxford English Dictionary** defines disaster as "anything that befalls of ruinous

or distressing nature; a sudden or great misfortune, mishap, or misadventure; a calamity"

- **The Disaster Management Act, 2005** defines disaster as "a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area"
- **The United Nations** defines disaster as "the occurrence of sudden or major misfortune which disrupts the basic fabric and normal functioning of the society or community"

Thus, these definitions emphasize several features of disasters such as:

- They usually occur suddenly.
- Their impact is experienced over a long period.
- Overcoming the impact of disasters takes a lot of effort.
- They can be natural or man-made.
- They lead to sudden disruption of normal life, causing severe damage to life and property
- The available social and economic protection mechanisms are inadequate to cope.

D - DESTRUCTION

I - INJURY

S - SUFFERING

A - AWFUL

S - SEVERE

T - TRAGEDIES

E - EGREGIOUS

R - RAMBUNCTIOUS

Therefore, it can be concluded that disaster is the actual occurrence of the apprehended catastrophe. It is a disturbance of natural equilibrium. Disasters proceed by cause-effect

due to endogenous (inherent) and exogenous (external) factors, which combine to excite the phenomenon into a large-scale destructive event. Disasters are a result of vulnerabilities, which go on unabated/ unchecked over time, which crystallizes finally in a destructive event of great magnitude.

Check Your Progress -1

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. _____ is a potentially damaging physical event.
2. _____ refers to susceptibility of a place.
3. _____ refers to the probability that loss will occur as the result of an adverse phenomenon happening or the expected losses.
4. The word disaster is derived from French word _____ which means _____ in Greek.
5. Hazard (low) \times _____ = Disaster (less destructive).

11.4 CLASSIFICATION OF DISASTER

Disasters can be categorized in various ways. As per severity, disasters are classified as minor or major (in impact). The most common way of categorizing disasters is based on the underlying cause or nature of origin - natural or man-made.

Natural Disasters: These are the hazards that are caused by nature. The most common natural disasters that are known to the man kind are hailstorms, thunderstorm, very heavy snowfall, very heavy rainfalls, squalls, gale force winds, cyclones, heat and cold waves, earthquakes, volcanic eruptions, floods, and droughts which cause loss to property and life.

Manmade Disasters: These are the hazards that are caused by humans or their action. These are hazards that are caused by human beings either deliberately or by accident such

as industrial and chemical accident, road and railway accidents, aviation disasters, building collapse, communal violence, bomb blasts, explosions, fires, accidents, spillage, building collapse, electricity failure, chemical and nuclear radiation, bomb blasts, terrorism, war, insurgency etc. Some of the disasters can be associated with human activities such as industrialization, deforestation, urbanization which invariably produce air pollution, water pollution those in turn cause global warming, climate change, depletion of glaciers, depletion of ozone layer, increase in ultraviolet radiation, avalanches, flash floods and water-logging in low lying areas.

However, the High Powered Committee on Disaster Management (August 1999) under the Chairmanship of Shri. J.C. Pant identified five major groups of hazards in its final report. This exhaustive classification of over thirty hazards is as follows:

GROUP I: Water & Climate Related Hazards- floods and drainage management; cyclones; tornadoes and hurricanes; hailstorm; cloud burst; heat wave and cold wave; snow avalanches; droughts; sea erosion; thunder and lightning.

GROUP II: Geologically Related Hazards- landslides and mudflows; earthquakes; dam failures/dam bursts; mine fires.

GROUP III: Chemical, Industrial & Nuclear Hazards- chemical and industrial disasters; nuclear disasters.

GROUP IV: Accident Related Hazards- forest fires; urban fires; mine flooding; oil spill; major building collapse; serial bomb blasts; festival related disasters; electrical disasters and fires; air, road and rail accidents; boat capsizing; village fires.

GROUP V: Biologically Related Hazards- biological disasters and epidemic; pest attacks; cattle epidemics; food poisoning.

11.5 STRATEGIES TO TACKLE DISASTER

Rather than facing disasters with a fatalistic attitude, countries are approaching disasters with a view to mitigate their effects, and by being prepared to face them. However there are several barriers to risk reduction activities. Governments and organizations view risk reduction as an add-on project whereas activities involved in the work should be integrated and mainstreamed. Risk mitigation is frequently viewed as a technical issue but in reality there are several interconnected issues which need to be tackled from different perspectives.

Professionals who need to be involved in risk reduction come from a range of disciplines, e.g., engineers, architects, doctors, social workers etc.

As expenses on risk reduction activities are distributed across several heads, hence concerted planned actions do not take place. As monetary investment in risk reduction can be very high and returns may not be very visible, there is in general low commitment to risk reduction measures. But investment in disaster management can reduce the damage caused and increase the resilience of the nation. When the core of infrastructure systems is disaster-resistant, it is easier for a country to maintain the national economy and support development after the disaster.

Hence, traditional perception of disasters as natural phenomena outside the realm of human intervention is misconstruing the problem; it is giving way to a 'systems perspective', which encompasses, ecological and social perspective to disasters, whereby disasters are understood as totalizing events in which all dimensions of a social-structural formation involving organized human action in the environmental context in which it takes place is studied. As a society interacts with its environment with its values and perceptions and engages in a series of processes over which it has incomplete control and knowledge of, for example, development and planning processes involving production and distribution of goods over long periods of time; underlying hazards turn to disasters. By systemic understanding, hazard simply acts as a 'catalyst' in that it brings forth underlying tensions that are always present as potential pressures. Systems' perspective is therefore rightly applied to understanding the phenomenon underlying disasters.

11.6 TIMED AND UNTIMED DISASTERS

Timed disasters are the ones which are expected to happen. These are predictable such as fire outbreak, epidemics, flooding, building collapse etc. Necessary arrangements can be made beforehand so as to face the situation in some way or another. Although the disaster cannot be stopped from happening but precautionary measures such a migration or storage of food etc. can be taken so as minimize the problems howsoever possible.

Untimed disasters are those which are not easily predicted, for example earthquake, drought and volcano. Such disasters are totally unexpected and may lead to more losses of man and material. These are usually uncontrollable and harm is also extended.

Check Your Progress -2

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson

1. Broadly there are _____ types of disaster namely_____ .
2. Earthquake is a _____ disaster.
3. _____ disasters are predictable.
4. Food poisoning is an example of _____ disasters.
5. The high Power Committee on Disaster Management came in _____ was chaired by _____.

11.7 DISASTER MANAGEMENT

We all are clear about the meaning of disaster. We have just learnt about the strategies to tackle disaster. As such things are unpredictable; we need to stay prepared for any disastrous situation. What to do then? How to tackle pre and post effects? What is to be done for managing such situation? What is disaster management?

Management is a process of dealing with or controlling a situation. It includes the strategy of organizing and coordinating the efforts to accomplish some objectives through the application of available resources, such as financial, natural, technological and human. Thus, disaster management is a plan that has been framed strategically and a process that has to be administered and employed to protect critical assets resulting from natural or human made calamities. It is the body of policy and administrative decisions and operational activities which pertain to the various stages of a disaster. It is a systematic process which is based on the key management principles of planning, organizing, leading, coordinating and controlling the effects of disaster. Thus, disaster management is a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for:

- i) prevention of danger or threat of any danger
- ii) mitigation or reduction of risk of any disaster or its severity or consequences
- iii) capacity building

- iv) preparedness to deal with any disaster
- v) prompt response to any threatening disaster situation or disaster
- vi) assessing the severity or magnitude of effects of any disaster
- vii) evacuation, rescue and relief
- viii) rehabilitation and reconstruction.

The Disaster Management Act attempts to define and deal with disasters in a holistic way, linking causes, both natural and man-made, impacts, including life, property and environment, and developing a management plan that includes not only the post disaster aspects of response, relief and reconstruction, but also the pre-disaster aspects of prevention, mitigation and preparedness.

