*Version 1.0*

# HAZARDS, DISASTERS AND YOUR COMMUNITY

## A PRIMER FOR PARLIAMENTARIANS

**Government of India**
**Ministry of Home Affairs**
**National Disaster Management Division**

*"towards safer INDIA"*

# ▪ HAZARDS, DISASTERS AND YOUR COMMUNITY ▪

VERSION 1.0

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and Ankush Agarwal under the GoI-UNDP Disaster Risk Management Programme

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CHAPTER 1

# HAZARDS AND DISASTERS

## WHAT IS A HAZARD? HOW IS IT CLASSIFIED?

A dangerous condition or events that threaten or have the potential for causing injury to life or damage to property or the environment. They can be categorized in various ways but, based on the origin, hazards worldwide are basically grouped in two broad headings:

1. Natural Hazards (hazards with meteorological, geological or even biological origin)
2. Unnatural Hazards (hazards with human-caused or technological origin)

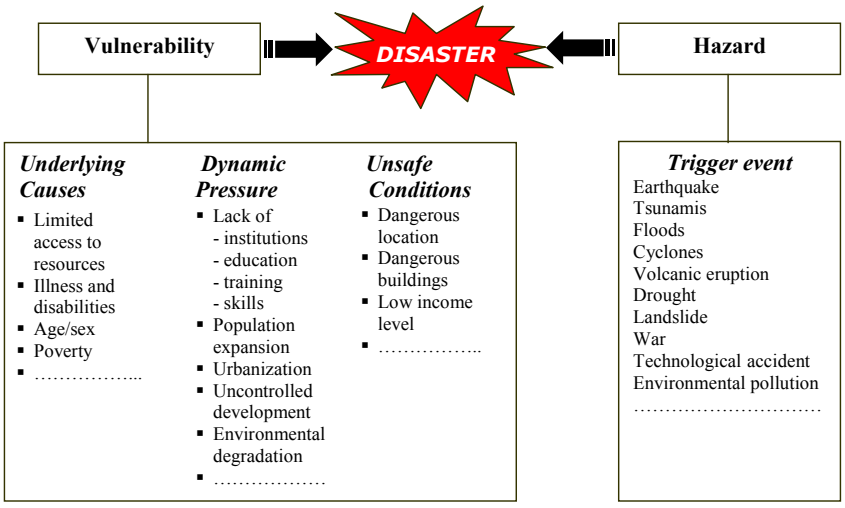
It is also important to know that natural phenomena are extreme climatological, hydrological, or geological, processes that do not pose any threat to persons or property. A massive earthquake in an unpopulated area, for example, is a natural phenomenon, *not a hazard*. It is when these natural phenomena interact with the man made environment or fragile areas which causes wide spread damage.

## WHAT ARE DISASTERS?

Almost everyday we witness in the newspaper or on the TV, there are reports of disasters around the world. So what are disasters? How are they different from accidents? Disaster is defined as:

",,,,,a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses which exceed the ability of the affected society to cope using its own resources."

A disaster is the product of a hazard such as earthquake, flood or windstorm coinciding with a vulnerable situation which might include communities, cities or villages. There are two main components in this definition: hazard and vulnerability. Without vulnerability or hazard there is no disaster. A disaster occurs when



hazards and vulnerability meet. See the figure along with underlying issues under each.

There are several important characteristics that make Disasters different from Accidents. The loss of a sole income earner in a car crash may be a disaster to a family, but only an accident to the community. Variables such as Causes, Frequency, Duration of the Impact, Speed of Onset, Scope of the Impact, Destructive Potential, Human Vulnerability etc determine the difference.

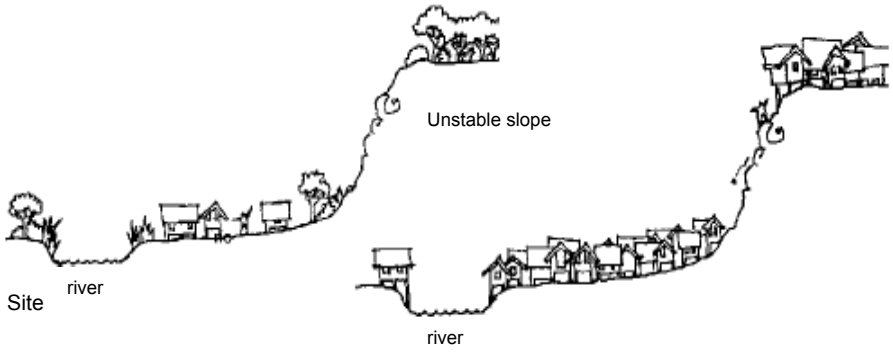
## WHAT IS VULNERABILITY?

Vulnerability is defined as *"The extent to which a community, structure, service, or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrain or a disaster prone area."*

Now take for example a house built from cane and thatch and the other a brick building. The house built from cane and thatch that can be blown in a tropical cyclone are more vulnerable to the wind than a brick building. A badly constructed brick building is more likely to disintegrate with the violent ground shaking of an earthquake than cane or thatch hut and is more vulnerable to earthquake hazard. Hence structures should be built strong enough to resist maximum force exerted by any event or for combination of event. Such measure will take care of the *physical vulnerability*.

Social and economic conditions also determine the vulnerability of a society to an extent. It has been observed that human losses in disasters in developing countries like India tend to be high when compared to developed countries where material losses predominate.

See the figure where the settlements are located in hazardous slopes. Many landslide and flooding disasters are linked to what you see in the figure below. Unchecked growth of settlements in unsafe areas exposes the people to the hazard. In case of an earthquake or landslide the ground may fail and the houses on the top may topple or slide and affect the settlements at the lower level even if they are designed well for earthquake forces.



Site after pressures from population growth and urbanization

## WHAT IS RISK?

Risk is a measure of the expected losses (deaths, injuries, property, economic activity etc) due to a hazard of a particular magnitude occurring in a given area over a specific time period.

The figure on the right illustrates essentially the four factors essentially hazards, location, exposure, and vulnerability which contribute to risk. They are:


- *Hazards* (physical effects generated in the naturally occurring event),
- *Location* of the hazards relative to the community at risk,
- *Exposure* (the value and importance of the various types of structures and lifeline systems such as water-supply, communication network, transportation network etc in the community serving the population, and
- *Vulnerability* of the exposed structures and systems to the hazards expected to affect them during their useful life.

Risk reduction can take place in two ways:

**1. Preparedness**

This protective process embraces measures which enable governments, communities and individuals to respond rapidly to disaster situations to cope with them effectively. Preparedness includes the formulation of viable emergency plans, the development of warning systems, the maintenance of inventories and the training of personnel. It may also embrace search and rescue measures as well as evacuation plans for areas that may be at risk from a recurring disaster.

Preparedness therefore encompasses those measures taken before a disaster event which are aimed at minimising loss of life, disruption of critical services, and damage when the disaster occurs. All preparedness planning needs to be supported by appropriate legislation with clear allocation of responsibilities and budgetary provisions.

**2. Mitigation**

Mitigation embraces all measures taken to reduce both the effect of the hazard itself and the vulnerable conditions to it in order to reduce the scale of a future disaster. Therefore mitigation activities can be focused on the hazard itself or the elements exposed to the threat. Examples of mitigation measures which are hazard specific include modifying the occurrence of the hazard, e.g. water management in drought prone areas, avoiding the hazard by siting people away from the hazard and by strengthening structures to reduce damage when a hazard occurs.

