

6

Chapter

Disaster Management

Objectives

- ❖ Understanding disasters and hazards and related issues
social and environmental
- ❖ Types of Disaster
- ❖ Technical terminology involved
- ❖ Their occurrence/causes, Impact and preventive measures

6.1 ■ Understanding Disasters and Hazards and Related Issues Social and Environmental:

Environmental hazards may be defined as, those extreme events either natural or man-induced, which exceed the tolerable magnitude within or beyond certain time limits, make adjustment difficult, result in catastrophic losses of property, income and live and become the headlines of different news media at world level.

Three alternating or say parallel terms viz. Environmental Hazards, Environmental Stresses and Environmental Disasters.

Hazards are generally taken to the processes, both natural & anthropogenic, which can cause an accident/extreme event or danger where as 'disaster' is a sudden adverse or unfortunate extreme event which cause great damage to human beings as well as plants & animals. This chapter includes types of disaster, vulnerability & precautions during different disasters. Hazards and disaster are closely related. A hazard is a natural event while the disaster is its consequences. Disasters occur rapidly, instantaneously and indiscriminately. Hazards are the processes where as the disasters are the results or responses of environmental hazards. Disasters have serious impact on human life, economy and environment.

6.2 ■ Types of Disaster

Disaster can be categorized into various types based on the cause/origin and speed/devastation.

6.2.1 ■ Based on the Cause/Origin

Disasters are classified into following two categories:

6.2.1.1 Natural Hazards/Disaster

It is an event that is caused by a natural hazard and lead to human, economic, material and environmental losses. These types of disasters are further subdivided into main and sub-categories as follows.

1. Planetary Hazards/Disaster

(i) Terrestrial (indogeneous) disaster

- Volcanic eruption
- Earthquakes
- Tsunami
- Landslide

(ii) Atmospheric (exogeneous) disaster

2. Infrequent Events

- Cyclone
- Hailstorm
- Lightning
- Tornado
- Hurricanes

3. Cumulative Disaster

- Cold wave
- Heat wave
- Drought
- Floods

4. Extra-Planetary or Extra-Terrestrial Hazards/Disasters

- Mutual collision of meteors
- Collision of meteors with earth

Another type of classification of natural disaster is as follows:

6.2.1.2 Man-made (Anthropogenic) Hazards and Disaster**1. Physical Disaster**

- Accelerated soil erosion
- Reservoir-induced seismic

2. Chemical Disaster

- Explosions and Radioactive contamination
- Large-scale leakage of gas
- Release of toxic chemicals (such as arsenic etc.) and Nuclear Explosion

3. Biological Hazard and Disasters

- Eutrophication
- Insect swarms
- Population explosion

4. Technological Disaster

- Nuclear and industrial accidents (such as failure of nuclear plant)

- Nuclear wars
- Collapse of residential buildings

6.2.2 ■ Based on the Speed

These are classified as follows:

6.2.2.1 Rapid Onset Disaster

A disaster that is caused by an instantaneous shock, such as cyclone, earthquake, flash flood, volcanic eruption etc.

6.2.2.2 Slow Onset Disaster

A disaster that continues for many days, months or even years like drought, pest infestation, famine etc.

6.2.3 ■ Based on the Devastation

These are further classified as follows:

6.2.3.1 Major Natural Disaster

1. Cyclone
2. Drought
3. Earthquake
4. Flood

6.2.3.2 Minor Natural Disaster

1. Heat waves
2. Mud slides
3. Storm
4. Thunderstorms
5. Cold waves

6.2.3.3 Major Man-Made Disaster

1. Deforestation
2. Epidemic

3. Chemical pollution
4. Wars
5. Setting of fires

6.2.3.4 Minor Man-made Disaster

1. Road/train accidents, riots
2. Environmental pollution
3. Food poisoning
4. Industrial disaster/crisis

6.3 ■ Technical terminology Involved

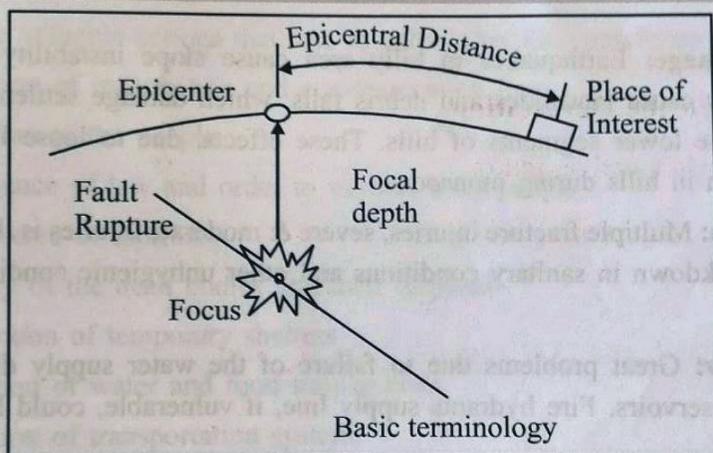


Fig. 6.1

6.4 ■ Their occurrence / Causes, Impact and Preventive Measures

6.4.1 ■ Earthquake

6.4.1.1 Cause of Earthquake

Earthquake is caused due to the shifting of rock layers under earth's surface. The earthquake releases tremendous energy. The earthquake magnitude is measured in Richter scale. If the Richter scale is 3 to 4 then it is called a minor earthquake. When it is 4 to 5 then it is known as moderate earthquake. When the value is 6 to 8 it is called a major earthquake. If the magnitude crosses 8 then complete destruction occurs. The point of origin of an earthquake under the earth

is called the focus or hypocentre. The point directly above the focus on the surface is called the epicentre. The impact of earthquake is usually strongest and worst near the epicentre. If the focus of earthquake is nearer to the earth's surface, about 0 to 70 km, then it is called Shallow focus earthquakes and these earthquakes are very destructive and damaging. The earth's crust is made up of massive interlocking blocks of rock called tectonic plates. Tectonic plates are placed on semi liquid rock called mantle. This mantle causes the movement of tectonic plates. These plates move against each other and collide or disturbed in any manner; the pressure is build up between them. These plate slip suddenly along fault lines to release the pressure.

6.4.1.2 Effects of Earthquakes

1. **Damage to Human Structures:** Earthquake cause heavy loss of human properties by damaging buildings, roads, rails, factories, dams, bridges etc. Weaker structures are damaged more.
2. **Physical Damage:** Earthquakes in hilly area cause slope instability and slope failure and ultimately cause landslides and debris falls, which damage settlements and transport systems on the lower segments of hills. These effects, due to loose lithologies, become more common in hills during monsoon.
3. **Public Health:** Multiple fracture injuries, severe & moderate injuries is the most widespread problem, breakdown in sanitary conditions and other unhygienic conditions could lead to epidemic.
4. **Water Supply:** Great problems due to failure of the water supply distribution network and storage reservoirs. Fire hydrants supply line, if vulnerable, could hamper fire service operations.
5. **Transport Network:** In many ways, affected due to failure of roads & bridges, railway tracks, failure of airport runways and related infrastructure collapse.
6. **Electrical & Communication:** All links got affected. Transmission towers, transformers, transponders may collapse.

6.4.1.3 Prevention & Control of Earthquake

The total mitigation program to reduce the impact of a severe earthquake can be splitted in three phases as follows—

1. Prevention Phase before Earthquake Disaster

Following are a few important actions to be taken or considered:

- Preparation of earthquake catalogues with details of epicentres and geological tectonic maps.

- Installation of seismological observatories for moderating seismic activity.
- Identification of seismic zones with seismic risks.
- Development of antiseismic codes of design and construction of various structures.
Training of architects and engineers in earthquake engineering principles and use of antiseismic codes.
- Promulgation of laws for adopting earthquake resistant features in new constructions.
- Development of methods for existing structures to strengthen against seismic movements.
- Earthquake insurance of various structures and human lives to reduce the economic impact.

2. Emergency Phase Workings after Disaster

Following are valuable actions that can be taken after the occurrence of earthquake:

- Restoration of information and communication lines.
- Evacuation of the people.
- Maintenance of law and order to support local people.
- Medical care of injured.
- Recovery of the dead bodies and their disposal.
- Construction of temporary shelters.
- Restoration of water and food supply lines.
- Restoration of transportation system.
- Preventing people from entering into buildings liable to collapse.
- Quick assessment of damage.
- Management of required sources for reconstruction and rehabilitation and development of self-reliance among affected people.
- Collection of scientific data to monitor the aftershocks.

3. Consolidation and Reconstruction Phase

This phase involves the following actions:

- Detailed survey of damages done to the man-made structures to prepare proposals regarding their repairs, restoration, strengthening or demolition.
- Selection of proper site for new settlements.
- Adoption of strategy for new constructions.
- Review of seismic codes and norms of constructions.

6.4.2 ■ Tsunami

6.4.2.1 Causes of Tsunami

1. **Earthquakes/ Volcanic Eruptions:** Submarine earthquakes and volcanic eruptions are the major cause of tsunami. The intensity and magnitude of waves depend on the intensity of earthquake/volcanic eruption. The line along which subduction takes place is known as Benioff zone. Along this zone violent volcanic eruptions and severe earthquakes of deep focus take place.
2. **Disturbance in Rock Strata:** It is known as Isostatic balance of the earth's plates. It is a geological process leading to compression and formation of mountains under the sea. During such geological processes any or all of the following actions on the seabed may take place:
 - Earthquakes may be caused.
 - Some part of the sea floor may be raised and another part may be lowered.
 - Vertical and lateral displacement of rocks may set off violent motion of ocean water.In each of the above cases tsunamis may be generated.
3. **Tides:** Regular and periodic rise and fall of ocean water called tides have been observed to cause pressure on tectonic plates, leading to plate movements and consequent earthquakes and volcanic eruptions. They may then cause tsunami waves.