Disaster Management Cycle: Although, by their very definitions, disasters are most often sudden and may not be avoidable, but four basic measures can prevent hazards from developing into disasters altogether or reduce the effects of disasters and are to be kept in mind:

- 1. Mitigation
- 2. Preparedness
- 3. Response
- 4. Recovery

1. **Mitigation:** Mitigation is the action of reducing the severity, seriousness or bad effects of something. It implies that whilst it may be possible to prevent some disaster effects, other effects will persist but can be modified or reduced provided appropriate actions are taken. It is achieved by taking long term preventive measures after risk analysis, which is assessment of vulnerability to hazards. Mitigation consists of specific programs and steps taken with the intent to reduce the effects of disasters on a nation or a community e.g. development and application of building codes to have buildings earthquake-proof.
2. **Preparedness:** Preparedness is a continuous process of planning, managing, organizing, training, equipping, and improving activities for the enhancement of capabilities of an organization to prevent, protect against, respond to, and recover from, the effects of disasters. Preparedness assumes that there is an awareness of

the possibility of a disaster in an organization or a community and willingness of the members to contribute to the efforts in preparing to face it. When disaster strikes, the immediate crucial stage is appropriate response. It is usually regarded as comprising measures which enable governments, organizations, communities and individuals to respond rapidly and effectively to disaster situations, e.g. formulation and maintenance of valid, up-to-date counter disaster plans which can be brought into effect whenever required, evacuation of population temporarily to a safe location, provision of warning systems, emergency communications, public education and awareness and training programs including exercises and tests. Preparedness may include-

- **Warning** - the time or a period when a hazard has been identified but yet is not very threatening in a particular area.
 - **Threat** - the time or period when a hazard has been identified and is assessed as threatening in a particular area.
 - **Precaution** - action taken after receipt of warning to offset effects of disaster impact such as closing offices, schools; keeping emergency power generators ready; storing emergency water supplies.
 - **Disaster impact** - when disaster occurs, impact can vary between different types of disasters, e.g. an earthquake may give no warning and its impact time can be short, yet the result can be very severe. A cyclone may provide a long warning period and impact time, but it may pass or back-track.
3. **Response:** The response phase includes saving of human lives and the mobilization of the necessary emergency services in the disaster area. These include basic emergency services, such as fire fighters, police and ambulance. They may be supported by a number of secondary emergency services, such as specialist rescue teams. Response measures are applied immediately after the disaster, e.g. implementation of plan, activation of counter-disaster system, search and rescue, provision of emergency food, shelter, medical assistance. It is also called emergency response, i.e., applied for a short period of time (2-3 weeks after impact).
 4. **Recovery:** The last stage in the disaster management cycle is recovery. The aim of the recovery phase is to restore the affected area to its previous state. It differs

from the response phase in its focus and is primarily concerned with actions that involve rebuilding destroyed property, re-employment and the repair of other essential infrastructure. Recovery is the process by which communities and the nation are assisted in returning to their proper level of functioning following a disaster. It may take 5-10 years or even more. Recovery includes - restoration, rehabilitation and reconstruction, for example, restoration of essential services, restoration of repairable homes and other buildings, provision of temporary housing.

Recognizing that some of life's hardest lessons can also be the most beneficial, a disaster is occasionally used to rebuild a community. Thus, disaster mitigation, preparedness, response and recovery are four aspects of the disaster management cycle and can be shown as:



Principles of Disaster Management: Basic guidelines or principles underlying the process of disaster management can be listed as:

1. **Comprehensive:** disaster managers consider and take into account all hazards, all phases and all impacts relevant to disasters.
2. **Progressive:** disaster managers anticipate future disasters and take preventive and preparatory measures.
3. **Professional:** disaster management is knowledge based approach and needs expertise for further improvement.

4. **Flexible:** the process involves creative and innovative approaches in solving the problem.
5. **Coordinated:** it involves synchronization of various activities to achieve a common purpose of controlling a problematic situation.
6. **Risk Driven:** the process of disaster management uses risk management principle in assigning priorities and resources.
7. **Integrated:** it ensures unity of efforts among all levels of government and all elements of a community.
8. **Collaborative:** it creates and sustains broad and sincere relationships among individuals and organizations.

Check Your Progress -3

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson

1. There are _____ parts of disaster management cycle.
2. _____ is the action of reducing the severity of something.
3. Preparedness include _____, _____, _____ and _____.
4. Restoration, rehabilitation and reconstruction are components of _____.

11.8 TEACHERS, SCHOOLS AND COMMUNITY ACTIVITIES IN DISASTER MANAGEMENT

The primary role of a teacher is to deliver classroom instruction that helps students learn. To accomplish this, teachers must prepare effective lessons, grade student work and offer feedback, manage classroom materials, productively navigate the curriculum, and collaborate with other staff. But teacher's role is not limited to the classroom activities, they carry responsibility of nation. Alone they can do nothing. A good community support is always needed for extended services. Not only a teacher but various agencies can play important role in maintaining community services. So preventing or supporting community at the time of disaster is also significant

Role players in disaster:

- Common People: individuals, house -holds, volunteers.
- Gram Panchayat: sarpanch, panchayat secretary, panchayat members.
- Village elders: caste/community/religious leaders, teachers, doctors, engineers, retired army & police personnel.
- Govt. Depts. Officers: agriculture, medical, engineers (housing, roads & buildings, irrigation) revenue department, public health, police etc. NGOs

Community activities for disaster management:

- Planning, physical protection and response capacity development.
- Protect people (each other) from physical harm.
- Minimize disruption spread of rumours.
- Develop and maintain a culture of safety.
- Assess hazards, vulnerabilities, capacities and resources.
- Plan and implement for physical risk reduction, maintenance of safe facilities, standard operating procedures and training for disaster response.
- Test mitigation and preparedness plans and skills regularly with realistic simulation drills.
- Revise plans based on your experience.

Institutional activities for disaster management: Educational institutions can also play role in disaster management. They can:

- act as safe shelters.
- can be turned into health center for locality.
- disaster management information center where database could be maintained population, health etc.
- a center for learning and counseling.
- feeding center.
- training center for disaster management volunteers, local people, teachers, government officials and community members.

Also, the schools along with their members can help in:

- Ensure the continuity of education for all children.
- Assessment and planning- establishing or empowering disaster management committee; assessing risks, hazards, vulnerabilities and capacities; making contingency plans for educational continuity; communicating the plans to common masses.
- Physical and environmental protection- structural safety maintenance, non-structural mitigation; local infrastructure and environmental mitigation; fire safety.
- Response capacity development- standard operating procedures; response skills and organization; response provisions.
- Practicing, monitoring, and improving- holding simulation drills to practice, reflect upon and update plan; monitoring indicators for school disaster management.

Teacher activities in disaster management: Teachers also play a crucial role in class especially in aspects of disaster education. In educational planning, the role of human resources is of great importance. Similarly, in disaster planning, teacher can act responsibly and lead the situation using their expertise. . The teacher who is aware of disasters and its management can improve the practices successfully. Whatever is the scope of school in managing disasters, it cannot be accomplished without its teachers.

11.9 LET US SUM UP

Disaster is a sudden accident or natural event that can cause great damage to life and property. Disasters can be natural or manmade, timed or untimed. Because they are sudden and swift, the amount of damage they can cause cannot be estimated. What remains in our hand is to control it with proper planning. Disaster management cycle is needed to be understood which explains the meaning and need of mitigation, preparedness, response and recovery. Since, such disasters can be vast and have tendency to hit normal life of humans as well as animals, individual and society both have to play significant role in its control. so, proper understanding of disaster, its effects and control is important for every individual for self - safety and community survival.

11.10 LESSON END EXERCISE

1. Elaborate the difference between hazard and disaster.
2. Explain different types of disaster.
3. Enlist various strategies to tackle disaster.
4. Elaborate the role of teachers in disaster management.
5. Explain disaster management cycle.

11.11 SUGGESTED FURTHER READINGS

Bradley, A.T. (2011). The Disaster Preparedness Handbook: A Guide for Families. New York: Sky Horse Publishing Inc.

Collins, L. (2000). Disaster Management and Preparedness. Washington: Lewis Publishers.

Rajagopal, S., & Chari, S.K. (2005). Disaster Management: A Reader. Bangalore: National Institute of Advanced Studies.

Sharma, V.K. (1995). Disaster Management. Delhi: Medtech Publishers.

Sulphy, M.M. (2016). Disaster Management. Delhi: PHI Learning Private Limited.

11.12 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress -1:

1. Hazard, 2. Vulnerability, 3. Risk, 4. Disaster, bad star, 5. Vulnerability (low).

Check Your Progress -2:

1. two, natural and manmade, 2. Geological hazard, 3. Timed, 4. biological hazard, 5. August(1999), Shri J.C. Pant.

Check Your Progress -3:

1. four, 2. Mitigation, 3. Warning, threat, precaution & impact, 4. Recovery.