In addition to these physical measures, mitigation should also be aimed at reducing the physical, economic and social vulnerability to threats and the underlying causes for this vulnerability.

## DISASTER MANAGEMENT CYCLE

Disaster management can be defined as the body of policy and administrative decisions and operational activities which pertain to the various stages of a disaster at all levels. Broadly disaster management can be divided into pre-disaster and post-disaster contexts. There are three key stages of activity that are taken up within disaster management. They are:

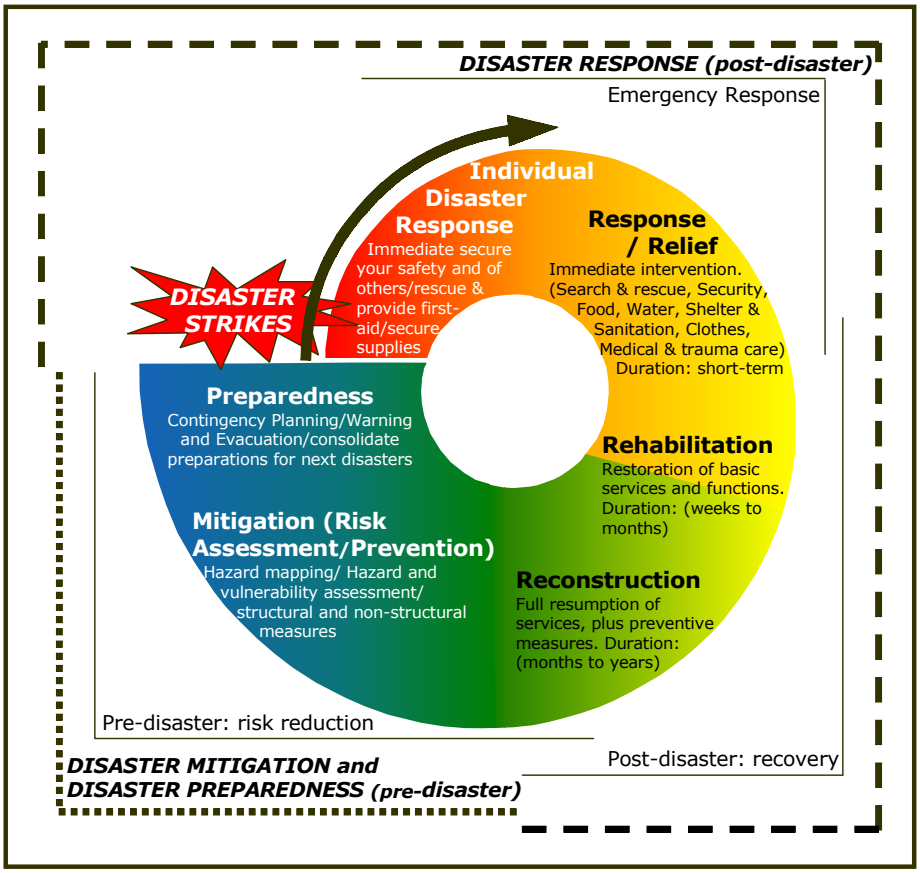
*1. Before a disaster strikes* ***(pre-disaster).***

Activities taken to reduce human and property losses caused by the hazard and ensure that these losses are also minimized when the disaster strikes. Risk reduction activities are taken under this stage and they are termed as mitigation and preparedness activities.

*2. During a disaster* ***(disaster occurrence).***

Activities taken to ensure that the needs and provisions of victims are met and suffering is minimized. Activities taken under this stage are called as ***emergency response activities***

**DISASTER MANAGEMENT**




***Reference:*** *Are you Prepared? Learning from the Great Hanshin-Awaji Earthquake Disaster - Handbook for Disaster Reduction and Volunteer activities*

*3. After a disaster* ***(post-disaster)***

Activities taken to achieve early recovery and does not expose the earlier vulnerable conditions. Activities taken under this stage are called as ***response and recovery activities***.

## PERSONAL AND COMMUNITY AWARENESS

As Indians we need to be aware of likely hazards and potential hazards, how, when and where they are likely to occur, and the problems which may result of an event. With 60% of the land mass susceptible to seismic hazard damage (Moderate, High and Very High Zone); 40 million hectares (8%) of landmass prone to floods; 8000 Km long coastline with two cyclone seasons; 68% of the total area vulnerable to drought; Hilly regions vulnerable to avalanches/landslides/Hailstorms/cloudbursts; other Human caused hazards it is important most of all, we should be aware of how to cope with their effects.

During the time of a disaster there will be delay before outside help arrives. At first, self-help is essential and depends on a prepared community – that is a community which has:

- An alert, informed and actively aware population
- A Preparedness and Response Plan
- An active and involved local Government,
- Agreed, coordinated arrangements for response, preparedness and mitigation measures.

CHAPTER 2

# EARTHQUAKES HAZARDS AND DISASTERS

## AN EARTHQUAKE –

**is a series of underground shock waves and movements on the earth's surface caused by natural processes writhing the earths crust.**

*On January 26 2001 a devastating earthquake occurred in the Kachchh district of the state of Gujarat. The earthquake measured a magnitude of M6.9 on Richter Scale. According to official estimates, the total loss of life was 13,805 and 12, 05,198 houses were damaged.*

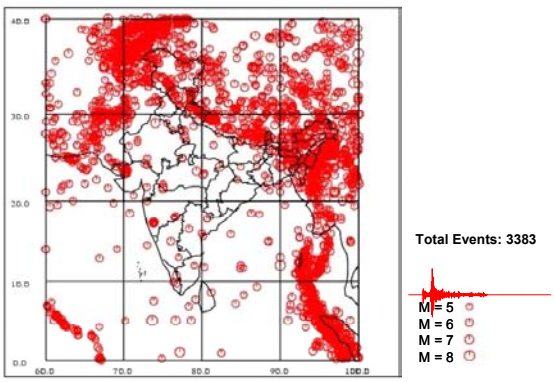
day or night, with sudden impact and limited any warning sign. Extensive research has been conducted in recent decades but there is no accepted method of earthquake prediction as on date.

### ELEMENTS AT RISK

Several key factors that contribute to vulnerability of human populations to earthquakes:

- Location of settlements in an earthquake prone area, especially on soft ground, on area prone to landslides or along fault lines.
- Dense collection of weak buildings with high occupancy.
- Non-engineered buildings constructed by earth, rubble, buildings with heavy roofs (more vulnerable than light weight structures), poor quality and maintenance of buildings
- Weak or flexible storey intending for parking purposes.

### INDIAN EARTHQUAKES




The Indian subcontinent lies upon the Indian Plate. This plate is moving northward at about 5 centimetres per year and in doing so, collides with the Eurasian Plate. Upon the Eurasian Plate lie the Tibet plateau & Central Asia. Due to this collision, the Himalayas are thrust higher and very many earthquakes are generated in the process. This is the cause of earthquakes from the Himalayas to the Arakan Yoma.

