T.Y.B.A.
GEOGRAPHY PAPER- VIII
GEOGRAPHY OF AGRIGULTURE AND DISASTER

Dr. Devanand Shinde
Vice Chancellor Incharge
University of Mumbai,
Mumbai

Dr. Dhaneswar Harichandan
Director Incharge,
Institure of Distance & Open Learning,
University of Mumbai, Mumbai

Anil R. Bankar
Associate Prof. of History & Asst. Director &
Incharge Study Material Section,
IDOL, University of Mumbai

Programme Co-ordinator : **Anil R. Bankar**
Asst. Prof. Cum Asst. Director,
IDOL, University of Mumbai.

Editor : **Dr. Maushmi Datta**
Associated Prof, Dept. of Geography,
N.K. College, Malad, Mumbai

Course Writer : **Dr. Shivram A. Thakur**
H.O.D. of Geography,
S.P.K. Mahavidyalaya, Sawantiwadi

: **Dr. R.B. Patil**
H.O.D. of Geography
Pondaghat Arts & Commerce College.
Kankavli

: **Dr. Hemant M. Pednekar**
Principal,
Arts, Science & Commerce College,
Onde, Vikramgad

: **Dr. Maushmi Datta**
Associated Prof, Dept. of Geography,
N.K. College, Malad, Mumbai

January, 2018, T.Y.B.A. GEOGRAPHY PAPER - VIII, GEOGRAPHY OF AGRICULTURE AND DISASTER

Published by : Director Incharge
Institute of Distance and Open Learning ,
University of Mumbai,
Vidyanagari, Mumbai - 400 098.

DTP Composed : Ashwini Arts
Gurukripa Chawl, M.C. Chagla Marg, Bamanwada,
Vile Parle (E), Mumbai - 400 099.

Printed by :

CONTENTS

I

GEOGRAPHY OF AGRICULTURE AND DISASTER MANAGEMENT

(Section – A) Agricultural Geography

Unit I

Introduction to Agricultural Geography

Definitions – Origin of agriculture and
Diffusion – Agriculture and human civilization.
Determinants of agriculture – Physical factors: Topography, climate and soils; Socio – Economic Factors: Size of landholding, labour supply and skill, capital and technology, transport, market and government policy.

Unit II

Major agricultural types in the world

Subsistence agriculture, Commercial agriculture & their sub types, Distribution of major crops in the World.

Unit III

Agriculture in India

Characteristics of Indian agriculture
Green Revolution in India, Problem associated with Indian agriculture, National Agricultural Policies.

Unit IV

Agricultural Trade

Role of WTO in agricultural trade practices - Impact of Liberalization, privatization and Globalization on agricultural market

Unit V

Economics of agricultural land use

Economic development of agricultural land use model of Lewis/Hoover's – Limitations of the model and its applicability in India.
Organic agriculture, Nutritional agriculture
Sustainable development of Agriculture

(Section – B) Geography of Disaster Management

Unit-VI

Introduction to Disaster Management

Definition of disaster, Difference between hazards, calamity and disaster Vulnerability, capacity, risk - Disaster management cycle - Disaster management in India - Financial arrangements in Disaster management - Role of NGOs, community based organizations, media and communication in disaster management – Role of geography and GIS in disaster management

Unit-VII

Natural Disaster: Floods and Droughts

Meaning and nature- Types of natural disasters in India – Effects of disasters – Efforts to mitigate disasters Floods and Droughts with reference to Nature, Geographical distribution, Causes and impact, Forecasting, warning & monitoring, Preparedness and Response, Mitigation -case studies.

Unit-VIII

Natural Disaster : Cyclone, Earthquakes, Landslides with reference to Nature, Geographical distribution, Causes and impact, Forecasting, warning & monitoring, Preparedness and Response, Mitigation - case studies.

Unit-IX

Man-made disaster : Forest Fire, Terrorism, Distinction from Natural disaster Causes of man-made disasters, Basic facts of manmade disaster, Need and scope for improving disaster management systems, Types of man-made disasters, response to man-made disasters, specific risk reduction and preparedness measures, Typical post-disaster needs, case studies Forest Fire, Terrorism with reference to Nature, Geographical distribution, Causes and impact , Response to man-made disasters, specific risk reduction and preparedness measures, typical post-disaster needs, case studies.

Unit-X

Man-made disaster Road, Rail Accidents, Air and Sea Accidents with reference to Nature Geographical distribution , Causes and impact , Response to man-made disasters, Specific risk reduction and preparedness measures, Typical post-disaster needs, case studies

1

INTRODUCTION TO AGRICULTURAL GEOGRAPHY

1.0 After going through this chapter you will be able to understand the following features:

1.0 OBJECTIVES

By the end of this unit you will be able to –

- Understand the definitions and origin of agriculture
- Learn diffusion of agriculture

- Know agriculture and human civilization
- Analyse determinants of agriculture such as different physical and socio-economic factors

1.1 INTRODUCTION

In this first unit of agriculture we are going to learn the definitions and origin of agriculture along with diffusion of agriculture. Agriculture and human civilization will also be learnt. Analysis of determinants of agriculture such as different physical and socio-economic factors will be studied in the latter part of this unit.

1.2 SUBJECT-DISCUSSION

Agriculture is derived from Latin words Ager and Cultura. Ager means land or field and Cultura means cultivation. Therefore the term agriculture means cultivation of land. It is the cultivation and breeding of animals which was primarily used to sustain human life. It was the key development in the rise of sedentary human civilization. Food occupies the first place on the hierarchical needs of man so we cannot neglect agriculture. If we do the same there will certainly invite some risk in the economic stability of a country. Land is a very important determinant of agricultural growth and productivity. Apart from land market, transport, capital, technology are other determinants.

1.3 DEFINITION OF AGRICULTURAL GEOGRAPHY

Geography is a discipline that draws its subject matter both from the physical and social sciences. Agriculture falls within geographic studies because of its structural and spatial characteristics. Its taxonomic character also plays an important role regarding this. Specialisation in agricultural geography is the result of recent development of geography. Hence like any other specialised branch of geography, Agricultural geography, has acquired a stable position over the last few decades.

The study of the ways in which patterns of agricultural activity vary from place to place, involving both the description of those patterns and the attempt to explain them is known as agricultural geography. Agricultural geography being a branch of economic geography deals with areas of land cultivation and the effect of such cultivation on the physical landscape. The territorial distribution of agriculture is recognised differently from that of industry because the relation between agricultural production and the natural environment is very special. In this case the land is a

means of production. Therefore Agricultural Geography is concerned with the spatial variations, distribution and location of agricultural activities on the earth's surface and the factors responsible for them. It is dominated by the interrelationship and effects of both physical and socio-economic factors on spatial farm enterprises and farm operations. Etymologically agricultural geography means the art of cultivation of soil with reference to natural environment and human circumstances. Since agriculture is one of the primary economic activities, the study and relationship of agriculture with its environment may well deserve the title 'Geoagercultura'. Agricultural Geography addresses bio-physical determinants of agricultural patterns and productivity; socio- cultural and economic determinants of agricultural patterns and productivity; agricultural activities and spatial organization; agricultural decision making analysis; agricultural technological changes; agriculture and economic development; and global emerging issues in agriculture from spatial and temporal perspectives. Like any other specialists, geographers are taking interests in studying various aspects of agriculture at macro, meso and micro levels.

Among the elements of the economic-geographic study of agricultural geography classification and mapping of different kinds of land use is the most important one. It also includes study of the forms of organization of land used for agricultural enterprises, study of the economic factors that affects the geography of agriculture, economic evaluation of types of natural environments and sector-by-sector analysis of the geography of agriculture and of agricultural regionalization.

In a nutshell, Agricultural geography is a branch of geography that deals with areas of land cultivation and the effect of such cultivation on the physical landscape.

1.4 ORIGIN OF AGRICULTURE

Agriculture has no single, simple origin. It is believed that agriculture developed at multiple times in multiple areas. Archaeobotanists opine that pinpointing the absolute beginnings of agriculture is difficult because the transition of human beings from purely hunter-gatherers to farmers began many thousands of years ago when there was no scope for documentation. A wide variety of plants and animals have been independently domesticated at different times and in numerous places. The first agriculture appears to have developed at the closing of the last Pleistocene glacial period, or Ice Age, about 11,700 years ago.

Archaeobotanists have discovered the cultivation of specific food plant characteristics in the early Holocene period in the Levant

region of the Fertile Crescent. Anthropological and archaeological evidence from sites across Southwest Asia and North Africa indicate use of wild grain. There is even early evidence for planned cultivation. The eight founder crops of agriculture such as first emmer and einkorn wheat, then hulled barley, peas, lentils, bitter vetch, chick peas, and flax appeared after 9,500 B.C.E. These eight crops occur almost simultaneously on Pre-Pottery Neolithic B sites in the Levant. By 7000 B.C.E. sowing and harvesting reached Mesopotamia and farming was established on the banks of the Nile River By 6000 B.C.E. During this period agriculture was developed also in the Far East, in China, with rice as the primary crop. Maize was first domesticated, probably from teosinte, in the Americas around 3000-2700 B.C.E. The potato, the tomato, the pepper, squash, several varieties of bean, and several other plants were also developed in the New World. Agriculture was also independently developed on the island of New Guinea.

1.4.1 Causes of the Agrarian Transformation

Global climate change is one of the reasons behind the development of farming. With the end of the last ice age, approximately 11,000 years ago, the climatic conditions fundamentally changed in many regions of the world. The changes were more pronounced in temperate regions than in the tropics. At that time temperatures warmed, glaciers melted, sea levels rose and as a result ecosystems throughout the world reorganized. Increase in temperature and altered precipitation patterns brought about changes in vegetation. Forests were established in Central Europe and some other regions, replacing the treeless tundra or steppe that existed during the ice age. Distinct changes in the distribution of different vegetation zones also occurred in many regions of the tropics and subtropics. Moreover, toward the end of the ice age most of the large animal species that existed in the ice age environments of Europe, North America, and parts of Asia became extinct.

Agriculture first started in the Middle East and there many animals were first domesticated also. Climatic changes brought changes in the distribution and growing patterns of crops such as wild grains on which hunters and gatherers depended. The shift to sedentary farming was also observed in areas where there was increase in human populations. It is possible that the population growth was caused by changes in the climate and plant and animal life, forcing hunting bands to move into the territories where these shifts had been minimal. As the population grew, more and more attention was given to the grain harvest, which eventually led to the conscious and systematic cultivation of plants and thus the agrarian revolution.

Some social reasons, such as accumulation of food surplus for competitive gift-giving as in the Pacific Northwest potlatch culture, may be considered as another one behind this. Plant and animal management was and is a familiar concept within hunting and gathering cultures, but it took on new dimensions as natural selection and mutation produced phenotypes that were increasingly reliant upon people.

1.4.2 Transition from Hunting and Gathering to Farming

The transition to agriculture occurred as a result of the need to find alternative sources of food. It was not a voluntary act. Among innumerable theories associated with transition from hunting and gathering to farming two main groups of hypotheses are discussed.

1. According to the first hypothesis, agriculture is an innovation that made the life more superior compared to the hunter-gatherer one. Some groups of humans discovered the potential of producing plants in fields. These early farmers acquired a secure source of food in one hand and became sedentary on the other. Hence an initiation of cultural progress began. This also led a way to somewhat higher standard of living. Such groups served as examples for the hunter-and-gatherer groups, which subsequently also began to practice agriculture.

2. According to the second hypothesis, a shortage of food resources (primarily the lack of wild animals for the hunters) was the precondition for the development of agriculture. Reasons for this include an increase in human population density in combination with decreases in big-game species because of overhunting.

Therefore it may be said that the emergence of agriculture was a gradual process and not a sudden event. Evidence from different regions around world depict that the decline in wild animal populations give way to plant productions. In the earliest phases of crop production, the cultivated plants probably served as a kind of food reserve or alternative, in case of failure in hunting.

1.5 DIFFUSION OF AGRICULTURE

“Diffusion is the process by which an innovation is communicated through certain channels overtime among the members of a social system.” Diffusion means the spread of new practices and ideas both in a social and a geographical sense. Social diffusion refers to the spread of an innovation from its originating sources (in the case of new farm practices usually agricultural scientists) among a group of potential users.

1.5.1 Elements of Diffusion Process are as follows:

I. Innovation
II. Communication Channels
III. Time
IV. Social System

The diffusion of agricultural innovations is a process whereby new ways of doing things are spread within and between agrarian communities. The quality of being new indicates a degree of uncertainty because there are a variable number of alternatives. Moreover some range of relative probability of outcomes associated with the actions involved may also lead to the uncertainty.

Rogers (1983) opined that the diffusion of innovations includes the communication of information. Information about innovations may come via impersonal channels, such as the mass media, or it may pass through social networks. From an individual's point of view, the process of innovation is usually conceived to start with initial awareness of the innovation and how it functions. It ends with adoption or non-adoption. In between these end points is an interactive, iterative process of attitude formation, decision making, and action. The cumulative frequency of adopters over time describes an S-shaped (logistic) curve. The frequency distribution over time is often bell shaped and approximately normal.

1.6 AGRICULTURE AND HUMAN CIVILIZATION

Agriculture changed the world in such a way that it's considered the turning point of human history. It all started more 10,000 years ago when people decided to change from a nomadic lifestyle (hunter-gatherers) to producers of food or agriculture. This transition in their lifestyle helped them to have more time which in turn enabled them to do other things since they no longer had to go from place to place searching for food instead they could built and dwell in permanent homes and villages. Furthermore, all this ample time allowed people to start innovations. This also helped to expand their knowledge by studying the life around them. Learning the phenomenon in the sky also became a part of it. With the development of settlements populations grew and as a result new social classes such as warriors and priests emerged. The logic behind this was the fact that warriors were required to defend the villages against any outside force. A separate priesthood made an appearance to conduct religious rituals. Therefore, as the time passed, civilizations began to flourish.

Cultivation of plants requires more labour than hunting and gathering so development of agriculture is not natural. It is a gradual process. It may be assumed that Stone Age humans gave

up their former ways of life slowly. History tells us that between about 8000 and 3500 B.C., greater numbers of humans shifted to cultivation of crops and domesticated animals for their subsistence. By about 7000 B.C., the advancement of their tools and skills was sufficient enough for cultivation. By 3500 B.C., agricultural peoples in the Middle East could support sufficient numbers of non-cultivating specialists to give rise to the first civilizations. As this pattern spread to or developed independently in other centres around the world, the character of most human lives and the history of the species as a whole were fundamentally transformed.

Thus agriculture played the role of main catalyst for the development of the human civilization.

1.6.1 The Domestication of Plants and Animals :

The people who first cultivated cereal grains had the scope to observe them growing in the wild. They obtained their seeds when they gathered other plants for their leaves and roots. In Late Palaeolithic times both wild barley and wheat grew over large areas in present-day Turkey, Iraq, Syria, Jordan, Lebanon, and Israel. Beginning and the practice of agriculture has a gradual growth. Possibly the hunting-and-gathering population dwelling in these areas experimented with planting and nurturing seeds taken from the wilds. They might have accidentally discovered the principles of domestication by observing the growth of seeds dropped near their campsites. Archaeological evidence suggests that the first agriculturists retained their hunting-and-gathering activities as a safeguard so that they do not suffer from starvation. But the Stone Age peoples became more proficient at cultivating a huge range of crops. They were expert in cultivating protein-rich legumes such as peas and beans, various fruits, olives also. This effort of the Stone Age peoples diminished other activities outside agriculture. Most probably the earliest farmers sprinkled wild seeds on the ground. This might have cut down on labour but reduced the possible yield. Down the ages men tried to select the best grain for seed so that crop yields is improved. With the increased dependence on agricultural production for subsistence the some wandering people chose to settle down. Others who practiced a mix of hunting and shifting cultivation continue to roam about.

Different animal species were tamed in different ways. Dogs, for example, were originally wolves that hunted humans or scavenged at their campsites. Sheep, goats, and pigs were first domesticated in the Middle East between 8500 and 7000 B.C. The central place of bull and cattle symbolism in the sacrificial and fertility cults of many early peoples has led some archaeologists to argue that their domestication was originally motivated by religious sentiments rather than a desire for new sources of food and clothing.

Domesticated animals such as cattle and sheep provided New Stone Age humans with additional sources of protein-rich meat and in some cases milk. Ploughs and wheels did not come into use until the Bronze Age (c. 4000-3500 B.C.). So most Neolithic peoples made little use of animal power for farming, transportation, or travel. The Neolithic peoples used domesticated herd animals as a steady source of manure to enrich the soil. The domestication of animals gave rise to pastoralism. It has thrived in semiarid areas such as central Asia, the Sudanic belt south of the Sahara desert in Africa, and the savannah zone of East and South Africa. This was the strongest competitor to sedentary agriculture throughout most of the world. Horse-riding nomads who herd sheep or cattle have destroyed powerful kingdoms and the camel nomads of Arabia played critical roles in the rise of Islamic civilization. In the recent period the power of nomadic peoples were broken when Industrial Revolution came into being. The continuation of their cultures was also threatened by the steady encroachment of sedentary peoples.

1.7 Determinants of agriculture

Factors influencing agriculture in India :

- **Agriculture in India is influenced by the following factors:-**

1.7.1 Physical factors:

i. Topography and altitude
ii. Climate
iii. Soil

1.7.2 Topography and altitude

Nature of relief plays an important role in the development of agriculture. Rice requires flat land where water can remain stagnant but for tea plantation land along hill slope is more preferred as stagnation of water is harmful to these crops. Similarly apples are grown at higher elevations 1500m above sea level in cooler climate. While coconut plantations are found along the coast. The badland of Chambal ravines in Madhya Pradesh, Rajasthan and U.P. are not suitable for agriculture due to gully erosion.

1.7.3 Climate

Climate is one of the most important factors affecting agriculture. Temperature, rainfall wind plays an important role in growth of plants.

- **Temperature**

For most of the crops upper limit of temperature is normally 40 degree Celsius. The lower limit of the crops is different. Temperature plays an important role in the different stages of development of crops. Example: germination, foliation, blossoming etc.

Crops like cocoa, coffee, rubber, spices, tobacco require different temperature more than 18 degree Celsius.

- **Rainfall**

Water is essential for the plant growth but excessive water or rainfall is harmful to the crops. Heavy rainfall at the time of maturity of cotton, wheat, oilseeds, millets, gram etc causes loss of grain and fodder. Dry farming is practiced in the drought prone areas of India, where the amount of rainfall is less.

- **Wind**

Strong wind destroys cops. The movement of wind increases evaporation and transpiration and hence the requirement of water increases.

1.7.4 Soil

The fertility of soil, its texture and humus contents is directly related to crops and their productivities.

Types of Soil	Crops
Alluvial	Wheat, barley, gram, oilseed, pulses, sugarcane
Clayey loam	Rice
Regur	Cotton
Sandy	Bajra, guar, pulses, black gram
Saline alkaline	Nil

1.7.5 Socio –Economic Factors:

In addition to the physical factors there are various socio-cultural, economic, political, technological and infrastructural factors which also determine the agricultural land use, cropping patterns and agricultural processes. Among these factors, size of holdings, labour supply and skill, capital, technological development, transport, market, government policy have a close impact on agricultural activities. These factors have been discussed below.

i. Size of Holdings and Fragmentation of Fields:

The size of holdings and fragmentation of fields have a close connection with agricultural land use patterns and yields per unit area. The size of holdings in the densely populated areas of the developing countries is generally very small. The size of holding and the size of farm decide the degree of risk that a farm operator may bear. If the size of the farm is large then the farmer has a greater capacity to take the risk and vice versa. The highly

populated countries of Asia are characterized by low to very low per capita landholdings hampering mechanization. Furthermore, small holdings cause great wastage of time, labour and cattle. Adopting scientific methods of cultivation and application of HYV seeds is impossible in small holdings. In India, the average size of holding is very small. In fact, about 70 per cent of the total holdings are below one and a half hectares. Fragmentation of Fields hinders better agricultural returns also. This is well observed in the countries like India, Pakistan, Bangladesh and Sri Lanka where subdivision and fragmentation of holdings is conspicuous. According to the law of inheritance in these countries, the property of the deceased is equally divided among the male heirs which are a wasteful and un-economic method of land utilization as there is no scope for adoption of improved agricultural practices. Thus a large proportion of land is found outside the possibility of effective cultivation or economic development. It leads to increased overhead costs and hence there is a low return from agriculture. The division of holdings is economically not justifiable.

ii. Labour supply and skill:

The availability of labour is considered as a major limitation in the agricultural land use and cropping patterns of a region. Its quantity and quality at the periods of peak labour demand have great influence on decision making process of the farmer. The labour inputs vary considerably round the year for most of the agricultural enterprises with the result that many farmers employ a mixed system of production in order to keep their labour fully employed. The developed and industrialized nations offer alternative and financially attractive employment. There are greater leisure opportunities for the industrial workers. Thus decline of agricultural labour is observed in developed countries. In India, very few job opportunities occur outside agriculture. This leads to unemployment of agricultural landless labour and small size farmers.

iii. Capital and technology:

a. Capital

Capital supports selection of crops because agricultural inputs like the livestock, irrigation, seeds, fertilizers, insecticides, pesticides, feeding stuffs, labour, purchase of land, machinery, carts, vehicles, various agricultural equipment's, buildings, fuel and power, sprays, veterinary services and repairs and maintenance require capital. All the farmers' decisions vary on the basis of capital to invest. Farmers have an inclination towards the market oriented crops. These need more capital for getting higher returns. In agricultural system like plantation there is permanent investment. This creates great restriction on the selection of alternative cropping patterns. Moreover to develop irrigation facilities, one of the primary bases of agriculture i, enormous amount of capital is

required. The deserts such as the Nile valley, Turkmenistan, Uzbekistan, and parts of Thar Desert grow cotton, cereals, vegetables and citrus fruits with the help of irrigation.

b. **Technology**:

Technology makes it possible to carry out farming operations more quickly. It also helps to have maximum outputs. The technological developments have brought changes in the use of tools. Thus use of modern hand tools, animals drawn implements, tractors, thrashers and more economic patterns of farm management is playing a vital role in the selection of crops grown. These changes help in improving the crop yields. The improved tools and farm implements can change appreciably the cropping patterns, cropping intensity and crop combinations resulting into high agricultural returns. Tractors have largely transformed the agricultural landscape of the Punjab and Haryana in India. Here the farmers used to spent lot of time on the fields before mechanisation but when bullocks were replaced by tractors that time was greatly shortened. This empowers the farmers to cultivate their fallow land before it becomes infested with weeds in the summer season.

iv. Transportation Facilities:

Transportation facilities directly influence the cropping patterns of a region. Well connected transport facilities favour the economies in farm labour and storage costs. Thus farmers can save labour and storage cost. These savings in turn help the farmers to buy fertilizers and better equipments. By good transport linkages farmers get the opportunity to put their less accessible land to more productive use. In the United States, by truck farming the farmer is able to supply his perishable crops (vegetables, flowers and fruits) to the distant markets within a short period of time at a reasonable rate of transportation. But in the hilly states of northeast India (Meghalaya, Mizoram, Nagaland, Manipur, Arunachal Pradesh) poor means of transportation and inadequate road linkages hinder surplus costly crops like ginger, pineapple and banana to reach the markets in time and therefore deprive the cultivators of most of the profits.

v. Marketing Facilities:

The accessibility to the market has a major role too. The intensity of agriculture along with its production changes with the location of cultivation. If it is away from the marketing centres the production of crops will decline and vice versa. Apart from accessibility the size of market is also an important factor because a market may encourage transport and handling innovations together with economic scale. Wheat has a great international market because it is convenient to handle even though it is a bulky commodity.

vi. Government Policies:

The agricultural land use and cropping patterns are also influenced by the government policies. The fluctuations in the price of sugarcane, wheat, oilseeds and legumes provide impetus or disincentives to the cultivators to grow these crops. Sometimes under certain political situations the government may stop the farmers to grow certain crops. Apart from the domestic policies, the governments enter into international agreements to supply certain agricultural commodities to each other in order to maintain the balance of trade. These international agreements have a close bearing on the cropping patterns of different countries.

1.8 SUMMARY

The agriculture is the English adaptation of Latin word 'agricultural'. There are various reasons behind the development of farming. Climatic changes associated with the retreat of the glaciers at the end of the last Ice Age (about 12,000 B.C.), may have played an important role. Based on the type of land, climatic conditions, technological know how, capital, market and transportation farmers all over the world practice different types of farming. A large variety of crop is grown around the world to meet the basic needs human populations. Thus efforts are constantly taken by the farmers as well as the governments so that agriculture can meet the increasing demand of ever growing population.

1.9 CHECK YOUR PROGRESS/ EXERCISE

1. **True and false**
   a. The size of holdings in the sparsely populated areas of the developing countries is generally very small.
   b. In the countries like India, Pakistan, Bangladesh and Sri Lanka subdivision and fragmentation of holdings is very conspicuous.
   c. The availability of labour is considered as a major advantage in the agricultural land use and cropping patterns of a region.
   d. In agricultural system like plantation there is permanent investment.
   e. Technology makes it possible to carry out farming operations more quickly.

2. **Fill in the blanks**
   a. Agriculture is derived from Latin words _____and _____.

b. Agricultural geography being a branch of _____ geography deals with areas of land cultivation and the effect of such cultivation on the physical landscape.

c. Agricultural geography is dominated by the interrelationship and effects of both _____ and socio-economic factors on spatial farm enterprises and farm operations.

d. Archaeobotanists have discovered the cultivation of specific food plant characteristics in the early Holocene period in the Levant region of the _____ _____.

e. Agriculture started more 10,000 years ago when people decided to change from a _____ lifestyle (hunter-gatherers) to producers of food or agriculture.

3. **Multiple choice questions:**

a. Cultivation of rice requires

   i. flat land where water can flow.

   ii. land along hill slope.

   iii. flat land where water can remain stagnant.

b. Dry farming is practiced

   i. in the drought prone areas of India, where the amount of rainfall is less.

   ii. in the flood prone areas of India, where the amount of rainfall is more.

   iii. in the drought prone areas of India, where the amount of rainfall is more.

c. The movement of wind

   i. decreases evaporation and transpiration and hence the requirement of water decreases.

   ii. increases evaporation and transpiration and hence the requirement of fertiliser increases.

   iii. increases evaporation and transpiration and hence the requirement of water increases.

d. Small holdings of land

   i. cause no wastage of time, labour and cattle.

   ii. cause great wastage of time, labour and cattle.

   iii. cause great wastage of water, fuel and manure.

e. In the United States the farmer supplies his perishable crops such as vegetables, flowers and fruits to the distant markets by

   i. bus farming

   ii. truck farming

iii. cart farming

4. **Answer the Following Questions:**

1. Define Agricultural Geography.
2. Critically analyse the relationship between Agriculture and human civilization.
3. What do you understand by the term Diffusion of agriculture?
4. State the different determinants of agriculture. Elaborate your answer by discussing any three of them.
5. Write short notes on:
   a. The domestication of plants and animals
   b. Elements of Diffusion Process

1.10 ANSWERS TO THE SELF LEARNING QUESTIONS

1.a. false, The size of holdings in the densely populated areas of the developing countries is generally very small.

1. b. True

1. c. false, The availability of labour is considered as a major limitation in the agricultural land use and cropping patterns of a region.

1.d. true

1.e. true

2. a. Ager, Cultura

2. b. economic

2. c. physical and socio-economic

2. d. Fertile Crescent.

2.e. nomadic

3.a.iii.

3.b.i.

3.c.iii.

3.d.ii.

3.d.ii.

1.11 TECHNICAL WORDS:

Fertile Crescent: The Fertile Crescent stretches from the Nile River valley of Egypt northward along the coasts of the historical regions of Palestine and Phoenicia, then eastward along the Tigris and Euphrates rivers to the Persian Gulf.

Emmer: It is a long-established species of wheat with bearded ears and spikelets that each contain two grains, now grown mainly for fodder and breakfast cereals.

Einkorn: It is an old kind of wheat with small bearded ears and spikelets that each contains one slender grain, used as fodder in prehistoric times but now rarely grown.

Teosinte: It is a Mexican grass which is grown as fodder and is considered to be one of the parent plants of modern maize.

The New World-the Americas, the western hemisphere

Agrarian civilization: A large, organized human society that relies on a large number of its members producing food through agriculture. May incorporate hundreds of thousands or even millions of people, and include cities together with their surrounding farmed countryside. Common features of agrarian civilizations include coerced tribute (“taxing”), specialized occupations, hierarchies, state religions, kings or queens, armies, systems of writing and numbers, and monumental architecture.

Agrarian era: An era of human history, beginning roughly 10,000 years ago and lasting until the beginning of the modern era, when the production of food through agriculture was a central focus of many human societies, and a large number of people living in those societies worked the land.

Agrarian surplus: The production of more crops and other food than immediately needed. One key to how a civilization develops specialized roles and a division of labor. The society that produces food in surplus can afford to have a class of people who don’t need to farm. These people can fulfill other duties in an increasingly complex society, including the roles of leaders, judges, bureaucrats, doctors, priests, artisans, slaves, or soldiers.

Agriculture: The cultivation of plant and animal species those are useful to humans for food or other purposes. A form of symbiosis, it generally results in genetic changes in the “domesticated” species over time. Agriculture can be vastly more productive than foraging technologies, though agricultural societies are also vulnerable to

crop failure, disease, and other problems. Its appearance marks a fundamental transformation in human history.

Domestication: The process by which humans breed a population of plants or animals to make them more productive, easier to control, or more beneficial to humans in other ways. Domestication results in genetic changes to the species and often works as a form of symbiosis, in which domesticated species benefit from human protection. Agriculture depends on the process of domestication.

Government: A person or group of people who maintain leadership and control over a city, state, or civilization.

Ice Age: A cold period on Earth when much of the globe is covered by ice sheets and glaciers.

Irrigation: The control of the flow of water to support agriculture.

Mesopotamia: A region between the Tigris and Euphrates rivers that was the site of some of the earliest agrarian civilizations. Much of the region lies in modern-day Iraq.

Natufians: A group of people who lived in part of the Fertile Crescent some 12,000–15,000 years ago. Though they did not farm, they lived in settled villages, and their culture suggests some of the transitional stages between foraging and early forms of agriculture.

Pastoralism: A way of life similar to agricultural, but based primarily on the exploitation of domesticated animals rather than plants. To allow their domesticated animals to graze over large areas, pastoralists are generally nomadic.

Teosinte: A type of wild maize that is the ancestor of corn.

Uruk: A major city that emerged in Sumer about 5,500 years ago; one of the first big cities to emerge in the world, and probably the largest city in the world at its height.

1.12 TASK

- In a chart make two columns and write down the physical and socio-economic factors that determine the growth of agriculture.

1.13 REFERENCES FOR FURTHER STUDY

- Bansil, B. C. (1975): 'Agricultural Problems of India', Delhi.
- Bayliss Smith, T.P. (1987): The Ecology of Agricultural Systems. Cambridge, University Press, London.
- Berry, B.J.L. et. al. (1976): The Geography of Economic Systems. Prentice Hall, New York.
- Gregor, H.P.: Geography of Agriculture. Prentice Hall, New York, 1970.
- Grigg, D. (1984): 'An Introduction to Agricultural Geography', Hutchinson, Publication, London
- Morgan W.B. and Norton, R.J.C. (1971): Agricultural Geography. Mathuen, London,
- Morgan, W. B. and Munton, R. J. C. (1977): 'Agricultural Geography' Methuen, London.
- Morgan, W.B. (1978): Agriculture in the Third World - A Spatial Analysis. West view Press, Boulde.
- Singh J. (1997): Agricultural Development in South Asia: A Comparative A Study in the Green Revolution Experiences, national Books Organization, New Delhi.
- Singh, J. and Dhillon, S. S. (1984): 'Agricultural Geography', McGraw Hill, New Delhi.
- Singh, J. and Dhillon, S.S. (1988), "Agricultural Geography", 2nd edition, Tata McGraw-Hill, New Delhi
- Symons, L. (1972): 'Agricultural Geography', Bell and Sons, London
- The Hindu (2006): Survey of Indian Agriculture 2006. New Delhi.
- Wigley, G.(1981), Tropical Agriculture: The Development of Production, 4th edition, Arnold, London

2

MAJOR AGRICULTURAL TYPES IN THE WORLD

2.0. After going through this chapter you will be able to understand the following features:

Unit Structure :

2.0 OBJECTIVES

By the end of this unit you will be able to –

- Understand the Major agricultural types in the world
- Learn Subsistence agriculture
- Analyse Commercial agriculture & their sub types
- Know Distribution of major crops in the World.

2.1 INTRODUCTION

In this first unit of agriculture we have learnt the definitions and origin of agriculture along with diffusion of agriculture. Agriculture and human civilization as well as determinants of agriculture have also been learnt. In the present unit we are going to study the major agricultural types in the world such as subsistence agriculture and commercial agriculture & their sub

types. Distribution of major crops in the World will be learnt in the latter part of this unit.

2.2 SUBJECT-DISCUSSION

Before the advent of agriculture, all human beings were hunters, gatherers or fishers. Agriculture is the term used to describe the act of growing crops and raising livestock for human consumption and use. In recent history, agriculture has been the main source of the food we consume on a daily basis. It is practiced practically all over the world in varied geographical and economic conditions. Therefore classification of agricultural has become very difficult because of the complexity of farming activities. Economic geographers have classified the types of agriculture depending on their expansion, availability of water, cropping pattern, volume of production, season variations, regional concentrations, social system, ownership of land, etc. Currently agriculture is divided into two main types such as subsistence agriculture and commercial agriculture. In subsistence agriculture a farmer lives on a small amount of land and produces enough food to ensure the survival of the individual family. If there is excess food produced, it is sold locally to other families or individuals. Commercial agriculture is concerned with production of food, animals and cash crops in large quantities for sale.

2.3 MAJOR AGRICULTURAL TYPES IN THE WORLD

Scholars have attempted to identify various types of agriculture on the basis above stated criterion. The following are the major types of agriculture in the world.

1. On the basis of the expansion of land:

i. Intensive agriculture

ii. Extensive agriculture

2. On the basis of availability of water:

i. Humid farming

ii. Irrigated farming

iii. Dry farming

3. On the basis of cropping pattern:

i. Monoculture: single crop agriculture

ii. Duoculture: double crop agriculture

iii. Oligoculture: multiple crop agriculture

4. **On the basis of seasonal variations**:
   i. Winter crop agriculture
   ii. Summer crop agriculture
   iii. Autumn crop agriculture
5. **On the basis of volume of production and their nature**:
   i. Simple subsistence agriculture
   ii. Intensive subsistence agriculture
   iii. Commercial grain farming
   iv. Plantation agriculture
6. **On the basis of social system:**
   i. Capitalistic
   ii. Socialistic
   iii. Feudalistic
7. **On the basis of ownership of land:**
   i. Collective state farming
   ii. Cooperative farming
   iii. Individual farming
8. **On the basis of regional characteristics**:
   i. Monsoon type of agriculture
   ii. Mediterranean agriculture
   iii. Mixed farming of North-West Europe
   iv. Tropical and sub-tropical plantation agriculture

We have already learnt that there is a great deal of overlapping in agricultural types. So, complexities arise in classification of the same. To avoid such complications, world's agricultural types are classified according to the characteristic features along with the crops produced.

2.4 SUBSISTENCE AGRICULTURE AND ITS SUB TYPES

Subsistence agriculture is a mode of agriculture in which a plot of land produces only enough food to feed the family or small community working it. It is a system of farming intended to provide a self-sufficient lifestyle for the farmer and family. Crops and livestock are maintained to support family needs with little or no excess produced for marketing.

2.4.1 Types of subsistence farming are as follows:

a. Primitive or Simple Subsistence Farming
b. Sedentary Subsistence Agriculture
c. Nomadic Herding
d. Intensive Subsistence Farming

a. Simple subsistence farming

This type of farming is mainly practiced by tribes of the tropics, especially in Africa, in tropical South Central America, and in South-east Asia. It is also known as shifting cultivation where the elders select sites in the forests or hill slopes and farmers grow food only for themselves and their families. In this type of farming the virgin forests are cleared by fire and farming is done. The cultivated patches are usually very small, and primitive tools are used. Main crops grown are tapioca, yam, cassava, corn, millet and bananas. Crops are grown for short periods. Long periods of fallowing are followed after that. No 'crop rotation' is found here. It is marked by 'Field rotation'.

The primitive subsistence agriculture or shifting cultivation is characterised by the following features:

a. Sites for cultivation are usually selected in the virgin forest by the experienced elders.
b. The forests are usually cleared by fire and the ashes add to the fertility of the soil.
c. The cultivated patches are usually very small. These are separated from one another by dense forests or bush.
d. Cultivation is done with very primitive tools like sticks and hoes. No modern machines are used. Not even drought animals. Manual labour is the only way to clear the land to produce food for the farmer.
e. Few crops are raised and the main crops are starchy foods, e.g., tapioca, cassava or manioc, yams, maize or corn, millet, upland rice, beans and bananas.
f. Short periods of crop occupancy alternate with long periods of fallowing.
g. The exhaustion of soil nutrients, deterioration of the lightly constructed bamboo houses, and attack by insect-pests, diseases or wild animals made this forms of agriculture a 'migratory' one. It supports many of the aboriginal tribes of the tropical rain forest in spite of various efforts of the local governments to resettle them.

b. Sedentary Subsistence Agriculture

Sedentary subsistence agriculture is a more advanced form of subsistence farming found in tropical lowlands. This type of agriculture has the ability to sustain a comparatively larger population on a permanent basis. In this type of farming the community stays permanently in one spot and the fallowed fields are frequently reused. In some places crop rotation is also practised. More intensive methods of tillage is involved here thus a greater employment of manpower in the fields are found. Crude hand implements are often still used. Animals like buffaloes, swine and horses are used for drought purposes on the farm as well as to supply milk or meat. Many sedentary farmers in Central America and South-East Asia also find jobs on plantations and return to their homes periodically with their earnings.

c. Nomadic Herding

Nomadic Herding is also known as nomadic pastoralism. It is the raising of animals in areas that are generally not suitable for the cultivation of crops. Animals are used for meat, milk, or other products and the caretakers follow or guide their animals to areas with the best pasture, often following seasonal rains. Nomadic herding is becoming quite rare today on Earth as populations expand and become more urban, but it is still practiced in some of Earth's great grasslands, like northern Africa and central Asia including Mongolia. A particular subset of pastoral nomadism is transhumance, the seasonal movement from a winter home to summer pastures. Transhumance is frequently practiced in mountain environments like the Alps of Europe or the mountains of New Zealand, as sheep or goats are taken to alpine pastures for the summer but returned to the valleys for winter.

d. Intensive subsistence agriculture

Intensive subsistence agriculture also known as ‘oriental agriculture’ is found in the Monsoon lands of Asia. In Intensive farming a large amount of produce is generated from a relatively small area of land with high inputs to achieve a high yield per hectare. Hence it is a type of farming where there is high output per unit of land and relatively low output per worker. Its striking features include an intensive use of land, much manual labour, low use of farm machinery or modern tools and the use of a variety of manures and fertilisers.. It is more commonly found in those areas where the demand for food is higher, like high populous societies. It is well developed in and mostly confined to the monsoon lands of Asia such as China, Japan, Korea, India, Pakistan, Sri Lanka, the greater part of continental South-East Asia and parts of insular South-East Asia. In intensive subsistence agriculture the farmer cultivates a small plot of land using simple tools and more labour. To get the most out of their land farmers also apply various cultivation techniques. Commercially produced fertilizer is also use

to ensure that crops get all the nutrients required for a large quantity of yield. Irrigation is often resorted to in order to compensate for lack of moisture. Sometimes it is also known as 'monsoon type of agriculture'.

2.4.2 The main characteristics of the intensive subsistence agriculture are as follows:

i. **Very small holdings**: Farms have been subdivided through many generations. As a result they have become extremely small and often uneconomic to run. An average farm in Japan is approximately 0.6 hectare but in India and elsewhere in Asia farms may be even smaller.

ii. **Farming is very intensive**: In Monsoon Asia every bit of tillable land is utilised for agriculture. The fields are separated by narrow, handmade ridges and footpaths by which the farmers move around their farms. Additional land is made available for cultivation by draining swampy areas, irrigating drier areas and terracing hill slopes to produce flat areas that are suitable for paddy cultivation. Only the steepest hills and the most infertile areas are left uncultivated. Farming is so intensive that double- or treble- cropping is practised, that is, several crops are grown on the same land during the course of a year.

iii. **Much hand labour is entailed:** Based on tradition in this type of farming much hand labour is required in wet paddy cultivation. Ploughing is done with the help of buffaloes whereas the fields are raked by hand. The paddy is planted painstakingly in precise rows by the women. Harvesting is done with sickles and threshing is done by hand. Farm implements are often still very simple. Despite the invention of modern machineries the basic tools used for cultivation are simple ploughs, the cangkul, a kind of spade and hoes. Nowadays modern machineries, capable of working in the flooded fields, are used. Separate machines which can plough, plant and harvest the paddy are also used at present. Such machines are not yet widely used because most farmers cannot afford to buy them, but they are extensively used in more affluent Japan and are gradually spreading throughout Monsoon Asia.

iv. **Use of animal and plant manures**: To ensure high yields and continued fertility farmers make use of every available type of manure including farm wastes, rotten vegetables, clippings, fish wastes, guano, animal dung (especially those from the pig sties and poultry yards) and human excreta. Artificial fertilisers are now being used in Japan, India and China.

v. Dominance of paddy and other food crops: Paddy is the most dominating crop produced in intensive subsistence agriculture. But due to some geographical factors such as relief,

climate, soil etc. it is not practicable to grow paddy in many parts of Monsoon Asia. Wheat, soya beans, barley or kaoliang (a type of millet) are grown as major food crops in most parts of North China, Manchuria, North Korea, northern Japan and Punjab. In the India Deccan and parts of the Indus basin sorghum or millet is the dominant crop due to the scarcity of rain and the poorer soils.

Recently this type of agriculture has gone through a significant improvement in the form of mechanisation by using improved seeds and fertilisers and other modern systems of agro-science. The countries like China, India, Japan, Malaysia, Korea, Taiwan, Philippines, etc., have adopted improved system of agriculture.

2.5 COMMERCIAL AGRICULTURE AND ITS SUB TYPES

Commercial agriculture also referred to as industrialised agriculture. It is a type of agriculture where large quantities of crops and livestock are produced through industrialised techniques for the purpose of sale. In commercial agriculture the farmer produces with intent to sell some or even all of his production. The goal of this type of agriculture is to increase crop yield, which is the amount of food that is produced for each unit of land. Crops such as wheat, maize, tea, coffee, sugarcane, cashew, rubber, banana, and cotton are harvested in this type of farming and sold in the world markets. Actually commercial agriculture is the opposite of subsistence agriculture. They are participating in commerce, thus the name "commercial farming." Therefore a commercial farm contributes in a substantial way to the area's existing agricultural economy and helps maintain farm markets and agricultural processors.

2.5.1 Characteristics of commercial agriculture :

a. **It involves huge capital-** One important feature of commercial farming is that it needs a lot of capital investment because the farmer has to prepare a comparatively huge land by ploughing and harrowing. He must also buy seeds or seedlings and use pesticides and fertilizers. As this is supposed to be done on a large plot of land a huge capital outlay is required.

b. **It employs skilled labour**- The commercial farmer needs a lot of labour to execute his project

c. **Cash crops are produced**- Under commercial agriculture crops are cultivated mainly for sale. The thousands of acres of cocoa, rice, maize, millet etc. are harvested and sold to marketing companies or to individuals.

d. **It is a large scale venture**-Another major feature of commercial farming is that it is a business that is undertaken on a large scale. The acreage that is put under cultivation is very big varying from thousands of acres to few hundred acres or just a few tens.

e. **Highly mechanized**-A commercial farmer employs modernized methods of farming such as tractors, harrowers, planters and combines harvesters. Thus he can clear more acreage to maximize his profits.

f. **Can be farmed all year round**-In commercial farming the farmer does not have to depend on the rains as the subsistence farmers do. He can irrigate the land. Hence can plant throughout the year

g. **Commercial Agriculture requires organized market**.

h. **Commercial Agriculture demands adequate record keeping**.

i. **Commercial Agriculture ensures specialization.**

2.5.2 Types of Commercial Agriculture

a. Mixed Crop and Livestock
b. Dairy Farming
c. Mediterranean Agriculture
d. Commercial Grain Farming
e. Commercial Gardening
f. Livestock Ranching
g. Plantation Farming

a. Mixed Crop and Livestock

This type of farming is a combination of ranching with commercial grain farming where farmers use much of their land to grow crops not for human consumption but as animal feed, or fodder. They feed their crops to animals which are raised for commercial sale. A traditional pig farm in the American mid-west is an example.

b. Dairy Farming

In Dairy Farming cows are kept in the farms. The principal goal of keeping them is to sell their milk. Dairy farming can be considered a variation on mixed livestock and crop farming, since the cows are kept on a relatively small area of the farm and other areas of the farm are often used to grow fodder. Milk is perishable and expensive to transport so dairy farms are located nearer to the major population centers.

c. Mediterranean Agriculture

Mediterranean Agriculture is an agricultural type closely associated with the Mediterranean climate region where rain falls in winter and summers are dry. Therefore some crops are planted and

raised in winter and some mature during the dry season. Crops especially wheat, olives, and grapes are produced here. Animals such as sheep and goats that are capable of tolerating the dry season are preferred.

d. Commercial Grain Farming

In Commercial Grain Farming land is used for a single grain such as corn, wheat, barley, soybeans, or rice. Grain crops are often irrigated but many cereal grains such as wheat are planted in semiarid regions where other crops cannot be grown. Commercial grain farms achieve profitability through economies of scale, planting huge tracts of land with a single crop and relying on extensive use of machinery to plough, plant, fertilize, and harvest.

e. Commercial Gardening

Commercial gardening, also known as truck farming or commercial agriculture, is the production of fruits, vegetables, flowers, and citrus as cash crops. Growers usually concentrate on fruits or vegetables that have relatively high value. In cooler climates growers may rely on greenhouses. This helps the farmer to grow crops from warmer climates or to extend the growing season.

f. Livestock Ranching

Livestock Ranching is the raising of domesticated animals for the production of meat and other byproducts such as leather and wool. It is the commercial counterpart to nomadic herding. Land which can support grass, but not suitable for commercial grains, is used as rangeland for animals like sheep or cattle. The farmer does not live here. He lives in another place and travels by car or truck to the rangelands. Many areas in the American west are used in this manner.

g. Plantation Farming

Plantation agriculture is a form of commercial agriculture. It is mostly found in the developing world. Here crops are grown in favorable conditions for export to rich countries. Crops are grown for profit. Plantation agriculture covers a wide area. It involves a lot of capital, manual and skilled labour, a lot of machinery, agrochemical, irrigation and drainage schemes. In plantation usually perennial crops are grown. Generally plantations have transport facilities that help efficient transportation of crops to ports for export or local markets.Countries that have plantation agriculture usually experience high annual temperatures and receive high annual rainfall.

2.6 DISTRIBUTION OF MAJOR CROPS IN THE WORLD

Down the ages humans have transformed the surface of the planet through agricultural activities, and today 12% of the land surface is used for cultivation and another 22% is used for pastures and rangelands.

2.6.1 The global distribution of major crop groups is discussed below.

a. Cereals: Cereals are the most prevalent group of crops across the world and it is the only group of crops whose cultivation exceeds 20% of global land area or 61% of the total cultivated land. Actually, wheat, maize, barley, rice, and millet are dominant over more than two thirds of the cropland of the world. But cereal is not at all the dominant crop in the Caribbean and central Africa. The dominant major crop is sugar cane and cassava in the Caribbean and central Africa, respectively.

- **Wheat** is the most abundant crop among cereals. It occupies 22% of the total cultivated area in the world. The most intensive wheat cultivation occurs in the temperate latitudes of northern and southern hemispheres. Wheat is most prevalent in the Great Plains of the United States, the Canadian Prairie Provinces, the Indus and the upper Ganges Valleys, along the Kazakhstan and Russian border, and in southern Australia. Wheat is also found throughout Europe, in southern South America, in parts of eastern Africa, and in eastern China.

- **Maize** is geographically present everywhere with the third largest extent in the world. It is cultivated over 13% of the world's croplands, occurring from approximately 50 N to 45 S. Maize attains its highest cultivation intensity in the U.S. maize belt, but it is also a major commodity in north-eastern China (Manchuria), along the Rift Valley in Africa, and in Eastern Europe.

- **Barley and rye** are grown in colder latitudes, around 55 N in Canada, the northern United States, and European Russia. Barley is the crop with the fourth largest area, with 9% of the world's croplands, while rye is cultivated over 2% of the world's croplands.

- **Rice** dominates the tropical and sub-tropical belts, especially in the Northern Hemisphere and is the second most extensive crop in the world. It is a major crop of south and Southeast Asia. It is also cultivated in the Amazon Basin, the southern United States, and southern Australia. It occupies 11% of the global cultivated area.

- **Sorghum** is the only cereal that does not emerge as a dominant crop in any region. It is common throughout the Rift Valley and the

Sahel region in Africa, the southern half of the Mississippi Valley, and India. It occupies 3%of the global cultivated area.

- **Millet** also appears in the Rift Valley and the Sahel region in Africa and to a lesser degree throughout parts of Asia. But it is most abundant in western India. It occupies 2% of the global cultivated area.

b. Roots and Tubers

Roots and tubers are another important human staple. These crops cover a smaller area compared to cereals.

- **Potatoes** and **cassava** two major crops from this category together cover 4% of the world's total harvested area. Potatoes are extensively grown in the colder temperate latitudes between 40 N and 75 N. while cassava is grown in the equatorial and tropical regions from lying between 20 N to 30 S. Cassava also grown in northern Brazil, south central Africa, Thailand, Micronesia, and Polynesia.

c. Sugar Crops

- **Sugar beets and sugar cane** both produce sugar. Climatic condition needed for sugar cane is warmth throughout the year, while sugar beets favour much cooler conditions. The two sugar crops together take up slightly more than 2% of the cultivated croplands in the world. Sugar beets are cultivated in the temperate latitudes of the Northern Hemisphere from 40 N to 60 N, mostly in Europe and the European part of Russia whereas sugar cane is a tropical crop, cultivated mostly in the Caribbean and Florida, but also in Central and South America, India, and other parts of south Asia.

d. Pulses

- **Dry beans, dry broad beans, dry peas, chick-peas, dry cow peas, pigeon peas, lentils, Bambara beans, vetches, and lupins** are included in the group of pulses**.** These are mainly cultivated in warm climates between 60 N to 50 S, the most intense cultivation being around 25 N. They occupy 4% of the cultivated land on global scale. As a group, they occupy third position in cultivation area, after cereals and oil-bearing crops.

e. Oil-Bearing Crops

- Oil-bearing crops such as **soybeans, groundnuts (or peanuts), rapeseed (or canola), sunflower and oil palm fruit** are grown over 10% of the cropland on a global scale. This percentage is slightly higher for developed countries (12%) and slightly lower for developing countries (9%).

- **Soybeans, rapeseed (or canola), and sunflower** are cultivated in temperate latitudes. Soybeans occupy 5% of the world's croplands. Rapeseed/canola and sunflower each occupy 2% of the world's croplands. Cultivation of soybeans, in North and South America, has shown an increasing trend in recent years.

- **Groundnuts** (or peanuts) and oil palm fruit are grown in equatorial and tropical regions respectively. Groundnuts occupy 1%, and oil palm fruit occupies less than 1% of the world's croplands. Peanuts are grown in the south-eastern United States and eastern China. But peanuts are grown with great intensities in southern India and Gambia.

f. Fibre and Non-Food Crop

- **Cotton** is a major fibre and non-food crop. It is cultivated over 3% of the croplands, mostly around 30 N (in the south-eastern United States and Uzbekistan, and in Tajikistan, where cotton is the major agricultural commodity) and around 20 N (in India and Pakistan). Smaller areas of cotton cultivation can also be found throughout southern South America, the southern half of Africa, and in Australia.

g. Minor group of crops

- **Fruit**: Among these the most dominant are fruit. It occupies slightly more than 3% of the world's croplands.

- **Other Oil-Bearing Crops** like Coconut, olives, safflower, sesame, and linseeds and other cereals such as oats and mixed grains; and other crops such as coffee, tobacco, and cocoa together occupy slightly less than 3% of the world's croplands. Vegetables, other roots and tubers, nuts, other fibres, and spices each take up less than 2% of the world's cropland area.

2.7 SUMMARY

Agriculture is the practice of growing plants and raising animals for food and some other uses. Subsistence farming is a mode of agriculture in which a plot of land produces only enough food to feed those who work it. Subsistence agriculture means that the producer and their family will consume most or all of their production. These producers may barter or sell some of their production but most of what they consume comes from their own toil. On the other hand commercial agriculture is a large-scale production of crops for sale, intended for widespread distribution to wholesalers or retail outlets. In commercial farming crops such as wheat, maize, tea, coffee, sugarcane, cashew, rubber, banana, and cotton are harvested and sold in the world markets. In many

countries, plantation agriculture has become popular. It involves the mass planting and production of fruits, vegetables and cash crops.

2.8 CHECK YOUR PROGRESS/ EXERCISE

1. **True and false**

a. Intensive Subsistence Farming is mainly practiced by tribes of the tropics, especially in Africa, in tropical South Central America, and in South-east Asia.

b. Nomadic Herding is also known as nomadic pastoralism.

c. Intensive subsistence agriculture is found in the mountains of New Zealand.

d. In Commercial grain farming ploughing is done with the help of buffaloes whereas the fields are raked by hand.

e. Commercial agriculture also referred to as industrialised agriculture.

2. **Fill in the blanks**

a. _____ is frequently practiced in mountain environments like the Alps of Europe or the mountains of New Zealand.

b. In _____ _____agriculture the farmer cultivates a small plot of land using simple tools and more labour.

c. _____ _____, also known as truck farming or commercial agriculture, is the production of fruits, vegetables, flowers, and citrus as cash crops.

d. _____ _____ is the raising of domesticated animals for the production of meat and other byproducts such as leather and wool.

e. In _____ _____ Farming land is used for a single grain such as corn, wheat, barley, soybeans, or rice.

3. **Multiple choice questions**

a. Plantation agriculture is a form of commercial agriculture

i. which is mostly found in the developed world and here crops are grown for export.

ii. which is mostly found in the developing world and here crops are grown for export.

iii. which is mostly found in the developing world and here crops are grown only for consumption of the grower.

b. Mixed Crop and Livestock farming is a

i. combination of ranching with commercial grain farming where farmers use much of their land to grow crops not for human consumption but as animal feed, or fodder.

ii. combination of ranching with intensive subsistence farming where farmers use small plot of their land to grow crops for animal feed.

iii. combination of ranching with commercial grain farming where farmers use much of their land to grow crops not for animal feed, or fodder but as human consumption.

c. Simple subsistence farming is marked by
   i. Field rotation
   ii. Cop rotation
   iii. nomadic pastoralism

d. The crop that dominates the tropical and sub-tropical belts, especially in the Northern Hemisphere and is the second most extensive crop in the world is
   i. wheat
   ii. barley
   iii. rice

e. The most abundant crop among cereals that occupies 22% of the total cultivated area in the world is
   i. wheat
   ii. barley
   iii. rice

4. **Answer the Following Questions:**

1. What are the major types of agriculture in the world? Elaborate your answer with suitable examples.
2. Highlight the features of commercial farming.
3. Highlight the features of subsistence agriculture.
4. What are the major crop groups of the world? Elaborate your answer with suitable examples.
5. Write short notes on:
   a. Sedentary Subsistence Agriculture
   b. Dairy Farming
   c. Commercial Gardening
   d. Roots and Tubers
   e. Cereals
   f. Sorghum

2.9 ANSWERS TO THE SELF LEARNING QUESTIONS

1.a. false, Simple subsistence farming is mainly practiced by tribes of the tropics, especially in Africa, in tropical South Central America, and in South-east Asia.

1.b. true

1.c. false, Intensive subsistence agriculture is found in the Monsoon lands of Asia.

1.d.. false, In Intensive subsistence agriculture ploughing is done with the help of buffaloes whereas the fields are raked by hand.

1.e. true

2.a. Transhumance

2.b. intensive subsistence

2.c. Commercial gardening

2.d. Livestock Ranching

2.e. Commercial Grain

3.a.ii.

3.b.i.

3.c.i.

3.d.iii

3.e.i.

2.10 TECHNICAL WORDS

- **Agricultural**: to do with farming. The work of growing crops or rearing animals.
- **Cash Crop**: where a crop is sold in the market for cash; the term is often applied to crops grown in LEDCs which are exported to the MEDCs.
- **Cereals**: crops where the seeds are the main product e.g. wheat, corn.
- **Commercial Farming**: farming for a profit, where food is produced by advanced technological means for sale in the market. Often very few workers are employed. (See Subsistence Farming). Market Gardening in the Barcelona area is an example of commercial farming.
- **Crops**: cereals, vegetables and fruit grown by people.
- **Crop Rotation**: a method of farming which avoids growing the same crop in a field continuously. A regular change of crops

maintains soil fertility and reduces the risk of pests and diseases. See Fallow.

- **Cultivation**: the growing of crops.
- **Dairy Farm**: one which specialises in dairy cows, producing milk, butter, cheeses, yoghurt etc.
- **Fallow**: a field left for a year with just grass in order for it to naturally regain its nutrients after several years of crops. This is usually part of a Crop Rotation cycle.
- **Fertiliser**: nutrients applied to the soil, either artificial (inorganic) or natural (organic).
- **Irrigation**: the artificial watering of the land.
- **Plantation**: a large farm in the tropics where one main cash crop is grown, often run by a transnational corporation.
- **Slash and Burn:** a more destructive form of shifting cultivation where population pressure caused by immigration to the Rain Forests leads to people clearing large areas of trees in order to farm and returning to former clearings long before the soil fertility has recovered.
- **Subsistence farming**: farming or a system of farming that provides all or almost all the goods required by the farm family usually without any significant surplus for sale.
- **Intensive subsistence agriculture**: It is a method of agriculture where farmers get more food per acre compared to other subsistence farming methods. This allows farmers to make the most of each harvest.
- **Yield**: how many crops a particular field, farm, or area of land produces. It also applies to milk (yields) from dairy cows.

2.11 TASK

- In a chart draw a world map and show the distribution of major crops of the world.

2.12 REFERENCES FOR FURTHER STUDY

- Bansil, B. C. (1975): ‘Agricultural Problems of India’, Delhi.
- Bayliss Smith, T.P. (1987): The Ecology of Agricultural Systems. Cambridge, University Press, London.
- Berry, B.J.L. et. al. (1976): The Geography of Economic Systems. Prentice Hall, New York.

- Gregor, H.P.: Geography of Agriculture. Prentice Hall, New York, 1970.
- Grigg, D. (1984): 'An Introduction to Agricultural Geography', Hutchinson, Publication, London
- Morgan W.B. and Norton, R.J.C. (1971): Agricultural Geography. Mathuen, London,
- Morgan, W. B. and Munton, R. J. C. (1977): 'Agricultural Geography' Methuen, London.
- Morgan, W.B. (1978): Agriculture in the Third World - A Spatial Analysis. West view Press, Boulde.
- Singh J. (1997): Agricultural Development in South Asia: A Comparative A Study in the Green Revolution Experiences, national Books Organization, New Delhi.
- Singh, J. and Dhillon, S. S. (1984): 'Agricultural Geography', McGraw Hill, New Delhi.
- Singh, J. and Dhillon, S.S. (1988), "Agricultural Geography", 2nd edition, Tata McGraw-Hill, New Delhi
- Symons, L. (1972): 'Agricultural Geography', Bell and Sons, London
- The Hindu (2006): Survey of Indian Agriculture 2006. New Delhi.
- Wigley, G.(1981), Tropical Agriculture: The Development of Production, 4th edition, Arnold, London.

❖❖❖❖

3

AGRICULTURE IN INDIA

3.0. After going through this chapter you will be able to understand the following features:

Unit Structure :

3.0 OBJECTIVES

By the end of this unit you will be able to –

- Understand the Characteristics of Indian agriculture
- Learn Green Revolution in India
- Analyse problem associated with Indian agriculture
- Know National Agricultural Policies

3.1 INTRODUCTION

In the previous two units we have studied different aspects of agriculture. The first unit dealt with the definitions and origin of agriculture along with diffusion of agriculture. In the second unit we learnt the major agricultural types in the world such as subsistence agriculture and commercial agriculture and their sub types. In the present unit, that is the third one, we will study the characteristics of

Indian agriculture and Green Revolution in India. Problem associated with Indian agriculture along with National Agricultural Policies will be discussed in the latter part of this unit.

3.2 SUBJECT-DISCUSSION

Agriculture has been the backbone of the Indian economy. It will continue to remain the same in the coming decades as it has to support almost 17 per cent of world population from 2.3 per cent of world geographical area and 4.2 per cent of world's water resources. Indian agriculture is characterized by agro-ecological diversities in soil, rainfall, temperature, and cropping system. The country receives favourable solar energy along with 3 trillion m3 of rainwater. Moreover 14 major, 44 medium and 55 minor rivers share about 83 per cent of the drainage basin. In spite of these favourable conditions it is facing the problem of declining productivity. When the constraints of low productivity in agriculture were realized the central and state governments put emphasis on the need for accelerated development of agriculture. Adoption of high yielding varieties by farmers along with the use of higher doses of fertilizer accelerated the pace of progress in agriculture. Assured irrigation through tube wells also helped in increasing the progress in this field.

The Green Revolution changed India's status from a food-deficient country to one of the world's leading agricultural nations. Until 1967 the government largely concentrated on expanding the farming areas. But the population grew at a much faster rate than food production. So to increase production an immediate action was required which came in the form of the Green Revolution.

3.3 CHARACTERISTICS OF INDIAN AGRICULTURE

Indian economy is primarily based on agriculture. The socio-economic condition of the farmer, policy of the government and the life of the people is directly and indirectly controlled by agriculture. It engages about 70 percent of the total workforce. The characteristics of Indian agriculture are as follows:

1. Pressure of overpopulation :

The population in India is increasing at a rapid pace exerting heavy pressure on agriculture. About 70 percent of the total population of India is directly or indirectly dependent on agriculture. India has more arable land area than any country except the United States but due to overpopulation, industrialization and urbanization there is an increasing pressure on arable land in the country. Indian present agri-land holding is only about 0.10 hectare as against 0.30 hectare in 1951.The world average per capital arable land holding

is about 4.5 hectares. Due is increase in population the pressure on land holding increased. Available agricultural land is divided into small farms leading to lower agricultural productivity. Moreover use of arable land for residential sector, transportation development, industrial zones and construction of big reservoirs has lessened the total arable land area.

2. Labour Intensive Agriculture :

Most of the agricultural operations are carried out manually by human hands along with traditional equipments. Traditional technology is the main cause of low production. The use of machinery for different agricultural operations like ploughing, spraying, sowing, harvesting etc. is totally absent in most of the areas. With the increase of population, land holdings get fragmented so modern machinery and equipment cannot be used on such farms. The rich farmers of Haryana, Punjab, Gujarat, and Maharashtra started to use machinery for different agricultural operations.

3. Mixed farming :

Mixed crop is one of the characteristics of subsistence agriculture and is a common phenomena in the rain fed areas of the country. In different seasons farmers grow mixed crops in their farm. They generally grow millets, maize and pulses in the kharif season and wheat gram and barley in the rabi season.

4. Subsistence Agriculture:

The farmers own a small piece of land and grow crops mainly for their family consumption. They consume almost the entire farm produce with little surplus to sell in the market. The greater part of the countries agriculture is subsistence in character. It is only in the irrigated part of Punjab, Haryana, Western UP and some river plains where agriculture has become market oriented.

5. Dominance of food Grain :

The greater proportion, more than two-thirds of the total cropped area, is devoted to the cultivation of food crops. Rice, maize, pulses and millets are the dominating crops in kharif season whereas crops like wheat, gram and barley dominate rabi season.

6. Highest proportion of Area Under Cultivation :

The percentage of arable land, which is the area under cultivation of crops and pastures, in India is about 55 percent of the total geographical area. This percentage is much higher than Canada (4%), China (12%), Japan (15%) and USA (16%).

7. Small land holding :

The average size of holdings in India is very low. It is less than 2 hectares or 5 acres. The small size of land holding and

fragmentation of farms is mainly due to some socio-cultural are economic factors. The fragmented and small size fields are not favourable for the modern and advanced machine operation in agriculture. All this has rendered mechanisation impossible.

8. Rainfed farming :

Indian agriculture is mainly dependent upon monsoon which has an uncertain, unreliable and irregular manner. Rain fall being insufficient or unevenly distributed, affect the agricultural production adversely.

9. Low productivity :

In comparison with the other countries India's agricultural productivity is lowest in the world. The low fertility of soil, less use of fertilizers, green-manure and absence of following scientific crop rotation results into low yield per unit area. The consumption of chemical fertilizers has remained in lower level in the areas of dry and rain fed farming.

10. Indebtedness of farmers :

Indebtedness is a common feature among subsistent cultivators. In India about 85 percent of cultivators are under debt. The poor and small farmers still depend on money-lenders in Maharashtra, Karnataka, Tamil Nadu, Orissa, Gujarat, Punjab and U.P.

3.4 GREEN REVOLUTION IN INDIA

3.4.1. Introduction of Green Revolution in India :

Between the 1940s and the late 1960s there was a worldwide increase in the agriculture production particularly in the developing world. This revolution was known as the Green Revolution. Norman Ernest Borlaug, an American biologist, is known as the "father of the Green Revolution". The term 'Green Revolution' is applied to successful agricultural experiments in many developing countries. India is one of the countries where it was most successful.

The Green Revolution changed India's status from a food-deficient country to one of the world's leading agricultural nations. Until 1967 the government largely concentrated on expanding the farming areas. But as a perfect case of Malthusian economics the population grew at a much faster rate than food production. So to increase production an immediate action was required which came in the form of the Green Revolution.

In India due to the introduction of high-yielding varieties, use of pesticides, and better management techniques there was great increase in production of food grains, like rice and wheat. This is

collectively known as the Indian Green Revolution. These were sudden and quickly spread to yield dramatic results. Hence it is termed as a revolution in green agriculture. It provided the increase in production needed to make India self-sufficient in food grains. The programme was initiated with the help of the United States based Rockefeller Foundation and was based on high-yielding varieties of wheat, rice and other food grains that had been developed In Mexico and in the Philippines. Of the high yielding seeds, wheat produced the best results.

Prof. M. S. Swaminathan, the adviser of the minister of agriculture, invited Dr. Borlaug to India and lobbied with the then prime minister Lal Bahadur Shastri to import 18000 tons of Mexican seed. According to Prof. M.S. Swaminathan green revolution not only removed the tag of 'begging bowl' image of India but also secured forests and land, due to the productivity improvement.