DISASTER AND ITS OUTCOME ON EDUCATION

Structure

- 12.1 Introduction
- 12.2 Objectives
- 12.3 Phases of Disaster Management
- 12.4 Disaster Management and Education
- 12.5 Agencies of Education for Disaster Management
 - 12.5.1 Formal, Informal and Non-Formal Agencies
 - 12.5.2 Active and Passive Agencies
 - 12.5.3 Commercial and Non-Commercial Agencies
- 12.6 Need to learn about Disaster Management
- 12.7 Outcomes of Disaster Management Education
- 12.8 Let Us Sum Up
- 12.9 Lessons End Exercise
- 12.10 Suggested Further Readings
- 12.11 Answers to Check Your Progress

12.1 INTRODUCTION

Disasters and emergencies have been increasing all over the world. Today, with technological advancement, acquiring knowledge and its application in the realm of action is regarded as the only effective way for preventing disasters or reducing its effects. Also,

education is the mother of all subjects and key to learning process. The importance of education and the effect of different methods of education on disaster risk reduction and preparedness in vulnerable people is important to be understood. Also, it is very important for all of us to know about various agencies of education and how these agencies work for making us learn that how disaster occurs, what should be done to minimize its during and after effects, how to keep ourselves and our surroundings safe, in short how to manage a disaster situation. Disaster education is a new area of enquiry in the field of education. The pedagogical space for preparing the public for disasters is extensive and includes not only school based initiatives and public information campaigns but also family and community learning, adult education and popular culture, which is more preferably called as public pedagogies.

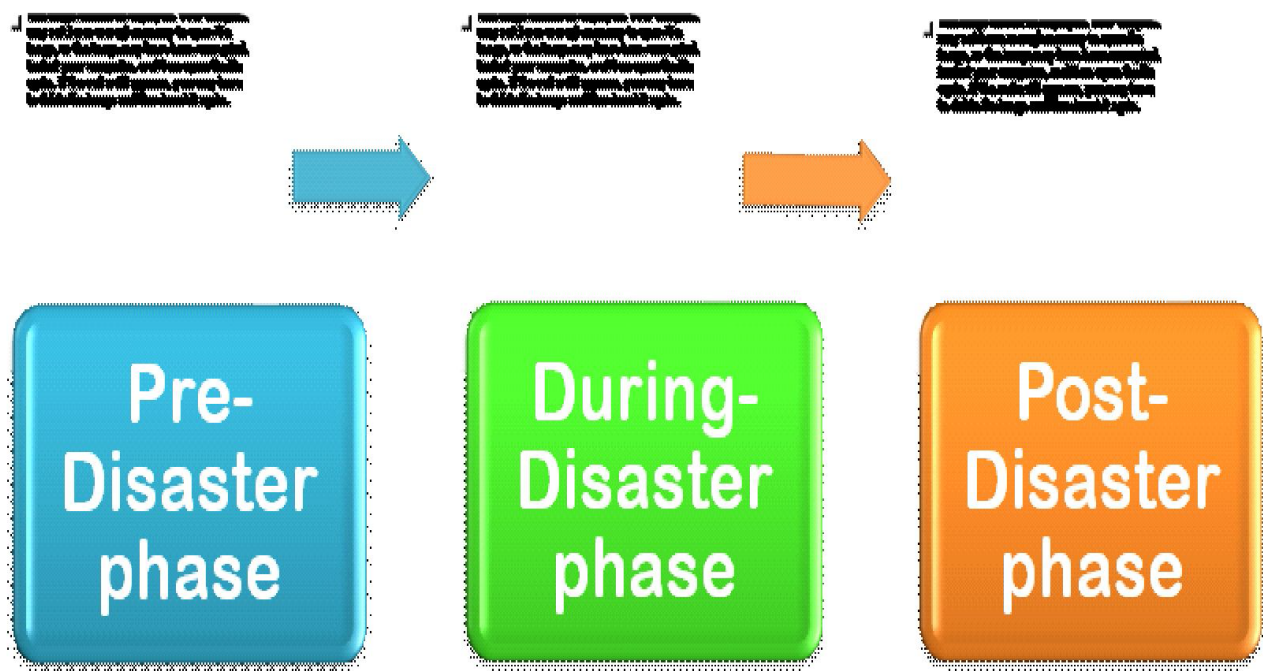
12.2 OBJECTIVES

After going through this lesson, you shall be able to:

- justify the need of education in disaster management,
- elaborate the need of disaster management education at different levels,
- understand various agencies of education, and
- enlist various outcomes of disaster management education.

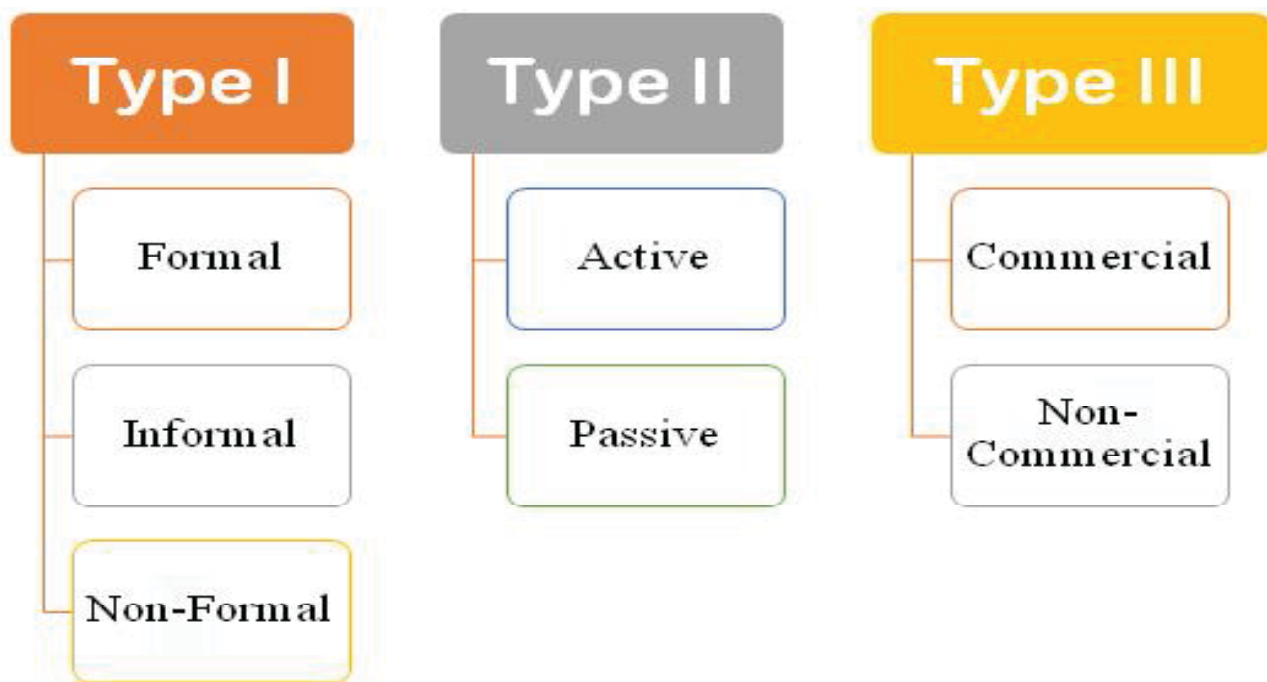
12.3 PHASES OF DISASTER MANAGEMENT

Generally, from the view of normal community, disaster management is an organization, which supports for the community only in relief operation and rehabilitation activities. But apart from the relief operation the main motto of the organization is to visualize the worst situation in prior and plan for the appropriate mitigation measures. As we have studied about disaster management cycle, we need to learn about phases of disaster also. The phases of disaster are the sequence in which disaster occurs laying its effects and this makes its management more needed. The phases of disaster are broadly classified into three types namely, pre-disaster phase, during disaster phase and post disaster phase.



The three key stages or phases of activities that are taken up within disaster risk management are:

1. **Pre-Disaster Phase:** This phase meant before the disastrous event for which the proactive action plan is taken for the reduction of potential impact to the human as well as damage to the environment. This action plan taken before the disaster ensures the losses and damages to the minimal level. This phase comprises of certain systems to be adapted for the reduction of risk in case of disaster they are as follows:
 - i) **Prevention:** The misleading concept engulfed to the community is with the term prevention, it doesn't mean that preventing the natural hazard or man-made disaster. This system of prevention is adapted in pre- disaster phase to reduce the intensity of impact and lessen the damage to the environment and human.
 - ii) **Mitigation:** The reduction of risk in any disaster includes the vital activities of reducing the risk to the acceptable level and reducing the scale of impact of disaster to the least level. The system mitigation is put forth for the elimination of root cause and the reduction of vulnerable condition to the minimal level. Further adding, the mitigation measures also aims to reduce the vulnerability level in terms of



12.5.1 Formal, Informal and Non- formal agencies:

1. **Formal Agencies:** Formal agencies are those institutions and organizations which are set up by the society deliberately with the exclusive aim imparting definite and ready-made tidbits of knowledge in a specified time under a structured environment. There are well-defined aims and objectives, specific curriculum, definite teachers and students, definite and fixed time and place in such agencies. In short, everything or every aspects of education are pre-planned or planned in advance. Such agencies include school, college, university, library, religious institution, the recreation club, the museum, picture and art galleries, zoo, etc. These can play a significant role in imparting disaster as well as disaster management education.
2. **Informal Agencies:** Informal agencies are those institutions which exercise a great educative influence upon the individuals indirectly and ceaselessly throughout their life. They are called indirect agencies influencing the behavior of the individuals. Education is provided to the individuals informally and unconsciously. These agencies lack all formalities, rules, systematization, pre-planning, premeditation or training. There are not particular places or location for imparting education. Individuals learn incidentally and naturally by their own initiatives and efforts. Among the agencies of informal education are family, community, state, social gathering, physical, social and economic threats. Therefore, mitigation involves of varied levels of proactive measures implemented with help the experts like medical professionals, engineers, relief force and other authorized persons. Hence the scale and severity of natural hazards are reduced with the adaptation of various engineering strategies known as Mitigation.