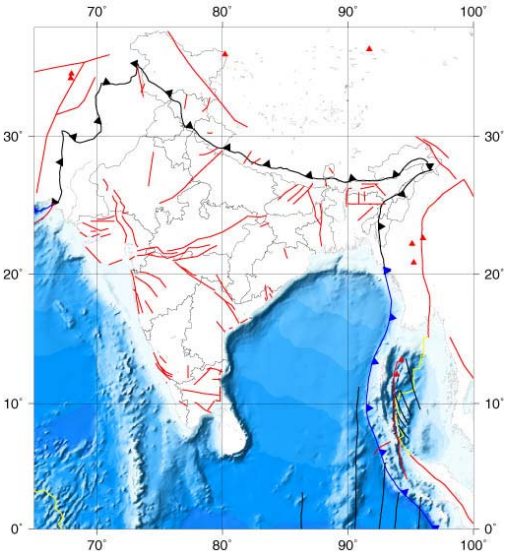
*Figure to the left showing plot of Earthquakes (M>= 5.0) from IMD Catalogue for the period from 1800 to Sept, 2001 (Total events 3383 events).*

**List of some significant earthquakes in India**

| Date | Location | Magnitude M >6 | Date | Location | Magnitude M >6 |
|---|---|---|---|---|---|
| 1819 JUN 16 | KUTCH,GUJARAT | 8.0 | 1956 JUL 21 | ANJAR, GUJARAT | 7.0 |
| 1869 JAN 10 | NEAR CACHAR, ASSAM | 7.5 | 1967 DEC 10 | KOYNA, MAHARASHTRA | 6.5 |
| 1885 MAY 30 | SOPOR, J&K | 7.0 | 1975 JAN 19 | KINNAUR, HP | 6.2 |
| 1897 JUN 12 | SHILLONGPLATEAU | 8.7 | 1988 AUG 06 | MANIPUR-MYANMAR BORDER | 6.6 |
| 1905 APR 04 | KANGRA, H.P | 8.0 | 1988 AUG 21 | BIHAR-NEPAL BORDER | 6.4 |
| 1918 JUL 08 | SRIMANGAL, ASSAM | 7.6 | 1991 OCT 20 | UTTARKASHI, UP HILLS | 6.6 |
| 1930 JUL 02 | DHUBRI, ASSAM | 7.1 | 1993 SEP 30 | LATUR-OSMANABAD, MAHARASHTRA | 6.3 |
| 1934JAN 15 | BIHAR-NEPALBORDER | 8.3 | 1997 MAY 22 | JABALPUR,MP | 6.0 |
| 1941 JUN 26 | ANDAMAN ISLANDS | 8.1 | 1999 MAR 29 | CHAMOLI DIST, UP | 6.8 |
| 1943 OCT 23 | ASSAM | 7.2 | 2001 JAN 26 | BHUJ , GUJARAT | 6.9 |
| 1950 AUG 15 | ARUNACHAL PRADESH-CHINA BORDER | 8.5 | | | |

*Source: http://www.imd.ernet.in/section/seismo/static/signif.htm*

The same process, results in earthquakes in the Andaman & Nicobar Islands. Sometimes earthquakes of different magnitudes occur within the Indian Plate, in the peninsula and in adjoining parts of the Arabian Sea or the Bay of Bengal. These arise due to localized systems of forces in the crust sometimes associated with ancient geological structures such as in the Rann of Kachchh. All earthquakes in peninsula India falls within this category.




*Tectonic Map of India. Red lines showing active fault zones.*
*(Source: www.asc-india.org)*

## HAZARD ZONES

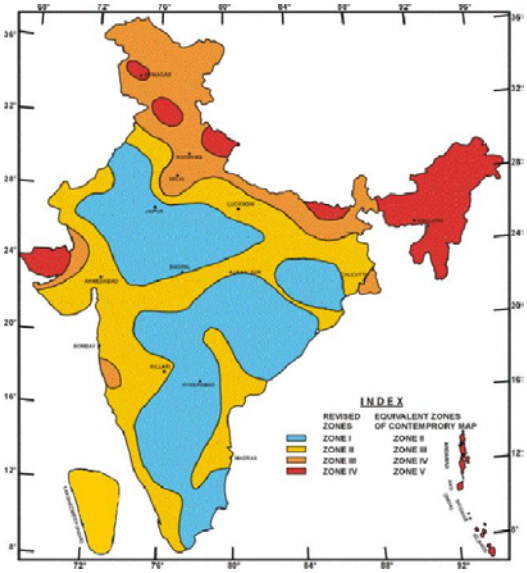



*Figure showing the Seismic Zones of India. The country is divided into four seismic Zones – II, III, IV and V*
*(Source: IS1893 (Part 1) : 2002)*

As per the latest seismic zoning map of India the country is divided into four Seismic Zones. Zone V marked in red shows the area of Very High Risk Zone, Zone IV marked in orange shows the area of High Risk Zone. Zone III marked in yellow shows the region of Moderate Risk Zone and Zone II marked in blue shows the region of Low risk Zone. Zone V is the most vulnerable to earthquakes, where historically some of the country's most powerful shock has occurred.

Geographically this zone includes the Andaman & Nicobar Islands, all of North-Eastern India, parts of north-western Bihar, eastern sections of Uttaranchal, the Kangra Valley in Himachal Pradesh, near the Srinagar area in Jammu & Kashmir and the Rann of Kutchh in Gujarat. Earthquakes with magnitudes in excess of 7.0 have occurred in these areas, and have had intensities higher than IX.

Much of India lies in Zone III, where a maximum intensity of VII can be expected. New Delhi lies in Zone IV whereas Mumbai and Chennai lie in Zone III. All states and UTs across the country have experienced earthquakes.

## Measuring the Size of an Earthquake - MSK 64 Intensity Scale

Intensity is a qualitative measure of the actual shaking at a location during an earthquake, and is notated in a roman capital numeral. The MSK (Medvedev, Sponheuer and Karnik) scale is more convenient for application in field and is widely used in India. The zoning criterion of the map is based on likely intensity. The scale range from I (least perceptive) to XII (most severe). The intensity scales are bas ed on three features of shaking – perception by people, performance o f buildings, and changes to natural surroundings.

The seismic zoning map broadly classifies India into zones where one can expect earthquake shaking of the more or less the same maximum intensity. The shaking intensity associated with different zones is shown in the table below:

