UNIT 3 FLOOD

Structure

3.0 LEARNING OUTCOME

After studying this Unit, you should be able to:

- understand the nature of flood disaster;
- identify the flood-prone areas;
- explain the causes and impacts of flood disaster;
- describe the forecasting, warning and monitoring system;
- appreciate the importance of preparedness and response system; and
- discuss the lessons learnt on the basis of past flood disasters,

3.1 INTRODUCTION

Roods are one of the most dramatic interactions between man and environment emphasising both the sheer force of natural events and man's (as yet) inadequate efforts to harness them or even to control them. Floods are always newsworthy whether it is a locality or a town isolated by swirling waters or a major disaster attracting attention of the whole world as in Bangladesh in 1974 or the Mississippi in USA in 1993, or Mumbai in 2005.

Although man has been responding to floods since times immemorial and learning in the process; much more is still to be understood by hydrologists, engineers, farmers, town planners, policy-makers, and above all by the general public for whom floods are often an unexpected, inexplicable and always a traumatic experience. Therefore, it is necessary to understand the phenomenon of flood and learn more about it.

In this Unit, we will discuss the nature, causes and impacts of floods. In addition, we will highlight the geographical distribution of flood prone areas in India. In the context of disaster management, we will explain the structural and non-structural methods, preparedness, response, and experiences of past flood disaster management. Lastly, we will bring out the lessons learnt on the basis of past experiences in the subsequent sections.

3.2 NATURE OF FLOODS

Everyone knows that generally speaking, flood means inundation due to overflowing of a large volume of water, whatever be its source. But a simple statement like this does not bring forth the various aspects of the phenomenon of flood. It should be helpful to look at some of the accepted scientific definitions of flood.

Flood is a rise, usually brief, in the water level in a stream to apeak from which the water level recedes at a slower rate. – WMO/UNESCO International Glossary of Hydrology (WMO – 1974).

Flood (or River Flood) is a relatively high flow or stage in ariver, markedly higher than theusual. A mass of water rising, swelling and overflowing land – ICID Multilingual Technical Dictionary of Irrigation &Drainage (ICID – 1996).

Two facts emerge from these definitions of flood. Firstly, flood is aphenomenon created by water. There is no concept of flood without large andunmanageable volume of water. Secondly, flood (in most cases) is a phenomenon of streams and rivers and their surrounding areas.

However, areas with no stream or river may'also suffer from floods in the case of inadequate drainage – a situation being experienced increasingly by unplanned or ill-planned growth in urban centers in addition to that created by blockages in agricultural areas. This is called "flooding" or "inundation" to distinguish it from river floods, although both the words, "floods" and "flooding", are often used in a synonymous manner. Areas far from river or canal banks and not usually prone to floods may experience flooding if there is a sudden rush of water in river or canal. Furthermore, there are large bodies of water (besides streams and rivers) which could spill over to create flooding. For example, Himachal Pradesh suffered heavy floods from the spill from the Parichu lake in 2005 and earlier as well. The term "Flooding" is therefore defined by the International Commission on Irrigation &Drainage ICID (1996) in two contexts as reproduced below.

Flooding or Inundation:

- Overflowing by water of the normal confines of a river, stream, lake, sea or other body of water or accumulation of water by lack of drainage over areas that are normally not submerged. Inundation normally means only a few decimeters of water and this does not have to originate from flood.
- Controlled spreading of water for the purpose of irrigation, etc.

Basic Factors in Flood or Flooding

It is obvious that there will be no flood if the incoming volume of water could be easily and quickly drained out. This drainage can be either through run-off if the topography of the area is favourable or through infiltration, that is seepage in the ground, in case it is possible. Therefore, the ground condition is the other basic factor in creating a flood, water of course being the primary basic factor. Water could becoming from different sources and the antecedent ground conditions may involve different dimensions as indicated in table 3.1.