- iii) **Preparedness:** This system plays a vital role in this phase which involves the government, vulnerable communities and each and every individual responsibility to enact accordingly to manage the disastrous situations efficiently. This phase of system implements the suitable emergency plans, effective communication to the responders and sensitize the public with mock drill. The system also enhances the layout of rescue operations and evacuations plans from the vulnerable areas to the safest heaven. This system can be success only if there is proper planning, coordination and apportionment of responsibilities with sufficient financial support from the government.
- iv) **Early Warning:** This system encrypts the process of monitoring closely the existing situation and effectively communicates to the community approaching to the vulnerable area. The early warning system shall be activated in different perspective by various departments. The Indian Meteorological Department is one of most sensitive department who provides early warning to the community abruptly in accordance to the weather pattern.

Disaster Effect: This states an instantaneous event of natural hazard taking place and affecting the vulnerable elements. The duration of disastrous event directly depends on the type of hazard occurred at the existing level.

- 2. **During a Disaster (Disaster Occurrence):** Initiatives taken to ensure that the needs and provisions of victims are met and suffering is minimized. Activities taken under this stage are called emergency response activities. This is a critical phase to ensure the victim to be responded immediately with a relief force and also provide the victim with the basic needs to minimize the level of pain.
 - i) **Response:** This system aims to provide an instantaneous response to protect the life of the victim, enhance the affected population with the support in terms of both mentally and physically. This response system is the aid provided to the victim in limited manner which might be mandate for their survival. The limited aids provided by the response team are first aid to the victim, emergency shelter for the affected community, food and drinking water facilities and transportation of vulnerable refugees to the safe heaven. To the greater extent this also have the capability to provide the temporary repairs to infrastructure damaged in any disasters.
- 3. **After a Disaster (Post-Disaster):** Initiatives taken in response to a disaster with a purpose to achieve early recovery and rehabilitation of affected communities, immediately after a disaster strikes. These are called as response and recovery activities. This is a reactive phase where the system starts to work only aftermath of any disasters. After the phase of response, the hasty recovery is mandate for the affected community. The relief personnel should ensure that all the affected

victims are rescued and provided them with all basic needs. After the calm of disaster, this system must provide the affected community with reconstruction of their houses and rehabilitation support for the affected victim.

- i) **Recovery:** This phase implements the activities to recover the affected victim from the place where the incident occurred. The recovery of fatalities also needed for the operation team to be executed after the disaster. This system aims to ensure that the affected population should restore their lives in all aspects. This activity continues until the systems returns back to the normal.
- ii) **Rehabilitation:** This system includes assisting the affected victim with basic essential needs, temporary public services and also temporary shelter. This system should also be capable of providing short term measure to assist them for the recovery in long term.
- iii) **Reconstruction:** This phase challenges to bring back the community as more resilient by repairing the damaged buildings, reconstruction of retrofitting structures, and other emergency facilities. This system enables the long term development of community in more sustainable manner, so that if the disaster strikes again the loss shall be acceptable and minimal.

India, as the developing country has taken serious steps to mitigate the impact of disaster to minimal level. They have developed their skills to react proactively than after the reaction. Long term mitigation measures are engulfed by adopting various technologies to cope up with various unpredicted disasters. The Government of India with the support of individual state government implemented the appropriate disaster risk reduction procedures for the achievement of zero loss during any phases of disaster.

12.4 DISASTER MANAGEMENT AND EDUCATION

Education is important and represents a priority, because if human beings don't become aware of disaster risks, acquire the necessary knowledge and develop the appropriate behavior, attitudes and level of involvement, they will not be able to prevent them. It is important for education to facilitate and contribute to the creation of a culture of prevention and for the population and communities to take action to prepare for a disaster. Education for disaster preparedness can provide life-saving and life-sustaining information and skills that protect in particular children and young people during and after emergencies.

So, it becomes very important to teach students about disaster management and avoid risk of any losses. In fact students should be trained well in disaster management tasks and should be asked to train their family as well as society too. Learning about variety of disasters their causes and hence prevention is very important for everyone Once disaster

has occurred everyone should be aware of its controlling measures. Instead of being getting panic and enhancing the problem, it is important to understand how to manage in such situation, help themselves and help others too.

Government of India, Ministry of Human Resource Development in its tenth five year plan emphasized the need for integrating disaster management in the existing education system in India. For this purpose, disaster management in the curriculum of school & professional education has been recommended to the boards. Central Board of Secondary Education has integrated a short course on disaster management in the school curriculum. They introduced the subject on disaster management as a frontline curriculum in social science. The curriculum contains nature & type of hazards, natural & manmade disasters, role of community & schools in disaster management, efforts made for disaster preparedness & mitigation, survival skills, main emphasis of the subject, awareness & sensitization of students & teachers on various hazards, preventive & precautionary measures.

Check Your Progress-1

Note: (a) Answer the questions given below

(b) Compare your answers with those given at the end of this lesson.

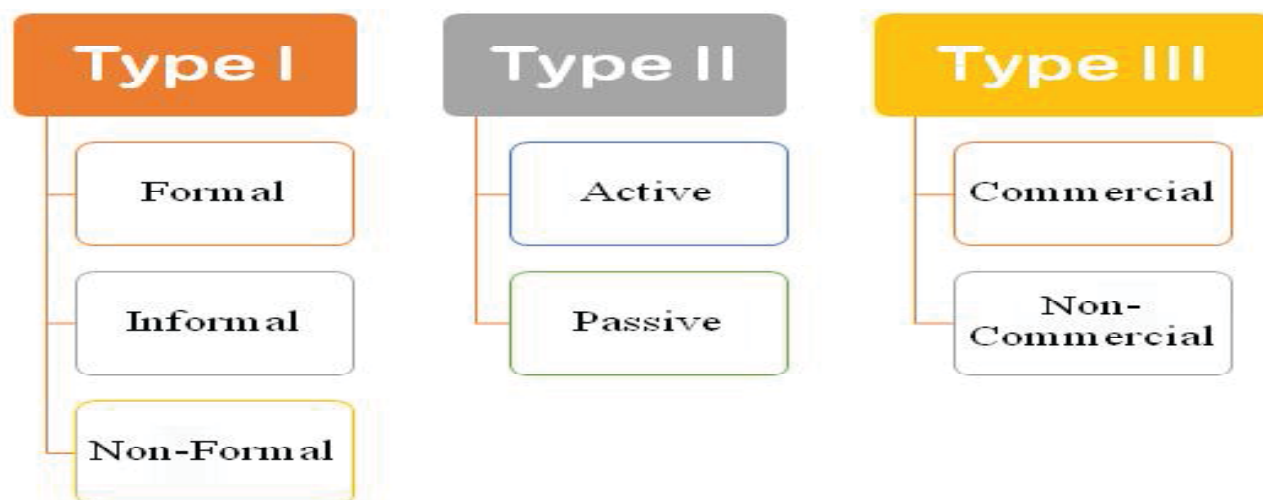
1. The three key stages of activities that are taken up within disaster risk management are _____, _____ and _____.
2. Initiatives taken in response to a disaster with a purpose to a disaster with a purpose to achieve early recover and rehabilitation are called as _____.
3. Ministry of Human Resource Development in its _____ plan emphasized the need for integrating disaster management in the existing education system in

12.5 AGENCIES OF EDUCATION FOR DISASTER MANAGEMENT

For the continuity and development of its life, society counts upon education. Education not only shapes the behavior of the individuals but also helps in transformation of rich cultural heritage to the rising generation. Therefore, society establishes and develops institutions for achieving the modification of behavior and passing on cultural heritage to the successive generation, more precisely, through which the child directly or indirectly

receives learning-formal and informal to carry out functions of education. These institutions are called "sources" or "agencies of education." These agencies work for all types of education, either it be disaster education or value education or any type of education. In the present context, the following agencies are described in terms of disaster management education.