| Zone | Area liable to shaking intensity | Description *(Arrangement in paragraphs of scale as follows: i) Persons and surroundings, ii) Structures of all kinds, iii) Nature)* |
|---|---|---|
| II | VI (and lower) | **VI Frightening**<br>i) Felt by most indoors and outdoors. Many people in buildings are frightened and run outdoors. A few persons loose their balance. Domestic animals rum out of their stalls.<br>In many instances, dishes and glassware may break, and books fall down, pictures move, and unstable objects overturn. Heavy furniture may possibly move and small steeple bells may ring.<br>ii) Damage of Grade 1*** is sustained in single** buildings of Type B* and in many** of Type A*. Damage in some buildings of Type A is of Grade 2***.<br>iii) Cracks up to widths of 1cm possible in wet ground; in mountains occasional landslips: change in flow of springs and in level of well water are observed. |
| III | VII | **VII Damage of Buildings**<br>i) Most people are frightened and run outdoors. Many find it difficult to stand. The vibration is noticed by persons driving motor cars. Large bells ring.<br>ii) In many buildings of Type C* damage of Grade 1 is caused; in many buildings of Type B damage is of Grade 2. Most** buildings of Type A suffer damage of Grade 3***, few of Grade 4***. In single instances, landslides of roadway on steep slopes: crack in roads; seams of pipelines damaged; cracks in stone walls.<br>iii) Waves are formed on water, and is made turbid by mud stirred up. Water levels in wells change, and the flow of springs changes. Some times dry springs have their flow resorted and existing springs stop flowing. In isolated instances parts of sand and gravelly banks slip off. |
| IV | VIII | **VIII Destruction of buildings**<br>i) Fright and panic; also persons driving motor cars are disturbed, Here and there branches of trees break off. Even heavy furniture moves and partly overturns. Hanging lamps are damaged in part.<br>ii) Most buildings of Type C suffer damage of Grade 2, and few of Grade 3, Most buildings of Type B suffer damage of Grade 3. Most buildings of Type A suffer damage of Grade 4. Occasional breaking of pipe seams. Memorials and monuments move and twist. Tombstones overturn. Stone walls collapse.<br>iii) Small landslips in hollows and on banked roads on steep slopes; cracks in ground up to widths of several centimeters. Water in lakes becomes turbid. New reservoirs come into existence. Dry wells refill and existing |
| V | IX (and higher) | **IX General damage of buildings**<br>i) General panic; considerable damage to furniture. Animals run to and fro in confusion, and cry.<br>ii) Many buildings of Type C suffer damage of Grade 3, and a few of Grade 4. Many buildings of Type B show a damage of Grade 4 and a few of Grade 5. Many buildings of Type A suffer damage of Grade 5. Monuments and columns fall. Considerable damage to reservoirs; underground pipes partly broken. In individual cases, railway lines are bent and roadway damaged.<br>iii) On flat land overflow of water, sand and mud is often observed. Ground cracks to widths of up to 10 cm, on slopes and river banks more than 10 cm. Further more, a large number of slight cracks in ground; falls of rock, many land slides and earth flows; large waves in water. Dry wells renew their flow and existing wells dry up. |
| | | **X General Destruction of Buildings** **XI Destruction** **XII Landscape Changes** |

*Note: Fore more information on MSK 64 Intensity Scale refer Indian Seismic Code IS 1893 (Part 1)*

***a) Type of Structures (Buildings)***

*Type A* - Building in field-stone, rural structures, unburnt-brick houses, clay houses.
*Type B* - Ordinary brick buildings, buildings of large block and prefabricated type, half timbered structures, buildings in natural hewn stone.
*Type C* - Reinforced buildings, well built wooden structures.

***b) Definition of Quantity**

| | | | | | |
|---|---|---|---|---|---|
| ***Single*** | Few - About 5 percent | ***Many*** | About 50 percent | ***Most*** | About 75 percent |

**** Classification of Damage to buildings***

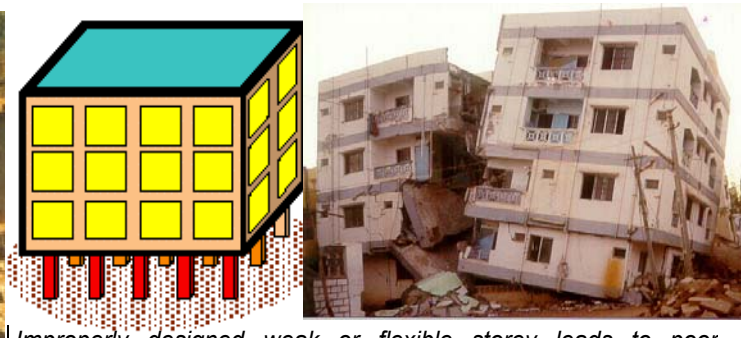
| | | |
|---|---|---|
| Grade 1 | Slight damage | Fine cracks in plaster; fall of small pieces of plaster |
| Grade 2 | Moderate damage | Small cracks in walls; fall of fairly larger pieces of plaster; pantiles slip off; cracks in chimneys parts of chimney fall down. |
| Grade 3 | Heavy damage | Large and deep cracks in walls; fall of chimneys. |
| Grade 4 | Destruction | Gaps in walls; parts of buildings may collapse; separate parts of the buildings lose their cohesion; and inner walls collapse. |
| Grade 5 | Total damage | Total collapse of the buildings |

## TYPICAL EFFECTS

*Physical Damage* – damage or loss of buildings and service structures. Fires, floods due to dam failures, landslides could occur.

*Casualties* – often high, near to the epicenter and in places where the population density is high (say, multistoried buildings) and structures are not resistant to earthquake forces.

*Partial collapse of non engineered building (stone masonry walls) during 1991 Uttarkashi earthquake. (Source: Earthquake Tips IITK-BMTPC)*



*Improperly designed weak or flexible storey leads to poor performance during earthquakes. Many buildings with open ground storeys intended for parking collapsed in the Bhuj earthquake. Seen is the picture is a vertical split of a building due to collapse of a partially open ground storey building. (Source www.nicee.org Earthquake Tips IITK-BMTPC)*

*Public health* – multiple fracture injuries, moderately and severely injured is the most widespread problem, breakdown in sanitary conditions and large number of casualties could lead to epidemics.

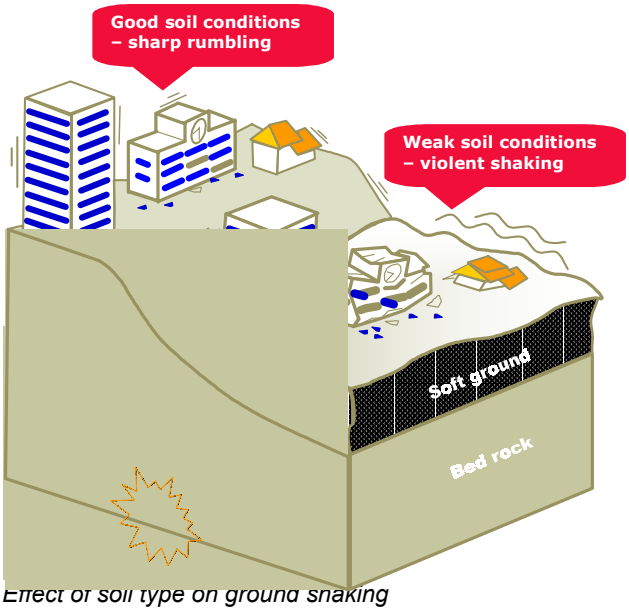
*Water supply* – severe problems due to failure of the water supply distribution network and storage reservoirs. Fire hydrants supply lines if vulnerable could hamper fire service operations.

*Transport network* – severely affected due to failure of roads and bridges, railway tracks, failure of airport runways and related infrastructure.

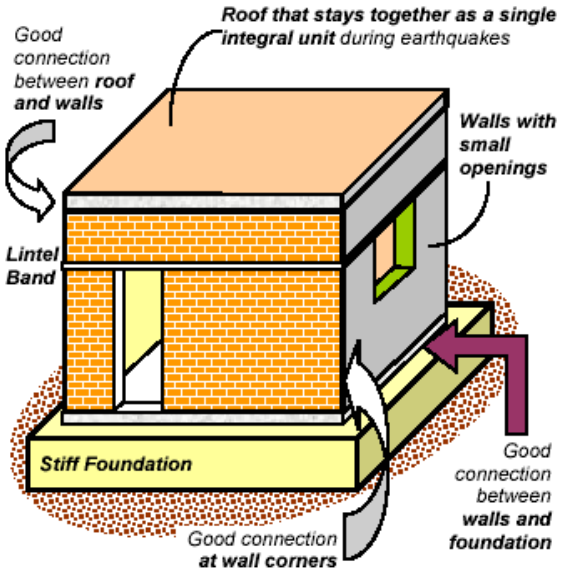
*Electricity and Communication* – all links affected. Transmission towers, transponders, transformers collapse.