6.4.2.2 Effects of Tsunamis

1. **Instability:** The geographers and earth scientist measures instability in terms of loss caused by tectonic displacement to weak slopes, undersea mountain chains and hills. These cause damage to settlements on the coasts, transport systems and shipping lanes in the sea. For example, in a country like Papua New Guinea, law forbids settlements within 800 meters from the sea. Similar restriction because of instability is imposed on settlements in earthquake prone areas.
2. **Loss of Human Lives:** In December 2004 tsunami, newspaper and electronic media screamed in bold letters or by other means—“150,000 dead and still counting”. The WHO, after its inspectors toured the area, released a report saying that more people will die of epidemic and other diseases.
3. **Mud & Debris Flow:** In Andaman and Nicobar Islands, it caused great loss to corals reefs. These areas are environmentally very sensitive known as coral bleaching, mud and

debris cover cause death of corals. The corals are already facing threat because of global warming.

4. **Private, Public & Commercial Losses:** This includes damages and destruction caused to houses, roads, buildings, port facilities, ships, boats, sea resorts, hotels and other property owned by individual, government and private companies. The loss in India alone is put 10,000 crores. The Bhuj earthquake is said to have caused a loss of Rs.12,000 crores.
5. **Damage to Port Towns & Cities:** Major town and cities in India on West and East coast like Kanyakumari, Chennai, Nagercoil, Nagapattinam and many others including thousands of villages were heavily damaged.
6. **Electricity & Communication:** Bridges, water pipes, telecommunication like vehicular traffic cars, buses & trucks were damaged in thousands.

6.4.2.3 Precaution and Control of Tsunami

1. **Plantation of Trees:** The trees acted as breakers of destructive power and velocity of winds and water.
2. To procure tsunami/earthquake monitoring system.
3. **Early Warning System:** Progress in Science & Technology has made it possible to provide advance warning of tsunamigenic earthquake. The early warning system consists of a sensor placed on sea bed. A floating buoy links the warning system with ground stations via a satellite.

6.4.3 ■ Landslide

6.4.3.1 Causes of Landslide

Landslides may be caused by natural as well as anthropogenic factors. Some of the causes are discussed in the following sections.

1. **Natural Causes:** The following are some of the natural causes of landslides:

- **Earthquakes:** Most of the landslides are induced by earthquakes and these landslides become the major contributors of casualties during such earthquakes. The heightened seismic activity during an earthquake reactivates old landslides and leads to the formation of new ones.
- **Volcanic Eruptions:** Landslides on volcanoes are common because of the massive height of their cones. These cones are often weakened by the rise and eruption of magma, and the tremendous weight of the lava cause them to settle under the force of gravity leading to landslides.

- **Torrential Rains and Glaciers:** Heavy rains and glaciers increase the moisture content, lead to saturation, and hence weaken the slopes, causing the wet earth to slide downwards.
2. **Anthropogenic Causes:** In addition to natural causes, human activities may also trigger off landslides in susceptible areas. The following are some of the anthropogenic causes of landslides:
- Construction of dams, bridges, tunnels, roads, etc.
 - Use of explosives for breaking rocks during mining.
 - Destruction of vegetation from the slopes leaving them vulnerable to runoff.

6.4.3.2 Effects of Landslides

1. **Physical Damage:** Landslides destroy anything that comes in their way. They bury or blocks roads, river flow, communication lines, settlements, agricultural land etc. It also includes loss to agricultural production and land area. In addition physical effects like flooding may also occur.
2. **Casualties:** They cause maximum fatalities depending on the place & time of occurrence. Catastrophic landslides have killed many thousands of persons.

6.4.3.3 Control of Landslides

Landslides control may prove effective provided the landslides prone areas are surveyed from time to time.

1. **Hazard mapping** will locate areas prone to slope failures. This will allow identifying avoidance of areas for building settlements.
2. **Land use** practices like existing natural vegetation, i.e., forest and natural grassland, in good condition should be preserved. Upper slopes are to be reforested with suitable tree species. In construction of canals, roads, irrigation etc. proper care is to be taken to prevent the blockage of natural drainage.
3. **Retaining walls** can be built to avoid land from slipping (these walls are seen along roads in hills stations).
4. **Surface Drainage Control Works:** The surface drainage control works are applied to control the movement of landslides accompanied by infiltration of spring flows and rainwater.
5. **Engineered structures** with strong bases can withstand or take the ground movement forces. Underground installations should be made flexible in order to withstand forces caused by the landslides.

6. **Increasing vegetation cover** is the most effective and cheapest way of arresting landslides. This helps to bind the top layer of the soil with inner layers, while preventing excessive runoff and soil erosion.

6.4.4 ■ Volcanic Eruption

6.4.4.1 Cause of Volcanic Eruption

Several activities taking place inside the earth crust by volcanic eruption. Hot matter comes out from the interior of the earth crust through a crack or hole and accumulates in course of several years, in form of conical mountains. Sometimes rainwater enters the interior of the earth, it is converted into steam and gas due to high temperature. These gases and steam comes out with a bang and throw large amount of lava & ashes with full force.

6.4.4.2 Effects of Volcanic Eruptions

1. **Ozone Depletion:** It produces lot of gases particularly chlorine gas which are the natural source of ozone depletion.
2. **Environmental Pollution:** It pollutes the environment with its acidic gases and ash.
3. **Increase the Temperature of Marine Water:** It increases the immediate marine temperature killing many aquatic biotas.
4. **Formation of Plateau:** Sometimes volcanic eruptions spread in several kilometer long areas resulting into the formations of extensive sheet of lava, which in turn convert into Plateau. For e.g. In Deccan region of India, lava sheet is about 2000 meters thick.

6.4.4.3 Prevention and Control of Volcanic Eruption

1. By volcanic warning and careful planning, major loss of life and property can be avoided.
2. Volcanic eruptions give a warning, so proper steps can be taken to evacuate the nearby places.

6.4.5 ■ Cyclones

The word cyclone is derived from the Greek word cyclos meaning the coils of a snake. "Cyclones are violent storm, often of vast extent, characterized by high wind rotating about a calm centre of low atmospheric pressure. This centre moves onwards, often with a velocity of 50 km per hours." When the cyclones move on the land they are called hurricanes, typhoons.

1. **Hurricanes:** The cyclone in the Western Atlantic Ocean or West Indies is called as hurricanes.
Generally, hurricanes blow at the speed of 120 km/hr or more. It caused wide spread destruction of life, property, environments and the ecosystems.
2. **Typhoon:** It is a very strong wind having the velocity of 240 km/hrs or more. These also occur in Western Pacific Oceans. It brings heavy rain and very violet strong wind. It starts slowly but gradually it becomes very powerful. The diameter of a typhoon may be large as 480 km. Typhoons are more dangerous than hurricanes.

6.4.5.1 Causes of Cyclone

Wind blows from all sides towards the low pressure centre resulting in fast spiral motion and the whirling air to rise up. The high-speed wind moves in anti-clockwise direction in northern hemisphere and in clockwise direction in southern hemisphere. Each cyclone comprises a relatively calm area in the centre called eye, surrounded with spiral cloud bands. The severity of cyclones is measured on the Beaufort scale (named after Francis Beaufort), based on easily observable indicators such as tree movement and damage to structure.

6.4.5.2 Types of Cyclones

It is categorized on the basis of severity.

1. Normal
2. Severe
3. Very severe

Super cyclone is the example of Very severe type cyclone. The word super cyclone has been coined By IMD (India Meteorological Department) assessing severity of Odisha cyclone of 1999.

6.4.5.3 Effects of Cyclones

1. **Physical Damage:** Structures will be destroyed or damaged by the heavy flooding wind force, storm and landslides. Roofs of lightweight material suffer from severe damage. Houses collapse and people are rendered homeless.
2. **Casualties & Public Health:** Caused by flying and flooding elements, contamination of water, which is unfit for drinking. There can be outbreak of diseases like Cholera, jaundice or viral fever due to intake of impure water.
3. **Water Supplies:** Piped and ground water supply may get contaminated by flood because of floating corpse of animals and human beings

4. **Crops & Food Supplies:** High winds and rains will destroy the standing crop and food stock lying in low-lying areas. Plantation type crops like coconut and banana are extremely vulnerable. Seawater will increase the salinity and make the soil unfit for cultivation.
5. **Communication:** Severe damage in the communication links. Transport links may be curtailed.

6.4.5.4 Control of Cyclones

1. **Hazard Mapping:** A hazard map will illustrate the area vulnerable to the cyclone in any particular year. It is an effective mitigation tool.
2. **Land Use Control:** Designed in such a way that least critical events are placed in vulnerable areas. Location of settlements in the flood plains is of severe risk. Vulnerable areas should be kept for playgrounds, parks or as grazing lands.
3. **Forecasting & Warning:** Forecasting a cyclonic event is the best measure of minimizing the losses due to cyclone. Advanced systems of cyclone forecasting are now available to almost all the developed nations of the world. Warming should be issued immediately to concerned government agencies and to the public.
4. **Multipurpose Cyclone Shelters:** Multipurpose cyclone shelters of suitable designs have been built up in vulnerable locations of coastal Odisha.
5. **Engineered Structures:** Structures need to be constructed to withstand wind forces. Good site selection is equally important. Majority of the buildings in coastal areas are built with locally available things or elements and have no engineering inputs. Good construction practice should be adopted.
6. **Relief Task:** Relief measures such as an economic help and support by individuals, community and governmental and non-governmental organizations should be ensured to help in resettlement and rehabilitation of affected people. Awareness should be spread at all levels of the community to prepare everyone for emergencies. They should be trained about stock of food grains, drinking water, medicines etc. and to keep trade implements.
7. **Maintaining Telecommunications:** Cyclone disrupts communication and other services badly. Thus, cuts it off the affected area from the rest of the world. Andhra Pradesh has a system of HAM radio operators. They communicate with each other using voice computer, morse code, pocket radios and satellite links. During the super cyclone disaster in Odisha, where telecommunication office was ineffective, there was only one satellite phone in whole Odisha state set up by HAM radio operators on midnight of October 1999. Its role was found very effective in maintaining telecommunication in cyclone-affected areas for rescues of people.