Classification of Agencies of Education



12.5.1 Formal, Informal and Non- formal agencies:

1. **Formal Agencies:** Formal agencies are those institutions and organizations which are set up by the society deliberately with the exclusive aim imparting definite and ready-made tidbits of knowledge in a specified time under a structured environment. There are well-defined aims and objectives, specific curriculum, definite teachers and students, definite and fixed time and place in such agencies. In short, everything or every aspects of education are pre-planned or planned in advance. Such agencies include school, college, university, library, religious institution, the recreation club, the museum, picture and art galleries, zoo, etc. These can play a significant role in imparting disaster as well as disaster management education.
2. **Informal Agencies:** Informal agencies are those institutions which exercise a great educative influence upon the individuals indirectly and ceaselessly throughout their life. They are called indirect agencies influencing the behavior of the individuals. Education is provided to the individuals informally and unconsciously. These agencies lack all formalities, rules, systematization, pre-planning, premeditation or training. There are not particular places or location for imparting education. Individuals learn incidentally and naturally by their own initiatives and efforts. Among the agencies of informal education are family, community, state, social gathering,

play-ground, associations, religious ceremonies, crowds, market places, cinema house, news-paper, fairs, exhibitions, radio, television, public meeting, field trip etc.

3. **Non- Formal Agencies:** Non formal agencies are in- between the formal and informal types of education. It is midway because it is partly formal and partly informal; it is both intentional and incidental. Simply, any organized educational activity outside the established formal system - whether operating separately or as an important feature of some broader activity - that is intended to serve identifiable learning clienteles and learning objectives. For example, open school, open universities, correspondence courses, distance learning centers fall under non formal agencies of education.

12.5.2 Active and Passive Agencies:

1. **Active Agencies:** Those agencies which provide for education through the interaction of the persons are called active agencies of education. The interaction is a two-way process. Both the educator and the educand or the individual and the group influence and react to each other. The agency is called active because both the agency and the individual actively participate and share in the educative process. Examples of such agencies are the family, the school, the church, the youth activity groups, associations, social welfare agencies, sports club, museum, art galleries, entertainment programmes, etc.
2. **Passive agencies** are those agencies which potentially influence the individual but are not influenced at all by the individual. The interaction is one-way traffic. Such agencies are called passive, for the individual plays passive role as he is not able to influence the agencies. Examples of such agencies are library, press, cinema, newspaper, radio, television, theatre, magazine, etc.

12.5.3 Commercial and Non-Commercial Agencies:

1. **Commercial Agencies:** Commercial agencies are those agencies which give various kinds of knowledge, discoveries, inventions and achievements of human race. Through these agencies, the child develops social attitudes and receives all kinds of social interaction and experiences. These agencies have commercial objectives and include cinema, press, radio, television, theatre, clubs, newspapers, magazines, periodicals etc.

2. **Non-Commercial Agencies:** Non-commercial agencies are those agencies which come into being for social good. Social well-being is their concern, not the profit making. The examples are sports club, educational tours, debates, scouting, youth forums, welfare programmes, adult education centers, red-cross units etc. These are meant for social good and character formation of children.

Check Your Progress-2

Note: (a) Answer the questions given below

(b) Compare your answers with those given at the end of this lesson.

1. A Child directly or indirectly receives formal and informal learning regarding disaster management through sources called

12.6 NEED TO LEARN ABOUT DISASTER MANAGEMENT

India as a nation is prone to various hazards due to its unique geo-climatic conditions. Flood, drought, cyclone, earthquake and landslide have been frequent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. Experience and knowledge of the past shows that when attention has been given to adequate preparedness measures, the loss of life and property has considerably reduced. Therefore, wisdom dictates that the warning to prepare should come at a time and season conducive to preparation. And when it comes to disaster risk reduction activities one of the best available options is that of incorporating disaster management education in educational institutes - be it in formal schooling curriculum or in non-formal education. So, India as a nation is strongly adhering to incorporate the culture of timely preparedness and mitigation activities in its endeavor by giving strong emphasis on its institutional and policy framework for Disaster Risk Reduction.

According to India United Nations Centre for Regional Development (2008) project, in India there are different types of school system - the Central Board of Secondary Education, State Education Boards, the Council for Indian School Certificate Examinations (CISCE), National Open School and International Schools. According to the latest government

survey there are 1,124,033 schools in India in which about one-third of the population study. With nearly 85% of the land area prone to disaster it is high time the 34% of the country's future generation has been prepared to combat future disasters. GOI, Ministry of Human Resource Development has recommended the different school boards to incorporate Disaster Management in the school curriculum. Apart from Schools, there is huge scope for Disaster education in our colleges and universities. With the advancement in the field of information and technology, there is also great potential of online and Distance Learning education in our country.

Every country is at the risk of exposure to some type of disaster, whether natural or man-made. In order for each country to prepare for any kind of disaster, it must inform its citizens about the different types of disasters. The local residents must also be aware of how they can effectively participate in preparing for a disaster, mitigating potential impacts of a disaster and the recovery process after a disaster. One of the most effective mechanisms for a country to prepare for a disaster is by conducting education and public awareness programmes at the local community level. Public awareness in disaster management is a process of educating and empowering the population through sharing knowledge and information about the various types of disasters and their potential risks as widely as possible so that people act appropriately when a disaster happens.

Check Your Progress-3

Note: (a) Answer the questions given below

(b) Compare your answers with those given at the end of this lesson.

1. One of the most effective mechanisms for a country to prepare for a disaster is by _____
2. About _____ of the land is prone to earthquake in India.
3. _____ helps in developing critical decision making skill among society members.

12.7 POSSIBLE OUTCOMES OF DISASTER MANAGEMENT EDUCATION

Education is a fundamental human right and it is essential to ensure that all are able to realize their potential. A key aim of education is to give all citizens the necessary skills and values to improve their quality of life. To achieve this aim, we need to improve access to education and to increase the quality of educational facilities in an equitable manner. The physical environment in which learning takes place has a large impact on the outcomes of education. It is important to create safe learning environments for our nation's children. Events of children deaths due to building collapse, fire accidents and stampedes bring to light the need to be continually vigilant to ensure for the safety of students and staff in schools. Kumbhakonam fire tragedy like incidents reiterate the need to have school level emergency preparedness and response plans, and schedule time in the busy school day to practice drills to respond effectively and efficiently to disaster situations. Educational Institutions can contribute towards the generation of knowledge in the area of disasters, develop expertise in specific types of disaster and impart training in different fields. Disaster awareness education in educational institutions has the following advantages:

- It provides contemporary and relevant information about local environments.
- It prepares for participation in both pre and post disaster activities of the affected/ vulnerable community on a wider scale.
- It contributes past experience with recent developments in technology to combat disaster.
- It helps to develop effective domain abilities for collective work as successful disaster management efforts involve effective teamwork and spirit.
- It promotes informed decision-making in the event of a disaster.

Building a culture of safety and resilience to disasters through schools

Practical recommendations to integrate teaching on local risk and hazards into the curriculum are like set targets on teaching on disaster risk, defining ages to be taught, time dedicated, etc. and ensure targets are transparent and monitored by citizens. Incorporate teaching on local hazards into existing subjects such as earth science or geography. Community vulnerability assessment tools can be used to develop teaching methods. Provide adequate

teacher training. Involve teachers unions to ensure widespread understanding and commitment from teachers.

Recommendations to increase the physical safety and resilience of school buildings

Ensure all new school buildings adhere to building codes that incorporate disaster resilience (design, location, construction materials and methods, inspection, monitoring and maintenance). Conduct a safety review of existing school infrastructure in the context of local hazards. On the back of a safety review, set time bound, transparent targets for the repair, refitting and rebuilding of schools. Develop a legal and institutional framework for systematically implementing, monitoring and evaluating school protection, involving stakeholders from all levels.

Integrating disaster risk reduction into school curriculum

Lessons learnt at school are often transmitted to the home. The method of integrating disaster risk reduction into the school curriculum differs from country to country. Sometimes this is integrated as an independent subject. Often, the concepts of disaster risk reduction are taught by combining with portions and specific chapters of other subjects such as environmental studies, geography, science, etc. Basic approaches to integrate disaster management as a part of school curriculum are:

- Plan in advance of the National Curriculum Development Cycle.
- Establish Partnerships between the Ministry of Education and the National Disaster Management Office.
- Adopt a consultative process.
- Link with processes of the education sector programmes funded by the multilateral and bilateral agencies and the Education sector Working Group led by the Ministry of Education.