## MAIN MITIGATION STRATEGIES

***Engineered structures*** (designed and built) to withstand ground shaking. Architectural and engineering inputs put together to improve building design and construction practice. *Analyze soil type* before construction and do not build structures on soft soil. To accommodate on weak soils adopt safety measures in design. *Note: Buildings built on soft soils are more likely to get damaged even if the earthquake is not particularly strong in magnitude. Similar problem persists in the alluvial plains and conditions across the river banks. Heavy damages are concentrated when ground is soft.*

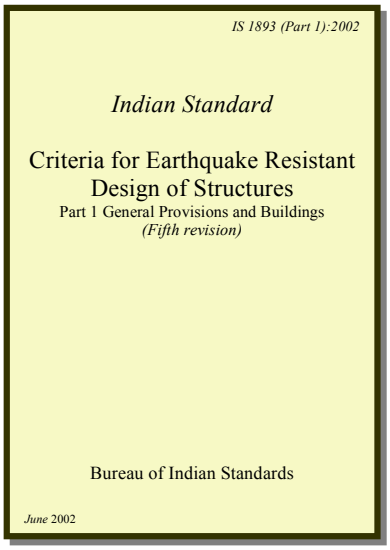



*Effect of soil type on ground shaking*




*Essential requirements in a Masonry building*

Follow ***Indian Standard Codes*** for construction of buildings.
Enforcement of the ***Byelaws*** including ***Land use*** control and restriction on density and heights of buildings
***Strengthening*** of important lifeline buildings which need to be functional after a disaster. Upgrade level of safety of hospital, fire service buildings etc.
***Public awareness***, sensitization and training programmes for *A*rchitects, *B*uilders, *C*ontractors, *D*esigners, *E*ngineers, *F*inanciers, *G*overnment functionaries, *H*ouse owners, *M*asons etc.
Reduce possible damages from secondary effects such as like fire, floods, landslides etc. e.g. identify potential landslide sites and restrict construction in those areas.




*This Indian Standard is adopted by Bureau of Indian Standards and it gives recommendations for design criteria of structures.*

## COMMUNITY BASED MITIGATION

**Community preparedness** along with public education is vital for mitigating the earthquake impact. Earthquake drills and Public awareness programme.
**Community based Earthquake Risk Management Project** should be developed and sustainable programmes launched. Retrofitting of schools and important buildings, purchase of emergency response equipment and facilities, establishing proper insurance can be the programmes under Earthquake Risk Management Project. A large number of local masons and engineers will be trained in disaster resistant construction techniques. A large number of masons, engineers and architects can get trained in this process.

*Retrofitting of School Building of Ahmedabad Municipal Corporation.*

This building was partly damaged during the earthquake. The school was retrofitted and is functioning.

## WEB RESOURCES:

- www.nicee.org: Website of The National Information Center of Earthquake Engineering (NICEE) hosted at Indian Institute of Technology Kanpur (IITK) is intended to collect and maintain information resources on Earthquake Engineering and make these available to the interested professionals, researchers, academicians and others with a view to mitigate earthquake disasters in India. The host also gives IITK-BMTPC Earthquake Tips.
- www.imd.ernet.in/section/seismo/static/welcome.htm Earthquake Information – India Meteorological Department, India. IMD detects and locates earthquakes and evaluates seismicity in different parts of the country.
- www.bmtpc.org In order to bridge the gap between research and development and large scale application of new building material technologies, the erstwhile Ministry of Urban Development, Government of India, had established the Building Materials And Technology Promotion Council in July 1990.
- www.earthquake.usgs.gov Source for science about the Earth, its natural and living resources, natural hazards, and the environment.
- www.neic.cr.usgs.gov National Earthquake Information Center (NEIC) - World Data Center for Seismology Earthquake information and observation station: The site hosts one of the most comprehensive systems.
- www.quake.wr.usgs.gov Earthquake Reporting Service: U.S. Geological Survey and UC Berkeley service for earthquake reporting. Earthquake basics and educational material; geological and historical information; links to professional and amateur organizations; online access to earthquake data. Current research activities and results in seismology, crystal structure and deformation, geology and borehole physics. for more
- www.asc-india.org Amateur Seismic Centre is a comprehensive website carrying details of state wise seismicty for the country. This also has extensive reports on various past earthquakes with rare photographs and maps.

CHAPTER 3

# TSUNAMI HAZARDS AND DISASTERS

**TSUN**

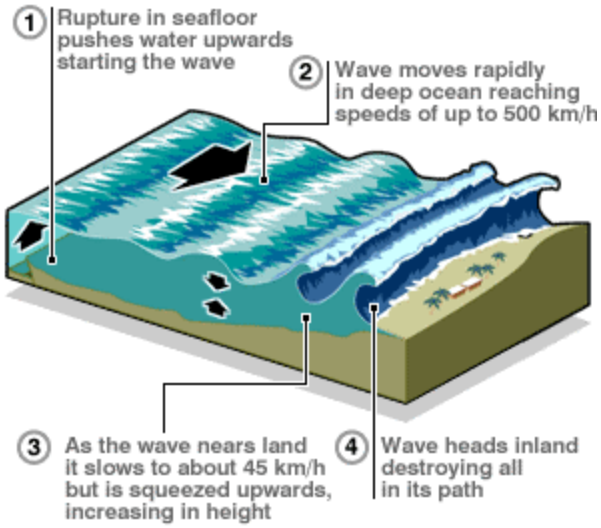
**is a Japanese word meaning "harbour wave". These waves, which often affect distant shores, originate from undersea or coastal seismic activity, landslides, and volcanic eruptions. Whatever the cause, sea water is displaced with a violent motion and swells up, ultimately surging over land with great destructive power.**

## ONSET TYPE and CAUSES

If the earthquake or under water land movement is near the coast then tsunami may strike suddenly and if the earth movement is far in the sea then it may take few minutes to hours before striking the coast. The onset is extensive and often very destructive. The general causes of Tsunamis are geological movements. It is produced in *three major ways*. The most common of these is fault movement on the sea floor, accompanied by an earthquake. To say that an ***earthquake*** causes a tsunami is not completely correct. Rather, both earthquakes and tsunamis result from fault movements. Probably the second most common cause of tsunamis is a ***landslide*** either occurring underwater or originating above the sea and then plunging into the water. The third major cause of tsunamis is ***volcanic activity***. The flank of a volcano, located near the shore or underwater, may be uplifted or depressed similar to the action of a fault. Or, the volcano may actually explode. In 1883, the violent explosion of the famous volcano, Krakatoa in Indonesia, produced tsunamis measuring 40 meters which crashed upon Java and Sumatra. over 36,000 people lost their lives as a result of tsunami waves from Krakatoa. The giant tsunamis that are capable of crossing oceans are nearly always

*26th December, 2004, A massive earthquake of Magnitude 9.0 hit Indonessia generating Tsunami waves in South-east Asia & eastern coast of India. Height of tsunami waves ranged from 3 – 10 m affecting a total coastal length of 2260 km in the States of Andhra Pradesh, Tamil Nadu, Kerala & UTs of Pondicherry, Andaman & Nicobar Islands. Tsunami waves travelled upto a depth of 3 km from the coast killing more than 10,000 people & affected more than lakh of houses leaving behind a huge trail of destruction.*

created by movement of the sea floor associated with earthquakes which occur beneath the sea floor or near the ocean.