❖ The following HYV seeds were used in the green revolution:

- wheat: sona, pb 18, kalyan
- bajra: hv 1
- maize: ganga 101, ranjit
- jowar : csh 2

The seeds were first used under IADP but the HVYP used these seeds exhaustively along with the other measures. Total food grains production in the country got double from 1955-56 to 1977-78 and the role of green revolution is evident from the increased production in 1971-72.

3.4.2. History behind Green Revolution in India

In 1943 the British ruled India faced the world's worst recorded food disaster known as the Bengal Famine. An acute shortfall in food production has been put forwarded to explain that suffering. Economist Amartya Sen opined that along with food shortage, World War II made food supplies a low priority to the British rulers. Moreover, Indian traders hoarded food in order to sell at higher prices. This led to the catastrophe of famine. So food security turned out to be of supreme importance in independent India's agenda. This awareness resulted into the Green Revolution in India. Legislative measures also taken to ensure that there would never be any storing of food for reasons of profit by the businessman.

3.4.3. Components of Green Revolution

The Green Revolution portrays an ancient turning point away from primitive agriculture in the developed countries and toward the incorporation of modern First World agricultural techniques. The components that led to the phenomenal success of green revolution in India are as follows:

a. High Yielding Varieties (HYV) of seeds.
b. Use of chemical fertilizers
c. Surface and Ground Irrigation
d. Use of Insecticides and Pesticides.
e. Command Area Development (CAD).
f. Consolidation of holdings.
g. Land reforms.
h. Supply of agricultural credit.
i. Rural electrification.
j. Rural Roads and Marketing.
k. Farm Mechanisation.
l. Agricultural Universities.
m. Soil Testing
n. Guaranteed Minimum Prices
o. Multiple Cropping Programme:

3.4.4. The discussion about the components that led to the phenomenal success of green revolution in India is stated under.

a. High Yielding Varieties of seeds:

The high yielding variety of seeds (HYV), characterized by shorter stems, which could resist damages by wind and had larger leaf surface for photosynthesis, short maturing period and better response to chemical fertilizers is one of the basic pre- requisite of intensive agriculture. During 1991-92, the area under high yielding varieties of seeds was 64.7 million hectares which rose to 79.0 million hectares in 2000-01.

b. Irrigation:

Water along with HYV seeds and fertilizer forms a significant input to increase agricultural production. Irrigation in Indian agriculture is very necessary because of its diversified climatic conditions, dependency and uncertainty of Monsoon rainfall. Introduction of H.Y.V seeds and multiple cropping need water throughout the year. So to stabilize cropping pattern and raise production irrigation is needed. B.B. Vohra had put stress on ground water rather than on surface water so that there is an availability of water at the right time and in the right quantity when HYV seeds are used. In many districts of Haryana and Punjab the ground water exploitation is very high.

c. Use of Chemical Fertilizers:

The National Commission on Agriculture has opined that increased agricultural production is related to increased consumption of fertilizers. Thus the use of chemical fertilizer may be attributed to the acceleration of the growth of agricultural output in the short period. The consumption of fertilizers increased from

5.51 million tonnes in 1980-81 to 12.9 million tonnes in 1990-91. In 2001-02, consumption was recorded to be 17.3 million tonnes.

d. Use of Insecticides and Pesticides:

Crop production, under the Green Revolution technology, has increased with the intensive use of irrigation and fertilizers. But it has been estimated that about 10 per cent crop is damaged every year due to defective and inadequate plant protection measures. With the adoption of HYV the need of such measures has been strengthened as it is conducive to the growth of the plant population. Hence central insecticides laboratory having its two branches at Hyderabad and Bombay and two regional centres at Kanpur and Chandigarh continue to increase efforts to ensure pesticides to cultivators. Punjab, Haryana, Andhra Pradesh and Tamil Nadu consumed over 55 per cent of the country's pesticides in 2003-04.

e. Command Area Development (CAD)

To bridge the gap between potential created and utilized in selected major or medium irrigation projects of the country for optimising agricultural production from the irrigated land, Command Area Development Programme, a centrally sponsored scheme was launched in January 1975.

f. Consolidation of holdings:

Indian agriculture is characterised by small and fragmented land holdings. This acts as one of the important hindrances in the growth of agriculture in India. Consolidation of holdings has been introduced to solve this problem.

g. Land reforms:

Land reform usually refers to redistribution of land from the rich to the poor and includes regulation of ownership, operation, leasing, sales, and inheritance. India being an agrarian economy suffers from unequal distribution of land. Before independence occupation of about 70 per cent of the rural population was agriculture yet agricultural production was noticeably low resulting into the dependence on foreign countries for food supply. The green revolution aimed at increase in agricultural productivity and for that high-yielding varieties of seeds were introduced. But it was observed that the larger landholders profited more than the small landholders as they were capable of affording costly fertiliser, high quality of seed, and pesticides, use of machinery and reliable supply of water. So land reform was on the top of priority list on the policy agenda at the time of Independence. With the abolition of the Zamindari tenants became owners of land. Under this act a farmer cannot own more land than the ceiling limits. After obtaining the ownership rights, farmers worked hard on their farms leading to an immense increase in agricultural production.

h. Supply of Agricultural Credit:

Credit is considered as one of the vital inputs in any agricultural developmental programmes. The other inputs such as, technology, HYV seeds, fertilizers, pesticides, irrigation water and machinery are very much dependent on the availability of credit. So farmers needed credit and started to get more credit facilities. Earlier they used to get loan from the moneylender with very high rate of interest. Now credit needs are filled by credit institutions such as Cooperatives, Commercial Banks and Regional Rural Banks extend loans to farmers on easy terms. Thus, with the availability of cheap credit, farmers are in position to use improved seeds, fertilizers, machines etc. They have also arranged for minor irrigation facilities.

i. Rural electrification:

Electricity, one of the cheap sources of energy, has a significant role in the development of agriculture. Hence rural electrification has become an essential input in modem agricultural system. Electricity is used to lift water by pump sets, process and preserve agricultural produce and the like. A massive programme of rural electrification was taken up just after the Independence. At the end of the Fourth Five year Plan about 1, 55,297 villages had been electrified and there were 24 lakh pump sets. Up to the end of the Seventh Five Year Plan 4, 70,836 villages were electrified and 83, 58,363 pump-sets had been energised. As on 31 March, 2004,4,73,892 villages out of a total of 5, 87,556 villages (i.e. 86.25 per cent of the total villages) had been electrified and about 1, 40, 02,634 pump sets had been energised. Among all the states of India, Haryana was the first state to electrify all its 6759 villages in 1970. Punjab, Kerala, Andhra Pradesh, Karnataka, Gujarat, Himachal Pradesh, Tamil Nadu, J and K, Maharashtra and Nagaland have 97 to 100 per cent villages electrified.

j. Rural Roads and Marketing:

Rural Roads and Marketing has been established as a vital segment of infrastructure in improving agricultural productivity under the Green Revolution programme. Although rural roads play an important role in connecting the villages to the neighbouring markets and villages there is still a big gap between the requirement and availability of village roads.

Marketing is also essential for agriculture as regulated markets enable the farmer to sell his agricultural produce and to purchase farm implements and tools, fertilizers, pesticides and other agricultural inputs as well as goods of everyday use.

k. Farm Mechanisation:

Introduction of farm mechanisation has helped in saving human labour. Moreover with mechanisation farm operations

became faster. As a result farm efficiency and productivity increased. Hence farm mechanisation played a significant role in the success of The Green Revolution.

l. Agricultural Universities:

Many Agricultural universities and institutes like National Seeds Corporation, Agro Industries Corporations, National Cooperative Development Corporation etc. have been set up to promote services to the cultivators at their door steps. These were engaged in agricultural research and passed on the research findings to the farmers. Success of Green Revolution largely depends upon the work done by these universities. Punjab, Haryana and Uttar Pradesh, are the best examples of such a progress.

m. Soil Testing:

Soil testing also has beneficial effects on Green Revolution. Soil of different regions is tested in Government laboratories. By this it became easier to know what type of fertilizers and seeds will be more fruitful in different regions.

n. Guaranteed Minimum Prices:

The guaranteed minimum prices have been given due recognition as an incentive to agricultural production. Support price policy for food grains was adopted in 1964 throughout the country. In order to advice the Govt, for suitable price policies for agriculture. Agricultural Price Commission (APC) was set up in the subsequent year (presently known as Agricultural Price and Cost Commission) (APCC). Similarly, Food Corporation of India was also set up for the purchase of food grains.

o. Multiple Cropping Programme:

The approach in the new agricultural strategy is the introduction of multiple cropping programmes in the country. It aims at maximizing production per unit of land and per unit of time by taking three or four crops in a year. By adopting multiple cropping programmes, there are two advantages as of getting increased returns and economizing the farm resources.

3.4.5. Positive impacts of Green Revolution

Green revolution transformed India from economically underdeveloped country into a powerful force on Earth.

3.4.5.1. Positive impacts of the Green Revolution are as follows:

a. Increase in Agricultural Production:

With the introduction of Special Food grains Production Programme (SFPP) and the Special Rice Production Programme (SRPP) the total annual average production of food grains in India

increased from 81.0 million tonnes during the Third Plan to 264.8 million tonnes in 2013-2014.The production of wheat, rice, maize and potatoes has increased to a significant extent.

b. Reduction in import of food-grains:

The main benefit of Green Revolution was the increase in the production of food-grains, as a result of which there was a drastic reduction in their imports.

c. Renovation and advancement of agricultural infrastructure:

Renovation and advancement of agricultural infrastructure in the country was another positive impact of green revolution especially in the sector of irrigation. Dams were constructed and a few other facilities for irrigation were initiated in order to provide the arable lands with necessary water resources

d. Significant economic effects:

- Green Revolution gave opportunity to Indian government to cover all the monetary debts, which were taken for implementing this massive project in industrial agriculture, to the World Bank and its affiliates.

- Increase of farmers ' incomes and reducing the amount of people living below the poverty line may be included.

- Increase in employment opportunities in the rural areas.

e. Possibilities of hunger and food crises lowered:

Green revolution helped Indian nation to avoid possible hunger and food crises. With lowering prices for food, allowing people to consume better and healthier foods, enhancing the variety of foodstuffs there was improvement of the nutrition of people.

f. Strengthening the Forward and Backward Linkages:

Green revolution played a pivotal role in strengthening the linkages between agriculture and industry. Modernisation of agriculture and development of agro-based industries has strengthened both forward and the backward linkages between agriculture and the industry.

g. Change in Attitudes of farmers:

With the adoption of new strategy of Green revolution there is a change in Agricultural status of India from subsistence activity to commercial farming. This has changed the attitudes of farmers too in India.

h. Capitalistic Farming:

Farmers having more than 10 hectares of land invested large amount of money in various inputs like HYV seeds, fertilizers, machines, etc. to get the maximum benefit from Green Revolution technology. This has encouraged capitalistic farming.

i. Industrial Growth:

There was an increased demand for different types of machines like tractors, harvestors, threshers, combines, diesel engines, electric motors, pumping sets, etc. with farm mechanisation. Moreover demand for chemical fertilizers, pesticides, insecticides, weedicides, etc. also increased considerably. Thus industries producing these items progressed very rapidly. Other than these several agricultural products are also used as raw materials in various agro based industries. Textile, sugar, vanaspati, etc. are some superb examples of agro based industries.

3.4.6. Negative impact of Green Revolution

The Green Revolution programme made the country self-sufficient in food grains. But it has some negative impact that includes the following:

i. Inter-Crop Imbalances:

The negative effect of Green Revolution is first felt on food-grains. All food-grains such as wheat, rice, jowar, bajra and maize have gained from the Green Revolution but wheat benefited the most. It has seized areas from coarse cereals, pulses and oilseeds and as a result their cultivation became uneconomic.

ii. Regional Disparities:

Regional disparity affected only 40 per cent of the total cropped area and 60 per cent is still untouched by it. Actually green revolution showed its effect on those areas which were already in better agricultural condition. This resulted into regional disparities in economic development at regional levels.

iii. Increase in Inter-Personal Inequalities:

Big farmers who had 10 hectares or more land enjoyed the advantages of green revolution the most as they were financially solid to buy farm implements, better seeds, fertilizers and can arrange for regular supply of irrigation water to the crops. On the other hand the small and marginal farmers lacking enough resources to purchase these farm inputs are deprived of the benefits of the same.

iv. Unemployment:

New agricultural strategy along with increased mechanisation of agriculture created a problem of labour displacement and extensive unemployment among agricultural labourers in the rural areas.

v. Other Problems:

- Agriculture did not reach the expected goal in the beginning because there were differential rates of growth of different crops.
- Reports from some states like Punjab and Haryana tell that excessive use of chemical fertilizer (150-200 kg/ha) caused destruction of useful microorganisms, insects and worms in soil.
- Imbalance in nutrient status causing significant deficiency of N, P, K, Zn, S, Mo and B and disturbance of soil texture and its physicochemical properties.
- Environmental degradation like depletion of stratospheric ozone, nitrate toxication etc. causing health hazards like cancer, methamoglobinemia respiratory illness, hypertension etc.
- Pollution with heavy metals and pesticide chemicals causing serious damage to food quality from the safety point of view.
- Adoption of new agricultural strategy through IADP and HYVP led to the growth of capitalist farming in Indian agriculture as the adoption of these programmes were very much restricted among the big farmers, necessitating a heavy amount of investment
- The new agricultural strategy failed to recognise the need for institutional reforms in Indian agriculture.

3.5 PROBLEM ASSOCIATED WITH INDIAN AGRICULTURE

Indian agriculture is suffering from various problems. Some of them are natural while others are manmade. They are discussed below.

1. Instability:

Agriculture in India is largely dependent on monsoon. Hence, production of food-grains suffers and it fluctuates year after year. A year may have abundant output of cereals while another face acute shortage.

2. Seeds:

To attain higher crop yields and sustained growth in agricultural production good quality seed is required. But because of exorbitant prices of better seeds these are out of reach of the majority of farmers, especially small and marginal farmers. To eradicate this problem the Government of India established the National Seeds Corporation (NSC) in 1963 and the State Farmers Corporation of India (SFCI) in 1969. Thirteen State Seed Corporations (SSCs) were also established to augment the supply of improved seeds to the farmers.

3. Cropping Pattern:

The crops grown in India are divided into food crops and non-food crops. Food crops comprise food-grains, sugarcane and other beverages whereas non-food crops include different kinds of fibres and oilseeds. There is a fall in agricultural activity production primarily due to decrease in the output of non-food articles.

4. Land Ownership:

Although the ownership of agricultural land in India is fairly widely distributed, there is some degree of concentration of land holding. Inequality in land distribution is the consequence of frequent changes in land ownership in India. It is believed that large area of land in India are owned by a relatively small section of the rich farmers, landlords and money-lenders, while the vast majority of farmers own very little amount of land, or no land at all.

5. Sub-Division and Fragmentation of Holding:

Sub-division of agricultural land into smaller plots has occurred due to our inheritance laws where the land belonging to the father is equally distributed among his sons. This distribution of land does not entail a collection or consolidated one, but its nature is fragmented. Also different tracts have different levels of fertility and they are not distributed accordingly. Irrigation becomes difficult on such small and fragmented fields. Further, a lot of fertile agricultural land is wasted in providing boundaries. Moreover sometimes small farmers are forced to sell a portion of their land to repay their debt. This creates further sub-division of land. Sub-division and fragmentation of the holdings is one of the main causes of our low agricultural productivity and backward state of our agriculture.

The only solution to this problem is the consolidation of holdings which means the reallocation of holdings which are fragmented.

6. Most holdings are small and uneconomic:

As most holdings are small and uneconomic the advantages of large-scale farming cannot be derived and cost per unit with

'uneconomic' holdings is high, output per hectare is low. Thus peasants cannot generate sufficient marketable surplus. So they are not only poor but are often in debt.

7. Land Tenure:

The land tenure system of India is also not perfect. In the pre-independence period, most tenants suffered from insecurity of tenancy. They could be evicted any time. However, various steps have been taken after Independence to provide security of tenancy.

8. Manures, Fertilizers and Biocides:

Cultivation is continuing on Indian soil since time immemorial. But much care has not been taken for replenishing. Thus depletion and exhaustion of soils arose resulting in their low productivity. The average yields of almost all the crops are among the lowest in the world. This problem can be solved by using more manures and fertilizers. Cow dung provides the best manure to the soils. But it has a limited use because much of cow dung is used as kitchen fuel as dung cakes. Moreover chemical fertilizers are costly and are often beyond the reach of the poor farmers. The fertilizer problem is, therefore, both acute and complex. The government has given high incentive especially in the form of heavy subsidy for using chemical fertilizers.

9. Irrigation:

Irrigation is the most important agricultural input in a tropical monsoon country like India where rainfall is uncertain, unreliable and erratic. Thus it is impossible for India to achieve sustained progress in agriculture unless and until more than half of the cropped area is brought under assured irrigation. But small and fragmented fields create difficulties for irrigation. Under such circumstances, the farmer cannot concentrate on improvement.

10. Lack of mechanisation:

In India mechanization in agriculture is not up to mark. The major constraint of farm mechanization here was small size of farm holding. Moreover farmers were incapable of adoption of improved farm equipment because they were not of aware about various farm implements and machinery. So, most of the agricultural operations in India are carried on by human hand using simple and conventional tools and implements like wooden plough, sickle, etc. This has resulted into huge wastage of human labour and low yields per capita labour force. Therefore an urgent need is felt regarding mechanisation of the agricultural operations.

11. Conditions of Agricultural Labourers:

The conditions of most agricultural labourers in India are far from satisfactory. There is also the problem of surplus labour or

disguised unemployment. This pushes the wage rates below the subsistence levels.

12. Agricultural Marketing:

Agricultural marketing is still in a bad shape particularly in rural India. Due to the absence of proper marketing facilities, the farmers are bound to depend upon local traders and middlemen for the disposal of their farm produce. Hence these are sold at throw-away price.

13. Inadequate storage facilities:

The farmers are compelled to sell their produce immediately after the harvest at very low market prices because the storage facilities in the rural areas are either totally absent or grossly inadequate.

14. Inadequate transport:

One of the main handicaps with Indian agriculture is the lack of cheap and efficient means of transportation. Even at present there are lakhs of villages which are not well connected with main roads or with market centres.

15. Scarcity of capital:

Agriculture being an important industry requires capital. With the advancement of farm technology the need for capital has increased. But the main suppliers of money to the farmer are the money-lenders, traders and commission agents who charge high rate of interest and purchase the agricultural produce at very low price.

16. Neglect of crop rotation:

A proper rotation of crops controls successful conduct of agricultural operations. Most farmers in India being illiterate do not understand how important this point is. Since they are not aware of the need for crop rotation they use the same type of crop. Therefore the land loses its fertility considerably.

17. Other problems

Adequate attention is not given to increase the non-farm income opportunities so that during slack seasons the farmers can be absorbed gainfully.

3.6 NATIONAL AGRICULTURAL POLICY

The National Agriculture Policy was announced on 28th July, 2000. It promotes agricultural productivity for national food security and economic growth and development through value chain development.

National Agriculture Policy attempts to make a reality of vast untapped growth potential of Indian Agriculture. It also seeks way to strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro-business, create employment in rural areas, secure affair standard of living for the farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges arising out of economic liberalization and globalization over the next two decades.

3.6.1. National Agriculture Policy aims to attain the following:

- A growth rate in excess of four per cent annum in the agriculture sector;
- Growth that is based on efficient use of resources and conserves our soil, water and bio-diversity;
- Growth with equality, i.e. growth which is widespread across regions and famers;
- Growth that is demand driven and caters to domestic markets and maximizes benefits from exports of agricultural products in the face of the challenges arising from economic liberalization and globalisation
- Growth that is sustainable technologically, environmentally and economically.

3.6.2. The main features of the National Agricultural Policy are:

I. Privatisation of agriculture and price protection of farmers in the post QR (Quantitative Restrictions) regime would be part of the government's strategy to synergise agricultural growth.

II. Private sector participation is planned to promote through contract farming and land leasing arrangements. This would allow accelerated technology transfer, capital inflow, assured markets for crop production especially of oilseeds, cotton and horticultural crops.

III. The policy foresees evolving a 'National Livestock Breeding Strategy' to meet the requirement of milk, meat, egg and livestock products. It also envisages the importance of draught animals as a source of energy for farming operations.

IV. High priority would be granted to evolve new location-specific and economically viable improved varieties of farm and horticulture crops, livestock species and aquaculture.

V. The restrictions on the movement of agricultural commodities throughout the country would be deconstructed. There would be a review in the structure of taxes on food grains and other commercial crops.

VI. The excise duty on materials such as farm machinery and implements and fertilizers used as inputs in agricultural production, post-harvest stage and processing would be reviewed.

VII. Rural electrification would be treated as more important than others. It would be treated as a prime mover for agricultural development.

VIII. The use of new as well as renewable sources of energy for irrigation and other agricultural purposes would be encouraged.

IX. Progressive institutionalisation of rural and farm credit would be continued for providing timely and adequate credit to farmers.

X. New venture must be made to provide a package insurance policy for the farmers.

3.6.3. Criticism

The National agricultural policy is a broad policy and takes into account several aspects of agricultural sector. But it was severely criticised by the researchers.

- According to Thamarajakshi (2000) the themes of the National agricultural policy are too general and unrelated to the specified objectives.

- Deshpande and Praschita (2006) pointed out that "The National Agricultural Policy has not followed some simple steps in evolving a national level policy frame". They opined that the policy ignored the importance of evolving a policy with the involvement of all the stakeholders. It also missed the important steps of review of earlier experience, inviting comments, deliberations on various dimensions of the policy etc.

3.7 SUMMARY

India is a country where agriculture is the main occupation and backbone of the country's economy. Some of the outstanding features of Indian agriculture are subsistence agriculture, pressure of population on agriculture, importance of animals, dependent upon monsoon, variety of crops, predominance of food crops etc. With arable land area at 168 million hectares, India ranks second only to the U.S. in size of agriculture. This is because India is plagued with innumerable problems in the field of agriculture. One of the major problems of Indian agriculture is that a large number of people depend solely on agriculture. Fragmentation of land

holdings and lack of modernisation may be included in the so called problems faced by Indian agriculture.

Green revolution brought great increase in production of food grains. It was typically observed in plains of Punjab and Haryana and parts of Western India. It has two types of effects on Indian economy, namely, (a) economic effects and (b) sociological effects. Economic Effects include increase in agricultural production and productivity with the adoption of HYV technology. The new agricultural technology has increased the number of employment opportunities in the agricultural sector.

3.8 CHECK YOUR PROGRESS/ EXERCISE

1. **True and false**

a. The population in India is increasing at a rapid pace exerting heavy pressure on agriculture.

b. The greater proportion, more than two-thirds of the total cropped area, is devoted to the cultivation of non-food crops.

c. Indian agriculture is mainly dependent upon monsoon.

d. The poor and small farmers in Maharashtra, Karnataka, Tamil Nadu, Orissa, Gujarat, Punjab and U.P. never depended on money-lenders.

e. In 1943 the British ruled India faced the world's worst recorded food disaster known as the Orissa Famine.

2. **Fill in the blanks**

a. The main benefit of _____ Revolution was the increase in the production of food-grains.

b. Green revolution played a pivotal role in strengthening the linkages between agriculture and _____.

c. Most land holdings in India are small and _____.

d. A proper rotation of _____ controls successful conduct of agricultural operations.

e. A lot of fertile agricultural land is wasted in providing_____.

3. **Multiple choice questions**

a. The Green Revolution changed India's status

i. from a food-abundant country to one of the world's leading agricultural nations.

ii. from a food-deficient country to one of the world's leading agricultural nations.

iii. from a food- abundant country to one of the world's laggard agricultural nations.

b. Most of the agricultural operations in India
i. are carried out by modern equipments.
ii. are carried out manually by human hands along with traditional equipments.
iii. are carried out manually by human hands along with modern equipments.

c. One of the positive impacts of Green Revolution is
i. reduction in export of food-grains.
ii. reduction in import of food-grains.
iii. reduction in agricultural production.

d. One of the negative impacts of Green Revolution is
i. renovation and advancement of agricultural infrastructure
ii. possibilities of hunger and food crises lowered
iii. inter-crop imbalances

e. Sub-division of agricultural land into smaller plots has occurred due to
i. our inheritance laws where the land belonging to the father is equally distributed among his sons.
ii. our inheritance laws where the land belonging to the mother is equally distributed among her sons.
iii. our inheritance laws where the land belonging to the father is equally distributed among his daughters.

4. **Answer the Following Questions:**
1. State the characteristics of Indian agriculture.
2. Define Green Revolution in India.
3. What are the various problem associated with Indian agriculture?
4. What do you understand by the term ‘National Agricultural Policies’?
5. Write short notes on:
a. Sub-division and fragmentation of holding
b. Positive effects of Green Revolution
c. Negative effects of Green Revolution
d. Nain features of the National Agricultural Policy

3.9 ANSWERS TO THE SELF LEARNING QUESTIONS

1.a.true
1.b. false,The greater proportion, more than two-thirds of the total cropped area, is devoted to the cultivation of food crops
1.c. true

1.d. false, The poor and small farmers still depend on money-lenders in Maharashtra, Karnataka, Tamil Nadu, Orissa, Gujarat, Punjab and U.P.
1.e. false, In 1943 the British ruled India faced the world's worst recorded food disaster known as the Bengal Famine
2.a. Green
2.b. industry
2.c. uneconomic
2.d. crops
2.e. boundaries
3.a.ii.
3.b.ii.
3.c. ii
3.d.iii.
3.e.i.

3.10 TECHNICAL WORDS:

- **Green Revolution**: The green revolution is the increase in crop yields based on cultivation of high—response varieties of wheat, rice, maize and millet, and intensive use of fertilizers, pesticides, irrigation and machinery.
- **Crops**: cereals, vegetables and fruit grown by people.
- **Crop Rotation**: a method of farming which avoids growing the same crop in a field continuously. A regular change of crops maintains soil fertility and reduces the risk of pests and diseases. See Fallow.
- **Cultivation**: the growing of crops.
- **Fertiliser**: nutrients applied to the soil, either artificial (inorganic) or natural (organic).
- **HYVs**: High Yielding Varieties: new types of seed which have been scientifically developed to produce more food per plant.
- **Intensive Farming**: one with high capital and/or labour inputs, a small area of land, and high outputs.
- **Land Tenure**: how the land is owned e.g. tenant, share-cropper, absentee landlord.
- **Monsoon**: the rainy season in south-east Asia.
- **Solar Energy**: the main source of energy on Earth, taken into the food chain by photosynthesis in plants or used by people as a source of electricity and heating.
- **Yield**: how many crops a particular field, farm, or area of land produces.

3.11 TASK

- In a chart define Green Revolution and compare the positive and negative effects of Green revolution in two columns.

3.1. REFERENCES FOR FURTHER STUDY

- Bansil, B. C. (1975): 'Agricultural Problems of India', Delhi.
- Bayliss Smith, T.P. (1987): The Ecology of Agricultural Systems. Cambridge, University Press, London.
- Singh J. (1997): Agricultural Development in South Asia: A Comparative A Study in the Green Revolution Experiences, national Books Organization, New Delhi.
- Singh, J. and Dhillon, S. S. (1984): 'Agricultural Geography', McGraw Hill, New Delhi.
- Singh, J. and Dhillon, S.S. (1988), "Agricultural Geography", 2nd edition, Tata McGraw-Hill, New Delhi
- Symons, L. (1972): 'Agricultural Geography', Bell and Sons, London
- The Hindu (2006): Survey of Indian Agriculture 2006. New Delhi.
- Wigley, G.(1981), Tropical Agriculture: The Development of Production, 4th edition, Arnold, London.
- Agronomy by Yellamananda Reddy
- Plant Breeding by B.D. Singh

4

AGRICULTURAL TRADE

4.0. After going through this chapter you will be able to understand the following features:

4.1. OBJECTIVES

By the end of this unit you will be able to –

- Understand the Agricultural Trade
- Learn Role of WTO in agricultural trade practices
- Analyse Impact of Liberalization, privatization and Globalization on agricultural market

4.2. INTRODUCTION

In the previous units we have studied different aspects of agriculture. The first unit dealt with the definitions and origin of agriculture along with diffusion of agriculture. In the second unit we learnt the major agricultural types in the world such as subsistence

agriculture and commercial agriculture and their sub types. In the third unit we have studied the characteristics of Indian agriculture, Green Revolution in India, Problem associated with Indian agriculture along with National Agricultural Policies. In the present unit we will be studying Agricultural Trade. Role of WTO in agricultural trade practices will also be discussed. Impact of Liberalization, privatization and Globalization on agricultural market will be learnt in the latter part of this unit.

4.3. SUBJECT-DISCUSSION

Romans grew crops solely for the purpose of trade. Therefore the concept of agricultural trade dates back to the time of the Romans itself. Since the very distant past there has been an expansion in agricultural trade. It has expanded into a global enterprise and incorporates innumerable commodities. The modern agricultural market is vast and covers more than just food importing and food exporting. Livestock, raw materials, fibres, and stimulants are other commodities that can be traded. An advance in technology has made agricultural trade more global. Trade agreements made among countries has played an important role regarding this also. As trade becomes more global, countries are taking steps to support policies that promote fair trade and sustainable agriculture practices. Agricultural trade in many countries remains as an important part of overall economic activity. It also plays a pivotal role in domestic agricultural production and employment. Beside these the trading system also plays a major role in global food security and ensures temporary or protracted food deficits arising from adverse climatic and other conditions that can be met from world markets. WTO plays big role in agriculture.

4.4. AN INTRODUCTION TO AGRICULTURAL TRADE

Agricultural trade involves the buying and selling of products that have been produced through the forestry and farming industries. It is a generator of income and welfare for the millions of people who are directly or indirectly involved in it.It is capable of providing the consumer greater access to a number of agriculture goods and most of the time at an affordable price. For example, European countries can acquire cocoa, coffee, and tropical fruits by through agricultural trade. Trade is beneficial in the cold winter months because it brings fresh fruits and vegetables to countries like Canada, the United Kingdom, and the United States during that period.

Among the agricultural goods traded internationally, food products make up almost 80 per cent of the total. The other main category of agricultural products is raw materials. Since the mid-1980s, trade in processed and other high value agricultural products has been expanding much faster than trade in the basic primary products such as cereals.

Food products mainly cereals, vegetables, and fruits are bought and sold in agricultural markets so that it can meet global food demand. Animals such as cattle, sheep, pigs, chickens, and horses are often traded for food and recreation. These animals are also traded for leather production. Beside these, raw materials like lumber and bamboo, are also bought and sold on agricultural markets. But one of the most frequently traded agricultural commodities is fibre. This includes materials like hemp, silk, wool, and cotton. Stimulants like tobacco and alcohol also make up a considerable portion of the agriculture market.

Moreover the economy of any developing country is often operated by its ability to export agricultural products. Agricultural trade provides opportunities for poorer nations but most of these countries lack the infrastructure to distribute the products to a satisfactory or acceptable extent. To these one more point may be added that they can have difficulty competing if high tariffs are placed on their exported goods. As a result, international agricultural trade can be difficult in developing nations, particularly for small-scale or rural farm operations.

4.5. ROLE OF WTO IN AGRICULTURAL TRADE PRACTICES

The volume of world agricultural exports has significantly increased over the last few decades. But its growth rate has lagged behind that of manufactures. Hence a steady decline in agriculture's share in world merchandise trade is found. In 1998, agricultural trade accounted for 10.5 per cent of total merchandise trade and when trade in services is taken into account, agriculture's share in global exports drops to 8.5 per cent. Nevertheless, with respect to world trade agriculture lies ahead of sectors like mining products, automotive products, chemicals, textiles and clothing or iron and steel.

The World Trade Organization (WTO) is the only global international organization that deals with the rules of trade between nations. . It is an organization that liberalized trade and a forum for governments to negotiate trade agreements. World Trade Organization is also recognised as a place for them to settle trade disputes. Actually it is a negotiating forum where the member governments go, to try to sort out the trade problems they face with each other.

The system's most important purpose is to help trade flow as freely as possible by removing any obstacles. This means undesirable side-effects is avoided as far as possible as this is important for economic development and well-being. In a way it also ensures that individuals, companies and governments know what the trade rules are around the world, and give them the assurance that there will be no sudden changes of policy. Hence the rules have to be "transparent" and predictable.

Another important side to the WTO's work is that it also helps to settle disputes. Trade relations often involve conflicting interests. Disputes are settled through some neutral procedure based on an agreed legal foundation.

Steps have been taken by the WTO members to reform the agriculture sector. They took steps to address the subsidies and high trade barriers by which the agricultural trade had been distorted. They aimed to establish a fairer trading system so that the market access is increased and the livelihoods of farmers around the world are improved. The WTO Agreement on Agriculture came into force in 1995. It represents a significant step towards reforming agricultural trade to make it equitable and more competitive. The Agriculture Committee plays the role to oversee implementation of the Agreement.

For further reform members continued to conduct negotiations and in 2015 they adopted a historic decision. The decision was to abolish agricultural export subsidies. It has also set rules for other forms of farm export support.

4.5.1. Trade policies prior to the WTO

Agriculture has always been covered by the GATT. But before the WTO differences were found in the rules applied to agricultural primary products and to industrial products. The GATT 1947 allowed countries to use export subsidies on agricultural

primary products while export subsidies on industrial products were prohibited.

4.5.2. How WTO was born

The WTO was born out of negotiations, and everything the WTO does is the result of negotiations. The bulk of the WTO's current work comes from the 1986-94 negotiations called the Uruguay Round and earlier negotiations under the General Agreement on Tariffs and Trade (GATT). The WTO is currently the host to new negotiations, under the “Doha Development Agenda” launched in 2001.

4.5.3. Uruguay Round agricultural negotiations

It was evident in the Uruguay Round negotiations that the causes of disorder in world agriculture went beyond import access problems and this had been the traditional focus of GATT negotiations. To get to the roots of the problems, disciplines regarding the measures affecting trade in agriculture like domestic agricultural policies and the subsidization of agricultural exports were considered necessary. Clearer rules for sanitary and phytosanitary measures were also considered to be required.

The agricultural negotiations in the Uruguay Round were not at all easy. The broad scope of the negotiations and their political sensitivity required ample time to reach an agreement on the new rules. Moreover much technical work was also needed so that sound means to formalise commitments in policy areas beyond the scope of prior GATT practice is established. The Agreement on Agriculture and the Agreement on the Application of Sanitary and Phytosanitary Measures were negotiated in parallel, and a Decision on Measures Concerning the Possible Negative Effects of the Reform Programme on Least-developed and Net Food-importing Developing Countries also formed part of the overall outcome.

4.5.4. Introduction to the Agreement on Agriculture

On 1 January 1995, the Agreement on Agriculture came into force. The preamble to the Agreement accepts that the agreed long-term objective of the reform process initiated by the Uruguay Round reform programme is to establish a fair and market-oriented agricultural trading system. The reform programme comprises specific commitments to reduce support and protection in the areas of domestic support, export subsidies and market access, and

through the establishment of strengthened and more operationally effective GATT rules and disciplines. The Agreement also considers non-trade concerns, such as food security and the need to protect the environment, and provides special and differential treatment for developing countries, including an improvement in the opportunities and terms of access for agricultural products of particular export interest to these Members.

4.5.5. Relationship with other WTO Agreements

In principle, all WTO agreements and understandings on trade in goods apply to agriculture, including the GATT 1994 and WTO agreements on such matters as customs valuation, import licensing procedures, pre-shipment inspection, emergency safeguard measures, subsidies and technical barriers to trade. However, where there is any conflict between these agreements and the Agreement on Agriculture, the provisions of the Agreement on Agriculture prevail. The WTO Agreements on Trade in Services and on Trade-Related Aspects of Intellectual Property rights are also applicable to agriculture.

4.5.6. Rules and commitments

The Agreement on Agriculture establishes a number of generally applicable rules with regard to trade-related agricultural measures, primarily in the areas of market access, domestic support and export competition.

4.5.7. Implementation period

The implementation period for the country-specific commitments is the six-year period commencing in 1995. However, developing countries have the flexibility to implement their reduction and other specific commitments over a period of up to 10 years. For the purpose of the peace clause, the implementation period is the nine-year period commencing in 1995.

4.5.8. Committee on Agriculture

The Agreement established a Committee on Agriculture which oversees the implementation of the Agreement on Agriculture. For this cause the Committee generally meets four times per year. Special meetings are also convened as and when required.

4.6. IMPACT OF LIBERALIZATION ON AGRICULTURAL MARKET

Since July, 1991 the country has taken a series of measures to structure the economy and improve the balance of payments position. The New Economic Policy (NEP-1991) introduced changes in the areas of trade policies, monetary & financial policies, fiscal & budgetary policies, and pricing & institutional reforms. The salient features of NEP-1991 are (i) liberalization (internal and external), (ii) extending privatization, (iii) redirecting scarce Public Sector Resources to Areas where the private sector is unlikely to enter, (iv) globalization of economy, and (v) market friendly state.

In today's world liberalization is an unquestionable trend and affects all aspects of economics in the world. There is lot of anxiety as well as apprehension about the impact of trade liberalization on producers, consumers and the economy.

India being a founder member of the World Trade Organization (WTO) is committed in moving in the direction of liberalization of trade in agricultural commodities. Quantitative restrictions on imports have phased out and exports have liberalized. At present except for a few commodities, agricultural exports and imports are permitted through private trade.

The economic liberalization in India refers to ongoing economic reforms in India that started on 24 July 1991. Indian agriculture rotates around many small farmers who earn their livelihoods from cultivating small plots of land with little access to resources like water, seed and fertilizer. Almost 60% of India's population directly depends on agriculture.

Until June 1991, India followed a very restrictive economic policy characterized by exclusion of the private sector from many important industries. India faced liquidity crisis in 1991. The balance of payment situation had deteriorated so sharply and the foreign exchange reserves had fallen so low that, the possibility of default in payment was imminent.

The economic liberalization ushered in June 1991 changed the scenario very substantially. Recently Government has undertaken export promotion measures. Agricultural commodities are sold by the farmers through four marketing channels, such as:

a. direct to consumers

b. through wholesalers and retailers

c. through public agencies

d. through processors

4.6.1. Role of the government

The government takes part in agricultural trade through purchase of agricultural commodities under

- the MSP programme
- procurement of food grains
- monopoly purchase
- open market purchases of commodities

In the case of food grains, especially rice and wheat, the government purchase agency i.e. Food Corporation of India, is an important market functionary for cereals. State agencies namely National Cooperative Marketing Federation of India (NAFED), Cotton Corporation of India (CCI) and Jute Corporation of India (JCI) enter into open market procurement of various agricultural commodities.

4.6.2. Liberalization and its effects on Agriculture: The neo-liberal economic policy packages

The economic reforms do not include any specific package designed for agriculture. Since the beginning of the 1990s the policies of the central government directly as well as indirectly had brought changes on farmers' welfare. We may say that the idea rather was to free agricultural markets and liberalize external trade in agricultural commodities. Nevertheless, the changes in patterns of government spending and financial measures affected the conditions of cultivation. The neo-liberal economic reform strategy involved the following measures which specifically affected the rural areas:

- Actual declines in Central government revenue expenditure on rural development, cuts in particular subsidies such as on fertilizer in real terms, and an the overall decline in per capita government expenditure on rural areas.

- Reduction in public investment in agriculture, including in research and extension.
- Very substantial declines in public infrastructure and energy investments that affect the rural areas, including in irrigation.
- Reduced spread and rising prices of the public distribution system for food. This had a substantial adverse effect on rural household food consumption in most parts of the country.
- Financial liberalization measures including redefining priority sector lending by banks, which effectively reduced the availability of rural credit, and thus made farm investment more expensive and more difficult, especially for smaller farmers.
- Liberalization and removal of restrictions on internal trade in agricultural commodities, across states within India.
- Liberalization of external trade, first through lifting restrictions on exports of agricultural goods, and then by shifting from quantitative restrictions to tariffs on imports of agricultural commodities.

Liberalization of food grain markets appears to have beneficial effects through freeing the locked resources of the Government for better usage through investments and implementing poverty alleviation schemes like National Food for Work Programme, National Rural Employment Guarantee Scheme, Indira Housing Schemes and National Social Assistance Programme. Due to excessive government interventions in the marketing of Indian agricultural commodities within the country there is a need to liberalize domestic agricultural markets from the existing, and even non-existing, regulated physical markets in favour of private markets, forward markets, and contract farming.

The biggest problem Indian agriculture faces today is debt. This is the number one cause of farmer suicides too. Lack of proper credit facilities makes farmers turn to private moneylenders who charge exorbitant rates of interest. Farmers get caught into a debt trap when he borrows again to repay these debts.

So, the gap between imports and exports is widening therefore the government should find out a plan of action designed to increase its exports and decrease the gap. The government to promote exports may adopt the following strategies like:

- Improvement of post-harvest technology
- Improvements in agricultural productivities
- Increase the irrigation potentials
- Encourage the farmers to adopt least-cost production methods to reduce cost of cultivation through strengthening of extension services and to provide necessary infrastructural facilities at the regional level to promote farm export.

4.6.3. The impact of Trade Liberalization of Agricultural Markets

With the beginning of trade liberalization international agricultural markets have undergone changes. Point to be noted that these structural changes are quite apart from trade policy reform effects. These changes are as follows:

- Important changes in food consumption patterns continued.
- Important changes observed in farm production with modern or industrial-type agricultural and livestock production moving to larger-scale.
- Three different kinds of capital inputs are used in the farm sector:
    a. purchased capital, such as machinery, which largely acts as a substitute for labour inputs.
    b. purchased capital such as fertilizers, pesticides and more recently, genetically modified organisms, which serve as substitutes for land.
    c. natural capital not directly linked with land, including livestock.
- With a decline in transportation costs profound changes in agricultural markets observed. This includes a decrease in the cost of marine transportation too. An extension in roads that penetrate into natural areas for resource extraction established new locations of production also.
- There were numerous impacts of improved transportation on biodiversity too.

To conclude it may be said that Indian agricultural markets are expected to get affected through various readjustments in the output-vector because it exists before and after trade liberalization both at global and Indian borders. Beside all these food security issues must be kept in view during the process of liberalization of trade in agriculture.

4.7. IMPACT OF PRIVATIZATION ON AGRICULTURAL MARKET

Privatisation is defined as the transfer of ownership and control of public sector units to private individuals or companies. It is unavoidable because of structural adjustment programmes imposed by IMF.

4.7.1. Objectives of Privatisation:

- To strengthen the private sectors.
- Government to concentrate on areas like education and infrastructure.

When globalization came into being the government became aware that to achieve global standard in public sectors its increasing inefficiency must be controlled. So a decision to privatise the Public Sectors was taken. Bureaucratic administration, out dated technology, corruption, lack of accountability, domination of trade unions, political interference and lack of proper marketing activities are the reasons behind the inefficiency of Public Sectors.

4.7.2. Privatisation has its own advantages and disadvantages such as:

- **Advantages**:

a. Efficiency

b. Absence of political interference

c. Quality service.

d. Systematic marketing

e. Use of modern Technology

f. Accountability

g. Creation of competitive environment.

h. Innovations

i. Research and development

j. Optimum utilisation of resources

k. Infra structure.

- **Disadvantages**

a. Exploitation of labour.

b. Abuse of powers by executives.

c. Unequal distribution of wealth and income.

d. Lack of job security for employees.

Agriculture is "public" in terms of policy and programme needs. It is "private" in terms of production, marketing and consumption decisions. Privatisation has become inevitable in the present situation. But some control should be exercised by the government over private sectors.

Government can regulate and facilitate agricultural marketing so that it can ensure fair trade and protection of public interest. This maybe done by providing market information and improving market infrastructure and standardization, rather than monopolizing or competing in input supply, production, marketing, transportation, storage, processing or trading.

Public enterprises pursue social objectives. They face political pressures, bureaucratic failure and lack of financial discipline.As a result they suffer from poor performance in terms of financial outlay and output. On the other hand, privatization tends to be more helpful to competition and financial discipline. Hence there is economic efficiency. The competition is often imperfect due to private monopoly, public and merit goods, externalities, and information problems. Nevertheless, the private sector option is viewed as superior in terms of tackling economic distortions and promoting economic growth.

4.8. IMPACT OF GLOBALIZATION ON AGRICULTURAL MARKET

Globalisation is the term used to describe the recent impact of innovations in communications and transport systems on trade and the growing interdependence of countries due to economic development and economic output. With the aim to increase the volume of trade, including trade in agricultural products, the nations have to reduce the high levels of protection between trading blocks of countries. Moreover for many countries, increased economic liberalisation and openness has led to growth too. Furthermore for some countries as well as for some communities within countries the transition from a protected, centrally controlled economy has a possibility to bring with it serious, negative, short and medium term consequences.

Under globalisation, particularly after 1990, the farmers in India have been exposed to new challenges. India is an important producer of rice, cotton, rubber, tea, coffee, and jute and spices. In spite of this our agricultural products are not capable of competing with the developed countries because of the highly subsidised agriculture in those countries. History tells us that during the British period cotton was exported to Britain as a raw material for their textile industries in Manchester and Liverpool. Thus cotton textile industry flourished in Britain due to the availability of good quality cotton from India.

4.8.1. Impact of Globalization on Agriculture:

Although India is the second largest producer of food in the world the average annual growth rate of its agriculture is very slow. Prior to liberalization of the economy during 1980-1990 it was 3.1 %.

Since then it was observed that the annual growth rates have declined consistently relative to annual growth rate of the population. Several factors were responsible for this fall in growth rate. The reasons are stated under:

- lack of credit
- inadequate irrigation cover
- indebtedness
- continuing use of obsolete technology
- improper use of inputs and decline in the public investments

There was decline in overall growth of employment during 1993-94 to 2004-05. This was mainly due to fall in creation of employment opportunities in agriculture. Moreover, there was increase in knowledge and many foreign firms entered in the non-agricultural sectors. So the labours shifted to manufacturing and services sectors.

With globalization farmers were coaxedto shift from traditional crops to export-oriented 'cash crops' such as cotton and tobacco. But these crops needed far more inputs in terms of fertilizers, pesticides and water. The growth in yields of principal crops notablyrice and wheat have also slowed down. There has been a decline in overall area under food grains during 2011-12 also. This is due to a shortfall in the area underjowar in Maharashtra, Rajasthan and Gujarat; Bajra in Maharashtra, Gujarat and Haryana; and in pulses in Maharashtra, Uttar Pradesh, Andhra Pradesh, and Rajasthan.

Appropriate use of agricultural equipments made farming financially viable and profitable. There has been considerable progress in farm mechanization but it is not spread across the country evenly. Among many supply side constraints to agricultural production irrigation is the most important one as it only covers only about 40 percent of net sown area. There has been a slow down in the growth rate of direct demand for food grain consumption on account of several factors and there is a need to address these challenges of the agriculture sector through coordinated efforts directed at improving farm production and productivity through high value crops, developing rural infrastructure, renewing thrust on the irrigation sector, strengthening marketing infrastructure, and supporting investment in R&D with due emphasis on environmental concerns.

4.9. SUMMARY

Going through this unit we have come to know that there is a severe global economic crisis. To solve this serious deterioration in the economic situation of many countries around the world transparency and effective monitoring of trade and trade-related measures should be taken. The contribution of WTO members to manage the trade policies is worth mentioning. This unit has also helped us to have a better understanding of why countries have chosen to cooperate with one another in trade matters down the years. Governments of different nations have embraced numerous

objectives at different times, especially the relative standing of their economies in the international order. This also includes the priorities imposed by their level of economic development.

The advent of globalization as a result of liberalization and privatization has both positive and negative impacts on our economy. From India's perspective, globalization has improved our conditions of living and opened up employment in fields like entertainment, telecommunication, travel and hospitality.

4.10. CHECK YOUR PROGRESS/ EXERCISE

1. **True and false**

   a. Agricultural trade in many countries remains as an important part of overall economic activity.

   b. Trade is not at all beneficial in the cold winter months.

   c. An important side to the WTO's work is that it encourages disputes in trade relations.

   d. To reform the agriculture sector WTO members took steps to address the subsidies and high trade barriers by which the agricultural trade had been distorted.

   e. The WTO Agreement on Agriculture came into force in 1985.

2. **Fill in the blanks**

   a. The WTO was born out of_____, and everything the WTO does is the result of negotiations.

   b. One of the objectives of privatisation is to strengthen the _____ sectors.

   c. Under_____, particularly after 1990, the farmers in India have been exposed to new challenges.

   d. India is the _____largest producer of food in the world but the average annual growth rate of its agriculture is very slow

   e. With globalization farmers were coaxed to shift from traditional crops to export-oriented _____ _____ such as cotton and tobacco.

3. **Multiple choice questions**

a. Trade relations often involve conflicting interests and disputes are settled

   i. through some neutral procedure based on mediation.

   ii. through some neutral procedure based on an agreed legal foundation.

   iii. through some biased procedure based on facilitation.

b. The bulk of the WTO's current work comes from

   i. the 1986-94 negotiations called the Brazil Round.

   ii. the 1986-94 negotiations called the Uruguay Round.

   iii. the 1988-98 negotiations called the Uruguay Round.

c. The economic liberalization in India refers to ongoing economic reforms in India

   i. that started on 24 July 1991

   ii. that started on 24 July 1992

   iii. that started on 24 July 1981

d. Agricultural commodities are sold by the farmers through four marketing channels, such as:

   i. direct to consumers ,through local resellers, through public agencies, through processors

   ii. direct to consumers ,through wholesalers and value added reseller, through field agents, through processors

   iii. direct to consumers ,through wholesalers and retailers, through public agencies, through processors

e. Appropriate use of agricultural equipments made farming financially

   i. unachievable and non profitable

   ii. fruitless and irreversible

   iii. viable and profitable

4. **Answer the Following Questions:**

1. Define Agricultural Trade. Elaborate your answer with suitable examples.
2. State the Role of WTO in agricultural trade practices.
3. What are the impacts of Liberalization on agricultural market?
4. What do you know about the impact of privatization on agricultural market?
5. Write a short note on the impact of Globalization on agricultural market.

4.11. ANSWERS TO THE SELF LEARNING QUESTIONS.

1.a. true

1.b. false, Trade is beneficial in the cold winter months

1.c. false, An important side to the WTO's work is that it helps to settle disputes.

1.d. true

1. e. false, The WTO Agreement on Agriculture came into force in 1995.

2.a. negotiations

2.b. private

2.c. globalisation

2.d. second

2.e. 'cash crops'

3.a.ii.

3.b.ii.

3.c.i.

3.d.iii.

3.e.iii.

4.12. TECHNICAL WORDS:

- **Privatisation:** the transfer of a business, industry, or service from public to private ownership and control
- **Globalisation**: the process by which businesses or other organizations develop international influence or start operating on an international scale.
- **Liberalization:** the removal or loosening of restrictions on something, typically an economic or political system.
- **IMF**: The International Monetary Fund (IMF) is the central institution embodying the international monetary system and promotes balanced expansion of world trade, reduced trade restrictions, stable exchange rates, minimal trade imbalances, avoidance of currency devaluations, and the correction of balance-of-payment problems. The IMF's goal is to prevent and remedy international financial crises by encouraging countries to maintain sound economic policies. Because of its size, the IMF is also a forum for discussion of global economic policies. The IMF is headquartered in Washington, D.C., but has offices in Paris, Tokyo, New York, and Geneva.

4.13. TASK

- In a chart write down the impact of Liberalization on agricultural market and role of government in points.

4.14. REFERENCES FOR FURTHER STUDY

- Bansil, B. C. (1975): ‘Agricultural Problems of India’, Delhi.
- Bayliss Smith, T.P. (1987): The Ecology of Agricultural Systems. Cambridge, University Press, London.
- Singh J. (1997): Agricultural Development in South Asia: A Comparative A Study in the Green Revolution Experiences, national Books Organization, New Delhi.
- Singh, J. and Dhillon, S. S. (1984): ‘Agricultural Geography’, McGraw Hill, New Delhi.

- Singh, J. and Dhillon, S.S. (1988), “Agricultural Geography”, 2nd edition, Tata McGraw-Hill, New Delhi
- P.J. Edwards et al (1999), “The Effects of Alternative Tillage Systems on Biodiversity in Agro-ecosystems,” in D. Wood and J.M. Lenne, eds., Agro biodiversity: Characterization, Utilization and management, CABI Publishing Ltd., London.
- Acharya, S.S., ‘Agricultural Marketing,’ in State of the Indian Farmer (New Delhi, Ministry of Agriculture and Academic Publishers, 2004), vol. xvii.
- Ackerman, F., ‘The Shrinking Gains from Trade: A Critical Assessment of Doha Round Projections,’ Working Paper No. 05-01 (Global Development and Environment Institute, Tufts University, 2005).
- Chadha, R., D.K. Brown, A.V. Deardorff, and R.M. Stern, ‘Computational Analysis of the Impact on India of the
- Uruguay Round and the Doha Development Agenda Negotiations,’ in AadityaMattoo and RobertM. Stern (eds), India.
- Symons, L. (1972): ‘Agricultural Geography’, Bell and Sons, London
- The Hindu (2006): Survey of Indian Agriculture 2006. New Delhi.
- Wigley, G.(1981), Tropical Agriculture: The Development of Production, 4th edition, Arnold, London.
- Agronomy by Yellamananda Reddy
- Plant Breeding by B.D. Singh

5

ECONOMICS OF AGRICULTURAL LAND USE

5.0. After going through this chapter you will be able to understand the following features:

5.1. OBJECTIVES

By the end of this unit you will be able to –

- Understand Economic development of agricultural land use model of Lewis
- Analyse Limitations of the Lewis model and its applicability in India
- Analyse Economic development of agricultural land use model of Hoover's
- Learn Limitations of the Hoover's model and its applicability in India

- Study Organic agriculture
- Study Nutritional agriculture
- Learn Sustainable development of Agriculture

5.2. INTRODUCTION

In the previous units we have studied different aspects of agriculture. The first unit dealt with the definitions and origin of agriculture along with diffusion of agriculture. In the second unit we learnt the major agricultural types in the world such as subsistence agriculture and commercial agriculture and their sub types. In the third unit we have studied the characteristics of Indian agriculture, Green Revolution in India, Problem associated with Indian agriculture along with National Agricultural Policies. In the fourth unit we studied Agricultural Trade. Role of WTO in agricultural trade practices have also been discussed along with Impact of Liberalization, privatization and Globalization on agricultural market. In the present unit we will study the Economic development of agricultural land use model of Lewis and Hoover's. The limitations of the Hoover's and Lewis model and its applicability in India will also be learnt. Organic agriculture, Nutritional agriculture and Sustainable development of Agriculture will be studied in the latter part of this unit.

5.3. SUBJECT-DISCUSSION

Agriculture is the most extensive form of human occupation where half of the world's population earns its livelihood. It has changed dramatically, especially since the end of World War II. Regarding the economics of agricultural land use we have aimed to study Lewis model. Lewis Offers a model of growth based on existence of disguised unemployment in less developed countries. It is propounded in his work, 'Economic development with Unlimited Supply of Labour'. It is also known as the two-sector surplus labour model. Next come Hoover's model. Among those who added to Weber's efforts is E.M. Hoover, who gave considerable attention to the impacts of supply and demand on locational analysis. Hoover related supply and demand to the locations of individual firms, general industrial arrangements over the landscape, and the problems of communities and regions.

Among different farming systems, Organic farming system is not new and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good condition.

Agriculture has made remarkable advances down the ages, but contribution of the same in improving the nutrition and health of poor farmers and consumers in developing countries lags behind. Nutrition starts with what we eat and food is the product of agriculture sector. By working on our food systems, on the way we produce, collect, store, transport, transform and distribute foods, we can improve our diets, our health and our impact on natural resources.

Sustainable agriculture is a subject of great interest and lively debate in many parts of the world and is used to define farming practices that are conducted with three main aims; environmental conservation, economic profitability as well as social equity. One thing that should be noted about sustainable agriculture is that it does not advocate for the use of chemicals and commercial fertilizers in the cultivation of crops. Most agriculturalists agree that the concept of sustainable agriculture is of paramount importance to the sustainability of our biosphere and its ever increasing human population.

5.4. ECONOMIC DEVELOPMENT OF AGRICULTURAL LAND USE MODEL OF LEWIS

5.4.1. Lewis Model of Unlimited Supply of Labour:

In the mid 1950s, Nobel Laureate, W. Arthur Lewis presented his model of unlimited supply of labour or of surplus labour economy. The dual-sector model is a model is invented by W. Arthur Lewis. It is commonly known as the Lewis model after him. The theory was first published in the form of an article in the Manchester School in May 1954. It explains the growth of a developing economy in terms of a labour transition between the capitalist sector and the subsistence sector. By surplus labour it was meant that even if part of manpower is withdrawn from the process of production no fall in the amount of output will be observed.

5.4.2. Assumptions of the Lewis Model are stated under:

- There is a duel economy i.e., the economy is characterized by a traditional, over-populated rural subsistence sector furnished with zero MPL, and the high productivity modern urban industrial sector.
- The subsistence sector does not make the use of 'Reproducible Capital', while the modern sector uses the produced means of capital.

- The production in the advanced sector is higher than the production in traditional and backward sector.
- According to Lewis, the supply of labour is perfectly elastic. In other words, the supply of labour is greater than demand for labour.
- The Lewis model assumes that there is a surplus of unproductive labour in the agricultural sector in a developing economy.
- These workers are tempted towards the growing manufacturing sector as higher wages are offered there.
- The model assumes that the wages in the manufacturing sector are more or less fixed.
- Entrepreneurs in the manufacturing sector make profit because they charge a price above the fixed wage rate.
- It also assumes that these profits will be reinvested in the business in the form of fixed capital.
- An advanced manufacturing sector means an economy has moved from a traditional to an industrialized one.

Lewis has made an attempt to revive the classical model and had firmly stressed that the classical assumption of unlimited supply of labour is more relevant under conditions prevailing in majority of UDC (Urban District Council). Prof. Lewis has studied the process of economic development in the dual or two sector economy with special reference to UDC.

5.4.3. The followings are the sources of unlimited supply of labour in UDCs.

a. With the increase in population more than required number of labours is found working with lands. They are called disguised unemployed.
b. In UDCs innumerable people are engaged in temporary and part time jobs. So, there will be no fall in the production even if their number is lessened.
c. The landlords and feudal have an army of tenants who do not make any contribution towards production. They are also prepared to work even at lesser wages.
d. The women in UDCs do not work, but they just perform house-hold duties. Thus they also represent unemployment.
e. The high birth rate in UDCs leads to grow unemployment.

5.4.4. Basic Thesis of the Lewis Model:

Lewis model is a classical type model. This model states that at the prevailing subsistence wages there may be unlimited supplies of labour. The industrial and advanced modern sector can be developed on the basis of agriculture. This can be done by transferring the labour from traditional sector and modern sector.

Lewis says that the wages in industrial sector is constant. The capitalists will earn 'surplus'. Such surplus will be re-invested in the modern sector and that will lead in absorption of labourers who have migrated from subsistence sector. Hence the surplus labours or the labourers who were part of disguised unemployment will get employment. So the labour transfer as well as the modern sector employment growth is brought about by output expansion in that sector. The speed with which this expansion occurs is determined by the rate of industrial investment and capital accumulation in the modern sector. The wages have been assumed constant, but Lewis says that the urban wages are at least 30% higher than the average rural income. So the workers are induced to migrate from their home areas.

5.5. LIMITATIONS OF THE LEWIS MODEL AND ITS APPLICABILITY IN INDIA

Lewis two-sector development model is simple. It is roughly in conformity with the historical growth in the West. In spite of these it has some flaw as stated under.

i. **Proportionality between Employment Creation and Capital Accumulation:** Lewis model assumes that there exists proportionality in the labour transfer and employment creation in modern sector and rate of capital accumulation in the modern sector. The faster the rate of capital accumulation, the higher the growth rates of the modern sector and faster the rate of new job creation. But if the capitalists reinvest their profits in the labour-saving capital equipment rather increasing the labour employment (what has been assumed in Lewis model) the jobs will not be created and modern sector will not expand. This happened in case of Pakistan where during 2nd five year plan, the wages remained constant and the capitalists rather re-ploughing their surplus shifted it to the 'Swiss Banks'. All this led to resentment against the strategy of increasing the surpluses of capitalistic class. Now we employ a diagram where we shall show that labour demand curves do not shift uniformly outward. It is so because that increase in capital stock will embody labour saving technology.

ii. **Peak Harvesting and Sowing Season:** Lewis did not pay attention to the pattern of seasonality of labour demand in traditional agricultural sector.

iii. **Rise in Urban Wages:** According to Prof. Mabro the absorption of surplus labour itself may end pre-maturely because competitors (producers) may alter wage rates and lower the share of profit. It has been shown that rural-urban migration in Egyptian economy was accompanied by increase in wage rate of 15% and a fall in profits by 12%.

iv. **Full Impact of Growing Population:** Lewis model underestimates the full impact on the poor economy of a rapidly growing population, i.e., its effects on agri. surplus, the capitalist profit share, wage rates and overall employment opportunities. Similarly, Lewis assumed that the rate of growth in manufacturing sector would be identical to that in agri. sector. But, if industrial development involves more intensive use of capital than labour, then the flow of labour from agri. to industry will simply create more unemployment.

v. **Ignoring the Balanced Growth:** Lewis ignored the balanced growth between agricultural sector and industrial sector. But we know that there, exists a linkage between agri. growth and industrial expansion in poor countries. If a part of profits made by capitalists is not devoted to agri. sector, the process of industrialization would be jeopardized (perhaps, due to reduced supply of raw material). Because of this flaw, Ranis-Fei model considers the balanced growth of both sectors. This will be discussed after this model.

vi. **Ignoring the Role of Leakages:** Lewis has ignored the role which the leakages can play in the economy. As Lewis assumed that all of increase in profits is diverted into savings. It means that savings of producers are equal to one. But, practically it is not so. The increase in profits may accompany the increase in consumption. As in Pakistan during 2nd plan the capitalistic class diverted their increased profits to palacious houses and conspicuous consumption. In such tike situation the MPS out of profits will be less than one.

vii. **Process of Migration is Neither Smooth Nor Costless:** Lewis assumed that the transfer of unskilled labour from agriculture to industry is regarded as almost smooth and costless. But, practically it is no so as industry requires different types of labour. If this problem is removed with the

help of investment in education and skill formation, the process of migration will become costlier and expensive.

5.6. ECONOMIC DEVELOPMENT OF AGRICULTURAL LAND USE MODEL OF HOOVER'S

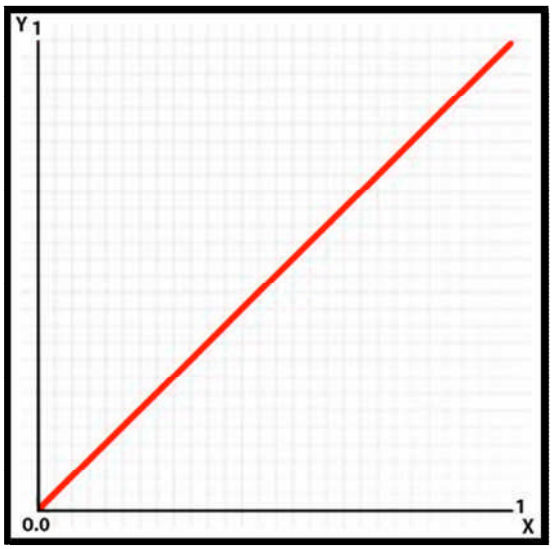
Hoover propounded a least cost theory of location, in which he tried to overcome some of the weaknesses of Weber's theory. Hoover initially assumes a perfect competition between producers or sellers at any one location. Secondly, he assumes perfect mobility of factors of production and takes transportation costs and production or extraction costs as the determinants of location. He considers extractive industries first, with the location of deposits given, and attempts to find the area that each producing point will serve. The delivered price for any buyers will be the cost of extraction plus transport costs.

5.6.1. E.M. Hoover: Spatial Differences in Supply and Demand

E.M. Hoover added to Weber's efforts by giving considerable attention to the impacts of supply and demand on locational analysis. Hoover completed his two major works in 1937 and 1948. In1937 he explained location theory in his book 'The Location Theory and the Shoe and Leather industry.' But in 1948 a more selective approach about it was given in his book 'The Location of Economic Activity', where the approach of transport cost has been explained more precisely. According to Hoover the two factors most important for industrial location are production cost and transport cost. If there is no change in the production cost, transport cost will be the only variable affecting the price of commodity. Hoover also includes the influence of diminishing returns to scale. According to him extractive industries operate in such a situation where average cost rises with increasing production especially when the market area increases.

Hoover had also taken into account the locational influences of short-term economic changes like recessions or times of high inflation. Beside this he also considered locational influences to long-term trends such as innovations in technology. To find out why some regions do well while other are distressed he included these factors in his analyses of regional differences. Hoover was also interested in the effects of the configuration of transfer costs and rate-setting decisions. While studying these variables, he pointed out the impacts of the long-haul advantage on Weber's locational triangle. The long-haul advantage is beneficial when merchandise, goods, or raw materials are transported over a long distance.

If it were true that transportation costs are directly proportional to distance (as Weber assumes in his model), the locational impacts of a firm using a single raw-material source and one market would be graphically represented by a straight line that would rise diagonally from the source to the market, and the costs of distributing the resultant product could also be graphically represented by a linear line. In other words, the costs of transport in either case would simply be a direct function of distance.



Y = transportation costs, X = distance

If weight-losing materials were used, the line would bend upward to the right because the cost of procurement would be greater. In this case, the least-cost site for production would have been at the site of the raw material.

Hoover argued that transportation rate curves are not linear. They do not begin at 0as there are terminal costs involved. Goods or raw materials must be loaded and unloaded. Moreover the costs related to the paperwork must be included.

Hoover states like Weber that when production cost difference is absent, the best location will be at the point of minimum transport cost. This kind of location may occur at the point of market, at the place where the localized material is available or any other place. But the market price of each producer is different at different places because of difference in production cost and transport cost. That is why each producer gets different size of market areas to deal with.

He has represented this by a system of isotims, radiating from the point of production and joining places of equal delivered price. Buyers will obtain the commodity from the source that offers

the lowest delivered price and the boundary between the market area of two producers will be a line joining the points at which delivered price is the same from both sources. As long as the cost of extraction does not vary with output, transport costs are the only variable affecting price, but Hoover extends his analysis to include the influence of diminishing returns to scale. He follows Weber, fairly closely at first, pointing that in the absence of production cost differences the best location will be at the point of minimum transport costs, which may be at a material source, at the market or at an intermediate point: The least-transport-cost location is found by drawing isotims around given material and market points, from which lines of equal total transport cost (isodopanes) can be constructed. But Hoover goes further than Weber by showing how different sections of the market will be served by different producing points. He also differs with Weber's emphasis on least transport cost points within locational triangles. Even with the assumption of uniform transport costs, the possibility of a separate minimum point not at one corner of the triangle is much less than might be thought at first sight. It is far more likely than what Weber suggested that a material or the market will have a pull which will be greater than that of the other corners. The chance of a location not at one corner is even less likely, if the fact that transfer costs are actually less than proportional to distance is also considered. In addition, loading costs and other terminal changes operate against least cost location inside the triangle. If a separate point away from material sources and market does occur, Hoover suggests that perhaps this is a sign that industry is not primarily transport oriented at all and that possibly a low labour cost location enters into the picture. He claims that in practice the influence of transfer costs tends to locate production at markets, at sources of raw material, or at junction breakpoints in the transport network. In considering, production costs, Hoover follow Weber's analysis of a cheap labour location very closely. He views it as a possible production point if the saving in labour cost compensates for increasing transfer charges.