School Emergency Evacuation Plan (SEEP)

School is a typical vulnerable environment where the concentration of safety exists to the higher level than any other public facilities. This is because of the young communities present in the vicinity who will not be able to tackle the devastating situations due to inadequate training and awareness. The Government of India (GoI) with collaboration of UNDP proactively introduced an initiative of school disaster risk management programme

for the mitigation and preparedness of any disastrous events. The target of implementation of school safety programme is an enduring process that incorporates preparedness and mitigation measures to the children, teachers and other stake holders. According to the context of National Institute of Disaster Management (NIDM), there shall be a school safety advisory committee which includes board members, teaching staffs, non- teaching staffs, parents, students, media, and legal authorities and residents from local. These committees can develop and implement the appropriate response plan for any disasters. Hence each and every school shall have a school level emergency evacuation and response plan to cope up with any disastrous events. The district wide emergency evacuation plan for all schools draws the framework for schools to implement adequate methodologies for an appropriate response plan. This plan shall provide the general guidance for each school buildings along the study area to develop a school level emergency preparedness and response plan. The significant key to success in an emergency evacuation and response plan is the ability of the school authorities with the positive collaboration of external agencies, and other emergency services, which is mandatory for the school to promote safer environment. Emergency evacuation in the school premises involves enthusiastic skills and knowledge, more specifically in handling the physically challenged people to the safer heaven. The purpose of emergency evacuation plan in the school is to safeguard the vulnerable people and to provide reliability support. The main key functional team listed below can be militarized during any disaster phases, which have a collective approach to act proactively.

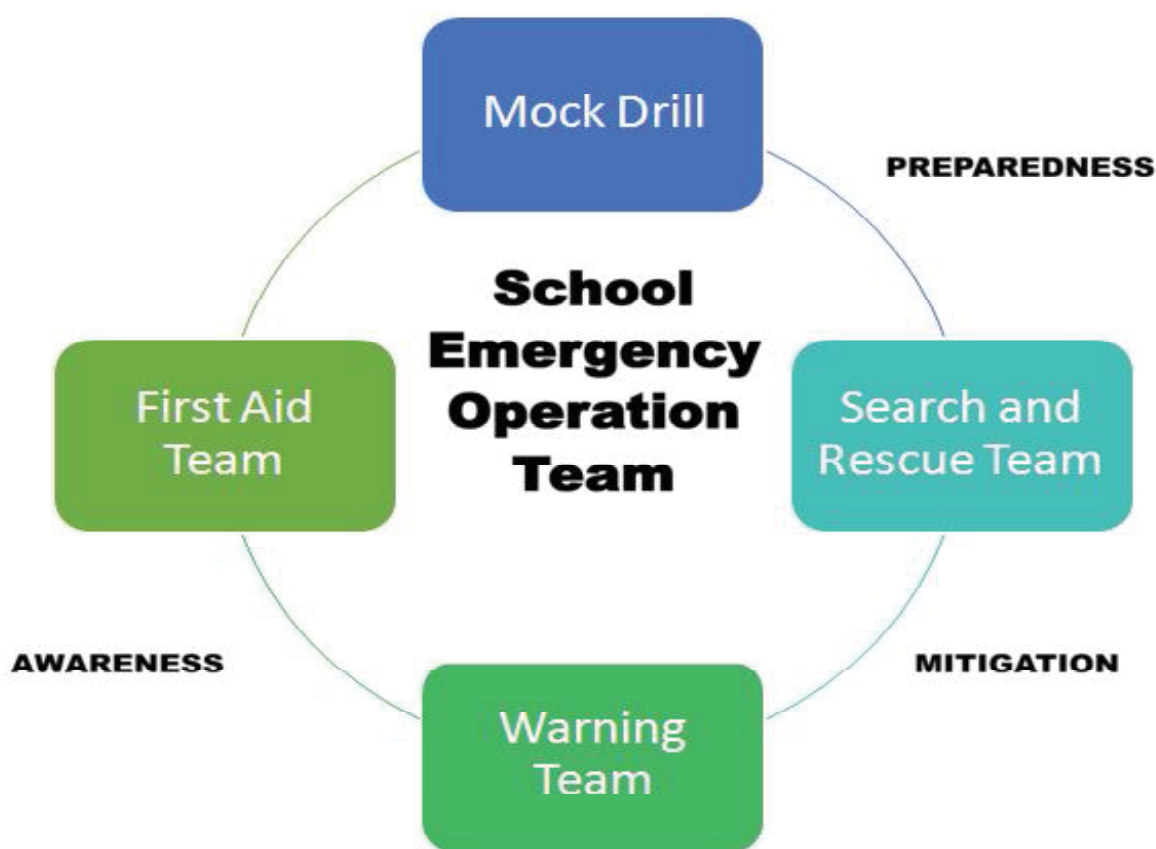
i) Incident Command Team: They are the responsible team who has an authority to take decision at any worse situations. They shall be headed by an appointed person by a school management usually NCC officers or NSS officers may act as incident commander in all schools. During any emergency situation, the emergency commander is the primary responsible and capable person who shall have authority to take decisions irrespective to the top management with the coordination of District Magistrate.

ii) Communication Team: They are the direct supporters to incident commanders, who will communicate the information rapidly to all the responders as well as to the vulnerable communities to be affected. They shall have connections with all emergency services such as health services, fire services, police services, district emergency operation centre, and other relevant officials who can react instantly in particular to disastrous events.

In school premises the communication shall be executed with help of available audio system or through the megaphone.

iii) Response Team: They are the real protagonist, who carries out the emergency response plan to all the vulnerable communities. They shall be well organized and enthusiastic, who manages the devastating disastrous situation. This team has to fulfill the rescue operation in addition, to that they will also provide appropriate first aid and psychosocial support to the victim. In the school premises, normally the volunteers from different stream such NCC and NSS shall act as efficient responder to handle any unplanned events.

iv) External Members: They are the supporters who provide the rehabilitation support to the rescued community by providing shelter, and other essential services such as drinking water and food. They can be non- governmental organizations, who can take special care in providing the necessary services to the community affected by disaster.



Benefits of early childhood disaster education

- Earlier onset disaster prevention education makes it easy for children to think about disaster issues, resilience, and risk reduction officials from an early age.

- Children tend to define what they have learned from their parents. As a result, education for children can gradually increase the level of awareness of the community.
- Individuals familiar with the concepts of hazards and disasters in their childhood can respond better and faster when disasters and accidents occur.
- People do not simply forget what they learn at an early age.
- In many countries, a high proportion of people in the community are children.

Advantages of disaster awareness education (DME):

- DME provides contemporary & relevant information about local environment to the students as well as teachers.
- It helps in encouraging participation in both pre & post disaster activities and during disaster as well.
- It makes us know and understand about technology to combat disaster.
- It encourages effective teamwork & spirit during the hour of need.
- It helps in developing critical decision making skill among society members.

Check Your Progress-4

Note: (a) Answer the questions given below

(b) Compare your answers with those given at the end of this lesson.

1. Which team has to fulfil the rescue operation alongwith providing appropriate first aid and psychosocial support to the victim?
2. According to _____ there shall be a school safety advisory committee which includes board members, teaching staffs, non-teaching staffs, parents, students, media and legal authorities and residents from local.
3. Incident Command Team should be headed by _____
4. _____ shall provide the general guidance for each school buildings along the study area to develop a school level emergency preparedness and response plan.

12.8 LET US SUM UP

The major role that education can in natural disaster management is in the form of teaching children about risk reduction and management material. Children often spread learning to their families and communities, so is the saying that educating a child means educating a family. Educated students in disaster management will surely help the victims with basic needs whatsoever possible for them. This will reduce panic rate and uncontrolled disaster effects as well. Proper knowledge about first aid will again be very helpful in saving millions of lives. However, extending disaster preparedness education to communities is more important than just school learning. So, community training programmes should also be encouraged.

12.9 LESSONS END EXERCISE

1. Justify the need of education in disaster management at school level for students.
2. Elaborate the need of disaster management education in Indian context.
3. In your view, what are the advantages and limitations of disaster management education in India?
4. What are the various phases of disaster management?

12.10 SUGGESTED FURTHER READINGS

Bhandari, R.K. (2013). Disaster Education and Management: A Joyride for Students, Teachers and Disaster Managers. New Delhi: Springer India.