Houses can be strengthened to resist flood and wind damage. All elements holding the structures need to be anchored in a well manner to resist the uplift or flying off of the objects. For instance, avoid large overhangs for roofs and projections should be tied down. A row of planted trees will act as a shield.

6.4.6 ■ Floods

Floods refer to large volume of water flow in the rivers, lakes and other surface runoff waters. Sometimes, this large volume of water is so high that it crosses bank or flood plains and spreads out to large distance from the normal level or course. This large volume of water submerges a vast land surface across the river and becomes a flood..

6.4.6.1 Types of Floods

- Flash Floods:** These occur within hours of heavy rainfall and are usually associated with towering cumulus clouds, severe thunderstorms and tropical cyclones or the passage of cold weather fronts. Flash floods may also be caused by dam failure or other river obstructions.
- River Floods:** River floods are caused by precipitation over large catchment areas or by melting of snow or sometimes both.
- Coastal Floods:** These are associated with the cyclonic activities such as hurricanes, tropical cyclones etc. Coastal floods are often aggravated by wind-induced storm surges along the coast.

6.4.6.2 Causes of Flood

The main cause of flood can be grouped into two types.

1. Natural causes:

- Uncertainty of Rain:** In most of the arid and semi-arid regions, low and erratic rainfall slowly reduces the depth and width of streams and river channels. Under such conditions, whenever heavy rainfall occurs, water channels fail to carry away all the water causing excess water to overflow.
- Landslides and volcanic eruptions also cause flood.

2. Man-made causes:

- Urbanization:** Faulty town planning is another factor that contributes in causing floods. Housing colonies often come up in low-lying areas, which are easily submerged even with moderate rains.
- Change in River Course:** Due to high pressure of torrential rains, river channel changes its source. The flow capacity of a river channel through meander loop is reduced, causing water to spread to adjacent areas.

- **Riparian Dams:** Riparian Dams constructed for controlling floods, control flood in one area but increase the chance and intensity of flood in other areas.
- **Deforestation:** The canopy, undergrowth & the root system in forests provides some protection from floods by trapping & absorbing precipitation. Flood plains are the areas bordering a river that is prone to flooding whenever the level of river rises.
- Man made impediments in river channels, man-made ponds, dams, powerhouses, roads, railway bridges, playground etc. restrict the natural flow of river & cause floods.

6.4.6.3 Effects of Floods

Floods cause severe damage and disrupt the normal functioning of ecosystems in the flood affected area. The following are some of the adverse effects of floods:

1. **Damage to Life & Properties:** Floods destroy houses and other constructions and kill thousands of people.
2. **Crop Damage:** Flood damages agricultural lands and reduce the yield.
3. **Disturbance in Transportation:** Floods harm road and bridges, creating disturbance in transportation.
4. **Spread of Disease Vectors & Pathogens:** Floods increase the population of disease vectors such as flies & mosquitoes. Dead bodies, decomposing plant & animal remains, promote growth of pathogenic bacteria and viruses.
5. **Loss of Biodiversity:** Long lasting floods eliminate sensitive plant & animal species & pose a threat to biodiversity.
6. **Economic Crisis:** The severe losses caused by flood create economic pressure on state & central governments.

6.4.6.4 Prevention and Control of Floods

The intensity of flood can be minimized using the following measures:

1. **Plantation on Slope:** Plantation helps in regulating river flow and control soil erosion.
2. **Drainage Management:** Improvement of channels by removing debris and sediments & restricting the deposition of excess debris and sediment help in regulating the rate of river flow.
3. **Flood Plain Zoning:** Flood plain can be managed by dividing them into different temporal plots. This is commonly referred to as flood plain zoning.

4. **Construction:** To construct the whole village or settlement on a raised platform higher than the high flood level.
5. **Forecasting:** Possible damage can be minimized by forecasting the occurrence of floods and warning the people about the possible danger.

6.4.7 ■ Drought

Drought is an insidious natural hazard, which results from a departure of precipitation from expected or normal that, when extended over a season or longer period of time, is insufficient to meet the demands of human, plant and animal activities.

6.4.7.1 Types of Droughts

1. **Hydrological Drought:** Many watersheds experience depleted amounts of available water. Lack of water in river systems and reservoirs can impact hydroelectric power companies, farmers, wildlife and communities.
2. **Meteorological Drought:** Most locations around the world have their own meteorological definition of drought based on the climate normal in the area. A normally rainy area that gets less rain than usual can be considered as drought.
3. **Agricultural Drought:** When soil moisture becomes a problem, the agricultural industry is in trouble with drought. Shortage in precipitation, changes in evapotranspiration, and reduced ground water levels can create stress and problems for crops.

6.4.7.2 Cause of Drought

1. **Rainfall Deficiency:** When over all rainfall deficiency is more than 10% of the long period average than more than 20% of the country area is affected by such type of drought conditions.
2. **Deforestation:** Excessive amount of evaporation of soil water due to deforestation.
3. **Excessive Use of Groundwater:** Excessive use of ground and surface water will cause drought.
4. **Global Warming:** It causes the change in rainfall patterns, which in turn results into drought.

6.4.7.3 Effects of Droughts

1. **Hunger & Famine:** In a drought there may not be enough water to grow crops or enough grass and grain to feed animals. Food prices will go up and only the rich can buy. If there is no food people go hungry and if the drought goes for a long time there may be famine and people die.

2. **Thirst:** Humans, animals and plants, all need water to survive. Humans can only live a few days without water.
3. **Disease:** If there is no water for drinking, bathing or even flushing toilets. There can be a wide range of dangerous diseases.
4. **Land Degradation:** If there is no water, the plants holding down the soil will die, and winds can quickly strip the land of top soil. The natural habitat of native animals is damaged and some may not survive. Wetlands and lakes may dry up.
5. **Bush Fires:** When there is no water everything dries up including the forest and bush. Lightning strikes or carelessness often starts huge bush fires, those can burn animals, houses and property. Humans are also killed in bush fires.
6. **Economy:** The country's economy may suffer, as it may have to import food and support farmers and unemployed and starving people.
7. **Social Conflict and War:** If there is no water, people will fight to get what little there is. There may be war in the future over water, when countries hold back river water from flowing on to a neighbouring country.
8. **Migration or Relocation:** In times of drought people may leave their homes and search for somewhere better. These refugees may not easily find another home.

6.4.7.4 Prevention & Control of Drought

1. **Drought monitoring** is continuous observation of rainfall situation, water availability in rivers, lakes, reservoirs and comparing with the existing water demand of various sectors of society.
2. **Water supply augmentation** and conservation through rainwater harvesting in houses and fields increases the content of water available. Water harvesting by either allowing the runoff water from all the fields to a common point for or allowing it to filter into the soil where it has fallen for ex-contour bunds, contour cultivation, raised bed planting etc. helps increase water level for sustained agricultural production.
3. Expansion of irrigation facilities decreases the drought vulnerability.
4. Land use based on its capability helps in proper use of land and water and can avoid the undue demand created because of their misuse.
5. Livelihood planning identifies those livelihoods, which are minimum affected by the drought. Some of such livelihood contains increased off farm employment opportunities. Collection of non-timber forest produces from the community forests and carpentry etc.

6.4.8 ■ Forest Fires

The most common hazard in forests is forest fire. Forest fire poses a threat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the biodiversity and the ecology and environment of a region. During summer, when there is no rain for months, the forests become littered with dry senescent leaves which could burst into flames ignited by the slightest spark. Sunny day, low humidity and strong breeze act as catalyst in forest fires.

6.4.8.1 Type of Forest Fires

Forest fire is one of the most important ecological factors in the terrestrial environment. On the basis of their damage of the forest, the fires are of following three types:

1. Surface fires
2. Ground fires
3. Crown fires or wild fires.

1. Surface Fires: A forest fire may burn primarily as a surface fire spreading along the ground as the surface litter (senescent leaves, dry grasses etc.) on the forest floor and is engulfed by the spreading flames.

2. Ground Fires: Fires sweeping the forest surface may generate ground fires, which burn in thick accumulation of organic matter. These fires are flameless and subterranean and almost all plants rooted in the burning material are burnt, leaving the woody species with thick root barks.

3. Crown Fires or Wild Fires: These fires are most destructive, killing all the vegetation from the ground upward. In the forests, these fires travel from one crown to another. Conifers are badly destructed by crown fires. Buried seeds and subterranean organs in the ground escape these fires. A crown fire is particularly very dangerous in a coniferous forest because resinous material given off burning logs burn furiously. On hill slopes, if the fire starts downhill, it spread up fast as heated air adjacent to a slope tends to flow up the slope spreading flames along with it. If the fire starts uphill, there is less likelihood of it spreading downwards.