Greenhut praised Hoover's contribution in the field of location theory. He pointed out thatalthough it has not so much theoretical originality but its main contribution lies in anintelligent and carefuldiscussion of the influences of various location factors. A detailed consideration of transfer costs is also praise worthy.

5.7. LIMITATIONS OF THE HOOVERS MODEL

Hoover's contribution has some limitations too.

- Like Weber, he viewed transport orientation as something that could be analysed separately. He did not integrate other causal factors into his theory as fully as he might have done.
- In spite of his references to market areas, he was more concerned with cost than with the demand factor.
- Greenhut has also criticised Hoover for his failure to probe deeply into locational interdependence.

5.8. ORGANIC AGRICULTURE

Organic farming, an alternative agricultural system relies on ecosystem management rather than external agricultural inputs. It was originated early in the 20th century in reaction to rapidly changing farming practices. This system begins to consider potential environmental and social impacts by eliminating the use of synthetic inputs, such as synthetic fertilizers and pesticides, veterinary drugs, genetically modified seeds and breeds, preservatives, additives and irradiation. These are replaced with site-specific management practices. All these maintain and increase long-term soil fertility as well as prevent pest and diseases. Many studies have shown that organic farming methods can produce even higher yields than conventional methods.

An increasing number of farmers have shown lack of interest in farming during last few years. Moreover the people who used to cultivate are migrating to other areas. Organic farming is one way to promote either self-sufficiency or food security.

Use of massive inputs of chemical fertilizers and toxic pesticides poisons the land and water heavily. The after-effects of this are severe environmental consequences, including loss of topsoil, decrease in soil fertility, surface and ground water contamination and loss of genetic diversity. Nowadays various organic agriculture organizations are developing organic farming relying on fertilizers of organic origin like compost manure, green manure, and bone meal. It also put emphasis on techniques such as crop rotation and companion planting. Biological pest control, mixed cropping and the fostering of insect predators are also

encouraged. Moreover, organic standards are planned to allow the use of naturally occurring substances and prohibits synthetic substances. For example, naturally occurring pesticides such as pyrethrin and rotenone are permitted, while synthetic fertilizers and pesticides are generally forbidden. But some synthetic substances such as copper sulphate, elemental sulphur and Ivermectin are allowed. The arguments for organic farming include real advantages in sustainability, openness, self-sufficiency, independence, health, food security, and food safety. Nonetheless the match between perception and reality is continually challenged.

Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organic farming organizations established in 1972.

5.8.1. Three different driving forces can be identified for organic agriculture:

i. **Consumer or market-driven organic agriculture**. Products are clearly identified through certification and labelling. Consumers take a conscious decision on how their food is produced, processed, handled and marketed. The consumer therefore has a strong influence over organic production.

ii. **Service-driven organic agriculture**. In countries such as in the European Union (EU), subsidies for organic agriculture are available to generate environmental goods and services, such as reducing groundwater pollution or creating a more biologically diverse landscape.

iii. **Farmer-driven organic agriculture**. Some farmers believe that conventional agriculture is unsustainable and have developed alternative modes of production to improve their family health, farm economies and/or self-reliance. In many developing countries, organic agriculture is adopted as a method to improve household food security or to achieve a reduction of input costs. Produce is not necessarily sold on the market or is sold without a price distinction as it is not certified. In developed countries, small farmers are increasingly developing direct channels to deliver non-certified organic produce to consumers. In the United States of America (USA), farmers marketing small quantities of organic products are formally exempt from certification.

5.8.2. Advantages of organic farming

a. It helps in maintaining environmental health by reducing the level of pollution.

b. It reduces human and animal health hazards by reducing the level of residues in the product.

c. It helps to keep agricultural production at a sustainable level.

d. It reduces the cost of agricultural production and also improves the soil health.

e. It ensures optimum utilization of natural resources for short-term benefit and helps in conserving them for future generation.

f. It not only saves energy for both animal and machine, but also reduces risk of crop failure.

g. It improves the soil physical properties such as granulation, good aeration, easy root penetration as well as improves water-holding capacity. It also reduces erosion.

h. It improves the soil's chemical properties such as supply and retention of soil nutrients, reduces nutrient loss into water bodies and environment and promotes favourable chemical reactions.

5.8.3. Nutrient management in organic farming

In organic farming soil is tried to make healthy and rich in organic matter with all the nutrients that the plants need. The organic sources such as green manure and bio-fertilizers add different nutrients to the soil. Soil with high organic matter resists soil erosion and holds water better. Hence less irrigation is needed. Lime is added to soil to adjust the soil's pH balance. Most of the organic fertilizers used are recycled by-products from other industries that would otherwise go to waste. Farmers also make compost from animal manures and mushroom compost.

5.8.4. Different available organic inputs are described below:

1. **Organic manures**- It is easily available but being low in nutrient content high application rates are needed to meet crop nutrient requirements. In many developing countries, including India, it is observed that the availability of organic manures is not sufficient

for crop requirements because cattle dung is extensively used in energy production. Green manuring is done with Sesbania, cowpea, green gram etc. However, considering these constraints International Federation of Organic Agriculture Movement (IFOAM) and Codex Alimentarius have approved the use of some inorganic sources of plant nutrients like rock phosphate, basic slag, rock potash etc. in organic farming systems.

2. **Bacterial and fungal bio-fertilizers**- Contribution of biological fixation of nitrogen on surface of earth is the highest (67.3%) among all the sources of N fixation. Rhizobium, Azotobacter, Azospirillum, Plant growth promoting rhizobacteria, Mycorrhizal fungi etc. are some bacterial and fungal biofertilizers that may be used as a component of organic farming in different crops.

5.8.5. Weed management in organic farming

In organic farming, chemical herbicides cannot be used. So weeding can be done only manually.

5.8.6. Insect pest management

The presence of pests is anticipated in advance in organic farming. So the planting schedules and locations are adjusted accordingly to avoid serious pest problems. To combat harmful pests a population of beneficial insects is built up. Larvae of these beneficial insects feed off the eggs of pests.

5.8.7. Diseases management in organic farming

Plant diseases restrict crop yield. Proper fertility management to crops through balanced supply of macro and micronutrients and adoption of crop rotation have shown to improve the resistance of crops to certain diseases.

5.8.8. Limitations and implications of Organic farming are as follows:

a. Organic manure is not abundantly available. It is more expensive compared to chemical fertilizers, if purchased.

b. Production in organic farming declines especially during first few years, so the farmer should be given premium prices for organic produce.

c. Ordinary Indian farmer is not capable to understand the guidelines for organic production, processing, transportation and certification.

d. Marketing of organic produce is also not properly streamlined.

There are a number of farms in India where thousands of farmers cultivating million acres of land are not classified as organic though they are. Their produce is sold in the open market along with conventionally grown produce at the same price.

5.9. NUTRITIONAL AGRICULTURE

Agriculture and nutrition share a common point that is “food.” Food is the end result of agricultural activities. So agricultural sector presents key opportunities for improving nutrition and health .Hence it is a vital input into good nutrition. Without agriculture there is little food or nutrition. Actually the origin of agricultural development was to provide adequate food “for the health and strength of all people”. Therefore it may be assumed that the field of nutrition is closely connected with food consumption. However availability of food from agriculture never ensures good nutrition. Agriculture does not directly influence consumer demand but can help make nutritious food available to consumers at affordable prices.

5.9.1. The probable impacts of agricultural activities on health and nutrition are many. These are stated under.

I. One area of impact is household ability to produce, purchase and consume more, better and cheaper food. Agricultural advances, such as the Green Revolution has led to the doubling of cereal production and yields. This has helped in economic growth and improved the well-being of many people. More recently, biofortification efforts to breed and disseminate crops that are rich in micronutrients, such as vitamin A, zinc and iron, have improved vitamin and mineral intake among consumers in Africa and Asia.

II. One more important contribution of agriculture towards nutrition and health is increased rural income. Poverty is an important contributor to poor health and under-nutrition. The poor people mainly dwell in rural areas and derive a significant share of their income from agricultural activities.

Agricultural growth has reduced poverty to a large extent and has allowed people in improving their food habits.

III. Agricultural intensification has been essential to feed the world's growing population, but it has also brought its own risks for people's health, including zoonotic diseases, water- and food-borne diseases, occupational hazards, and natural resource degradation and overuse.

In spite of major progress a lot of improvements must be done in the field of Nutritional agriculture because an estimated 805 million people still go hungry around the world. There are many people also suffer from hidden hunger, that is, deficiencies of essential vitamins and minerals, which are associated with a number of negative health and economic impacts. Moreover, 2.1 billion people worldwide are obese and overweight. There is also a rise in non-communicable diseases such as diabetes, heart disease and some forms of cancer. Therefore serious concerns remain about the nutrition and health situation throughout the developing world.

To take advantage of agriculture's potential and improve nutrition and health simultaneously we should refine our knowledge on the agriculture-nutrition-health nexus. Moreover instead of straightforward agricultural growth we should promote "smarter" growth by learning more about the health and nutrition impacts of different sub-sectoral patterns of agricultural development. So investments in research and education systems are considered as important steps to build up this knowledge base.

With this knowledge, agricultural strategies should be designed to minimize risks and maximize the benefits to nutrition and health across the entire value chain, from production to consumption. Development and circulation of more nutritious, bio fortified food consumed by poor people are one of the important steps. Others include public information campaigns and pricing policies addressing both under nutrition and obesity. Policy-makers should focus on improved processing practices including better transportation and storage infrastructure that reduces food loss and waste. Partnerships between the private and public sectors also play an especially important role in improving the efficiency of post-harvest value chains.

Nutrition is much more than food availability and it encompasses access to food at the household level, health

services and a healthy environment and adequate child caring practices. Although under nutrition is one of the world's most serious public health challenges but it is least addressed. There are more than 162 million undernourished children in developing countries. As the world moves toward the new Sustainable Development goals, country and development partners will need to step up progress on child health and nutrition outcomes to enhance both human and economic development prospects.

To conclude it may be said that most agriculturalists do not consider the main goal of agricultural development to be the improvement of human health but they recognize that agriculture plays an important role as a major livelihood and driver of economic growth in countries. Therefore we must all seriously take some actions regarding agricultural growth not only to increase food production but also to enhance nutrition and health and help people overcome poor health and malnutrition. A stronger nutrition-agriculture alliance will give us an advantage at the beginning.

5.10. SUSTAINABLE AGRICULTURE

Sustainable agriculture can be defined in many ways. In simplest terms, it is the production of food, fibre, or other plant or animal products using farming techniques that protect the environment, public health, human communities, and animal welfare. Sustainable agriculture complements modern agriculture. It ultimately seeks to sustain farmers, resources and communities by promoting farming practices and methods that are profitable, environmentally sound and good for communities.

5.10.1. Definition:

Sustainable agriculture is a type of agriculture that focuses on producing long-term crops and livestock while having minimal effects on the environment. This type of agriculture attempts to find a good balance between the need for food production and the preservation of the ecological system within the environment.

5.10.2. In short Sustainable Agriculture is:

- Economically Viable: If it is not profitable, it is not sustainable.
- Socially Supportive: The quality of life of farmers, farm families and farm communities is important.

- Ecologically Sound. We must preserve the resource base that sustains us all.

5.10.3. Besides producing food sustainable agriculture is associated with several goals. These are stated under.

a. conservation of water

b. reducing the use of fertilizers and pesticides

c. promoting biodiversity in crops grown and the ecosystem

d. maintains economic stability of farms and help farmers improve their techniques and quality of life

5.10.4. Farming strategies that are used to make agriculture more sustainable are as follows:

a. One of the most common techniques in sustainable agriculture is growing plants that can create their own nutrients. These reduce the use of fertilizers. Rotating crops are changing frequently in fields so they minimize the use of pesticide.

b. Another common technique is mixing crops, which reduces the risk of a disease. Hence reduces the need for pesticides and herbicides.

c. Sustainable farmers also utilize water management systems, such as drip irrigation, that waste less water.

5.10.5. Benefits of Sustainable Agriculture

There are many benefits of sustainable agriculture such as human health benefits and environmental benefits.

a. <u>Human health benefits</u>

- Regarding human health it may be said that crops grown through sustainable agriculture are better for people as chemical pesticides and fertilizers are absent in sustainable agriculture. This limits the risk of people becoming ill from exposure to these chemicals.

- Furthermore, the crops produced through sustainable agriculture can also be more nutritious because the overall crops are healthier and more natural.

b. <u>Environmental benefits</u>

- The positive impact of sustainable agriculture on environment is that it uses 30% less energy per unit of crop yield in comparison to industrialized agriculture. So there is less release of chemicals and pollution into the environment.
- Sustainable agriculture maintains soil quality, reduces soil degradation and erosion, and saves water. Hence benefits the environment.
- It also increases biodiversity of the area by providing a variety of organisms with healthy and natural environments to live in.

5.10.6. Issues Associated with Sustainable Agriculture

Despite many benefits sustainable agriculture is not free from issues associated with it. Various ecological, social and economic challenges must be addressed if agriculture is to be truly sustainable.

- **Disadvantages of sustainable agriculture are discussed below.**

a. One of the main concerns is that sustainable agriculture does not produce as much food as industrialized agriculture.

b. This kind of farming limits the proper use of land as well as hinders the full exploitation of land, labour and capital since it advocate for the use of productive resources sparingly.

c. Moreover, it is also not very easy to maintain the fertility of soil by simply rotating crops on the same piece of land.

d. Since sustainable agriculture stresses on the need to use land sparingly, the income that is generated from farming is also very limited and it does not give the farmers room to exploit their full potential.

e. Also the cropping methods like crop rotation and mixed cropping involves a lot of manual labour.

f. The income incurred from sustainable farming methods is very less because it focuses on using the available land scarcely.

5.11. SUMMARY

Going through this unit we have come to know that Lewis and Hoover's theory both are important in learning the economics of agriculture despite several limitations. It is confirmed that nutrition is about much more than food availability. It encloses the access to food at the household level, health services and a healthy environment and adequate child caring practices.To achieve proper nutrition in food there should be development in countries' capacities to evaluate and monitor nutrition situations. Also analysis ofoptions and implementation of agricultural policies and programmes that have positive impact on nutrition must be done. Organic farming is a production system which avoids the use of synthetically compounded fertilizers, pesticides, growth regulators, genetically modified organisms and livestock food additives. Sustainable agriculture is the production of food, fiber, or other plant or animal products using farming techniques that protect the environment, public health, human communities, and animal welfare.

5.12. CHECK YOUR PROGRESS/ EXERCISE

1. **True and false**

   a. The dual-sector model is a model is invented by W. Arthur Lewis.

   b. The high birth rate in UDCs leads to grow unemployment.

   c. Lewis says that the wages in industrial sector is variable.

   d. Hoover propounded a least cost theory of location, in which he tried to overcome some of the weaknesses of Johann Heinrich von Thünen'stheory.

   e. Organic manure is abundantly available and it is less expensive compared to chemical fertilizers, if purchased.

2. **Fill in the blanks**

   a. In many developing countries, _____ agriculture is adopted as a method to improve household food security or to achieve a reduction of input costs.

   b. Plant diseases restrict crop_____.

   c. Agriculture and nutrition share a common point that is "_____."

d. Hoover initially assumes a perfect competition between producers or sellers at any one_____.

e. Hoover he was more concerned with cost than with the _____factor.

3. **Multiple choice questions**

a. Lewis ignored the balanced growth between

i. agricultural sector and health care sector

ii. agricultural sector and industrial sector

iii. financial sector and industrial sector

b. In organic farming, weeding can be done only manually because

i. natural organic manures cannot be used.

ii. organic herbicides cannot be used.

iii. chemical herbicides cannot be used.

c. In organic farming soil is tried to make healthy and rich in organic matter

i. with all the nutrients that the plants need

ii. with enough water that help the farmer to plough

iii. with all the nutrients that the insects in the soil need to breed

d. Lewis assumed that all of increase in profits is

i. diverted into leakages.

ii. diverted into savings.

iii. diverted into expenditure.

e. Hoover differs with Weber's emphasis on

i. maximum transport cost points within locational triangles.

ii. least production cost points within locational triangles

iii. least transport cost points within locational triangles

4. **Answer the Following Questions:**

1. Analyse Lewis Model of Unlimited Supply of Labour with example.
2. State the limitations of the Lewis model.
3. Define organic agriculture. What are the advantages of organic farming?
4. What is Sustainable agriculture? State the benefits of Sustainable Agriculture. What are the issues Associated with Sustainable Agriculture?
5. Write short notes on:
    a. Economic development of agricultural land use model of Hoover's
    b. Nutrient management in organic farming
    c. Diseases management in organic farming
    d. Farming strategies that are used to make agriculture more sustainable
    e. Limitations of the Hoovers model

5.13. ANSWERS TO THE SELF LEARNING QUESTIONS.

1.a. true

1.b. true

1.c. false, Lewis says that the wages in industrial sector is constant.

1.d. false, Hoover propounded a least cost theory of location, in which he tried to overcome some of the weaknesses of Weber's theory

1.e. false, Organic manure is not abundantly available and it is more expensive compared to chemical fertilizers, if purchased.

2. a. Organic

2.b. yield

2.c. food

2.d. location

2.e. demand

3.a.ii.

3.b.iii.

3.c.i.

3.d. ii.

3.e.iii.

5.14. TECHNICAL WORDS:

- **Disguised unemployment-**It exists where part of the labour force is either left without work or is working in a redundant manner where worker productivity is essentially zero.
- **UDC**- in British it is abbreviation for Urban District Council.
- **Herbicide**- commonly known as weed killers, are chemical substances used to control unwanted plants.
- **Sustainable agriculture**- It is the production of food, fiber, or other plant or animal products using farming techniques that protect the environment, public health, human communities, and animal welfare.
- **Bio-fertilizers**-Bio-fertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants' uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil.

5.15. TASK

- In a chart write down the farming strategies that are used to make agriculture more sustainable.

5.16. REFERENCES FOR FURTHER STUDY

- Bayliss Smith, T.P. (1987): The Ecology of Agricultural Systems. Cambridge, University Press, London.
- Singh J. (1997): Agricultural Development in South Asia: A Comparative A Study in the Green Revolution Experiences, national Books Organization, New Delhi.
- Singh, J. and Dhillon, S. S. (1984): 'Agricultural Geography', McGraw Hill, New Delhi.
- Singh, J. and Dhillon, S.S. (1988), "Agricultural Geography", 2nd edition, Tata McGraw-Hill, New Delhi
- P.J. Edwards et al (1999), "The Effects of Alternative Tillage Systems on Biodiversity in Agro-ecosystems," in D. Wood and J.M. Lenne, eds., Agro biodiversity: Characterization, Utilization and management, CABI Publishing Ltd., London.
- Acharya, S.S., 'Agricultural Marketing,' in State of the Indian Farmer (New Delhi, Ministry of Agriculture and Academic Publishers, 2004), vol. xvii.
- Ackerman, F., 'The Shrinking Gains from Trade: A Critical Assessment of Doha Round Projections,' Working Paper No. 05-01 (Global Development and Environment Institute, Tufts University, 2005).
- Grigg, D. (1995): An Introduction to Agricultural Geography, Routledge, London
- Symons, L. (1970): Agricultural Geography, G. Bell and Sons Ltd., London
- Hussain, M. (1978): Agricultural Geography, Rawat Publication, Jaipur
- Vaidya, B. C. (1997): Agricultural Land use in India, Manak Publications, New Delhi

❖❖❖❖

6

INTRODUCTION TO DISASTER MANAGEMENT

After going through this chapter you will be able to understand the following features:

6.1. OBJECTIVES

By the end of this unit you will be able to –

- Define disaster
- Know about the difference between hazards, calamity and disaster
- Understand vulnerability, capacity, risk
- Discuss disaster management cycle
- Understand disaster management in India –
- Learn financial arrangements in disaster management –
- Understand the role of NGOs,

- Know role of community based organizations
- Know role of media and communication in disaster management
- Discuss role of geography and GIS in disaster management

6.2. INTRODUCTION

The main aim of learning about disaster management is to lessen the impact of disasters around the world. The United Nations defines a disaster as a serious disruption of the functioning of a community or a society. It essentially deals with management of resources and information on disastrous events. Disaster management tries to coordinate these resources effectively and seamlessly. The role of Indian government in prevention and control of disasters is noticeable.

6.3. SUBJECT-DISCUSSION

Disaster management is a relatively new identifiable profession, where the tasks of a disaster manager, is of a disaster relief assistant during and after a disaster emergency. It is not necessarily a full-time activity. Indeed, for most people in the field, their concerns for disaster issues form only a part of their total responsibilities. There has been a growing awareness in recent years that all of these disaster management activities, in fact, comprise the process of disaster management. But the role of people who are involved in the field of disasters must be coherent and cohesive. This includes the spectrum of activities from administration to project implementation. Also Disaster prevention to disaster mitigation to disaster preparedness to disaster response comes under this category. Disaster management would succeed only if there is elimination of the underlying causes of disasters. This would again contribute to minimizing the people's vulnerability to disaster. Positive responses to emergencies will make an enormous impact on the current deadly state of disaster events. Disaster managers will require several skills and technologies to achieve their goal and must have vigorous training.

The term "disaster management" includes the complete field of disaster-related activities. Generally people have an intention to think disaster management in terms of the post-disaster actions taken by relief and reconstruction officials. But it is observed that disaster management covers a much broader scope where many modern disaster managers find themselves far more involved in pre-disaster activities than in post-disaster response.

6.4 DEFINITION OF DISASTER

There are innumerable definitions of a disaster. Among relief organizations definitions vary according to each agency's roles, biases, and capabilities. In short a sudden accident or a natural catastrophe that causes great damage or loss of life is known as disaster. It is a situation resulting from an environmental phenomenon or armed conflict that produces stress, personal injury, physical damage, and economic disruption of great magnitude. Here one important point must be noted that even though disasters are referred to by the event that caused them; a disaster is not the event itself. Earthquake may be taken as an example to explain this. It is a natural phenomenon. But if it does not strike a populated area with weak buildings, it is not likely to be a disaster.

Which event will qualify as a disaster entirely depends upon who is defining it. For example to a government, an oil refinery explosion could be a major disaster, but it is unlikely to trigger a massive response from the United Nations or from voluntary agencies (VOLAGS) unless hundreds of low-income families are hurt in the same. On the contrary, disasters caused by long-term environmental degradation will often draw attention from VOLAGS long before governments mobilize their resources.

There lie differences between disasters and accidents. A disaster is separated from an accident, or incident, by its magnitude of need and of victims involved. When an airliner crash it is of course severe and costly, but the number of people affected is relatively small. We should also differentiate disasters from individual, non extreme or small-scale suffering. For example, a world-wide growing phenomenon is hunger. It is a major concern, and often being endemic, is addressed with different approaches. Only when hunger becomes widespread and acute, or turns out to be a famine, the situation qualifies as a Disaster. This distinction is important because it not only helps to define disasters as a separate set of events but also gives a starting point for studying and understanding their importance, their impact, and the proper responses they require.

6.4.1 Disasters are of three types:

1. Natural Disasters

Natural disasters refer to those disasters that are triggered by natural phenomena such as earthquakes, cyclones, floods, etc. These are again technically known as natural hazards. The term "natural disaster" can be misleading because it implies that the disasters are solely a result of natural hazards-when in fact, human

endeavours are a major contributing factor in creating a disaster. For example, if settlements or farms were not located in flood plains, disasters would not result from floods. If housing were built to earthquake- and cyclone-resistant standards, these hazards would be of scientific interest only and not result in disasters.

Recently, environmental degradation has begun to occur more frequently as a novel disaster. It results typically from poor farming, grazing, or settlement practices, or because of demands for fuel wood. Excessive exploitation of natural resources or improper use or maintenance of lands changes the ecological balance; the resulting effects of deforestation, desertification, erosion, siltation, or flooding often bring disaster.

Increased flooding due to overgrazing or poor farming practices in the upper portions of a watershed, and increased desertification resulting from overgrazing or improper use of water resources are a few examples. This type of disaster is a growing concern not only because of the environmental consequences but also because large numbers of people can be displaced. The resulting social disruption can cause massive problems.

2. Man-made Disasters

The term "man-made disasters" usually refers to disasters resulting from man-made hazards. Man-made disasters can be divided into three categories: armed conflict, technological disasters, and disasters that are not caused by natural hazards but that occur in human settlements.

3. Technological Disasters

Technological disasters are usually a result of accidents or incidents occurring in the manufacture, transport, or distribution of hazardous substances such as fuel, chemicals, explosives, or nuclear materials. The catastrophic gas leak at the pesticide plant in Bhopal, India, in 1984 is an example.

Environmentalists opine that such disasters are common in industrializing and developing countries as these lack the trained workers and government regulators to detect and correct hazards in larger and complex plants. Moreover, the level of technical expertise among workers in developed countries is better than in developing countries. Often developing countries also believe that environmental safeguards are too costly and hence the working conditions in developing countries are unsafe. For example, in a plant in a country where the workers do not have shoes it is difficult to require the workers to wear steel-toed safety boots.

The type of accidents in both developed and developing countries is not much different from each other, but the likelihood of their occurring and the potential damage is much greater. The death tolls from the resulting accidents could be magnified because Third World industries often are encircled by shantytowns and slums filled with migrants from the surrounding countryside. In other cases, technological disasters are more economic than physical. For example, large refineries have exploded with minimal loss of life, yet the cost of restoring those facilities can be a major burden substantially affecting the entire economy of a small country.

6.5 DIFFERENCE BETWEEN HAZARDS, CALAMITY AND DISASTER

- **Difference between hazards and disaster**

A situation that poses a level of threat to life, health, property, or environment and is very dangerous for human and animal life is known as **hazard**. Most hazards are dormant or potential, with only a theoretical risk of harm. An active hazard creates an emergency. Hazard and possibility interact together to create risk

On the other hand, **disaster** is the result of a hazard that may be natural or manmade. Natural hazards are things that take place in nature that cause harm. The word "natural" is used to note that the disaster is caused by nature. Some examples of natural hazards are: earthquakes, hurricanes, sinkholes, hail storms, wildfires, and the like. It might also be helpful to keep in mind that one natural hazard can lead to another. For example, an earthquake can cause a tsunami. Natural disasters are slightly different. They are the effects of natural hazards on humanity. For example, the tsunami in Indonesia caused a great amount of loss of property and more importantly lives. The earthquake and tsunami in Japan also caused loss of property and lives, as well as nuclear fallout.

❖ **The differences between the two are as follows:**

• A **hazard** is a situation where there is a threat to life, health, environment or property where as, a **disaster** is an event that completely disrupts the normal ways of a community. It brings on human, economical, and environmental losses to the community which the community cannot bear on its own.

• **Hazards** are natural or manmade phenomenon that are a feature of our planet and cannot be prevented. In their dormant state,

hazards just pose a threat to life and property while **disasters** are the result of a hazard that may be natural or manmade.

• These hazards are termed as disasters when they cause widespread destruction of property and human lives. Once a hazard becomes active and is no longer just a threat, it becomes a disaster.

• Both hazards and disasters are natural as well as manmade.

• We can prevent hazards becoming disasters if we learn to live in harmony with nature and take precautionary steps.

- **Difference between calamity and disaster**

Calamity is an event resulting in great loss while **disaster** is an unexpected natural or man-made catastrophe of substantial extent causing significant physical damage or destruction, loss of life or sometimes permanent change to the natural environment.

6.6 VULNERABILITY, CAPACITY, RISK

6.6.1 Vulnerability is a condition wherein human settlements, buildings, agriculture, or human health are exposed to a disaster by virtue of their construction or proximity to hazardous terrain.

6.6.2 Capacity

Capacity is the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals. Capacity development is the process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.

According to UN/ISDR (2004), **capacity** is "a combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk or the effects of a **disaster**". This includes physical and human resources as well as leadership and **management**. UNDP (United Nations Development Programme) understands capacity development as a locally-driven, society-wide transformation, and recognizes that capable individuals, organizations and societies play an indispensable role in the successful reduction and management of disaster risks.

We can simplify the term and say that if capacity is the means to plan and achieve, then capacity development describes the way to those means. Capacity development commonly refers to a process that is driven from the inside and starts from existing capacity assets. Capacity building, however, refers to a process that supports only the initial stages of building or creating capacities, often by outsiders, and is based on an assumption that there are no existing capacities from which to start. It is therefore less comprehensive than capacity development.

For UNDP, developing sustainable DRR (Disaster risk reduction) capacities at national and local level is based on the following assumptions:

- Locally generated, owned and sustained capacity is essential to the success of any DRR enterprise.
- The development of DRR (Disaster risk reduction) capacity is the concern of an entire society, rather than of any single agency, professional discipline, or stakeholder group.
- The development of technical capacities associated with professional disciplines or functions—such as environmental management or land-use management—needs to be combined with other types of capacity development that include the promotion of leadership and other managerial capacities and performance-enhancing measures
- An enabling environment—i.e. strong political ownership and commitment at the highest levels of authority, extensive participation, transparency and clear public accountability— is essential for translating capacity into performance.

The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during crises or adverse conditions. Coping capacities contribute to the reduction of disaster risks.

6.6.3 Risk

Risk is the relative degree of probability that a hazardous event will occur. An active fault zone, for example, would be an area of high risk.

The combination of vulnerability and hazard gives us disaster risk or the possibility of a disaster in an area. Thus, risk is a potential to cause damage. Disaster risk is the product of hazard and vulnerability divided by capacity for convenience. Conventionally risk is expressed by the notation.

Risk = Hazards X Vulnerability/Capacity

Thus risk increases with increase in hazards and vulnerability and decreases with the increase in capacity.

Capacity is defined as the community to intervene and manage a hazard in order reduces potential impact.

For reducing risk, we have to reduce hazards and vulnerability and increase capacity. But we know that in most cases, extent of hazard is given and cannot be changed.

6.7 DISASTER MANAGEMENT CYCLE

Disaster Risk Management includes each and every activities, programmes and measures which can be taken up before, during and after a disaster with the purpose to avoid a disaster, reduce its impact or recover from its losses. The three key stages of activities that are taken up within disaster risk management are as follows. (See Figure)

Fig: Disaster management cycle

1. Before a disaster (pre-disaster).

Pre-disaster activities are those which have been taken to reduce human and property losses caused by a potential hazard. Such as carrying out awareness campaigns, strengthening the existing weak structures, preparation of the disaster management plans at household and community level, etc. Such risk reduction measures taken under this stage are termed as mitigation and preparedness activities.

2. During a disaster (disaster occurrence).

These include 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.

3. After a disaster (post-disaster).

There are 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.

The Disaster risk management cycle diagram (DRMC) enhances the range of initiatives which generally occur during the Emergency response as well as in the Recovery stages of a disaster. Some of these cut across both stages (such things as coordination and the provision of ongoing assistance); whilst other activities are unique to each stage (e.g. Early Warning and Evacuation during Emergency Response; and Reconstruction and Economic and 48 Social Recovery as part of Recovery). The DRMC also highlights the role of the media, where there is a strong relationship between this and funding opportunities. This diagram works best for relatively sudden-onset disasters, such as floods, earthquakes, bushfires, tsunamis, cyclones etc, but is less reflective of slow-onset disasters, such as drought, where there is no obviously recognizable single event which triggers the movement into the Emergency Response stage. According to Warfield (2008) disaster management aims to reduce, or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery.

The disaster management cycle illustrates the ongoing process by which governments, businesses, and civil society plan for and reduce the impact of disasters, react during and immediately following a disaster, and take steps to recover after a disaster has occurred. Appropriate actions at all points in the cycle lead to greater preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next iteration of the cycle. The complete disaster management cycle includes the shaping of public

policies and plans that either modify the causes of disasters or mitigate their effects on people, property, and infrastructure. The mitigation and preparedness phases occur as disaster management improvements are made in anticipation of a disaster event. Developmental considerations play a key role in contributing to the mitigation and preparation of a community to effectively confront a disaster. As a disaster occurs, disaster management actors, in particular humanitarian organizations become involved in the immediate response and long-term recovery phases.

The four disaster management phases illustrated here does not always, or even generally, occur in isolation or in this precise order. Often phases of the cycle overlap and the length of each phase greatly depends on the severity of the disaster.

- **Mitigation** - Minimizing the effects of disaster. Examples: building codes and zoning; vulnerability analyses; public education.
- **Preparedness** - Planning how to respond. Examples: preparedness plans; emergency exercises/training; warning systems.
- **Response** - Efforts to minimize the hazards created by a disaster. Examples: search and rescue; emergency relief.
- **Recovery** - Returning the community to normal. Examples: temporary housing; grants; medical care.

Disasters are as old as human history but the dramatic increase and the damage caused by them in the recent past have become a cause of national and international concern. Over the past decade, the number of natural and manmade disasters has climbed inexorably. From 1994 to 1998, reported disasters average was 428 per year but from 1999 to 2003, this figure went up to an average of 707 disaster events per year.

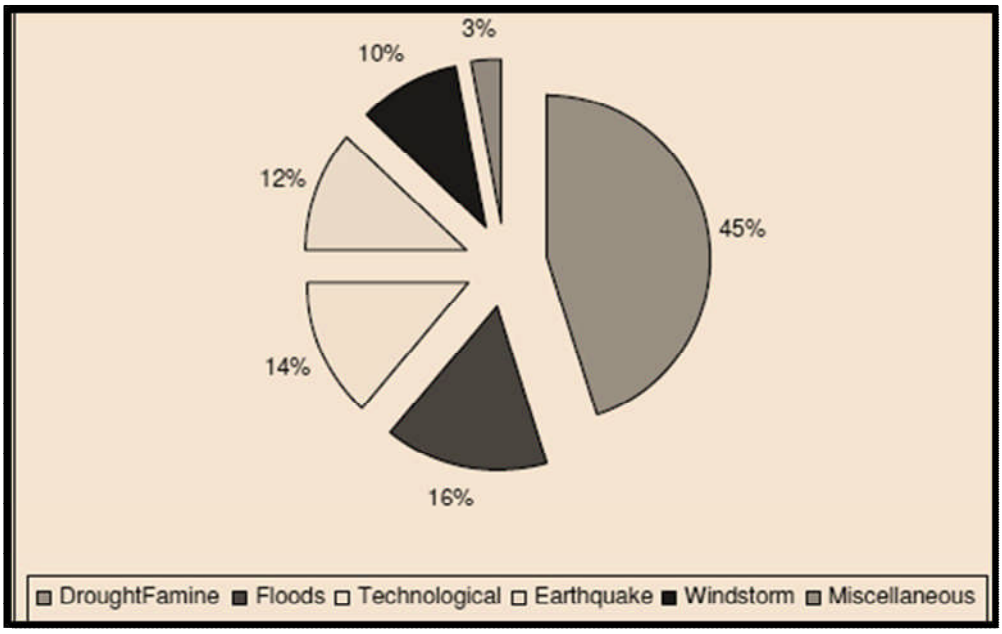


Fig: Reported Deaths from all Disasters: World Scenario (1992-2001)

6.8 DISASTER MANAGEMENT IN INDIA

India is the largest democracy and the second most populous country in the world with about 6 billion people. India is integrated, yet highly diversified country. India lies in South Asia, surrounded on three sides by the Arabian Sea, the Indian Ocean, and the Bay of Bengal. To the north there are the Himalayan mountain ranges. The geographical area of India is 3.4 million square kilometers, and the coastline is 7,500 kilometers long. India was economically the richest country in the world till Mughals invaded for looting. India knew mining and processing of diamonds, and all the great diamonds belonged to India. The per capita GDP in 2005 was only $ 736, and India stood at 128th among the countries in terms of the Human Development Index (UNDP 2007).Poverty is the main root cause of disasters in India.

Having some of the world's most severe droughts, famines, cyclones, earthquakes, chemical disasters, mid-air head-on air collisions, rail accidents, and road accidents, India stands out to be the most disaster prone countries of the world. India is also one of the most terrorist prone countries.

India was, until recently, reactive and only responded to disasters and provided relief from calamity. It was a relief driven disaster management system. India also has world's oldest famine relief codes. In recent times, there has been a paradigm shift and

India has become or is becoming more proactive with emphasis on disaster prevention, mitigation and preparedness.

Traditionally India accepted international help in responding to disasters. Although, after the 2004 Indian Ocean tsunami, India refused to accept international response assistance from foreign governments, it deployed its defense personnel, medical teams, disaster experts, ships, helicopters, and other type of human, material, and equipment resources to help Sri Lanka, Mauritius, and Indonesia. It may be noted that India itself suffered from the tsunami and was internally responding at the same time.

Disasters do not recognize or respect national geographic boundaries. The tsunami experience illustrates it vividly. In the increasingly globalized world, more disasters will be spread over many countries and will be regional in nature. India has set up an example of responding internally and simultaneously in neighboring countries for the other countries to follow.

India took a pioneering step regarding disaster management. In the academic year 2003-2004, India planned of starting disaster management education as part of social sciences in class VIII. In the subsequent academic year 2004-2005 disaster management, was added to class IX. In the following academic years disaster management was progressively added to classes XI and XII. This was done by the Central Board of Secondary Education. India is also implementing community based disaster management program, along with disaster management education in schools, with the help of United Nations Development Program in all-hazard vulnerable districts.

Some changes have been brought in disaster policy and creation of new organizations on the basis of catastrophic disasters in recent times. Policy changes include the enactment of Disaster Management Act, 2005 and development of the national disaster management response framework. The National Disaster Management Authority was established to spearhead in creation of culture of disaster resilience. The National Institute of Disaster Management itself and along with Disaster Management Cells in the states is providing training opportunities in disaster management.

6.8.1 Disaster Policy

The mode of Indian disaster policy has been changed from response and calamity relief to disaster prevention, preparation and mitigation. Another significant change of disaster management is to move from government to public private partnership, and community disaster management. In this regard, significant

changes have been made, but the authoritarian attitude of the government officials is the main stumbling block.

After the Great Famine of 1876-1878 the Famine Commission of 1880 was constituted and there was eventual adoption of Famine Relief Code. India probably has the world's oldest disaster relief code which started in1880. This relief code provides details of the relief to be given by the government to the affected people.

The India Disaster Report (Parsuraman and Unikrishnan 2000) provides the nature of disaster response by the government of India. It identifies key issues with respect to the availability of and access to disaster-related information and its quality, the absence of coherent disaster preparedness and response policy, and urgent actions and interventions needed. It shows that significant advances in health and social and economic development have been repeatedly interrupted and reversed by disasters.

Although India was following five year national plans, the earlier five year plans did not mention disaster management. The Tenth Five-Year Plan 2002-2007 for the first time had a detailed chapter entitled Disaster Management and The Development Perspective. The plan emphasized the fact that no development will be sustainable without mitigation being built into the development process. Disaster mitigation and prevention were adopted as essential component of the development strategy.

High priority was given to Disaster management in the country. The Eleventh Five Year Plan 2007-2012 (Planning Commission 20008) states, "The development process needs to be sensitive towards disaster prevention, preparedness and mitigation. Disaster management has therefore emerged as a high priority for the country. Going beyond the historical focus on relief and rehabilitation after the event, there is a need to look ahead and plan for disaster preparedness and mitigation in order to ensure that periodic shocks to our development efforts are minimized."

The Eleventh Five Year Plan aims at consolidating the process by giving impetus to projects and programs that develop and nurture the culture of safety and the integration of disaster prevention and mitigation into the development process.

The guidance and direction to achieve this paradigm shift will need to flow from National Disaster Management Authority (NDMA), and in the true spirit of the Disaster Management Act, 2005 to all stakeholders including State Governments and Union Territories, right up to the Panchyat Raj (local administration by five locally elected citizens) Institutions. Communities at large will need

to be mobilized to achieve this common objective as they are the first responders (and not the usually thought fire, ambulance, and police). Even the best of isolated efforts will not bear fruit unless they are part of an overall, well-considered approach, and responsibilities of all stakeholders are clearly spelt out and accountability and sustainability factored in.

The impact of 2001 Gujarat Earthquake was huge. It had very serious effect on the government and policy makers, in addition to victims, their families, and general citizenry. The Government of Gujarat for the first time in India enacted the Gujarat Disaster Management Act, 2003. Before that, neither at the federal level nor at the state level there was any act to deal with the management of disasters of various kinds in a comprehensive manner. The state and federal governments were largely following the relief code and the rules and regulations, and the government orders issued over the years, which were not consolidated.

❖ **Every citizen's aid is demanded for the following purposes, namely**

(a) Prevention,
(b) Response,
(c) Warning,
(d) Emergency operation,
(e) Evacuation, and
(f) Recovery.

The recurrent occurrences of different types of disasters compelled Government of India to establish many different committee and commissions to suggest dealing with the problem. Recently there is the establishment of High Power Committee on Disaster Management (HPC) in 1999 for making recommendations on the preparation of Disaster Management plans and suggestions for effective mitigation mechanisms.

The Government of India has long been thinking of a National Disaster Management Authority. The Gujarat earthquake gave extra impetus for having a national disaster management authority.

Finally on December 23, 2005 the Disaster Management Act, 2005 was enacted by the Government of India. The Disaster Management Act, 2005 mandated creation of National Disaster Management Authority, with Prime Minister as the Chairman, and State Disaster Management Authorities headed by the respective Chief Ministers, to spearhead and implement a holistic and integrated approach to disaster management in India. The act also

provided for creation of National Institution of Disaster Management.

NDMA has prepared a disaster management policy framework. The themes underpinning this policy are:

- Community-based disaster management, including integration of the policy, plans and execution at the grass root level.
- Capacity development in all related areas.
- Consolidation of past initiatives and best practices.
- Cooperation with agencies at national, regional and international levels.
- Compliance and coordination to generate a multi-sectoral synergy.
- The objectives guiding the policy formulation have evolved to include:
- Promoting a culture of prevention and preparedness – by centre-staging disaster management (DM) as an overriding priority at all levels and at all times.
- Encouraging mitigation measures based on state-of-the-art technology and environmental sustainability.
- Mainstreaming DM concerns into the development planning process.
- Putting in place a streamlined institutional techno-legal framework in order to create and preserve the integrity of an enabling regulatory environment and a compliance regime.
- Developing contemporary forecasting and early warning systems backed by responsive and fail-safe communications and Information Technology (IT) support.
- Promoting a productive partnership with the Media, NGOs and the Corporate Sector in the areas of awareness generation and capacity development.
- Ensuring efficient response and relief with a caring humane approach towards the vulnerable sections of the society.
- Making reconstruction an opportunity to build back better and construct disaster-resilient structures and habitats (NDMA 2009).

Presently the Emergency Management and Research Institute (EMRI), a non-profit professional organization, operating in the Public Private Partnership mode, have brought out significant improvements in dealing with emergency medical services. This is

a free service delivered through state-of-art emergency call response centres and has over 1,800 ambulances across Andhra Pradesh, Gujarat, Uttarakhand, Goa, Chennai, Rajasthan, Karnataka, Assam and Meghalaya. EMRI handles medical, police and disaster emergencies. More emphasis is put on medical help, through the "1-0-8 Emergency service".

Although India refused any foreign aid for response and relief after the tsunami it has welcomed foreign institutional support for rehabilitation, and reconstruction investment. India has reconstruction investment projects with World Bank and the Asian Development Bank.

It may be clarified that the Government of India refused to receive the financial assistance for response and relief from the foreign governments. However, the government did not prevent private organizations or individuals from providing assistance through private channels.

The government also passed a comprehensive new environmental law called the Environmental Protection Act of 1986. The new law vastly improved regulatory coverage of hazardous technologies and substances.

6.8.2 Organization of Disaster Management

Disaster management is the responsibility of local administration, under the supervision of the State Government, facilitated by the Government of India. The 35 states and union territories are divided into about 600 districts. Each district is administrated by a Collector and District Magistrate.

Each state has a Disaster Management Cell, located generally in the State Administrative Training Institutes. Major funding for the faculties of the Disaster Management Cell comes from the Central Government. Each cell is supposed to carry training in disaster management and prepare plans and documents
.

Droughts and famine were recurrent and the administration developed considerable expertise in calamity relief operations.

Even before the enactment of the Disaster Management Act, 2005 the National Disaster Management Authority was set up in July 2005 by an executive order with the Prime Minister of India as the Chairperson of NDMA.

The NDMA is responsible and has the authority for laying down the policies, plans, and guidelines to be followed by Ministries and Departments of the Central Government for disaster

management. The NDMA is to coordinate the enforcement and implementation of the policies and plans for disaster management and arrange for, and oversee the provision of funds for mitigation measures, preparedness and response, to frame guidelines for the minimum standards of relief to be provided to persons affected by disaster, and give directions regarding relief in loan repayment or grant fresh loans on such confessional terms as may be deemed appropriate. Such measures can be taken by NDMA to prevent disaster.

To combat nuclear, biological and chemical disasters a multi-disciplinary, multi-skilled, high-tech National Disaster Response Force (NDRF) of eight battalions has been set up. This deals with all types of disasters capable of insertion by air, sea and land.

The National Disaster Mitigation Resource Centre (NDMRC) will be co-located with the NDRF battalions. These will also serve as repositories for NDMRC bricks of relief stores for 25,000 affected people, in each of the nine locations. These will cater to the emergent requirements especially for the first 72 to 96 hours. At Kolkata and Chandigarh, additional bricks of stores for 50,000 people each will be kept for high altitude areas. These stores will supplement the reserves maintained by the respective states/UTs. In addition, these centres will assist in running mock drills and capacity development programs. During disasters, they will act as facilitators to the states/UTs in deployment of central resources and provide much needed additional link to the centre.

The Government of India decided to make the Ministry of Home Affairs as the nodal ministry. The government issued an order on October 16, 2003 upgrading the NCDM and establishing the National Institute of Disaster Management (NIDM). NIDM is a premier national organization working for human resource development at national level in the area of disaster mitigation and management.

After the Orissa Super Cyclone of 1999 under the influence of reconstruction donor organizations, led by the World Bank, the Government of Orissa established Orissa State Disaster Management Authority (OSDMA).

The Mumbai terror attacks acted as a catalyst for the establishment of the National Investigation Agency (NIA). The agency will probe such incidents which are found to have complex inter-state and international linkages and possible connection with other activities like smuggling of arms and drugs, pushing in and circulation of fake Indian currency and infiltration across the borders.

6.9 FINANCIAL ARRANGEMENTS IN DISASTER MANAGEMENT

The policy arrangements for meeting relief expenditure related to natural disasters are, by and large, based on the recommendations of successive Finance Commissions. The two main windows presently open for meeting such expenditures are the Calamity Relief Fund (CRF) and National Calamity Contingency Fund (NCCF). The Calamity Relief Fund is used for meeting the expenditure for providing immediate relief to the victims of cyclone, drought, earthquake, fire, flood and hailstorm. Expenditure on restoration of damaged capital works should ordinarily be met from the normal budgetary heads, except when it is to be incurred as part of providing immediate relief, such as restoration of drinking water sources or provision of shelters etc., or restoration of communication links for facilitating relief operations. The amount of annual contribution to the CRF of each State for each of the financial years 2000-01 to 2004-05 is as indicated by the Finance Commission. Of the total contribution indicated, the Government of India contributes 75 percent of the total yearly allocation in the form of a non-plan grant, and the balance amount is contributed by the State Government concerned. A total of Rs.11, 007.59 crore was provided for the Calamity Relief Fund from 2000-05. Pursuant to the recommendations of the Eleventh Finance Commission, apart from the CRF, a National Calamity Contingency Fund (NCCF) Scheme came into force with effect from the financial year 2000-01 and would be operative till the end of the financial year 2004-05. NCCF is intended to cover natural calamities like cyclone, drought, earthquake, fire, flood and hailstorm, which are considered to be of severe nature requiring expenditure by the State Government in excess of the balances available in its own Calamity Relief Fund. The assistance from NCCF is available only for immediate relief and rehabilitation. Any reconstruction of assets or restoration of damaged capital should be financed through re-allocation of Plan funds. The initial corpus of the National Fund is Rs.500 crores, provided by the Government of India. This fund is required to be recouped by levy of special surcharge for a limited period on central taxes. Assistance provided by the Centre to the States from the National Fund is to be financed by levy of a special surcharge on the central taxes for a limited period. A list of items and norms of expenditure for assistance chargeable to CRF / NCCF in the wake of natural calamities is prescribed in detail from time to time. There are a number of important ongoing schemes that specifically help reduce disaster vulnerability. Some of these are: Integrated Wasteland Development Programme (IWDP), Drought Prone Area Programme (DPAP), Desert Development Programme (DDP), Flood Control Programmes, National Afforestation & Eco-development Programme (NA&ED), Accelerated Rural Water Supply Programme (ARWSP), Crop Insurance, Sampurn Grameen

Rozgar Yojana (SGRY), Food for Work etc. The High Power Committee (HPC) constituted by GOI on Disaster Management which submitted its report in October 2001 recommended that at least 10 percent of plan funds at the national, state and district levels be earmarked and apportioned for schemes which specifically address areas such as prevention, reduction, preparedness and mitigation of disasters. The Eleventh Finance Commission too paid detailed attention to the issue of disaster management and, in its chapter on calamity relief, came out with a number of recommendations, of which the following have a direct bearing on the Plan:

a) Expenditure on restoration of infrastructure and other capital assets, except those that are intrinsically connected with relief operations and connectivity with the affected area and population, should be met from the plan funds on priority basis.

b) Medium and long-term measures are devised by the concerned Ministries of the Government of India, the State Governments and the Planning Commission to reduce, and if possible, eliminate, the occurrences of these calamities by undertaking developmental works.

c) The Planning Commission, in consultation with the State Governments and concerned Ministries, should be able to identify works of a capital nature to prevent the recurrence of specific calamities. These works may be funded under the Plan. In order to move towards safer development, development projects should be sensitive towards disaster mitigation. With the kind of economic losses and developmental setbacks that the country has been suffering year after year, it makes good economic sense to spend a little extra today in a planned way on steps and components that can help in prevention and mitigation of disasters, than be forced to spend many multiples more lately on restoration and rehabilitation. The design of development projects and the process of development should take the aspect of disaster reduction and mitigation within its ambit; otherwise, the development ceases to be sustainable and eventually causes more hardship and loss to the nation.

6.10 ROLE OF NON-GOVERNMENTAL DEVELOPMENT ORGANIZATIONS (NGOS)

Many nongovernmental development organizations (NGOs) have disaster specialists among their staffs. This fact establishes that disasters often occur where development agencies have normal programs, and they are unable to avoid and get involved in post-disaster activities. There are specialists who help in developing disaster plans for their organizations and manage post disaster operations. Disaster management specialists are also

present outside this systems specifically oriented towards disaster management or relief. Government ministries, such as agriculture, forestry, public health, defence, and public works will often have major departments or key personnel assigned to disaster management or mitigation roles. It is common, for instance, to find a public works department employee who has assigned responsibilities for flood control activities. To be effective, that person must exercise responsibility not only in flood fighting but also inland use, settlement planning and evacuation. Thus, the effective disaster manager must have input into a variety of activities.

6.11 ROLE OF COMMUNITY BASED ORGANIZATIONS:

Disaster Management means a planned and systematic approach towards understanding and solving problems in the wake of disasters involving the systematic observation and analysis of measures relating to disaster prevention, mitigation, preparedness, emergency response, rehabilitation and reconstruction. In other words, disaster management is a function of community preparedness. A natural hazard can transform into a natural disaster depending on its impact on society in terms of loss of life and property. To enhance community preparedness, a proper safety plan is very much is essential. The community preparedness plan involves all pre-disaster planning to reduce the loss as a result of natural disaster. It is basically a synthesis of various specific plans to solve a common purpose.

Community is the first responder in any disaster situation. So, there is a great need for community level initiatives in managing disasters. As a result initiatives taken by various agencies, including the state, need to be people-centric. Moreover, the level of community participation should be gauged through the role played by the community in the process of planning and decision-making.

The local economies must be strengthening, so that people become independent of external assistance. The voluntary sector has been in the forefront of mobilizing communities, enabling them to cope with disasters in the past decades. Their initiatives and experiences have been consolidated and demonstrated on a larger scale with the help of the state. Development organizations working in communities share a good rapport with the community. This has again helped the state in implementing its plans more effectively; village level plans prepared after the Super Cyclone in Orissa could be seen as an example of the same.

The global experience of the development community has demonstrated that Community-based Disaster Risk Reduction (CBDRR) efforts approached from a social and behaviour change perspective ensure that the poorest, most vulnerable and marginalised communities understand the simple and practical actions required to protect lives and personal assets in case of natural disasters. Perhaps the major lesson learnt is that CBDRR can change the mindset of both communities and other stakeholders.

6.11.1 Community Based Disaster Risk Management (CBDRM)

Community based disaster management, is the only proven method of disaster management; and it is hoped that India would be world leader in disaster management. It is a process where the risk communities, the first responders, are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks in order to reduce their vulnerabilities and enhance their capacities. Due to the severity and widespread nature of natural disasters in India, the need for the institutionalization of CBDRM in government policy making and programmes has been considered as of significant value to the nation.

Best example of Community based disaster management was seen in Maharashtra when it was plagued by unprecedented floods causing havoc in Mumbai, Pune and other districts resulting in tremendous loss to human life, public and private property. The development sector responded to the needs of impacted through a process of relief, rehabilitation and livelihood restoration. There is a huge reservoir of knowledge and expertise in development sector in the world.

The most prominent disaster managers are the personnel in governmental disaster preparedness agencies, national emergency or relief agencies, national reconstruction agencies, and emergency service agencies, departments or ministries. All require disaster management specialists. Municipal or provincial governments often have disaster managers. A large city has a director of emergency services. It also has persons in public health departments, police departments, or public works departments. They may be assigned additional responsibilities in emergency management.

Intergovernmental organizations often have specialized disaster or emergency management agencies. Such as, the United Nations Disaster Relief Office (UNDRO) provides a wide variety of emergency management services to member governments. The United Nations High Commissioner for Refugees (UNHCR) and the United Nations Relief and Works Agency (UNRWA) provide specialized assistance to refugees.

Even within the non disaster agencies of the United Nations, there are often special emergency management offices like UNICEF, which has an Emergency Unit; the World Health Organization, which has a Director of Emergency Relief Operations; and the Pan American Health Organization (a regional office of WHO), which has an Emergency Preparedness and Disaster Relief Coordination office that focuses specifically on the Americas. The World Food Program also has a special Office for Emergency Relief.

Many nongovernmental organizations, like National Red Cross and Red Crescent Societies, the League of Red Cross and Red Crescent Societies, and the International Committee of the Red Cross, are specifically organized to provide emergency services. They function both at the local level and at the international level. There are also millions of other private relief organizations throughout the world. These are organized to provide specialized assistance to disaster victims.

6.12 ROLE OF MEDIA AND COMMUNICATION IN DISASTER MANAGEMENT

Communication plays a pivotal role in disaster reduction. It is true that they often overlap. But these roles may be divided into five broad categories: Technical communications systems, such as satellites, remote sensing devices, and computer networks, and other technology-based communication systems research, predict, track, and provide early warning of natural hazards. Disaster site communications maintain links with disaster response officials, the government, affected populations, and sources of emergency relief supplies. Organizational communications are essential for the effective, dependable operation and interaction of private, governmental, and multinational disaster prevention and relief organizations. Communication for scientific development and policy formation, between scientists, engineers, government officials, other disaster response officials, insurers, the media, and the public develop our knowledge of natural hazards and how to keep them from becoming disasters. Public education and communication--through electronic and print media, wired and cellular telephones, and alternative media-to-educate the public about natural hazards and disaster prevention, warn of approaching hazards, and facilitate participation in public discussions about disaster preparedness and response.

Each of these uses of communications in response to disasters has attracted the attention of scientists, disaster relief officials, and communications specialists. Technical communications systems, disaster site communications, and organizational communications, in particular, have been the subject

of ongoing international discussions and reports, a number of which are reprinted elsewhere in this volume. The importance of communications in disaster mitigation has played a significant role in the IDNDR. Dr. Rattien, now Executive Director of the National Academy of Sciences Commission on Geosciences, Environment and Resources, concluded: "Mass communications is inextricably entwined with disasters and hazard mitigation."

6.13 ROLE OF GEOGRAPHY AND GIS IN DISASTER MANAGEMENT

Geography has a many-decades long record of research and practical application in understanding and managing hazard and disaster. It examines some of the earlier conceptions of geography's interest in human-environment interactions and discusses shifts in understanding the nature of hazard, including recent emphasis on vulnerability.

Geographic Information Systems (GIS), Remote Sensing (RS), and Global Positioning Systems (GPS) have gained much attention for their applications in disaster management and are increasingly utilized throughout the entire disaster management cycle as a tool to support decision making.

Geo-data acquisition through mobile GIS and digital video: an urban disaster management perspective.

1. Software availability

Two different types of software packages were tested. One group was tested with the objective of analysing the capacity to import points internally tracked by the GPS and export them into a GIS. The second group was tested with the objective of analysing the capture of still images from digital video. ArcPad proved the most adequate software for handling GPS data; it is user-friendly and it allows to virtually skip several steps since it constitutes a mini or light version of ArcView that has the ability to link real-time to a GPS unit. Moreover, it can be customized using the ArcPad Application Builder. For the automated production of still images based on video, the Scenalyzer Live software was the only one amongst those tested that was able to automatically save a sequence of images using the time-code as their filename.

6.14 SUMMARY:

After going through the chapter we may conclude that natural disasters are very much part of the natural cycles. It is somewhat obvious that public perception plays an important role in natural disaster management. Existing technologies are capable in providing important as well as new information to the disaster managers that could save lives, reduce damage to property, and

lessen the environmental impacts of natural disasters. In spite of all these there are innumerable shortcomings that inhibit optimal decision-making for disaster management. Disasters are of three types, natural disasters, man-made disasters and technological disasters. Often the best response to natural or man-made disasters can be effective planning before tragedy strikes. Disaster management will be fruitful if the managers themselves know what to do in a disaster and how to prepare for one.

As a result of her unique geo-climatic conditions India has been traditionally vulnerable to natural disasters such as floods, droughts, cyclones, earthquakes and landslides. The loss in terms of private, community and public assets has been astronomical. It is the poor and the under-privileged who are worst affected on account of disasters. Hence in India disaster management occupies an important place in this country's policy. Furthermore, identification of hazards and assessment of risks affecting the state is a vital step in the process of reducing the impacts of disasters.

6.15 CHECK YOUR PROGRESS/ EXERCISE

1. True false

a. A disaster is separated from an accident by its magnitude of need and victims involved.

b. Man made refer to those disasters that are triggered by natural phenomena such as earthquakes, cyclones, floods, etc.

c. Overgrazing or poor farming practices in the upper portions of a watershed has increased flooding.

d. The catastrophic gas leak at the pesticide plant in Bhopal, India, in 1984 is an example of man-made disaster

e. Communication plays a pivotal role in disaster reduction.

2. Fill in the blanks

a. A hazard is a situation where there is a threat to life, health, environment or property where as, a _____ is an event that completely disrupts the normal ways of a community.

b. Risk increases with increase in hazards and vulnerability and decreases with the increase in_____.

c. Minimizing the effects of disaster such as building codes and zoning, vulnerability analyses and public education is known as _____.

d. Disasters do not recognize or respect national geographic_____.

e. _____ disasters are more economic than physical.

3. Multiple choice question

a. Man-made disasters can be divided into the following categories

i. environmental degradation, increased desertification resulting from overgrazing, and disasters that are not caused by natural hazards but that occur in human settlements.

ii. armed conflict, technological disasters, and disasters that are not caused by natural hazards but that occur in human settlements.

iii. result of accidents or incidents occurring while distribution of hazardous substances, armed conflict, environmental degradation.

b. Hazards are termed as disasters

i. when they cause widespread destruction of property and human lives.

ii. when they cause great loss to agricultural field only.

iii. when they cause great loss human lives after epidemic.

c. In disaster management phase preparedness means

i. planning how to respond

ii. returning the community to normal.

iii. minimizing the effects of disaster.

d. India has brought some changes in disaster policy that include

i. the enactment of Disaster Management Act, 2010 and development of the national disaster management response framework

ii. the enactment of Hazards Management Act, 2005 and development of the national disaster management response framework

iii. the enactment of Disaster Management Act, 2005 and development of the national disaster management response framework.

e. The two main windows presently open for meeting relief expenditure related to natural disasters are

i. Orissa State Disaster Management Authority (OSDMA) and the Calamity Relief Fund (CRF)

ii. National Disaster Response Force (NDRF) and National Disaster Mitigation Resource Centre (NDMRC)

iii. the Calamity Relief Fund (CRF) and National Calamity Contingency Fund (NCCF).

4. Answers the following Questions

1. Define disaster.
2. What are the differences between hazards, calamity and disaster-
3. What are the financial arrangements in Disaster management in India?
4. What is the Role of NGOs in disaster management in India?
5. How does community based organizations help in disaster management in India?
6. State the role of geography and GIS in disaster management.
7. What is disaster management cycle?

6.16 ANSWERS TO THE SELF LEARNING QUESTIONS.

1.a. true
1.b.false, Natural disasters
1.c.true
1.d.false, Technological Disasters
1.e. true

2.a. disaster
2.b. capacity
2.c. mitigation
2.d. boundaries
2.e. Technological

3.a.ii.
3.b.i.
3.c.i.
3.d.iii.
3.e.iii.

6.17 TECHNICAL WORDS:

1. **Disaster**-is an event that completely disrupts the normal ways of a community and brings human, economic and environmental losses upon the community.

2. **Hazard**-is a situation that poses a level of threat to life, health, property, or environment.

3. **Calamity**: a serious accident or bad event causing damage or suffering

4. **Vulnerability**-is the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard.

5. **Capacity-**is a combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster

6. **Emergency services**-The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.

7. **Environmental degradation**-The reduction of the capacity of the environment to meet social and ecological objectives and needs.

8. **Risk**: The combination of the probability of an event and its negative consequences.

9. **Mitigation**: The lessening or limitation of the adverse impacts of hazards and related disasters.

10. **Forecast**: Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.

6.18 TASK

1. In a chart draw Disaster management cycle and describe how it functions

2. In a chart with the help of bullets write down the disaster management policy framework prepared by National Disaster Management Authority (NDMA).

6.19 REFERENCES FOR FURTHER STUDY

1. Ministry of Home Affairs, Govt. of India, Disaster Management in India
2. Module 4 - Capacity Building in Asia using Information Technology Applications (CASITA)
3. Asian Disaster Preparedness Center (ADPC), Bangkok.
4. Encyclopedia of Disaster Management: Volume IV by Alfred Scott
5. Disaster Management: Future Challenges and Opportunities by Jagbir Singh
6. Disaster Management by Harsh K. Gupta
7. Oxford dictionary

7

NATURAL DISASTER: FLOODS AND DROUGHTS

After going through this chapter you will be able to understand the following features:

7.1. OBJECTIVES

By the end of this unit you will be able to –

- Define floods and droughts
- Know about the meaning and nature of floods and droughts
- Understand types of natural disasters in India
- Discuss effects of disasters
- Understand efforts to mitigate disasters
- Discuss floods and droughts with reference to nature

- Learn geographical distribution of floods and droughts
- Understand causes and impact of floods and droughts
- Define forecasting, warning & monitoring, preparedness and response of floods and droughts
- Learn mitigation and discuss case studies

7.2. INTRODUCTION

In the previous chapter we have studied that the main aim to learn disaster management is to lessen the impact of disasters around the world. We also know that disaster management tries to coordinate various resources effectively and seamlessly. In this chapter we are going to study two natural disasters, flood and drought, its causes and impact. Beside these two there are also different types of natural disasters like landslides, earthquakes etc. occur in India. Now we will learn the effects of these disasters and the efforts taken to mitigate them. Case studies regarding different disasters are also a part of this chapter.

7.3. SUBJECT-DISCUSSION

Earth is in a state of constant change. Some of these changes become very devastating in their after effects and hence are recognized as environmental disasters. But not all environmental disasters are the result of natural change. Some are the results of human error, carelessness also. A debate continues on the topic of natural disasters and on the role of human in the same. Some human practises such as developmental activities are to be blamed regarding constant rise of natural disasters like floods, drought etc. If we go through the reports of natural disasters for the past few years we will notice that there is an increase in the natural disasters. The tsunamis which hit parts of Asia and America in 2004/2005 and floods in the part of Uttarakhand, India are two examples of destruction caused by natural calamities. The severity of a disaster is measured in lives lost, economic loss, and the ability of the population to rebuild. Regardless of how environmental disasters are caused though, each and every disaster has not forgotten to leave its mark on the surface of Earth.

So, results of natural disasters are high death rate with extensive destruction. Events that occur in unpopulated areas are not considered disasters. So a flood on an uninhabited island would not count as a disaster, but a flood in a populated area is called a natural disaster. Floods, droughts, cyclones, earthquakes, landslides and avalanches are some of the major natural disasters that repeatedly and increasingly affect India.

7.4 MEANING AND NATURE - NATURAL DISASTER:

Natural disasters refer to those disasters that are triggered by natural phenomena such as earthquakes, cyclones, floods, etc. These are again technically known as natural hazards. The term "natural disaster" can be misleading because it implies that the disasters are solely a result of natural hazards when in fact, human endeavours are a major contributing factor in creating a disaster. For example, if settlements or farms were not located in flood plains, disasters would not result from floods. If housing were built to earthquake- and cyclone-resistant standards, these hazards would be of scientific interest only and not result in disasters.

Recently, environmental degradation has begun to occur more frequently as a novel disaster. It results typically from poor farming, grazing, or settlement practices, or because of demands for fuel wood. Excessive exploitation of natural resources or improper use or maintenance of lands changes the ecological balance; the resulting effects of deforestation, desertification, erosion, siltation, or flooding often bring disaster.

Increased flooding due to overgrazing or poor farming practices in the upper portions of a watershed, and increased desertification resulting from overgrazing or improper use of water resources are a few examples. This type of disaster is a growing concern not only because of the environmental consequences but also because large numbers of people can be displaced. The resulting social disruption can cause massive problems.

7.5 TYPES OF NATURAL DISASTERS IN INDIA

Several natural disasters in India happened due to climatic conditions of India. These have caused massive losses of Indian life and property. **Droughts, floods, flash floods, cyclones, avalanches, landslides** brought on by torrential rains, and snowstorms pose the greatest threats. In order to be classified as a disaster these phenomena must have profound environmental effect and /or human loss. These frequently incur financial loss too.