Khan, M. (2015). Disaster Education and Management. USA: Scitus Academics LLC.

Shaw, R., Shiwaku, K., & Takeuchi, Y. (2011). Disaster Education. UK: Emerald Group Publishing Limited.

Vidyanathan, S. (2013). An Introduction to Disaster Management. New Delhi: Ikon Books.

12.11 ANSWERS TO CHECK YOUR PROGRESS

Check your Progress-1

1. pre-disaster, during- disaster and post-disaster; 2. Response and rehabilitation activities; 3. tenth five year.

Check Your Progress-2

1. Agencies of education; 2. Formal, Informal and Non-Formal; Active and Passive; Commercial and Non-Commercial; 3. Newspaper; 4. Non-formal

Check Your Progress-3

1. Conducting public awareness programmes; 2. 60%; 3. Disaster Management Education.

Check Your Progress-4

- Response team; 2. National Institute of Disaster Management; 3. NCC or NSS officer; 4.

STUDENTS AND FALLOUT OF DISASTER ON THEIR EDUCATION

Structure

- 13.1 Introduction
- 13.2 Objectives
- 13.3 Status of Disaster Management Education in India
- 13.4 Rebuilding Educational Program for Disaster Management
- 13.5 Role of School Management in Overcoming Disasters in School
- 13.6 Role of Students in Disaster Management
- 13.7 Role of Teachers in Disaster Management
- 13.8 Role of Community in Disaster Management
- 13.9 Let Us Sum Up
- 13.10 Lesson End Exercise
- 13.11 Suggested Further Readings
- 13.12 Answers to Check Your Progress

13.1 INTRODUCTION

There are various agencies of education namely home, school and community. Individual learns from his home and family first. Then he goes to school and learn from his teachers. Finally, he lives in community, learns there and serves there. Learning and serving in society makes a person responsible. Thus, education plays a great role in shaping personality as well as community. Responsibility is best seen in times of crisis. Disaster management

education therefore, is very important for every individual. There are various organizations that give opportunities of research and learning in our country. Disaster management education can be given formally, non-formally and informally. Let's know how this is possible in the following section.

13.2 OBJECTIVES

After going through lesson, you shall be able to:

- assess the status of disaster management education in India,
- elaborate the role of universities in disaster management,
- explain the role of schools in disaster management,
- explain the role of teachers in disaster management, and
- explain the role of students in disaster management

13.3 STATUS OF DISASTER MANAGEMENT EDUCATION IN INDIA

Education in India can be given formally, non-formally and informally. Most common modes are formal education system and non - formal education system or open learning or distance mode of learning.

Status of Formal Education in India: Formal education refers to the disciplined education system which is time bound and included one to one interaction between teacher and students.

1. **Central Board of Secondary Education:** As already discussed briefly in previous chapter, according to India UNCRD (2008) project, in a first attempt by an educational institution in the country the Central Board of Secondary Education (CBSE) has integrated a short course on Disaster Management in the school curriculum. Around 7300 schools in the country follow CBSE curriculum and almost 900,000 children are enrolled with it. Apart from India the board has its schools in the gulf and some neighboring countries such as Nepal, Bangladesh and in the far east African countries. A brief outline of the course content is:
 - Class VIII focuses on preparedness measures to be taken by students and teachers for various disasters.

- Class IX focuses on mitigation measures.
 - Class X focuses on the role of government and other agencies in disaster management, role of science and technology in disaster management and initiating the concept of volunteerism among the children.
 - Class XI (Sociology) focuses on gender and child rights in disaster management, role of community in disaster management.
 - Class XI (Geography) focuses on the concept of various hazards.
2. State Education Boards: As recommended by the Government of India, Ministry of Home Affairs, various State Governments are in the process of introducing disaster management in the school education. The status of disaster education in various states under the State Education Boards as compiled by the Ministry of Home Affairs is given below:
- Tamil Nadu State: Course curriculum has been drafted and implemented.
 - Orissa State: "bipatibiparjayaosurakhya" or "Disaster Risk Safety" was launched by Orissa State Disaster Mitigation Authority (OSDMA) for students. The Orissa Board of Secondary Education has included a chapter on Disaster Management in the class VIII geography syllabus.
 - Maharashtra State: Education Ministry has initiated the process of incorporating Disaster Management in school curriculum.
 - Bihar State: Disaster Management has been carried forward through SarvaShikshaAbhiyan. The Government of Bihar has incorporated Disaster Management in course curriculum from class V onwards in Social Science and the text book is being developed.
 - Gujarat State: Text books on disaster management for classes VII, VIII and IX have been drafted.
 - West Bengal State: The Kolkata Municipal Corporation is in the process to introduce disaster management course in the schools run by the civic body.
- " Jharkhand State: The state government of Jharkhand had included a text book on disaster management in the class IX syllabus as part of the social sciences subject.

Status of Non-Formal Education in India: Non formal education refers to a

system where there is flexibility in teaching learning process. There is no one to one teaching classes, students are provided with the study material which they can learn on their own pace and according to availability of time.

According to IndiaUnited Nation Centre for Regional Development (2008) project, in India disaster management training has been included in the defense training of student cadets under various schemes such as NCC (National Cadet Corps), NSS (National Service Scheme), Scouts and Guides, National Yuva Kendras (NYKs), Civil Defense, Sainik Board etc. the initiatives taken by some of the states are as follows:-

- Tamil Nadu State: Project Officers of National Service Scheme were identified as Master Trainers from Cuddalore District and were sensitized on Disaster Management. The Master Trainers in-turn planned sensitization training program for all the NSS Program officers in the district and then in turn organized the sensitization program for the NSS volunteers in their respective schools in Cuddalore District. A Group of NSS, NCC, Scout & Guides Project Officers from vulnerable districts in Tamil Nadu were trained at Anna Institute of Management Chennai about Disaster Management during the month of February 2006.
- Gujarat State: Gujarat State Disaster Management Authority (GSDMA) has successfully completed a two year project, Gujarat School Safety Initiative-I (GSSI-I) to promote culture of disaster safety in selected 150 schools in association with SEEDS in the districts of Ahmedabad, Vadodara and Jamnagar. Training of 500 NCC Girl cadets on first aid, search and rescue, and Ham radio was organized in Jasani hospital, Ahmedabad.
- Maharashtra State: An essay competition was organized in Dhule district of Maharashtra to create awareness among students. Nearly 180 students participated in the competition.
- Uttaranchal State: NSS volunteers in secondary and senior secondary school levels are being trained on first aid, search and rescue and preparing contingency plan.
- Assam State: In Nagaon district, 1800 NCC cadets were sensitized on DRM activities in association with the Commandant of 8th Assam Battalion.

- Kerala State: Nearly 170 volunteers - 120 from National Service Scheme and 50 from Nehru Yuvak Kendra Sangham (NYKS) were sensitized in two separate programs in Kozhikode on Disaster Management, including first aid and search and rescue concepts, vulnerability profile of the country, the national initiative and the need for the preparedness.
- Tripura State: Training of 250 NSS officers and volunteers in the city of Agartala has been initiated.
- Himachal Pradesh State: Under the SESIS (School Earthquake Safety Initiative Shimla) programme, students from 20 schools were given awareness on earthquake risk and were trained in first aid, fire safety, search and rescue etc., under a project implemented by SEEDS with the support of European Commission & Christian Aid

Role of Open Learning and Distance Education in Disaster Management

Open Distance Learning system is gaining currency to cater to variety of needs of different segments of the society. It has been recognized as one of the most effective tools of reaching to a large number of clientele. It does not bind learners with the constraints of time and place. ODL system is required to be extensively used for paving the way for educating the clientele and imparting required knowledge and skills to them.

Disaster management education through ODL system shall aim at:

- Wider dissemination of need based knowledge;
- Financial viability;
- Flexible mode of learning;
- Optimum utilization of Information and Communication Technologies;
- Vast reach and accessibility;
- Capacity building in new and multi-disciplinary areas like disaster management;
- Use of multi-media approach; etc.

Though at present, besides Indira Gandhi National Open University, the distance education programmes are offered by 14 State Open Universities and 230 Departments of Distance Education in different universities in India, yet the number of universities offering education programmes in the area of disaster management in India is far too less than required.