6.4.8.2 Causes of Forest Fire

1. Natural Causes: Many forest fire starts from natural causes such as lightning which set trees on fire. However, rain extinguishes such fires without causing much damage. High atmospheric temperature and dryness are favourable circumstances for a fire to start.

2. Man-made Causes:

- Fire is caused when a source of fire like naked flame, cigarette or bidi, electric spark or any source of ignition comes into contact with inflammable material.

- Electrical wiring can cause a fire, if it is not capable to carry the load being supplied.
- Rubbish waste material that is left to destroy can easily contribute to the spread of fires.

6.4.8.3 Effects of Forest Fires

Fire effects the vegetation directly or indirectly in various ways:

1. **Direct Effects:** Surface fires and crown fires kill the vegetation of all types and injure them severely, whereas the ground fires burn the undergrowth of the forest and some of the underground parts of the plants, direct effects of fires include the burning of biomass, release of carbon dioxide and nitrogen gases and ash in the atmosphere deposit of nutrients.
2. **Indirect Effects:** Some of the effects of burning of forests are indirect. Fire causes removal of competition for surviving species, which causes the abundant growth of the fire-resistant species at the cost of fire-susceptible species. The injuries or scars left on the stems of woody plants serve as sites for the entry of parasitic fungi and insects. Changes in the environmental factors such as the increase in light at the ground surface and soil nutrients, increase in soil organic matter and decrease in rainfall interception are also caused by forest fires. The fire also affects adaptations for some plant species, The fires in the forest also affect wildlife population and their habitats. There are a number of plant species, which develop adaptations to the fire. Certain species of pines, oaks and shrubs develop thick bark or fire resistant seeds or fruits. Apart from the harmful effects of fires, it is useful in the management of vegetation. Fire induces regeneration and reproduction in some plant species such as of herbs in the grassland. Thinning of the ground surface also helps in sprouting and more growth of plants. Nutrition of the ground is also increased. Fire also eliminates the diseases and insects outbreaks.

6.4.8.4 Control of Fires

1. The best way to control a forest fire is, to prevent it from spreading which can be done by creating firebreaks in the shape of small clearings of ditches in the forests.
2. To keep the source of fire under watch and control, do not allow combustible or inflammable material to pile up unnecessarily.
3. To adopt safe practices in areas near forests viz. factories, coal mines, oil stores, chemical plants and even in household kitchens.
4. Combustible materials like packing materials, solvents, glues, gases stored or flammable liquids in work place can be extremely dangerous. Store the materials both in terms of required quality and in a secure area outside the premises.

5. Forest fire arise when villages leaves ashes or burn 'bidi' carelessly when they go for searching wood and grazing their cattle.
6. To incorporate fire reducing and fire fighting techniques and equipment.

6.4.9 ■ Cloud Burst

A **cloudburst** is sudden copious rainfall. It is a sudden aggressive rainstorm falling for a short period of time limited to a small geographical area. Meteorologists say the rain from a **cloudburst** is usually of the shower type with a fall rate equal to or greater than 100 mm (4.94 inches) per hour.

6.4.9.1 Causes of Cloud Burst

It happens because the rain forming in the **cloud** has been unable to fall down in a steady shower. Sometimes this happens when the **cloud** is ready to rain and the ground below is scorching hot. Or maybe a very warm current of air is blowing under the rain **cloud**. Either of these events causes a strong updraft of warm air.

6.4.9.2. Effects of Cloud Burst

1. Causes flash floods resulting in loss of animal life.
2. Loss of flora due to unwanted water supply.
3. Soil erosion due to abundant water.
4. Large volume of water, can cause landslides.
5. Damage to the infra structures like houses, bridges.

6.5 ■ Vulnerability of Indian Continent to Different Types of Disaster

India's size, unique geo-physical characteristics, and behaviour of monsoon make it one of the most disaster-prone countries in the world. Scholars often described it using two meaningful adjective like Indian-subcontinent and the land of unity in diversity (in terms of its physical and socio-cultural attributes). In other words, Indian sub continent is prone to multiple hazards (one area vulnerable to more than one hazard) and highly vulnerable to both natural and man-made disaster that generally result in heavy loss of life and properties etc. These occur in different parts of India in varying intensity. This means that we are vulnerable in different degrees to disasters caused by these hazards.

On the basis of geographic and climatic considerations, India can be divided into five disaster proneness zones.

1. **Deccan Plateau:** A drought prone area (interior parts of Andhra Pradesh and Karnataka etc.)
2. **The Western Desert:** A drought prone area (Rajasthan, Kachchh in Gujarat etc.)
3. **Indo-Gangetic Plains:** The major river valleys such as Ganga, Brahmaputra.
4. **Coastal Areas:** The eastern coastline and island of Andaman and Nicobar, Lakshadweep are vulnerable to cyclones and tidal waves.
5. **Northern Mountain part including foot hills:** Himalayas and Western Ghats regions are prone to landslides, strong cold waves and Earthquake etc.

Government of India, Ministry of Home Affairs, and United Nations Development programme have signed an agreement on August 2002 for implementation of **Disaster Risk Management Programme** to reduce the vulnerability of the communities to natural disasters, in identified multi-hazards disaster prone areas.

Goal of Disaster Risk Management

Sustainable Reduction in natural disaster risk in some of the most hazard prone districts in selected states of India.

The following main objective of this programme are:

1. Environment building education, awareness programme and strengthening the capacity at all levels in natural disaster risk management and sustainable recovery.
2. Multi-hazards preparedness response and mitigation plans for the programme at state, district, block and village/ward levels.
3. National capacity building support to the ministry of home affairs.
4. Networking knowledge on effective approaches, tools and methods for natural disaster risk management developing and promoting policy frameworks.

Programme Phases

The programme has been divided into following two phases over a period of six years.

Phase I (2002-2004): This would provide support to carry out the activities in 28 select districts in the states of Bihar, Gujarat and Odisha.

Phase II (2003-2004): This would cover 141 districts in the states of Assam, Meghalaya, Sikkim, West Bengal, Uttarakhand, UP, Delhi, Maharashtra, Tamil Nadu, Mizoram, Manipur, Tripura, Arunachal Pradesh and Nagaland.

Risk analysis

It is the measure of the expected losses due to a hazardous event of a particular magnitude occurring in a given area over a specific time period.

This can be better understood by following equation:

$$\text{Risk (of hazard/disaster)} = \text{Probability (the occurrence of a hazard)} \times \text{Losses (of a hazard)}.$$

In simple terms, risk is a quantum of probable losses due to hazards event or disaster.

■ Review Questions

1. What is the difference between environmental hazards and disasters? What are their types.
2. Write a note on geological natural hazard.
3. What to do and not to do during different types of disasters.
4. How to measure and locate an earthquake?
5. Write short notes on:
 - (a) Risk reduction measures for floods
 - (b) Types of landslide



Man-Made Disasters

Objectives

- ❖ Chemical Disasters
- ❖ Nuclear Hazards
- ❖ Power Break Downs
- ❖ Traffic accidents
- ❖ Fire Hazards
- ❖ Component Of Disaster Management
- ❖ Study of major disasters

7.1 ■ Chemical Disasters

7.1.1 ■ Cause of Chemical Disasters

In the event of fires, chemical explosions or leaks occurring in industrial areas, people are exposed to the following dangers:

The fire spreading in the industry and the residential areas nearby:

1. Chemical gas leak (poisonous)
2. Heat waves
3. Low oxygen level
4. Combustion of different products and heat waves
5. Contamination of the nearby environment (water, land and air)
6. Falling of structural elements and machinery.

Major chemical disasters are associated with exposure of mankind to toxic chemicals, heavy metal like lead, pesticides like DDT etc. Persistent Organic Pollutants (POP's) also cause several problems. Some chemicals like benzene etc. are carcinogenic in nature and cause cancer.

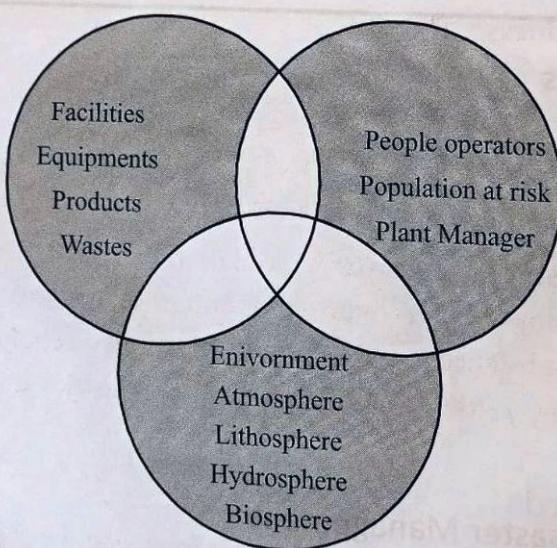


Figure 7.1 : Components of Industrial Disaster

7.1.2 ■ Effect of Chemical Disaster

1. **Physical Damage:** Damage to structure and infrastructure. In case of explosion of fire or release of toxins in the atmosphere the geographical spread can be high. By certain

chemical leaks, monumental buildings and other places loose their luster and shining. The gases and chemicals also cause corrosion.

2. **Casualties:** Many persons may be killed, injured and would require immediate treatment. The routes of exposure in chemical tragedies are inhalation, skin contact, eye exposure and ingestion. Health effects are explained in terms of the system organs getting affected and may include heart failure, cancer, brain damage, genetic disorders, deformation, congenital disorders etc.
3. **Environmental Damage:** Contamination of water, air, land and standing crops may occur. Particular areas may become worst for living due to the damage caused to the environment.