Excessive down pour during monsoons caused landslides in hilly areas which disturb the life to a huge extent in those areas and even in the nearby ones. Other dangers include frequent summer dust storms, which usually track from north to south; they cause extensive property damage in North India and deposit large amounts of dust from arid regions. Hail is also common in parts of India, causing severe damage to standing crops such as rice and wheat.

7.5.1. **Some of the natural disasters in India are as follows:**

I. Landslides in India

In India, the landslides keep happening frequently in lower Himalayas because these hills are not old enough and are still into formation. One more reason behind the occurrence of landslides in these regions is deforestation as the trees that hold the soil tight have been cut in huge number. Apart from lower Himalayas some areas of Western Ghats also experience landslides, though not such heavy ones. In major parts of Himachal Pradesh, Kashmir and Sikkim, avalanches are quite common.

II. Floods in India

Flood is the most widely occurring natural calamity that takes place in almost all the regions of India. The heavy rainfall causes the water-levels of major rivers like Brahmaputra to rise up resulting into destruction everywhere in that region. Crops are affected widely. Another cause that contributes majorly to this disaster is global warming. The huge ice deposits, melting at a fast pace, increase the water levels further. For past few decades, floods have been occurring in Central India mostly. The imbalance in environmental cycle has led to all sorts of environmental issues, floods being most common of them.

Some of the heaviest recorded floods in India have been the Gujarat flood of 2005, the Ladakh floods of 2010, the Brahmaputra floods and Himalayan Flash floods of 2012, the Assam floods of 2013, One of the most recent natural disasters to have affected India is the massive flood which affected Jammu &Kashmir in September, 2014 which claimed thousands of lives.

III. Flash Floods

Another catastrophic natural disaster to have hit the country was the flash floods in River Ganga in 2013. Heavy and sudden rains in the region caused destructive landslides in Uttarakhand, which took toll of thousands of lives, most of them being pilgrims of Badrinath and Kedarnath, while thousands were reported missing.

IV. Drought in India

Drought in India has caused tens of millions of deaths over the course of the 18th, 19th, and 20th centuries. Indian agriculture is heavily dependent on the southwest summer monsoon. In some parts of India, the failure of the monsoons result in water shortages, resulting in below-average crop yields.

V. Cyclones that Devastated India

Cyclones play the most devastating role as natural disaster. The coastal regions that come under Inter tropical Convergence Zone including the Bay of Bengal are hit by cyclones which are characterized by storming rains that lead to complete blackout and cutoff from all sorts of connectivity even for important supplies.

India's western coast, bordering Arabian Sea, experiences mild cyclones only rarely; these mainly strike Gujarat and, less frequently, Kerala. The powerful cyclones are majorly experienced in the coastal states such as Andhra Pradesh, Orissa, Tamil Nadu, and West Bengal in the Bay of Bengal region.

Among many other cyclones the Odisha Cyclone 05B that struck Orissa on 29 October 1999, was the most devastating one that had cost thousands of lives and left millions of people homeless. It was the worst in more than a quarter-century. With peak winds of 160 miles per hour (257 km/h), it was the equivalent of a Category 5 hurricane.

VI. Earthquakes in India

India has a history of havoc created by earthquakes which happen due to sliding of various layers of the earth. The Indian sub-continent is moving towards rest of Asia at a considerable rate. This has created various zones that are prone to earthquakes. Till date, the areas in India that have been affected by earthquakes are Kangra in Himachal Pradesh, Andaman & Nicobar, Jammu & Kashmir, West Bengal, New Delhi, Gangtok in Sikkim, Ratnagiri in Maharashtra, parts of Gujarat, Latur in Maharashtra, Uttarkashi in Uttarakhand, parts of Himachal Pradesh, Arunachal Pradesh and Kolkata in West Bengal. Almost all of India has suffered from the fury of earthquake.

Latur earthquake is one of the most devastating natural disasters in India of all time which hit Latur in Maharashtra on September 30, 1993. The earthquake which killed nearly 20000 and left 30000 injured, measured 6.4 on the Richter scale. It also caused huge damage to property, reducing thousands of buildings to rubble.

Apart from these major natural issues, there are many more like drought, heat waves and wildfires that have been bothering life in India to a great extent. Several measures have been taken to avoid the extent of damage, yet a lot needs to be done in this regard.

7.6 EFFECTS OF DISASTERS

India is among the world's most disaster prone areas as a large part of the country is exposed to natural hazards. These have turned into disasters causing loss of life and property. The consequences of natural disaster caused by earthquakes, flood, volcanic eruption, landslides, and hurricanes are catastrophic. In recent years these hazards took toll of thousands of lives and caused massive destruction of property. These have adversely affected the vital sectors of the country's development as agriculture, communication, irrigation, power projects and rural and urban settlements get affected. However, irrespective of the duration of a disaster, the damage in the form of deaths, injuries and losses of property is immense. The magnitude of the disasters can be judged by the fact that only during the past two decades; occurrences of floods, earthquakes, landslides, cyclones, etc. have killed several million people.

7.6.1. Some of the common natural disasters, their effects on environment are discussed below:

i. **Effects of Earthquake on the Environment**:

Earthquake is one of the most catastrophic natural disasters. The destruction, caused by an earthquake depends on its magnitude and duration or the amount of shaking that occurs. There are places located in the unstable regions of the earth crust, which are subjected to tectonic activities. In India, the entire Himalayan region, parts of the Gangetic Plain, Kutch and Andaman and Nicobar islands are in the earthquake hazard zone. In the last 500 years, earthquakes around the world have killed several million people. Massive loss of life and property occurs due to collapse of buildings. Besides, roads, bridges, canals, electric poles, etc. are severely damaged. Certain regions of the earth are more prone to earthquakes.

The major earthquakes of India are as follows:

Date	Details
October, 2005	Jammu and Kashmir, intensity 7.4, about 40,000 people died
26th January, 2001	Gujarat, intensity 7.9, about 20,000 people died.
29th March, 1999	Chamoli, Uttaranchal, intensity 6.8, about 1000 people died
22nd May, 1997	Jabalpur and Mandla, M.P., about 50 people died
30th September, 1993	Latur and Osmanabad, Maharashtra, about 10,000 people died
20th October, 1991	Uttarkashi, Uttaranchal, intensity 6.6, about 1000 people died

❖ **The major impacts of earthquakes are as follows:**

Shaking of the ground and surface rupture:

This is the main cause of destruction in which buildings, bridges, roads, canals and other structures are damaged.

Liquefaction:

Earthquakes make sands and silts to transform from a solid to liquid state. This also results in building collapse.

Landslides:

Earthquakes of high intensity often trigger many landslides in the hilly regions.

Fires:

It is a major hazard associated with earthquakes. The shakings of the ground and building damage often break the gas pipes and electric lines that cause fires.

Changes in the land elevation:

The surface topography of a region and groundwater conditions are altered after an earthquake.

ii. <u>Effects of Flood on the Environment</u>

The lives lost in floods may be less in comparison to earthquakes or cyclones but the damage to the environment is immense. The problem is further aggravated if the floods last for a longer duration of time. Floods cause huge losses of life and property in the affected region. There is great damage to agriculture and livestock too.

Beside damage of property and death of human and animals Floods have other effects too. They are as follows:

1. Floods cause the spread of many epidemic diseases such as diarrhea, gastroenteritis, jaundice, malaria, etc.
2. Rapid runoff causes soil erosion.
3. Wildlife habitat and forests are often destroyed.
4. Manmade structures like buildings, bridges, roads, sewer lines, power lines, etc. are damaged.
5. Floods cause widespread damage to the standing crops and degrade the agricultural land.
6. Flood affected areas are faced with acute shortage of food and drinking water.

iii. The evil effects of drought

Drought has manifold impact on the geography of a country as it affects all aspects of our society, be it economic, political or social. The direct impact of a drought on Indian economy is in the area of agriculture. A weak monsoon will result into a crop failure and hence will affect a hundreds of millions of poor agricultural labourers, small farmers and their families. Such dire situations will force the farmer to borrow loans from exploitive moneylenders which would then trap them into a vicious cycle of debt and poverty. School drop-outs, malnutrition and in the worst conditions suicide would define the conditions of these agricultural families during drought. The suicides of farmers in the Vidarbha region of Maharashtra during the drought of 2009 are known to us.

As Indian agriculture is primarily dependent on irrigation facilities rain water is extremely essential for agriculture. Drought affects the Kharif crops and has negative implications for India's rice yield and hits the economy of our country known to have paddy-culture. Occurrence of a drought adversely affects the agricultural production by lowering the produce and would lead to high food insecurity in the nation. As a result there would be food shortage and insecurity which would lead to high inflation with extreme hike in prices of food grains making survival difficult for the poor.

Beside agriculture the agro-based industries will also suffer a drop in the production level and incur huge losses due to shortage of agricultural raw materials.

Drinking water problems would constitute one of the basic problems faced by one and all. The occupation of animal husbandry would be hard hit due to degradation of green pasture lands and loss of fodder. Further, India receives a lot of its economic resources from forests and drought reduces this forest cover. Lack of rainfall also increases the chances of forest fires leading to loss of trees and the resources.

Hence, it is clear that drought crushes our nation and it is important to control it.

❖ In short the impact of drought is as follows:

- Drought during the monsoon period decreases production, which in turn, increases the prices of agricultural commodities and affects their demand;

- In a free market situation, farmers will benefit from higher prices but consumers will be badly hit, and demand will thus come down.

- Benefits of higher prices are not passed on to the majority of farmers, especially smallholders, but are seized by middlemen or traders. Thus, both smallholder farmers and poor consumers are affected by a drought.

iv. Effects of landslides and snow avalanches

Landslides occur in remote mountain areas with difficult terrain and adverse weather conditions where the villages and hamlets are small entities with weak housing, makeshift structures and poor resources. Landslides and snow avalanches give almost no notice in most cases and enormous amount of rock, soil or snow come crashing with fantastic speed on the often-unprepared communities. Considering these facts it may be said that the effects of landslides is catastrophic.

The direct and indirect effects of landslides and avalanche are as follows:

i) Direct effects cause physical damage

Anything in the top of a landslide or in its path or at its bottom will suffer severe damage. In case of a snow avalanche of "slab type" where massive slabs of hardened snow come hurtling down, the hit is very hard and devastating where as the "loose snow' type of snow avalanche may engulf and cover larger area.

- Apart from injuries and fatalities to human and cattle lives blockages of roads, mountain passes and streams and damage to electric and communication lines fall under the direct effects of landslides and snow avalanches.
- Blockage of streams and later release of the impounded water create flash floods with disastrous effects.
- Falling of large volumes of debris from landslides or snow avalanches in mountain lakes can generate flash floods.
- Snow avalanches create additional suffering due to extremely low temperatures and the associated freezing effect.
- Even if there are survivors among the victims, they may suffer hypothermia and frost-bite before help arrives.

ii) Indirect Effects and long-term Impacts

Apart from loss of houses, destruction of property and shattering of family life due to death or injury to kith and kin, the indirect effects and long-term impacts of landslides and snow avalanches lead to further loss of productivity (agriculture, poultry, small scale cottage industry, forest produce) in an already marginal productivity scenario.

7.7 EFFORTS TO MITIGATE DISASTERS

An action taken to reduce both human suffering and property loss resulting from extreme natural phenomena is known as **Mitigation**. This includes measures like land use planning, improved disaster-resistant building techniques, and better agricultural practices.

The primary focus of disaster management should be to prevent disasters and/or to mitigate those that do happen. Disaster managers can generally use four sets of tools. They are:

- Hazard management and vulnerability reduction
- Economic diversification
- Political intervention
- Public awareness.
- Hazard management and vulnerability reduction and Economic diversification are applied exclusively to disasters caused by natural phenomena, while the Political intervention and Public awareness are used to try to mitigate impending refugee situations.

Generally government, intergovernmental organizations, carries out hazard management programs. The larger VOLAGS also play the same role along with these two because many of the hazard management activities involve vast areas and require large amounts of resources. At the community level, small agencies and communities can undertake a variety of activities with little outside assistance. Planting windbreaks and building flood embankments are examples of such activities.

<u>The range of specific tools for mitigating environmental hazards is</u>:

- Planning
- Building regulations, including zoning, building codes, performance standards, and Improved urban design
- Strategic development or investment of sites and services
- Economic incentives
- Housing education, i.e., the training of home builders to improve the quality and performance of housing
- Code encouragement, i.e., the use of building inspectors to advise and encourage Home owners to utilize disaster-resistant construction
- Financial incentives as an inducement for builders to use hazard- resistant construction Techniques

- Insurance
- Environmental management, for example, reforestation and rangeland management in Watersheds
- Immunization campaigns to reduce the threat of disease.

All the tools listed above require a technical understanding of the threats and the possible solutions.

7.7.1. Planning Strategies

Various strategies that can mitigate the impacts of hazards can be adopted through normal planning. Among these are:

A. To reduce losses there must be adjustment in normal development programs. For example, crops that are more wind or flood-resistant may be introduced in areas prone to floods or cyclones.

B. Diversification is extremely important in the economic field where economies are based on a single cash crop. Diversification will help protect the economy against natural disasters and also against unanticipated price fluctuations on the international market. Small island countries that depend on exporting bananas, palm oil, or other tropical agricultural products are vulnerable to extensive damage in a cyclone. Such countries could diversify into fishing, light manufacturing, or other activities.

C. Developing "disaster resistant" economic activities within a region. Some economic activities are relatively unaffected by certain types of disasters. For example, warehousing is more suitable than manufacturing for locating in flood plains. Coconut palms are more suitable than citrus or other fruit trees in cyclone-prone coastal areas. Efforts should be made to identify and to encourage the development of enterprises that are less vulnerable to the hazards.

7.7.2. Regulations

❖ Planners can use three sets of regulatory controls for hazard management. These are stated under:

I. land-use planning and zoning;
II. building codes and performance standards; and
III. land-use and building standards.

Conventional land-use controls regulate function, density, and location of activities, the rate of development, and limits of growth. "Zoning" may be defined as a division of land into districts or land-use zones. Zoning ordinances are usually divided into broad land-use categories, such as agricultural, residential,

industrial, and/or commercial uses. Sub-zones may include such designations as reforestation areas, range-land management zones, and watershed management zones. Hazardous area can be zoned permanently for agricultural or recreational use, thus minimizing concentrations of a population or a built environment on this site

Building codes are used to control the built environment within an area.

Building codes and land-use zoning are often criticized as being ineffective in less developed countries, since enforcement is difficult and most growth is unregulated.

7.7.3. Strategic Development or Investment

Planners often encourage development away from hazardous areas. For this they invest or create a favourable environment in less vulnerable regions or communities. This strategy is often difficult to implement in regional development as most hazards are not site or area-specific; they can threaten wide areas. It may be said that earthquake zones often extend for thousands of miles, and relocation of threatened settlements or enterprises is often not possible. Moreover, hazards that occur infrequently are usually not considered in economic development planning. In spite of all these Strategic investment has proven successful in agricultural sectors. India has been successful in extending irrigation, land reclamation activities, and regional farm-to-market roads onto coastal plains.

7.7.4. Economic Incentives

In order to encourage development away from hazardous areas Governments extend a number of economic incentives to people and organizations. Such incentives include provision of land, loans, grants, favourable credit, favourable taxation, technical assistance, or a combination of these.

The role played by government of Bangladesh to reduce human and agricultural losses is unique. They initiated a program to provide small plots of irrigated land, low-cost loans for initial land development were made available through cooperating private sector institutions to landless peasants. After arriving in the new areas, technical assistance for farming was provided by government agricultural extortionists.

7.7.5. Public Information and Education for Hazard Management

Effective hazard management requires an informed public, especially those at risk. In hazard management this is called public awareness. Public awareness campaigns disseminate information about the types of hazard, the effects of a hazard, the measures available to reduce the impact, and the actions to take when the hazard strikes.

❖ **Typical public awareness activities include:**

- Film and video programs that illustrate and describe the hazard and the risk and demonstrate what can be done to prevent or mitigate losses.
- Radio programs.
- School curricula and booklets that include lessons and projects about hazard mitigation.
- Comic books (perhaps based on the films or video programs) made available for general distribution.
- Posters placed around the community to act as a general reminder of the issues.
- Presentations on the subject made to public groups or private organizations (e.g., neighborhood councils).
- Brochures and handouts distributed door-to-door or at public event, fairs, etc.
- Features or articles in local media, especially periodicals.

7.7.6. Economic Mitigation

By economic mitigation the disaster's impact on the economy and on the economic well-being of the disaster victims is reduced. This is done by strengthening those sectors of the economy that are particularly vulnerable to disasters, by diversifying the economy, by introducing or expanding "disaster-resistant" economic activities, and by spreading or relocating economic activities to less vulnerable areas so that not all the principal enterprises would be affected at the same time.

The methodology used for economic mitigation is same as physical loss. Once hazard mapping has been completed, planners identify those sectors of the economy that are vulnerable to disasters. First, the key elements of the economy and those that are not particularly vulnerable to disaster are identified. Every economic activity is examined to determine if a hazard could affect

a significant portion of that activity. This analysis is conducted on both the macro and micro levels.

Although Economic diversification and insurance are the two primary economic mitigation measures there are too few programs currently available for low-income persons in the developing countries. In some cases governments and large economic institutions have found alternative ways of providing insurance to low-income people.

7.7.7. Adjusting On-Going Development Activities

Adjustment to on-going development programs is a major way to address disaster mitigation. Many development projects have the potential to reduce either physical or economic vulnerability of families and communities. For example, housing programs can incorporate, often at little or no additional cost, a variety of disaster-resistant construction and planning techniques.

Areas of particular interest are:

- Housing and urban development programs (siting and construction);
- Establishment of new settlements.
- Forestry projects.
- Agricultural development projects land reclamation.
- Rangeland management.

7.7.8. Diversification and Expansion of the Social Support Network

Diversification of a community's social structure is an important mitigation measure. This can best be accomplished through extending normal development work in one of the following three ways.

I. The first is institution building. Local organizations that serve as a means of coping with disasters or providing support to disaster victims should be identified and strengthened.

II. The second activity is to increase the number of coping mechanisms within the community.

III. The third activity is to broaden the scope of service of local groups and to encourage activities that promote cooperation among different elements or groups within the society. Such cooperation can reduce the social impact of a disaster.

7.8 FLOODS AND DROUGHTS WITH REFERENCE TO NATURE

7.8.1. Floods

a. Floods reference to Nature

Flood is a state of high water level along a river channel or on coast that leads to inundation of land which is not normally submerged. Flood is an attribute of physical environment and thus is an important component of hydrological cycle of a drainage basin. Flood is a natural phenomenon in response to heavy rainfall but it becomes a hazard when it inflicts loss to the lives and properties of the people.

b. Geographical distribution of floods

Floods occur most often in low-lying coastal areas and river floodplains. Any plain low-lying area adjacent a river, lagoon or lake is more likely to have floods anytime the water level rises. This includes coastal areas and shorelines, as seawater can easily be swept inland by strong winds, tides and tsunamis.

Flood Prone Areas in India

National Flood Commission (RBA) -1980 assessed the total flood prone area in the country as 40 m.ha. which included the unprotected flood area of 33.516 m ha and the balance as protected area. Subsequently, the Working Groups on Flood Management for X and XI Plans assessed the flood prone area in the country as 45.64 m ha.

The states falling within the periphery of "India Flood Prone Areas" are West Bengal, Orissa, Andhra Pradesh, Kerala, Assam, Bihar, Gujarat, Uttar Pradesh, Haryana and Punjab. The intense monsoon rains from southwest causes rivers like Brahmaputra, Ganga, Yamuna etc. to swell their banks, which in turn floods the adjacent areas. Over the past few decades, central India has become familiar with precipitation events like torrential rains and flash floods. The major flood prone areas in India are the river banks and deltas of Ravi, Yamuna-Sahibi, Gandak, Sutlej, Ganga, Ghaggar, Kosi, Teesta, Brahmaputra, Mahanadi, Mahananda, Damodar, Godavari, Mayurakshi, Sabarmati and their tributaries.

Flood prone areas of India

States	1953-78 (mha)	1953-88 (mha)
Andhra Pradesh	1.39	1.39
Arunachal Pradesh	-	0.00
Assam	3.15	3.82
Bihar	4.26	4.26
Goa	-	0.00
Gujarat	1.39	1.39
Haryana	2.35	2.35
Himachal Pradesh	0.23	0.39
Jammu & Kashmir	0.08	0.51
Karnataka	0.02	0.26

c. Causes of Floods

Floods are results of unfavourable combinations of meteorological and physical condition of the drainage basin which leads to excessive water run-off and consequent relative reduction in carrying capacity of channels leading to bank full conditions. The causative factors, in recent times, have been aided and accentuated by human impact. **The various conditions responsible for flood are:**

(A) Meteorological Conditions

1. Cyclones.
2. Cloud Burst.

(B) Physical Conditions

1. Narrow outlets.
2. Large catchments areas.
3. Lack of well developed drainage channel.
4. Siltation and rising of channel
5. Presence of unconsolidated soil.
6. Blocking effect of landslides.
7. Meandering.

(C) Human Impact

1. Construction of dams and reservoirs.
2. Bursting of dams
3. Deforestation.
4. Faulty slope practices.
5. Construction of embankments.

(A).Meteorological Causes

1. Heavy rainfall.

India is one of the world's wettest countries receives an annual average rainfall of 115 cm. Nearly 80 per cent of which is received from June to September in all the states, except Tamil Nadu, during the southwest monsoons. It usually exceeds 100 cm in areas east of 78" E longitude. It extends to 250 cm along the entire west coast and Western Ghats and over most of Assam and sub- Himalayan West Bengal. Because of this seasonal concentration of rainfall, rivers remain practically day during summer while in rainy season they swell, overflowing their banks.

Heavy incessant rainfall for long period is the basic cause of floods because huge amount of water gets collected on the surface flowing as run-off.

High intensity rainfall gives average annual amount of 250 cms. in the plain area and 500 cms. in the hilly sector in Assam that periodically causes floods in the Brahmaputra valley. High rainfall in the Himalayas and in the plains causes disastrous floods in the Himalayan rivers draining through the North Indian plains. Higher magnitude of rainfall coupled with a larger catchment area leads to a greater volume of overland flow.

2. Cloudbursts.

Excessive rain within a short period is called a cloudburst. Cloudbursts are very common in the Himalayan region, Orissa, and central and western India including Rajasthan and Gujarat.

3. Tropical Cyclones

Cyclones are the most important cause of floods in the coastal areas. Certain parts of our vast coastline especially Andhra Pradesh, and Orissa coast in the east

and the Gujarat coast in the west are particularly prone to onslaught of cyclonic storms which originate and develop over warm seas. These violent storms are accompanied by huge tidal waves and intense rainfall. The tidal waves cause widespread inundations in the coastal belts. It is inevitable that the heavy downpour which accompanies cyclones will bring flood in the affected region. In November 1982 and in 1983 in Saurashtra, cyclones resulted in overflowing of 27 dams some by over 2m.

Although floods due to cyclonic storms are a natural calamity we must have some precautionary measures to minimize the impact of cyclonic storms.

(B). Physical Conditions

1. Large Catchment area

A large catchment area collects water from a larger area thus even if the rainfall conditions are not fairly heavy, chances of flooding in the consequent stream is high simply because the volume of water collected from such a larger area becomes very large. The catchment areas of the Ganga and the Godavari are very large and the volume of the water carried by these rivers is also very large.

2. Inadequate drainage arrangement

Even if the catchment area is quite small and the rainfall in the catchment area is not heavy, flood occurs because water, if it does not drain quickly, accumulates and leads to flood. The reasons behind the inadequacy of the drainage arrangement in different regions of the country are as follows.

(a) Under-Developed drainage channels. Particularly in the states of Punjab and Rajasthan, the drainage channels are not well developed. Heavy amount of rainfall in these regions cause flash floods as the rivers are unable to accommodate enormous volume of water. Moreover, unconsolidated soil of this region chokes and blocks the natural drainage thus leading to floods.

(b) Reduced Carrying capacity of rivers. The capacity of channels carrying water is diminished by the accumulation of sediments derived from massive erosion in the catchment areas. The deposition of the sediment on the beds restricts the passage of the water and hence the carrying capacity of the channel is reduced. This results in spreading of the flood water on the adjacent

plain. The extensive flooding in eastern Uttar Pradesh and northern Bihar especially by the Narayani and the Kosi rivers is primarily due to reduced carrying capacity of the rivers choked with sediments which have been derived from accelerated erosion in the Himalayan region and inadequacy of slope in flood plains.

(c) Blocking of natural flow by landslides: Landslides lead to impoundment of water and a consequent rising of the water level leading to bank full conditions. If the natural dam bursts, it causes disastrous floods downstream. This normally happens in the Himalayan region. This was happened with the Bhagirathi River in 1978 when a landslide caused a dam formation. The bursting of this dam, 14 hours later, caused widespread havoc up to Uttarkashi and wiped out the hamlets of Gangnani and Dabrani on the pilgrim route to Gangotri.

(d) Meandering of the rivers. Sinuous and meandering course of rivers obstruct the normal discharge of water thus reducing the velocity which delays the passage of water resulting into stagnation of water. For example the meandering loops in Brahmaputra.

(e) Formation of sand bars. Sand bar formation is a common phenomenon in the coastal regions particularly near estuaries. Long shore drift which leads to formation of sand bars chokes the mouth of estuaries and deltas. This impedes the natural drainage, particularly, in times of heavy rainfall when the river carries a greater volume of water. In the delta areas of West Bengal and Orissa the problem has been aggravated by the influence of sea tides which deposit silt on the mouth of the rivers and also in the drainage channels. This leads to a constant deterioration in the discharge capacity of the river.

(C). Anthropogenic Factors and Human Impact

Flood is a natural phenomenon with the presence of certain meteorological and physical conditions. But in recent times some incidence of flooding has been largely due to human impact on the physical conditions. The flood discharge of stream depends on the amount of run-off or the ground flow of rainwater. Run-off is determined by the amount of infiltration of water which, in turn, is determined by the nature and extent of vegetation, texture of the soil and length and steepness of the slope.

The human impact has altered all of these components. The most important of all is the destruction of forest cover.

1. Deforestation

Vegetation has a strong control over runoff as it performs two important functions- by allowing infiltration and hence decreasing runoff. Raindrops are intercepted by forest canopy and thus reach the ground slowly through the leaves, branches and stems of trees. On the ground the lead litters and the grass allows infiltration into the soil and thus reduces runoff. The absence of vegetation on the other hand, exposes the surface to beating rains. The infiltration gets reduced and most of the water flows as surface runoff bringing floods downstream. Thus wherever man has resorted to indiscriminate deforestation, as in Siwaliks, Lower Himalayas, Chhotanagpur plateau, Western Ghats and elsewhere floods have become a rule in the downstream areas. This is evident in Tista and Torsa in West Bengal, Chambal in Madhya Pradesh, Gandak in Uttar Pradesh and Kosi in Bihar, etc.

2. Siltation

Higher surface runoff resulting from deforestation additionally accelerates erosion and increase the sediment load of the streams. Increased sediment load causes siltation of river beds and filling of the valleys and hence, reduces the water accommodating capacity of the river valleys. In south eastern Nepal the beds of the rivers in the Bhabhar belt are rising at the rate of 15-30 cm/yr. The bed of river Kosi in Bihar is now at a higher level that the flood plain, the river flowing within considerably raised levees. Rise of the channel to a greater or less degree has also been responsible for floods in the Gangetic plain and the Brahmaputra plain.

3. Faulty agricultural Practices

In India, valley side slopes of the rivers are ploughed down to the channel, transverse to the contours. This is done to dry out the moisture which had accumulated during the wet rabi season. After the crops are harvested, the ploughed fields are baked by the blazing sun in the summer and the loose soils become extremely dry. With the first showers in the coming rainy season, the loose soils get saturated with water and slump in to the river bed following overland flow. The

river beds thus get gradually stilled. Simultaneously, the cultivation of valley side slopes reduces the gradient of river banks finally flattening the valley. As the flattening gradually proceeds, the water accommodating capacity of the river decreases and the river takes very little time in attaining bank full conditions. The water then spreads over the valley sides inundating the low lying flood plains.

4. Faulty Irrigation Practices

In the Punjab, Haryana and western Uttar Pradesh there is a network of canals in the alluvial formation. The constant seepage of water from the canals raises the water table in the adjoining areas. With further application of water for irrigation, in these regions of inadequate drainage a condition of water logging arises. Under these conditions, even in rainfall is not so heavy the entire rainfall flows as surface runoff because the ground does not absorb the water, bringing floods.

5. Increasing urbanization.

Increasing urbanization helps to increase the surface runoff and thus the dimension and magnitude of floods. The construction of roads, building, pavements, etc., reduces the infiltration capacity and increases the surface runoff. The increases surface runoff finds its way through the drains into the nearby stream locally increasing the volume and magnitude of floods. Additionally, urbanization has also led to siltation of river beds caused by dumping of garbage from the nearby centres, extension of settlement in the low lying areas, filing up of nallas (urban drains), construction of bridges, roads, embankments, etc. Consequently the drainage capacity of the river has been reduced.

Although the causes of floods are many and each individual cause may bring about flood, floods actually result from a combination of these causes. For example, two factors, namely, heavy precipitation and deforestation have been the most important causes of floods and although there has not been a change in the overall rainfall pattern, deforestation has increased surface runoff and consequently incidence of floods.

d. <u>Impact of floods</u>

Floods are gradually becoming more and more damaging as they appear with an increased frequency, intensity and magnitude. The most important impact of floods is the loss of life and property. Indirect losses result from the breakdown of the communication,

disruption of rail and road traffic and other essential services whose restoration may cost crores of rupees.

The impact of flood was not, perhaps felt to the same extent in the past as it is being felt now because earlier only fewer people lived on the land and there was no such proliferation of industrial activity and other works. Now with an increase in population, areas close to the river have also become habituated. The principle where a river has the right of way stay out of its way is not followed by the people who have little option in setting themselves or locating industrial projects. Floods have caused heavy damage on nine occasions in the last 40 years – 1955,1971,1973,1977, 1978,1980,1984,1988 and 1989. On an average, the area affected by floods annually is about eight million ha, out of which the cropped area affected is about 3.7 ha. Rashtriya Barh Ayog has assessed the maximum area prone to the floods in the country to be about 40 million ha, out of which 32 million ha is a protectable area. The maximum area damaged in any one year was 17.5 million ha in 1978. the average (period 1953-91) annual total damage to crops, houses and public utilities is about Rs. 9500 million, while the maximum annual damage was Rs. 46300 million in 1988.

In India, states like Assam, Bihar and parts of Gangetic Uttar Pradesh are quite prone to floods during the rainy season. The Ganga and Brahmaputra rivers and their tributaries are most susceptible to floods. However, heavy rains cause occasional floods in parts of Gujarat, Maharashtra, Karnataka and Tamil Nadu. Flooding, in India, is a major problem and some part or the other is affected by the fury of floods usually during the months from July to September.

These figures indicate the magnitude of the flood problem in the country.

Sl.No.	Item	Average flood damage 1953-90	Maximum drainage in one year (Year)
1	Area affected (in Million ha)	7.94	17.50 (1978)
2	Population affected (in Million ha)	32.86	70.45 (1978)
3	Cropped Area Affected (in Million ha)	3.66	10.14 (1988)
4	Value of damage to crops (in Rs. Crore)	448.32	2510.90 (1988)
5	Houses Damaged (in Million Nos)	1.22	3.51 (1978)
6	Value of damage to Crops (in Rs.Crore)	132.31	741.60 (1988)
7	Cattle Lose (Nos.)	102.905	618.248 (1979)
8	Human Lives Lost (nos.)	1532	11316 (1977)
9	Value of Damage to Public Utilities (in Rs. Crores)	347.38	2050.04 (1985)
10	Total Damage to Crops, houses and Public Utilities (in Rs. Crore)	937.56	4630.30 (1988)

e. <u>Forecasting, warning & monitoring of floods</u>

Disasters do not recognize or respect national geographic boundaries. In the increasingly globalized world, more disasters will be spread over many countries and will be regional in nature. India has set up an example of responding internally and simultaneously in neighbouring countries for the other countries to follow. At the present time, warning is possible for droughts and famines, cyclones and most severe weather phenomena, volcanoes, large scale fires, and in some cases earthquakes.

i. Flood Forecasting

By monitoring events, specialists look for indicators that tell when, where, and what magnitude the disaster may be. This is known as prediction or forecasting.

Advance information about flood plays a key role regarding flood control. Losses due to flood, especially of human life and livestock, can be considerably reduced by flood forecasting and early warning to the affected areas. Normally a flood peak takes a few hours to few days to pass from a point downstream along a river. So, if the water level is constantly monitored, it is possible to issue forecast of floods downstream well in advance for the local authorities to take precautionary steps to minimize the loss of life and property. Flood forecasting is the most effective way of flood management.

The Central Water Commission (CWC) is entrusted with the task of forecasting floods. It has a network of 157 forecast stations in 11 flood prone states and 2 Union territories. Bihar has the largest number of flood forecasting stations. The network uses INSAT extensively for monitoring and transmitting data. In 1992, the accuracy of forecasts was 96%.

During IX Plan, 55 telemetry stations were installed in Mahanadi and Chambal Basins besides setting up of two Earth receiving Stations (ERS) at Jaipur (Rajasthan) and Burla (Orissa). During X Plan, modernization of 168 stations was undertaken; out of which 166 stations besides 11 Modelling Centres have been set up till date. During XI Plan, additional 222 stations and 10 Modelling Centres are proposed to be installed; which would help the concerned States in taking appropriate measures in advance for evacuation of people and shifting them and their properties to safer locations.

ii. Warning Phase

The objective of warning phase is to provide disaster (flood, in particular case) managers with enough information so they can give the people at risk adequate notice or warning to prepare for the disaster and, if necessary, to evacuate. Work is also underway in refugee management to develop early warning techniques that will let relief agencies know of impending refugee crises.

Early Warning- Building codes do not exist against storm surge inundation. Prescribed means today to save life and properties against storm surge inundation is to evacuate people to safer places as quickly as possible on receipt of warnings. Coordinated

early warning systems against tropical cyclone are now in existence around the globe and it is possible to warn the affected population at least 24 to 36 hours in advance about the danger from a tropical cyclone. By taking advantage of early warning systems, it is now possible by prepared and knowledgeable communities to minimize the loss of lives and properties.

iii. Monitoring flood

In India, a two tier system of flood management exists as briefly described below:

State Level Mechanism - The State Level Mechanism includes the Water Resources Departments, State Technical Advisory Committee and Flood Control Board. In some States, the Irrigation Departments and Public Works Departments look after flood matters.

Central Government Mechanism – The Union Government has set up following organizations and various expert committees to enable the State Governments in addressing flood problems in a comprehensive manner:

Central Water Commission (CWC) – The Government of India set up Central Water Commission as presently named in 1945 for achieving the goal of furthering and promoting measures of flood control, conservation and utilization of water resources throughout the country in the areas of beneficial uses, irrigation and hydropower generation, flood management and river conservation.

Brahmaputra Board – The Government of India set up Brahmaputra Board under Brahmaputra Board Act, 1980 (46 of 1980) under the then Ministry of Irrigation (now Ministry of Water Resources) The jurisdiction of Brahmaputra Board includes all NE States in Brahmaputra and Barak Basin. The main functions of Brahmaputra Board are as under:

- Survey and investigations in Brahmaputra and Barak valley.
- Preparation of master plans to control floods, bank erosion, and improvement of drainage system.
- Preparation of DPRs for dams and other projects
- Standard specifications for construction operation and maintenance of dams.
- Construction of multipurpose dams and maintenance thereof.
- Any other function for implementation of Brahmaputra Board Act-1980.

Brahmaputra Board prepared master plans for the flood management for river Brahmaputra and Barak. Besides this, the Board has undertaken survey and investigations for preparation of master plans for tackling the problems of flood, erosion and drainage congestion including DPRs for multipurpose projects.

Ganga Flood Control Commission - The Ganga Flood Control Commission (GFCC) was set up by Government of India in 1972 for preparation of comprehensive plan of flood control for Ganga Basin and to draw out a phased coordinated programme of implementation of works and monitoring & appraisal of flood management schemes of Ganga basin States. The GFCC has prepared comprehensive plans of flood management of the 23 sub-basins in the Ganga Basin besides drawing out a phased programme of implementation of these works to proper standards, examination and monitoring of various flood management schemes in the Ganga Basin States.

Farakka Barrage Project Authority – The Farakka Barrage Project Authority carries out anti-erosion and river bank protection works in its jurisdiction in near river vicinity of the Barrage.

National Disaster Management Authority (NDMA) - For prevention and mitigation effects of disasters including flood disasters and for undertaking a holistic, coordinated and prompt response to any disaster situation, the Government of India has set up a National Disaster Management Authority (NDMA) in 2005 under the Chairmanship of Honourable Prime Minister of India. The functions of the NDMA are:

(i) lay down policies on disaster management;

(ii) approve national Plan;

(iii) approve plans prepared by the Ministries or departments of the Government of India in accordance with the National Plan; (iv) lay down guidelines to be followed by the State Authorities in drawing up the State Plan;

(v) lay down guidelines to be followed by the different Ministries or departments of the government of India for the purpose of integrating the measures for prevention of disaster or the mitigation of its effects in their development plans and projects;

(vi) coordinate the enforcement and implementation of the policy and plan for disaster management;

(vii) recommend provision of funds for the purpose of mitigation;

(viii) provide such support to other countries affected by major disasters as may be determined by the central Government;

(ix) take such other measures for the prevention of disaster, or the mitigation, or preparedness and capacity building for dealing with the threatening disaster situation or disaster as it may consider necessary;

(x) lay down broad policies and guidelines for the functioning of the National Institute of Disaster Management.

The NDMA has issued guidelines in January, 2008 for management of floods and the roles of various Central and State agencies have been specified for preparation of flood mitigation plans and taking relief measures during flood disasters.

f. Preparedness and Response of floods

Development of a culture of prevention is an essential component of an integrated approach to disaster reduction. Prepare and maintain in a state of readiness 'Preparedness and Response Plans' at National, State and District levels and adoption of a policy of self reliance in each vulnerable area. Education and training in disaster prevention, mitigation and preparedness for enhancement of capabilities at all levels. There should be identification and strengthening of existing centres of excellence in order to improve disaster prevention, reduction and mitigation capabilities.

Preparedness means those actions taken to limit the impact of natural phenomena by structuring response and establishing a mechanism for effecting a quick and orderly reaction. Preparedness activities could include pre-positioning supplies and equipment; developing emergency action plans, manuals, and procedures; developing warning, evacuation, and sheltering plans; strengthening or otherwise protecting critical facilities; etc.

Culture of Preparedness -To cope with the effects of natural disasters post-disaster management involve many problems such as law and order, evacuation and warnings, communications, search and rescue, fire-fighting, medical and psychiatric assistance, provision of relief and sheltering, etc.

After the initial trauma of the occurrence of the natural disaster, like flood, is over within the first few days or weeks, the phase of reconstruction and economic, social and psychological rehabilitation is taken up by the people themselves and by the government authorities.

Experience has shown that by the presence of a well-functioning warning system, combined with preparedness on the part of the vulnerable community, destruction from floods may be minimized. A community that is prepared to face disasters receives and understands warnings of impending hazards and has taken

precautionary and mitigatory measures will be able to cope better and resume their normal life sooner.

❖ **Flood preparedness and response in India**

In order to respond effectively to floods, Ministry of Home Affairs has initiated National Disaster Risk Management Programme in all the flood-prone States. Assistance is being provided to the States to draw up disaster management plans at the State, District, Block/Taluka and Village levels. Awareness generation campaigns to sensitize all the stakeholders on the need for flood preparedness and mitigation measures. Elected representatives and officials are being trained in flood disaster management under the programme. Bihar Orissa, West Bengal, Assam and Uttar Pradesh are among the 17 multi-hazard prone States where this programme is being implemented with UNDP, USAID and European Commission.

7.8.2 Mitigation - case studies – flood

❖ **Mumbai flood - July 26, 2005**

The following are the glimpse of complexity of Mumbai Flood

- **Mumbai,** with an Area of 437 Sq. Km, is originally a group of 7 islands having many reclaimed areas that are just 5 mtrs. above low tide sea level.
- Mithi River divides the city into the western & the eastern suburbs can cause floods.
- Rapid urbanisation in the city with mostly private houses has blocked the waterways.
- Railway lines typically 10 mtrs. above low tide level & Subways close to high tide level are highly affected by floods. So, there are 82 chronic flooding spots in Mumbai.
- The ratio of > 75 mm rainfall days to flooding days increased from 1:7 to 1.5:1 during the last sixty years.
- Existing technology does not forecast rainfall >250 mm accurately – limitations with India Meteorological Department (IMD).
- July 26, 2005 – 944 mm rainfall. Rainfall from clouds few kms. long could not be predicted.
- Sea level rising by 3 mm ever year.
- Multiplicity of organisations: over 20 agencies from the GoI, GoM, and MCGM

- The scourge of rainfall -Mumbai get about 2500 mm of rainfall , but in Mumbai the water has to discharge in one-sixth of the time, due to concentration of rainfall in monsoons during July and August

Government Recovery Plan

1. Storm Water Drainage

- Upgrade the storm water drainage system to mitigate the effects of events like July 26th 2005, when almost 35% of annual rainfall occurred on a single day.
- Widening and deepening of existing water channels and causeways.
- Providing smooth transition for waterways near bridges
- Moderating the river course by replacing existing sharp bends with longer gentler bends

2. Actions by MCGM

- Operates a control room - the Main Centre of Communication
- Discharge pumps – 196 nos. deployed to discharge water
- 6 Nos. search and rescue teams kept ready under the fire brigade
- 600 personnel from Civil Defence and 10 persons per ward from NGO
- 500 buses kept ready by the transport service provider
- De-silting of Mithi river - 5.68 lakh M^3 silt removed pre-2007 and 3.70 lakhs M^3 thereafter
- 2652 residential and 1148 commercial structures removed.
- 1769 residential and 349 commercial structures rehabilitated
- Additional bridges at Kranti Nagar and Kurla-Kalina Road started.

3. Actions by State Government

- Active traffic management- diversion when roads are waterlogged
- State government hospitals/ supplement municipal hospitals.
- Home Guards & Civil Defence for disaster management
- 288 retaining walls in 74 places have been undertaken by the Slum Improvement Board

- The Chief Minister of Maharashtra acts as the highest coordinating authority - Chairs a 'Monsoon-preparedness' meeting
- Regular follow-up meetings by the Chief Secretary and Additional Chief Secretary (Home Department).

4. Actions by Government of India

- Honorable Prime Minister sanctioned a special grant of Rs. 1200 crores outside the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) as 100% subsidy
- The work involves widening of drains and construction of pumping stations
- Rehabilitation of slums up to 01.01.2000.

5. Conclusion and Recommendation

- Shift from conventional / reactive approach to strategic approach
- Step up structural measures such as gates on Vihar and Tulsi lakes, holding ponds upstream of airport on Mithi river, augmentation of railway culverts
- Contour mapping of city required for better storm-water management
- Upgrade flood warning and forecasting measures to "nowcasting".
- Network of Doppler Weather Radars to be put in place
- Restoration of existing water bodies, natural drainage, resettle the encroachment, enforcement of rain water harvesting etc. to moderate the discharge.
- Create public awareness about warnings, teach people how to react and ensure self help grooming; collaborate with NGOs
- "Flood insurance" products have to be encouraged to cover partial loss to business

6. Mumbai Floods - Aftermath - Lessons Learnt

- Sustainable and meticulously planned growth is the key. Expert reports prepared for future planning
- In India - post 2005 Mumbai floods - disaster management bill passed, policy is emerging
- Political action is necessary. Regular monitoring by political executive became order of the day

- Informed, trained bureaucrats can offer co-ordinated response. Regular interaction with experts in training and research institutions
- Effective communication is the key. It can make or break the response measures
- Disaster response has to be 'people centric'. People with strong civic sense and resilience make all the difference
- Local committees trained in facilitating self help foster the government initiatives
- Empowered communities respond better

7.8.3. Drought

Drought refers to a situation when rainfall fails in general and the ground water loses its potentiality affecting the biotic life adversely. Drought is a relative phenomenon in the sense that the amount of moisture available is not that important to life as its effectiveness.

Drought is basically a distress situation caused by lack of rainfall. The failure of rains may be reviewed from two aspects. Firstly, the rainfall may be insufficient, but secondly, it may be sufficient for the region as a whole but with a wide gap, separating two or more spells of rain. Thus the quantum as well as the time of the rainfall both is important. In other words, drought is a relative phenomenon. Therefore the amount of rainfall is not that important as is its effectiveness.

a. Drought: Type and distribution

❖ **Type of drought**

A distress situation caused by lack of water falls in three categories of drought, depending on meteorological, hydrological and agricultural aspects. Usually, we talk about meteorological drought, which is a situation when the actual rainfall is significantly less than the climatologically expected rainfall over a wide area. But all observed drought is not meteorological drought. The other form of drought are hydrological drought, surface water drought, ground water drought and agricultural or soil water drought.

- **Meteorological drought**

The special situation in which the rains do not arrive in time or in adequate quantity is called meteorological drought.

As has been pointed above it is the effectiveness of the rainfall rather than its quantity that is more important. The average

rainfall rather than its quantity that is more important. The average rainfall in India is 105 cm. and it is considered to be the largest anywhere in the world for the country of comparable size, but it fluctuates widely. It is either delayed or it ends earlier or in between there are long breaks or the rainfall is concentrated in just one part and is completely absent in another.

- **Hydrological drought**

Hydrological drought comprises surface water drought and ground water drought. It is associated with the drying up of surface water such as rivers, streams, lakes and reservoirs. Hydrological drought occurs when meteorological drought is sufficiently prolonged.

- **Surface water drought**

Apart from meteorological drought there are many other processes through which water scarcity gets generated. Deforestation and hydrological destabilization in the mountain catchment of rivers can make rivers and streams dry up in the post monsoon period. In such a situation surface water drought occurs even though the rainfall is normal. This has happened in Cherrapunji where it has become normal. With the destruction of hydrological capacity of the mixed natural forests in the catchment, the entire 450 inches (1200 cm) of rainfall instantly runs off as soon as monsoon is over the springs and the streams start drying up and water scarcity sets in one of the wettest spot of the earth, during march-April

- **Ground – Water drought**

Most of the ground water that is utilized in India comes from the shallow aquifer zone with depth less than 400 to 500 feet.

The lowering of the ground water table as a result of excessive pumping without a compensatory replenishment creates an almost irreversible ground water drought even in normal rainfall conditions. Except in the alluvial areas of the Indo-Genetic plain, the rest of the country especially in the Peninsula has very limited ground-water potential due to existence of hard cry stalling rocks.

- **Agricultural drought**

Agricultural drought or soil water drought occurs when soils lose their effective moisture conserving capacity through a complex of diverse processes and consequently leads to land aridisation. Agricultural drought may not be present even when meteorological drought exists and vice-versa.

❖ Distribution of drought

Various Governmental agencies have devised ways to delineate drought prone areas.

On the basis of coefficient of variation

The coefficient of variation varies from 15 to 30 percent in India. So there are areas of higher variability and areas of lower variability. Lower the variability higher is the reliability and vice versa.

The highly variable rainfall areas are Rajasthan, Gujarat and Kachchh where variability is from 50 to 80 percent. Other areas where the variability is from 30 to 50 percent include the interior of the Peninsula to lee of Sahyadris or Western Ghats.

The Indian Meteorological Department (IMD) approach

The Indian meteorological department uses two measures the first describes rainfall conditions while the second represents drought severity.

Rainfall conditions are defined as follows.

Excess + 20 percent or more of the average of 70-100 years

Normal + 19 per cent to 19 per cent of the average of 70-100 years

Deficient - 20 percent to 59 percent of the average of 70-100 years

Scanty - 60 percent or less of the average of 70-100 years

The precipitation is expressed on a weekly and monthly basis.

Drought is described as moderate or severe if the seasonal rainfall (southwest monsoon) deficiency is 26-50 percent or more than 50 percent of the normal, respectively. The criteria used by the Indian Meteorological Department are the most accepted measure of drought, principally because of its simplicity. Other measures of drought have been proposed. Subramanyam (1964), for example, defined drought intensities using standard deviation of the aridity index, while Krisbnan and Thanvi (1971) used the aridity index of the Kharif (monsoon season) cropping season to describe the drought intensity. A drought prone area is defined as one in which the probability of a drought year is greater than 20 percent. A chronic drought prone area is one in which the probability of a drought year is greater than 40 percent. A drought year occurs when less than 75 per cent of the normal rainfall is received.

b. Geographical distribution of drought

The drought area and the chronic drought affected areas are:

(a) Drought affected areas

- Gujarat, Rajasthan and adjoining parts of the Punjab, Haryana, West Uttar Pradesh and west Madhya Pradesh
- Madhya Maharashtra, interior Karnataka, Rayalseems, South Telengana and parts of Tamilnadu.
- Small portion of north-west Bihar and adjoining east Uttar Pradesh, south west Bihar including Palamau and Garhwal district.
- Small portion of north east Bihar and adjoining portion of West Bengal.

(b) Chronically drought affected areas.

❖ This includes western part of Rajasthan and Kachchh. Thus the three drought areas are:

- The track comprising the desert and semi arid region of India in a rectangular from running from Ahmedabad to Kanpur and From Kanpur to Jalandhar comprising an area of about 0.6 million sq. km.
- The track comprising the regions lying in the lee of Sahyadri comprising an area of about 0.37 million sq. km.
- Pockets of drought which comprises Thirunelveli and Coimbatore districts of Tamil Nadu, Saurashtra and Kachchh region, Puruliya district of West Bengal and Kalahandi region of Orissa comprising 0.1 million sq. km. Thus are total area affected by inadequate rainfall is over 1 million sq.km. Thus the total area affected by inadequate rainfall is over 1 million sq. km.

The rainfall criterion described above is useful for a continuous monitoring of the monsoon season. The sum of the season's rainfall becomes the basis for describing a region under moderate or severe drought. When more than 50 percent of the area in the country is under moderate of severe drought, the country is described as severely affected by drought; and when the affected area is 26-50percent of the country, it is described as an incidence of moderate drought.

It is seen that most of the areas susceptible to drought fall between arid and semi arid zones of the country and chronically affected drought areas are identified with extreme arid conditions. However, droughts may occur outside this zone in areas like

Maharashtra, Chhattisgarh in Madhya Pradesh and some areas in the east in sub humid regions.

c. Causes of droughts

There are six major causes of drought as far as rainfall is concerned

1. Late onset and early withdrawal of monsoons
2. Lean rainfall due to absence of depressions (low pressure system) passing over India.
3. Prolonged breaks in monsoon rainfall
4. Re-establishment of southern branch of jet stream
5. Up welling of cool water over the Arabian Sea and extension of cool Somali currents over the Arabian Sea
6. The movement of monsoon trough closer to the Himalayan zone

The reasons behind late onset and early withdrawal of monsoons are not clearly known. The physical mechanism which leads to this meteorological situation is not fully understood. The more information on cloud structure will definitely help to know the conditions that leads to the late or an early onset of monsoon.

The absence of depressions and low pressure systems passing over India is actually associated with the global weather systems. The southern oscillation is one such meteorological system that affects the generation of these depressions. The low pressure system which dominates the area around Tahiti in central Pacific and associated high pressure over land on Asia and southeast region naturally prevents the formation of cyclones and depressions over Indonesia and the Bay of Bengal.

The prolonged break in monsoon rainfall is again part of the global weather dynamics. Previous rainfall data suggests that prolonged breaks in monsoon rainfalls have a tendency to occur towards the second half of the season that is in August and September. This type of phenomena occurred in 1974, in 1979 in 1981. These breaks are linked with quasi stationary anti-cyclonic circulation that establishes itself over North West India. This anti cyclonic circulation inhibits the upward motion of air suppressing rainfall generating conditions. Again how meteorological features influence this type of circulation is not fully understood.

The re-establishment of the southern branch of jet stream is also a part of the global weather dynamics which cannot be fully explained. The effect of re establishment of jet stream is the suppression of convection. Suppressed convection inhibits cloud formation and consequently rainfall.

The upwelling phenomenon over the Arabian Sea caused due to pushing of cool Somali current decreases the sea water temperature by as much as 2 to 4 degrees. The low surface water temperature decreases evaporation and consequently the moisture content of the wind. With lowered moisture content, the amount of rainfall all along the western coastal belt and in the lee of Sahyadri is also lowered.

Rainfall along the axis of the monsoon trough is heavy because the trough is the passage ways of smaller depressions. Thus when the monsoon trough lies close to the Himalayas there is abnormally heavy precipitation in the foothills. This causes floods while the rest of plain goes dry and invites drought.

Lack of water cannot be considered as the sole criteria for drought. If it was so then the areas receiving heavy rainfall such as North-Eastern India and the Western Ghats regions would have not been drought affected. But drought like conditions does exist in these places during March-April. It must be recognized that climatic and rainfall variability is intrinsic part of tropical meteorology. India's weather conditions like many part of tropical world a characterized by short term fluctuations which are not adequately explained. When the monsoons appear over India, depressions and cyclonic disturbances can cause appreciable spatial variations in rainfall. At the same time these disturbances do not give a common pattern. For example, during 1917 and 1918 monsoon season the numbers of disturbances were equal while 1917 and 1918 are the wettest and driest season of India, respectively, during the period 1901 to 1960.

Droughts' resulting from failure of rainfall is a product of meteorological variability. Droughts are bound to re-occur because they are, after all, a part of tropical meteorology. Except for small pockets of north east there is no area in India that has not been affected by drought at one time or the other.

Probability of Occurrence of Drought in Drought Prone Meteorological Subdivisions

Meteorological Subdivisions	Frequency of Deficient Rainfall (75 % of normal or less
Assam, Northeast Region	Very rare, once in 15 years
West Bengal, West Madhya Pradesh, Konkan, Coastal Andhra Pradesh, Maharashtra, Kerala, Bihar, Orissa.	Once in five years.
South interior Karnataka, Eastern Uttar Pradesh, Vidarbha, Gujarat, Eastern Rajasthan, Western Uttar Pradesh	Once in five years
Tamil Nadu, Kashmir	Once in Four years
Rayalseema, Telangana, Western Rajasthan	Twice in five years

d. Impact of drought

Although the drought is short term phenomena, its impact is felt over a much longer period. Its adverse impact is felt widely in the form of depletion of underground water resources, lowering water table, death of human, animal alike, etc., and these are greatly aggravated by the cumulative impact of successive droughts. This happens only if the drought is severe. A mild drought followed by a good season may not leave its marks.

Drought has manifold impact on the geography of a country that can be studied under the following heads.

I. Physical impact

Meteorological drought has an immediate effect on the soil moisture, ground water table and surface runoff. The water table is lowered and the surface runoff is reduced to lower the reservoir levels. The absence of recharge, lower water table and cause the wells to dry up. The drying up of wells has an adverse effect on irrigation. A meteorological drought also causes the runoff to decrease causing the rivers to dry up during the dry season. This in turn also affects the lowering of the reservoir water level.

II. Impact on Agriculture

Indian agriculture is still largely monsoon controlled. It is dependent on environmental factors such as rainfall, ground water condition and soil moisture condition. Hence it is largely prone to meteorological, hydrological and agricultural drought. The effect is manifested in the shortfalls of agricultural production in drought years.

The major drought of 1918, 1965, 1966, 1972, 1979 and 1982 caused losses in food grain production.

Extent and impact of drought in important drought years

Drought Year	% of the Country Affected	% Reduction in Food Grain Production over the Previous Peak year	Total food Grain Production (in million metric tons)	Import of Food Grains (in million metric tons)
1918-19	73	32.3	-	-
1965-66	54	18.8	72.4	10.6
1972-73	43	7.7	97.0	3.6
1979-80	41	17.0	109.0	0
1982-83	37	3.7	128.4	0

A shortfall in production may be the direct impact of meteorological drought but consecutive meteorological drought, hydrological and agricultural and agricultural droughts have a long range and far reaching impact on agriculture. This impact may be in the form of changes in cropping patterns and impoverishment in cattle.

III. Social and Economic Impact

Droughts do affect the social and economic life of people, but the severity of the impact depends on:

a) The manner in which it is tackled.
b) The stability, strength and resilience of the economy of the society.

The consequences are:

1) Decline in crop acreage.
2) Set bank to agricultural production (crop production, milk production0.
3) Fall in employment in the agricultural sector due to showing down of agricultural activity.
4) Fall in purchasing power of those engaged in agriculture
5) Scarcity of drinking water, fall in water-table.
6) Scarcity of food grains.
7) Rise in the price of food grain and other commodities
8) Scarcity of fodder.
9) Distress sale of cattle.
10) Loss of cattle life.
11) Low intake of food.
12) Malnutrition especially among children.
13) Ill health and spread of diseases like diarrhoea, dysentery or cholera famine and ophthalmic diseases caused by starvation.
14) Distress sale and mortgage of land, jeweller and personal property.
15) Migration of people in search of employment, depopulation of area.
16) Death due to malnutrition/starvation/diseases,
17) Fall in effective demand from agriculture sector leading to dislocation of productive processes and slowing down of the economic activities in the secondary and tertiary sectors.
18) Low morale of people
19) Social stress and tension, disruption of social institutions and relationships and social crimes. E.g., looting of grain shops.
20) Growth of fatalism, reliance on heavenly powers.

The impact is greatest on the most vulnerable sections of the society who have a hand to mouth economy and very little margin and staying power. These include the landless and marginal farmers, the artisans like the weavers whose very existence depends on local demand. On the contrary the richer sections take advantages of scarcity and high prices of food to make a fortune out of their surplus stock.

To conclude it may be said that a severe drought followed by a moderately good season leads to a secular decline of the economy. On the contrary, a milk drought followed by good seasons and effective handling of the consequences may not come in the way of secular upward movement of the economy. In the long term, some consequences of drought may be easily overcome, but most of them leave a permanent imprint on the economy.

In spite of some irreversible changes, like loss of life, assets and wealth if a drought is followed by a good rain, it will lead to an increased fodder production. It will also replenish the depleted food stocks and may also increase opportunities of gainful employment.

e. Forecasting, warning & monitoring of drought

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature.

Management of Drought

Drought can be managed in two ways

1) Preventing the causative aspects of drought.
2) Providing relief to victims of drought and also rehabilitating them.

The reoccurrence of drought can be prevented by eliminating the causes which are responsible for it.

Management of Meteorological Drought

Meteorological drought will be a part and parcel of India's climate conditions as long as India is in the tropical realm. The complexity of meteorological phenomena on such as re-establishment of jet stream, movement of monsoonal trough close to the Himalayas, El Nino effects and global pressure changes (walker's Circulation), the upwelling phenomena in Arabian Sea, etc., cannot be managed as they are part of a complex atmospheric circulation.

The meteorological drought can be managed by predicting the variability of changing weather to some extent. By predictions the impact of climatic variations may be lessened. A prediction that the rainfall will be less than the normal will help the farmer to judiciously choose crops that are less water demanding. On the other hand, if a water demanding crop is sown, in the absence of current information about rainfalls, an artificial drought condition may occur.

Management of Hydrological Drought

In so far as hydrological drought is concerned which is readily manmade, management can be done through various techniques and methods.

Hydrological drought management aims at preventing the drying up of surface streams and checking the fall in ground water table. This can be done by

a) Biological Methods

b) Engineering Methods

c) Involving local people

Biological Methods

Biological methods involve taking help of vegetation, i.e. bringing about overall change either in the type of tree grown or overall planning in integrated manner.

1) A deforested region decreases percolation hence lowers the ground water table. This increases run-off and flood incidence. Therefore, checking indiscriminate deforestation growing apace in the hilly region is important.

2) Treatment of watershed by planting suitable trees under social forestry and farm forestry. It should be an integral part of watershed management. This will reduce the prospect of flooding in the lower portion and consequently surface water drought and at the same time, recharge the aquifers through its input into the intake basins.

3) Converting monoculture plantations of pine or eucalyptus by ecologically suitable trees. This will provide adequate defence to the soil against the direct hit of raindrops during intense storm reducing the prospects of flash flood and hence prevent surface water drought. This method will be particularly effective in the lower Himalayan region. In addition, monoculture eucalyptus plantation which drains a large amount of water through its enormous evapotranspiration capabilities should be replaced by trees which provide not only economic security but also ecologic security to the people. This will also help in raising the water table and tiding over artificial ground water drought.

Engineering Methods

Engineering methods involve artificial recharge of ground water by different methods. These are stated under:

Aquifer recharge

In the mountainous terrain, the most effective and appropriate way of recharging ground water is to cover the watershed with thick vegetation multi-storeyed forests with trees, shrubs and grasses and thick carpet of litter. This will allow greater infiltration of rainwater.

In flatter terrains ground water can be recharged artificially in addition to putting the ground under forest cover. This can be done by allowing the flood water to spread on the fields and fill the excavated trenches, tanks, ditches and furrows on the sides of the roads and railway lines. The stored water will eventually find its way to underground reserve.

Another way of artificial recharge is injecting water through wells in areas where excessive water has been withdrawn such as the southern and central parts of Mehasana district of Gujarat. This method, to a large extent, will help to reverse the irreversible drop in water table. These types of efforts have been made in the Ghaggar basin at Kurukshetra and near Ahmedabad where water from the Sabarmati River was injected through siphon pumps. In the peninsular regions the traditional tank system causes one such mechanism to recharge ground water, by increasing percolation from surface storage of rain water.

Diversion and storage of excess water

Diverting water from a water surplus region to water scarce and drought prone areas will considerably abate the distress situation. Rajasthan Canal Project has done the same thing. It has brought the water of the Himalayan river to the dry lands of Jaisalmer Bikaner division in the desert; The Yamuna canal likewise transfers of water as the main plank.

Involving local people

The involvement of local people and the mobilization of the energy for water conservation are necessary. If the people are given leadership they would themselves undertake such projects despite unwillingness of administration. One of the examples of this type of mass action in India is by Mukti Sanbarsh Babini in Sangli district of Maharashtra where the people through Sbramdan (donation of labour) constructed a small dam across a dry river.

Management of Agricultural Drought

The choice of crops in India has evolved according to the variations of climate and soil conditions. It is in this perspective of the built in resilience of indigenous practices and enhanced vulnerability of green revolution agriculture that the droughts in India are to be analyzed. The HYV's need more water thereby

creating an artificial drought condition in the wheat monoculture region of the Punjab, Haryana and Uttar Pradesh. Hence the first task would be to resort to the original cropping pattern suitable to that agro climatic region. The native crops are not only less water demanding but the indigenous mix also helps to check the nutrient deficiency in the soil. Alternatively, stress should be put on drought resistant verities and crops like sorghum, pearl millet, sunflower in drought prone areas.

b. Preparedness and Response

Post Drought Management

The impact of drought can be mitigated by providing relief and rehabilitation. The Government has launched the Drought Prone Area Programme with a view to mitigate the effects of drought.

Drought Prone Area Programme (DPAP)

The precursor of the Drought Prone Area Programme (DPAP) was the Rural Works Programme (RWP) initiated at the beginning of the country's Fourth Five Year Plan. This was based on the decision that much of the amount, the Central Government spent on relief in famine affected areas could be so deployed in the areas of chronically affected by the drought as to generate considerable employment in the rural sector largely related to a pre planned programme of rural works. Soon after the implementation of the RWP, it was realized that mere rural works would not be meaningful in bringing about drought mitigation and needed to be given area development approach. As a part of the midterm appraisal of the Fourth Plan, the TWP was redesigned as DPAP and funding on this basis commenced from 1972-73. After a number of reviews presently the DPAP cover 415 blocks in 95 districts of the country. The Minhas Committee, constituted by the Planning Commission had recommended that DPAP should aim at integrated development of agriculture with focus on restoration of ecological balance. Apart from irrigation, forestry, soil and moisture conservation, it recommended changes I agronomic practices, restructuring of cropping pattern, livestock development, rural communication and drinking water supply as important elements of the strategy of integrated rural development. Later in 1980, the entire programme was reviewed by a Task Force under the Chairmanship of M. S. Swaminathan, the then Member (Agriculture), Planning Commission. The Task Force redefined the scope and objective of DPAP and DDP. While reiterating the ongoing approach and strategy, it emphasized on:

a) Promoting a more productive dry land agriculture on the basis of the soil water climate resources of the area

b) Development and productive use of the water resources of the area;

c) Soil and moisture conservation, including promotion of proper land use practices;

d) Afforestation, including farm forestry; and

e) Livestock development, including development pasture and fodder resources.

Desert Development Programme (DDP)

The DDP launched in 1977-78, covering presently 131 blocks in 21 districts, was also to have a similar approach with accent on control of desertification.

In 1987, the Central Sanctioning Committee sought to sharpen the focus by limiting the programme activities to the core sectors of soil conservation, water resource conservation, and afforestation and pasture development.

The following are the suggestions stated for drought mitigation:

1. Drought prone areas should incorporate short term and long term development projects such as fodder bank, pasture development/rangeland management as disaster mitigation practice.
2. An area specific watershed model development plan should be prepared for arid, Semi arid and sub humid regions of the country.
3. In rain fed agricultural zones (having less rainfall and frequent droughts), considerable stress should be placed on development of khadi and village industries/college and handicrafts industries projects to provide gainful employment to the local people and check people's migration towards cities.
4. The development programmes such as national Watershed Development Programme for rain fed areas, DPAP, Desert Development Programme, National Rural Employment Programme, Drinking Water Programme and Poverty Alleviation Programmes should be integrated to form a comprehensive Drought Mitigation Programme.
5. Public participation and use of traditional practices for Disaster Mitigation should be give proper attention.

Local communities have devised indigenous safety mechanisms and drought oriented farming methods in many parts of the country. From the experience of managing the past droughts particularly the severe drought of 1987, a number of programmes

have been launched by the Government to mitigate the impact of drought in the long run. These programmes include Drought Prone Area Programme (DPAP), Desert Development Programme (DDP); National Watershed Development Project for Rain fed Areas (NWDPRA), Watershed Development Programme for Shifting Cultivation (WDPSC), Integrated Water Development Project (IWDP), Integrated Afforestation and Eco-development Project Scheme (IAEPS).

c. Mitigation - case studies Latur, Maharashtra

Drought has devastated the once-prosperous Latur. Latur, with a population of about half a million, is one of the eight districts in the Marathwada region facing severe drought. The vagaries of nature have already taken their toll: the farmer in the hinterland has no way out, and the common man clings to a collapsing water infrastructure in the cramped city. Geographically, the impact of the crisis has varied. The north-eastern belt, Jalkot, Ahmedpur, Deoni, Nitur, Udgir, faces more of a hydrological drought and scarcity. The slightly better-off and greener north-western Bel, Renapur, Latur City and Ausa, is hit by both agricultural and meteorological drought.