Table 3.1 Basic Factors in Flood and Flooding

Sources	Water	Ground Conditions
Rain	Heavy rains Cloud burst Depressions Cyclonic stonns	Water table Soaking capacity Waterlogging Run-off
Snowmelt		
Breaches	Embankments (rivers, canals, lakes) Dams	
Sea water	Storm surge (brought in when a cyclonic storm hits coast) Tsunami	

To summarise,

- Floods occur when large volume of water from heavy rainfall, riverspill, snowrnelts, storm surge or beach is not able to drain off quickly through normal processes of run-off and absorption in the ground.
- Flood envisages in –flow and out-flow of water and imbalance between them.
- Storm surge or tsumani results in saline flood,
- Inadequate drainage creates/aggravates flood.
- Waterlogging creates flooding.

Types of Floods

Water and ground, being the basic factors in floods, decide the types of floods. Consequent upon variation in the nature of these two factors, floods may be classified as follows depending upon the source of water and the ground location.

- **Precipitation Floods**
  - i) Rainfall Hoods
    - Heavy rainfall floods
    - Single event floods
    - Multiple event floods

    Flash Floods
    - Single event (cloud burst)
    - Multiple event (temporary blocking)

    Seasonal floods
  - ii) Precipitation other than Rainfall Floods
    - Snowmelt
    - Icemelt
- **Non-Precipitation Floods**
  - i) Estuarine Hoods
  - ii) Coastal Floods

- Storm surges due to cyclonic storms
- Tsunamis due to under-ocean earthquakes

iii) Breach Floods due to breaches in canals, river embankments and levees

iv) Dam burst Floods

One iinportant message that comes from this classification is that floods can be either slow-developing type (as the water accumulates and ground gets saturated) or sudden onset type (when an enormous volume of water suddenly gushes in and is far beyond the normal conveyance capacity of available natural or manmade drainage channels).

3.3 GEOGRAPHICAL DISTRIBUTION

The geographical location of India renders her to be one of the most disaster prone countries in the world. It has been assessed that 25 out of the 35 states and Union Territories are flood-prone. These are (in alphabetical order): Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhatisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, J & K, M.P., Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Pondichen-y, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttaranchal, U.P., and West Bengal. The most affected states are, Assam, Bihar, Orissa, U.P. and West Bengal. Although the heavy rains resulting from monsoon arid cyclones and the storm surge associated with cyclones also led to floods, the occurrence of floods in India is mainly associated with the river systems of the country. The basin of the Himalayan rivers, covering a part of Punjab, Haryana, Himachal Pradesh, Delhi, Rajasthan, Uttar Pradesh, Bihar and West Bengal, is subject to inundation, erosion and inadequate drainage, steep gradients of the rivers and the change in the course of rivers. Brahmaputra basin is also subject to the earthquakes and landslides which obstruct the free flow of water. Floods are an annual feature in the Brahamputra basin and cause heavy damages by inundation and erosion. Assam valley is considered is to be one of thew flood affected areas of the country in which floods occur mostly due to heavy rains during the rainy season and silting of tributaries like Dihang and Lohit. The North-Western river basin, covering the states of Jammu and Kashmir, parts of Punjab, Himachal Pradesh and Rajasthan, has the river system of Jhelum, Satluj, Beas, Ravi and Chenab. In Kashmir valley, the Jhelum is unable to carry the river discharge. In Punjab and Haryana plain, the problem is mainly due to lack of adequate drainage.

The Central Indian and the peninsular river basins, covering the states of Madhya Pradesh, Orissa, Andhra Pradesh, Maharashtra and Gujarat, contain the Tapi, Narmada and Chambal rivers. In their basins, at times the rainfall in excess, causes floods in some of the rivers. However, such floods do not occur every year and when they do occur, they are not of long duration. As against, this, heavy floods occur in the Godavari, Krishna and Cauvery rivers at long intervals and the flood problem is said to be generally not serious. But when they do occur, they often exceed those in other rivers and regions and cause heavy losses of crops by inundating the deltas. In Andhra Pradesh, the Kolleru lake submerges vast areas along its fringes and cyclonic storms bring heavy flooding in the coastal areas. The tsunami disaster of December 2004 has added a new dimension to coastal flooding.