7.1.3 ■ Prevention and Control of Chemical Disaster

1. **Hazard Mapping:** Inventories and maps of storage locations of hazardous or toxic substances along with the possible features should be shown and familiar to all. The community staying in the immediate vicinity should be familiar to this hazard and possible effects in case of an accident should be known. The map should also determine the area that may get affected in case a mishap occurs. Hazard map should determine possible area getting affected and safe route for evacuation should be marked.
2. **Community Preparedness:** The community should be familiar with the hazardous installation and know how to fight the circumstances. The community members should watch out the pollution levels of the industry and participate in mock drill.
3. **Land Use Planning:** Industrial area should be separated and away from the populated residential area. The green belt should separate the industrial area and the residential area.
4. **Other possible risk reduction measures:** Maintain the wind flow diagram of the region, properly improve warning system, improve pollution dispersion capabilities, limit storage capacity of the toxic substances, and develop emergency relief and evacuation planning for employee and nearby settlements, insurance for industries and safety legislation.

7.2 ■ Nuclear Hazards

Radiation is the emission of rays and particles from a source and the source of ionizing radiation is the group of radioactive elements. The radiations are of two types:

1. Corpuscular radiations (particulate in nature, e.g. α and β radiations)
2. Electromagnetic radiations (waves of shorter wavelengths, e.g. X-rays, UV rays, infrared ray)

High-energy radiations, which have ionizing property, are emitted by radioactive elements and are called ionizing radiations.

7.2.1 ■ Sources Of Radiation Exposure

The sources of radiation, to which man is exposed, can be:

1. Natural
2. Man-made.

- Natural sources include cosmic rays, environmental and living organisms. Radionuclides of radium, thorium, uranium and isotopes of potassium (K40) and carbon (C14) are very common in soil, rock, air and water. Uranium and thorium ores are found in Kerala.

Man is also exposed to internal radiation due to presence of small amounts of uranium, thorium and isotopes of K, C and Strontium (Sr) in the body. Internal radiation values vary from 25 to 75 m rads/yr.

- Man-made sources include X-rays machines, radioactive fallouts (nuclear tests), nuclear reactor wastes, industrial, medical and research uses or radioactive materials and miscellaneous (TV, tubelight, radium watches etc.). Of these, nuclear power sources are important and of concern as their radionuclides are released in water as well as in the atmosphere.

7.2.2 ■ Sources Of Radioactive Pollution

Three main sources of radioactive pollution are as follows:

1. Radioactive fallout from atomic weapon testing.
2. Radioactive fallout from small atomic weapons used for peaceful purposes.
3. Atomic waste material.

7.2.3 ■ Biological Effects Of Radiation

The effect of radioactive pollutants depends upon:

1. Half-life time
2. Energy releasing capacity
3. Rate of diffusion
4. Rate of deposition of contaminants

Various atmospheric and climatic conditions also determine the pollution effects.

Biological effects of ionizing radiations may be:

1. Short Range Effects
2. Long Range Effects

The short-range effects are acute and expressed within few days or weeks after the exposure to radiation. The effects may be:

1. Physical Crippling or
2. Immediate Death.

The long-range effects take longer time to express. Such delayed effects of radiations are now centers of world's interest. These include:

1. Genetic changes
2. Point mutations and chromosomal aberrations
3. Increased incidence of tumors and cancers
4. Shortening of life span
5. Loss of vitality
6. Anemia
7. Hemorrhages

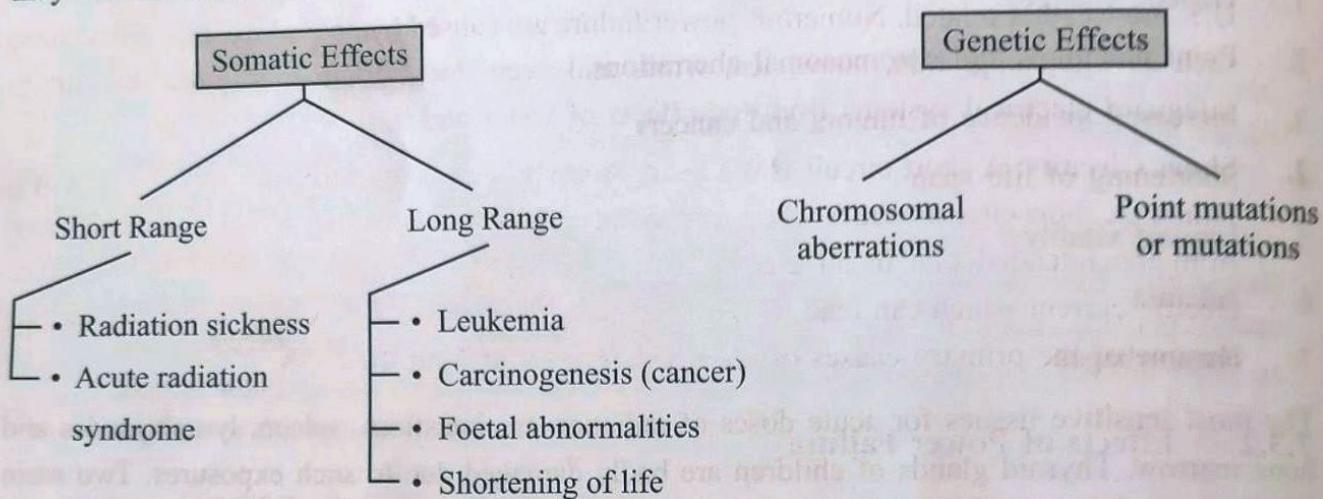
The most sensitive tissues for acute doses of radiation are intestines, spleen, lymph, nodes and bone marrow. Thyroid glands of children are badly damaged due to such exposures. Two main radioactive elements in the nuclear fallout are Iodine-131 and Strontium-90 (I-131 and Sr-90). I-131 easily enters the food chain at any level and gets concentrated in the terminal component through the process of biological amplifications. Unfortunately, man is most often the last link of many food chains. Once I-131 becomes accumulated in the human body, it can damage:

1. White blood cells
2. Bone marrow
3. Spleen etc.
4. Lymph nodes and cause:
 - Lung tumors
 - Skin cancer
 - Sterility
 - Defective eyesight

Strontium can replace calcium in plants and animals, and Sr-90 is a bone seeker. It causes:

1. Bone cancer
2. Tissue degeneration.

Sr-90 reaches dairy products through vegetation and use of it by cattle and then to man by consumption of contaminated food, meat, milk and dairy products. Transmutations and radioactive isotopes incorporated in the structural component of the body of the organisms cause complete chaos in the system as the very basis of internal structure of the body may crumble down. Organism infested with radioactive substances is a moving source of radioactivity and health hazards for others who come in contact with him. The biological effects of ionizing radiation may also be divided into two main groups, the somatic and genetic effects, as follows:



7.2.4 ■ Protective Measures

Following are a few important measures to protect from damage done by radioactive substances:

1. While handling UV lamps, dark glass spectacles or goggles must be worn. Ultra violet rays cannot penetrate dark glasses.
2. Visible light neutralizes UV damage considerably. Thus, exposure to sunlight to any individual exposed to UV could be a good remedial measure to treat the exposed individual.
3. Nuclear fallout hazards must be minimized by adopting certain precautions, e.g.
 - (i) High level wastes are long-lived and have high radioactivity per unit volume. These must be contained somewhere as follows:
 - (a) In underground tanks without treatments.
 - (b) Liquids should be converted into inert solids like ceramics and then buried in deep ground.
 - (c) Stored in deep salt mines.
 - (ii) Low level wastes, which have a very low radioactivity, must be dispersed into the environment in such a way that these cannot enter the food chain. The high-level components of these wastes should be separated and disposed like high-level wastes.

4. The radioactive wastes should be stored in places where these gradually decay to their final stable products.

7.3 ■ Power Break Downs

7.3.1 ■ Causes of Power Failure

1. **Weather Related:** The Edison Electric Institute states that 70% of power outages in the U.S. are weather related. Numerous power failure are caused by natural weather phenomena such as lightening, rain, snow, ice, wind, and even dust. While it is more difficult to safeguard electrical systems from the effects of water and dust
2. **Short Circuits:** A short circuit is the most commonly used term to describe the cause of a failure. A short circuit occurs when an electric current travels along a path that is different from the intended one in an electric circuit. When this happens, there is an excessive electric current which can lead to circuit damage, fire and explosion. In fact, short circuits are one of the primary causes of electrical fires throughout the world.

7.3.2 ■ Effects of Power Failure

Electricity is being used for irrigation, sowing, storing of allied products. Impending power cuts not only affects rural households in a pretty bad way, but also impacts urban life adversely. Here are a few key indicators:

- Transportation system depends largely on electricity, ranging from train services to automatic signalling system. Power cuts can make the entire system go haywire.
- Healthcare industry gets badly hit by power cuts. Life saving equipment cannot run automatically without power, major operations got cancelled.
- Power outages bring production lines to an abrupt halt. This may translate into loss of material, breakdown of machinery and loss of productive time.
- Consulting services firm and software development facilities house hundreds of highly paid professionals. Even a brief period of down time leaves them stranded and results in loss of billable hours.
- Pharmaceutical industries, petrochemical industries and food processing plants rely heavily on uninterrupted availability of power for storage and preservation of perishables that have extremely limited life spans. Power outages can cause in-process products damage, spoilage or contamination.