There are some man-made factors also.

1. Current drought is a disaster of water management, accompanied by corruption, water-intensive cropping patterns and absence of a long-term view to manage water and drought.

2. Government's plans of irrigation failed as its plans for upcoming projects were entangled in corruption, plagued with delays and cost overruns.

3. Building unviable large dams, wrong cropping patterns, water diversion for non-priority uses, neglect of local water systems and unaccountable water management by the State government, the Centre and the Maharashtra Water Resources Regulatory Authority

4. The precarious state of water in the state can be blamed on the increasing area under sugarcane cultivation in Maharashtra, water-intensive activities like running of sugar and wine factories in drought-affected districts.

5. Real estate builders continue to exploit the land further by coming up with massive construction projects in drought affected areas. These luxurious projects often target the elite who prefer large swimming pools in their backyards. And to top it all, the Indian premier league, which is the country's most popular Cricket tournament, is going to be held in Maharashtra this month.

Natural factors:

1. One third area of Maharashtra falls under semi-arid climatic zone – therefore deficient rainfall pattern – and non-perennial rivers.

2. El-Nino – leading to warming of central Pacific waters and consequently drought conditions in India. 2014 and 2015 have been reported to have witnessed worst El-Nino in metrological history.

3. These region lies in the leeward side of Western Ghats, therefore receives very less rainfall and absence of perennial forests also affects the rainfall pattern.

Groundwater levels at Jalkot being 4.7 metres are at an alarming level while at Ahmedpur it is -4.38m and at Deoni, is 4.08m. According to the groundwater act, levels below -1m are 'manageable scarcity', below -2m are 'critical' and below -3m are 'alarming'. Jalkot hit the danger mark in October 2015, when the average fall was -3.53m across its ten talukas.

It has been noticed that after three deficient monsoons in a row the east's few barrages and dams have gone bone dry. In the 33 small water projects at Ahmedpur, with a total capacity of 14.4 million cubic metres (mcm.), current water availability is zero. Same is observed in Jalkot's 10 water projects (capacity 25.26 mcm).

Ironically, this is in an 'assured rainfall' zone (it gets 700–800 mm each monsoon), while the prosperous western sugar belt is a 'Declared DPAP (Drought Prone Areas Programme) Zone'. This is because it is home to three powerful sugar factories, and has major sources of water, including the Manjra dam and Bhandarwadi barrage, among others.

<u>Suggestions to mitigate droughts in Latur</u>

1. Mostly all the drought affected districts are the major producers of sugar, therefore needs a shift in cropping pattern, more focus to cultivation of other crops that require lesser amount of water.
2. Restoration of ecological balance – By Conserving, developing and harnessing land, water and other natural resources including rainfall
3. Integrated watershed management – under National Watershed Programme – and with focus on strategies like Agro-forestry, Agro-horticulture
4. Adoption of micro-irrigation methods and new technologies in agriculture for high yield and less water usage (Drip and Sprinkler irrigation systems)

5. Drought resistant crops with technological intervention (bio-technology)
6. Replicate water harvesting technique prevalent in other states – TN – compulsory roof top, Rajasthan's traditional practice of storing water in Tanks.
7. Empowering farmers with knowledge of water management techniques, drought resistant crops, conservation of ground water. Awareness and self regulation among people will help to conserve the limited water resources.

The water train *Jaldoot*, commissioned by the railway ministry in collaboration with the Maharashtra government, was one of the key measures to alleviate the situation, transporting half a million litres of water on each of its trips from Miraj in Sangli district. Miraj gets its water from the Warna dam, downstream of river Krishna. The dam has a storage capacity of 34 thousand million cubic feet (tmcft) and currently has around 14 tmcft left. The railway ministry and the Maharashtra government zeroed in on Miraj because it has surplus water and offers the logistical convenience too for this difficult operation.

Indian Railways and local government authorities in Latur have made arrangements to run a 50-wagon service soon, with each wagon carrying at least 50,000 litres. A 25-wagon service is supposed to run on Tuesday and Wednesday. Considering Latur's population of 500,000, each water train journey has theoretically brought one litre of water to every Latur resident. In normal times Latur's water demand is 60 million litres per day, which works out to around 100 litres per day per person.

7.9 SUMMARY:

We know that natural disasters are very much part of the natural cycles. Although natural disasters are very powerful and sudden they are not incapable of being guarded against. Modern technology has provided us with enough gadgets for forecasting natural disasters. We may not totally prevent heavy damages inflicted upon by the natural disasters but lessening its effects to some extent is possible. There should not be any gap in our knowledge of natural disaster losses because poor knowledge hinders implementation of effective disaster mitigation policies and emergency response programmes. People must take interest in getting as much awareness as possible about the safeguard measures. We must particularly aim to help and protect the poorest and most vulnerable.

Our history tells that extremes of water, whether through scarcity, causing drought or abundance, causing flood, have

challenged mankind down the ages. Modern era is technologically advanced but still experience huge losses of human life and property as a result of floods and droughts every year. There are innumerable reasons that cause floods. The meteorological conditions like cyclones and cloud burst, physical conditions like, narrow outlets, large catchments areas, lack of well developed drainage channel, siltation and rising of channel, presence of unconsolidated soil, blocking effect of landslides and meandering are responsible for the occurrence of flood. To these the human impacts such as construction of dams and reservoirs, bursting of dams, deforestation, faulty slope practices and construction of embankments may be added. As far as rainfall is concerned there are various causes of drought also such as, late onset and early withdrawal of monsoons, lean rainfall due to absence of depressions (low pressure system) passing over India, prolonged breaks in monsoon rainfall, re-establishment of southern branch of jet stream, up welling of cool water over the Arabian sea and extension of cool Somali currents over the Arabian sea, the movement of monsoon trough closer to the Himalayan zone.

7.10 CHECK YOUR PROGRESS/ EXERCISE

1. True false

a. If settlements or farms were not located in flood plains, disasters would not result from floods.

b. Excessive down pour during monsoons caused cyclones in hilly areas which disturb the life to a huge extent in those areas and even in the nearby ones.

c. Landslide is the most widely occurring natural calamity that takes place in almost all the regions of India.

d. The coastal regions that come under Inter tropical Convergence Zone including the Bay of Bengal are hit by cyclones.

e. Earthquakes make sands and silts to transform from a solid to liquid state.

2. Fill in the blanks

a. India's _____ coast, bordering Arabian Sea, experiences cyclones only rarely but the coastal states such as Andhra Pradesh, Orissa, Tamil Nadu, and West Bengal in the _____ region experience powerful cyclones.

b. Latur earthquake is one of the most devastating natural disasters in India of all time which hit Latur in _____ on September 30, _____.

c. The surface _____ of a region and groundwater conditions are altered after an earthquake.

d. Floods cause the spread of many _____ diseases such as diarrhea, gastroenteritis, jaundice, malaria, etc.

e. Drought affects the _____ crops and has negative implications for India's rice yield and hits the economy of our country known to have _____ culture.

3. Multiple choice question

a. Chronically drought affected areas.
i. includes western part of Maharashtra and Kachchh.
ii. includes western part of Rajasthan and Karnataka.
iii. includes western part of Rajasthan and Kachchh.

b. Indian agriculture is heavily dependent on the
i. South-west summer monsoon.
ii. North-east retreating monsoon.
iii. South-east summer monsoon.

c. Late onset and early withdrawal of monsoons cause
i. drought
ii. flood
iii. cyclone

d. The objective of warning phase is to provide disaster managers with
i. no information t all so that people at risk can prepare for the disaster evacuate.
ii. enough information so they can give the people at risk adequate notice or warning to prepare for the disaster and, if necessary, to evacuate.
iii. enough food and water so they can give the people at risk adequate supplement prepare for the disaster and evacuate.

e. One of the causes of floods is reduced carrying capacity of rivers
i. by the accumulation of water in the catchment areas.
ii. by the accumulation of sediments derived from massive erosion in the catchment areas.
iii. by the accumulation of sediments derived from massive deposition in the catchment areas.

4. <u>Answers the following Questions</u>

a. What are the different types of natural disasters in India?
b. State different effects of natural disasters.
c. What are the different efforts taken to mitigate disasters?
d. Define floods and droughts.
e. What are the causes of floods?

f. What are the causes of droughts?
g. What are the impacts of flood?
h. What are the effects of droughts?
i. How will one Forecast, warn & monitor floods and droughts?
j. What do you understand by Preparedness and Response of flood?
k. What do you understand by Preparedness and Response of drought?

7.11 ANSWERS TO THE SELF LEARNING QUESTIONS.

1.a.true
1.b. false, caused landslides
1.c.false, Flood
1.d. true
1.e.true

2.a. western, Bay of Bengal
2.b. Maharashtra, 1993
2.c. topography
2.d. epidemic
2.e. Kharif, paddy

3.a.iii.
3.b.i.
3.c.i.
3.d.ii.
3.e.ii.

7.12 TECHNICAL WORDS:

1. **Natural disasters**- are extreme, sudden natural events caused by environmental factors such as a flood, earthquake, or hurricane that injure people and damage property.
2. **Flood**- An overflowing of large amount of water beyond its normal onto land that is normally dry
3. **Droughts**- a long period when there is little or no rain
4. **Forecast**- predict or estimate any future event or trend relying mainly on data from the past and present and analysis of trends.
5. **Warn**-inform someone of a possible danger, problem, or other unpleasant situation especially one in the future
6. **Monitor**- a device used for observing, checking, or keeping a continuous record of something.

7.13 TASK

1. In a map of India point out the drought prone regions.
2. In a map of India mark river Brahmaputra.
3. In a chart define flood and write the important points of causes of floods.

7.14 REFERENCES FOR FURTHER STUDY

1. Ministry of Home Affairs, Govt. of India, Disaster Management in India
2. Module 4 - Capacity Building in Asia using Information Technology Applications (CASITA)
3. Asian Disaster Preparedness Center (ADPC), Bangkok.
4. Encyclopedia of Disaster Management: Volume IV by Alfred Scott
5. Disaster Management: Future Challenges and Opportunities by Jagbir Singh
6. Disaster Management by Harsh K. Gupta
7. Oxford dictionary

8

NATURAL DISASTER

After going through this chapter you will be able to understand the following features:

8.1. OBJECTIVES

By the end of this unit you will be able to –

- Define Natural Disaster
- Know about Cyclone
- Understand Earthquakes
- Discuss Landslides with reference to Nature
- Understand Geographical distribution of Natural Disaster
- Discuss Causes and impact of Natural Disaster
- Learn Forecasting, warning & monitoring of natural disaster
- Understand preparedness and response of natural disaster
- Learn mitigation - case studies of natural disaster

8.2. INTRODUCTION

In the last two chapters we have studied disaster management and how it tries to coordinate various resources effectively and seamlessly. Furthermore, two natural disasters, flood and drought, its causes and impact have also been studied. In this chapter we are going to study natural disasters like, cyclone, earthquakes, landslides, geographical distribution of natural disaster, causes and impact of natural disaster, forecasting, warning & monitoring of natural disaster, preparedness and response of natural disaster,

8.3. SUBJECT-DISCUSSION

The term 'disaster' means 'bad star' in Latin. Disaster is a sudden disastrous event that brings great damage, loss, destruction and devastation to life and property, with no or very little prior knowledge. The damage caused by disaster is incalculable and varies with the geographical location, climate and the type of the earth surface. This influences the mental, socio-economic, political and cultural state of the affected area.

Disaster may be of two types natural and manmade. Floods, cyclones, drought, earthquakes are natural disaster as they happen due to changes in the natural conditions where as Nuclear holocausts, Fire accidents are manmade disasters. A disaster completely disrupts the normal daily life.

The word cyclone refers to many different types of storms. An earthquake is a trembling or a shaking movement of the ground and a landslide is the movement of rock, debris or earth down a slope. Now, all these natural disasters have a varied geographical distribution. If we know the cause and impact of natural disaster it would have been easier for us to reduce damage both in material terms and in terms of loss of human life.

8.4 NATURAL DISASTER

A natural disaster is a major adverse event that results from natural processes of the Earth. Natural disaster includes floods, hurricanes, tornadoes, cyclones, volcanic eruptions, earthquakes, tsunamis, and other geologic processes. It results in large-scale loss of life or damage to property.

8.5 CYCLONE

A cyclone is a large-scale, atmospheric wind-and-pressure system characterized by low pressure at its center and by circular wind motion, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere. They are usually characterized by inward spiraling winds that rotate counterclockwise in the Northern Hemisphere and clockwise in the southern hemisphere. All large-scale cyclones are centered on areas of low atmospheric pressure. A cyclone is formed when a warm temperature of the sea reaches a threshold level and the wind structure is rising. In other words, cyclone derives their energy from the warm tropical oceans and do not form unless the sea-surface temperature is above 26.5°C. However, once formed they can persist at lower temperatures and dissipate over land or colder oceans. The eye of the cyclone is the centre of the cyclone where the focus lies. The areas surrounding the eye will be most affected because of the strong wind.

8.5.1 Geographical distribution of cyclone

World distribution of tropical cyclones is limited to six regions, all of them over tropical and subtropical oceans.

1. West Indies, Gulf of Mexico, and Caribbean Sea;
2. western North Pacific, including the Philippine Islands, China Sea, and Japanese Islands;
3. Arabian Sea and Bay of Bengal;
4. Eastern Pacific coastal region off Mexico and Central America;
5. South Indian Ocean, off Madagascar;
6. Western South Pacific, in the region of Samoa and Fiji Islands and the east coast of Australia.

8.5.2 Causes of cyclones

In tropical oceans the water in the oceans' surface layer heated by the direct solar radiation. As a result the air above the tropical ocean is characterised by high temperature and humidity resulting in air inflation that easily leads to low density per unit volume of air. Weak wind near the equator causes the lighter air to soar and incur convection that further attracts inflow of surrounding cooler air. The intake air then warms up and soars again, creating a positive feedback cycle that eventually forms an air column with high temperature, light weight and low density. This is how the tropical depression forms. Cyclones form only over warm ocean waters near the equator. To form a cyclone, warm, moist air over

the ocean rises upward from near the surface. As this air moves up and away from the ocean surface, it leaves less air near the surface. As basically the warm air rises, it causes an area of low air pressure below. Air from surrounding areas with higher air pressure pushes in to the low pressure area. Then this new "cool" air becomes warm and moist and rises, too. And the cycle continues. As the warmed, moist air rises and cools the water in the air forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the ocean surface.

As the storm system rotates faster and faster, an eye forms in the centre. It is very calm and clear in the eye, with very low air pressure. Higher pressure air from above flows down into the eye. When the winds in the rotating storm reach 39 mph (63 kmph), the storm is called a "tropical storm". And when the wind speeds reach 74 mph (119 kmph), the storm is officially a "tropical cyclone" or hurricane. Tropical cyclones usually weaken when they hit land, because they are no longer being "fed" by the energy from the warm ocean waters. However, they often move far inland, dumping many centimetres of rain and causing lots of wind damage before they die out completely.

❖ **There are four stages that form a cyclone which include:**

1. Formative Stage
2. Immature Cyclone
3. Mature Cyclone
4. Decay stage

To form, tropical cyclones require large bodies of warm water (26.5o C over a depth of at least 50m). The atmosphere must also be conducive to convection (i.e. it must cool rapidly with height to ensure a warm air parcel from the surface will continue to rise to a high enough height to form a cumulonimbus cloud – A thunderstorm). They must form at least 500km (300miles) from the equator to ensure the Carioles 'force' is strong enough to allow the central low pressure to be maintained, otherwise air would move in too quickly and 'fill' the low pressure killing the storm. An existing area of disturbance (to provide some weak spin) is also required in formation – The storm cannot form spontaneously out of the blue. Finally less than 10m/s of vertical wind shear (how much the wind varies with height). If shear is greater than this than the deep convection will be disrupted and the developing storm can be 'torn' apart. Tropical cyclones obtain all of their energy from latent heat (the energy released when water cools from water vapour to liquid water i.e. in a cloud). This heat originated in the warm, tropical oceans as mentioned above. If a tropical atmospheric disturbance occurs (such as a tropical wave leaving the west coast of Africa), thunderstorms can begin to develop more widely in the warm,

humid tropical air. As air rises into the thunderstorms, further air is entrained into the surface low and this enhances the weak circulation that initiated the thunderstorms. The large quantity of rising air also creates a high pressure system above, leading to diverging air aloft enhancing the upward motion of air in the thunderstorms. As the surface winds increase to between 20-34 knots, the disturbance becomes known as a tropical depression. A distinct area of low pressure usually forms at this point at the centre of the group of thunderstorms and the wind moving faster inwards causes the spin to increase (just as an ice skaters spin increases when they move their arms inwards). The sea now becomes rougher, leading to greater friction and so the winds converge further into the centre of the low. A feedback mechanism now occurs. The rising air has extra heat and moisture from the increasingly choppy sea. This results in more and stronger thunderstorms which release more latent heat. This causes the surface pressure to lower further, causing stronger winds, choppier seas and greater surface convergence of winds. When winds reach between 35-64knots the weather system is classed as a tropical storm. Above 65knots we call it a tropical cyclone (or hurricane etc depending on geographic location). By this point the distinctive eye usually forms where slowly sinking air in the centre of the storm creates a region of relative calm (the eye) surrounded by violent winds (the eye wall - figure 2). This development will continue until the moisture is cut off (the cyclone moves over land), the heat is cut off (the cyclone moves too far north or south), or wind shear increases and shears the storm apart. When the cyclone is ‘full’ of thunderstorms, latent heat release slows as the entire air mass warms and this also limits cyclone growth. These factors mean that wind gusts in cyclones rarely exceed 200knots. Tropical cyclones generally last about a week but this can vary considerably. The oldest cyclone (Hurricane Tina 1992) lasted for 24 days. The average diameter is around 500km and they extend to a height of around 15km. Tropical cyclones can release up to 200x1018J per day (approx 1PW = 1x1015Watts!). This is equivalent to exploding a 10 megaton nuclear bomb every 20 minutes! Obviously when tropical cyclones make landfall the strength of the wind causes considerable damage. However the storm surge is often the most deadly part (~90% of tropical cyclone deaths are due to the storm surge) caused partly by the very low central pressure causing a rise in sea levels but mainly by the winds whipping up the sea by up to 5m. Hurricanes, typhoons, cyclones, Willy-willy’s are all words used for tropical cyclone. The different terms are used in different parts of the world.

❖ **India also has history of suffering from cyclones.**

- The 1935, tropical cyclone killed 30,000 people.
- In 1942, tropical storm in Orissa and West Bengal killed 40,000 people.
- In 1943, Rajputana tropical storm, 5,000 people were killed.
- In eastern coast of Orissa, 1971 tropical storm killed 9,658.
- In 1977 cyclone, in Tamil Nadu, Andhra Pradesh and Kerala 14,204 people were killed.
- The biggest cyclone disaster is the Orissa super cyclone. It hit the Orissa coast of India on October 29, 1999 accompanied with 155 mph (250 km/h) cyclone winds and water surge from the sea. It caused the deaths of over 10,000 people, and heavy to extreme damage in its path of destruction. Following the cyclone, with the help of the World Bank, Orissa State Disaster Management Authority was formed.

8.5.3 Impact of cyclone

Tropical storms are a type of severe spinning (rotating) storm that occurs over the ocean near the tropics. As they gather speed, the spinning of the earth, the Coriolis effect, pushes them westward and away from the equator. If they reach land there are several things that you would notice

High Winds: The extreme wind speeds in tropical cyclones are directly related to the steep pressure gradients near the cyclone centre. Wind damage increases exponentially with increased wind speed. In severe cyclones the maximum sustained winds can approach 200 km/h with short period gusts closer to 300 km/h. Such violent winds can devastate natural vegetation and all but the strongest man-made structures.

Storm Surge: As a tropical cyclone crosses the coast the combination of low pressure near the centre and strong onshore winds can produce a large increase in sea level, called a storm surge. This can bring about sea waves breaking into areas not normally affected, producing absolute destruction of buildings or other facilities. In highly vulnerable areas such as the Ganges River Delta of Bangladesh, where a large population inhabits the fertile flats close to sea level, the results can be disastrous. Storm surges in this area have resulted in death tolls exceeding 100,000.

Flood Rains and Landslides: In some areas of the world (especially the Philippines, China and Japan), torrential rain brought by tropical cyclones can produce landslides in mountainous terrain, sometimes with disastrous results. In early November 1991

on the Philippines island of Leyte an estimated 6,000 people died and a further 20,000 were left homeless when flood rains in the wake of Typhoon Thelma caused flash flooding, landslides and a burst dam. Hardest hit was the port city of Ormoc where a huge mudslide occurred on nearby hillsides made much worse by extensive logging operations that had removed the protection of the trees.

8.5.4 Forecasting , warning, monitoring cyclone:

❖ **Cyclone Forecast and Stages of Cyclone Warning**

Tropical cyclone forecasting is the science of forecasting. It states where a tropical cyclone's centre, and its effects, is expected to be at some point in the future. There are several elements to tropical cyclone forecasting: track forecasting, intensity forecasting, rainfall forecasting, storm surge, and tornado forecasting. The skill in regard to track forecasting has increased, but intensity forecasting skill remains nearly unchanged over the past several years.

Cyclones vary considerably in their predictability. Much effort has been dedicated to improving the forecasting skill in both location and intensity. The Bureau of Meteorology routinely issues forecasts of cyclone location and intensity at 12, 24 and 48 hour time-steps. All official forecasts are verified by comparison with the **best track**, the official estimate of the location and intensity of a tropical cyclone. A best track is prepared for every tropical cyclone, after the fact, using all available data.

Unpredictable nature of Tropical cyclones is seen when some exhibit rapid changes in intensity or change course speed up or slow down, primarily in response to changes in the surrounding environment. Cyclone*Lena* (1993), for example, was moving to the west but made a U-turn and returned close to its original path. Also cyclones at the category 1 stage are typically difficult to locate as the centre may not be apparent from satellite imagery, compared to stronger systems that have a well-defined eye. Those systems that markedly change their course or intensity close to the coast present the greatest challenge to forecasters and decision-makers in the community. Community awareness is much higher when a cyclone develops well offshore prior to crossing compared to one that rapidly develops near the coast.

The cyclone tracking, forecasting and advance warning are being done precisely after the Meteorological application program of INSAT series of Indian Geo-Stationary Satellites have become operational since October 1983. Monitoring of the cyclone is done by taking hourly pictures. This has helped the forecaster to improve

his skill in issuing the timely warnings to the public. Satellite pictures received by the IMD HQ at New Delhi are further disseminated to all the forecasting Offices through satellite based Digital Meteorological Data Dissemination Systems. The Government has strengthened the Meteorological Department, by providing Cyclone Surveillance Radars at Calcutta, Paradeep, Visakhapatnam, Machilipatnam, Chennai and Karaikal in the east coast and at Kochi, Goa, Mumbai and Bhuj in the west coast for further cyclone warning when they are within a close approach of 500 km off coast.

Area Cyclone Warning Centres (ACWC) and the Cyclone Warning Centres (CWC) of IMD are responsible for cyclone forecasting in the Bay of Bengal and Arabian Sea - the National Cyclone Warning Centre at New Delhi being the coordinator. Computerised Operational Advisory Forecasts on cyclone movements are being issued by the Numerical Weather Prediction (NWP) division of the Department at the H.Q., New Delhi.

After receipt of pre-cyclone watch bulletin issued by HQ, ACWC/CWC will monitor issue of warnings under two stages warning system- Cyclone Alert and Cyclone Warning.

Cyclone Alert, the first stage warning: This is issued 48 hrs. in advance of the commencement of adverse weather, to Collector of coastal districts and the Chief Secretary of the concerned maritime state. After issue of alert message for broadcast, the concerned AIRs are to be requested to maintain round the clock watch to receive & broadcast the subsequent numbered bulletins.

Cyclone warning is the second stage warning: This is issued 24 hrs. in advance of the commencement of adverse weather.

Third stage of warning: If the storm is tracked by radar with a high degree of confidence, any other crucial warning will be sent more frequently to all the concerned recipients (Collectors & Chief Secretaries), subsequent to this warning. These recipients will be informed that subsequent warning on the storm will be broadcast by AIR stations.

The fourth stage of the warning, i.e. Post Landfall Outlook (PLO) meant for Interior districts issued 12 hrs. before the estimated landfall of the storm in order to bring to the notice of the Collectors of interior districts about their area likely to be affected by cyclone.

One of the means of communication, on which IMD depends for the dissemination of these warnings, other than AIR, is satellite, based Cyclone Warning Dissemination System (CWDS) installed at maritime district HQ, so that district authorities can initiate

appropriate precautionary measures on receipt of such warnings. This scheme makes use of the S-band broadcast capability of INSAT satellite. At present there are 5 CWDS stations located in Kerala, which are at Thiruvananthapuram, Alappuzha, Ernakulam, Thrissur and Kozhikode.

Fisheries Warnings: When wind speed over sea area is expected to exceed 45 kmph in the sea area up to 75 Nautical miles from the coast, wind warnings are issued and communicated to the Director of Fisheries, all Dy. Directors of Fisheries and Director of Ports through fax/SMS through VPN connection, advising fisherman to be cautious while venturing into the sea.

Heavy rainfall warnings : When rainfall amount is expected to exceed 7 cm, heavy rainfall warnings are issued to District Collectors and various agencies, such as public services, PWD, Irrigation, Hydroelectric, Port, telegraphs, Railway and Community Project Officials, so that the disaster management machinery can be kept in readiness

8.5.5 Monitoring cyclone

Observation of tropical cyclone has been carried out over the past couple of centuries in various ways. The passage of typhoons, hurricanes, and other tropical cyclones have been detected by word of mouth from sailors recently coming to port or by radio transmissions from ships at sea, from sediment deposits in near shore estuaries, to the wiping out of cities near the coastline. Moreover, since World War II, with the advancement in technology planes have been used to survey the ocean basins, satellites to monitor the world's oceans from outer space using a variety of methods, radars to monitor their progress near the coastline, and recently the introduction of unmanned aerial vehicles to penetrate storms. Recent studies have concentrated on studying hurricane impacts lying within rocks or near shore lake sediments, which are branches of a new field known as paleotempestology.

8.5.6 .Mitigation cyclone

- **National Cyclone Mitigation Project**

A project for Cyclone Mitigation (estimated cost Rs. 1050 crore) has been drawn up in consultation with the cyclone prone States. This project envisages construction of cyclone shelters, coastal shelter belt plantation in areas which are prone to storm surges, strengthening of warning systems, training and education etc. This project has also been given in-principle clearance by the Planning Commission and is being taken up with World Bank assistance.

The Government of India has approved a National Cyclone Risk Mitigation Project (NCRMP), to be implemented in cyclone prone coastal States and Union Territories. The Project will be implemented in three phases as a Centrally Sponsored Scheme with 75% contribution by the Central Government and 25% contribution by the State Governments for the component consisting of structural and non-structural measures.

A Project Oversight Committee will be constituted under the chairmanship of the Home Secretary for overall review and policy level directions of the scheme. A Project Steering Committee chaired by Secretary, NDMA will be constituted with representation of key Ministries/organisations. At state level, a Project Implementation unit will be set up.

The National Disaster Management Authority (NDMA) has been designated as the implementing agency. The scheme is regularly monitored by NDMA and MHA.

Objectives of NDMA

(i) To upgrade cyclone forecasting, tracking and warning systems and capacity building in multi-hazard risk management.
(ii) To construct major infrastructure including multi-purpose cyclone shelters and embankments.

After the Orissa Super Cyclone of 1999 under the influence of reconstruction donor organizations, led by the World Bank, the Government of Orissa established Orissa State Disaster Management Authority (OSDMA). This was an institutional innovation for speedy reconstruction, disaster management planning, preparedness, training, and related matters, avoiding the bureaucratic red tape.

8.5.7 Preparedness and Response of cyclone

The significant improvements in disaster management, preparedness, forecasting capabilities and early warning, such as the improvements exhibited by India during Cyclone Phailin in October 2013, have helped to mitigate some disaster-related impacts. Preparedness and early warning communications and activities had been much improved since the comparable Cyclone 05B 14 years earlier.

On the evening of October 12, 2013 a very severe tropical cyclone, Phailin, brought torrential downpours, damaging winds of more than 220 kilometres per hour (km/h) and storm surges of up to 3.5 metres (m) to the eastern Indian states of Odisha and Andhra Pradesh. Effective disaster planning, preparation and dissemination

of early warning information led to a minimal death toll in the wake of the strongest cyclone to hit India in 14 years. In mid-October 2013, Cyclone Phailin swept over the Bay of Bengal and across the eastern coast of India. The evacuation of more than a million people in the states of Odisha and Andhra Pradesh in response to effective early warnings resulted in a much lower death toll than a catastrophic cyclone of similar strength that struck in 1999, leaving 10,000 people dead. Continued early warning efforts could have similar positive results in the future, and when accompanied by good communication and adequate preparation, impacts of disasters could be mitigated or even prevented.

Regarding forecasts, the India Meteorological Department (IMD) was able to predict wind velocity more accurately, contributing to better forecasts and more effective early warning communications. Warnings from the IMD were disseminated as early as four days before Phailin made landfall, as compared with two days of warning provided for Cyclone 05B in 1999. In addition to early warning alerts that prompted evacuations, precautions to protect cattle were taken and reservoirs were lowered to mitigate anticipated flooding. Also, preparedness meetings were held among various Disaster Response Teams in Odisha and volunteer teams, such as the International Federation of Red Cross (IFRC), were also on hand to assist with evacuation and relief.

8.5.8 Case study cyclone: Super Cyclonic Storm, Orissa on 29 October, 1999

Orissa was battered by a Super Cyclonic Storm on 29 October, 1999 that made landfall near Paradip. The estimated maximum wind speed reached 260-270 kmph in the core area which produced a huge storm surge that led to sea-level elevation of more than 20 feet and took away valuable lives of nearly 10,000 people. It was accompanied with exceptionally heavy rains which led to devastating floods and cut off the State from the rest of the country. Undoubtedly it was the most intense one.

It had some unique features such as rapid intensification, small radius of eye wall confining the large surge close to the point of landfall and relatively long life after landfall. Climatologically there is a high frequency of dissipation of cyclones in October because of strong easterly winds aloft. It was first detected when it was at its low pressure stage over the gulf of Siam by the IMD cyclone surveillance system on the morning of October 24, five days before it made landfall. Winds of up to 260 kph raged for over 36 hours. Coastal districts of Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Puri and Ganjam were forced to evacuate their homes. Landfall point was between Ersama and Balikuda in Jagatsinghpur district (southwest of Paradip). Time of landfall was 10.30 am, October 29,

1999. It had very high wind speed. The wind speed of the super cyclone was so high that the anemometer, a device used for measuring wind speed, at the IMD office and at Paradip had failed to record it. Eye of storm was Paradip. There was three days of torrential rain. The super cyclone centered over coastal areas of Odisha for three days was accompanied by torrential rain as a tidal surge of about 7 to 10 metre that swept more than 20 km inland. Diameter of cyclone was 200 km. It originated from about 550 km east of the Andaman Islands as a depression. Many districts and towns were affected by this super cyclone. The storm in 1999 led to 45 cm to 95 cm of rainfall and affected 14 coastal districts, 28 coastal towns and two major cities of Bhubaneswar and Cuttack. Death toll was also noticeable. While the official death toll then was 9,885 people, unofficial sources estimated the toll to be above 50,000. An estimated 1,500 children were orphaned. Of the total casualty, Jagatsinghpur district alone had accounted for 8,119 people. At least 13 million people, including 3.3 million children, 5 million women and nearly 3.5 million elderly people were affected in 1999. The storm had left 7,505 people injured and number of livestock lost was 3,15,886 head of cattle. 16,50,086 houses damaged, 23,129 houses washed away, 7,46,337 houses fully destroyed and 8,80,620 houses partially damaged by the super cyclone.

After the Orissa Super Cyclone of 1999 under the influence of reconstruction donor organizations, led by the World Bank, the Government of Orissa established Orissa State Disaster Management Authority (OSDMA). This was an institutional innovation for speedy reconstruction, disaster management planning, preparedness, training, and related matters, avoiding the bureaucratic red tape.

Within two days after the cyclone hit the Orissa coast, three INSAT portable mobile telephony terminals were handed over to the Civil Administration in Bhubaneswar for relief work. These terminals work with the INSAT-2C Mobile Satellite Service (MSS) transponders. Within 3 to 4 days, five Very Small Aperture Terminals (VSATs) were airlifted from Delhi and a network of five VSATs was established. HCL Comnet and Essel Shyam supplied the VSATs. At present, VSATs are located at Krishi Bhavan, New Delhi; Secretariat, Bhubaneswar-1; Secretariat, Bhubaneswar-2; District HQ Collector Offices in Jagatsinghpur and Kendrapada; and in Paradeep, Erassama and Balikuda. It helped in establishing contact between the Relief Commissioner at Delhi and the Orissa Secretariat via VSAT network, operating through the INSAT-2C Extended C band transponders. This network of VSATs has now been extended to 13 places.

Use of Remote Sensing Data

Immediately after the super cyclone hit the Orissa coast and the following days, maps showing flood inundated areas were prepared using the data from Indian Remote Sensing satellites and the microwave data from the Canadian RADARSAT. As the affected areas were clouded making it difficult for using optical remote sensing data that is provided by Indian Remote Sensing satellites (IRS), the microwave data from RADARSAT were also procured to complement IRS data. The maps generated at National Remote Sensing Agency, Hyderabad, using the data from the satellites were rushed to Bhubaneswar within 24 hours of data acquisition and provided to various officials for using them for relief and rescue operations. The maps were used by Indian Air Force and the Indian Army who were in-charge of air dropping of food and other essential materials. Maps were also given to officers in charge of health services

8.6 EARTHQUAKES WITH REFERENCE TO NATURE

❖ **Earthquake**

An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. The seismicity, seismism or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time. Earthquakes are measured using observations from seismometers.

It is a sudden violent shaking of the ground, typically causing great destruction, as a result of movements within the earth's crust or volcanic action or sudden slip on a fault. The tectonic plates are always slowly moving, but they get stuck at their edges due to friction. When the stress on the edge overcomes the friction, there is an earthquake that releases energy suddenly in the form seismic waves that travel through the earth's crust and cause the shaking that we feel. The tectonic plates in the earth’s crust which are almost hundred kilometres in thickness get dislocated because of seismic waves. An earthquake is a natural phenomenon. But sometimes activities like oil drilling, coal mining, and construction of big dams also add up to the seismic activity.

The moment magnitude is the most common scale on which earthquakes larger than approximately 5 are reported for the entire globe. The more numerous earthquakes smaller than magnitude 5 reported by national seismological observatories are measured mostly on the local magnitude scale, also referred to as the Richter scale. So, earthquake intensity is measured with the help of **seismometers** known as **Richter scale**. A magnitude of 3 on

Richter scale is indiscernible whereas a magnitude higher than 7 usually causes damage and destruction. These two scales are numerically similar over their range of validity. Magnitude 3 or lower earthquakes are mostly almost imperceptible and magnitude 7 and over potentially causes serious damage over large areas, depending on their depth. The largest earthquakes in historic times have been of magnitude slightly over 9, although there is no limit to the possible magnitude. One of the worst earthquakes to hit was a magnitude of over 9 in Japan in 2011, it was the largest Japanese earthquake since records began. Intensity of shaking is measured on the modified Mercalli scale. The shallower an earthquake, the more damage to structures it causes, all else being equal. At the Earth's surface, earthquakes manifest themselves by shaking and sometimes displacement of the ground.

An earthquake's point of initial rupture is called its focus or hypocenter. The **epicenter** is the point at ground level directly above the hypocenter.

The damage caused due to an earthquake depends on the location of the epicentre of the earthquake. Major destruction occurs near the epicentre of the earthquake because maximum intensity locates at the centre. Sometimes because of earthquakes there may be volcanic eruptions and landslides. When the epicenter of a large earthquake is located offshore, the seabed may be displaced sufficiently to cause a tsunami.

- **Aftershocks**

An aftershock is an earthquake that occurs after a previous earthquake, the main shock. It occurs in the same region of the main shock but in a smaller magnitude. Aftershocks are formed as the crust around the displaced fault plane adjusts to the effects of the main shock. If an aftershock is larger than the main shock, the aftershock is re-designated as the main shock and the original main shock is re-designated as a foreshock.

- **Earthquake swarms**

Earthquake swarms are sequences of earthquakes striking in a specific area within a short period of time. They are different from earthquakes followed by a series of aftershocks by the fact that no single earthquake in the sequence is obviously the main shock; therefore none have notable higher magnitudes than the other. An example of an earthquake swarm is the 2004 activity at Yellowstone National Park.

- **Earthquake storms**

A series of earthquakes occur in a sort of earthquake storm, where the earthquakes strike a fault in clusters, each triggered by the shaking or stress redistribution of the previous earthquakes. Similar to aftershocks but on adjacent segments of fault, these storms occur over the course of years, and with some of the later earthquakes as damaging as the early ones. Such a pattern was observed in the sequence of about a dozen earthquakes that struck the North Anatolian Fault in Turkey in the 20th century and has been inferred for older anomalous clusters of large earthquakes in the Middle East.

- **Measuring and locating earthquakes**

Earthquakes can be recorded by seismometers up to great distances, because seismic waves travel through the whole Earth's interior. The absolute magnitude of a quake is conventionally reported by numbers on the Moment magnitude scale (formerly Richter scale, magnitude 7 causing serious damage over large areas), whereas the felt magnitude is reported using the modified Mercalli intensity scale (intensity II–XII).

Every tremor produces different types of seismic waves, which travel through rock with different velocities:

- Longitudinal P-waves (shock- or pressure waves)
- Transverse S-waves (both body waves)
- Surface waves — (Rayleigh and Love waves)

Propagation velocity of the seismic waves ranges from approx. 3 km/s up to 13 km/s, depending on the density and elasticity of the medium. In the Earth's interior the shock- or P waves travel much faster than the S waves (approx. relation 1.7 : 1). The differences in travel time from the epicentre to the observatory are a measure of the distance and can be used to image both sources of quakes and structures within the Earth. Also the depth of the hypocenter can be computed roughly. In solid rock P-waves travel at about 6 to 7 km per second; the velocity increases within the deep mantle to ~13 km/s. The velocity of S-waves ranges from 2–3 km/s in light sediments and 4–5 km/s in the Earth's crust up to 7 km/s in the deep mantle. As a consequence, the first waves of a distant earthquake arrive at an observatory via the Earth's mantle.

Rule of thumb: On the average, the kilometer distance to the earthquake is the number of seconds between the P and S wave

times 8. Slight deviations are caused by in homogeneities of subsurface structure. By such analyses of seismograms the Earth's core was located in 1913 by Beno Gutenberg. Earthquakes are not only categorized by their magnitude but also by the place where they occur. The world is divided into 754 Flinn-Engdahl regions (F-E regions), which are based on political and geographical boundaries as well as seismic activity. More active zones are divided into smaller F-E regions whereas less active zones belong to larger F-E regions.

- **Size and frequency**

Almost 500,000 earthquakes occur each year that can be detected with the latest instruments. Among these, around 100,000 can be felt.

8.6.1 Geographical distribution of earthquakes

Minor earthquake prone areas on earth are Italy, Greece, New Zealand, Turkey, Portugal, Pakistan, Iran, Indonesia, Peru, Chile, Guatemala, Mexico, California and Alaska. Majority of earthquakes occur in the course of 40,000 km long circum-Pacific seismic belt which is in the shape of a horseshoe. Himalayan mountain plate is another zone where massive earthquakes may occur. With rapid rise in population in countries like Japan, Mexico and Tehran, because of their presence in seismic zones, major earthquakes may occur. If we list out the top 10 earthquake prone countries, it goes like:

1. Japan
2. Indonesia
3. United States of America
4. New Zealand
5. Fiji
6. Tonga
7. Chile
8. Papua New Guinea
9. Mexico
10. Solomon Islands

8.6.2 Causes and impact of earthquakes

❖ Causes

Earthquakes are caused mostly by rupture of geological faults, but also by other events such as volcanic activity, landslides, mine blasts, and nuclear tests.

• Naturally occurring earthquakes

Earth's tectonic plates are marked by faults or fractures. **Earthquakes** are usually caused when underground rock suddenly breaks along a fault. When the tectonic plates slide past each other or have a collision with each other, an earthquake occurs. This sudden release of energy causes the seismic waves that make the ground shake. When two blocks of rock or two plates are rubbing against each other, they stick a little but don't just slide smoothly; the rocks catch on each other. The rocks still push against each other, but do not move. After a while, the rocks break because of all the pressure that's built up. When the rocks break, earthquake occurs. During and after the earthquake, the plates or blocks of rock start moving, and they continue to move until they get stuck again.

i. Tectonic earthquakes

Tectonic earthquakes occur anywhere in the earth where there is sufficient stored elastic strain energy to drive fracture propagation along a fault plane. The sides of a fault move past each other smoothly and aseismically only if there are no irregularities or asperities along the fault surface that increase the frictional resistance. Most fault surfaces do have such asperities and this leads to a form of stick-slip behaviour. Once the fault has locked, continued relative motion between the plates leads to increasing stress and therefore, stored strain energy in the volume around the fault surface. This continues until the stress has risen sufficiently to break through the asperity, suddenly allowing sliding over the locked portion of the fault, releasing the stored energy. This energy is released as a combination of radiated elastic strain seismic waves, frictional heating of the fault surface, and cracking of the rock, thus causing an earthquake. This process of gradual build-up of strain and stress punctuated by occasional sudden earthquake failure is referred to as the elastic-rebound theory. It is estimated that only 10 percent or less of an earthquake's total energy is radiated as seismic energy. Most of the earthquake's energy is used to power the earthquake fracture growth or is converted into heat generated by friction. Therefore, earthquakes lower the Earth's available elastic potential energy and raise its temperature, though these changes are negligible compared to the

conductive and convective flow of heat out from the Earth's deep interior.

ii. Earthquake fault types

There are three main types of fault that may cause an earthquake: normal, reverse (thrust) and strike-slip.

Normal faults occur mainly in areas where the crust is being extended such as a divergent boundary. Earthquakes associated with normal faults are generally less than magnitude 7. This is so because the energy released in an earthquake, and thus its magnitude, is proportional to the area of the fault that ruptures and the stress drop.

Reverse faults occur in areas where the crust is being shortened such as at a convergent boundary. Reverse faults, particularly those along convergent plate boundaries are associated with the most powerful earthquakes, including almost all of those of magnitude 8 or more.

Strike-slip faults are steep structures where the two sides of the fault slip horizontally past each other. Many earthquakes are caused by movement on faults that have components of both dip-slip and strike-slip; this is known as oblique slip. Strike-slip faults, particularly continental transforms can produce major earthquakes up to about magnitude 8.

The most important parameter controlling the maximum earthquake magnitude on a fault is however not the maximum available length, but the available width because the latter varies by a factor of 20.

iii. Earthquakes away from plate boundaries

Where plate boundaries occur within continental lithosphere, deformation is spread out over a much larger area than the plate boundary itself. In the case of the San Andreas fault continental transform, many earthquakes occur away from the plate boundary and are related to strains developed within the broader zone of deformation caused by major irregularities in the fault trace (e.g., the "Big bend" region). Another example is the strongly oblique convergent plate boundary between the Arabian and Eurasian plates where it runs through the north-western part of the Zagros Mountains. This is demonstrated by earthquake focal mechanisms. All tectonic plates have internal stress fields caused by their interactions with neighbouring plates and sedimentary loading or unloading (e.g. deglaciation) these stresses may be sufficient to

cause failure along existing fault planes, giving rise to intraplate earthquakes.

iv. Shallow-focus and deep-focus earthquakes

The majority of tectonic earthquakes originate at the ring of fire in depths not exceeding tens of kilometres. Earthquakes occurring at a depth of less than 70 km are classified as 'shallow-focus' earthquakes, while those with a focal-depth between 70 and 300 km are commonly termed 'mid-focus' or 'intermediate-depth' earthquakes. Deep-focus earthquakes occur at a depth where the subducted lithosphere should no longer be brittle, due to the high temperature and pressure.

v. Earthquakes and volcanic activity

Earthquakes often occur in volcanic regions. These are caused both by tectonic faults and the movement of magma in volcanoes. Such earthquakes can serve as an early warning of volcanic eruptions, as during the Mount St. Helens eruption of 1980. Earthquake swarms can serve as markers for the location of the flowing magma throughout the volcanoes. These swarms can be recorded by seismometers and tiltmeters (a device that measures ground slope) and used as sensors to predict imminent or upcoming eruptions.

vi. Rupture dynamics

A tectonic earthquake begins by an initial rupture at a point on the fault surface, a process known as nucleation. The scale of the nucleation zone is uncertain, with some evidence, such as the rupture dimensions of the smallest earthquakes, suggesting that it is smaller than 100 m while other evidence, such as a slow component revealed by low-frequency spectra of some earthquakes, suggests that it is larger. The possibility that the nucleation involves some sort of preparation process is supported by the observation that about 40% of earthquakes are preceded by foreshocks. Once the rupture has initiated it begins to propagate along the fault surface. The mechanics of this process are poorly understood, partly because it is difficult to recreate the high sliding velocities in a laboratory.

vii. Tidal forces

Research work has shown a robust correlation between small tidally induced forces and non-volcanic tremor activity.

viii. Earthquake clusters

Most earthquakes form part of a sequence, related to each other in terms of location and time. Most earthquake clusters consist of small tremors that cause little to no damage, but there is a theory that earthquakes can recur in a regular pattern.

ix. Human induced seismic activity

With the development and enhancement in technology, man has exploited the wealth of the nature. Human activities that lead to earthquakes are drilling for oil wells, coal mining, and collecting large volumes of water for construction of a dam. The underground explosions to break rock while making tunnels for roads, railroads, subways, or mines do not cause very strong seismic waves and we may not even feel them. Sometimes seismic waves occur when the roof or walls of a mine collapse and this can be felt by people near the mine. The largest underground explosions, from tests of nuclear warheads (bombs), can create seismic waves very much like large earthquakes. As an example, the 2008 Sichuan earthquake that occurred in China was because of the construction of a dam. In Australia also there was coal mining activity which resulted in an earthquake.

8.6.3 Impact of earthquakes

❖ A number of natural changes occur due to an earthquake.

i. Ground rupture

The ground shakes and ruptures because of which building and other structures get damaged. The severity of destruction depends on how close the area is to the epicenter. Ground rupture means the breakage and displacement of the earth's surface. It is a major threat to huge structures like bridges, dams and nuclear power plants.

ii. Landslides

Another major threat that occurs due to an earthquake is landslides. When the earthquake is accompanied by other major threats like wildfires, volcanic activity or storms, landslides may occur.

iii. Fire

Due to the damage of electrical power or gas lines chances of fire eruption are high due to an earthquake.

iv. Soil liquefaction

When water saturated granular material like sand loses its strength due to earthquake it gets modified into a liquid. This process may cause damage to bridges and buildings. There is a chance of these structures getting collapsed to the ground.

v. Tsunami

When earthquake occurs in the sea bed, the sea waves rise in the sea. It has long and sudden movements dispensing large volumes of water. Depending on the depth of the water these waves travel at a speed of 600-800 kilometers per hour. These waters are capable enough to drown the structures and building all along the sea coast. Usually tsunamis occur in the seal when the earthquake hit is above 7.5 on the Richter scale. After the tsunami in 2003 that devastated lakhs of people across Indian Ocean, countries all over the world are taking precautions and have invested in tsunami warning systems.

❖ **After effects**

A major **earthquake causes** lot of destruction and damage to buildings and structures. Because of lack of basic amenities, diseases may spread. It will take lot of time for rehabilitation of people.

Man has been making a steady progress in all fields. There are several discoveries and innovations to his credit. Except for being ready to face any type of natural calamities, there is nothing that man can do in such circumstances. Time and again nature proves that it is mightier than human beings.

8.6.4 Forecasting, warning & monitoring earthquake

❖ **Forecasting**

Earthquake prediction is a branch of the science of seismology. It is concerned with the specification of the time, location, and magnitude of future earthquakes within stated confidence limits but with sufficient precision that a warning can be issued.

Seismologists feel compelled to provide earthquake predictions to society. Location, magnitude, and recurrence interval of earthquakes have large uncertainty. For example, the estimated magnitudes for earthquakes in the New Madrid Seismic Zone range from M 6.6 to M 8.0, and estimates of the recurrence interval range from 500 to 50,000 years. Uncertainties of this scale indicate that earthquakes cannot be predicted or forecasted reliably. One such example is Iben Browning's forecast: a 50% chance of a major earthquake with a magnitude of about 7 in the New Madrid Seismic

Zone within a few days of 3 December 1990. Even though the 1975 Haicheng, China, earthquake has been claimed as a successful prediction, it was not predicted scientifically.

Generally, the location, magnitude, and recurrence interval of earthquakes and their respective uncertainties are quantified by a probability model (distribution), such as a Gaussian (normal) model with a mean and standard deviation or by a logic tree. A mean magnitude of M 7.5 and mean recurrence interval of 200 years were assumed for the characteristic fault. The prediction for this case may be that an M 7.5 earthquake "could occur" along the fault in the next month, next year, or in 50 years or that an M 7.5 earthquake "will probably occur" along the fault in the next month, next year, or in 50 years. To make a forecast, a probability model has to be introduced to describe earthquake occurrence in time (e.g., the Poisson, empirical, Brownian passage time, or time predictable). Although the Poisson model (i.e., time independent) contradicts the generally accepted physical model (i.e., Reid's elastic rebound theory), it is the most commonly used model for estimating earthquake probability. The Poisson model assumes the exceedance probability (PE) of the M 7.5 earthquake occurrence along the fault over a specified time period (t) can be estimated by Embedded Image1in which τ is the mean recurrence interval of the earthquake. For time periods of 1 month, 1 year, and 50 years, equation (1) yields PEs of about 0.042%, 0.5%, and 22.1%, respectively. Thus, the forecast that an M 7.5 earthquake will occur along the fault within the next month is 0.042%; the probability that an M 7.5 earthquake will occur within the next 50 years is 22.1%.

❖ **Warning earthquake**

Earthquakes and Buildings

Early alert capabilities in some cases will allow some systems to automatically shut down before the strong shaking starts so that the services and people using them will be safe. Such systems may include elevators, utilities such as water and gas, and factory assembly lines.

Small building are more affected, or shaken, by high frequency waves (short and frequent). For example, a small boat sailing in the ocean will not be greatly affected by a large swell. On the other hand several small waves in quick succession can overturn, or capsize, the boat. The same way, a small building experience more shakes by high frequency earthquake waves. Large structures or high rise buildings are more affected by long period, or slow shaking. For instance, an ocean liner will experience little disturbance by short waves in quick succession. However, a large swell will significantly affect the ship. Similarly, a skyscraper

will sustain greater shaking by long period earthquake waves, than by the shorter waves.

❖ **Monitoring earthquake**

Earthquake Monitoring: Magnitude vs. Intensity

Earthquake monitoring started long ago, but the technology has advanced dramatically from its origin in 132 AD in China where the first "seismoscope" was constructed with carved dragons and frogs.

Intensity scales measure the amount of shaking at a particular location. Therefore, the intensity of an earthquake will vary depending on where you are. Sometimes earthquakes are referred to by the maximum intensity they produce.

Magnitude scales, like the Richter magnitude and moment magnitude, measure the size of the earthquake at its source. Thus, they do not depend on where the measurement of the earthquake is made. On the Richter scale, an increase of one unit of magnitude (for example, from 4.6 to 5.6) represents a 10-fold increase in wave amplitude on a seismogram or approximately a 30-fold increase in the energy released. Except in special circumstances, earthquakes below magnitude 2.5 are not generally felt by humans. Often, several slightly different magnitudes are reported for an earthquake. This happens because different measurement procedures will often give slightly different magnitudes for the same earthquake.

8.6.5 Preparedness and Response

❖ **Preparedness**

Although earthquake is not a new disaster it is necessary to be prepared against this disaster. Prediction and forecasting of earthquake is impossible, hence preparation should be taken against earthquake. It may lessen the damages occurred due to the earthquake is less.

i. Pre-Disaster Preventive Measures

a. Long-term measures

- Re-framing buildings' codes, guidelines, manuals and byelaws and their strict implementation.
- Tougher legislation for highly seismic areas

- Incorporating earthquake resistant features in all buildings at high-risk areas.
- Making all public utilities like water supply systems, communication networks, electricity lines etc. earthquake-proof.
- Creating alternative arrangements to reduce damages to infrastructure facilities.
- Constructing earthquake-resistant community buildings and buildings (used to gather large groups during or after an earthquake) like schools, dharamshalas, hospitals, prayer halls, etc., especially in seismic zones of moderate to higher intensities.
- Supporting R&D in various aspects of disaster mitigation, preparedness and prevention and post-disaster management.
- Evolving educational curricula in architecture and engineering institutions and technical training in polytechnics and schools to include disaster related topics.

b. Medium term measures

- Retrofitting of weak structures in highly seismic zones.
- Preparation of disaster related literature in local languages with dos and don'ts for construction.
- Getting communities involved in the process of disaster mitigation through education and awareness.
- Networking of local NGOs working in the area of disaster management.

ii. Post-Disaster Preventive Measures

- Maintenance of law and order, prevention of trespassing, looting etc.
- Evacuation of people.
- Recovery of dead bodies and their disposal.
- Medical care for the injured.
- Supply of food and drinking water.
- Temporary shelters like tents, metal sheds etc.
- Repairing lines of communication and information.
- Restoring transport routes.
- Quick assessment of destruction and demarcation of destroyed areas, according to the grade of damage.

- Cordoning off severely damaged structures that are liable to collapse during aftershocks

➢ The following efforts will be useful for preparedness:

- Train communities in high-risk areas in post-disaster search, rescue and relief.
- Practice an extensive programme of mass drills in high-risk areas for earthquake damage reduction.
- Train local NGOs and strengthen their capacity and capabilities.
- Inculcate basic know-how amongst school kids on earthquake dos and don'ts along with safety drills.
- Train field personnel in the science and art of carrying out post disaster damage surveys, for (a) urgent relief purposes and (b) for repair, reconstruction and retrofitting purposes. During emergencies, affected people need to be involved in the relief activities so as to create a feeling of self-reliance. Also, the sooner they are integrated, the shorter will the period of relief will be.

➢ Post-disaster work would involve:

- Detailed survey of buildings for assessment of damage and repair/ reconstruction and seismic strengthening or demolition.
- Selection of sites for new settlements, if required.
- Execution of the reconstruction programme.
- Review of the existing seismic zoning maps and risk maps.
- Review of seismic codes and norms of construction.
- Training of personnel, engineers, architects, builders and masons.

8.6.6 Response

In the aftermath of an earthquake, workers are found to be involved in a variety of response and recovery operations. Collapsed structures are a common result of earthquakes. Rescue workers, engineers and emergency responders may have to enter collapsed structures to perform search and rescue activities, and all possible safety and health precautions should be taken to ensure they can perform their duties safely.

8.6.7 Mitigation - case studies

❖ Earthquake Risk Mitigation

There is a comprehensive programme for earthquake risk mitigation. The building construction in urban and suburban areas is regulated by the Town and Country Planning Acts and Building Regulations. The BIS (Bureau of Indian Standards) have laid down the standards for construction in the seismic zones but these were not followed properly. Even if it is done, there is lack of knowledge regarding seismically safe construction among the architects and engineers. Moreover lack of awareness regarding their vulnerability among the population led to most of the construction in the urban/sub-urban areas being without reference to BIS standards.

In the rural areas, mode of construction has changed from mud and thatch to brick and concrete construction and the bulk of the housing is non-engineered construction thereby increasing the vulnerability. The increasing population has led to settlements in vulnerable areas close to the river bed areas which are prone to liquefaction. The Government has moved to address these issues.

- **National Core Group for Earthquake Risk Mitigation**

A National Core Group for Earthquake Risk Mitigation has been constituted consisting of experts in earthquake engineering and administrators. The Core Group has been assigned with the responsibility of drawing up a strategy and plan of action for mitigating the impact of earthquakes.

- **Review of building bye-laws and their adoption**

Most casualties during earthquakes are caused by the collapse of structures. Therefore structural mitigation measures are the key to make a significant impact towards earthquake safety in our country. In view of this the States in earthquake prone zones have been requested to review, and if necessary, amend their building bye-laws to incorporate the BIS seismic codes for construction in the concerned zones.

- **Development and Revision of Codes**

There are Bureau of Indian Standard (BIS) codes which are relevant for multi-hazard resistant design and construction. These codes have to be regularly updated. An action plan has been drawn up for revision of existing codes, development of new codes and documents/commentaries, and making these codes and documents available all over the country including on-line access to these codes.

- **Hazard Safety Cells in States**

The States have been advised to constitute Hazard Safety Cells (HSC) headed by the Chief Engineer (Designs), State Public Works Department with necessary engineering staff so as to establish mechanism for proper implementation of the building codes in all future Govt. constructions, and to ensure the safety of buildings and structures from various hazards. The HSC will also be responsible for carrying out appropriate design review of all Government buildings to be constructed in the State, act as an advisory cell to the State Government on the different aspects of building safety against hazards and act as a consultant to the State Government for retrofitting of the lifeline buildings. Rajasthan, West Bengal and Chhattisgarh have already constituted these cells and other States are in the process.

- **National Programme for Capacity Building of Engineers and Architects in Earthquake Risk Mitigation**

Two National Programmes for Capacity Building in Earthquake Risk Mitigation for Engineers and Architects respectively, have been approved to assist the State Govts in building capacities for earthquake mitigation. These two programmes are being implemented for training of 10,000 engineers and 10,000 architects in the States in seismically safe building designs and related techno-legal requirements.

- **Training of rural monsoons**

A programme to assist the States/UTs in training and certification of 50000 masons has been formulated in consultation with Housing and Urban Development Corporation (HUDCO) and the Ministry of Rural Development. The training module for masons to include multi-hazard resistant construction has also been prepared by an expert committee, and revised curriculum will be introduced in the vocational training programme of Ministry of Human Resource Development.

- **Earthquake Engineering in Undergraduate Engineering/ Architecture Curricula**

The role of engineers and architects is crucial in reducing earthquake risks by ensuring that the construction adheres to the norms of seismically safety. In view of this, the elements of earthquake engineering are being integrated into the undergraduate engineering and architecture courses.

- **Hospital Preparedness and Emergency Health Management in Medical Education**

As hospital preparedness is crucial to any disaster response system each hospital should have an emergency preparedness plan to deal with mass casualty incidents and the hospital administration/ doctor trained for this emergency. The curriculum for medical doctors does not include Hospital Preparedness for emergencies. Therefore capacity building through in-service training of the current heath managers and medical personnel in Hospital Preparedness for emergencies or mass causality incident management is essential.

- **Acceleration Urban Earthquake Vulnerability Reduction Programme**

An accelerated urban earthquake vulnerability reduction programme has been taken up in 38 cities in seismic zones III, IV & V with population of half a million and above. 474 Orientation programmes have been organized for senior officers and representatives of the local planning and development bodies to sensitize them on earthquake preparedness and mitigation measures.

- **Mainstreaming Mitigation in Rural Development Schemes**

Rural housing and community assets for vulnerable sections of the population are created at a fairly large scale by the Ministry of Rural Development under the Indira Awas Yojna(IAY) and Sampooran Grameen Rojgar Yojna(SGRY). About 250 thousand small but compact housing units are constructed every year, besides community assets such as community centres, recreation centres, anganwadi centres etc. Technology support is provided by about two hundred rural housing centres spread over the entire country.

8.6.8 Case study: The 2001 Gujarat earthquake

India has witnessed some of the most devastating earthquakes during the last century like the one in Kangra (1905), Bihar-Nepal (1934) and in Assam (1950). In the recent past, earthquakes have caused havoc in Uttarkashi (1991), Latur (1993), Jabalpur (1997), Chamoli (1999) and in Bhuj (2001).

The 2001 Gujarat earthquake

Gujarat lies 3–400 km from the plate boundary between the Indian Plate and the Eurasian Plate, but the current tectonics is still governed by the effects of the continuing continental collision along

this boundary. The 2001 Gujarat earthquake also known as Bhuj earthquake occurred on 26 January, at 08:46 AM IST. Location was 10 km. North-Northeast of Jamnagar/290 km. Southeast of Hyderabad in Pakistan. It lasted for over 2 minutes. The epicentre was about 9 km south-southwest of the village of Chobari in Bhachau Taluka of Kutch District of Gujarat, India. The intraplate earthquake reached 7.7 on the moment magnitude scale and had a maximum felt intensity of X (Extreme) on the Mercalli intensity scale. The earthquake killed between 13,805 and 20,023 people (including 18 in south-eastern Pakistan), injured another 167,000 and destroyed nearly 400,000 homes.

Fig: Map of Bhuj

The effect of the earthquake was felt throughout the Indian sub-continent. Most affected districts in Gujarat were Kutch, Jamnagar, Surendranagar, Rajkot, and Surat. Worst affected towns & cities were Bhuj, Bhachau, Rapar, Anjar, Ahmedabad, Jodiya, Morbi, and Gandhidham. Among industrial Impacts damages on Kandla port is important. Other affected states were Andhra Pradesh, Delhi, Madhya Pradesh, and Maharashtra. Outside India affected countries were Bangladesh, China, Nepal and Pakistan.

Over 7,000 villages in 19 districts were affected either severely or moderately. 13,805 people lost their lives and more than 1,67,000 were injured. About 1.2 million houses were damaged partially or completely. Social infrastructure and public infrastructure were severely damaged. More than 1,000 health units and 12,000 schools were damaged. Roads, bridges, Public buildings, Dams and irrigation structures were also affected

severely. The total primary loss was about US $3,189 million and the secondary loss was about US $ 635 million and the tertiary loss was about US $ 2,097 million.

The State Government immediately conceptualized a comprehensive rehabilitation and reconstruction programme which addressed all important concerns that arose from the earthquake starting from immediate relief, economic rehabilitation, livelihood restoration as well as long term capacity building of all stakeholders to fight future disasters.

The Government prepared Gujarat Earthquake Reconstruction and Rehabilitation Policy which encompasses all measures and institutional initiatives taken by the Government in the earthquake affected areas. The Policy represented a framework of entitlements and a prospectus of development which reflected the vision of a successful reconstruction and rehabilitation plan.

After the initial relief phase, Government of Gujarat launched a massive reconstruction and rehabilitation program in the affected areas. It was a great challenge to conceptualize a massive reconstruction program, yet within a very short period government announced a comprehensive reconstruction and rehabilitation policy which included assistance for restoration of private houses, economic rehabilitation, and reconstruction of public infrastructure, prepare the people to face disasters through community participation and multi hazard preparedness programs; human resource development; and livelihood support, based on sustainable economy and ecology. Gujarat State Disaster Management Authority was created as the nodal agency to implement the massive reconstruction program.

➢ <u>The task accomplished is as follows:</u> ‰

- Over 9,08,710(99%) houses repaired and
- 1,97,091 houses (89%)houses reconstructed ‰
- 42,678 schoolrooms repaired (100%) ‰
- 12,442 Schoolrooms reconstructed (152%) ‰
- 3,391 public building repaired ‰
- 1,245 public buildings reconstructed ‰
- 5,223 km of transmission and distribution lines repaired ‰
- Repair/reconstruction of 640 km of state highways & 3,061 km of rural roads completed ‰
- Laying of 2,750 km of water supply pipelines including drilling of 222 deep tube wells ‰
- Restored the livelihood of 2,00,000 families

Better houses, upgraded infrastructure, good hospitals and schools can certainly be counted as something that has changed for the better in the earthquake affected areas.

The Gujarat earthquake did not only result in changes in focus from relief to mitigation and setting up of institutional mechanism for the same in Gujarat, but has brought about a major change at the national level towards disaster management. At the National level, emphasis now is being laid on disaster mitigation. The planning commission has recommended for utilizing 10% of the plan funds for pre-disaster mitigation and planning. A national level disaster management authority on the lines of GSDMA is being worked out at the central government level. Draft bill on National Disaster Management has been prepared. Many of the lessons learnt and best practices of Gujarat initiated after the earthquake is being replicated at the national level and at the state level in other states including setting up of disaster management authorities and enactment of bills etc. The approach and process of Gujarat earthquake reconstruction is now being looked at as a model for reconstruction in the earthquake affected areas in Bam and Tsunami reconstruction in Srilanka, Indonesia and in the tsunami affected south Indian states.

The various initiatives undertaken for integrating reconstruction and long-term disaster management capacity building have resulted in a major change in the way reconstruction programs are being done in India and the neighbouring countries. This has in turn resulted in a major shift towards prevention and mitigation of disasters from the age-old relief oriented disaster management in India.

8.7 LANDSLIDE

A landslide is the movement of rock, debris or earth down a slope. They result from the failure of the materials which make up the hill slope and are driven by the force of gravity. In other words, when soil, rock, and other earth debris can no longer hold it together and gives way to gravity, landslides happen. Landslides are known also as landslips, slumps or slope failure.

Although landslides are primarily associated with steep slopes, they also can occur in areas of generally low relief. In these areas landslides occur as cut-and-fill failures (highway and building excavations), river bluff failures, lateral spreading landslides, the collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit

mines. Underwater landslides on the floors of lakes or reservoirs, or in offshore marine settings, also usually involve areas of low relief and small slope gradients. Landslides that occur underwater cause tidal waves and damage to coastal areas. These landslides are called submarine landslides.

The downward force or movement of landslide material can vary from abrupt collapses to slow gradual slides (a mere millimetres per year) and at rates which range from almost undetectable to extremely rapid with disastrous effects. Sudden and rapid events are the most dangerous because of a lack of warning and the speed at which material can travel down the slope as well as the force of its resulting impact. Extremely slow landslides might move only millimetres or centimetres a year and can be active over many years. Although this type of landslide is not a threat to people they can cause considerable damage to property.

Landslides can be triggered by natural causes or by human activity. Natural causes include earthquakes, volcanic activity, changes in groundwater, a disturbance or change of slope. Intense rainfall over a short period of time tends to trigger shallow, fast-moving mud and debris flows. Slow, steady rainfall over a long period of time may trigger deeper, slow-moving landslides. Different materials behave differently, too. They range from a single boulder in a rock fall or topple to tens of millions of cubic metres of material in a debris flow.

They can also vary in their extent, with some occurring very locally and impacting a very small area or hill slope while others affect much larger regional areas. The distance travelled by landslide material can also differ significantly with slides travelling from a few centimetres to many kilometres depending on the volume of material, water content and gradient of the slope.

❖ **Areas those are generally prone to landslide hazards**

- Existing on old landslides.
- On or at the base of slopes.
- In or at the base of minor drainage hollows.
- At the base or top of an old fill slope.
- At the base or top of a steep cut slope.

- Developed hillsides where leach field septic systems are used.