3.4 CAUSES AND IMPACTS

Flood in itself is not a disaster. It exists as a natural phenomenon characteristic of all rivers so long as it does not threaten human life and property. In fact, flood brings in the much needed water and fertile silt. But the vulnerability of human life and property turns flood into a hazard and the actual devastation by flood is termed as flood disaster.

Causes

The causal factors of flood have been discussed by Ward in terms of primary and secondary factors; the former result from external climatological forces, whereas the latter are the flood intensifying factors which tend to be more drainage and basin specific. The climatological factors, particularly excessive rainfall, act as the most important cause of floods. Excess over the anticipated seasonal rain over wide spatial tracts usually gives rise to the annual monsoonal floods and heavy rains from sudden storms give rise to flash floods over small areas. Prolonged rainfall in localised small drainage basins often results into heavy flooding. Flood intensifying factors refer to those variables that accelerate the drainage basin response to a particular rainfall input.

Human causes of flooding basically refer to the encroachment of the flood plains. Floods remain a non-event as long as the floodplains are leftuntouched by human activities. But the increasing pressure of population and the resultant shortage of land for human activities necessitate the occupation of flood plains. This interference with the intrinsic domain of the river-system leads to flood-disaster:

Thus, we find that floods are mainly caused due to heavy water inflow and inadequate capacity within the banks of a river to contain high flows. River bank erosion and silting of river beds aggravate the floods. Obstruction of flow, change in the river course, synchronisation of floods in the main and tributary rivers, retardation of flow due to tidal and backwater effects and poor natural drainage are the other aggravatingfactors.

Storm surge brought in by cyclones and tsunami are the cause of coastal floods. These floods are not only highly destructive but are very corrosive because of the high salinity of sea water.

Impacts

Worldwidestatistics indicate that even if we consider only the three basic indicators of the adverse impacts of a disaster viz. significant damage, persons affected and number of deaths, floods are by far the most destructive of all natural disasters. The position in India is similar. This highly destructive characteristic of floods arises from the facts that they cover large areas and are recurrent in nature. The situation is compounded by human encroachment on what was river's space viz. flood plains. The enormous investments made in the flood plains in the forms of physical constructions and resultant concentration of human activities in such areas have turned floods into a serious natural hazard. In such circumstances, whenever the river is in spate, colossal loss of lives and properties is experienced.

Whenever the flood disaster strikes, it heralds strings of typical adverse effects in the day to day life of the people. One such impact relates to the physical damages in the form of washing away of structures. Moreover, the inundation of the landscape makes the building and other physical structures untenable for long and ultimately leads to their collapse. The floating debris after the collapse of the physical structures further causes damages to lives and properties. In mountainous and hilly terrain, the saturated soils often result into landslides creating more hardships to the people.

Threat of epidemics and menace to public health are the other prominent adverse effects of the flooding. The intermixing of the toxic and unhygienic substances in the life cycle of the people leads to the outbreak of endemic diseases like malaria, diarrhea, laptospirosis and viral infections. Amongst the bare minimum necessities of the people, the most affected utility is the water supply. The carriage of poisonous substances by the flood water contaminates the wells and other sources of drinking water. In urbanised areas, the collapse of the water supply system and contamination of the ground water make the supply of clean drinking water to the people a daunting task. Finally, the adverse impact of flooding is also found in terms of losses to harvests and the washing away of food stocks. It also results in loss of animals, farm tools and the ancillary stocks of the peasants.