7.4 ■ Traffic Accidents

A road accident refers to any accident involving at least one road vehicle, occurring on a road open to public circulation, and in which at least one person is injured or killed. Road accidents are undoubtedly the most frequent and, overall, the cause of the most damage. The reasons for this are the extremely dense road traffic and the relatively great freedom of movement given to drivers.

7.4.1 ■ Causes of Road Accidents

1. **Distracted Driving:** Distracted drivers are the top cause of car accidents today. A distracted driver is a motorist that diverts his or her attention from the road, usually to talk on a cell phone, send a text message or eat food.
2. **Speeding:** Many drivers ignore the speed limit and drive 10, 20 and sometimes 30 mph over the limit. Speed kills, and traveling above the speed limit is an easy way to cause a car accident. The faster you drive, the slower your reaction time will be if needed to prevent an auto accident.
3. **Drunk Driving:** Driving under the influence of alcohol causes car accidents every day.
4. **Night Driving:** Driving in the daylight can be hazardous, but driving at night nearly doubles the risk of a car accident occurring.
5. **Unsafe Lane Changes:** There will always come a time where you need to get over to another lane (i.e. exit from a freeway, get in the correct lane to make a turn, etc.). When drivers don't make safe lane changes properly, it often leads to a car accident.
6. **Tire Blowouts:** Most highways are littered with the scattered remains of a tire blowout. Tire blowouts can cause you to lose control of your vehicle, and they are especially dangerous for bigger automobiles like semi-trucks.

7.4.2 ■ Prevention from Accidents

1. **Helmets for two-wheeler riders:** Setting and enforcing mandatory helmet use is an effective intervention for reducing injuries and fatalities among two-wheeler users. Wearing a helmet decreases the risk and severity of injuries by about 72% and likelihood of death by 39% as per WHO road safety manual on use of helmets.
2. **Seat-Belts:** It should be mandatory to wear seatbelts both for the front and rear occupants of the car. Wearing a seat-belt reduces the risk of a fatality among front-seat passengers by 40–50% and of rear-seat passengers by between 25–75%.

3. **Setting and Enforcing Speed Limits:** Pedestrians have a 90% chance of survival if hit by a car travelling at a speed of 30km/h or below, but less than a 50% chance of surviving an impact of 45km/h or above. Speed-monitoring cameras and radars and speed-limiting governors in vehicles are useful devices in enforcing the speed limit.
4. **Setting and Enforcing Alcohol Limits:** Drinking and driving is one of the main causes of road crashes worldwide. Laws that establish blood alcohol concentration (BAC) of 0.05g/dl or below are effective at reducing the number of alcohol-related crashes.
5. **Banning Drivers from Using hand-held Mobile Phones:** Drivers using a mobile phone are approximately four times more likely to be involved in a crash than when a driver does not use a phone.

7.5 ■ Fire Hazards

Fire hazards include all types of live flames, causes of sparks, hot objects, and chemicals that are potential for ignition, or that can aggravate a fire to become large and uncontrolled. Fire hazards also include all types of potential threats to fire prevention practices, firefighting, built-in fire safety systems and situations that restrict the escape of people from an affected building or area in the event of a fire.

7.5.1 ■ Causes of Fire

- All types of flames used for any work
- Electric wires, higher loads, loose connections and old electrical equipment
- All cooking and heat generating appliances
- All works and situations where fire is essential like welding, cutting, metal casting etc.
- Improper storage of tools, equipment and items during and at the end of the day's work
- Smoking and personal lighters and matches
- Fireworks, pyro techniques, ammunitions and explosives
- Improper and unauthorized storage of flammable and hazardous materials and chemicals especially the flammable ones
- Insufficient capacity and numbers of emergency exits and stairs
- Hindrance to sight or reach firefighting equipment, markings and alarm systems
- Absence of fire detection and alarm system
- Violation of building and fire codes

7.5.2 ■ Preventive Measures

- Security provisions to help prevent wilful fire raising and arson;
- Prohibition on smoking;
- Positioning of heat sources to prevent contact with combustible material;
- Control of contractors or employees using blowlamps, cutting or welding equipment;
- Risk assessment and control for the use of articles and substances which pose fire hazards to avoid the manifestation of fire risks;
- Maintenance programmes for electrical wiring and appliances;
- Temperature control that avoids need for portable heaters or coolers;
- Design or positioning of heaters, machinery or office equipment so that ventilators cannot be obstructed;
- Adequate supervision of cooking facilities;
- Special engineering solutions, such as to make it impossible for a fire to begin or take hold by controlling the presence of oxygen, fuel or energy. These three components, the so-called 'fire triangle', are the three prerequisites for fire.

7.6 ■ Component of Disaster Management

A high potential earthquake of 6.4 magnitudes on the Richter scale struck the Marathwada region of Maharashtra state in the early morning of 30th September 1993 at 3:55 A.M. Killari village was the epicenter of this earthquake. 10,000 people of this area including Latur were killed and nearly 2,00,000 houses fell. The poorly constructed houses of this area fell like ninepins. This zone had been declared like a Zone 1 risk zone and all the people were least prepared. So, the Commonwealth Government recognizes four main elements of emergency and disaster management. These four elements are: Preparedness, Response, Recovery and Prevention/Planning/Mitigation (PRRP) and advocates the development of disaster arrangement of follow all of them:

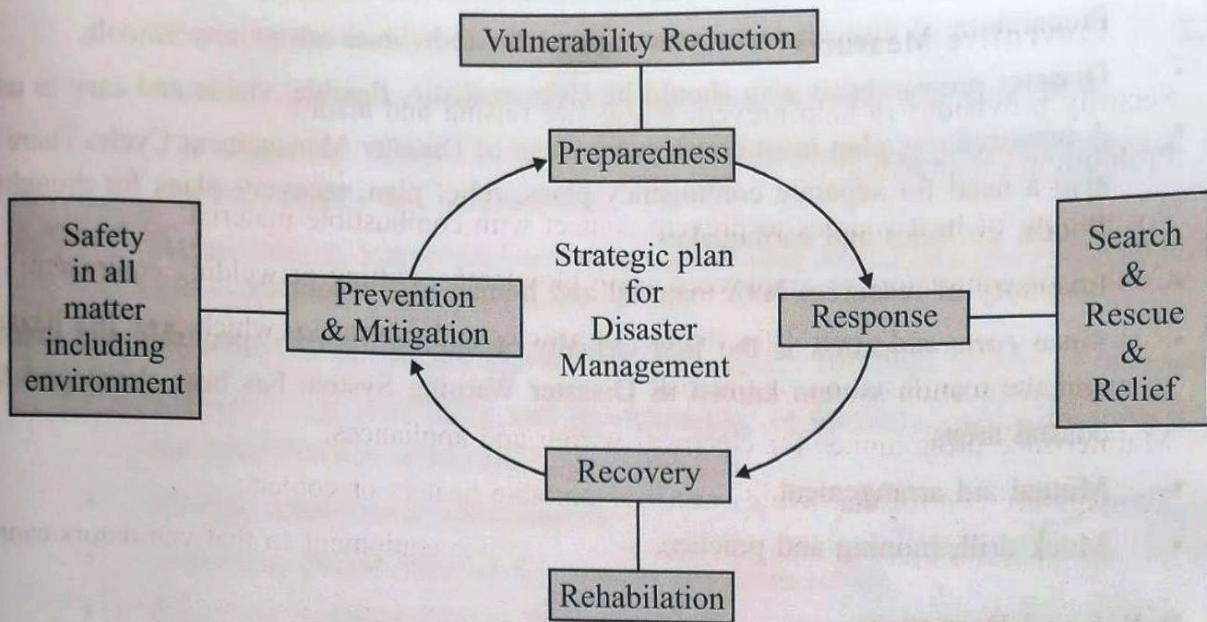


Figure 7.2 : Components of disaster management

1. **Preparedness:** Measures to make sure that services and communities are capable of coping with the effect of disaster.
2. **Response:** Measures taken in anticipation of during and immediately after a disaster to ensure that the effects of the disaster are minimized.
3. **Recovery:** Measures, which are taken to support emergency, affected communities in the reconstruction of the physical infrastructure and restoration of emotional and economic well being.
4. **Prevention:** Measures, which are taken to reduce the incidence of severity of disasters/ emergencies. Well-formulated disaster management plan comprises the following different phases:

1. **Preparedness:**

- Identifying the vulnerable groups by
 - (a) Government Ministries and Department.
 - (b) Academic and Training Institutes.
 - (c) Research Organizations.
 - (d) Non-governmental Organizations.
 - (e) International Agencies.

- Preparation of disaster management plans for individual/community/schools.
- Disaster preparedness plan should be clear, realistic, flexible, viable and easy to use.
- A preparedness plan must cover every stage of Disaster Management Cycle. There is also a need for separate contingency plans, relief plan, recovery plans for droughts, floods, cyclones and earthquakes.
- Inventory of resources both material and human skill resources.
- Since communication is the first casualty, a satellite based dependable and unique communication system known as Disaster Warning System has been developed for coastal areas.
- Mutual aid arrangement.
- Mock drill, training and practice.

2. Relief and Response:

- Activate the emergency operation centers (control room).
- Mobilizing resources.
- Implementing the disaster management plan.
- Important steps that are required to be taken up by the concerned agencies to provide disaster relief to the affected communities include search, rescue and evacuation tasks.
- Setting up community kitchen, using local groups.
- Provided adequate shelter and power supplies, food security (food subsidies, distribution and storage).
- Establishment of communication network, appropriate health and sanitation facilities, public information, security and welfare mechanism.
- Medical camps
- Issuing updated warnings.
- Warehousing and stockpiling of essential items for distribution of relief material.
- Setting up temporary living arrangement.
- Establishment of animal shelters in disaster affected areas.