❖ **Areas that are typically considered safe from landslides**

- On hard, non-jointed bedrock that has not moved in the past.
- On relatively flat-lying areas away from sudden changes in slope angle.
- At the top or along the nose of ridges, set back from the tops of slopes.

❖ **The basic types of landslide movement are:**

a. Fall

This is generally characterised by a rapid to extremely rapid rate of movement with the descent of material characterised by a freefall period. Falls are commonly triggered by earthquakes or erosion processes.

b. Topple

This is characterized by the tilting of rock without collapse, or by the forward rotation of rocks about a pivot point. Topples have a rapid rate of movement and failure is generally influenced by the fracture pattern in rock. Material descends by abrupt falling, sliding, bouncing and rolling.

c. Flow

This is the most destructive and turbulent form of landslide. Flows have a high water content which causes the slope material to lose cohesion, turning it into a slurry. They are channeled by the landscape and move rapidly.

d. Slide

This is one of the most common forms of failure and can be subdivided into translational and rotational slides. Rotational slides are sometimes called slumps because they move with rotation. Translational slides have a planar, or two dimensional surface of rupture. Slides are most common when the toe of the slope is undercut. They have a moderate rate of movement and

the coherence of material is retained, moving largely intact or in broken pieces.

e. <u>Spread</u>

This phenomenon is characterized by the gradual lateral displacement of large volumes of distributed material over very gentle or flat terrain. Failure is caused by liquefaction which is the process when saturated loose sediment with little or no cohesion such as sands or silts are transformed into a liquid-like state. This process is triggered by rapid ground motion most commonly during earthquakes.

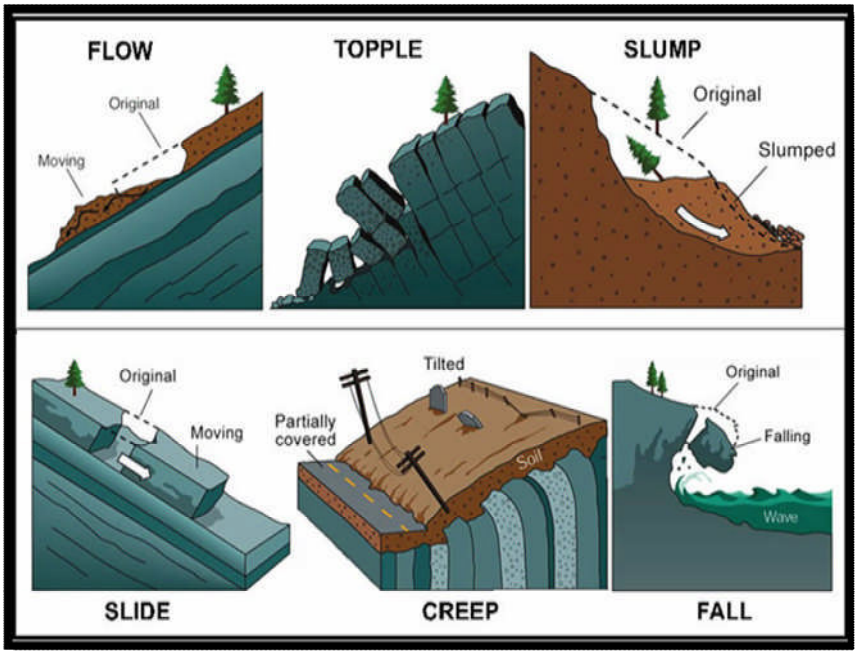


Fig: Landslide

❖ **In past years, there have been some serious and fatal landslides in India. A list of worst landslides is as follows:**

- **Guwahati landslide, Assam:** The landslide took place on September 18, 1948 due to heavy rains. Over 500 people died in the landslide and according to the reports, the landslide buried an entire village
- **Darjeeling landslide, West Bengal:** The landslide happened around October 4, 1968. The landslide was triggered by floods and the 60 km long highway was cut in 91 parts. As per reports, thousands of people died in the landslide
- **Malpa landslide, Uttarakhand:** Consecutives landslides occurred between August 11 and August 17 in 1998 in the village of

Malpa where over 380 people died as the entire village washed away in the landslide. The landslide is one of the worst landslides in India

- **Mumbai landslide, Maharashtra:** The landslide was caused in July 2000. The landslide took place in the suburbs of Mumbai due heavy rains which was followed by land erosion. As per reports around 67 people died and the local trains were also stricken
- **Amboori landslide, Kerala:** The landslide was known as the worst landslide in Kerala's history. The landslide occurred on November 9, 2001 due to heavy rains and around 40 people died in the incident
- **Kedarnath landslide, Uttarakhand:** The landslide took place on June 16, 2013 and was the result of Uttarakhand floods. Over 5700 were reported dead and over 4,200 villages had been affected by the floods and post-floods landslide
- **Malin landslide, Maharashtra:** The landslide occurred on July 30, 2014, in a village in Malin. The landslide occurred due to heavy rainfall and around 151 people died and 100 people went missing after the disaster.

8.7.1 Geographical distribution of landslide

Landslides happen everywhere and in different geological locations. Landslides are common, natural mass-wasting phenomena in mountainous areas throughout the world.

Landslide prone areas can include locations which have previous evidence of landslide activity. This evidence can be obvious from a fresh scar in the landscape. Sometimes it is difficult to identify if the slide has been covered by vegetation or property development.

Other landslide prone areas include slopes made up of low strength, sensitive, collapsible weathered or disjointed material with internal and external weaknesses. Landscapes where there has been removal of vegetation, constant seepage or erosion of slope material by ocean waves and rivers or creeks also are more prone to landslides.

Landslides often occur along planes of weakness that may parallel the hill slope. In bedrock, planes of weakness are usually beds, joints or fractures. Soils

such as silt and clay are weaker than rock and commonly has complex or multiple planes of weakness.

8.7.2 Causes and impact of landslides

❖ Causes

Landslides are part of the process of hill slope erosion and can be triggered by both natural and man-induced changes in the environment. The geologic history of an area, and activities associated with human occupation, directly determines the conditions that lead to slope failure.

The basic causes of slope instability are fairly well known such as weaknesses in the composition or structure of the rock or soil; variable, such as heavy rain, snowmelt, and changes in ground-water level; transient, such as seismic or volcanic activity; or due to new environmental conditions, such as those imposed by construction activity. Almost every landslide has multiple causes.

Slope movement occurs when forces acting down-slope (mainly due to gravity) exceed the strength of the earth materials that compose the slope. Some slopes are susceptible to landslides whereas others are more stable. Many factors contribute to the instability of slopes, but the main controlling factors are the nature of the underlying bedrock and soil, the configuration of the slope, the geometry of the slope, and ground-water conditions.

➢ Natural factors

There are a number of natural factors that can cause slope failure. Some of these, such as long-term or cyclic climate changes, are not discernible without instrumentation and/or long-term record-keeping.

I. Climate

Long-term climate changes can have a significant impact on slope stability. An overall decrease in precipitation results in a lowering of the water table, as well as a decrease in the weight of the soil mass, decreased solution of materials, and less intense freeze-thaw activity. An increase in precipitation or ground saturation will raise the level of the ground-water.

II. Erosion

Erosion by intermittent running water (gullying), streams, rivers, waves or currents, wind, and ice removes toe and lateral slope support of potential landslides.

III. Weathering

Landslides can be triggered by gradual processes such as weathering, or by external mechanisms. Weathering is the natural process of rock deterioration which produces weak, landslide-prone materials.

IV. Geological factors are weak, sensitive or weathered materials.

V. Gravity works more effectively on steeper slopes.

VI. Heavy and prolonged rainfall cause rapid rise in water level and saturation. Also elevation of pore water pressure by saturation of slope material from either intense or prolonged rainfall and seepage causes landslides.

VII. Earthquakes – plate tectonic moves the soil that covers it also moves vibrations caused by earthquakes also moves soil

VIII. Forest fire – causes erosion and induce floods and landslides

IX. Volcanoes – kill vegetation over extensive area and spreads volcanic rocks, subsequent rainy season will trigger landslides.

X. Waves – can erode the beach or the toe of a bluff, cutting into slope

- **<u>External mechanisms include:</u>**

a. Undercutting of a slope by stream erosion, wave action, glaciers, or human activity such as road building,
b. Intense or prolonged rainfall, rapid snowmelt, or sharp fluctuations in ground-water levels,
c. Shocks or vibrations caused by earthquakes or construction activity,
d. Loading on upper slopes, or
e. A combination of these and other factors.

- **Three distinct physical events occur during a landslide**:

I. the initial slope failure,
II. the subsequent transport, and
III. the final deposition of the slide materials.

Once a landslide is triggered, material is transported by various mechanisms including sliding, flowing and falling.

❖ **Effects of human activity**

Slope failures can be triggered by construction activity that undercuts or overloads dangerous slopes. So it may be said that landslides result directly or indirectly from the activities of people.

Poorly planned forest clearing may increase rates of surface water run-off or ground-water infiltration. Inefficient irrigation increase ground-water pressures, which in turn reduces the stability of rock and sediment.

People increase the risk of landslides by modifying the landscape, for example, by building on unstable slopes or in the path of potential landslides. Unfortunately, many people are unaware of their exposure to landslide risks.

❖ **Impact of landslide**

Landslides are a major catastrophe the world as it has widespread and significant impact. The effects of catastrophic landslides are dangerous to humans and to other living things.

1. **Landslides affect the following elements of the environment:**

a. the topography of the earth's surface;
b. the character and quality of rivers and streams and groundwater flow;
c. the forests that cover much of the earth's surface; and
d. the habitats of natural wildlife that exist on the earth's surface, including its rivers, lakes, and oceans.

Blocking of natural flow by landslides:

Large amounts of earth and organic materials enter streams as sediment as a result of this landslide and erosion activity, thus reducing the potability of the water and quality of habitat for fish and wildlife.

Landslides lead to impoundment of water and a consequent rising of the water level leading to bankfull conditions. It the natural dam bursts, it causes disastrous floods downstream. This normally happens in the Himalayan region and this is what happened with the Bhagirathi River in 1978 when a landslide caused a dam formation. The bursting of this dam, 14 hours later, caused widespread havoc up to Uttarkashi and wiped out the hamlets of Gangnani and Dabrani on the pilgrim route to Gangotri.

Biotic destruction

Biotic destruction by landslides is also common; widespread stripping of forest cover by mass movements has been noted in many parts of the world. Removal of forest cover impacts wildlife habitat.

Ecological role

The ecological role that landslides play is often overlooked. Landslides contribute to aquatic and terrestrial biodiversity. Debris flows and other mass movement play an important role in supplying sediment and coarse woody debris to maintain pool/riffle habitat in streams.

2. Social effects

Landslides cause property damage, injury and death and adversely affect a variety of resources. For example, water supplies, fisheries, sewage disposal systems, forests, dams and roadways can be affected for years after a slide event.

I. Economic Decline

Landslides cause damage to property. This brings losses to the economy of a country. Hence economic rehabilitation is needed in the area that has experienced a landslide.

The negative economic effects of landslides include the cost to repair structures, loss of property value, disruption of transportation routes, medical costs in the event of injury, and indirect costs such as lost timber and lost fish stocks. Water availability, quantity and quality can be affected by landslides. Geotechnical studies and engineering projects to assess and stabilize potentially dangerous sites can be costly.

II. Landslide losses

a. Large, infrequent landslides contribute less to personal and property losses than do the smaller, more frequent slides and debris torrents in populated areas. Landslides can lead to damage to property resulting from

b. Land massive collapse can cause the destruction of a city.

c. Damages to roads may affect communication system

III. Loss of Life

The force flow or mud. Infrastructure land such as buildings, roads, places of leisure and so on can be destroyed by the landslide occurred. For example:

Destruction of a building and placement. Loss of life is a dangerous effect.

8.7.3 Forecasting, warning & monitoring

a. Forecasting

Landslide forecast at regional and local scale is important not only for scientist from different fields of research (engineering geology, geomorphology, civil engineering, etc.) but also for policy makers and local authorities in order to assess the remedial measures and disaster mitigation.

1. Use of rain gauges

Currently equipment to measure landslides includes **rain gauges**, such as those used in the Chittagong region of Bangladesh, which record levels of rainfall that can then be compared to previous data of levels that triggered a landslide.

2. Use of point-based sensors

But many current systems use **point-based sensors**, in other words systems that rely on ground plugged devices that are able to monitor only from fixed positions.

3. Use of optical fibres

A new way of measuring to predict landslides is the **use of optical fibres** in cables as sensors. They have the ability to detect a change of one centimetre over a distance of a kilometer. Being able to measure and track early pre-failure soil movements, it is then possible to detect the signs of an imminent landslide. When installed, these sensors can permanently monitor changes happening to the land. The system, called Stimulated Brillouin Scattering, uses the interaction of light with acoustic waves. Unlike these conventional tools, optical fibres make measurements along the whole sensing cable which allows for a fully distributed measurement of land deformation.

The advantage is the continuous monitoring of large areas with high accuracy. They can also be used in difficult-to-access places, for example underneath bridges, outside the walls of tunnels, near dams and along pipelines and railways in remote rural areas.

4. ELDEWAS early warning system.

ELDEWAS stands for “Early Landslide Detection and Warning System”. This system makes use of regularly updated weather conditions and forecasts, coupling these to regional information on elevation profiles, slopes and land use, allowing it to issue an early warning in case of danger.

5. Seismic ripples

Researchers said that the seismic ripples reveal new information about how landslides work,.

6. GIS

GIS offers a superior method for landslide analysis because it allows one to capture, store, manipulate, analyze, and display large amounts of data quickly and effectively. Using GIS, extremely detailed maps can be generated to show past events and likely

future events which have the potential to save lives, property, and money.

b. Warning

A village-level early warning system based on rainfall threshold data and landslide records could be the most viable method for landslide risk management in the Western Ghats, according to a scientific paper presented at a workshop organised by the National Centre for Earth Science Studies.

Geologists opine that forecasting of the trigger, in some cases the rainfall, could provide information on when landsliding would occur. This, in conjunction with landslide susceptibility maps, could be used to delineate potentially hazardous areas in the Western Ghats and provide early warning.

c. Monitoring

Monitoring is essential to predicting the behaviour of landslides and forecasting which storms can trigger large numbers of landslides. Scientists in the USGS Landslide Hazards Program monitor selected landslides and hillsides in order to learn more about the physical processes that trigger landslides or control their movement.

8.7.4 Preparedness and Response

Landslides happen quickly and with little notice and can travel several miles from their source, growing in size and picking up trees, cars, boulders, and other objects and materials.

❖ **Emergency Preparedness Landslides**

➢ We must observe the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before.
- New cracks or unusual bulges in the ground, street pavements or sidewalks.
- Soil moving away from foundations.
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house.

- Tilting or cracking of concrete floors and foundations.
- Broken water lines and other underground utilities.
- Leaning telephone poles, trees, retaining walls or fences.
- Offset fence lines.
- Sunken or down-dropped road beds.
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content).
- Sudden decrease in creek water levels though rain is still falling or just recently stopped.
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb.
- A faint rumbling sound that increases in volume is noticeable as the landslide nears.
- Unusual sounds, such as trees cracking or boulders knocking together, might indicate moving debris.

❖ **Measure to be taken before a landslide**

- No constructions near steep slopes, close to mountain edges, near drainage ways, or natural erosion valleys.
- Contact local officials, state geological surveys or departments of natural resources, and university departments of geology and for information on landslides in your area.
- Note the places where runoff water converges, increasing flow in channels.
- Learn about the emergency-response and evacuation plans for your area.
- To minimize home hazards installation of flexible pipe fittings must be done so that gas or water leaks may be avoided.

❖ **Measure to be taken during a landslide**

- We should stay alert and awake.
- Must leave, if possible, the areas susceptible to landslides and debris flows.

- Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger landslides.
- Be alert for any sudden increase or decrease in water flow of a stream and for a change from clear to muddy water. Such changes may indicate landslide activity upstream.
- Be aware that strong shaking from earthquakes can induce or intensify the effects of landslides.

❖ **Measure to be taken if you suspect imminent landslide danger**

- Contact local fire, police, or public works department. Local officials are the best persons able to assess potential danger.
- Inform affected neighbours.
- Evacuate.
- Curl into a tight ball and protect your head if escape is not possible.

❖ **Measure to be taken after a landslide**

- Stay away from the slide area. There may be danger of additional slides.
- Listen to local radio or television stations for the latest emergency information.
- Watch for flooding. Floods sometimes follow landslides and debris flows because they may both be started by the same event.
- Check for injured and trapped persons near the slide. Direct rescuers to their locations.
- Help a neighbour who may require special assistance - infants, elderly people, and people with disabilities.
- Check the building foundation
- Replant damaged ground as soon as possible since erosion caused by loss of ground cover can lead to flash flooding and additional landslides in the near future.

- Seek advice from a geotechnical expert for evaluating landslide hazards or designing corrective techniques to reduce landslide risk who will be able to advise you of the best ways to prevent or reduce landslide risk, without creating further hazard.

8.7.5 Mitigation - case studies

❖ **National Landslide Risk Mitigation Project:**

This project aims to strengthen the structural and non-structural landslide mitigation efforts to reduce the landslide risk and vulnerability in hilly districts prone to landslides and mud flows.

❖ **Landslide Hazard Mitigation**

A National Core Group has been constituted under the Chairmanship of Secretary, Border Management and comprising of Secretary, Department of Science and Technology, Secretary, Road Transport & Highways, and the Heads of Geological Survey of India and National Remote Sensing Agency for drawing up a strategy and plan of action for mitigating the impact of landslides, provide advice and guidance to the State Governments on various aspects of landslide mitigation, monitor the activities relating to landslide mitigation including landslide hazard zonation and to evolve early warning systems and protocols for landslides/landslide risk reduction.

The States/UTs have been requested to share the list of habitation close to landslide prone areas in order to supplement GSI's ongoing assessment of such areas based on the Survey of India's Toposheet and their existing data base on landslide for the purpose of landslide hazard zonation being carried out by them. A national strategy for mitigating landslide hazard in the country is being drawn up in consultation with all the agencies concerned.

Case study

❖ **Kedarnath landslide, Uttarakhand:**

The landslide took place on June 16, 2013 and was the result of Uttarakhand floods. Over 5700 were reported dead and over 4,200 villages had been affected by the floods and post-floods landslide. Two Northern Indian states-**Uttarakhand** and **Himachal Pradesh**, and their adjoining areas have experienced heavy rainfall that triggered devastating floods and landslides.

From 14 to 17 June 2013 Uttarakhand received heavy rainfall, which was about 375 percent more than the benchmark rainfall during a normal monsoon. This caused heavy floods in

Uttarakhand, Himachal Pradesh and Western Nepal, and acute rainfall in other nearby regions of Delhi, Haryana, and Uttar Pradesh and some parts of Tibet. In the city of Dehra Dun, capital of Uttarakhand, this was the wettest June day for over five decades. Heavy rainfall for four consecutive days as well as melting snow aggravated the floods. Warnings by the India Meteorological Department predicting heavy rains were not given wide publicity beforehand, causing thousands of people to be caught unaware, resulting in huge loss of life and property.

The heavy rains resulted in large flash floods and massive landslides. Entire villages and settlements such as Kedarnath were affected. Over 70,000 people were stuck in various regions because of damaged or blocked roads. Although the Kedarnath Temple itself had not been damaged, its base was inundated with water, mud and boulders from the landslide, damaging its perimeter. Many hotels around the temple were destroyed, resulting in several casualties.

The Army, Air Force, Navy, Indo-Tibetan Border Police, Border Security Force, National Disaster Response Force, Public Works Department and local administrations worked together for quick rescue operations. Several thousand soldiers were deployed for the rescue missions. Activists of political and social organizations are also involved in the rescue and management of relief centres. Helicopters were used to rescue people, but due to the rough terrain, heavy fog and rainfall, manoeuvering them was a challenge. Ministers from all over the country are chipping in with aid; money is flooding the Uttarakhand Disaster Management and Mitigation Centre. On June 25, an IAF rescue chopper crashed. Eight of those on-board were fatally injured.

The Indian Red Cross responded to the Uttarakhand disaster by mobilising the National disaster response team (NDRT), Regional disaster response team (RDRT) and National disaster watsan response team (NDWRT) members who were alerted for possible deployment. The National headquarters dispatched a two member team to Uttarakhand on the 19th June 2013 for carrying out assessment of the needs of the community in coordination with the officials of the Uttarakhand state Red Cross branch and to follow it with the organisation of relief work.

Relief materials in the form of 1050 Family tents (to accommodate upto 8 persons each), family packs (including kitchen sets, clothing, buckets etc.), stoves, lanterns and tarpaulins etc. worth INR 2,21,99,300 had been dispatched to Uttarakhand.

A Red Cross camp had been set up near Visas bhawan in Joshiyara, Uttarkashi. Red Cross life members gave first aid, navigation assistance, medicines, etc to people.

8.8 SUMMARY:

We already know that natural event such as a flood, drought, earthquake, landslide or cyclone causes great damage or loss of life. India is one of the most disaster-prone countries in the world because of its locational and geographical features.

As India has a long coast line of 8,000 kms. it experiences about five to six tropical cyclones on an average, which form in the Bay of Bengal and Arabian Sea every year.

India has the lofty Himalayan mountain ranges in the north. These are considered to be the world's youngest fold mountain ranges. The subterranean Himalayas are, therefore, geologically very active and are earthquake prone zone.

Moreover, the Himalayan, the north-east hill ranges and the Western Ghats experience considerable landslide activities of varying intensities.

To combat all these natural disasters long term planning and preparedness are considered as a part of the process of development planning in India. A number of special programmes are in operation over many years for mitigating the impact of natural disasters. Among other disaster monitoring systems GIS is considered as the best method to analyse cyclones because it could be used as a tool for developing a spatially enabled system.

8.9 CHECK YOUR PROGRESS/ EXERCISE

1. True false

a. Landslides cause property damage, injury and death and adversely affect a variety of resources.

b. Areas existing on old landslides are generally prone to landslide.

c. As hospital preparedness is not at all crucial to any disaster response system each hospital should not have an emergency preparedness plan to deal with mass casualty incidents.

d. No casualties during earthquakes are caused by the collapse of structures.

e. There are Bureau of Indian Standard (BIS) codes which are relevant for multi-hazard resistant design and construction.

2. Fill in the blanks

a. Every tremor produces different types of seismic waves and P waves travel much faster than the _____ waves.

b. _____ are usually caused when underground rock suddenly breaks along a fault.

c. When earthquake occurs in the sea bed, the sea waves rise in the sea dispensing large volumes of water, it is _____.

d. In earthquake monitoring _____ scales measure the amount of shaking at a particular location.

e. _____ is the most destructive and turbulent form of landslide.

3. Multiple choice question

a. There are four stages that form a cyclone which include:

i. Formative Stage, Immature Cyclone, Mature Cyclone, Decay stage

ii. Formative Stage, , Mature Cyclone, Decay stage, Immature Cyclone

iii. Immature Cyclone. Decay stage, Formative Stage, , Mature Cyclone

b. Orissa was battered by a Super Cyclonic Storm on 29 October, 1999

i. that made landfall near Digha.

ii. that made landfall near Bhubaneswar.

iii. that made landfall near Paradip.

c. An earthquake is the result of a sudden release of energy in the Earth's crust

i. that creates cyclones

ii. that creates heavy rainfall

iii. that creates seismic waves.

d. Earthquake intensity is measured with the help of seismometers known as

i. Richter scale

ii. Barometer

iii. Anemometer

e. Collapsed structures are a common result of
i. Earthquakes
ii. Flood
iii. drought

f. Areas that are typically considered safe from landslides
i. On soft, jointed bedrock that has moved in the past.
ii. On hard, non-jointed bedrock that has moved recently.
iii. On hard, non-jointed bedrock that has not moved in the past.

4. Answers the following Questions

1. What is Cyclone?
2. Define Earthquakes?
3. Define Landslides?
4. How earthquake is caused? What are its impacts?
5. What are the impacts of cyclone? Explain your answer with an example.
6. What are the Preparedness and Response of earthquake?
7. What are the Preparedness and Response of cyclone?
8. What are the Preparedness and Response of landslide?
9. What do you understand by forecasting earthquake?
10. Stat the Geographical distribution of earthquake, cyclone and landslide.

8.10 ANSWERS TO THE SELF LEARNING QUESTIONS.

1.a.true
1.b.true
1.c.false, hospital preparedness is crucial, should have an emergency preparedness plan
1.d. false, Most casualties
1.e. true

2.a. S
2.b. Earthquakes
2.c. Tsunami
2.d. Intensity
2.e. Flow

3.a.i.
3.b.ii
3.c.iii.
3.d.i.
3.e.i.
3.f..iii

8.11 TECHNICAL WORDS:

1. **Fault plane**- the flat surface of rock along which a geological fault occurs.
2. **Elastic-rebound theory** -explains how energy is spread during earthquakes.
3. **Rain gauge-**an instrument for measuring rainfall
4. **Aftershock**-a smaller earthquake following the main shock of a large earthquake
5. **Earthquake swarms** – these are sequences of earthquakes striking in a specific area within a short period of time
6. **Fault-** It is a crack in the Earth's crust resulting from the displacement of one side with respect to the other
7. **Optical fibre**-a thin flexible fibre with a glass core through which light signals can be sent with very little loss of strength
8. **Landslide**-a collapse and rapid downward movement of a mass of earth or rock from a mountain or cliff
9. **Geographic information system (GIS)** –it is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.
10. **Storm Surge**-a rising of the sea as a result of wind and atmospheric pressure changes associated with a storm

8.12 TASK

1. In a map of India point out the earthquake prone zones.
2. In a map of India point out Kedarnath, Uttarakhand.
3. In a chart describe National Landslide Risk Mitigation Project.

8.13 REFERENCES FOR FURTHER STUDY

1. Ministry of Home Affairs, Govt. of India, Disaster Management in India
2. Module 4 - Capacity Building in Asia using Information Technology Applications (CASITA)
3. India Country Report 1999- By Anil Sinha, Additional Central Relief Commissioner & Joint Secretary, Natural Disaster Management Division Ministry of Agriculture, Government of India
4. Asian Disaster Preparedness Center (ADPC), Bangkok.
5. Encyclopedia of Disaster Management: Volume IV by Alfred Scott
6. Disaster Management: Future Challenges and Opportunities by Jagbir Singh
7. Disaster Management by Harsh K. Gupta
8. Oxford dictionary

9

MAN-MADE DISASTER: FOREST FIRE, TERRORISM

After going through this chapter you will be able to understand the following features:

9.1 Objectives

9.2 Introduction

9.3 Subject discussion

9.4 Man-made disaster

9.5 Distinction from Natural disaster,

9.6 Causes of man-made disasters,

9.7 Basic facts of man-made disaster,

9.8 Need and scope for improving disaster management systems,

9.9 Types of man-made disasters,

9.10 Response to man-made disasters,

9.11 Specific risk reduction and preparedness measures,

9.12 Typical post-disaster needs

9.13 case studies

9.14 Forest Fire

i. with reference to Nature ,
ii. Geographical distribution ,
iii. Causes and impact ,
iv. Response to man-made disasters,
v. specific risk reduction and preparedness measures,
vi. typical post-disaster needs,
vii. case studies

9.15 Terrorism

i. with reference to Nature ,
ii. Geographical distribution ,
iii. Causes and impact ,

iv. Response to man-made disasters,
v. specific risk reduction and preparedness measures,
vi. typical post-disaster needs,
vii. case studies

9.1. OBJECTIVES

By the end of this unit you will be able to –

- Define Man-made disaster
- Learn the distinction between man-made disaster and natural disaster
- Understand causes of man-made disasters
- Discuss basic facts of man-made disaster
- Understand the need and scope for improving disaster management systems
- Discuss types of man-made disasters
- Learn response to man-made disasters
- Understand specific risk reduction and preparedness measures
- Define typical post-disaster needs
- Discuss case studies
- Define Forest Fire with reference to nature , geographical distribution , causes and impact, response to man-made disasters, specific risk reduction and preparedness measures, typical post-disaster needs, case studies
- Learn Terrorism with reference to nature, geographical distribution, causes and impact, response to man-made disasters, specific risk reduction and preparedness measures, typical post-disaster needs, case studies

9.2. INTRODUCTION

In the previous chapters we have studied about natural disasters and disaster management. We have discussed about natural disasters like flood, drought, cyclones, landslides, earthquakes; its causes and impact. Different case studies regarding these natural disasters in India have also been done. In the present chapter we are going to learn and define Man-made disasters and how is it different from natural disasters. The contrast between the two will help us to understand the causes of man-made disasters, basic facts of the same and the need and scope for improving disaster management systems. There are a variety of man-made disasters among which we are aiming to study Forest Fire and Terrorism with reference to nature, causes and impact, response to man-made disasters, specific risk reduction and preparedness measures, typical post-disaster needs, case studies.

9.3. SUBJECT-DISCUSSION

The United Nations defines a disaster as a serious disruption of the functioning of a community or a society. To lessen the impact of disasters around the world disaster management, with its various tools, plays a pivotal role. The interior as well as the exterior of the earth is in a mode of constant change. Some of these changes become very devastating in their after effects and are often recognized as environmental disasters. But not all environmental disasters are the result of natural change. Human error, carelessness has significant part in disasters termed as man-made. A debate continues on the topic of natural disasters and on the role of human in the same. Manmade disasters can be both intentional and unintentional. History of mankind is loaded with both natural and man-made disasters. Hence people of the world have always faced both types of disasters. Man-made disasters play havoc on human in modern times.

Forests fires, most common hazard in forests, are as old as the forests themselves. The Man made causes behind forest fire may be attributed to naked flame, cigarette or bidi, electric spark or any source of ignition that comes into contact with inflammable material. They create a very serious threat not only to the forest wealth but also to the entire regime to fauna and flora. The bio-diversity and the ecology and environment of a region also get disturbed.

Terrorism is not a new phenomenon and there is no universal agreement regarding the definition of terrorism. Terrorism is defined as the illegitimate use or threat of violence to further political objectives. It threatens the public with widespread death

and disease, fear, panic, and disruption to society – both psychologically and economically.

9.4 MAN-MADE DISASTER

Events which are caused by man either intentionally or by accident are know**n as Man-made Disasters.** Some of the examples are wars, civil wars, terrorism, errors in designing, nuclear disasters, industrial disasters etc. As their occurrence is unpredictable, man-made disasters pose a challenging and severe threat to public health and /or well-being which must be dealt with thorough vigilance and proper preparedness and response. Information on the major sources of man-made disasters helps to educate the public about their cause and effects so that emergency planning relating to these disasters become easier. With the advent of time as mankind has developed and become technologically advanced, frequency and magnitude of man-made disasters has increased in the same proportion. Man-made disasters are the results of industrial and material progress. Accidents happen due to negligence on the part of man. The Bhopal Gas tragedy is a result of an accident which played havoc on the local residence.

9.5 DISTINCTION FROM NATURAL DISASTER

On the other hand the term "**natural disasters**", as their names indicate refers to those disasters that are triggered by natural phenomena such as earthquakes, landslides, epidemics, and wildfires etc. and result in colossal loss of property and lives since time immemorial. A natural activity is not termed as a natural disaster until it has impact on human. For example, a volcano eruption at an uninhibited place is a natural event but not a natural disaster.

Natural disasters may be aggravated due to unpreparedness on the part of man. A natural disaster has a bigger impact when man is not prepared for it. For example, earthquake which cannot be predicted beforehand may engulf a large number of people at night while they are sleeping in their homes. While a hurricane or a tornado when predicted gives opportunity for preparation to face it.
The difference between natural and man-made disasters is that man-made disasters occur as a result of human action, while natural disaster occurs due to forces of nature. Man cannot avert them while man-made disasters are avoidable. They may be averted if man works efficiently and carefully. On the other hand we have no control over a natural disaster.

Man-made hazards or disasters are sometimes referred to as anthropogenic. Man-made disasters can be divided into different

categories. As with natural hazards, man-made hazards are events that have not happened, for instance terrorism.

Natural disasters are disasters that take place regardless of human action, but human action can increase the likelihood and impact of natural disasters, and nature can influence the likelihood and impact of human-made disasters.

In case of many minor natural disasters, direct involvement of man is observed in their occurrence**.** Furthermore, man-made disasters that are avoidable are more tragic in the sense that innocent lives lost in these disasters could have been saved.
One point may be noted that some natural disaster is indirectly the result of man's activities. For example draught may be the cause of cutting of forests. Thus, the number of man-made disasters is greater than natural disaster.

Man-made disasters are examples of specific cases where man-made hazards have become reality in an event. The rising population has resulted in high fuel consumption and reduction of natural resources. Over population also affects our social environment. Another type of disaster that falls in this category is nuclear bomb.

9.6 CAUSES OF MAN-MADE DISASTERS

Train accidents, aeroplane crashes, collapse of buildings, bridges, mines, tunnels, etc. are some of the common examples of man-made disasters. These happen as a result of human carelessness or mishandling of dangerous equipment's during technological and industrial use. The disasters are in the form of accidents, which occur all of a sudden and take a huge toll on life and property. Mostly such disasters cause injuries, diseases and casualties where they occur.

Human-instigated disasters are the consequence of technological hazards. Hazardous materials emergencies include chemical spills and groundwater contamination. Workplace fires are more common and can cause significant property damage and loss of life. Communities are also vulnerable to threats posed by extremist groups who use violence against both people and property.

High-risk targets include military and civilian government facilities, international airports, large cities and high-profile landmarks. Cyber-terrorism involves attacks against computers and networks done to intimidate or coerce a government or its people for political or social objectives.

9.7 BASIC FACTS OF MAN-MADE DISASTER

A series of man-made disasters have caused us to think over rampant development and exploitation of Earth's resources. Major man-made catastrophes in 2015 included maritime, aviation and rail disasters, fires and explosions, and terrorism and social unrest. These disasters are only a grim reminder that Earth cannot take more of human waste. Man should control his activities at present so that our coming generation in years does not suffer. Most of our industries still violate environmental laws and protocols and that should be checked. Our children need to be taught about sustainability and environment protection. There are several impacts of man-made disasters on the environment.

Leakage of toxic chemicals from the industries and accidents in the nuclear reactors has short-term and long-term effects on the environment and human health. Short-term effects on human health relate to casualties and diseases like blindness, cancer, paralysis, heart trouble, gastric and respiratory abnormalities. Long-term effects include genetic imbalances in humans and its impact on the future generations. Soil and water sources also remain polluted for long durations of time.

These are the net result of inadequately managed man-made hazards and they typically cost the most in terms of human suffering, loss of life and long-term damage to a country's economy and productive capacity.

9.7.1 A few basic facts of man-made disasters are as follows:

A series of explosions on August 12, 2015, in the Chinese port city of Tianjin killed 173 people and caused between $2.5 and $3.5 billion in insured losses, according to Swiss Re. It was the largest insured-loss event of the year and largest man-made loss event ever in Asia.

In 2015, 353 catastrophic events occurred, 198 natural catastrophes and 155 man-made disasters, according to Swiss Re. Natural catastrophes caused $28 billion in insured losses in 2015, while man-made disasters resulted in additional losses of about $9 billion.

The September 11 terrorist attack in the U.S. was the costliest man-made disaster in history, based on Swiss Re data. It caused $25.1 billion in insured losses (in 2015 dollars).

In the Bhopal Gas Tragedy over 500,000 people are exposed to Methyl Isocyanate gas and other chemicals.

Government records confirm a total of 3,787 deaths. Many other thousands were temporary or permanently injured in the backwash. Maharashtra witnessed its worst drought in 2013 in past 40 years. The rainfall analysis of 2012 to 1972 for the month of June to October reveals that 17 districts that were mentioned as drought affected regions were hit very badly. Indeed rainfall had been one of the contributors of drought. But the major contributory remained bad management of existing water resources, lack of proper policy of water distribution and more distribution of water to industries than to fields. Millions of people were affected as 64 out of 355 were affected by the calamity. People were rendered jobless as their crops were destroyed and their cattle died hungry. It was a total mishap of government policies and environment impact.

The example of Deep Water Horizon (BP) Explosion in the Gulf of Mexico in 2010 may be taken into consideration where not only did 11 men lose their lives, but the ecosystem in that area was devastated. Years later, the damage still exists and people are still suffering. Initially, it was told that only a few thousand barrels of oil were seeping out of the well each day, but in fact there were perhaps hundreds of thousands of barrels of oil gushing into the waters off of Mexico.

9.8 NEED AND SCOPE FOR IMPROVING DISASTER MANAGEMENT SYSTEMS

"Disaster management" can be defined as the range of activities designed to maintain control over disaster and emergency situations and to provide a framework for helping at-risk persons to avoid or recover from the impact of the disaster. Disaster management deals with situations that occur prior to, during, and after the disaster.

9.8.1 Need for Disaster management are as follows:

1. To avert a disaster: -

Disaster management teams can help to avert a disaster before it occurs by examining the possible causes of disaster. They may take appropriate measures to avert a disaster. For instance, forest fires, or even terrorists bombings can be averted through effective planning and pre-emptive action.

2. To undertake rescue operations: -

Trained disaster management personnel can undertake rescue operations effectively during floods, major fires, building collapses, and some manmade disasters.

3. To provide relief measures:

Disaster management team bears the responsibility to provide relief measures to the victims by making arrangement for food, clothing, and relief camps, medicines and so on. Such measures would reduce the misery of the disaster victims.

4. To undertake rehabilitation programmes:

Disaster management team can work effectively to undertake rehabilitation programmes in the affected areas. For instance, in the earthquake affected areas, construction of dwellings, schools and other infrastructure come under rehabilitation programmes.

5. To undertake liaison work:

The disaster management team undertakes liaison work relating to the disaster. The liaison work is required with various agencies-private and government (including hospitals) in order to obtain funds and donations, and other resources or services so as to manage and overcome the disaster.

6. To reduce trauma and tension: -

The Disaster management team can help to reduce the trauma and tension before and after the disaster. For instance, before a disaster, the team can properly guide the people to face or handle the disaster such as floods. Also, after the disaster, the team can provide not only material or financial support, but also psychological support to overcome the traumatic effect of disaster.

7. To protect the Environment: -

Disaster management team can help to protect and preserve the environment. For example, a disaster management team can plan pre-emptive action to avert forest fires. Etc.

8. To minimize losses: -

Disaster management teams can help to minimize loss of life and property. This is because; the Disaster management team can take pre-emptive actions to avert a disaster.

Generally people tend to think of disaster management only in terms of the post-disaster actions taken by relief and reconstruction officials. But the term "disaster management" encompasses the complete realm of disaster-related activities. It covers a much broader **scope** as to modern disaster managers involvement in pre-disaster activities is more than in post-disaster response. This is because many persons who work in the development field, or who plan routine economic, urban, regional or agricultural development projects, have disaster management responsibilities. For example, housing specialists planning a low-

income housing project in a disaster-prone area have the opportunity (and an obligation) to mitigate the impact of a future disaster if the houses incorporate disaster resistant construction technologies. In the same manner, agricultural development projects must be planned in such a way that they help stem environmental degradation and thus lower the farmer's vulnerability to losses from droughts, floods, cyclones, or other natural hazards. In fact, in dealing with natural hazards, the vast majority of disaster management activities are related to development projects; only a small portion are related to emergency response. Of course, disaster management also encompasses the field of emergency assistance and long-term maintenance for refugees and displaced persons. The refugee field of disaster management is highly specialized and requires not only many development skills but also a broader awareness of political, legal, and humanitarian issues.

4.8.2 The **objectives** of disaster management are:

a. to reduce or avoid the human, physical, and economic losses suffered by individuals, by the society, and by the country at large
b. to reduce personal suffering
c. to speed recovery.

9.9 TYPES OF MAN-MADE DISASTERS

4.9.1 Man-made disasters are mainly of two types:

a. **Local disasters** which are small-scale disasters such as train accidents, plane crashes and shipwrecks.

b. The other one is **Industrial and technological disasters**. These are much larger in scale and are the result of technology failures or industrial accidents. Such disasters affect both local population and may even cover a much larger area. Industrial disasters result due to accidental leakage of water or air pollutants. Many of the chemicals are extremely toxic and carcinogenic which affect the human population in an adverse way. Some people die instantly while others are crippled for whole life in the form of blindness, paralysis and many other chronic diseases.

9.9.2 Man-made disasters are those hazards caused directly or indirectly by human action or inaction.

❖ **They are as follows:**

1. **Sociological hazards**
   a. Crime
   b. Civil disorder
   c. Terrorism
   d. War

2. **Technological hazards**
   a. Industrial hazards
   b. Structural collapse
   c. Power outage
   d. Fire
   e. Hazardous materials
   f. Transportation

3. **Costs hazards**

1. <u>Sociological hazards</u>

a. **Crime**

Crime is an action or omission which constitutes an offence and is punishable by law. Punishments can range from the payment of a fine to incarceration in jail. Individual human societies may each define crime differently. While every crime violates the law, not every violation of the law counts as a crime; for example: breaches of contract and of other private law may rank as "offenses" or as "infractions". Modern societies generally regard crimes as offenses against the public or the state, distinguished from torts (offenses against private parties that can give rise to a civil cause of action). In context, not all crimes provide man-made hazards.

James Robert Scott, currently serving a sentence of 20 years to life in a Missouri prison, was convicted of causing a massive flood of the Mississippi River at West Quincy, Missouri as part of the Great Flood of 1993.This flood inundated 14,000 acres on the Missouri side of the river.

a. Civil disorder

Civil disorder is a broad term. It is also known as civil unrest. It is typically used by law enforcement to describe unrest that is caused by a group of people. Although civil disorder does not necessarily escalate to a disaster in all cases, the event may escalate into general chaos. Rioting has many causes, from antipathy over low minimum wages to racial segregation. Examples

of well-known civil disorders and riots are the Poll Tax Riots in the United Kingdom in 1990; the 1992 Los Angeles riots in which 53 people died; the 2008 Greek riots after a 15-year-old boy was fatally shot by police; and the 2010 Thai political protests in Bangkok during which 91 people died.

b. Terrorism

Terrorism is the unofficial or unauthorized use of violence and intimidation in the pursuit of political aims. This controversial term has varied definitions. One definition means a violent action targeting civilians exclusively. Another definition is the use or threatened use of violence for the purpose of creating fear in order to achieve a political, religious, or ideological goal.

The Federal Bureau of Investigation (FBI) defines terrorism as "the unlawful use of force against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in the furtherance of political or social objectives."

- **Terrorists use a variety of methods to achieve their ends:**

i. Biological - Biological weapons are of two types, one is replicating (infectious) agents, while the other is non-replicating (non-infecting or intoxicating) agents. Replicating agents are pathogenic bacteria, viruses or fungus. Non-replicating agents are produced from replicating agents, other living organisms and plants and are called "toxins".

ii. Nuclear-There are two fundamentally different threats in the area of nuclear terrorism. One is the use, threatened use or threatened detonation of a nuclear bomb. The other is the detonation, or threatened detonation, of a conventional explosive incorporating nuclear materials – radiological dispersal devices, also called RDD.

iii. Incendiary-An incendiary device is any mechanical, electrical or chemical device used intentionally to initiate combustion and start a fire.

iv. Chemical-Chemical weapons are defined as compounds that, through their chemicals properties, produce lethal or damaging effects in man, animal, plants or materials.

v. Explosive- The United States Department of Transportation (DOT) defines an explosive as a substance fitting into one of two categories: Any substance or article, including a device, designed to function by explosion (e.g., an extremely rapid release of gas and heat), or Any substance or article, including a device, which by chemical reaction within itself, can function in a similar manner even if not designed to function by

explosion, unless the substance or article is otherwise classified.

c. War

War is conflict between relatively large groups of people, which involves physical force inflicted by the use of weapons. Warfare has destroyed entire cultures, countries, economies and inflicted great suffering on humanity. Other terms for war can include armed conflict, hostilities, and police action. Acts of war are normally excluded from insurance contracts and disaster planning.

2. Technological hazards

a. Industrial hazards

Industrial disasters occur in a commercial context, such as mining accidents. They often have an environmental impact. The Bhopal disaster is the world's worst industrial disaster to date, and the Chernobyl disaster is regarded the worst nuclear accident in history. Hazards may have longer-term and more dispersed effects, such as dioxin and DDT poisoning.

b. Structural collapse

Main cause of structural collapses is by engineering failures. Bridge failures may be caused in several ways, such as under-design (as in the Tay Bridge disaster), by corrosion attack (such as in the Silver Bridge collapse), or by aerodynamic flutter of the deck (as in Galloping Gertie, the original Tacoma Narrows Bridge). Failure of dams was not infrequent during the Victorian era, such as the Dale Dyke dam failure in Sheffield, England in the 1860s, causing the Great Sheffield Flood. Other failures include balcony collapses or building collapses such as that of the World Trade Center.

c. Power outage

A power outage is an interruption of normal sources of electrical power. Short-term power outages (up to a few hours) are common and have minor adverse effect, since most businesses and health facilities are prepared to deal with them. Extended power outages, however, can disrupt personal and business activities as well as medical and rescue services, leading to business losses and medical emergencies. Extended loss of power can lead to civil disorder, as in the New York City blackout of 1977. Recent notable power outages include the 2005 Java–Bali Blackout which affected 100 million people and the 2009 Brazil and Paraguay blackout which affected 60 million people.

d. Fire

Casualties resulting from fires, regardless of their source or initial cause, can be aggravated by inadequate emergency

preparedness. Such hazards as a lack of accessible emergency exits, poorly marked escape routes, or improperly maintained fire extinguishers or sprinkler systems may result in many more deaths and injuries than might occur with such protections.

e. Hazardous materials

i. Radiation contamination

When nuclear weapons are detonated or nuclear containment systems are otherwise compromised, airborne radioactive particles can scatter and irradiate large areas. Not only is it deadly, but it also has a long-term effect on the next generation for those who are contaminated

During World War II, United States troops dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki. As a result, the radiation fallout contaminated the cities' water supplies, food sources, and half of the populations of each city were stricken with disease.

The Soviet republics of Ukraine and Belarus are part of a scenario like this after a reactor at the Chernobyl nuclear power plant suffered a meltdown in 1986.

ii. CBRNs

CBRN are weaponized or non-weaponized Chemical, Biological, Radiological and Nuclear materials that can cause great harm and pose significant threats in the hands of terrorists. The term is used to describe a non-conventional terror threat that, if used by a nation, would be considered use of a weapon of mass destruction.

Examples include Saddam Hussein's Halabja poison gas attack, and Lord Amherst giving smallpox laden blankets to Native Americans.

f. Transportation

i. Aviation

Air disasters are an incident rather than an accident. It is associated with the operation of an aircraft. An aircraft is a vehicle ranging from a helicopter, an airliner, or a space shuttle. The world's worst airliner disaster is the Tenerife crash of 1977, when miscommunications between air traffic control and an aircrew caused two fully-laden jets to collide on the runway, killing 583 people.

ii. Train

A train wreck or train crash is a type of disaster involving one or more trains. This often occurs as a result of miscommunication. When a moving train meets another train on the same track accident occurs. Again if a train wheel jumps off a track in a derailment or when a boiler explosion happens there will be train accidents causing disaster.

iii. Road

Traffic collisions are the leading cause of death, and road-based pollution creates a substantial health hazard, especially in major conurbations. The greenhouse effect of road transport is a significant fraction of the anthropogenic warming effect, and the rapid consumption of fossil fuel accelerates the Hubbard peak.

iv. Space

Space travel presents significant hazards, mostly to the direct participants (astronauts or cosmonauts and ground support personnel), but also carry the potential of disaster to the public at large. Accidents related to space travel have killed 22 astronauts and cosmonauts, and a larger number of people on the ground.

An example is the Space Shuttle Columbia, which disintegrated during a landing attempt over Texas in 2003, with a loss of all seven astronauts on board. The debris field extended from New Mexico to Mississippi.

3. Costs

Some man-made disasters have been particularly notable for the high costs associated with responding to and recovering from them, including:

Chernobyl disaster, 1986: $15 billion estimated cost of direct loss. It is estimated that the damages could accumulate to €235 billion for Ukraine and €201 billion for Belarus in the thirty years following the accident;

Three Mile Island, 1979: $1 billion;

September 11 attacks, 2001: $20.7 billion;

Exxon Valdez oil spill, 1989: The clean-up of oil spill cost an estimated $2.5 billion; recovery for settlements, $1.1 billion; and the economical loss (fisheries, tourism, etc) suffered due to the damage to the Alaskan ecosystem was estimated at $2.8 billion;

The costs of disasters vary considerably depending on a range of factors, such as the geographical location where they occur. When a disaster occurs in a densely-populated area in a

wealthy country, the financial damage might be huge, but when a comparable disaster occurs in a densely-populated area in a poorer country, the actual financial damage might relatively small, in part due to a lack of insurance. For example, the 2004 Indian Ocean earthquake and tsunami (although obviously not man-made) with a death toll of over 230,000 people, cost a 'mere' $15 billion, whereas the Deepwater Horizon oil spill, in which 11 people died, the damages were six-fold.

9.10 RESPONSE TO MAN-MADE DISASTERS

Man-made disasters have massive human and economic costs. They may cause many deaths, severe injuries, and food shortages. Most incidents of severe injuries and deaths occur during the time of impact, whereas disease outbreaks and food shortages often arise much later, depending on the nature and duration of the disaster. Anticipating the potential consequences of disasters can help determine the actions that need to be started before the disaster strikes to minimize its effects.

Response is the set of activities implemented after the impact of a disaster in order to assess the needs, reduce the suffering, limit the spread and the consequences of the disaster, open the way to rehabilitation.

9.10.1 Response when disaster strikes.

- We should follow the established emergency procedures for raising the alarm, evacuating personnel and making the disaster site safe when disaster strikes.
- One must contact the leader of the disaster response team to direct and brief the trained salvage personnel when disaster strikes.
- When permission is given to re-enter the site, we should make a preliminary assessment of the extent of the damage, and the equipment, supplies and services required when disaster strikes.
- We must stabilize the environment to prevent the growth of mould.
- Photograph damaged materials for insurance claim purposes.
- Set up an area for recording and packing material which requires freezing, and an area for air drying slightly wet material and other minor treatment.
- Transport water-damaged items to the nearest available freezing facility.

9.11 SPECIFIC RISK REDUCTION AND PREPAREDNESS MEASURES

Disaster Risk Reduction (DRR) measures are designed to protect livelihoods and the assets of communities and individuals from the impact of hazards. DRR is often a complementary or integral part of other programmes such as micro-finance, food security, promoting agricultural diversity, or capacity building. On occasions, particularly with preparedness planning and advocacy issues, it can be a stand-alone activity. DRR is a means of bridging the gap between development and humanitarian programmes and can be seen as a means of strengthening livelihood security.

Preparedness is getting ready to cope with disasters. Disaster preparedness refers to a broader range of activities, such as establishing emergency policies, developing evacuation plans, designating emergency shelters, and developing methods for rapid assessment of pre-positioning supplies. Materials planning emergency services, training and drills for emergency staff, training seminars and courses, and broad campaigns of public awareness aimed at preparing communities for the onset of a disaster are other aspects of preparedness.

Preparedness by reviewing the anticipated scope of a disaster, managers can plan adequate responses, develop organizational procedures, and prepare to meet the needs that are going to arise.

Preparedness activities fall under the domain of the United Nations Disaster Relief Office (UNDRO). UNDRO normally works through the UNDP resident representative in each country to provide planning assistance for disaster preparedness.

9.11.1 A few preparedness measures are stated under

- Develop a written preparedness, response and recovery plan.
- Keep the plan up-to-date, and test it.
- Keep together supplies and equipment required in a disaster and maintains them.
- Establish and train an in-house disaster response team. Training in
  - disaster response techniques,
  - identification and marking on floor-plans and enclosures of irreplaceable and important material for priority salvage.

- Prepare and keep an up-to-date set of documentation including :
  - Building floor-plans, with locations of cut-off switches and valves.
  - Inventory of holdings, with priorities for salvage marked on floor-plans.
  - List of names, addresses, and home telephone numbers of personnel with emergency responsibilities.
  - List of names, addresses, and home telephone numbers of the in-house disaster response team.
  - List of names, addresses and home telephone numbers of trained conservators with experience in salvaging water-damaged materials, resource organisations, and other facilities able to offer support in the event of a disaster.
  - List of disaster control services, in-house supplies and equipment, and in any central store, including locations and names of contacts with home telephone numbers.
  - List of suppliers of services and sources of additional equipment and supplies, including names of contacts and home telephone numbers.
  - Arrangements made to access freezing facilities.
  - Arrangements for funding emergency needs.
  - Copies of insurance policies.
  - Salvage procedures.
- Distribute the plan and documentation to appropriate locations on- and off-site.
- Institute procedures to notify appropriate people of the disaster and assemble them rapidly.

9.12 TYPICAL POST-DISASTER NEEDS

A Post-Disaster Needs Assessment (PDNA) comprises an approach to harmonize the assessment, analysis and prioritization of damages, losses and needs by a range of stakeholders (United Nations agencies and programmes, the World Bank, donors, non-governmental organizations) in support of the national government.

Over the past eight years, UNDP and the EU have geared up their support to countries around the world at risk for disasters by proactively preparing for future recovery processes and helping them to assess the needs after disasters do occur and to lay foundations for building back better.

PDNA process starts with the establishment of modalities among concerned agencies. It includes as commitment to one agreed output, constitution of PDNA management team, benchmarking of PDNA applications, framework constitution, assurance that assessment does not impede delivery of immediate relief and early recovery, organization's roles and responsibilities, composition of assessment team, resource requirements, assessment logistics and office based and field roles. It is organized on a timeline sequencing the activities related to the development and launch of PDNA.

Managing a PDNA requires close interaction between the national government and the respective country representatives from UN, European Commission, World Bank and other partners they may be supporting the PDNA.In disaster prone countries such interaction and planning for PDNA should ideally be initiated as a part of joint contingency planning for disaster event, in order that all the necessary agreements and arrangements for PDNA are in place before a disaster occurs and in order to avoid the tyranny of rush that often follows the onset of any particular major disaster.

The planned PDNA Study in India aims at producing standardized tools for post-disaster needs assessments in India that place the country at the forefront of the issue in the entire world. The project involves (i) analyzing in depth the existing procedures for disaster assessment in the most vulnerable 10 States of India;(ii) comparing them to the most in use methodologies elsewhere in the world; and (iii) producing a set of methodological tools for estimating disaster effects and impact and financial requirements for post-disaster recovery and disaster-resilient reconstruction that may be adopted by the country.

❖ <u>The process for successful post-disaster needs assessments normally carries the following sequence of events:</u>

1. Gathering of updated baseline information that describes the existence and availability of capital and physical assets in the affected area as well as the manner in which goods and services are produced and consumed by the population. This will serve as the basis for comparison of non-disaster to post-disaster conditions.
2. Field visits to affected areas by sectorial assessment teams in order to estimate the extent of destruction of physical assets and the negative effects on the production of goods and services arising from the disaster. This will enable the estimation by the assessment teams of the value or cost of the effects of the disaster (damage and production flow changes).

3. Aggregation of sectorial disaster effects, ensuring no double or multiple accounting, to estimate the total value of damage and production flow changes caused by the disaster.
4. Estimation of disaster impact at different levels of analysis:
    a. Macro-economic impact analysis, including impact on growth of gross domestic product (GDP), external sector, and fiscal sector, as well as the level of States;
    b. Personal or household impact analysis, including impact on employment, income and expenditure, and leading to estimation of disaster impact on human development and on the achievement of Millennium Development Goals (MDGs).
5. Estimation of post-disaster financial requirements or needs for:
    a. Recovery of personal income, access and provision of basic services, and of normal production levels of activity
    b. Reconstruct

9.13 CASE STUDIES

India has experienced a varied range of disasters over the years resulting in significant loss of lives. While nature's behaviour is not in human hands, reducing its impact certainly is. We have come to know that man-made disasters that have been a result of human carelessness, callousness, or sheer lack of foresight and planning has ended up with large number of innocent people losing lives, all of which could have been prevented.

9.13.1 Five worst man-made disasters in India are being stated under :

I. Bhopal Gas tragedy

On December 2-3 1984 in Bhopal toxic Methyl Isocyanate (MIC) gas leaked from the factory owned by Union Carbide. The gas silently spread out engulfing the densely populated areas around the factory. This was one of the worst chemical disasters globally that resulted in over 10,000 losing their lives and over 5.5 lakh persons affected and suffering from agonizing injuries, even today.

The tragedy was a result of human error and poor supervision at the factory.

II. AMRI Hospital fire, Kolkata

Around 3 am on the morning of 9 December 2011 fire caught in AMRI Hospital, Kolkata and spread rapidly to the floors above. Patients were trapped inside wards and with no exit possible. Of

the 160 persons inside the hospital at that time, 89 lost their lives, of which 85 were patients and 4 staff members.

This was a classic case of negligence on part of management and operational staff. The staffs were slow to react and got bogged down in protocol rather than call in the fire department immediately as the fire broke. The first responders at the site were the slum dwellers residing next to the hospital who took up the initiative of rescuing the patients.

III. Lalita Park Building Collapse

On 15 November 2010, a five storey residential building in a crowded neighbourhood of Lalita Park in West Delhi came crashing down like a pack of cards. 66 people lost their lives with over 80 injured. The cause of collapse was attributed to poor quality of construction, illegal addition of floors and recent floods in the city, all contributing to the building crashing under its own weight.

IV. Maha Kumbhmela stampede in Allahabad

Stampede caused by poor people management and lack of adequate infrastructure to monitor and manage large crowd gatherings, especially during religious occasions, has been a bane in India. One of the worst incidents took place on 3 February 1954 on the occasion of MahaKumbh in Allahabad. The resulting stampede took the lives of 820 and left over 100 injured.

V. Mandher Devi temple stampede in Wai, district Satara

Mandher Devi temple in Wai, district Satara in Maharashtra on 26 January 2005, when a stampede led to 350 persons being killed and left over 200 injured.

9.13.2 Five worst man-made disasters around the world :

I. The Gulf War Spill

A direct result of manmade disaster happened when 720 thousand cubic meters were spilled into the Persian Gulf during the war. Iraq found it a brilliant military strategy to drown the waters in petrol, so that it becomes hard for US forces to land. The amounts were just too much to clean up. The oil is now settled in the very sediment layers of the water bed. All marine wildlife suffered a great deal of damage and some local species even disappeared. The environment is in the process of recovering after 21 years and still has a long way to go.

II. Chernobyl

Chernobyl used to be a nuclear power plant near Pripryat, Ukraine. In 1986, an explosion, caused by poor management, cracked open one of the plant's nuclear reactors and leaked large quantities of radioactive particles into the atmosphere. The winds

spread the radioactive cloud all over USSR and Europe. It was classified as level 7 on the International Nuclear Event Scale.

III. The Tennesse Coal Ash Spill

The Kingston Fossil Fuel Power Plant produced fly coal ash as a by product of the coal combustion. The ash to be mixed with water and the mixture was supposed to be stored in dredge cells. A direct result of manmade disaster happened when 720 thousand cubic meters were spilled into the Persian Gulf during the war. Iraq found it a brilliant military strategy to drown the waters in petrol, so that it becomes hard for US forces to land. The amounts were just too much to clean up. The oil is now settled in the very sediment layers of the water bed. All marine wildlife suffered a great deal of damage, as some local species even disappeared. The environment still recovers after 21 years and still has a long way to go.

After a powerful rain storm, in 2008, the slurry gave weight and stormed down the hill in a massive landslide of mud and ash. Three hundred acres of land were buried under the filth and a lot of properties in Kingston were destroyed. An estimate of 675 million dollars of damage was caused to the residents and national land with another 975 million needed to clean up the slurry.

IV. The Sidoarjo mud volcano

It is known that mud volcanoes are results from seismic activity. Inspite of multiple times warning, an Indonesian drilling company PT LapindoBrantas, pushed forward with an excavation site in a known unstable area not far away from the ring of fire. This drilling reactivated previously inactive faults. This was complimented by a 6.3 magnitude earthquake to the south-west and several big aftershocks. A few days later, the drill hole erupted mud 200 metres above itself in result. It continues to this day, with the expectancy to continue for the next 25 to 30 years. Despite mud is not directly toxic, it's not edible or drinkable either. The amounts released continue to contaminate the surrounding waters and affects thousands of nearby inhabitants and wildlife.

V. The North Pacific Garbage Patch

Roughly 0.4 to 8.1 percent of the entire surface of the Pacific Ocean is covered in a mixture of toxic sludge, plastic, petrol and other thrown away waste**.**

9.14 FOREST FIRE

9.14.1 With reference to Nature

A Forest Fire is an uncontrolled fire, occurring in nature in an area of combustible vegetation, that wipes out large fields and

areas of land. These fires tend to thrive in very warm and dry climates, rather than the thick, moist rainforest types. These fires sometimes burn for days and weeks and may be so large that it becomes hard and takes a long time to gain control over the situation by the fire fighting crews. This could result in massive destruction by wiping out an entire forest and destroy almost every organic matter in it.

Although the causes of a significant number of forest fires remain unknown it is estimated that as many as nine out of ten forest fires are caused by humans. The most common cause of such fires is the use of open flames and disposable barbecue grills. Even a cigarette that is not properly extinguished can cause a forest fire.

Some forest fires also start as a consequence of downed power lines, sparks from trains, sparks from hedge trimmers along roadways or sparks from tools and forestry machinery doing work in the forest. Natural forest fires are due to lightning strikes.

In Norway, averages of about 1100 forest fires occur each year. Most of these are small and relatively easy to control. Only two per cent of the registered forest fires in Norway are larger than 100 decares.

Forest fires can be broadly classified into three types - ground fires, surface fires, and crown fires, depending on the type of fuel involved and its vertical arrangement. These two factors not only determine the intensity of the fire, but how fast it spreads as well.

9.14.2 Geographical distribution :

Forest fires typically occur in areas that suffer from extended periods of hot, dry weather. They usually begin in the summer or fall, and occur when branches dry out and fall from trees, becoming highly flammable. At that point, anything from human carelessness to lightning or volcanic activity can cause a forest fire.

Statistical data on fire loss is weak and in most of the cases unavailable. But it is estimated that the proportion of forest areas prone to forest fires annually ranges from 33% in some states to over 90% in others.

Most of the world burnt biomass matter is from savannas, and because2/3rd of the earth savannas are in Africa, that continent is now recognized as burnt centre of the planet. Biomass burning is generally believed to be a uniquely tropical phenomenon because most of the information we have on its geographical and temporal distribution is based on the observation of the tropics.

Because of poor satellite coverage, among other things, little information is available on biomass burning in boreal forests, which represent about 29% of the world's forests.

As per the Forest Survey of India (FSI) report on Vulnerability of India's Forests to Fires (2012), 42 million ha forest area in 168 districts of the country is highly vulnerable to forest fires. This includes around five million ha of very dense forests, 21 million ha of moderately dense forests and 16 million ha of open forests.

- **According to FAO report "Fire Management- Global Assessment 2006", regional estimates of human induced forest fires as follows:**

a) Mediterranean- 95%
b) South Asia 90 %
c) South America 85 %
d) North America 80 %
e) Balkan countries 59 %

The natural causes of forest fires are common in remote areas only.

9.14.3 Causes and impact :

The 'fire triangle', fuel, oxygen and a source of heat are the three prerequisites for a fire. The availability of these three elements can unleash an intense fire in the forest too. Forest fires can be witnessed throughout the world and they usually occur in cycles.

The extensive size and the speed, in spreading of forest fire have made them astounding. Forest fires can easily spread and engulf a vast area because of their ability to change direction and overcome barriers like rivers, roads, and firebreaks. A forest fire can be ignited by several factors, including both natural factors and human activities.

Forest fires can be broadly classified into three types - ground fires, surface fires, and crown fires, depending on the type of fuel involved and its vertical arrangement. These two factors not only determine the intensity of the fire, but also how fast it spreads. Ground fires are usually fuelled by subterranean roots, buried organic matter, and dead vegetative parts like leaves, branches, and bark and stems of trees that exist on the soil surface at various stages of decomposition. Though quite infrequent in nature, ground fires can burn slowly for days to months. They basically burn by smouldering, and can literally destroy all vegetation leaving behind only bare earth. Surface fires are fed by low-lying vegetation, shrubbery, leaves, grass, and other debris. A surface fire is usually

less intense as compared to a ground fire, and it does not pose major risks to mature trees and their roots. But factors like the build-up of fuel over a period of time, and drought or dry spells can increase the intensity of the surface fire, and cause it to spread rapidly to become a ground fire.

Causes of Forest Fires

Right from lightning and volcanic eruptions to unattended campfires can cause forest fires. Sometimes, a lighted cigarette left in the forest can also ignite a forest fires. The following are some of the most important factors that can cause forest fires, or increase their intensity to the extent that they can wreak havoc on the flora and fauna of the affected area.

a. Lightning

It has been estimated that lightning strikes the earth about 100 times in a second, and is responsible for causing almost 12% of the total forest fires in the United States.

Forest fires are usually caused by dry lightning or lightning not accompanied by rain. They often occur in isolated areas, and this is the reason why wildfires caused by lightning burn more areas than fires caused by human activities.

b. Volcanic Eruptions

Volcanic eruptions can also ignite forest fires, as the hot lava or magma burns everything that comes in its way.

c. Underground coal fires

Underground coal fires or the smouldering of coal deposits is another important contributory factor in reigniting, as well as spreading forest fires. Generally caused by lightning or a forest fire, an underground coal fire can continue to smoulder for a long time after the ground fire has been extinguished, and thus, it can reignite a forest fire.

d. Spontaneous Forest Fires

At times, wildfires can be spontaneous, especially when the weather is extremely hot and dry to create enough heat that can induce spontaneous combustion. Everything including wood has a temperature at which it burst into flames, which is called its flash point. For wood, the flash point is 572°F or 300°C.

The accumulation of dead organic matter such as leaves, twigs, and dry branches on the ground can increase the heat. At high temperatures, wood can also release hydrocarbon gases that react with oxygen to create a fire. Thus, wood can reach its flash point to ignite spontaneously in extremely hot and dry climatic conditions.

Spontaneous forest fires have been mostly observed in climates that are moist enough to promote the growth of vegetation, but are also characterized by extended hot and dry periods. The vegetated areas of Australia and Southeast Asia, the forested areas of the United States and Canada, and the Mediterranean basin are some areas where such spontaneous wildfires are quite common.