*Tsunami wave train formation: Seen in the figure is the rupture in the seafloor shunted in the vertical direction. This movement displaces hundreds of cubic kilometres of the overlaying water, generating a massive tsunami, or sea surge.*

## WARNING

Tsunami is not a single giant wave. It consists of ten or more waves which is termed as a "tsunami wave train". Since scientists cannot predict when earthquakes will occur, they cannot predict exactly when a tsunami will be generated. Studies of past historical tsunamis indicate where tsunamis are most likely to be generated, their potential heights, and flooding limits at specific coastal locations. With use of satellite technology it is possible to provide nearly immediate warnings of potentially tsunamigenic earthquakes. Warning time depends upon the distance of the epicenter from the coast line. The warning includes predicted times at selected coastal communities where the tsunami cold travel in a few hours. In case of tsunamigenic earthquakes or any other geological activity people near to the coastal areas may get very little time to evacuate on receiving of warning.

*Note: Ground shaking signals the occurrence of the earthquake. It is important to move away from the coastal areas since a tsunami may accompany the earthquake.*

## ELEMENTS AT RISK

All structures located within 200 m of the low lying coastal area are most vulnerable to the direct impact of the tsunami waves as well as the impact of debris & boulders brought by it. Settlements in adjacent areas will be vulnerable to floods & scour. Structures constructed of wood, mud, thatch, sheets and structures without proper anchorage to foundations are liable to be damaged by tsunami waves & flooding.

Other elements at risk are infrastructure facilities like ports & harbours, telephone and electricity poles, cables. Ships & fishing boats/nets near the coast also add to the destruction caused by tsunami waves.

## TYPICAL EFFECTS

*Physical damage* - Local tsunami events or those less than 30 minutes from the source cause the majority of damage. The force of can raze everything in its path. It is the flooding effect of a tsunami, however, that most greatly effects human settlements by water damage to homes and businesses, roads, bridges and other infrastructure. Ships, port facilities, boats/trawlers, fishing nets also get damaged.

*Men walk pass damaged fishing trawlers hit by a tsunami at Nagapattinam port*

*Environmental damage* - There is evidence of ever increasing impact upon the environment on account of the effects of tsunamis. The range varies from generation of tonnes of debris on account of structural collapse of weaker buildings, release of toxic chemicals into the environment on account of chemical leak/spillage/process failure/utility breakages/ collateral hazards and negative impact on the already fragile ecosystems.

*Casualties and public health:* Deaths occur principally from drowning as water inundates homes or neighborhoods. Many people may be washed out to sea or crushed by the giant waves. There may be some injuries from battering by debris and wounds may become contaminated.

*Water supply:* sewage pipes may be damaged causing major sewage disposal problems. Drinking water shortage arises due to breakage of water mains and contamination. Open wells and ground water may become unfit for drinking due to contamination of salt water and debris.

*Standing Crops and food supplies:* flooding by tsunami causes damage to the standing crops and also to the food supplies in the storage facilities. The land may be rendered infertile due to salt water incursion from the sea.

*An aerial view of a bridge destroyed by tsunamis near Pondicherry, in the southern Indian state of Tamil Nadu.*

*An aerial view of Pattinapakam, a slum which was destroyed by a tsunami, near Madras.*

## SPECIFIC PREPAREDNESS MEASURES

*Hazard mapping* – a hazard map should be prepared with designated areas expected to be damaged by flooding by tsunami waves. Historical data could be of help ion showing areas inundated in the past. Keeping in mind the vulnerable areas, evacuation routes should be constructed and mapped. The plan should be followed by evacuation drill.

*Early warning systems* – a well networked system in place can warn the communities of the coastal areas when the threat is perceived. Tsunami warning should be disseminated to local, state, national as well as the international community so as to be prepared as they are capable of crossing across continents. The information can be broadcasted to the local emergency officers and the general public. On receiving of the warning the action should be to evacuate the place as decided in the evacuation plan.

*Community Preparedness* – communities in the coastal areas are faced by the wrath of cyclones, storm surge and tsunami waves. It is important that the community is better prepared to take suitable actions on receiving of the threat and follow emergency evacuation plans and procedures. a community which choose to ignore warning may get severely effected if they are not prepared to take immediate measures.

*Bad siting - A view of a village that was destroyed by a tsunami at Kolachal, in Tamil Nadu*

## MAIN MITIGATION STRATEGIES

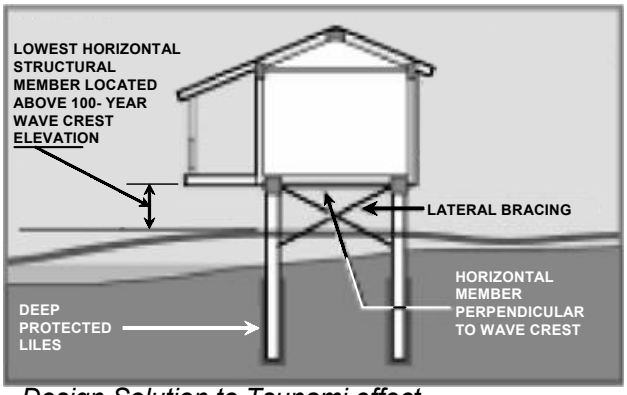
***Site Planning and Land Management***- Within the broader framework of a comprehensive plan, site planning determines the location, configuration, and density of development on particular sites and is, therefore, an important tool in reducing tsunami risk.

- The designation and zoning of tsunami hazard areas for such open-space uses as agriculture, parks and recreation, or natural hazard areas is recommended as the first land use planning strategy. This strategy is designed to keep development at a minimum in hazard areas.
- In areas where it is not feasible to restrict land to

open-space uses, other land use planning measures can be used. These include strategically controlling the type of development and uses allowed in hazard areas, and avoiding high-value and high-occupancy uses to the greatest degree possible.

- The capital improvement planning and budgeting process can be used to reinforce land use planning policies.

***Engineering structures*** – As most of the structures along the coast area comprises of fisherman community, which are constructed of light weight materials without any engineering inputs. Therefore there is an urgent need to educate the community about the good construction practices that they should adopt such as:



*Design Solution to Tsunami effect*

- Site selection – Avoid building or living in buildings within several hundred feet of the coastline as these areas are more likely to experience damage from tsunamis.
- Construct the structure on a higher ground level with respect to mean sea level.
- Elevate coastal homes: Most tsunami waves are less than 3 meters in height. Elevating house will help reduce damage to property from most tsunamis. Structural columns resist the impact while other walls are expendable. It is important to also take note that adequate measures are also brought into the design to cater for earthquake forces.
- Construction of water breakers to reduce the velocity of waves.
- Use of water & corrosion resistant materials for construction.
- Construction of community halls at higher locations, which can act as shelters at the time of a disaster.

***Flood management*** - Flooding will result from a tsunami. Tsunami waves will flood the coastal areas. Flood mitigation measures could be incorporated (see section on floods for additional information). Building barriers or buffers such as special breakwaters or seawalls can be an effective risk reduction measure against gushing waters in case of Tsunami/Storm surge during cyclones.