3. Recovery and Rehabilitation:

- Awaring the community on safety and health measures.
- Recovery stage of disaster management cycle covers rehabilitation and reconstruction activities.

- Restoring the essential services-roads, communication links.
- Counseling programme for those who have lost the near and dear ones.
- The objectives should be to pay extra attention on single parent families, women children, elderly and handicapped.
- Resurrection of educational and training activities should take place immediately after the major part of the relief work is over.
- Construction of cyclone and earthquake resistant buildings should be promoted.
- Strengthening, retrofitting and reconstructing of houses should also form a part of the rehabilitation endeavors.
- Finding employment opportunities.
- Collection usable material for construction from rubble.
- Providing financial support for reconstruction of new buildings.

4. Prevention, Planning and Mitigation:

- The prevention measures may be taken under the category of national development and also under the specific disaster management program.
- Community awareness and education.
- Preventing habitation in risk zone.
- Taking action to reduce the effects of hazards before if occur.
- Constructing stronger buildings, to the procedural, like standard techniques for incorporating hazard assessment in land use planning. It is a major component of disaster management plan.
- Watershed management, channel improvement alternative cropping pattern, live stock management and soil conservation techniques are also important components of disaster mitigation.

Although specific counter measures will often vary with different hazards, it is required to make a single set of management arrangements capable of encompassing all hazards. Disaster management is really a series of activities, which run parallel to one-another rather than in a sequence of pre and post disaster. It is more than an EXPAND AND CONTRACT model because it considers that the disaster intervention measures of disaster prevention, response, recovery and mitigation can be carried out at all times in a disaster prone community. However, the different components 'expand' and 'contract' depends on the relationship of the hazard and vulnerability of the community.

Risk Management

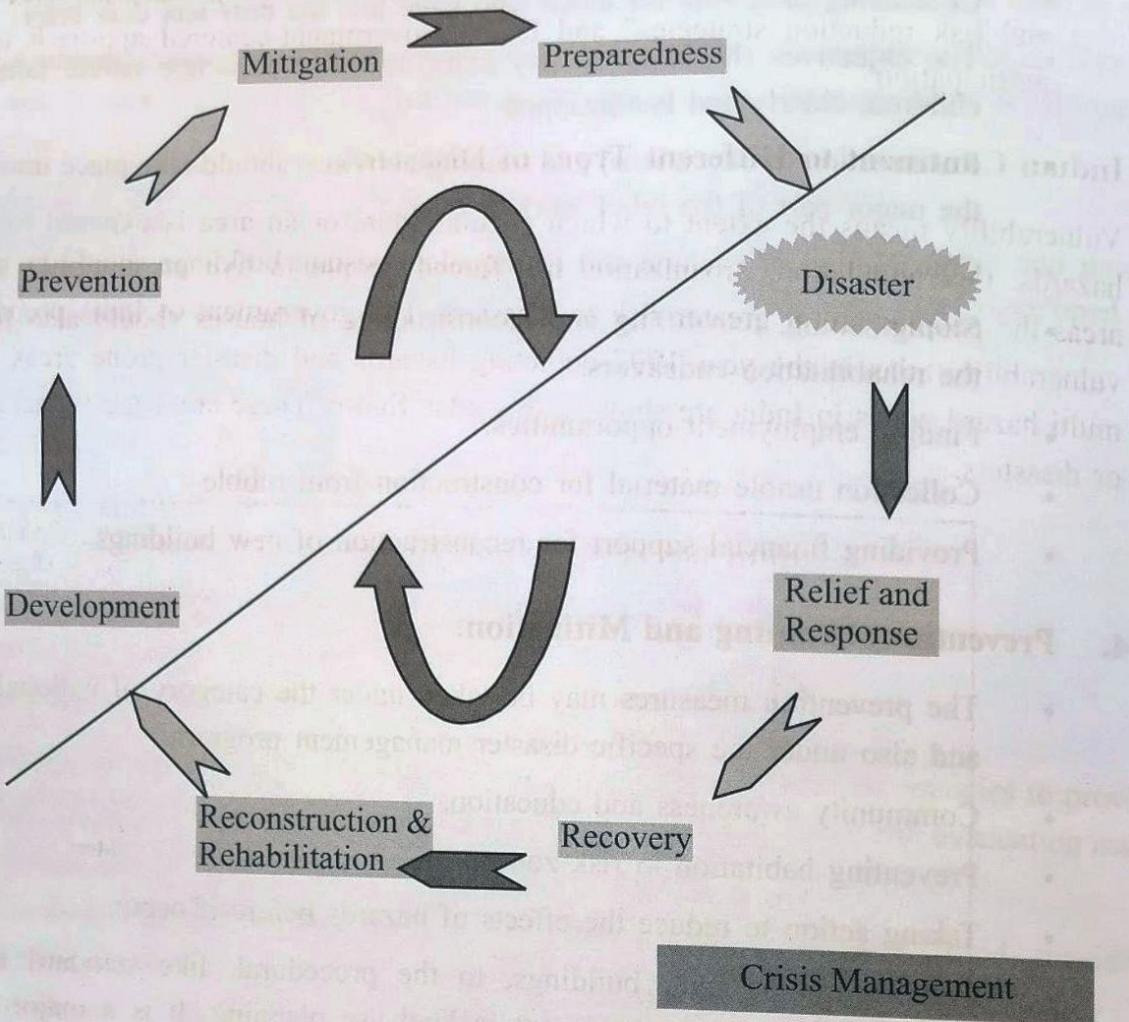


Figure 7.3 : Disaster Management Cycle

For instance, in the situation of immediate warning, the first step, which takes place, is Preparedness, which makes it sure that services and communities are capable of coping with the effects of disaster. It refers to specific measures, which are taken before a disaster strikes to facilitate rapid response. During the time of Relief and Response, the Government and the Non-governmental organizations distributes food, clothing and shelter to all the affected people. In the Recovery and Rehabilitation/Reconstruction phase affected persons reconstruct their houses, look for employment opportunities and essential services are restored such as the construction of roads, hospitals, bridges and schools. The Central Government and the State Government provide help in carrying out the normal work of development. In the last stage of development, there are the Prevention and Mitigation

activities where actions are carried out to minimize the effect of potential disaster. There has been a shift from “disaster response and recovery” to “disaster risk management and risk reduction strategies” and from “Government-centered approach to community participation”.

Indian Continent to Different Types of Disasters.

Vulnerability means the extent to which an individual or an area is exposed to the impact of hazards. Overpopulation, urbanization has forced people to live on marginal lands. In these areas the peoples are at greater risk to disasters. The government of India prepared a national vulnerability atlas in the year 1997 depicting hazards and disaster prone areas. The high-risk multi hazard zones in India are shown in this atlas figure. These areas are vulnerable to hazards or disasters.

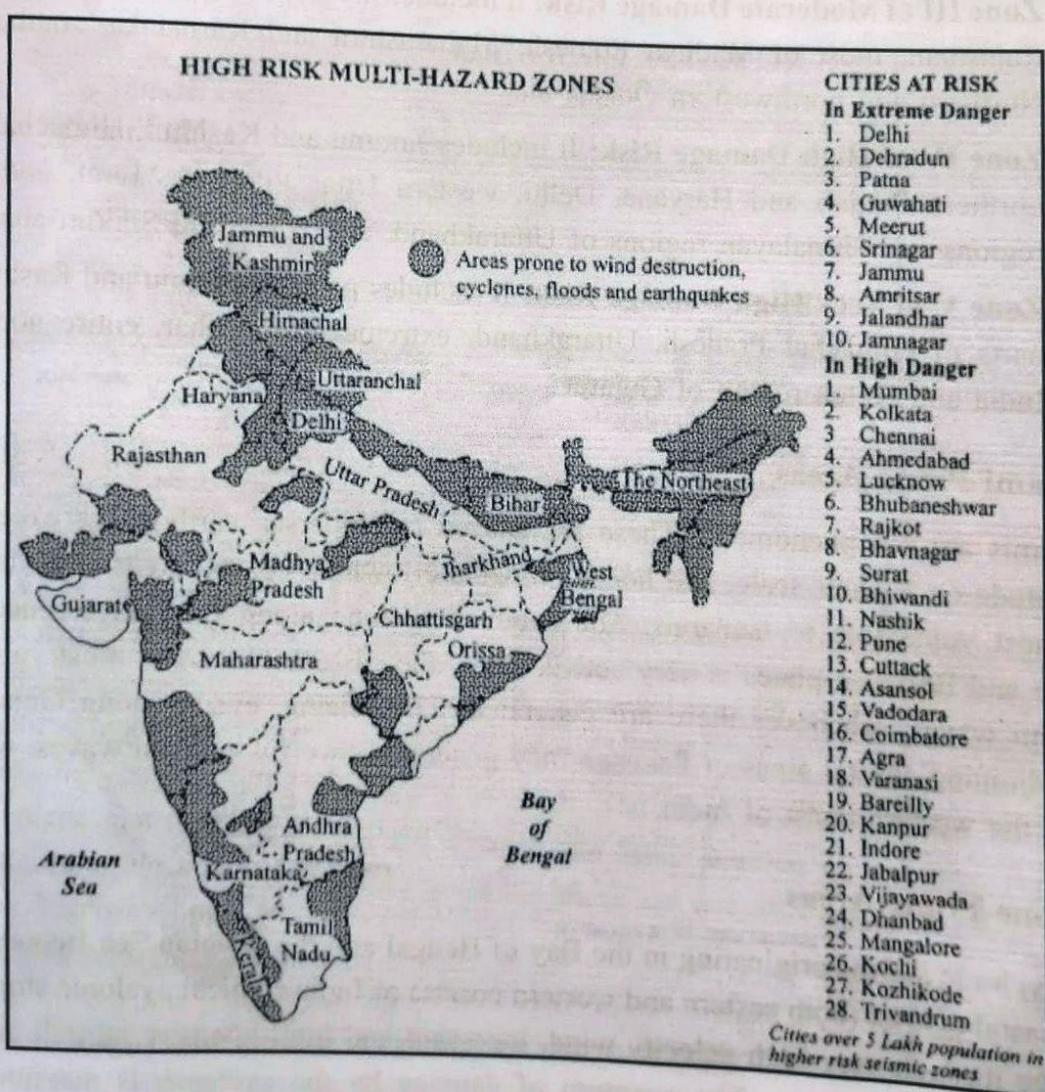


Figure 7.4 : High risk multi hazard zones of India

1. Earthquake Prone Areas

On the basis of magnitude of damage risk India has been divided into the following 5 damage risk zones.