Spontaneous forest fires usually occur in summer and fall, and also during drought, when fallen leaves, twigs, and other organic matter become dry and highly combustible. Strong winds can spread such forest fires to a large area, and make it difficult to contain them.

e. Friction leading to sparks

In dry season, friction may cause sparks by rolling stones in the mountainous areas which will lead to forest fires. A devastating forest fire occurred in Gwar village, located 40 km towards north-east from Rudraprayag district of Uttarakhand in February 2001 is an example of such fire.

f. Rubbing together

In bamboo areas, forest fires may occur by the rubbing together of clumps of dry bamboos.

g. Human Activities

According to forest fire statistics, 9 out of 10 forest fires are of human-caused origin**.**

Human activities, or to be more specific, human carelessness is responsible for causing more than 80% of all wildfires. They are stated under:

- Agricultural activities like burning grass-gorse or stubble.
- Throwing of burning cigarettes end or matches.
- Lighting of fires in restricted areas.
- Burning of wastes and garbage at non-authorized landfill sites.
- Military exercises.
- Hunting activities.
- Residential activities like the use of electrical tools that cause sparks and burn of wastes.
- Arson.
- Short-circuit of power lines.

h. Other Causes

Another important cause of wildfires is the sparks from rock falls. Forest fires can be frequent during the dry summer months, and the periods of droughts and strong winds. Even global warming is believed to play a role in creating frequent forest fires, by increasing the frequency and intensity of droughts.

Impacts of forest fires

Forest fires not only just have an impact on the environment, but on economy, society, and human health as well. Forest fires leave a visual impact because they cause damage to houses and other properties, environmental destruction, damage to local and national economies and the potential for loss of life.

If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. Once ground cover has been burned away, little is left to hold soil in place on steep slopes and hillsides. If the wild land fire destroyed the ground cover, then erosion becomes one of several potential problems**.**

a. The Positive Consequences of forest fires

- Forest fires clean up any dead or decaying matter strewn across forest. This enables an increase in new plant growth.
- Forest fires remove any harmful insects and diseased plants and hence maintain the balance within an ecosystem.
- Moreover there is a benefit of plant removal. It increases sunlight, which can assist in the regeneration of plant seeds.
- Forest fires can also increase the amount of plant and animal diversity within a particular ecosystem.
- In the midst of forest fires exceptional amount of nutrients are released into the soil, which can result in a flood of new plant growth. Some plants even require forest fires to germinate their seeds and stimulate growth, such as the peculiar species of Panderosa pine trees.
- Regular forest fires kill invasive species which in turn allows for indigenous species to continue thriving. If forest fires do not occur regularly, this can lead to forested regions being overrun with underbrush and trees. Subsequently, when these forests are finally subject to a forest fires, they may burn too hot, thereby stifling new growth rather than causing it.

b. The Negative Consequences of forest fires

Too much frequency of forest fires in a particular region can have a devastating impact on the ecosystem.

- Frequent forest fires are harmful for the natural cycles of the forests as it eradicates native plant species. This may also encourage growth of fire-resistant plants and other invasive plant species. Some of these invasive species being highly flammable often cause a perpetual cycle where they increase the risk of future forest fires that further destroy native plant species.
- Forest fires can worsen the levels of carbon dioxide in the atmosphere. Greenhouse effect is already plaguing our earth and forest fires strengthen it.
- Further, forest fires generate ash and destroy available plant nutrients, thereby greatly affecting the biodiversity of forests.
- With an increase in water runoff, forest fires can engender flash flood conditions and enable soil erosion.
- These fires also create heavy smog that is harmful to human and animal life, and they use up a lot of natural resources, including water, which could lead to periods of needed water preservation in the area.

To conclude it may be said, that forest fires whether are positive or negative is contingent on their frequency and cause. Unfortunately, their negative effects often overshadow the positive impacts. To strive towards a sustainable future, some precautionary measures must be taken regarding forest fires. Naturally occurring fires cannot be prevented, especially in areas where there is high risk of forest fires, with high summer temperatures. Therefore we must take extra caution so that man-made fires do not occur. We should be more educated and aware about the potential consequences of the forest fires.

9.14.4 Response to man-made disasters – Forest fires :

In the aftermath of a forest fire, workers may be involved in a variety of response and recovery operations. Some operations, such as utility restoration, cleaning up spills of hazardous materials, and search and rescue, should only be conducted by workers who have the proper training, equipment and experience.

A Forest Fire Response Plan describes how we will manage and report forest fires. In some respects forest fire planning is more important than prescribed fire planning because of the extensive damage that may occur during fire suppression, and the fact that many more sites are susceptible to forest fire than have fire prescribed for them. It is also important to plan for forest fire for good community relations. Large landholdings of flammable fuels may present a risk to neighbouring landowners. It is our responsibility as good neighbours to plan for forest fire and work with community fire-fighters to reduce risk when possible.

❖ **Some key components include:**

- the location of the site
- a physical description of the site (fuels, topography, fire-sensitive areas, etc.)
- a narrative of the procedure to be followed in the event of a wildfire (e.g. notification, evacuation, suppression action)
- identification of the fire control agency responsible for suppression in the area (e.g. volunteer fire department, state forestry agency), with contact phone numbers
- list of Nature Conservancy staff to be contacted in case of forest fire, with phone numbers
- information concerning any cooperative agreement with multiple landowners or agencies, such as a Mutual Aid Agreement
- communications procedures, including radio frequencies of responding agencies
- maps identifying
- roads into and on the site, and access gates
- natural features that could be used as firebreaks, such as streams, lakes, or changes in fuel types
- ecologically sensitive areas to be avoided by response vehicles
- wet or low-lying areas where response vehicles may get mired
- water sources
- location of flammable fuels or hazardous materials storage

In some areas, Conservancy fire programs may decide to develop a media response plan in anticipation of an escaped prescribed burn. This document would designate one or two staff to interact with the media and include a basic framework for a response and a fact sheet on the preserve or site which could be distributed to media contacts.

9.14.5 Specific risk reduction and preparedness measures :

Just as fire is an integral part of the forest**,** risk reduction and preparedness measures is an integral part of forest management. It is the process of planning, preventing and fighting fires to protect people, property and the forest resource. Risk reduction and preparedness are the measures that ensure an organized mobilization of personnel, funds, equipments, and supplies within a safe environment for effective relief. Often costly to achieve, it is found to be successful, though to the detriment of ecological values. The decision to fight a fire or leave it to burn out naturally is based on a hierarchy of priorities set by the government agency

responsible for fire management where the fire is burning. Avoiding forest fires can be achieved through various means, but in the end a combination of different measures offers the best protection.

9.14.5.1 Some of the measures are discussed below: :

a. Fire fighting reservoirs

Since time immemorial water is still the main way to extinguish forest fires. Hence it is necessary to have, or build and maintain, a fire fighting water supply system within suitable water courses or to create artificial reservoirs for water extraction in large, contiguous and fire endangered forested areas. It is important that these extraction points are sufficiently identified and easily accessible by fire engine.

b. Infrastructure

Communication system must be well maintained. Therefore, in order for fire engines to reach a forest stand it is important that the roads can bear heavy vehicles.

c. Machinery and equipment

Nowadays, alongside mobile fire extinguishing equipment, fighting forest fires continues to be hard manual work for as many people as are available to fight the fire. Hence it is the responsibility of forest enterprises of all ownership type in areas with a medium to high forest fire risk to maintain appropriate fire-fighting tools and machinery. These include hand tools such as spades, shovels, fire beaters and axes as well as transport vehicles or tractors and ploughs suitable for working in forests.

d. Forest Fire Monitoring

The introduction of automatic, camera supported forest fire observation systems has remarkable responses. Although the number of forest fires has not reduced but their extent has. It has helped in an early and exact identification of forest fires as well as a fast notification. This has again ensured that the technical team can be onsite quickly and can begin to fight the fire as soon as possible.

e. Aerial Surveillance

Aerial surveillance flights are another possible means to detect forest fires at an early stage during times of high fire risk. Besides the early detection and location of forest fires, this aerial support can also be helpful in directing the operational forces on the ground.

f. Mapping

Forest fire fighting maps at a scale of 1:50.000 using the UTM geographic coordinate system are the basis for all those fighting forest fires. All important elements such as fire fighting

water points, towns etc. are shown on these maps. The depiction follows the tactical symbols of the fire service. These maps are prepared by the authorities and are updated at least every five years.

g. Communication equipment

Forest fires can only be quickly and successfully fought with functioning communication between the fire service and forest authority operational teams. Mobile telephones and radios are required. Up-to date telephone lists are also needed.

h. Emergency and deployment plans, Control of operations

Before the outbreak of a fire, emergency and deployment plans have to be created.

i. Cooperation and joint exercises

Regarding forest fire risk reduction and preparedness collaboration between forest owners, the administration and different branches of the fire and emergency services is necessary as these work groups organise joint education and training courses, evaluate forest fire events and develop and update the emergency plans. They share common experiences and get to know each other during the evaluation, planning. Also implementation exercises help in building up a collegial relationship among each other. Therefore mistakes could be avoided, decisions are made quickly and decisively and the area of burnt land reduced.

9.14.6 Typical post-disaster needs :

The most important post-disaster needs for forest fire are efficient and timely generation and transfer of information related to fire warning. It is necessary to enhance the capacity of forest management functionaries at various levels to generate timely warning and translate it into useful information for field staff and others. The forest officials need to be trained in using various indicators to get prior information about forest fire at the earliest time possible to take timely action. The forest department may be provided with necessary equipment in detecting forest fire at the earliest possible. Forest officials are to be trained to use a variety of valuable information available at national and international levels and translate it for local use. Necessary collaboration is required with organisations involved in generating early warning about forest fire. Meteorological Departments and other national and international sources providing weather related information maybe collaborated to get prior information about the temperature and rainfall situation- two main deciding factors for forest fires.

The information available from different sources need to be dovetailed for making use at local level and necessary arrangement be made to disseminate this information at field level to make use

in taking appropriate preventive, preparedness and response actions in time. To get prepared and take necessary preventive measures in time, it is necessary that the vulnerability/ risk maps be prepared of forest area, depending mainly on past history, climatic conditions and other human induced factors like population density, socioeconomic conditions etc.

9.14.7 Case study forest fire, Uttarakhand, India, 2016 :

The frequency of forest fire in Uttarakhand during April 2016 was much higher and widespread than during April 2015. During April 2015, forest fire points were identified only in two districts viz. Nainital and Udham Singh Nagar with 1 and 6 fire points respectively, whereas in 2016, fire spread over 13 districts with a maximum number of fire points observed in PauriGarhwal followed by Nainital. Thus around 32% of the total 1270 fire points were observed in PauriGarhwal followed by around 22% in Nainital during April of the current year. The worst affected districts of PauriGarhwal, Nainital, Pithoragarh, Bageshwar and Chamoli.

A total of 1890.79 hectares of green cover have been destroyed this fire season as a major forest fire. Forest officials fear wildlife could have faced problems too. These fire set mainly in pine forests in the slopes of the sub-Himalayan region, produced clouds of smoke. The first incident of forest fire was reported on 2 February 2016 from Pithoragarh district on in the forests of Uttarakhand.

9.14.7.1 Cause :

Although the exact damage is yet to be ascertained there are some natural reasons for the forest to catch fire. Some experts suggest dry weather, poor rainfall, El Nino and very high temperatures, climate warming as major causes behind this and the windy conditions that fanned the fire and helped it to spread. Some others opine it was miscreants and the timber smugglers were accused of setting the forests on fire. Besides extraction of timber, other anthropogenic intervention for collection of honey, collection of sal seeds, improvement of growth of grass, hunting wild animals, encroaching forest land and many accidental fires lead to forest fire in Uttarakhand forest. The government has decided to study the reasons behind major fires, especially in summer, and prepare an action plan accordingly.

India has very poor data regarding forest fire and damages caused by them. Losses like carbon sequential capability, soil moisture and nutrient losses due to forest fire are very difficult to be ascertained but are of utmost importance for environmental conservation. It also contributes to global warming.

9.14.7.2 Effects

The forest fires in Uttarakhand have severely affected the wildlife reserves across the state. Going by the statistics, 70 hectares in Rajaji Tiger Reserve and 60 hectares in Kedarnath Musk Deer Sanctuary had come under fire. The Corbett Tiger Reserve and Kalagarh Tiger Reserve, which are home to famous Royal Bengal tigers – has already witnessed 48 incidents of forest fire that destroyed 260.9 hectares of the forest.

Himalayan glaciers have been affected severely by the Uttarakhand forest fire. Black carbon deposits in the glaciers from smoke and ash of forest fire have high temperature absorbing capacity w. This will cause ice to melt faster. The glaciers feed the rivers in Northern India. As a result of this forest fire they will now carry harmful chemicals and pollutions due to such carbon deposits on glaciers. Besides much human loss, flora, fauna and wild animal losses were also significantly observed during the two months of forest fire. This will create ecological imbalance with negative impact and disaster in the region in near future.

The damage to biodiversity with loss of flora, fauna, and bird species were significantly high than larger animals such as tigers, deer and elephants, who manage to escape to safer places. Besides, tourism is also very badly affected by this forest fire.

9.14.7.3 Preparedness :

Around 10,000 people of state and central government officials and residents were deployed to douse the fire.

Changes in the attitudes and actions of individuals, stakeholder groups, the private sector, and governments are required for action and implementation of sustainable forest fire prevention policies. Prevention of forest fire will require long-term coordinated efforts by public and private authorities with robust planning and informed policy implementation.

9.14.7.4 Measures :

Taking such a severity into consideration, the concerned Environment Minister has begun trial runs for a pre-fire alert system that will issue warnings via SMS about possible fire outbreaks in the country. The idea is to inform the forest department even before the fire starts spreading.

The Uttarakhand governor has increased the number of personnel deployed to control the fire to 6000. He has asked the SDRF, locals and district administration to do their bit.

The Central Government has earmarked Rs. 5 crore for the fire-fighting operations. Both the Prime Minister's Office and the Home Ministry are closely monitoring the situation.

9.15 TERRORISM

9.15.1 With reference to Nature :

In the modern sense terrorism is violence or other harmful acts committed against civilians for political or other ideological goals. Most definitions of terrorism include only those acts which are intended to create fear or "terror". These are not a lone attack but perpetrated for an ideological goal. They deliberately target or disregard the safety of non-combatants. Many definitions also include only acts of unlawful violence.

As a form of unconventional warfare, terrorism is sometimes used when attempting to force political change by convincing a government or population to agree to demands to avoid future harm or fear of harm, destabilizing an existing government, motivating a disgruntled population to join an uprising, escalating a conflict in the hopes of disrupting the status quo, expressing a grievance, or drawing attention to a cause.

An International Round Table on Constructing Peace, Deconstructing Terror hosted by Strategic Foresight Group recommended that a distinction should be made between terrorism and acts of terror. While acts of terror are criminal acts as per the United Nations Security Council Resolution 1373 and domestic jurisprudence of almost all countries in the world, terrorism refers to a phenomenon including the actual acts, the perpetrators of acts of terror themselves and their motives.

There is disagreement on definitions of terrorism. However, there is an intellectual consensus globally, that acts of terror should not be accepted under any circumstances. This is reflected in all important conventions including the United Nations counter terrorism strategy, the decisions of the Madrid Conference on terrorism, the Strategic Foresight Group and ALDE Round Tables at the European Parliament.

Official definitions determine counter-terrorism policy and are often developed to serve it. Most government definitions outline the following key criteria: target, objective, motive, perpetrator, and legitimacy or legality of the act. Terrorism is also often recognizable by a following statement from the perpetrators.

Violence- According to Walter Laqueur of the Center for Strategic and International Studies, "the only general characteristics of

terrorism generally agreed upon is that terrorism involves violence and the threat of violence." However, the criterion of violence alone does not produce a useful definition, as it includes many acts not usually considered terrorism: war, riot, organized crime, or even a simple assault. Properly destruction that does not endanger life is not usually considered a violent crime, but some have described property destruction by the Earth Liberation Front and Animal Liberation Front as violence and terrorism.

Psychological impact and fear- The attack was carried out in such a way as to maximize the severity and length of the psychological impact. Each act of terrorism is a "performance", devised to have an impact on many large audiences. Terrorists also attack national symbols to show their power and to shake the foundation of the country or society they are opposed to. This may negatively affect a government's legitimacy, while increasing the legitimacy of the given terrorist organization and/or ideology behind a terrorist act.

Perpetrated for a Political Goal- Something all terrorist attacks have in common is their perpetration for a political purpose. Terrorism is a political tactic, not unlike letter writing or protesting, that is used by activists when they believe no other means will affect the kinds of change they desire.

The change is desired so badly that failure is seen as a worse outcome that the deaths of civilians. This is often where the interrelationship between terrorism and religion occurs. When a political struggle is integrated into the framework of a religious or "cosmic" struggle, such as over the control of an ancestral homeland or holy site such as Israel and Jerusalem, falling in the political goal (nationalism) becomes equated with spiritual failure, which, for the highly committed, is worse than their own death or the deaths of innocent civilians.

Deliberate targeting of non-combatants- It is commonly held that the distinctive nature of terrorism lies in its intentional and specific selection of civilians as direct targets. Much of the time, the victims of terrorism are targeted not because they are threats, but because they are specific "symbols, tools, animals or corrupt beings" that tie into a specific view of the world that the terrorist possess. Their suffering accomplishes the terrorists' goals of instilling fear, getting a message out to an audience, or otherwise accomplishing their political end.

Disguise- Terrorists almost invariably pretend to be non-combatants, hide among non- combatants, fight from in the midst of non-combatants, and when they can, strive to mislead and provoke the government soldiers into attacking the wrong people, that the

government may be blamed for it. When an enemy is identifiable as a combatant, the word terrorism is rarely used. Mass executions of hostages, as by the Nazi military forces in the Second World War, certainly constituted crimes against humanity but are not commonly called terrorism.

Unlawfulness or illegitimacy- Some official (notably government) definitions of terrorism add a criterion of illegitimacy or unlawfulness to distinguish between actions authorized by a "legitimate" government (and thus "lawful") and those of other actors, including individuals and small groups. Using this criterion, actions that would otherwise qualify as terrorism would not be considered terrorism if they were government sanctioned. For example, firebombing a city, which is designed to affect civilian support for a cause, would not be considered terrorism if it were authorized by a "legitimate" government.

This criterion is inherently problematic and is not universally accepted, because: it denies the existence of state terrorism: the same act may or may not be classed as terrorism depending on whether its sponsorship is traced to a "legitimate" government; "legitimacy" and "lawfulness" are subjective, depending on the perspective of one government or another; and it diverges from the historically accepted meaning and origin of the term. For these reasons this criterion is not universally accepted. Most dictionary definitions of the term do not include this criterion.

Types of Terrorism

Terrorism classified terrorism into six categories-

a) **Civil Disorders: -** A form of collective violence interferes with the peace, security, and normal functioning of the community.

b) **Political Terrorism:-** violent criminal behavior designed primarily to generate fear in the community, or substantial segment of it, for political purposes.

c) **Non-Political Terrorism: -** Terrorism that is not aimed at political purposes but which exhibits "conscious design to create and maintain high degree of fear for coercive purposes, but the end is individual or collective gain rather than the achievement of a political objective".

d) **Quasi –Terrorism; -** The activities incidental to the commission of crimes of violence that are similar in form and method to genuine terrorism but which nevertheless lack its essential ingredient. It is not the main purpose of the quasi-terrorists to induce terror in the immediate victim as in the case of genuine terrorism, but the quasi-terrorist uses the modalities and techniques of the genuine terrorist and produces similar consequence and reaction. For example, the fleeing felon who

takes hostages is a quasi- terrorist, whose method are similar to those of the genuine terrorist but whose purpose are quite different.

e) **Limited Political Terrorism: -** Genuine political terrorism is characterized by a revolutionary approach; limited political terrorism refers to "acts of terrorism which are committed for ideological or political motives but which are not part of a concerted campaign to capture control of the state.

f) **Official or State Terrorism: -** Referring to nations whose rule is based upon fear and oppression that reach similar to terrorism or such proportions.

9.15.2 Geographical distribution

We may think that a geographic ontology would include things such as mountains, rivers, and streams, or perhaps cities, buildings and more abstract things like nations and their boundaries. But we certainly believe that no one would consider terrorism to be a part of such ontology. After innumerable attacks of terrorism in recent past it is believed that there is a new geography of terrorism, and we must create a new map of potential targets anywhere on Earth. Terrorism is an isolated phenomenon, occurring at various trouble spots around the world and it has no boundary.

9.15.3 Causes and impact of terrorism

Many opinions exist concerning the cause of terrorism. They range from demographic to socio-economic to political factors. Demographic factors may include congestion and high growth rates. On the other hand socioeconomic factors include poverty, unemployment, and land tenure problems. Disenfranchisement, ethnic conflict, religious conflict, territorial conflict, access to resources, or even revenge come under political factors.

9.15.3.1 Causes of terrorism:

❖ **All terrorist acts are motivated by the following facts:**

1. Social and political injustice: People choose terrorism when they are trying to fight what they perceive to be a social or political or historical wrong. When they have been stripped of their land or rights, or denied these.
2. The belief that violence or its threat will be effective, and usher in change. Many terrorists in history said sincerely that they chose violence after long deliberation, because they felt they had no choice.

3. Ethno-nationalism: When a population desire to break away from a government or ruling power to create a state of their own can cause the formation of terrorist groups. In the 20th century this was seen often times with regions or states attempting to gain independence from their colonial era masters.
4. Alienation /Discrimination: A sense of alienation felt by diasporas, acts as a driver of terrorism. Many times these groups face discrimination in the countries they reside, leading to further feelings of isolation. They commonly move from poorer countries, particularly Muslim states in the case of Europe, to wealthier ones to go to school or find work.
5. Religion- Perhaps the most commonly held belief today is that terrorism is caused by religion. Though it is not the main cause for terrorism, religion does play a significant role in driving some forms of it.
6. Socio-Economic Status- A sense of relative depravation and lack of upward mobility within society is another reason that drives terrorism because Globalization and the modern media have given the 'have nots' an acute awareness of their situation compared to the 'haves'. The economic differences between themselves and the Western world can infuriate some in underdeveloped countries, increasing tension and hostilities.
7. Political Grievances- A lack of political inclusiveness in states or grievances against a certain political order may cause individuals to join or create terrorist groups. Left and right wing terrorists often seek to a political system.
8. The Accidental Guerrilla- "Accidental Guerrilla" a theory put forwarded by David Kilcullen. According to him when terrorist organization moves into an area with poor government or that is conflict ridden, then uses this safe haven to spread their ideologies to other areas and as a base to carry out violent acts. When outside forces then intervene to deal with the threat posed to them by this group, this causes the local population to reject the 'foreign invaders' and ally with the terrorist group, thus creating more terrorists and popular support for terrorist movements.

❖ **The Intent of Terrorist Groups**

A terrorist group commits acts of violence to -

- Produce widespread fear
- Obtain worldwide, national, or local recognition for their cause by attracting the attention of the media
- Harass, weaken, or embarrass government security forces so that the government overreacts and appears repressive

- Steal or extort money and equipment, especially weapons and ammunition vital to the operation of their group
- Destroy facilities or disrupt lines of communication in order to create doubt that the government can provide for and protect its citizens
- Discourage foreign investments, tourism, or assistance programs that can affect the target country's economy and support of the government in power
- Influence government decisions, legislation, or other critical decisions
- Free prisoners
- Satisfy vengeance
- Turn the tide in a guerrilla war by forcing government security forces to concentrate their efforts in urban areas. This allows the terrorist group to establish itself among the local populace in rural areas

A global research report An Inclusive World prepared by an international team of researchers from all continents has analyzed causes of present day terrorism. It has reached the conclusions that terrorism all over the world functions like an economic market. There is demand for terrorists placed by greed or grievances. Supply is driven by relative deprivation resulting in triple deficits-developmental deficit, democratic deficit and dignity deficit. Acts of terror take place at the point of intersection between supply and demand. Those placing the demand use religion and other denominators as vehicles to establish links with those on the supply side. This pattern can be observed in all situations ranging from Colombia to Colombo and the Philippines to the Palestine.

Unfortunately the only real way to mitigate this is through economic development of the community, country, and region, but that takes time. For the foreseeable future there will always be those that are disgruntled by the comparison of living standards of the wealthy around the world versus their own, opening the doors to frustration and anger. Thus, this driver is remarkably hard to combat as globalization allows for more mechanisms of comparison between varying global socio-economic levels.

Terrorism is a forceful and unlawful method to achieve the desired goal. Its sole motive is to overthrow the existing law and order machinery. It is a deliberate use of violence against civilians and armed personnel and the state.

Impact of Terrorism on Society and Economy:

Terrorism is a deliberate use of violence against civilians and armed personnel and the state. It is a forceful as well as unlawful method towards the achievement of a desired goal. Its sole motive is to overthrow the existing law and order machinery.

a. Social impacts

Terrorism poses a serious law and order problem and leads to disintegration of society. The incident of murder, torture, mutilation, kidnapping, arson and extortion create atmosphere of suspicion, fear and panic all around. Life becomes uncertain. The terrorists kill unarmed civilians including women and children.

Organized crime and violence cause social disharmony. The inter relationship among various insurgent groups and their foreign linkages bring illegal money and encourages smuggling. Many insurgent groups collect certain percentage of money from the employees and businessmen on regular basis. Economic development of the area comes to an end. Our government has to make heavy expenditure to meet the challenges of terrorism.

A sense of victimhood is common to a society experiencing terrorism. The more the civilian population is targeted, the more this sense of victimhood increases. This sense of victimization in turn leads to a de-legitimization of the terrorists and the people they claim to represent. Consequently, the targeted society becomes unwilling or unable to consider the other side's grievances and objectives.

Another major social effect of terrorism is a rise in ethnocentrism and xenophobia as a group increases its solidarity in the face of violence.

b. Economic impacts

The indirect economic impacts of terrorist attacks, however, are potentially more significant than direct economic ones. The most direct economic effect of a terrorist attack is the damage caused to life and property at the site of the attack. The indirect economic effects of terrorism are many and varied, yet they are very difficult to accurately gauge. A long-running terrorist campaign can definitely impact a state's GDP, as happened to Israel during the second Intifada.

c. Psychological impacts

Children are at high risk for experiencing mental health difficulties after a disaster or act of terrorism include those who are near to or actually witness the event, those who lose loved ones as a result, and even those children who merely live in the affected community or watch coverage of the event on television.

Response to man-made disasters: Terrorism

Presumably there is no direct connection between poverty and terrorist behavior. But in the case of individuals, groups or whole societies, in which a sense of deprivation, relative or absolute, despair, humiliation or general hopelessness about one's future prevail terrorism, will potentially flourish.

Although countering terrorism has been on the agenda of the United Nations System for decades. But the attacks against the United States on 11 September 2001 prompted the Security Council to adopt resolution 1373. This for the first time established the Counter-Terrorism Committee (CTC)

After five years, all Member States of the General Assembly for the first time agreed on a common strategic framework to fight the scourge of terrorism: the UN Global Counter-Terrorism Strategy. The Strategy is a unique instrument to enhance the efforts of the international community to counter terrorism along four pillars:

- Addressing conditions conducive to the spread of terrorism;
- Preventing and combating terrorism;
- Building Member States' capacity to prevent and combat terrorism and to strengthen the role of the United Nations system in this regard;
- Ensuring the respect for human rights for all and the rule of law as the fundamental basis for countering terrorism.
- At the time of the adoption of the Strategy, the General Assembly also endorsed the Counter-Terrorism Implementation Task Force (CTITF), which had been established by the Secretary-General in 2005. Consisting of 38 entities of the UN and affiliated organizations, CTITF works to promote coordination and coherence within the UN System on counter-terrorism and to provide assistance to Member States.
- The UN Counter Terrorism Centre (UNCCT) provides capacity-building assistance to Member States and carries out counter-terrorism projects around the world in line with the four pillars of the Global Strategy.
- The Security Council works to enhance the capacity of Member States to prevent and respond to terrorist acts through its subsidiary bodies, which include the Counter-Terrorism Committee, the 1267/1989/2253 ISIL (Da'esh) and Al-Qaida Sanctions Committee, as well as the 1540 Committee on the non-proliferation of nuclear, chemical, and biological weapons. The Committees are supported in their work by different entities; whereas the Counter-Terrorism Committee has its Executive

Directorate (CTED) to carry out its policy decisions and conduct expert assessments of Member States, the 1267 Committee draws on a Monitoring Team.

Specific risk reduction and preparedness measures :

We cannot eliminate terrorist attacks completely, but the effects of these attacks can be mitigated to a large extent with precautions and pre-emptive strategies. The major characteristic of contemporary terrorism is its unexpectedness hence the time and manner of attacks are unpredictable. Today's terrorists kill in quantity and kill indiscriminately and normally their target is innocent civilians. They use unconventional weapons such as anthrax and radiological material. The physical damage from terror attacks may be smaller than that from large natural disasters but psychological damage of terror attacks is not at all negligible.

❖ The action of reducing the severity, seriousness of the effects of terrorist attacks is possible on four fronts, like

a. Intelligence
b. Deception
c. Physical & Operational Protection
d. Structural Hardening

a. **Intelligence**

To prevent the occurrence of potential terrorist threat we should use intelligence measures which can be done by understanding, preventing and pre-empting moves of the terrorists.

b. **Deception**

Now in deception tactics, the following measures must be followed:

I. the facility is made to appear to be more protected thereby not drawing the attention of an un-researched terrorist

II. the attacker is misdirected to a portion of the facility that is non-critical.

c. Physical & Operational Protection

The third level of preparedness considers implementing physical security measures along with on-line operational security forces in the form of surveillance, guards, and sensors.

d. **Structural Hardening**

When all the previous three measures fail to ward off the attacker, this strategy is built-in to save lives and to facilitate evacuation & rescue.

In spite of the fact that the above stated four strategies of intelligence, deception, physical & operational protection and structural hardening is required to fend off terrorism these can be effective in a different sequence also depending on the type of facility being protected and on the prevalent terrorist threat.

Typical post-disaster needs

Whatever their source or scale of disasters like terrorism may be they bring with them the potential to cause distress. Sometimes that distress is severe. The estimated number of deaths from terrorism worldwide rose from 3,329 in 2000 to 32,685 in 2014, according to a November 2015 analysis by the Institute for Economics and Peace. The vast majority of lives lost to terrorism in 2014 — 78 percent — took place in the five countries where most terrorism activity occurred: Iraq, Nigeria, Afghanistan, Pakistan, and Syria.

a) Psychosocial Support

Every person who is directly or indirectly involved in such an event may be affected and many may need **psychosocial** support. A sizeable minority of people may develop other psychosocial conditions and/or mental disorders for which they require more substantial and, sometimes, sustained intervention, including treatment.

There is high incidence of terrorism. Evidence of numbers of persons affected has increased very rapidly along with the numbers of people killed by these events.

Strategic preparedness supports psychosocial resilience and is, thereby, likely to improve responses to peoples psychosocial needs and reduces the risks of severe distress and mental disorder.

b) Economic needs of Terrorism:

Studies dating back to the early 1990s have investigated the microeconomic consequences of sector-specific attacks particularly in the fields of tourism, trade, and financial sectors. Attacks against tourist venues (e.g., airports, hotels, or attractions) or tourist mode of transportation (e.g., airplanes) make a tourist consider the risks involved with their vacation plans. Even a single heinous act at a popular terrorist venue can cause tourists to alter plans by vacationing to a terrorism-free country for a holiday. So government should take some strategy to ensure people so that tourism does not lose its position as economic support to the country.

c) Insurance claims

The terrorism is also costly for specific sectors of the economy as there are always unexpected claims on insurance

companies. Following the attacks, insurers generally stopped offering policies that covered losses due to terrorism, and these days, the costs of insuring against terrorism are subsidized by the federal government.

d) Net foreign direct investment

Foreign investors must be aware of all kinds of risks, those posed by terrorism.

Case study: Mumbai terrorist attacks of 2008

Since independence India has seen a number of terrorist attacks but the worst among all of these attacks was the 26/11 Mumbai attack of 2008.Multiple coordinated terrorist attacks occurred on November 26–29, 2008, in Mumbai (Bombay), Maharashtra, India's largest city, financial capital, and home to the Bollywood film industry. By selecting to attack Mumbai's most opulent and iconic hotel, the terrorists have sent a powerful message to India's leaders, foreign investors and tourists.

26/11 attack was different in a sense that for the first time, terrorists trained in Pakistan, used the sea route to enter India. The terrorists who participated in 26/11 Mumbai attacks were highly trained. Their objective was to create terror and get some key terrorists released who were involved in Kandahar hijacking episode.

- **The most notable targets were:**
  1. Chhatrapati Shivaji Terminus – formerly known as Victoria Station
  2. The Taj Mahal Palace and Tower Hotel
  3. Leopold Café
  4. The Trident-Oberoi Hotel
  5. Nariman House, a Jewish community center
  6. Cama Hospital

There were also shootings in the streets and strikes on many other locations.

Ten gunmen, believed to be connected to Lashkar-e-Taiba, a Pakistan-based terrorist organization, carried out the attacks. Attackers enter the grounds of the hotel between 9:35 and 9:45 p.m. on November 26. Militants first attack guests around the swimming pool and then move inside to the bars and restaurants of the hotel. Armed with automatic weapons and hand grenades, the terrorists targeted civilians at numerous sites in the southern part of

Mumbai, including the Chhatrapati Shivaji railway station, the popular Leopold Café, two hospitals, and a theatre. While most of the attacks ended within a few hours after they began at around 9:30 pm on November 26, the terror continued to unfold at three locations where hostages were taken—the Nariman House, where a Jewish outreach centre was located, and the luxury hotels Oberoi Trident and TajMahal Palace & Tower.

- **Casualties**

172 people were killed in the attacks. These included many local Mumbaikars, as well as visitors from all over the world. At both hotels, many staff died or was wounded as they attempted to protect their guests.

- **Loopholes**

The terrorist attacks in Mumbai exposed loopholes in the security system that India had in place to deal with this “new brand” of terrorism. These are urban warfare characterized by symbolic attacks, multiple targets, and high casualties.

Although subsequent reports indicate that there were several intelligence warnings by Indian along with U.S. sources before the attacks but that authorities, had ignored them. Moreover the lack of coordination between authorities in the Indian capital of New Delhi and officials in Maharashtra state also weakened the immediate crisis response.

The November attacks prompted the Indian government to introduce important new institutions as well as legal mechanisms to fight terrorism. On December 17, 2008, the Indian parliament consented to the creation of the National Investigation Agency, a federal counterterrorism group whose functions would be similar to many of those of the U.S. Federal Bureau of Investigation. Parliament also approved amendments to the Unlawful Activities (Prevention) Act that incorporated stringent mechanisms to contain and investigate terrorism.

9.16 SUMMARY:

We live in a civilized society where man has become his own enemy because many disastrous events are caused due to negligent human actions. These are known as man-made disasters. In short man-made disasters are those hazards caused directly or indirectly by human action or inaction. There are multiple factors that may relate to manmade disasters such as ignorance, unawareness, illiteracy, carelessly handling danger, chemical weapons etc. Train accidents, aeroplane crashes, collapse of buildings, bridges, mines, tunnels, etc. are some of the common

examples of man-made disasters. These happen as a result of human carelessness or mishandling of dangerous equipment's during technological and industrial use. Human has made much progress in the field of science and technology. With this advancement of science and technology human being is able to built nuclear power plants. Nuclear disaster refers to undesirable effect caused to the environment due to radioactive substances or radiations. Moreover, chemical disaster is the unintentional refuse of one or more hazardous substances which could harm human health or the environment. Bhopal Gas tragedies, AMRI Hospital fire, Kolkata are a few examples of man-made disasters. There is ardent need for Disaster management as it deals with situations that occur prior to, during, and after the disaster.

Terrorism is another man-made disaster which is a deliberate, criminal act. Terrorists use a variety of methods to achieve their ends like, biological, nuclear, incendiary, chemical and explosive. Others such as accidental disasters involve hazardous materials and transportation accidents.

So, regarding man-made disasters one may conclude that faulty technology can lead to costly mishaps. Man-made disasters can cause irreversible damage, and we human beings are causing these disasters because of our ignorance and some even being caused by intent. Most of disasters have taken many innocent lives from human, animals and forest. But we should attempt to prevent calamities before they happen and become more cautious so that we can care for our world and lower the rate of man-made disasters. Sometimes the best response to man-made disasters can be effective planning before tragedy strikes.

9.17 CHECK YOUR PROGRESS/ EXERCISE

1. True false

a. Events which are caused by man either intentionally or by accident are known as Man-made Disasters.

b. A natural activity is termed as a natural disaster even if it has no impact on human.

c. Leakage of toxic chemicals from the industries and accidents in the nuclear reactors has short-term effects like blindness, cancer, paralysis, heart trouble, gastric and respiratory abnormalities and long-term effects like genetic imbalances in humans.

d. On December 2-3 1984 in Bhopal toxic Methyl Isocyanate (MIC) gas leaked from the factory owned by Hindustan Carbide.

e. The 'fire triangle', fuel, oxygen and a source of heat are the three prerequisites for a fire.

f. Forest fires can be broadly classified into three types - ground fires, surface fires, and crown fires, depending on the type of fuel involved and its vertical arrangement.

g. Volcanic eruptions never ignite forest fires, as lava or magma never burns a thing that comes in its way.

h. United Kingdom and Mexico, and the Mediterranean basin are some areas where such spontaneous wildfires are quite common.

i. Throwing of burning cigarettes end or matches and lighting of fires in restricted areas are some of the examples of human carelessness that lead to 80% of all wildfires.

j. Terrorism is a deliberate use of violence against civilians and armed personnel and the state.

2. Fill in the blanks

a. Trained _____ _____ personnel can undertake rescue operations effectively during floods, major fires, building collapses, and some manmade disasters.

b. Regarding Forest Fire Monitoring the introduction of _____ camera supported forest fire observation systems has remarkable responses.

c. Terrorism is a man-made disaster which is a_____, criminal act.

d. Aerial _____ flights are another possible means to detect forest fires at an early stage during times of high fire risk.

e. Forest fire set mainly in _____ forests in the slopes of the sub-Himalayan region.

f. Forest fires can be frequent during the _____summer months, and the periods of _____ and strong winds

g. In AMRI Hospital fire, Kolkata patients were _____ inside wards and with no exit possible.

h. Bhopal Gas tragedy was a result of _____ error and poor supervision at the factory.

i. _____ fires clean up any dead or decaying matter strewn across forest.

j. Terrorist attack is carried out in such a way as to maximize the severity and length of the _____impact.

3. Multiple choice question

a. The forest fires in Uttarakhand have severely affected the
   i. wildlife reserves across the state.
   ii. medicinal plants across the state.
   iii. rabbits and hyenas across the state.

b. India has
   i. enough data regarding forest fire and damages caused by them.
   ii. started data procurement regarding forest fire and damages caused by them very recently.
   iii. very poor data regarding forest fire and damages caused by them.

c. Genuine political terrorism is characterized by
   i. a revolutionary approach and are committed for ideological or political motives
   ii. collective violence interfering with the peace, security, and normal functioning of the community.
   iii. violent criminal behavior designed primarily to generate fear in the community

d. The most important post-disaster needs for forest fire are
   i. efficient and timely rubbing together of clumps of dry bamboos.
   ii. efficient and timely generation and transfer of information related to fire warning.
   iii. efficient and timely accumulation of dead organic matter such as leaves, twigs, and dry branches on the ground.

e. In the Gulf War spill in Persian Gulf
   i. no marine wildlife suffered.
   ii. no question of suffering of marine wildlife as there was no marine life at all
   iii. all marine wildlife suffered a great deal of damage and some local species even disappeared.

4. <u>Answers the following Questions</u>

1) Distinguish between Man-made disaster and Natural disaster.
2) What are the causes of manmade disasters? Elaborate your answer stating different type of manmade disasters.
3) State the response to man-made disasters.
4) What are the Causes and impact of Forest Fire? Explain your answer with special reference to Uttarakhand forest fire in India.
5) What are the Causes and impact of Terrorism? Explain your answer with special reference to Mumbai attack 2008.

9.18 ANSWERS TO THE SELF LEARNING QUESTIONS

1.a.true

1.b. false, A natural activity is not termed as a natural disaster until it has impact on human.

1.c. true

1.d. false, Union Carbide

1.e. true

1.f. true

1.g. Volcanic eruptions ignite forest fires, as the hot lava or magma burns everything that comes in its way.

1.h. false United States and Canada, and the Mediterranean basin

1.i.true

1.j. true

2.a. disaster management

2.b. automatic

2.c. deliberate

2.d. surveillance

2.e. pine

2.f. dry, droughts

2.g. trapped

2.h. human

2.i. forest

2.j. psychological

3.a.i.

3.b.iii.

3.c.i.

3.d.ii

3.e.iii.

9.19 TECHNICAL WORDS:

1. **Blast injuries**- the harmful effects on the body of sudden changes in pressure produced by explosion.
2. **CBRN**- CBRN are weaponized or non-weaponized Chemical, Biological, Radiological and Nuclear materials that can cause great harm and pose significant threats in the hands of terrorists..
3. **Terrorism**- the use of violent acts to frighten the people in an area as a way of trying to achieve a political goal
4. **Trauma nursing**- is treating patients in a state of emergency, and handles urgent situations where the cause of injury or disease isn't yet known.
5. **UNDRO**-United Nations Disaster Relief Organization
6. **Ground fire**-Fire that consumes the organic material beneath the surface litter ground, such as peat fire.
7. **Hazard reduction**-Precautionary controlled and managed fire lit during cooler and wetter weather in order to reduce the available fuel load.

9.20 TASK

1. In a map of India point out the locations of five worst man-made disasters in India.
2. In a chart define terrorism and types of terrorism.

9.21 REFERENCES FOR FURTHER STUDY

1. Leonard Weinberg: Global Terrorism: A Beginner's Guide
2. Tore Bjorgo, ed.: Root Causes of Terrorism: Myths, Reality and Ways Forward (Routledge, 2005) papers from a 2003 experts workshop in Oslo
3. John Horgan: The Psychology of Terrorism (Routledge, 2005)
4. Sundri Khalsa: Forecasting Terrorism: Indicators and Proven Analytical Techniques
5. Ministry of Home Affairs, Govt. of India, Disaster Management in India
6. Module 4 - Capacity Building in Asia using Information Technology Applications (CASITA)
7. Asian Disaster Preparedness Center (ADPC), Bangkok.

8. Encyclopedia of Disaster Management: Volume IV by Alfred Scott
9. Disaster Management- by Mukesh Kapoor
10. Disaster Management-Global Challenges and local solutions-by Rajib Shaw / R. R. Krishnamurthy
11. Manmade Disasters-by K. K. Singh / Lotfi Aleya / Vinod Singh
12. Disaster Management and Strategies-Concept & Methods, Risk Reduction & Insurance, Experiences & Case Studies by Ashu Pasricha / Kiyanoush Ghalavand / Jai Narain Sharma
13. Management of Man-made Disasters-by S. L. Goel
14. Disaster Management: Future Challenges and Opportunities by Jagbir Singh
15. Disaster Management by Harsh K. Gupta
16. O'Brien, G. "UK Emergency Preparedness: A Step in the Right Direction?" Journal of International Affairs, Vol. 59, No. 2 (2006): 79.
17. Mueller, J. and Stewart, M.G., Terror, Security, and Money: Balancing the Risks, Benefits, and Costs of Homeland Security (New York: Oxford University Press, 2011).
18. Oxford dictionary

10

MAN-MADE DISASTER: ROAD, RAIL ACCIDENTS, AIR AND SEA ACCIDENTS

After going through this chapter you will be able to understand the following features:

10.0 OBJECTIVES

By the end of this unit you will be able to –

- Define road accidents with reference to nature
- Learn the geographical distribution of road accidents
- Learn Causes and impact of road accidents
- Understand Response to man-made disasters like road accidents
- Discuss specific risk reduction and preparedness measures for road accidents
- Define typical post-disaster needs for road accidents
- Discuss case studies of road accidents
- Define rail accidents with reference to nature
- Learn the geographical distribution of rail accidents
- Learn Causes and impact of rail accidents
- Understand Response to man-made disasters like rail accidents
- Discuss specific risk reduction and preparedness measures for rail accidents
- Define typical post-disaster needs for rail accidents
- Discuss case studies of rail accidents

- Define air accidents with reference to nature
- Learn the geographical distribution of air accidents
- Learn Causes and impact of air accidents
- Understand Response to man-made disasters like air accidents
- Discuss specific risk reduction and preparedness measures for air accidents
- Define typical post-disaster needs for air accidents
- Discuss case studies of air accidents
- Define sea accidents with reference to nature
- Learn the geographical distribution of sea accidents
- Learn Causes and impact of sea accidents
- Understand Response to man-made disasters like sea accidents
- Discuss specific risk reduction and preparedness measures for sea accidents
- Define typical post-disaster needs for air accidents
- Discuss case studies of air accidents

10.2 INTRODUCTION

In the previous chapters definition of natural disasters, disaster management along with causes and impacts of natural disasters like flood, drought, cyclones, landslides, earthquakes have been discussed. Man-made disasters, its difference from natural disasters and the contrast between the two were also learnt. Forest Fire and Terrorism have been studied. Different case studies regarding these natural and man-made disasters in India and around the world have also been studied. In the present chapter we are going to learn road accidents, rail accidents, air accidents, sea accidents with reference to nature, causes and impact, response to these disasters, specific risk reduction and preparedness measures, typical post-disaster needs, case studies.

10.2 SUBJECT-DISCUSSION

Any country's growth is seen as a direct consequence of transport development. There will not be prosperous growth if there is absence of a well-developed transportation system. Road, rail, air or sea accidents create economic and social crisis. These accidents affect global health too. Each year, road accidents kill more than a million men, women and children around the world.

More than millions are injured, among them innumerable people become permanently disabled.

With the rapid industrialization developed nations recognized the need to address the world's increasing motorization. The United Nations Economic Commission for Europe (UNECE) pioneered a coordinated international road safety policy with The Conventions on Road Traffic (1949; 1968) and the Protocol on Road Sign Signals (1949). Over the past 60 years, these documents have been ratified by over 90 countries and are regularly updated by a body of experts to incorporate new research, technologies and national best practices.

The Indian Railways is the largest rail-passenger carrier in the world. The rapidly growing economy of India has resulted in an exponentially increasing demand for transportation in recent years, and this has led to an enormous rise in the volume of traffic in the Indian Railways network. However, it is a commonly voiced opinion among economists that the current Indian Railways infrastructure is not capable of efficiently handling this increased volume of traffic, and this is resulting in frequent delay in running of trains and increasing cost of transportation.

Air crash is also known as an aviation accident. Much of the aviation such as airplane, helicopter, air balloon and jet plane are designed ensuring a high level of safety. As aviation accidents are unpredictable and unpreventable, accident do happen anytime and harm human life.

Ship accidents have occurred down the ages due to the complex environment in which ships operate. Therefore, oceans are considered the most dangerous workplace on the planet. Several vessel accidents and spills of oil and other fuel in recent years have drawn attention on the potential risks posed by vessels operating in the region. It is observed that maritime disasters have greatly diminished. Improved ships and more efficient navigation systems may be attributed to this. Also the increasing and more or less exclusive use of commercial aviation for passenger transport, especially for international travel has lessened marine travellers. Hence demise of travellers by ship wreck has reduced.

10.3 ROAD ACCIDENTS:

Road accident, considered as a 'global tragedy', is one of the major causes of death and injuries in the world. It has an ever-increasing trend. The problem of road accident is very acute in highway transportation due to complex flow pattern of vehicular traffic, presence of mixed traffic along with pedestrians.

In Asia alone, 400,000 people are killed on the roads annually and more than four million injured. According to WHO, every year, nearly one million people are killed, three millions are severely disabled for life and thirty millions are injured in road traffic accidents. Furthermore, the number of accidents is in constant increase throughout the world. In 1990, death on road accidents remained in 9th rank; and by 2020 road accidents will be the third leading cause of death worldwide.

Traffic accident leads to loss of life and property. Thus the traffic engineers have to undertake a big responsibility of providing safe traffic movements to the road users and ensure their safety. Road accidents cannot be totally prevented but by suitable traffic engineering and management the accident rate can be reduced to a certain extent. For this reason systematic study of traffic accidents are required to be carried out. Proper investigation of the cause of accident will help to propose preventive measures in terms of design and control.

10.3.1 Road accidents with reference to Nature

Road accidents are among the major causes of death and tend to be the most serious problem world over. Worldwide, the number of people killed in road traffic accidents (RTA) each year is estimated at almost 1.2 million, while the number of injured could be as high as 50 million.

❖ The nature of road accidents is as follows:

- Lane departure crashes include head on collisions and run-off-road collisions. These occur when a driver leaves the lane they are in and collide with another vehicle or a roadside object.
- The collisions at junctions include rear-end collision and angle or side impacts.
- Collisions involving pedestrians and cyclists
- Collisions with animals

10.3.2 Geographical distribution

Major car accidents occur near our home because most driving occurs close to home. The following are some of the most common places where car crashes happen:

1. Neighborhoods

It has been said that most car accidents happen close to home. Studies reveal that 52% of all accidents occur within 5 miles from a person's home. Common neighbourhood collisions include crashing into parked cars, backing out of a driveway and into someone driving by and side-swiping a car to avoid pedestrians or other vehicles in the road.

2. Parking Lots

In parking lots the most accidents occur. It is very common for 2 cars backing out of parking spaces to bump each other.

3. Daily Commutes

In large metropolitan areas such as New York and Los Angeles, people may not be completely alert during their commute, as they are either tired from getting up early or tired from working a long day. Moreover, commuters spend hours each day sitting in traffic travelling to and from work. and use this time to multi-task, such as shaving, eating or even reading the newspaper while behind the wheel.

From the above stated list we come to know the common places where usually car accidents occur. While every car crash cannot be avoided, there are certain steps all drivers can take to ensure their safety on the roads.

10.3.3 Causes and impacts of road accidents :

10.3.3.1 Causes of road accidents

Road accidents are undoubtedly the most frequent one. The reasons for this are the extremely dense road traffic and the relatively great freedom of movement given to drivers. The various causes of road accidents are:

1. Road Users:

a. Excessive speed and rash driving -Failing to follow the speed limit is the most common cause of traffic accidents.

b. violation of traffic rules

c. failure to perceive traffic situation or sign or signal in adequate time

d. carelessness

e. driver fatigue and falling asleep in the wheel – According to recently published data driver fatigue is the cause of 2.5-3.0 percent of all roadway related fatalities in the United States.

f. Alcoholic driving: driving while under the influence of a narcotic substance: According to studies driving while under the influence of alcohol results in a 900% increase in the probability of an auto accident.

2. Vehicle-

Common defective automobile and automobile parts failure of the following can cause severe injuries to occupants:

a. brakes

b. steering system

c. tyre burst
d. lighting system
e. seatbelt defects and
f. defective airbags.

3. Road Condition
a. Skidding road surface
b. pot holes
c. ruts

4. Road design–
Defects on Roadway Construction: The improper design of roadways result in hundreds of auto accident fatalities each year.

a. Defective geometric design like inadequate sight distance
b. inadequate width of shoulders
c. improper curve design
d. improper traffic control devices and improper lighting

5. Use of Mobile Phone –
Texting while driving: The proliferation of mobile phone use has resulted into an increased level of danger on our roads.

6. Rubber-necking –
Rubbernecking is another type of distracted driving and takes place when drivers look other things on the road not linked to their driving. Examples include watching other accidents, looking at sunsets, and nice views.

7. Improper Coning off of Construction Zones –
Road work is needed to maintain and built the countries transportation infrastructure. However in many cases road construction crews fail to safely cordon off construction zones resulting in an increased probability of auto accidents.

8. Environmental factors–
Example of weather condition posing the greatest dangers to motorists on the road includes icy roads, high winds, and rain after a prolonged drought resulting in oily surfaces. Moreover, unfavourable weather conditions like mist, snow, smoke and heavy rainfall which restrict normal visibility and makes driving unsafe.

9. Other forms of Distracted Driving –
There are numerous types of distracted driving.
a. improper location of advertisement boards,
b. gate of level crossing not closed when required
c. to loud music or changing the dial
d. reaching for objects in the vehicle.

10.3.3.2 The Impacts of Road Accidents

Road traffic accidents pose a public health and development challenge and greatly affect the human capital development of every nation. The immediate and later physical, social and psychological consequences of a road traffic accident are as follows:

A. Individual –

1. Physical

a. Death
b. Permanent loss of mobility/functioning
c. Fractures
d. Bruising
e. Burns

2. Psychological

a. Feelings of guilt
b. Post traumatic stress
c. Depression
d. Anxiety/fear

3. Economic

a. Loss of earnings
b. Medical bills
c. Damage to property

B. Community

1. Psychological- Traditionally we are aware of the mental health implications of any trauma but most of us tend to associate a road traffic accident with physical injury rather than psychological damage.

a. Loss of trust
b. Loss of family structure

2. Economic
   I. Loss of family income
   II. Loss of community cohesion
   III. Damage to property

C. National

Economic

   I. Loss of productivity

II. Cost to taxpayers: medical, legal, increased insurance premiums, administrative costs, counseling, ACC payments, damage to property

10.3.4 Response to Road Accidents:

Few road users are aware of the factors that could determine the time needed to respond to a vehicle accident. So importance lies in the awareness of these factors. Also steps that road users can take to assist emergency teams in responding swiftly to accidents must be taken into consideration. Up to 46 per cent of road traffic fatalities could be prevented if the right first aid assistance was available in those first moments.

❖ **Responses to Road Accidents are stated under:**

- All emergency medical calls are categorised and prioritised when they are received and resources are allocated according to the category and priority of the call as well as available resources at the time.
- A straight forward and consistent process is followed regarding the caller number and name, what and where the emergency is with all demographic information.
- This information is sent to the Emergency dispatchers through the Integrated Call Taking and immediate dispatch system who then use satellite tracking to allocate the closest, most appropriate resources to the call.

❖ **Following factors play a role in determining the time before a response vehicle will arrive at an accident scene**

- Callers not able to tell what the problem is.
- Third party callers that are not with the patient result in further phone calls to establish the nature of the emergency.
- Inaccurate demographic information
- Cross streets are not known, callers do not know what suburbs they live in or cannot give landmarks to pass on the staff who will attend to the scene.
- Informal settlement streets are not captured and some of the new estates do not have their internal road systems mapped.
- Meeting points are usually agreed where we then rely on a third party (friend, family, member of the public or security) to direct us to the scene.
- Availability and location of resources - we send our closest available resource according to their position in relation to the incident at the time. If our own resources are not available we

will ask service providers in the area to assist where we do not have resources.

- Traffic - we are finding it increasingly difficult to access certain areas during peak traffic times and emergency lanes are often used by non emergency vehicles or have been allocated as additional lanes to assist traffic flow.
- Some drivers are also reluctant to give way to emergency vehicles.

❖ **Possible reason for additional delays, if any**

- Additional delays happen when the vehicles stop responding when they get involved in accidents themselves
- Adverse weather conditions may also cause further delays as normal response driving is not possible.
- Access to the scene of the emergency and the patient is also sometimes restricted when the bystanders come in the way. Sometimes properties also not give easy access once the vehicles arrive.

There are several things can be done by the public also. Those are stated under:

- Public must ensure that they have information such as accurate address details and nature of the incident on hand when calling.
- Landmarks are very useful and in any case, if no street names exist, public must agree on a meeting area at a specific landmark.
- Public should allow emergency vehicle right of way to respond to the emergencies.
- Public should allow access to the scene of the incident and patient/s.
- Send someone to meet the vehicles
- Ensure that security at entrance points are made aware of emergencies in complexes,
- Switch on some outside lights if incident is at night
- Clear access routes and lock away any dangerous or vicious domestic animals.

❖ **Public must be aware of the following facts at the accident scene**

- Emergency services personnel need access to the scene and patients and members of the public can assist by allowing this and leaving them to do their jobs.

- Once the emergency personnel arrive, public must it to them so that they can perform their duty without any hindrance.
- Safety of the public is also a top priority and they must not approach any dangerous area or situation as they may just end up adding to the casualties and increase the workload for the emergency services.
- Members of the public must keep updating the call centre if anything changes or anything may need to change the level of the response or the resources allocated to it and can relay further information to the response team.

❖ **Quick response by emergency medical services to vehicle crashes is an important way to reduce the severity of injuries.**

- Crash victims have a better chance of recovery, if they receive quick medical treatment at the spot of an injury. Hence, improving first aid skills for the general public is a good way to improve survivability after a crash has occurred.
- Improving existing emergency response services, especially where these are currently poor is very important.

❖ **The World Bank suggests the following factors are important for effective post-crash care:**

- Efficient emergency notification
- Fast transport of qualified medical personnel
- Correct diagnosis at the scene
- Stabilization of the patient
- Prompt transport to the point of treatment
- Quality emergency room and trauma care
- Extensive rehabilitation services.

❖ Other emergency services (such as the police or fire brigade) can help make responses times quicker by giving medical services teams accurate information about the location, and the number and severity of injuries.

Several WHO guidelines are also available to help improve post-crash care.

10.3.5 Specific risk reduction and preparedness measures of road accident :

The factors involved in accidents are both internal and external. The risk involved, therefore, covers both.

(i) Internal factors: consist of those about the means of transport—the vehicle the driver and the driven.

(ii) External Factors: consist of people on the road, the other colliding factors, the road-side structure etc.

Unless immediate actions regarding road accidents are taken this will be the fifth leading cause of death by 2030, leading to estimated 2.4 million deaths per year. In addition to mortality, road traffic crashes injure or disable between 20 million and 50 million people a year. Road traffic injuries are predicted to become the third largest contributor to the global burden of disease by 2020. Over 90% of the world's fatalities on the roads occur in low-income and middle income countries, which have only 48% of the world's vehicles. In low-income and middle-income countries, the most vulnerable road users are pedestrians, cyclists or users of motorized two wheelers. So there must be specific risk reduction and preparedness measures of road accident. Drivers should carry an Emergency Kit in his Glove Compartment. He should carry a cell phone, a pen and paper for taking notes, a disposable camera to take photos of the vehicles at the scene, and a card with information about medical allergies or conditions that may require special attention if there are serious injuries. Also, keep a list of contact numbers for law enforcement agencies handy. Stock your glove compartment with small water bottles or pouches of water. Snacks with a long shelf life such as energy bars (replace them with fresh ones when you change your smoke alarm batteries).

❖ **<u>When the accident occurs</u>**

- We should keep calm and avoid panic as far as possible
- We must help family and neighbours who are in difficulty.
- We should follow the orders of the captain and the crew.
- We should keep identity papers and important personal documents such as medical and vaccination certificates and details of blood type at hand
- Other personal medicines must be kept with us in case we need them.
- When a major accident occurs in a road with traffic, one should direct the traffic along with taking care of one's own safety.
- We should not touch or move the seriously wounded unless there is a risk of fire or toxic fumes.
- The witnesses are bound to alert the rescue services and give them the exact location and nature of the accident. They should also provide the information about the type of vehicle involved the characteristics (code number) of any dangerous substances and the likely number of victims.

- Witnesses should also provide their names and addresses.

❖ **After the accident**

- One must keep calm and avoid panic.
- We should follow the instructions of the intervening bodies and of the rescue personnel.
- We must also try to collaborate with the rescuers and with the judicial authorities and experts in charge of the investigation.

10.3.6 Typical post-disaster needs of road accident

1. Stay at the Scene

One can face serious criminal penalties for being a hit-and-run driver if one leaves, particularly if someone sustains injuries or killed. He should never leave the accident scene until it is appropriate to do so.

2. Check on All Drivers and Passengers

Before assessing property damage, one must make sure everyone involved in the accident is alright. Prompt medical attention must be present at the accident spot for anyone who needs it. If a person is unconscious or has neck or back pain, we should not move them until qualified medical help arrives. But if any hazardous situation requires moving the person, that should be done without hesitation, with proper care and expertise.

3. Call the Police

If there's significant property damage, physical injury, or death, we need to call the police. We should also ask that a police report be filed in situations where police do arrive at the scene, and obtain the name and badge numbers of the responding officers.

4. Exchange Information

Get the names, numbers, addresses, drivers' license numbers, license plate numbers, and basic insurance information from all drivers involved. If there are passengers, also obtain their names, numbers, and addresses. In talking to other drivers, try to be cordial and cooperative.

5. Talk to Witnesses

Every witness must be asked for what he or she saw and if possible their names, numbers, or addresses must be collected. The opinion of the local people is also very important and they must be asked if they have ever witnessed other accidents in the same place before or in the same date.

6. Inform Your Insurance Company

We must promptly tell our insurance company that we have been in an accident and cooperate with them and tell them the truth about what happened and the extent of your injuries. Explain the facts clearly.

7. Keep Track of Your Medical Treatment

Note any doctors, physical therapists, chiropractors, or other medical professionals that you receive treatment from, and each medical provider that referred you to other caregivers. Keep a detailed account of the treatments or medications you receive. Also, request copies of all medical reports and bills as these help you prove your medical expenses later.

Medical expenses are relatively easy to document, but pain and suffering is trickier to prove. Keep a record of how your injuries have impacted your daily life. Include any missed workdays, list any routine activities you can't undertake, and describe how the injuries have affected your family life.

8. Photograph and Document the Accident:

Take photographs of any damage to your vehicle as soon as possible after the accident. Photos helps your insurance adjuster determine how much you should be compensated for the damage to your car and can help in court. Use your camera to document the damage to all the vehicles. We should keep in mind that we want our photos to show the overall context of the accident so that we can make our case to a claims adjuster. If there were witnesses, we must try to get their contact information; they may be able to help us if the other drivers dispute our version of what happened. However, we should in no way interfere with the on-going police investigation. If we cannot take pictures at the scene of the accident, we must take them as soon as possible after the accident.

9. Get a Property Damage Valuation

Obtain your insurance company's damage valuation. If you aren't satisfied with how your insurance company has valued your vehicle, don't give up. Get two independent repair estimates or replacement quotes. Assertively inform the adjuster of your concerns. If you can't agree on your car's value, consider mediation or consult an attorney.

10. Use Caution in Discussing the Incident

Don't talk to anyone about the accident other than your lawyer, your insurance company, and the police. Don't talk to a representative of another insurance company, without the knowledge of your attorney or insurer. If called by the other insurance company, be polite, but ask them to call your attorney or

insurer to arrange an interview. Also, tell your lawyer or insurer about the call.

11. Be Wary of Early Settlement Offers

Be careful if you're offered a settlement from an insurance company. Confirm all your physical injuries have been treated. Some injuries don't show up or reach their greatest level of discomfort until many days, weeks, or months later. Don't settle a claim until you know you'll be compensated for all your injuries, and consult an attorney before signing any settlement documents.

12. Consider Hiring an Attorney

If anyone was injured in the accident, it's best to consult an experienced attorney. An attorney can help you maximize your recovery if you're injured or better defend yourself if you're at fault. Most accident attorneys work on a contingency fee basis. That means that your lawyer only receives a fee if you're awarded damages or receive a settlement. Contact an experienced attorney now for a free claim review.

13. Keep Safety First.

Drivers who are involved in minor accidents with no serious injuries should move cars to the side of the road and out of the way of oncoming traffic. If they leave cars parked in the middle of the road or busy intersection additional accidents and injuries may occur. But in a road accident if a car cannot be moved, drivers and passengers should remain in the cars. They must keep their seatbelts fastened for their safety till help arrives. Make sure to turn on hazard lights and set out cones, flares or warning triangles if possible.

14. File An Accident Report.

Although law enforcement officers in many locations may not respond to accidents unless there are injuries, drivers should file a state vehicle accident report, which is available at police stations and often on the Department of Motor Vehicles Web site as a downloadable file. A police report often helps insurance companies speed up the claims process.

15. Know What Your Insurance Covers.

The whole insurance process will be easier following your accident if you know the details of your coverage. For example, don't wait until after an accident to find out that your policy doesn't automatically cover costs for towing or a replacement rental car. Generally, for only a dollar or two extra each month, you can add coverage for rental car reimbursement, which provides a rental car for little or no money while your car is in the repair shop or if it is stolen. Check your policy for specifics.

16. Light sticks and string to attract help.
If you are trapped in the vehicle, you can use the string to swing the light outside the window.

17. Other signalling devices include the rear-view mirror and the backs of CDs.

18. The Life hammer, an all-in-one tool that includes a blade to cut seatbelts and a double-sided hammer to easily and safely break side windows if the doors are stuck or the car is submerged.

19. However minor a car accident is, the driver must stop. In fact, failing to do so is an offence under the Road Traffic Act. He should make sure his car's engine is switched off and then turn his hazard lights on to alert other road users to his presence.

20. Keep a file. Keep all your accident-related documents and information together. This information should include a claim number, the claim's adjuster who is handling the claim, names and phone numbers of all contacts, receipts for a rental car and other expenses incurred as a result of the accident.

Despite the above facts one final question that usually arrives with an accident is who will pay for the damage. In case of a minor accident the drivers may decide to handle the damages themselves without the involvement of an insurance company. But this isn't always the best idea, for several reasons.

a. While the other driver may agree to pay for the damage to the other ones car on the day of the accident, he may see the repair bills and decide it's too high. At this point, time has passed and the insurance company will have more difficulty piecing together the evidence if one files a claim.
b. Also, keep we should keep in mind that we have no way of knowing whether another driver will change his mind and report the accident to his insurance company.

10.3.7 Case study of road accident

❖ **Indian scenario:**

In India road traffic injury is one of the leading causes of mortality and morbidity. Its India's worst kept secret that we have the world's most unsafe roads and the situation seems to be getting worse by the year. In 2004, India had just one per cent of total vehicles in the world but accounted for six per cent of total road accidents. Over 400 people were killed in road accidents every day in 2015, government data reveals. Indian roads, which account for the highest fatalities in the world, became yet more dangerous in

2015 with the number of deaths rising nearly 5% to 1.46 lakh. This translates to a death every 10 minutes on Indian roads, 400 deaths a day or one life snuffed out every 3.6 minutes, in what an expert described as a "daily massacre on our roads".

Fresh data submitted by the Ministry of Road Transport and Highways in the Rajya Sabha (May 2016) indicates just how alarming the situation is. 1,46,133 people were killed in road accidents in India in 2015, a 4.6% rise over 2014 when 1,39,671 people were killed.

In the past one decade, over 1.3 million people have been killed in road accidents but there is still no comprehensive road safety legislation in the country. According to the 234th report of the Standing Committee on Transport, Tourism and Culture which has recently been tabled in Parliament, there are several stumbling blocks for replacing the existing Motor Vehicles Act with a proposed Road Transport and Safety Bill, 2015.

According to the report, the Ministry "wanted to change the entire architecture over road transport and road safety in the whole country, basically, setting up a set of authorities at the Central level and the State level to control all aspects of transport and public transport including driving licences."

However, this has not been possible because "the main hitch is on sharing of revenues between the Centre and the state" in implementing the changes which have been proposed. In an effort to still try and push the safety measures through, the government claims it is trying to focus on noncontroversial, achievable goals such as "an increase in the penalty for drunken driving or increasing the penalty for unauthorized driving, minor driving."

While it is well established that our roads and highways are deadly to travel on, according to the data, the states with the highest number of road accidents in 2015 are Tamil Nadu, Maharashtra, Madhya Pradesh, Karnataka and Kerala. These states contribute 29.66% to the total number of accidents recorded nationwide. The same states also recorded the highest number of injuries at 2,75,873 in 2015.