Thus, floods threaten health and economic security of the affected community. Agricultural, industrial and commercial activities are obstructed temporarily or for long duration depending on the severity and duration of flood. Resulting unemployment leads to migration and socio-economic tensions. Wealth creation activities which lead to prosperity of the community suffer serious setback as does the developmental activity. Personal injuries are rare in case of floods except for bites from reptiles and other insects. Some of these could result in deaths either due to poisonous sting or shock or both. Most of the deaths in floods are due to drowning. Needless to say, the economically and socially disadvantaged sections of the community (the poor, sick, handicapped, old, children and women) suffer the most. There are large number of casualties among pets, domestic animals and wildlife due to drowning or killing by predators.

.We can summarise the serious consequences of floods as follows:

- Floods are the most frequent and most widespread of all the natural disasters.
- They result in death, destruction, degradation, disease and displacement.
- Whether a flood is of sudden onset type or develops slowly, it takes long to subside and leaves behind prolonged ill-effects.
- Economically and socially disadvantaged sections of the community suffer the most.
- Recurrent nature of floods aggravates the disaster.
- The natural hazard of flood turns into a long persisting socio-economic disaster.

Apart from these socio-economic impacts on the affected community, floods also act as agents of significant geomorphological changes in stream channels, flood plains and coastal areas. In the wake of floods, land forms are known to change as a result of the combined processes of erosion, transportation and sedimentation which involve removal of material from one part of drainage basin and its deposition in another.

3.5 FORECASTING, WARNING AND MONITORING

Loss of lives and property can be reduced significantly by giving advance information about the likelihood of floods. People, cattle and valuable moveable property can be transferred to safer places in that case. Therefore, forecasting, warning and monitoring of floods are accepted as important and cost effective non-structural, i.e. non-engineering methods of flood hazard mitigation. Modem advancements in technical and scientific know how have led to establishment of a credible forecasting and warning system.

India was one of the earliest countries to realise the importance of flood forecasting and warning system in flood loss mitigation. This realisation led to the setting up of a national network of flood forecasting stations covering most of the States and Union Territories including the National Capital Territory of Delhi. These forecasts and warnings are utilised for alerting the public and user agencies about an impending flood and for taking appropriate measures by concerned administrative and state engineering agencies responsible for flood disaster mitigation.

Flood forecasting and warning work started in India in 1958 with the setting up of a unit in the Central Water Commission (CWC), New Delhi. The first flood forecast was issued in July 1959 for the Delhi Railway Bridge on Yamuna river. Now, the network of flood forecasting arid warning has spread to cover almost all the flood prone interstate river basins in the country. The CWC presently is responsible for issuing flood forecasts at 157 Flood Forecasting Stations of which 132 stations are for water stage forecast and 25 for inflow forecast. These cover most of the inter-state rivers in the country. Bihar, being the most flood-prone state, has the largest number of Flood Forecasting stations i.e., 36 stations. Around 6000 flood forecasts are issued annually. These are

issued daily between May and October to take care of likely floods due to cyclones and monsoon.

Flood forecasts are issued by the Central Water Commission when river stage at the forecasting station is at or above the 'warning level', which is normally one meter below the 'danger level' of the forecasting site. The "Danger Level" is decided by the District revenue authorities taking the local conditions and the past records into consideration. Flood forecast is also issued whenever the predicted river stage is expected to be above the warning level. The flood forecasting and flood warning situation is monitored by the CWC in New Delhi by issuing water level and flood forecast bulletins on a day to day basis. This has been made possible by the computer aided flood forecasting and warning network and performance appraisal system (FFWNPAS) that not only helps in the evaluation of the performance of CWC flood forecasting network of stations but also provides for the online monitoring of any unprecedented flood situation.

Flood forecasting, warning and monitoring have gone a long way in providing reasonably reliable and timely information on flood disaster facilitating prior mitigation steps from the agencies concerned. Significant reduction of flood damages and sufferings of the people have been achieved by the flood warning system together with matching rescue and relief measures. Flood forecasting and warning have been helping in evacuation of people and cattle, removal of moveable property, setting up of relief camps and deployment of boats and taking appropriate action to mobilise medical relief, food, clothing and drinking water, thereby mitigating the adverse effects of flood disaster to a large extent.