13.4 REBUILDING EDUCATIONAL PROGRAM FOR DISASTER MANAGEMENT

As mentioned earlier our education system supports learning of disaster management as a part of curriculum. Non formal or distance learning also offers programmes for understanding disaster management. But mere theoretical learning and understanding of a subject may not be sufficient enough to train students in controlling the risk. Integrated Disaster Management Programme (IDMP) should be made mandatory for all under graduate and post graduate students with following objectives:

- Ensuring awareness on the nature and type of disasters.
- Management of the three phases of as disaster.
- Designing a disaster management plan.
- Training in rescue operations.
- Practicing evacuation drills.
- Understanding accident prevention and safety measures practically.
- Mandatory learning of environmental laws/ rules and audits.
- Understanding occupational health and occupational diseases.
- Do's and dont's during fire including fire-fighting tutorial and demonstration.
- Practically handling medical emergencies.
- Hands on training cardio-pulmonary-resuscitation.
- Identification of well-trained students and issuing them related identity cards and appreciation reward.

In order to make disaster management education compulsory and interesting among students, it is mandatory to remove the preconceived notion of the course as an additional learning burden. In spite of the constraints, the faculty and students

should realize that such programmes are an essential tool for building self-confidence, knowledge, aptitude, and survival skills, which will make our students leaders of men, be held in high esteem and become an asset to the community.

Disaster Management Education offers employment opportunities also. As the availability of qualified teachers to conduct the interactive sessions is a matter of prime concern. It is important to understand that trained manpower is necessary to deal with the situation before, during and after the disaster, helping in quick rehabilitation of the disaster affected people, understanding their psychological conditions and helping in their post disaster settlement. In the planning and policy making, trained and experienced personnel are highly required to give better suggestions.

So, teaching disaster management to students helps in earning as a teacher or trainer. Moreover, since the field is new, research is needed to be done. Becoming a researcher in the field also helps in earning. There are number of universities and institutes conducting research programmes/facilitating in disaster management in the country like Centre of Excellence of Disaster Management in Indian Institute of Technology, Roorkee; Department of Earthquake Engineering in Indian Institute of Technology, Roorkee; Centre of Earthquake Engineering in Indian Institute of Technology, Kanpur etc. After completing the research, there is good scope of employment in universities, institutes, NGOs, policy and planning organizations within country and abroad. There are good employment opportunities in disaster management in government as well as in private organizations. The work profile varies like teaching, research, consultancy, documentation, training organizer, field training and mock driller expert. Some organizations having likely employment opportunities are National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Govt. of India, New Delhi, SAARC Disaster Management Centre, NIDM Building, New Delhi, National Disaster Management Authority, Near Indira Gandhi International Airport, New Delhi. Indian Institute of Public Administration (IIPA), Indraprastha Estate, Ring Road, New Delhi, India Meteorological Department, Lodhi Road, New Delhi, Centre of Disaster Management, HCMRIPA, JLN Marg, Jaipur, Haryana Institute of Public Administration (HIPA), Gurgaon, Ambedkar Institute of Public Administration,

Chandigarh, Shri Krishna Institute of Public Administration, Ranchi, G.B.Pant Institute of Himalayan Environment and Development, Nainital, Uttarakhand, Disaster Management Centre, Bhopal. Disaster Mitigation Institute, Ahmedabad, Centre for Disaster Management, Guru Govind Singh Indraprastha University, KashmeriGate, Delhi, Indian and international level Non-Governmental Organizations (NGO) working in the field of Disasters Management, State Remote Sensing Applications Centers, International organizations having research and job opportunities and many more.

From the employment generation point of view too disaster management education is having alot to offer. Also it is quite obvious that there are good amount of opportunities available for the trained manpower as a number of national as well as international organizations are offering jobs in various arena of disaster management.

Check Your Progress -1

Note: (a) Answer the questions given below.

(b) Compare your answers with those given at the end of this lesson.

1. The first attempt to start formal Disaster Management teaching in the school curriculum was done by _____.
2. As per _____, disaster management training has been included in the defense training of NCC students in India.
3. _____ State Open Universities and _____ Departments of Distance Education in different universities offer disaster management education in India.
4. IDMP stands for _____.

13.5 ROLE OF SCHOOL MANAGEMENT IN OVERCOMING DISASTERS IN SCHOOL

School Management refers to a group of individuals who manage the overall functioning of

the school. They comprise of members who show excellence in planning, implementation and monitoring the developmental programs for school. They hold the complete control over school functioning. Being at the top of hierarchy of school functioning, they too can play significant role in disaster management.

- Preparedness and Mitigation is bound to yield more effective returns than distributing relief after a disaster.
- Create a culture of Preparedness and Prevention related to disaster.
- Evolve a code of conduct for all stake-holders.
- Plan for the safety measures in their school.
- Keep in touch with various local agencies in order to cope up with disaster management activities in the school.
- Train both their staffs & personnel in disaster management.
- Evaluate & improve plans with time for effective control in loss due to disaster and hence disaster management process.
- Circulate disaster plans in each classroom for students' orientation and interest.

13.6 ROLE OF STUDENTS IN DISASTER MANAGEMENT

Students can play a vital role in disaster management and risk control process as:

- Doing plantation in the school premises.
- Making their parents and community aware on various types of hazards and the preparedness measures to be taken.
- Getting knowledge on first aid, rescue and evacuation.
- Boosting the morale of the community after the disaster.
- Senior students can help villagers in preparing the Village Disaster Preparedness and Response Plan.
- The students can be volunteers in the first-aid team, rescue and evacuation team, early warning team in their village/city.
- They all can help in the preparation of the school disaster contingency plan.

13.7 ROLE OF TEACHERS IN DISASTER MANAGEMENT

Teachers are nation builders. They can change the destiny of any society. They are capable enough in shaping future of the school through their students. They hold power to change the world gradually. So, they can-not remain hidden in the process of disaster management and risk control. They can contribute to the process in a following ways:

- Plan ahead: Teacher should know school district's disaster management policy; school's various disaster protection systems; school floor plan; the escape plan, so as to act actively during any disaster and manage things properly.
- Discuss procedures with students: Teacher should discuss plans and procedures with students like how to stay orderly; how to check/test doors before opening; crawling low under smoky environment; knowing where to go; helping ownself first and then must helping others.
- Practice: Teacher can organize monthly school disaster (variety) drills and encourage parents and community for home drills related to disaster safety.

13.8 ROLE OF COMMUNITY IN DISASTER MANAGEMENT

Community is a home of school and society. No education is successful if it does not reach the community. In turn, community has a great role to play in successful happening of any event. Society can do a lot before, during or after the disaster. Some of the points can be shown as:

- In an area prone to natural or human disasters, publishing special newspaper section with emergency information on possible problems.
- Localizing the information by including the phone numbers of local emergency services offices, the Red Cross and hospitals.
- Working with local emergency to prepare special reports for people with mobility impairments on what to do if evacuation is ordered.
- Supporting local government in efforts to develop and enforcing land-use and building ordinances that regulate construction in susceptible areas

- Buildings should be located away from steep slopes, streams and rivers, intermittent-stream channels, the mouths of mountain channels and industries.

13.9 LET US SUM UP

Prevention is better than cure, is a novel saying which is extremely useful and applicable in the context of disaster management. It is evident from the facts that mitigation and investment in disaster preparedness can save thousands of lives, vital economic assets, livelihoods and reduce the cost of overall disaster relief. It is at this juncture that the role of education and schools in disaster risk reduction becomes extremely important. The importance of education in promoting and enabling Disaster Risk Reduction (DRR) has already been identified by researchers and policy makers throughout the world. In doing so, there is a renewed focus on disaster risk education in primary and secondary schools. Mainstreaming DRR into school curricula aims to raise awareness and provide a better understanding of disaster management for children, teachers and communities. Now with many universities are offering courses in Disaster Management and also with the openings of employment opportunities in various institutions it is high time that more and more students are motivated to join these courses and in turn make their career in the fields which is highly challenging and socially extremely rewarding. From the point of view of Education there is still a lot of room for improvement in higher education and research related activities which ultimately lead to Disaster risk reductions.

13.10 LESSON END EXERCISE

1. Elaborate the role of universities in disaster management.
2. Explain the role of schools in disaster management.
3. Explain the role of teachers in disaster management.
4. Explain the role of students in disaster management.
5. Enlist the objectives of integrated disaster management programme.

13.11 SUGGESTED FURTHER READINGS

Kathiresan, P., Saravanavel, J., & Gunasekaran, S. (2015). Disaster Management. Mumbai: Allied Publishers Private Limited.

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Patil, P. (2012). Disaster Management in India. Indian Streams Research Journal, 2(1).

Sharma, R.K. (2013). Disaster Management Education at UG level in the Indian University System. Journal of Advanced Pharmaceutical Technology & Research, 4(2).

13.12 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress-1

1. CBSE; 2. India United Nations Centre for Regional Development (2008), 3. 14, 230; 4. Integrated Disaster Management Programme.