- (a) **Zone I of Least Damage Risk:** It includes the place of some parts of Punjab and Haryana, plain areas of Uttar Pradesh, portions of plains of north Bihar and West Bengal, delta areas of the Godavari coastal plain areas of Maharashtra and Kerala, desert areas of Rajasthan and most areas of Gujarat except Kutch region.
- (b) **Zone II of Low Damage Risk:** It includes southern Punjab and Haryana, southern parts of plains of Uttar Pradesh, eastern Rajasthan, coastal districts of Odisha and Tamil Nadu etc.
- (c) **Zone III of Moderate Damage Risk:** It includes the areas of southern and southeastern Rajasthan, most of Madhya Pradesh, Maharashtra and Karnataka, southern Bihar, Northern and northwestern Odisha etc.
- (d) **Zone IV of High Damage Risk:** It includes Jammu and Kashmir, Himachal Pradesh, northern Punjab and Haryana, Delhi, western Uttar Pradesh, 'Tarai' and 'Bhabar' regions and Himalayan regions of Uttarakhand, and Bihar and Sikkim areas.
- (e) **Zone V of Very High Damage Risk:** It includes parts of Jammu and Kashmir, some parts of Himachal Pradesh, Uttarakhand, extreme north Bihar, entire north-eastern India and Kutch region of Gujarat.

2. Tsunami-Prone Areas

Tsunamis are sea phenomena. These are caused by undersea earthquakes exceeding 7.0 magnitude on Richter scale, and hence immediate lowland coastal areas and shallow seas are most vulnerable to tsunamis. The subduction zone along the convergence zone of Indian and Burmese plates is very active. Thus, the eastern coasts are most vulnerable to tsunami waves, whenever these are generated. The seismic events along Gujarat coasts and adjoining coastal areas of Pakistan may generate powerful tsunami waves, which may affect the western coast of India.

3. Cyclone-Prone Areas

The cyclonic storms originating in the Bay of Bengal and the Arabian Sea frequently strike the coastal district (both eastern and western coasts) of India tropical cyclonic storms do the damage through very high velocity wind, incessant and high intensity rainfall and several meters high tidal surges. The quantum of damage by the cyclones is maximum in the coastal areas and gradually decreases in land due to dissipation of storm energy. The eastern

coastal states of West Bengal, Odisha, Andhra Pradesh and Tamil Nadu are affected by the cyclones originating in the Bay of Bengal during different seasons of the year. The period from January to March is a lean period. A few isolated cyclones originate in the southern Bay of Bengal and affect Tamil Nadu coast. The coasts of Andhra Pradesh, Odisha and West Bengal are very often affected in May by the cyclones, which originate in the southern and central Bay of Bengal and move in north-west, north and north-east direction. The period of June to September is breeding period as most of the cyclones originate during this period in the central and northern Bay of Bengal and move west north westwards and affect the coastal districts of Andhra Pradesh, Odisha and West Bengal. The cyclones during post monsoon period (October-December) originate in the central and southern Bay of Bengal, move west and north-westward and mostly affect the coastal districts of Tamil Nadu and Andhra Pradesh. The origin and development of cyclones in the Arabian Sea during the period from January to March is of rare occurrence. Generally, they develop during the months of May, October, November and December in particular and during south-west monsoon period in general. They mostly affect the coasts of Maharashtra and Gujarat.

4. Flood-Prone Areas

Flood hazards and disasters in India are associated with the following 3 types of floods:

- River floods areas
- Storm surge floods
- Artificial floods or anthropogenic floods.

Most of the alluvial rivers of the country, namely the Ganga, the Yamuna, the Ram Ganga, the Gomati, the Gandak, the Kosi etc. are characterized by frequent floods almost every year. Thus the plains and riverside zones in Uttar Pradesh, Bihar and West Bengal are most vulnerable to severe floods. The flood plains of the Brahmaputra in Assam are chronic flood-prone areas. The delta regions of the Mahanadi and the Brahmini in Odisha, the Godavari and the Krishna in Andhra Pradesh, and the Cauvery in Tamil Nadu are also very vulnerable to recurrent floods. Though the lower reaches of the Tapi, the Narmada and the Sabarmati are flood-prone areas but these are not affected by frequent floods.

5. Drought-Prone Areas

Severe drought prone areas are divided into the following 3 zones:

- (a) **Zone 1:** Desert and semi-arid regions spread over an area of about 600,000 km² and form a rectangular tract which stretches from Ahmedabad to Kanpur (to form

eastern and southeastern border), from Kanpur to Jalandhar (to from north-eastern and northern boundary) and from Jalandhar to Rann of Kutch along the western international border. This zone includes whole of Rajasthan and Gujarat, western and south western parts of Punjab most of Haryana, southwestern part of Uttar Pradesh and narrow strip along the western and north western border of Madhya Pradesh.

- (b) **Zone 2:** The second chronic drought-prone zone forms a rectangular tract, which spreads, over the rain shadow areas of the Western Ghats. In fact, this zone is situated to the east of the Western Ghats and extends in a width of 300 km. It includes south-western Andhra Pradesh, eastern Karnataka (east of Western Ghats) and south western Maharashtra (east of Western Ghats).
- (c) **Zone 3:** Besides the aforesaid two broad zones of severe droughts, there are some scattered pocket of brought in the country such as Tirunelveli district located to the south of Vaigai river, Coimbatore area, Pol Jamau area of Jharkhand, Purulia district of West Bengal, Kalahandi region of Odisha etc. The scattered pockets of drought prone areas cover about 100,000 km² of area.

6. Landslide-Prone Areas

There are two major areas, which are vulnerable to landslides as follows:

- Himalayan region
- Western Ghats region

The most vulnerable areas to landslides in the Himalayan region are in the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, West Bengal, and Assam. The Garhwal and Kumaun Himalayas in Uttarakhand and Darjeeling Himalaya in West Bengal are most vulnerable to recurrent landslides. Large-scale deforestation has also been responsible for frequent landslides in the Himalayan regions of India, and Western Ghats region.

7.7 ■ Study of Major Disasters

Table 7.1 Top Ten Natural Disasters Since 1954

Year	Location	Type	Deaths
1954	China	Floods	30,000
1965	East Pakistan (now Bangladesh)	Tropical Cyclones	36,000
1968	Iran	Earthquakes	30,000
1970	Peru	Earthquakes	66,794
1970	East Pakistan (now Bangladesh)	Tropical Cyclones	500,000
1971	India	Tropical Cyclones	30,000
1976	China	Earthquakes	700,000
1990	Iran	Earthquakes	50,000
2004	Indonesia, Sri Lanka, India, etc.	Tsunamis	500,000
2005	Pakistan, India	Earthquakes	70,000

Table 7.2 Major disasters in India since 1970

S.No.	Disaster	Impact
	Earthquake	
1	20th October 1991 Uttarkashi	An earthquake of magnitude 6.6 killed 723 people
2	30th September 1993 Latur	Approximately 8000 people died and there was a heavy loss to infrastructure
3	22 May 1997, Jabalpur	39 people dead
4	29th March 1997, Chamoli	100 people dead
5	26th January, 2001, Bhuj, Gujarat	More than 10,000 dead and heavy loss to infrastructure
	Cyclone	
6	29th October 1971 Odisha	Cyclone and tidal waves killed 10,000 people
7	19th November, 1977,	Andhra Pradesh

8	29th and 30th October 1999, Odisha	Cyclone and tidal waves killed 9,000 and 18 million people were affected
	Landslide	
9	July 1991, Assam	300 people killed; heavy loss to roads and infrastructure
10	August 1993, Nagaland	500 killed and more than 200 houses destroyed and about 5kms. Road damaged.
11	18th August 1998, Malpa	210 people killed. Villages were washed away
	Flood	
12	1978 Floods in North East India	3,800 people killed and heavy loss to property
13	1994 Floods in Assam, Arunachal Pradesh, Jammu and Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, Goa, Kerala and Gujarat	More than 2000 people killed and thousands affected

■ Review Questions

1. Describe the vulnerability of Indian continent to different types of disasters.
2. Write short notes on:
 - (c) Risk reduction measures for chemical hazard
 - (d) Nuclear disaster
3. Describe the effect and causes of traffic accidents.
4. What are the preventive measures of chemical hazards.
5. Name two basins in India that are frequently affected by flood and explain the warning dissemination system of India in the flood affected regions.
6. Briefly describe the disaster management cycle with suitable examples.