It should be noted that the management of flood forecasting and warning services requires skilled and responsible personnel. The forecasting procedures involve trained hydrological and meteorological specialists. Formulation of the warnings, wide transmission to reach the public and user agencies in time and the consequential mitigation actions are handled by the District Administration. After the flood threat has passed off, the warning must be withdrawn ensuring that: the public and user agencies have been de-alerted.

3.6 PREPAREDNESS AND RESPONSE

Preparedness

As already emphasised, preparedness is the most crucial element of disaster management. Its objective is to ensure that in times of disaster, the vulnerable community is prepared and there are other appropriate systems to assist those affected by the disaster and enable them to help themselves. The aim of disaster preparedness is to minimise the adverse effects of a hazard through effective precautionary actions and ensure timely, appropriate and efficient organisation and delivery of emergency response following the impact of a disaster.

It has also been explained earlier that floods damage human settlements, necessitate evacuation to safer areas, damage crops, disrupt farming, wash away infrastructure, interrupt industrial production, create unemployment and lead to malnutrition and disease. Therefore, disaster preparedness in the context of floods ought to deal with all these aspects so as to prepare the community and government to face these problems effectively in the event of occurrence of floods. The primary responsibility of ensuring disaster preparedness, including that for floods, rests with the State and District Administration. They prepare comprehensive plans for disaster preparedness on the basis of risk analysis and vulnerability assessment.

Response

Once the disaster prepared plans are in place, the administration and the community at large are in position to respond to the onset of a disaster. These actions commence with the receipt of a

forecast or warning of the impending disaster and include the implementation of the disaster preparedness plans and procedures thus overlapping with disaster preparedness. The disaster response continues through the life cycle of the disaster (flood in this case) and upto the completion of the rescue, relief and rehabilitation programmes.

The response consists of a number of activities and each activity is formally or informally governed by a set of policies and procedures and each activity is typically under,the auspices of a nodal agency. The major disaster response'activities include warning,evacuation/migration, search and rescue, relief, camp management, health, hygiene, post-disaster assessment, survivor response and coping, security, emergency operations, reconstruction, rehabilitation and resettlement.

As in case of other disasters so in case of floods as well, the people in the community are the first responders. It is the effectiveness of their response which proves most important in saving precious lives and moveable property. They need to exhibit swift reaction with discipline and cooperation according to their preparedness plan. It is in this context that mock drills are essential and effective component of the preparedness level of any community vulnerable to floods or any other natural disaster.

3.7 MITIGATION

Various approaches are available to deal with floods and to mitigate their adverse impacts. As each situation is different, different approaches or their combination is adopted. Basically, these approaches fall under the following three categories:

- Modify the floods i.e., do not allow water to accumulate. In other words, keep flood water away from people.
- Modify the susceptibility of the people to flood damages i.e., keep the people away from flood water.
- Modify the loss burden inflicted by floods on the people.

Modification of floods would involve measures such as weather modification (if possible), catchment and land use modification, physical control works such as reservoirs and embankments. Modification of the susceptibility of the people would involve flood forecasting, warning, flood proofing, and flood plain management. Modifying the loss burden is possible through evacuation, pumping out water, avoidance of epidemics, flood insurance and compensation.