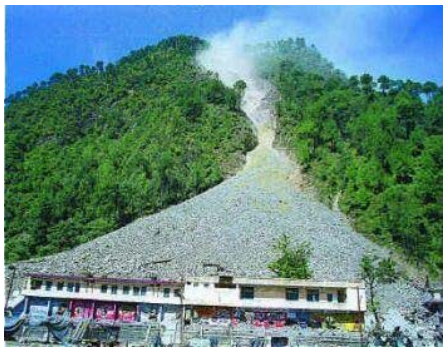
*Source: Part.1 Geologic Hazards – Tsunamis, INTRODUCTION TO HAZARDS, 3rd Edition DMTP 1997*

## WEB RESOURCES:

- http://ioc.unesco.org/itsu/ IOC/UNESCO International Coordination group for the Tsunami Warning System in the Pacific (ICG/ITSU), Paris, France
- http://quake.usgs.gov/tsunami/ Tsunamis and Earthquakes, USGS, USA
- www.asc-india.org Amateur Seismic Centre is a comprehensive website carrying details of state wise seismicity for the country. This also has extensive reports on various past Earthquakes/Tsunamis.
- http://www.prh.noaa.gov/pr/itic/ International Tsunami Information Center, Honolulu, Hawaii
- http://www.tsunami.org/ Pacific Tsunami Museum site. Includes answers to frequently asked questions, links, and information related to Pacific Ocean tsunamis.

CHAPTER 4

# LANDSLIDE HAZARDS AND DISASTERS



**LANDSLIDES –**
are slippery masses of rock, earth or debris which move by force of their own weight down mountain slopes or river banks

*In the picture:*
*(Top)House wrecked in landslide - Twenty-five residents of a private building in the heart of the Shimla town had a miraculous escape when a major portion of house collapsed following a landslide. The landslide was triggered by haphazard cutting of the hill below it for construction of a hotel.*

*(Bottom Left): The Varunavat mountain rising on the edge of Uttarkashi town. Huge cracks on its side have set off several landslides. A building in danger of being buried. (Bottom Right): A building partly buried under rocks and other debris.*

## ONSET TYPE and WARNING

Though they occur gradually, however sudden failure (sliding) can occur without warning. They may take place in combination with earthquakes, floods and volcanoes. There are no clearly established warnings in place indicating occurrence of landslide and hence difficult to predict the actual occurrence. Areas of high risk can be determined by use of information on geology, hydrology, vegetation cover, past occurrence and consequences in the region.

## CAUSES OF LANDSLIDES

***Geological Weak material:*** weathered materials, jointed or fissured materials, contrast in permeability and contrast in stiffness (stiff, dense material over plastic materials).
***Erosion:*** Wave erosion of slope toe, glacial erosion of slope toe, subterranean erosion (Deposition loading slope or its crest, Vegetation removal.
***Intense rainfall:*** Storms that produce intense rainfall for periods as short as several hours or have a more moderate intensity lasting several days have triggered abundant landslides.

*Bhachau Landslide - The land slipped during the 26th January 2001 earthquake event in Bhachau. Note people are still camped beneath. Monsoon rains could possibly wash the soil downslope.*

***Human Excavation*** *of slope* and its toe, Loading of slope/toe, draw down in reservoir, mining, deforestation, irrigation, vibration/blast, Water leakage from services.

***Earthquake shaking*** has triggered landslides in many different topographic and geologic settings. Rock falls, soil slides and rockslides from steep slopes involving relatively thin or shallow dis-aggregated soils or rock, or both have been the most abundant types of landslides triggered by historical earthquakes.

***Volcanic eruption*** Deposition of loose volcanic ash on hillsides commonly is followed by accelerated erosion and frequent mud or debris flows triggered by intense rainfall.

## ELEMENTS AT RISK

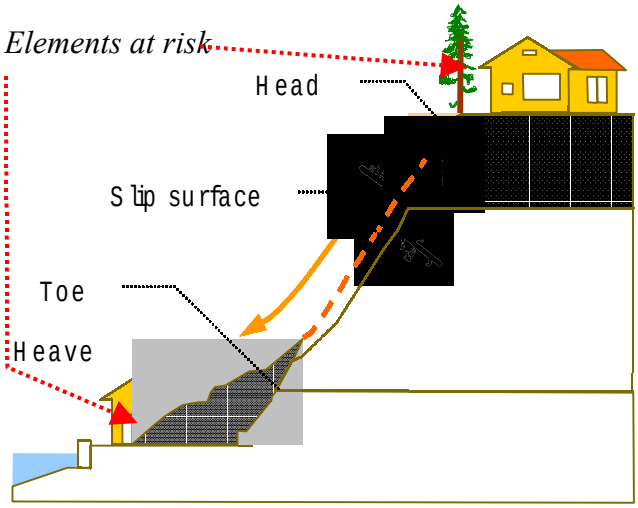
The most common elements at risk are the settlements built on the steep slopes, built at the toe and those built at the mouth of the streams emerging from the mountain valley. All those buildings constructed without appropriate foundation for a given soil and in sloppy areas are also at risk. Roads, communication line and buried utilities are vulnerable.

## INDIAN LANDSLIDES

Landslide constitute a major natural hazard in our country, which accounts for considerable loss of life and damage to communication routes, human settlements, agricultural fields and forest lands. The Indian subcontinent, with diverse physiographic, seismotectonic and climatological conditions is subjected to varying degree of landslide hazards; the Himalayas including Northeastern mountains ranges being the worst affected, followed by a section of Western Ghats and the Vindhyas. Removal of vegetation and toe erosion have also triggered slides Torrential monsoon on the vegetation cover removed slopes was the main causative factors in the Peninsular India namely in Western Ghat and Nilgiris. Human intervention by way of slope modification has added to this effect.

## HAZARD ZONES

The Landslide Hazard Zonation Map of India is produced in the next page. The Landslide Map needs to be popularized among the architects, engineers and development planners and also to the public so that it is used as a tool for regulating construction or development activities and means of managing or mitigating landslide disasters.




Red spot on the map show major landslides

*(Source: www.csre.iitb.ac.in)*

*Spots showing major landslides in India*

## Zone Significance of Landslides

The four point hazard scale of the Landslide Zones are – (1) Severe to Very High, (2) High, (3) Moderate to low, (4) Unlikely, was considered adequate. The zonal significance is given below:

| Zone | Significance |
|---|---|
| **Severe to Very High** | The area is well known for the danger of landslides, and for the perennial threat to life and property. Restrictions on all new constructions and adoption of improved land use and management practices deserve to be encouraged. Investments on landslide remediation measures, on public education and on early warning systems are strongly indicated. |
| **High** | This is a zone in which landslides have occurred in the past and are already to be expected in the future. New constructions in this zone should be strictly regulated and construction should be done only after proper site investigation and implementation of appropriate remedial package. Before the new construction projects are cleared in this zone, environment impact assessment should be made mandatory. |
| **Moderate to Low** | Engineered and well-regulated new construction activities and well-planned agricultural practices could be permitted. All construction activities should however be based on technically evaluated and certified plans by established institutions and authorized consultants. |
| **Unlikely** | No visible sign of slope instability are seen in this zone in the present stage of knowledge. No blanket restriction needs to be imposed on various land use practices provided they confirm to the prevailing building regulations and bye-laws. Location specific limitations may become necessary for high-density urban areas. |
| | Snow covered areas |

*Figure showing Landslide Hazard Zonation Map of India*
*Note: Fore more information refer Landslide Hazard Zonation Atlas of India (with reflections on some of the Major Landslides of India), published jointly by Building Materials and Technology Promotion Council – New Delhi & Centre for Disaster Mitigation and Management - Chennai.*