❖ Road Accident Statistics in India

- Over 1,37,000 people were killed in road accidents in 2013 alone, that is more than the number of people killed in all our wars put together.
- 16 children die on Indian roads daily.
- 5 lives end on Delhi’s roads every day.

- There is one death every four minutes due to a road accident in India.
- One serious road accident in the country occurs every minute and 16 die on Indian roads every hour.
- 1214 road crashes occur every day in India.
- Two wheelers account for 25% of total road crash deaths.
- 20 children under the age of 14 die every day due to road crashes in the country.
- 377 people die every day, equivalent to a jumbo jet crashing every day.
- Two people die every hour in Uttar Pradesh – State with maximum number of road crash deaths.
- Tamil Nadu is the state with the maximum number of road crash injuries
- Top 10 Cities with the highest number of Road Crash Deaths (Rank –Wise):

I. Delhi (City)
II. Chennai
III. Jaipur
IV. Bengaluru
V. Mumbai
VI. Kanpur
VII. Lucknow
VIII. Agra
IX. Hyderabad
X. Pune

(Source of Information: National Crime Records Bureau, Ministry of Road Transport & Highway, Law commission of India, Global status report on road safety 2013)

❖ **Here's a list of past accidents on the Mumbai-Pune expressway:**

May 28, 2016: Traffic disrupted on Mumbai Mumbai-Pune Expressway as a truck turned turtle, driver injured. A truck carrying heavy load of goods turned and toppled at Mumbai-Pune Expressway. There were no reported casualties in the accident, but the incident caused a massive traffic snarl.

May 27, 2016: Pune expressway accident zone: Builder D S Kulkarni injured, driver killed in car mishap.

May 16, 2016: Car crashed with bus on Pune-Mumbai expressway, 6 dead. A car carrying a family of a six collided with a bus on the Mumbai-Pune Expressway. All the passengers in the car including an eight-year-old died in the accident.

May 12, 2016: Hit-and-run: One killed on Mumbai-Pune Expressway. A monk from Ujjain lost his life in a hit-and-run accident on Mumbai-Pune Expressway. Another individual was left critically injured and was sent for treatment at Nigdi-based hospital.

Mar 17, 2016: Bus accident at Mumbai-Pune E-way, Two dead, seven injured. A speeding private bus carrying around 30 passengers hit a road-divider killing two passengers and seriously injuring 3 on the Mumbai-Pune Expressway.

Nov 24, 2015: Tempo accident at Pune-Mumbai Expressway killed 6.A speeding tempo crashed on a telephone post on Mumbai-Pune expressway and toppled. 6 people were killed and over 20 passengers were injured in the road mishap.

Nov 4, 2015: Major accident on Mumbai-Pune E-way, Two dead. A speeding truck rammed into cars on Mumbai-Pune expressway resulting in deaths of two people. Several people were left injured after the accident.

Sep 29, 2015: Two dead as car rams into stalled truck on Mumbai-Pune Expressway.

A car carrying 5 passengers rammed into a truck which was parked on the wrong side of the lane. The accident led to deaths of two passengers, injuring the remaining three, including an 18-month-old girl.

Sep 22, 2015: Expressway accident: Seven killed in yet another accident.

A speeding SUV rammed into a dumper truck on Pune-Mumbai expressway, killing seven people, including four women. Two people suffered minor injuries in the accident.

A state-run bus from from Telangana carrying 17 passengers and two drivers, rammed into a parked tempo on Mumbai-Pune E-way. The passengers including the driver and the conductor suffered injuries in the mishap.

To conclude it may be said that nothing should outrage a civilized country more than the avoidable loss of human life. When we see the scale of that loss is nearly 1.5 lakh a year with a rising trend our conscience demands action to prevent it. Strict implementation of simple traffic rules and transport norms can go a long way towards drastically reducing these deaths. But if not so, the dubious distinction of being the country with the largest number of road accident victims will remain ours.

10.4 RAIL ACCIDENTS

10.4.1 Rail accidents with reference to nature :

Railway accidents are comparatively rare but their consequences can be very severe, involving many injuries and loss of life. A high speed crash or derailment is inevitably very high profile in the media and can cause disruption to transport links for many weeks. The nature of the equipment involved often means that even 'minor' incidents can have significant operational and financial consequences.

Railway accidents include incidents such as:

a. Derailments
b. Collisions with objects on the track
c. Collisions with vehicles on level crossings
d. Potential inadequate maintenance of track and rolling stock
e. Mechanical failure of the permanent way and rolling stock
f. Fires on trains and in the load on trains

10.4.2 Geographical distribution of Rail accidents :

Train accidents are common around the world. Unfortunately when these accidents occur, people are often seriously injured or even killed. Accidents involving trains are often the result of mechanical failures and human error, and often it’s a combination of both.

Indian Railways (IR), the largest rail passenger carrier in the world, has experienced 11 major accidents due to derailment or collision between trains in the year 2010, leading to several human casualties and large-scale disruptions in traffic. Alarmingly, 8 of these 11 accidents have occurred within a specific geographical region known as the Indo-Gangetic plain.

10.4.3 Causes and Impact of rail accidents :

A rail accident is a type of disaster involving one or more trains. Rail accidents occur when trains travelling on the same tracks collide or when trains derail because of technical faults in the

rolling stock, the rails or the security systems, or because of landslides, avalanches or objects obstructing the rails by deliberate actions, such as terrorist attacks.

Causes

Generally, these accidents cannot be avoided because the train driver or security personnel do not have enough time to react. Such accidents cause direct and indirect damage to people and the environment, especially when they involve trains carrying freight or dangerous or polluting substances.

A majority of the train accidents that take place in India are due to human error. CNN-IBN has accessed an internal safety report of the Railways which says that 18 of 21 accidents in the last four months took place due to human error. Manpower shortage, financial bottlenecks and delay in installing anti-collision devices are among key reasons why safety is being compromised. Reports also show that there are shortages of 16,000 locomotive drivers in the railways. When driver over speed and skip red signals accidents happen. There is shortage of drivers too.

There are a variety of different reasons that these railroad accidents occur, and some of these include:

- Train conductor negligence
- Train derailment
- Improper maintenance of the train tracks
- Faulty equipment
- Collision with another train
- Collision with a car, bus or truck trying to cross train tracks
- Collapsed bridges
- Faulty train crossings- The number of European level crossing crashes between 1990 and 2009 remained the same in relation to the number of passenger kilometers travelled. This makes level crossing crashes a high priority issue. For example, in 1999 a passenger train collided with a tractor-semitrailer at a grade crossing in Bourbonnais, Illinois. U.S.

❖ **<u>Major reasons leading to rail accidents in India are as follows:</u>**

1. <u>Low investment</u>

- Official records say that the Indian Railway is carrying 15 times more people than its capacity for the past 20-23 years. Hence, damaging the old tracks is done by overloading.

- Most of the Indian trains are not equipped with fire detection systems. Sometimes smoke and fire detection systems are installed in AC coaches but not in the other compartments of the same train. Detecting fire in the open coaches is more problematic.
- In some nations devices to automatically stop the train if it crosses red signal are in place. These avert head on collisions to a great extent. But no such devices are provided in Indian Railways leading to certain avoidable collisions.
- Train crashes caused by carriage and equipment failure must be avoided by for example timely inspections and maintenance.

2. Human errors

The Human factor has proved to be the direct cause of several train crashes. Many studies have been carried out within this factor and contain aspects of the human factor through investigations of crash causes and user-friendly instruments and tools. The term is often used to denote the human tendency to misunderstand, make miscalculations, and mistakes. It has been found out by CNN-IBN after assessing the internal safety report of the Railways that 18 out of every 21 accidents occur because of human error.

- As the Indian Railways lacks new technologies, the chances of human error are more. Hence, it is one of the major causes of rail accidents in India.
- Moreover the organizations compromise on the safety measures because of low investment, delay in installing anti-collision devices and shortage in manpower.
- Shortage of staff is another major reason leading to human errors. Less staff means work overload. In India train accidents also occur because of the fault of driver and negligence of railway staff.
- Manual signaling system between stations must be replaced with automated one. Again this needs a huge investment, maintenance and management.

3. Unmanned crossings

- 15,000 crossings out of 50,000 in India are unmanned.
- Existing level-crossings have been improved and the construction of new ones has been minimized.
- Road users do not take proper precautions and cross lines even if the signal is red leading to accident. Overpass bridges, flyovers and fencing are done to reduce the accidents.

4. Physical environment

Physical environment factors can also be reasons for crashes.

- In the early days, trains sometimes collided with cows, but it did not create any severe injury events.
- Bridge collapses were other hazards.
- Improved materials and performance of railway tracks have reduced the number of crashes caused by, e.g., the weather or climate, which cause heat distortions of tracks, ice formations, problems induced by snow.
- The Physical environment such as bridges or steep embankments can further aggravate the crash.

Impact of Rail Accidents :

Train crashes causing severe consequences for passengers are not a problem of the past, rather they continue to be highly relevant today.

❖ Environmental

- In a rail accident, the damage is not only limited to the people injured or killed but also affect the environment by contaminating the surrounding area. These damages require extensive remediation and cleanup. Moreover a rail accident has significant effect on individuals as well as organizations regarding property damage and financial loss. They may even be injured or become ill as a result of toxic substances released into the environment by a train crash.
- Disruption of rail traffic.
- Loss of commercial and public confidence in the transport system.
- Often, physical environment made it difficult to evacuate and transport the injured from the steep embankment to the road.
- Further, railway crashes might happen far from roads as was the case when two trains collided head-on due to a signal malfunction in Japan, 1991, The rural setting of the crash hampered rescue efforts.

❖ Human factors

The Human factors also play an important role in the post-crash phase.

- Evacuation knowledge and well prepared train crew affect the outcome because, only if passengers are provided with

appropriate safety critical information they will be able to know how to handle the situation when it arises.

- Besides the physical injuries, train crashes affect the whole person (psychological, social, and existential).
- There are many studies focusing on, for example, psychological and psychiatric effects such as posttraumatic stress disorder (PTSD) among people who have been involved in serious disasters.
- Survivor's reactions are considered severe immediately after the event, but many people find pathways to recovery. There are survivors who experience trauma affects from 5 years after event to lifelong.

❖ Socio-economical environment factors

The Socio-economical environment factors comprise, e.g., guidelines, competence, resources, and disaster plans.

- If rescue personnel are not prepared and trained for a train crash, this will most likely affect the outcome. In a 2008 train crash in Los Angeles, two of the fatalities were passengers trapped under debris. They most likely they died from asphyxia due to the prolonged extrication time.

10.4.3 Response to rail accident :

Response: Once the Emergency occurs, the railway authorities coordinate with external organizations, perform the initial measures on the field, deploy staff on the site and define the need of technical means support. In this phase, the Emergency is usually solved by external organizations with the support of the railway authorities.

The first persons arriving at a railway accident site can render valuable assistance to minimise injury and loss of life, reduce property loss through damage, and prevent loss of clues and evidence that can identify the factors that contributed to the accident. Often Police and Emergency Services and representatives of the Railway Network Owner and/or Railway Operator are the first trained personnel to arrive at railway accident sites. In addition, supervisory officers coordinate response and recovery from locations off-site. Some of the responses are as follows:

- Emergency spill and hazmat response
- Licensed transportation services
- Railroad emergency response services
- Scrap metal bin services

- Scrap metal processing
- Site remediation
- Waste bulking and packaging
- Waste characterization and identification
- Waste container services
- Waste manifesting, tracking and reporting
- Waste transportation and disposal services

❖ <u>The following are some reportable matters in relation to rail accidents</u>:

1. The death of, or a serious injury to, a person on board the rail vehicle or in contact with the rail vehicle or anything attached to the rail vehicle or anything that has become detached from the rail vehicle.
2. A collision between the rail vehicle and one or more other rail vehicles, resulting in serious damage to any of the rail vehicles.
3. A collision between the rail vehicle and a person or vehicle at a level crossing, including a pedestrian crossing.
4. A collision between the rail vehicle and an obstruction that results in serious damage to, or destruction of, the rail vehicle or obstruction.
5. A running line derailment of the rail vehicle.

10.5.4 Specific risk reduction and preparedness measures of rail accident :

Preparedness: At this stage, the railway authorities define capacities, maintain the resources (human and technical) and define the Emergency Plans and Organization to be prepared for an unlikely Emergency situation. Preparedness largely approaches to achieve risk reduction from ‘‘people’’ side. So, preparedness may be largely common to all hazards but prevention and mitigation have to be hazard specific. Preparedness may be a matter of inculcation and readiness but prevention & mitigation have to be concrete and specific. Preparedness is people and area specific.

Best of preventive measures cannot ensure that disaster would not happen. Therefore it is essential to be prepared for emergency response through having an effective “Disaster Management Plan”, backed by provision of adequate support capacity and empowered delegation to enable response team to tackle the situation. Plan should be supported by provision of requisite infrastructure, reserved and kept spare in readiness for

emergency and otherwise. Indian Railways emergency response system has all these elements.

❖ Risk Reduction Programmes are as follows:

- Identifying, collecting and analyzing precursor accident data to identify risks
- Developing voluntary pilot programs in cooperation with stakeholders that are designed to mitigate identified and potential risks
- Propagating and institutionalizing best practices and lessons learned to the entire rail industry
- Providing analytical support, data, and recommendations needed by stakeholders to develop strategies, plans and processes to improve safety and promote positive organizational change

❖ The objectives to be achieved in case of a train accident are:

I. Save life and alleviate suffering,
II. Protect property including mails,
III. Provide succor and help to other passengers at the site of accident,
IV. Ascertain cause of the accident, and
V. Restore through lines of communication.

In order to make the above expeditiously possible, all railway resources in men and material, as warranted specific to the situation, are required to be promptly made available. This is legislated as written instructions. It is also strictly observed should the situation so require.

Railway's rolling stock is of special nature. So, in case of a railway accident, special equipment to clear the site is required. Railway tracks also pass through non-habited zones. Therefore, Indian Railways has provided specialised rail mounted Accident Relief Medical Vans (ARMVs) and Accident Relief Trains (ARTs). These can be either self propelled (SPARMVs / SPARTs) or locomotive hauled. The self propelled units have excellent mobility with superior speed potential. Hence the use of these units have increased and replaced conventional units except in case of ARTs having heavy lift 140T crane in its composition.

The Accident Relief Medical Vans (ARMVs) are specialised vans which have two or three coach units. In a two-coach format one coach has emergency medical relief including a mini operation theatre, while the other coach carries required rescue equipment including portable hydraulic and / or electrical cutters to cut open

railway coaches for rescuing trapped passengers should the need arise. The third coach in three-coach format generally carries additional equipment and staff. Movement to the site of accident depends highly on their distance from site. Other factors include obstruction of the railway tracks due the accident. Keeping these points in view Railways always keep co-ordination with various non-railway, government /non-government agencies, as this would help them further and their resources can be requisitioned immediately to help the affected persons.

The Disaster Management Act 2005 envisages participation by all stake holders based on their expertise. It has also been the experience that the golden hour is invariably managed by few on-board railway staff, railway staff working in vicinity, unaffected train passengers, local police and fire brigade, local hospitals and doctors and other rescue workers in the nearby areas.

The Accident Relief Trains are provided with necessary re-railing / handling equipment to clear the site of accident.

The location and beat of each ARMV and ART is clearly laid down and well publicised for information of all concerned. This is also available at all control rooms for requisitioning incase of need. ARMV and / or ART of adjoining and other beats can also be requisitioned should the need arise. Whenever any unit is not available for maintenance or any other reason the same is pre-informed to similar adjoining units so as to be available in readiness.

In order to keep ARMVs and ARTs in good fettle and readiness certain minimum staff is available with these, whereas other required pre-nominated staff is normally employed in their regular duties. In case of requirement these staff is automatically called. This system of dedicated staff supported by sufficient trained additional manpower, when needed, ensures provision of requisite resources, reserved and kept spare in readiness for emergency.

❖ **Training and preparedness of <u>rail accident</u>:**

Cyclic training and retraining of manpower, system of periodic inspections of the resource and rehearsing and examination of preparedness through mock drills are essential ingredients of a sound disaster response mechanism. These all elements are provided in railways disaster response system. The dedicated and nominated staffs for ARMVs and ARTs have specific work assigned to them in case called for. For example if the break down crane has to be brought in use pre-assigned staff by himself takes over the duty of watching supports ensuring stability of the crane. Both kinds of staff are sent for periodic training and

knowledge up gradation to zonal as well as divisional training schools. Even the officers are given training on disaster management at National Academy of Indian Railways at Vadodra. Active assistance of NDRF is also being taken for four week training of trainers on disaster management, who in turn becomes nodes for imparting further awareness among frontline staff. Extract from the relevant paras pertaining to disaster management training are at annexure 3 for reference purposes only. There is a well laid out system of periodic inspections of both ARMVs and ARTs at various levels with frequency increasing from weekly inspections at supervisory level to quarterly inspections at divisional officer's level. This is also a scheduled item of inspection during safety audit of the division and / or inspection at zonal level by Principal Head of Department of concerned officer who is invariably an HAG level officer. The preparedness of system is practiced through "mock drills". These are planned/"surprise" exercises wherein a situation is artificially created and ARMV / ART 'ordered' to carry out prescribed task. The exercise is also carried out at a larger scale involving other participants like NDRF and other stake holders in order to have synchronisation and coordination should the need arise. The system is tested for response from time to time by actual ordering of the ARMV and / or ART in day as well as night to check actual response in terms of available of manpower, readiness of system to turn out required unit in specified time etc. Incidentally the prescribed time for turning out ART during day and night is 30 minutes and 45 minutes respectively. Similarly the ARMV is to be turned out in 25 minutes and 15 minutes depending upon single exit or double exit irrespective of day or night.

10.5.6 Typical post-disaster needs of rail accident :

Recovery: This phase begins once the Emergency is solved (usually the injured people have been treated, the site has been processed by all the organizations according to their duties and those external organizations have finished their main tasks). Here, the railway authorities take a leading position with their own resources (human and technical) in order to restore the railway service as soon as possible. The findings of the emergency (accident) investigation are the basis to create or modify the safety rules and recommendations. This is known as the 360º safety circle.

1. Prevent the marshalling of the form of energy in the first place
2. Reduce the amount of energy marshalled
3. Prevent the release of energy
4. Modify the rate of spatial distribution of release of the energy from its source

5. Separate, in space or time, the energy being released from the susceptible structure
6. Separation by “barrier”
7. Modify appropriately contact surfaces (softening)
8. Strengthen the human resistance
9. Prevent aggravation of occurred injury event – emergency care
10. Restoration and rehabilitation of those injured

10.4.7 Case study of rail accident: India :

The Dehradun-Varanasi Janata Express (train number 14266) derailed near Bachhrawan in Uttar Pradesh, northern India, on 20 March 2015. The train was the Janata Express from Dehradun to Varanasi. Coming from Dehradun, the Janta Express train was heading for Varanasi, when the engine jumped the rails and its first two coaches, packed with passengers, collapsed, leaving 80 persons trapped. This accident occurred at 09:10 local time when a passenger train overshot a signal at Bachhrawan, Uttar Pradesh. As a result the locomotive and two carriages were derailed. In the train there were more than 400 passengers and 85 members of staff.

At least fifty-eight deaths and 150 people were injured in this accident.

The driver reported by radio that his brakes had failed, and that he could not stop the train. It was diverted into a siding and crashed through the buffers at Bachhrawan.

A team of doctors from the King George Medical University Hospital in Lucknow was dispatched to the scene of the accident. The injured were taken to the King George Medical University and Sanjay Gandhi Post Graduate Institute of Medical Sciences in Lucknow, or to a hospital in Rae Bareli.

The trapped passengers could be brought out only after steel cutting machines reached the site. Rescue workers used cutting machines to free passengers and recover the dead bodies, a witness said. Blood was splattered in and around the wreckage. The rescue operations concluded around 4 pm, with Divisional Railway Manager A K Lahoti declaring. The critically injured were sent to Sanjay Gandhi Post Graduate Institute of Medical Sciences and King George’s Medical University in Lucknow, while the others were admitted to the district hospital at Rae Bareli.

The police had a tough time controlling local villagers, who rushed to the spot.

10.5 AIR ACCIDENTS

In spite of air travel widely considered to be the safest form of travel it is still in its infancy and when midair calamity strikes, the results are often catastrophic.

10.5. 1Air accidents with reference to nature :

Take-off and landing are different phases of the flight. At these points the risks are greatest. It is found that most accidents occur in the immediate vicinity of airports.

In air accidents vertical distortion and horizontal contusion of the body are symptomatic of injuries of passengers and crew. The injured person is generally found poly traumatized. Hence to preserve life in such cases maximum organization, precision, and speed on the part of the local and regional rescue services is required. Moreover, careful enquiries into such catastrophes are indispensible for the development of effective preventive measures.

Another important point noted that over the last decade that 10% of all fatal aviation accidents occurred while the planes were on the ground. 22% of all fatal airline accidents have occurred during the “takeoff and climb” phase which involve three distinct phases, according to aviation experts.

The takeoff phase occurs when the plane is accelerating down the runway, while the initial climb is the steep ascent as the plane leaves the ground, followed by a gentler climb to cruising altitude.

Over the past ten years, six fatal accidents occurred during takeoff, four during the initial climb, and six during the climb-to-cruising altitude phase.

One such crash occurred in July 2000, when an Air France Concorde struck debris on the runway at Charles de Gaulle Airport in Paris, causing a catastrophic explosion shortly after takeoff.

When accidents do occur during cruising phase, however, they are far more dangerous for passengers. The seven fatal accidents documented in Boeing’s study resulted in 774 fatalities — or 20% of the 3,884 fatalities in commercial aviation accidents from 2004 to 2013.

The disappearance of MH370 over the Indian Ocean in March 2014, the shooting down of MH17 over Ukraine in July 2014 and the German wings flight in March 2015 was three notable incidents that occurred while the aircraft were cruising.

The descent, approach and landing phase of a flight is by far the most dangerous.

The point at which the aircraft begins to descend from its cruising altitude in preparation for landing marks the beginning of the phase in which most fatal aviation accidents occur.

10.5.2 Geographical distribution of air accidents :

Despite the series of high profile crashes in recent years that have seen a rise in the number of fatalities, the rate of aircraft accidents is low.

Figures from the Bureau of Aircraft Accident Archives (BAAA) make the German wings crash in the Alps the 17th such incident in 2015 compared to 33 that occurred up to the same point in 2014.

It also takes the total number of fatalities for 2015 so far at 247, which assumes the 150 on board today's German wings crash have all died.

In 2014, the BAAA say 1,328 died in aircraft accidents - the highest annual fatality figure since 2005 due to a series of crashes including Air Asia flight QZ8501 and the downing of MH17 in Ukraine. The organisation counts military transport planes and any aircraft capable of carrying six or more passengers.

The Aviation Safety Network put the number of fatalities, excluding QZ8501, at 526 for 2014, the highest since 2010. The ASN figures only include aircraft capable of carrying 14 or more passengers and exclude military aircraft. It also reportedly excludes casualties from hostile actions, such as the MH17 incident.

Using annual aircraft departure figures collated by the World Bank and the International Civil Aviation Organization, we can calculate the rough accident and fatality rate per million departures for the BAAA and ASN (with AirAsia added) figures up to 2014. I say rough as the coverage of countries in the World Bank dataset varies from year to year.

10.5.3 Causes and impact of air accidents :

10.5.3.1 The Most Common Reasons for air accidents :

Any news of air accident instantly raises questions about aircraft safety and the threat of terrorism. But without knowing the facts, it is not suggestible to speculate on what might actually have caused a specific crash. There are various causes behind any air accident. They are discussed below:

1. **Pilot Error**: The proportion of crashes caused by pilot error has increased. Half of all plane crashes are caused by pilot error. Aircraft are complex machines and so it requires a lot of management. Pilots are actively engaged with the aircraft at every stage of a flight so there are numerous opportunities for this to go wrong. This may include failing to programme the vital flight-management computer (FMC) correctly to miscalculating the required fuel uplift. Pilots must navigate through dangerous weather, respond to mechanical issues and execute a safe takeoff and landing. Some plane accidents are caused when pilots misread equipment, misjudge weather conditions or fail to recognize mechanical errors until it's too late.

Sometimes plane crashes happen when pilots become incapacitated during critical points of a flight. In 2005, a Helios Airways flight to Greece crashed because the flight cabin depressurized, incapacitating the entire flight crew. Some pilot errors can even be the result of mental problems. A flight to Tokyo crashed in 1987 because a pilot who was known to have serious psychological problems put the plane's engines into reverse mid-flight.

While such errors are regrettable, it is important to remember that the pilot is the last line of defence when things go catastrophically wrong.

2. **Mechanical Error**. The second most common cause of plane crashes is mechanical error. Equipment failures still account for around 20%-22% of all aviation accidents, despite improvements in design and manufacturing quality. While engines are significantly more reliable today than they were half a century ago, they still occasionally suffer catastrophic failures. Some mechanical errors occur because of a flaw in the plane's design. For example, in 1974 a Turkish Airlines flight to France crashed because of a design flaw in the latch of the cargo door. Sometimes, mechanical failure occurs when outside circumstances damage the plane. For example, in 1962 a United Airlines flight crashed because it was struck by a single swan that tore off the plane's left horizontal stabilizer. Birds have caused at least seven plane crashes to date.

3. **Weather**. Around 12% of all plane crashes are caused by bad weather conditions. Although flights are often grounded when weather conditions are deemed hazardous, storms, heavy winds and even fog can sneak up on pilots and air traffic controllers. Lightning strikes can be especially dangerous. Aviation accidents have happened because lightning caused electrical failure, because it ignited fuel tanks and pipes, and even because the flash itself caused temporary blindness.

Sometimes milder weather conditions can cause plane crashes as in the case of a flight to Lebanon in 1977.Here the pilot encountered a thick fog as he prepared to land. Circling back, he retried the landing several more times before fuel ran out and the plane could no longer stay aloft. In 2010, an Indonesian plane carrying 103 passengers crashed when inclement weather conditions caused the pilot to overshoot the runway. The plane skidded into a pool of water at the end of the runway and crashed into a nearby hillside. The impact of the crash caused the jet to break in half.

4. **Sabotage.** Plane crashes that are caused by sabotage account for about 9% of total plane crashes. Some sabotaged flights crash because of hijackers, and of course the most notable examples are the three flights that were hijacked on September 11th. But despite increasingly strict TSA regulations, some passengers still manage to smuggle bombs or firearms onto planes. When they're successful, a single passenger can bring down a jet, killing hundreds of people.

5. **Other Human Error**. About 7%, plane crashes are caused by some kinds of human errors. Several plane crashes are caused by air traffic controllers. Air traffic control mistakes have caused planes to crash into mountains, to land on occupied runways and even to collide in midair. Human error also lies in the field when a plane is loaded, fueled or maintained incorrectly. One of the more common fatal mistakes caused by humans is something called "fuel starvation" – but this isn't always the result of an improperly filled fuel tank. A Coastal Airlines flight in 1948 crashed because the fuel valves were positioned incorrectly, causing both engines to pull fuel from a single tank.

10.5.3.2 Impact of air accidents

Accident of an aircraft leads to human injury or even loss of human life, it also influence the reputation and the economy of air transportation industry of the country. To reduce the rate of accident researchers are addressing problem from various perspectives including improving meteorological forecasting techniques, collecting additional weather data automatically via on-board sensors and flight modems, and improving weather data dissemination.

❖ Economic effect

- If fewer people travel then there is a negative effect on the economy. If the same numbers of people travel, just on different airlines, then the overall effect is zero,

- Much cash moves around as there is insurance claims and paying the lawyers,
- At the crash site, there is much localized spending - securing the site, investigating the site, meals and accommodations for all those attending the site,
- An airline needs to buy a new aircraft,
- CNN needs to charter helicopters to fly over the crash site for the next three days. Employment for talking heads in Atlanta goes up,
- Funerals are expensive.
- The cost of rescue operations, recovering bodies, retrieving aircraft wreckage and investigation can run into millions of dollars.

❖ Emotional effect

Although the risk of dying in an air accident is very small (there is a much greater chance of being killed in a road accident), the public reaction to such events is intense. Loss of confidence in an airline, or in flying generally, is common, whether the accident was fatal or not. Crashes have other serious consequences.

❖ Psychological effect

Psychological research has shown that air accidents can cause serious mental health consequences for victims. These consequences take the form of Posttraumatic Stress Disorder and a variety of other disorders and symptoms which have been less investigated.

10.5.4 Response to air accidents :

Emergency Response begins as soon as an air crash is identified or reported. The numbering sequence is not meant to establish priority as all actions should be done as soon as possible.

Aircraft accidents are complex and unfortunate events that require a deft personal and corporate response. A company's first and highest responsibility is to the families of those involved in the accident. Every appropriate provision for their comfort and accommodation should be considered, assigned and acted upon first, prior to internal company or public comment. Company management should take steps immediately to notify the families, offer counseling and other support, make needed arrangements and keep them informed.

The primary sources for information regarding the aircraft, crew and passengers involved typically are internal and can be obtained from sources such as flight department records, flight department personnel not involved in the accident, company

human resource departments or personnel departments. The leadership of those departments should be contacted at the outset. Legal counsel, public affairs and investor-relations personnel, and insurance providers also should be contacted immediately.

Aircraft accidents often generate acute levels of public and professional scrutiny previously not experienced by management, in an area outside their expertise. Although this attention typically is long-term as an investigation unfolds, the broader public's interest usually is ephemeral. The early acknowledgment of and stated regret for an obvious tragedy, responsibility for the families of those involved in the accident, and a demonstrable corporate attitude of proactive cooperation with investigating authorities are highly recommended. The public's perception of a company's professionalism in the wake of a crisis often significantly influences public and shareholder opinion of the company's competency.

Ultimately, safety is the responsibility of company management, from the CEO down, and it should be treated as a fundamental matter of the company culture. Management should articulate in writing a strong, permanent and visible commitment to safety. Past aircraft accident investigators have noted that the implementation of corporate safety standards for air transportation often effectively prevent most accidents before they occur.

In the event an accident does occur, company management should have procedures in place to help them respond to the crisis quickly and effectively. The following sections recommend specific actions that company representatives should (or should not) take in the aftermath of an aircraft accident. They also identify the facts company representatives should know about the accident and about business aviation in general in order for them to answer likely press and public inquiries successfully.

❖ <u>To protect life, property and evidence the following should be kept in mind</u>

- Establish a security perimeter around the accident scene.
- Allow Public Safety Personnel access to preserve life, recover the fatally injured and stabilize hazardous materials.
- Prevent disturbance of the accident scene and the wreckage.
- Protect and preserve ground scars and marks made by the aircraft, vehicle, train, vessel, pipeline, and other physical evidence related to the accident.
- Document and photograph pavement evidence prior to re-opening of roadway. Mark possible evidence for analysis by the NTSB investigators upon arrival.

- Remove highway vehicles to a secure location and ensure that recovery operations do not alter critical pre-crash adjustments such as airbrake settings.
- Maintain a record of personnel who enter the accident scene.

10.5.5 Specific risk reduction and preparedness measures air accident :

10.5.5.1 Risk reduction :

In major aircraft accident wreckage, bodies and survivors may be strewn over a wide area. This situation is further complicated by hazardous cargo. The under stated measures may be taken as risk reduction.

- Automation is supposed to relieve an aircraft pilot's workload and reduce errors. The reality can unfortunately be very different sometimes. When the pilot and the aircraft do not interact as foreseen, automation technology can be the cause of disturbing instability, which has resulted in catastrophic failures.
- A risk reduction strategy has been developed for carriage of dangerous goods by air. When implemented it makes the carriage of these goods an acceptable practice.
- Approach and landing accident reduction (ALAR) has long been among the primary goals of the Flight Safety Foundation (FSF). When the international FSF ALAR Task Force published its report in 1998, it cited data showing that an average of 17 fatal ALAs had occurred each year from 1980 through 1998 in passenger and cargo operations involving aircraft weighing 5,700 kg/12,500 lb or more. The task force's work, and the subsequent safety products and international workshops on the subject, have helped reduce the risk of ALAs — but the accidents still occur.

10.5.5.2 Preparedness :

Preparedness involves actions designed to save lives and minimize damage. It is planning and training prior to a major air crash for appropriate response when an emergency occurs.

❖ In Preparedness measures the following are taken into consideration.

All responders will:

- Maintain a resource inventory of equipment and manpower which could be utilized.
- Train personnel in the responsibilities and emergency duties required under this plan.
- Conduct periodic exercises that will test the effectiveness of this plan.

- Review and update the plan as needed based on exercises, emergency response or changes in policy.
- Follow the established communications network identified in this plan

10.5.6 Typical post-disaster needs in air accidents :

Plane crashes are catastrophic, but not necessarily are un-survivable events. The National Transportation Safety Board stated in a report that the survival rate of crashes was 95.7%, analyzing airline accidents from 1983 to 2000. Sure, there are some accidents where everyone, or nearly everyone, died, but those are much rarer than you'd guess based on what you see in the news. The NTSB found that even in serious accidents where fire and substantial damage occurred, 76.6% of passengers still survived.

❖ 10 tips that could save a life in air accidents

1. If one has survived the crash landing, one has a chance of getting out of the airplane alive that too within 90 seconds only. This is because it takes, on average, just 90 seconds for a fire to burn through the plane's aluminum fuselage and consumes everything and everyone in it.
2. Young, slender men have the best chances of surviving a plane crash. Escaping a plane crash requires one to maneuver quickly through narrow aisles with luggage and wreckage strung about.
3. If possible travelers should fly in bigger planes if possible. One should also avoid regional carriers if possible as they have an accidents and incidents rate double that of national carriers and their pilots are often less experienced and overworked.
4. One should focus on finding a seat near an exit while flying
5. We should overcome the normalcy bias with an action plan. The Normalcy Bias causes our brains to assume that things will be predictable and normal all the time. When things aren't normal, it takes our brain a long time to process this. Instead of springing to action when something unexpected happens, our brain figures that what has happened cannot be so bad, because truly bad events are so out of the ordinary.
6. The flyer must read the safety card and listen to the flight attendants when they give their pre-flight safety spiel. A frequent flier may think he is justifiably confident, but he probably complacent. The FAA found in a report published a few years ago, that frequent fliers were the least informed on what to do and most susceptible to the normalcy bias in the event of a plane crash.

7. In the aviation world, Plus 3/Minus 8 refers to the first three minutes after takeoff and the last eight minutes before landing. According to flight crash investigators, close to 80% of all plane crashes occur during this timeframe. Hence, if you want to up your chances of survival, you need to be extra vigilant and ready to take action during the first 3 minutes after takeoff and the last 8 minutes before landing.
8. Put on your oxygen mask as soon as it drops. We all know that airplane cabins are pressurized so we can breathe normally even at 30,000 feet. But when a cabin loses pressure, there is very little air at high altitudes that getting oxygen to our bloodstream is certainly impossible. This is the time when oxygen masks are highly needed. They pump pure oxygen into our nose and mouth so that we can get the air we need.
9. Assuming brace position would help us survive in a plane crash and indeed up the chances of survival in an emergency crash landing. The positions help reduce the velocity of your head when it inevitably slams into the seat in front of you. Moreover, they help minimize limb flailing.
10. We must forget our carryon luggage and remember the kids. The thing actually happens is while rushing to get out of the plane, we may forget our kids. Our brain does peculiar things in disasters.

10.5.7 Case Study of air accidents: Air India Express Flight 812

Air India Express Flight 812 accident was the third deadliest aviation disaster in India. It was a scheduled passenger service from Dubai to Mangalore, at around 01:00 UTC on 22 May 2010. It overshot the runway on landing, fell over a cliff, and caught fire, spreading wreckage across the surrounding hillside. Of the 160 passengers and six crew members on board, only eight passengers survived.

10.6 SEA ACCIDENTS

Just as ashore, at sea also most accidents are preventable. However, the environment and working conditions aboard seagoing vessels pose additional hazards not found ashore. The responsibilities to avoid accidents flow from the top down; from the shore establishment to the Master, to each and every individual aboard. "Safety awareness" by all hands is the biggest single factor in reducing accidents.

10.6.1 Sea accidents with reference to nature :

Maritime disasters involving huge spills of mineral oil have subsequently provoked changes in maritime regulations due to the severe nature of the associated environmental impact and the

obvious links with poor vessel operation and maintenance. Hence, shipping accidents have been a catalyst for environmental protection regulation over the past 40 years. Environmental risk is linked to the type and amount of oil and/or hazardous substances being carried and the sensitivity of the marine area where any accident happens.

Areas of concern and contributory factors to shipping accidents are highlighted along with the implications these incidents have on the marine environment. It focuses in particular on the issues surrounding the role of flag states (the flag state is the country the ship is registered to and that has the authority and responsibility to enforce regulations over that vessels) and the extent of their responsibilities with respect to vessel safety and the implementation of international rules and regulations. Environmental risk is directly linked to the type and amount of hazardous substances, including oil, being transported and the sensitivity of the marine area where any accident could occur. Flag State performance continues to play an important role in the quality and safety of sea-going vessels around the world. Several organisations publish guidelines on flag State performance. These include bodies such as the International Chamber of Shipping (ICS), the Maritime International Secretariat Services (MARISEC) and the International Transport Workers' Federation (ITF).

❖ <u>The list of 12 main known types of maritime accidents as follows:</u>

1. Offshore Oil Rig Mishaps: Offshore oil rigs constitute great danger in terms of their heavy machinery and the complexities of the processes involved.
2. Cruise Vessel Mishaps: Cruise vessels form a very important part in the vacation itinerary of people. However, a major type of maritime accident occurs in cruise vessels. Cruise vessels could capsize or face tough weather conditions causing the ship to develop major problems.
3. Commercial Fishing Mishaps: Even fishing for commercial purposes can lead to fatal incidents, due to inexperienced fishermen. Harsh weather conditions can also could severe damages to a commercial fishing expedition.
4. Accidents on Tugboats: Tugboats are those which help move huge ships to enter docks. They are small in nature but are powerful to ensure that the large vessels are handled safely. But sometimes because of the blockage of the visibility of tugboats by the larger vessels, maritime accidents occur. Also human

error on the part of the pilot of the tugboat can also lead to unwanted and unexpected tugboat mishaps.

5. Accidents on Crude Oil Tankers and Cargo Ships: The major cause of accidents on cargo tankers is explosions.
6. Grounding of Ships: Ship grounding occurs when the bottom of the ship's hull scrapes through the ocean-bed. The danger to workers aboard the ship is an important consequence because of the mishap.
7. Maritime Accident because of Drugs and alcohol: If the workers of a particular ship engage in substance abuse or alcohol this could cause the worker to behave erratically and thereby lead to an unwanted maritime accident on board ships.
8. Crane Mishaps: Just like crane operations on the land, marine crane operations on ports and on ship are also risky.
9. Accidents in Shipyards: The shipyard is the place where the ship is assembled and constructed in its entirety. Fitting and welding accidents are common in the shipyard which could spare the worker his life but hamper the worker's overall working abilities. Similarly constant inhaling of poisonous fumes also becomes another shipyard accident cause.
10. Maritime Accidents on Diving Support Vessels: People who want to explore the mysteries of the deep sea use a diving support craft to take a plunge into the water.
11. Accidents on Barges: Barge mishaps occur mainly because of the overall build of the barges themselves, which allows them limited movement on the water and because of the problems of the barge-towing equipments. These problems could be caused due to inexperience on the part of the person at the helm of the towing boats or due to usage of faulty towing cables.
12. Cargo Hauling Accidents: Cargo hauling maritime accidents are those accidents caused to workers who work as cargo haulers. However, according to several maritime accident investigations, it has been reported that cargo hauling workers overstate their cargo-hauling injuries. The maritime accident investigation, consequentially reports that because of this, this profession has one of the most severe rate of work-place absenteeism.

10.6.2 Geographical distribution of sea accidents :

Despite the tremendous efforts of different maritime organizations to achieve a safe and secure maritime transportation system, the number of maritime accidents and incidents is still increasing.

Geographic Information System (GIS) is an effective and efficient tool for spatial analysis with high visualization. It is used to carry out the analysis of maritime accidents. It identifies the hot

spots areas and buffer analysis is used to calculate accidents that occurred in coastal areas. The acquired results stats that the area around the UK is the area with the greatest number of accidents, and the coastal areas around East Asian countries (such as China, Japan, and Korea) and the Mediterranean Sea are the areas with the next highest number of accidents. Moreover, maritime accidents may not frequently occur in the open sea; however, accidents frequently happen in coastal areas with 51.1% of the total accidents happening within 25 miles of the continents and 62.2% within 50 miles.

10.6.3 Causes and impact of sea accidents :

10.6.3.1 Causes

Ships are vulnerable to all sorts of accidents.

- Human error

Although the average seafarer is competent and well trained, has been shown the right way to work and has the appropriate equipment for the job, various research and statistics state that over 70% of marine accidents happened due to human error. These include trips and falls, fire, pollution and collisions, and are invariably due to a failure in safe working practices. These incidents often cause crew injuries or fatalities, with the ship being consequently delayed or damaged.

Human errors include neglected maintenance, insufficient checking of systems, lack of communication between crew members, fatigue, or an inadequate response to a minor incident causing it to escalate into a major accident. From a more practical point of view, analysis of the circumstances surrounding accidents demonstrates the high proportion of spills due to groundings and collisions.

Collisions are generally due to manoeuvring errors, especially in poor visibility and/or busy shipping traffic areas. Groundings are also often a result of manoeuvring errors, often made worse by high winds, challenging currents and bad weather.

- Mechanical failure

Human error can play a pivotal role, even when there has been a mechanical failure, either by way of a lack of maintenance or monitoring (failing to pick up a potential problem), a lack of suitable equipment or protective devices, or a breakdown in communication or procedures.

- Manning Issues

Crew fatigue and complacency can often be a major factor in incidents. The prudent ship-owner or manager will ensure that these are addressed by way of additional manning or rotating the

ship staff more regularly if the ship is employed on a demanding trade route. There are, however, owners and managers who are unable to do this, which could in part be due to a shortage of available trained seafarers, but is more often attributed to commercial or operational considerations. Good equipment can cost more, but safety should be accorded a higher priority, because a ship cannot be operated safely without the seafarer.

- Ship Design

Ships were often designed by people who had very little practical knowledge of what they were designing. But at present the ship design team usually incorporates the suggestions of seafarers who are familiar with or have sailed on the type of ship that is being designed. Proper supervision during the building process ensures that discrepancies and potential problem areas can be addressed.

- Operating Standards

In most of the marine accidents it has been studied that the operating manuals are hard to understand. Hence improved methodology in ship design does not completely address the problem because the seafarer then has to decipher the operating manuals that are supplied with the equipment.

Language can often be a major problem. The manual may not be written in the language of the crew on board, and is often merely a generic document. Given that adequate facilities are available for translation of manuals into just about any language, this is unacceptable.

- Lack of Unified Standards

Equipment problems are further compounded by the lack of a unified standard for essential equipment, including oily water separators, voyage data recorders and lifeboat launching equipment, and until regulatory and industry bodies are able to agree on a common standard, it is the seafarer who will be faced with understanding and operating equipment that is unfamiliar and unduly complex, often in less than ideal conditions.

It is often said that safety and quality must be initiated and led from the top. Unfortunately, this does not always happen. It is our collective responsibility to ensure that a seafarer is provided with an environment in which it is safe to live and work.

Apart from the above stated causes there are several other conditions that can lead to sea accidents that are as follows:

- weather conditions
- accidents caused by weather conditions, such as gales,

- narrow and/or congested waters,
- collision .with unknown objects,
- ship lying at anchor or moored at buoys with strong currents,
- maneuvering at close quarters or
- limited space and adverse conditions in port.
- cargo-related accidents occur through the carriage of dangerous goods, cargo on deck, heavy
- cargo or cases relevant to the ship seaworthiness.
- failure in the steering system, main engine, different devices,
- war, terrorism, piracy, collision and misinterpretation in communications at sea
- Natural conditions such as current, tide and tidal stream, severe wind, reduced visibility (fog, heavy snow and rain), storm seas, darkness etc. affect the ship or those controlling her.
- Technical failures are shortcomings within the ship, such as corrosion, steering failure, engine failure, or hull failure arising from defective materials or construction, or by the shore-based installations, such as aids to navigation.
- Route conditions may include navigational error like over reliance on inaccurate nautical charts, charts of suspect reliability or based upon old surveys, narrow channels with abrupt and angular windings, allowing for very limited maneuverability and exposed to dense marine traffic, such as the Turkish Straits, anchorage contiguous to traffic separation lanes, confined marine areas with insufficient sea room as well as navigational hazards such as shoals, reefs, wrecks etc.
- Ship-related factors could be the weakness of a ship, associated with her larger size, hence less maneuvering capability and stability or draught constraints.
- Human errors may include, inter alia, a lack of adequate knowledge and experience, technical inability, bad look-out, not paying proper attention to procedures and rules, carelessness in commanding a ship, misinterpretations of radar information, fatigue and lack of alertness, overworking, tiredness, insufficient rest periods, etc.
- Cargo-related factors mostly include dangerous goods and heavy cargoes; i.e. their hazardous characteristics (oils, chemicals, nuclear substances), the place/compartment they are stowed onboard ships (on deck or under deck), and degree of diligence that such cargoes need (grain, timber), all of which are related to ships' seaworthiness.

10.6.3.2 Effects of sea accidents :

Around 90% of world trading is carried out by the shipping industry. Despite shipping is considered a safe, economical, and environmental form of commercial transport, any shipping accident, small or big, is every seafarer's nightmare. Unfortunately, shipping accidents are inevitable cases of maritime field, in contravention of creative and innovative technologies in shipping sector and execution of precautionary safety rules and regulations.

Marine accidents adversely affect the human, the marine environment, properties and activities aboard ships and ashore in various forms and degree of extent. The effects of accidents vary from minor injuries to fatalities and from insignificant damage to very severe damage to the environment and property.

Shipping accidents affect marine environment in different ways. Not only accidents and collisions are the reasons of marine pollution, but also human errors as oil spillage, solid waste, oil transferring or bunkering accidentally may cause marine pollution.

The after effects of a ship collision on marine and human life are immeasurable. The ship involved in a collision suffers from heavy structural and stability damage. Apart from the damage to the ship, collision results in the following effects:

- Collision leads to detrimental environmental effects. If the ship is involved in a collision with a tanker or a chemical vessel then there are high chances of the chemical or oil leaking to the sea. Both major and minor oil spills can lead to untoward conditions for the marine life and also to the nearby coastal areas.
- Financial loss to both, the ship owner and the nearby local communities is huge.
- Ship collision renders substantial threat to human life. There has been accidents in past when the ship has sank within minutes, giving no chance to the people on board to escape.
- Collision with an offshore structure or a port leads to infrastructure damage and thus causes a heavy blow to human efforts. There has been collisions with bridges and port structures in the past, resulting in heavy financial and efforts loss.

10.6.4 Response to man-made disasters :sea accidents :

Accidents are the consequences of highly complex coincidences. Among the multitude of contributing factors human errors play a dominant role. Prevention of human error is therefore a promising target in accident prevention.

International Maritime Organization, IMO, estimates that more than half of packaged goods and bulk cargoes transported by sea today can be regarded as dangerous, hazardous or harmful to the environment. A great deal of these substances, materials and articles are also dangerous or hazardous from a human safety point of view. The increasing trend in maritime transport of chemicals and dangerous goods also gives rise to an increasing number of accidents involving such products. This development makes great demands on the personnel who are responsible for actions against such accidents in order to protect man and environment from damage.

The efforts to minimize the risks created in an emergency by protecting the people, the environment, and property, and the efforts to return the scene to normal pre-emergency conditions may be described as response.

Spills of chemicals as well as at sea are rarely detected without notice. They are most often involved in maritime accidents and can sometimes be observed, surveyed or monitored in the marine environment close to the site of the accident. Unknown lost packages of dangerous goods are sometimes detected floating at sea or washed ashore. Most often, however, such packages can be connected with known accidents. Hence, occurred accidents, and spills involving chemicals, as well as lost packages of dangerous goods must be reported to all relevant bodies according to national and international agreements and regulations. While responding to accidents involving chemicals or dangerous goods some general steps must be taken which are the same for many accidents.

There is nothing like a typical incident therefore the following list of advices includes such general routines that often should be applied.

- Don't panic. Staying calm will allow you to continue to think clearly and to keep your energy intact.
- Before leaving a ship or boat that is sinking, if you have the time, ensure that you are wearing long sleeved clothes and pants. Try to get a life jacket if you're not already wearing one; staying buoyant is vital.
- See how to escape a sinking ship for precise details on the moment of departure from the sinking vessel.
- Examine yourself. Before anything else, reassure yourself that you're alright, if you have any cuts or wounds, treat them.
- Hypothermia is a real risk when staying for any length in water, and the colder the water, the faster are the chances of it happening.

- Be aware that shock is a real possibility. Ask others for help.
- Assess the well being of others around you.
- Treat any victims who are suffering from shock. Loosen their clothing if it's tight and have them lay down with their head lower and their legs slightly elevated.
- Treat any concussion.
- If you're still in the water and lifeboats are not available, make use of debris. Clamber onto anything that could be used like a raft or cling onto floating debris.
- Keep all survivors together as much as possible.
- If sharks encircle your group of survivors, stay together. Don't panic and stay linked; sharks are more likely to go for an individual.
- Consider whether it's possible to signal for help. If you're in a lifeboat, it should be equipped with rescue flares; read the instructions and deploy them.
- If you're wrecked near enough to land to get cell phone reception, dial for emergency services and ask for the Coastguard.
- If on land, use fire or other means to signal for help.
- Head for land if relevant. If you can see land, steer your craft toward it if you have control over moving the lifeboat.
- Find food and water. You may need to find food immediately if supplies aren't with the lifeboat or if they have been consumed.
- Wait for rescue to arrive. Continue doing everything needed to attract attention.
- We should never rush into a chemical incident, instead try to use our common sense and assess the situation carefully.
- Plan the work on a worst possible case basis.
- Realize that each chemical is different and that a new incident is not going to be the same as an earlier one.
- Get a rapid general view of the situation and judge the need for the most urgent actions to be taken, such as medical care of victims, restriction of access, evacuation, reduction of leakages, etc.
- Warn passers-by, seafarers, public, etc. Inform appropriate authorities, agencies and mass media.
- Identify all involved chemicals. Note their mode of transport (bulk, container, palleted goods, etc.) as well as type of spill or

discharge (escaped chemicals, lost packaged dangerous goods).

- Judge the risk for fire, explosion, leakage as well as health risks and risks for adjacent areas (utilize e.g. the IMDG Code, Material Safety Data Sheets, Chemical Safety Cards, and Chemical Information Databases).
- Establish restriction areas (risk zones) and restrict access to these areas by guarding the entrances.
- Make preparations for procedures regarding decontamination, relieving and replacement of personnel, materials and equipment.
- Make appropriate arrangements for beaches, swimming areas, fishing grounds, fresh water intakes, etc., such as restriction of access or restriction of right to use.
- Use monitoring devices continuously for fire, explosion and health risks.
- Assess emission rates, volumes, properties and reactivity for involved chemicals.
- Assess initial drift, spread and evaporation (direction, distance, volumes) and calculate these behaviours by modelling programs and make forecast maps.
- Continuously monitor drift and spread in order to assess the risk, and continuously take appropriate actions based on the judgments.
- Take appropriate steps to stop or reduce damage to environment and property.
- Contact, as soon as possible, relevant environmental bodies and plan for appropriate handling of the hazardous waste that the accident and the operation may yield.

10.6.5 Specific risk reduction and preparedness measures of sea accidents :

Risks assessment is a complex process involving the identification of the risk and its sources, as well as of the occurrence and severity of their consequences. This is used to elaborate strategies for risk diminishing and safety improvement at sea by the adoption of measures for prevention, control and reduce the risks. To increase safety at sea, IMO has developed a structured and systematic methodology for a formal safety assessment (FSA), by using risk analysis and an efficient risk management. Formal safety assessment (FSA) represents IMO response to the necessity of a modern approach of the process of establishing regulations in order to improve safety at sea.

The level of safety at sea has been improved in the recent year but still accidents occur even today so, improvements are very much desired. A modern approach to safety regulation should be as follows:

- proactive – trying to anticipate hazards, rather than waiting for accidents to reveal them;
- systematic – using a formal, structured, methodical process for developing new rules and prioritising research;
- transparent – being clear what level of safety and reliability is achieved and what contribution each rule makes to it;
- cost-effective – achieving a suitable balance between the level of safety and reliability and the cost to the ship-owner in achieving it.

Risk identification consists of hazard identification, which should caused severe pollution of environment. It represents first step which is essential in a risk assessment. A hazard is identified as a situation with a potential for causing harm to human safety, the environment, property or business, regardless of how likely or unlikely such an occurrence might be. The hazards identification must be a well structured systematic and critical process.

The risk evaluation represents in fact an analysis of the risks generated by various dangers. It assumes the evaluation of the likelihood, respectively how often or probable is the risk occurrences and how severe are their consequences. This allows attention to be focused upon high risk areas and to identify and evaluate the factors which influence the level of risk.

The next step is risk assessment. For risk estimation the likelihood and consequences of events are combined to quantify risk.

On this basis the risk classification can be done in priority order for the effort to reduce them, making decisions for new safety measures and improving existing ones. Risk assessment of oil spills is very difficult due to multiple consequences and factors, which influenced their severity.

To conclude it may be said that the results from analysis of risk control, prevention and reduction measures are the basis for recommendation for decision-making bodies and regulators to bring risk to the lowest possible level. Response plans must clearly indicate the reporting requirements and must assign responsibilities for reporting pollution incident.

10.6.6 Typical post-disaster needs of sea accidents :

Surviving an accident at sea might bring up a different kind of pressure.

The most common reactions to at-sea disasters are

- Trouble sleeping and nightmares.
- Feeling overly jumpy and/or easily startled.
- Loss of concentration.
- Increased irritability or anger.

❖ **The victim may also experience the following symptoms which are extremely common reactions to sea accidents.**

- Flashbacks—memories, feelings, or sensations of the event that come back unexpectedly.
- Intense physical or emotional reactions when you smell, hear, feel, or see things that remind you of what happened (examples: diesel smell, rocking motion).
- A desire to avoid places, people, or other activities that remind you of the event.
- An inability to remember important details about the event.
- A sense of numbing, detachment, or lack of emotions.
- A lack of awareness of your surroundings (being in a daze or things seem “unreal”).
- Less interest in your usual activities.
- Hopelessness.
- Feeling that you must always be on the lookout for danger.

❖ <u>Following measures may help the victim of sea accidents</u>

1. Talking or writing about what the victim has experienced and how he is feeling is one of the most effective actions he can take to help himself and prevent future problems.
2. When the victim is in a safe environment, reflecting on what happened helps his mind make sense of the events and gain a sense of control over the difficult memories.
3. While close friends and family can be a great source of support, one should not be discouraged if other people have a hard time understanding ones reactions.

4. Talking about what happened can sometimes be difficult in a small coastal community. The victim might worry that his story will frighten others who also spend time on the water, he may hesitate to talk about the ways human error could have contributed to the disaster, or he may worry about overwhelming his loved ones.
5. It may be easier to talk to someone outside the victim's normal social circle, such as a counselor, doctor, nurse, or clergy person. Professional support can provide much-needed confidentiality, understanding, and a neutral perspective.
6. Engage in pleasant, distracting activities off and on, but try not to completely avoid thinking or talking about what happened.
7. Get adequate rest and eat healthy foods.
8. Try to maintain a normal schedule.
9. Take breaks and reminisce about those who lost their lives in the incident, if applicable.
10. Focus on something practical you can do now.
11. Use relaxation techniques.
12. Keep a journal.
13. Exercise in moderation. Exercising within 24 hours of the event will help your body process the stress hormones that flooded your body during the incident.
14. Focusing on their sense of purpose or mission in life.
15. Attachment to loved ones.
16. Maintaining a sense of humor.

❖ <u>Actions that is not helpful</u>

- Using alcohol or drugs to cope.
- Withdrawing from family, friends, pleasant activities.
- Working too much.
- Violence or conflict.
- Doing risky things.
- Extreme avoidance of places or activities that might remind you of the event.
- Excessive TV or computer games

10.6.7 Case Studies of sea accidents :

The RMS Titanic, the largest passenger liner in service of that time, sank on the night of 14 April through to the morning of 15 April 1912 in the North Atlantic Ocean. It was in her fourth days on

maiden voyage from Southampton to New York City. It has been estimated that Titanic had 2,224 people on board when she struck an iceberg. She took two hours and forty minutes to sink on 15 April and the result was deaths of more than 1,500 people. This is one of the deadliest maritime disasters in history.

10.7 SUMMARY:

Accidents can take place anywhere. Even the most advanced technology can't ensure accident free and hundred percent safe working conditions.

Many cities around the world are becoming increasingly unfriendly to pedestrians because of too many road accidents. It has turned out to be a global tragedy with ever-rising trend. Due to these accidents there is loss of life and limb on a large scale. These may be single vehicle accidents in which the vehicle is either colliding with fixed objects or with pedestrians or the vehicle may fall in a ditch. In case of multiple vehicle accidents two or more vehicle is involved. But both the cases may cause uncountable casualties. There are various reasons behind serious and most dangerous road accident such as design of the road, driver's impairment and vehicle design.

There has been an unbelievable growth in the frequency of rail accidents. The earliest railways had no signal systems hence station employees used hand gestures to train drivers indicating whether to stop or go on. This lead to rail accidents because drivers often missed or ignored the hand signals. With the advent of time fool-proof signaling system has been developed assuming that could prevent train accidents. It succeeded. But as soon as a new system was introduced to prevent one type of accident, a new type of error cropped up and caused another accident. So invention of new system to mitigate rail accidents continued. Serious design flaws, train conductor negligence, train derailment, improper maintenance of the train tracks, faulty equipment, collision with another train, collision with a car, bus or truck trying to cross train tracks and collapsed bridges are some of the major causes of rail accidents. To make India's railways safer we must put stress on fire detection systems, anti-collision technologies, improved staffing, new tracks and manned railway crossings.

Air transport has become the safest of all means of transportation because even with the constant rise in number of aircraft in operation accident rates has fallen. Sometimes plane crashes happen when pilots become incapacitated during critical points of a flight. Mechanical error, bad weather conditions, sabotage and some kinds of human errors are the various reasons behind air accidents. To avoid air accidents one may fly on larger

aircraft, choose non-stop flights and pay attention to the flight attendants. Moreover to mitigate these accidents New Air Navigation System should be improved, air traffic services must be enhanced and airspace capacity should be expanded. Strengthening disaster control measures for airports and aviation safety facilities, strengthening supervision over air carriers and shifting the emphasis to prevention in traffic safety administration are other measures introduced in improving the air traffic environment.

Marine areas are often congested with many vessels as they use the same waters. As a result high traffic volume may lead to sea accidents. Most accidents occur when ships cross sea channels or estuaries and involve overloaded or old vessels. Bad weather, technical problems or navigational errors are other reasons behind these disasters. Therefore we must have greater level of watchfulness than usual when maneuvering a vessel. Rescues in the case of sea accidents follow the principles of solidarity between seafaring people and the norms of national and international maritime law.

To conclude it may be said that when these accident occur we should keep calm and avoid panic as far as possible, keep identity papers and important personal documents with us, seek refuge at a sufficient distance from the place of accidents if possible, and try to activate the rescue process by alerting the local security or specialist services. After the accident also we should keep calm and avoid panic and follow the instructions of the intervening bodies and of the rescue personnel.

10.8 CHECK YOUR PROGRESS/ EXERCISE

1. True false

a. The problem of road accident is very acute in highway transportation due to complex flow pattern of vehicular traffic, presence of mixed traffic along with pedestrians.

b. Crash victims have a better chance of recovery, if they do not receive quick medical treatment at the spot of an injury.

c. For effective post-crash care, correct diagnosis at the scene and quality emergency room and trauma care is required.

d. Arunachal is the state with the maximum number of road crash injuries

e. In a rail accident, the damage is not only limited to the people injured or killed but also affect the environment by contaminating the surrounding area.

f. There are accident survivors who experience trauma affects from 5 years after the event to lifelong.

g. Half of all plane crashes are caused by cloudy weather.

h. Around 100% of all plane crashes are caused by bad weather conditions.

i. Several plane crashes are caused by air traffic controllers.

j. Economical research has shown that air accidents can cause serious mental health consequences for victims.

k. Air transport has become the safest of all means of transportation because even with the constant rise in number of aircraft in operation accident rates has increased.

2. Fill in the blanks

a. Traffic accident leads to loss of life and _____.

b. _____of traffic rules lead to road accidents.

c. _____ _____account for 25% of total road crash deaths.

d. The first persons arriving at a railway accident site can render valuable assistance to _____ injury and loss of life.

e. The Delhi-Varanasi Janata Express (train number 14266) derailed near Bachhrawan in Uttar Pradesh, northern India, on 20 March 2015.

f. _____ failures still account for around 20%-22% of all aviation accidents, despite improvements in design and manufacturing quality.

g. Plane crashes that are caused by _____ account for about 9% of total plane crashes.

h. If fewer people travel by air to avoid accidents then there is a _____ effect on the economy.

i. To protect life, property and evidence we should establish a _____ perimeter around the accident scene.

j. _____ oil rigs constitute great danger in terms of their heavy machinery and the complexities of the processes involved.

3. Multiple choice question

a. The RMS Titanic, the largest passenger liner in service of that time, sank on the night of 14 April through to the morning of 15 April 1912 in the
   i. North Atlantic Ocean.
   ii. Arabian Sea
   iii. Indian Ocean

b. The victims of sea accidents may have some common reactions like
   i. A desire to visit places, people, or other activities that remind the victim of the event
   ii. An ability to remember each and every details about the event.
   iii. Intense physical or emotional reactions when one smells, hear, feel, or see things that remind one of what happened (examples: diesel smell, rocking motion).

c. The most common reactions to sea disasters are
   i. trouble sleeping and nightmares, feeling overly jumpy and/or easily startled, loss of concentration.
   ii. sound sleep at night, feeling relaxed, increase of concentration.
   iii. trouble sleeping and nightmares, increase in appetite, loss of memories.

d. When sea disasters occur
   i. victims should panic and have cup cake from the pantry which will allow him to continue to think clearly and to keep his energy intact.
   ii. don't escape, staying in the ship will allow you to continue to think clearly and to keep your energy intact.
   iii. victims should not panic and stay calm which will allow him to continue to think clearly and to keep his energy intact.

e. Plane crashes are catastrophic,
   i. and necessarily are un-survivable events.
   ii. but not necessarily are un-survivable events
   iii. only the pilot survives

4. <u>Answers the following Questions</u>

1. Where do road accidents occur? Explain your answer with an example.
2. What are the causes and impacts of road accidents?
3. State the various responses to road accidents?
4. What are the specific risk reductions and preparedness measures of road accidents?
5. What are the post-disaster needs of road accidents?
6. Where do rail accidents occur? Explain your answer with an example.
7. What are the causes and impacts of rail accidents?
8. State the various responses to rail accidents?

9. What are the specific risk reductions and preparedness measures of rail accidents?
10. What are the post-disaster needs of rail accidents?
11. Where do air accidents occur? Explain your answer with an example.
12. What are the causes and impacts of air accidents?
13. State the various responses to air accidents?
14. What are the specific risk reductions and preparedness measures of air accidents?
15. What are the post-disaster needs of air accidents?
16. Where do sea accidents occur? Explain your answer with an example.
17. What are the causes and impacts of sea accidents?
18. State the various responses related to sea accidents?
19. What are the specific risk reductions and preparedness measures of sea accidents?
20. What are the post-disaster needs of sea accidents?

10.9 ANSWERS TO THE SELF LEARNING QUESTIONS

1.a. true

1.b. false, if they receive quick medical treatment at the spot of an injury.

1.c. true

1.d. false, Tamil Nadu

1.e.true

1.f. true

1.g. false, pilot error.

1.h. false, 12%

1.i.true

1.j. false, Psychological

1.k. false, accident rates has fallen

2.a. property

2.b. Violation

2.c. Two wheelers

2.d. minimise

2.e. Dehradun

2.f. Equipment

2.g. sabotage

2.h. negative

2.i. security

2.j. Offshore

3.a.i.

3.b.iii.

3.c.i.

3.d.iii.

3.e.ii.

10.10 TECHNICAL WORDS

1. **Aviation**-the flying or operating of aircraft
2. **Global**- worldwide
3. **Marine Environment** -The oceans, seas, bays, estuaries, and other major water bodies, including their surface interface and interaction, with the atmosphere and with the land
4. **Property**-a thing or things belonging to someone
5. **Rubberneck**-turn one's head to stare at something in a foolish manner
6. **Vessel**-a ship or large boat
7. **Valuation**-an estimation of the worth of something

10.11 TASK

1. In a map of world show in which ocean The RMS Titanic, sank.
2. In a chart draw columns and state effects of sea accidents.
3. In a chart draw columns and state the causes of road accidents.
4. In a chart draw columns and state the response to air accidents

10.12 REFERENCES FOR FURTHER STUDY

1. Leonard Weinberg: Global Terrorism: A Beginner's Guide
2. Tore Bjorgo, ed.: Root Causes of Terrorism: Myths, Reality and Ways Forward (Routledge, 2005) papers from a 2003 experts workshop in Oslo
3. John Horgan: The Psychology of Terrorism (Routledge, 2005)

4. Sundri Khalsa: Forecasting Terrorism: Indicators and Proven Analytical Techniques
5. Ministry of Home Affairs, Govt. of India, Disaster Management in India
6. Module 4 - Capacity Building in Asia using Information Technology Applications (CASITA)
7. Asian Disaster Preparedness Center (ADPC), Bangkok.
8. Encyclopedia of Disaster Management: Volume IV by Alfred Scott
9. Disaster Management- by Mukesh Kapoor
10. Disaster Management-Global Challenges and local solutions-by Rajib Shaw / R. R. Krishnamurthy
11. Manmade Disasters-by K. K. Singh / Lotfi Aleya / Vinod Singh
12. Disaster Management and Strategies-Concept & Methods, Risk Reduction & Insurance, Experiences & Case Studies by Ashu Pasricha / Kiyanoush Ghalavand / Jai Narain Sharma
13. Management of Man-made Disasters-by S. L. Goel
14. Disaster Management: Future Challenges and Opportunities by Jagbir Singh
15. Disaster Management by Harsh K. Gupta
16. O'Brien, G. "UK Emergency Preparedness: A Step in the Right Direction?" Journal of International Affairs, Vol. 59, No. 2 (2006): 79.
17. Mueller, J. and Stewart, M.G., Terror, Security, and Money: Balancing the Risks, Benefits, and Costs of Homeland Security (New York: Oxford University Press, 2011).
18. Oxford dictionary