Thus, modification of the hazard is possible through structural and non-structural measures. Structural measures such as construction of storage reservoirs, specially with provision of flood reserve, are highly costly and also involve problems of clashing priorities. Embankments are also not unmixed blessings. That is why, greater emphasis is on non-structural measures, which offer great scope for mitigation and seem to be more acceptable. Among these, adoption of flood plain zoning and regulation mechanism is an effective measure. It aims at dissemination of infonnation on the locations, extent of area and the likely intensity and frequency of flooding at different probabilities, to regulate indiscriminate and unplanned development of floodplains to reduce loss. The tlood plain management covers land use regulation, statutes, zoning ordinance, and government purchase of property and relocation. Report (1980) of the National Flood Commission recommended that the flood plain management measures should be undertaken wherever the necessary legislation existed and suitable legislation enacted in other States. The Central Water Commission circulated the guidelines on flood plain zoning, which highlighted that necessity of demarcation of areas liable to floods on large scale maps; demarcation of areas likely to be inundated for different flood frequencies; and delineation of the type of use to which the different zones as

demarcated in flood plains could be put to. The National Water Policy adopted in 1987 also recommended and emphasised on non-structural measures like flood plain zoning for minimisation of losses and to reduce the recurring expenditure on flood relief.

A major mitigation measure that has been widely debated in recent years and has been under consideration at very high levels of the Central Government relates to the proposal for linkings of rivers. Apart from flood control, this scheme is said to be beneficial for droughtproofing, adequate irrigation and generation of hydroelectric power. However it would involve enormous financial investment apart from engineering skills of a very high order on a large scale. Apart from inter-state claims and disputes, the scheme could be questioned on ecological, environmental and humanitarian grounds as all the ongoing river projects (Sardar Sarovar, Tehri) have faced protests from activist groups. There will also be an international aspect because many rivers of north and northeast India are inter-country rivers. But there is no doubt that the scheme of linking rivers has a high potential for flood mitigation. A few initiatives seem to be taking shape at inter-state levels on smaller scales. The agreement between U.P. and M.P. to link the Ken and Betwa rivers is a welcome effort in this direction.

3.8 PAST FLOOD DISASTERS

Floods are almost a regular feature of Indian life as severe floods occur almost every year in one part of the country or the other causing enormous loss of life, large scale damage to property and misery to millions of people. A few detailed case studies of major floods in India will be presented in Unit 4 but it is considered desirable to make brief mention of some of the recent widespread and severe floods in this Unit as well. But before that we should understand as to what decides the severity of a flood.

Of course, one method to judge the severity of a flood would be to take into account the damage inflicted in terms of lives lost, property and crops destroyed, infrastructure damaged and post-disaster expenses. The other method could be technical based on parameters such as the maximum level attained by the flowing water in a river.

Based on the first consideration, the year 1988 would seem to be the worst when the monsoon was excessive in most parts of the country and the resultant floods took a toll of 4252 human lives and destroyed property worth Rs. 4630 crore. On the technical consideration, the worst flood was in the river Teesta in the Sub-Himalayan region of West Bengal on 4th October 1968 when the river attained 18.1 metres above the danger level at the Anderson Bridge site. From these two examples, it would be clear that the severity of flood depends on the locality and is a function of a number of factors such as intensity and spread of rainfall, conditions of the catchment, physical characteristics of river and topography of the site.

West Bengal Floods, 2000

As West Bengal is criss-crossed by a large number of rivers, heavy rainfall during the monsoon and the resulting floods characterise life in most parts of the state. But what happened in 2000 surpassed many past records of flood disasters. It was catastrophic and massive in proportions bringing in its trail of death, destitution and destruction in many districts of the state. Approximately 10 million people were severely affected by the floods of 2000 that killed about 700 persons, destroyed 3 lakhs heads of cattle and 4 million tonnes of Kharif food grains. The scale and complexity of the calamity in terms of loss of human lives and cattle heads, destruction of physical assets and damage to productive capacity in the fields, plants and mines were of colossal proportions.

Bihar Floods – 2004

Floods are an annual feature of the landscape in Bihar as almost every year the Himalayan rivers meandering through north Bihar over-flow their banks bringing about a havoc in the vast areas of Bihar. Practically, the entire Bihar is prone to floods and hardly any year passes off when the state is not visited by floods. Sometimes, when the rainfall in the upper catchments of the Himalayan rivers is less, the intensity of the flood remains within manageable limits. But when heavy rainfall occurs in the catchments, the rivers go in spate beyond manageable limits and cause unbearable loss of life and property in the region.

The Bihar floods of 2004 present a peculiar but noteworthy case. There was above normal rainfall in the first two months of the monsoon season i.e. in June and July but it was very much deficient in the last two months viz. August and September making the total rainfall in Bihar in the four month monsoon season deficient to the extent of 14 percent below normal. The overall monsoon rainfall for the country as a whole was also below normal. Yet Bihar suffered floods. Reason was twofold. The flood plains were completely wet by June and July rainfall. Later although there was no appreciable rain in Bihar, if rained in thecatchment areas of the rivers resulting in appreciable floods in the rivers of Bihac

The Bihar floods of 2004 were quite destructive in terms of the magnitude of damages caused. They affected twenty districts, submerging vast areas falling under 304 developinent blocks. The devastation by the floods was more pronounced in the rural areas where about 9360 villages were marooned. The number of people affected were estimated at 12.5 l lakh out of which 710 persons, lost their lives. A staggering 3000 cattle heads were lost in these floods.

3.9 LESSONS LEARNT PROM PAST DISASTERS

The primary lesson learnt from the past flood disasters appears to indicate that floods cannot be checked through structural measures only, i.e. by constructing reservoirs, embankments and allied structures. The limited utility of these structural measures in effective tlood management has led to the realisation that non-stmctural measures of flood management may be more cost-effective and acceptable. Thus, modifying the susceptibility to tlood damages and loss burden by methods of flood plain management, flood proofing, flood disaster preparedness, flood forecasting and forewarning, and flood insurance needs to occupy the center stage in the overall flood disaster management strategy.

Another lesson drawn from the past disasters relates to assumption of flood as an isolated incident taking place in the wake of high stream flows overtopping natural or artificial banks of a stream. The need, however, is to view flood as an inalienable part of the ecology arising out of the interplay of a number of factors. Therefore, flood should be viewed in a broad perspective forming an integral part of the overall water resources development and the economic development of the region.

3.10 CONCLUSION

This unit has discussed in detail the nature of floods including the types of floods, the basic factors involved in floods and flooding. The geographical distribution of flood prone areas in India has been described. The causes and impacts of flood have been explained in detail. The forecasting, warning and monitoring system existing in India has been described. The preparedness, response and mitigation systems are explained in their conceptual framework and relating to the Indian scene. Giving the background of the concept of severity of flood, two cases of flood disasters of the recent past have been described briefly. Lastly, the unit discusses the lessons learnt.

3 . 1 KEY CONCEPTS

Catchment : The area from which a river or a lake receives water flow.

Estuarine Flood : Flood in the estuary of a river due to backflow from sea.

Flood Plain : The area of land encroached by the floodwater.

Non-Structural Measures : The non-engineeringmeasures of flood management Iike flood-plain management, Flood proofing, flood disaster preparedness,flood forecasting, warning and monitoring, flood insurance etc.

Precipitation : Rainfall or Snowfall.

Preparedness : All measures taken to protect people and their property from disasters and resultant damages.

Response : Sum total of the activitiesundertaken by the people and the institutions in the face of adisaster.

Structural Measures : Engineering measures such as reservoirs and embankments.

3.12 REFERENCES AND FURTHER READING

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3.13 ACTIVITY

1) Describe the nature and types of floods.

2) Explain the basic factors in flood and flooding.

3) Demarcate the major flood prone areas in India.

4) Discuss the causes and impacts of floods.

5) Differentiate between structural and non-structural measures of flood mitigation and discuss the importance of forecasting, warning and monitoring system in India.

6) Discuss the proposed plan of linking the rivers in the context of its usefulness to combat the flood menace in India.