## Major Landslides of India

| Date/Year | Location | Damage |
|---|---|---|
| 1867 and 1880 | Nainital, Uttaranchal | There have been two major landslides on the Sher-ka-Danda slope in Nainital. The 1180 landslide took place on account of rainfall and an earth tremor. A large portion of the range and the buildings were swept away in minutes. He slide permanently filled a portion of the Naini lake. |
| 1913 to 1993 | NH 1A, from Jammu to Srinagar at km 138, J&K | It is a old and notorious landslide. Nashri landslide causes disruptions and blockage of the road several times in the same year, requiring urgent action. Often many vehicles and equipments are buried in the huge debris generated. |
| Almost annual feature | NH 1A, Jammu-Srinagar Highway. | Almost every year landslides occur at the Khuni Nallah site destroying vital bridges and disrupting the traffic and the communication system. |
| 1957, July 1966 and 1972 | Gangtok-Siliguri road, Sikkim | The seimicity of the area and the rainfall both are the triggering factors of this slide. An average rainfall of about 3000mm is common in the slide area. The slope uphill of the road is a complex landform. |
| September 1968 | Himachal Pradesh | Active Maling slide- 1km of road and a bridge washed out |
| July 1968 | Garhwal Himalaya | Active Kaliasaur slide- continuous damage to road |
| July 1970 | Alaknanda, Uttaranchal | Landslide dam broke, huge boulders were thrown far and wide causing wide spread damage. There were numerous landslides in the region, besides reactivating the old ones. |
| December 1982 | Himachal Pradesh | Near Solding nallah 3 bridges & 1.5km length of road washed away |
| January 1982 | Nashri, J&K | Active slide from 1953. Every year road and communication network is damaged. |
| September 1985 | Hardwar-Badrinath Road | First time in 1920, then in 1952, 1963, 1964, 1965 and a major landslide in 1969, 1970, 1971, 1972 and Sept 1985 and so on. The Kaliasaur Landslide is the most persistent and regular occurring Landslide. |
| March 1989 | Himachal Pradesh | Nathpa, 500m road section is frequently damaged during successive year |
| October 1990 | Nilgris | 36 people killed and several injured. Several buildings and communication network damaged |
| July 1991 | Assam | 300 people killed, road and buildings damaged, Millions of rupees |
| November 1992 | Nilgiris | Road network and buildings damaged, Rs.5 million damage estimate |
| June 1993 | Aizawal | Four persons were buried |

| | | |
|---|---|---|
| July 1993 | Itanagar Arunachal Pradesh | 25 people buried alive 2 km road damaged |
| August 1993 | Kalimpong, West Bengal | 40 people killed, heavy loss of property |
| August 1993 | Kohima, Nagaland | 200 houses destroyed, 500 people died, about5km road stretch was damaged |
| November 1993 | Nilgris, Tamil Nadu | Occurrence of Landslide is widespread in Nilgiris. During 1993, about 408 landslides occurred of which Marapplam is the severest in terms of loss and magnitude. 40 people killed, property worth several lakhs damaged |
| January 1994 | Kashmir | National Highway 1A severely damaged |
| June 1994 | Varundh Ghat, Konkan Coast | 20 people killed, breaching of ghat road damaged to the extent of 1km. At several places |
| May 1995 | Aizwal Mizoram | 25 people killed road severely damaged |
| June 1995 | Malori Jammu | 6 persons killed, NH 1A damaged |
| September 1995 | Kullu, HP | 22 persons killed and several injured about 1 km road destroyed |
| 14 August 1998 | Okhimath | 69 people killed |
| 18 August 1998 | Malpa, Kali river | 210 people killed. The heap of debris created were about 15m high. The village was wiped out in the event. |

*The Malpa village as on 17 August 1998, a few hours before the rock avalanche wiped out the village around 0300hours on the 18 August, 1998.*

*The two pictures were taken from the same location upstream of Kali River. They provide a direct comparison of scenarios before and after the event.*

| | | |
|---|---|---|
| 9 Nov 2001 | Amboori, Kerala | This landslide caused the death of 38 persons and inflicted damage to houses. A large numbr of huge sized boulders, some of them weighing 5 to 10 tonnes rolled down during the slide. |

***Landslide in Kerala***

In the Kerala part of the Western Ghats several types of mass movements /landslides have been recorded. The most prevalent, recurring and disastrous type of mass movements noted in Kerala are the "*debris flows*". The swift and sudden down slope movement of highly water saturated overburden containing a varied assemblage of debris material ranging in size from soil particles to huge boulders destroying and carrying with it every thing that is lying in its path. *Note the boulder movement along the path.*

*(Source: www.gisdevelopment.net)*

## TYPICAL EFFECTS

*Physical Damage:* Landslides destroy anything that comes in their path. They block or bury roads, lines of communication, settlements, river flow, agricultural land, etc. It also includes loss to agricultural production and land area. In addition physical effects such as flooding may also occur.

*Casualties:* They cause maximum fatalities depending on the place and time of occurrence. Catastrophic landsides have killed many thousands of persons, such as the debris slide on the slopes of Huascaran in Peru triggered by an earthquake in 1970, which killed over 18,000 people.

## MAIN MITIGATION STRATEGIES

***Hazard mapping*** will locate areas prone to slope failures. This will permit to identify avoidance of areas for building settlements. These maps will serve as a tool for mitigation planning.

***Land use*** practices such as:

- Areas covered by degraded natural vegetation in upper slopes are to be afforested with suitable species. Existing patches of natural vegetation (forest and natural grass land) in good condition, should be preserved
- Any developmental activity initiated in the area should be taken up only after a detailed study of the region and slope protection should be carried out if necessary.
- In construction of roads, irrigation canals etc. proper care is to be taken to avoid blockage of natural drainage
- Total avoidance of settlement in the risk zone should be made mandatory.
- Relocate settlements and infrastructure that fall in the possible path of the landslide
- No construction of buildings in areas beyond a certain degree of slope.

***Retaining Walls*** can be built to stop land from slipping (these walls are commonly seen along roads in hill stations). It's constructed to prevent smaller sized and secondary landslides that often occur along the toe portion of the larger landslides.

***Surface Drainage Control Works***. The surface drainage control works are implemented to control the movement of landslides accompanied by infiltration of rain water and spring flows.

***Engineered structures*** with strong foundations can withstand or take the ground movement forces. Underground installations (pipes, cables, etc.) should be made flexible to move in order to withstand forces caused by the landslide

*Retaining wall - Reinforced wall constructed as a mitigation measure.*

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

***Insurance*** will assist individuals whose homes are likely to be damaged by landslides or by any other natural hazards. For new constructions it should include standards for selection of the site as well as construction technique.

## COMMUNITY BASED MITIGATION

The most damaging landslides are often related to human intervention such as construction of roads, housing and other infrastructure in vulnerable slopes and regions. Other community based activities that can mitigate landslides are education and awareness generation among the communities, establishing community based monitoring, timely warning and evacuation system.

Communities can play a vital role in identifying the areas where there is land instability. Compacting ground locally, slope stabilization (procedures such as terracing and tree planting may reduce damages to some extent), and avoiding construction of houses in hazardous locations are something that the community has to agree and adhere to avoid damage from the possible landslides. This would also reduce

*Surface drain ditch.*

the burden of shifting of settlements from hazardous slopes and rebuild in safe site as it is less practical to do in large scale.

**DEBRIS FLOWS OR MUDSLIES**

Fast-moving flows of mud and rock, called debris flows or mudslides, are among the most numerous and dangerous types of landslides in the world. They are particularly dangerous to life and property because of their high speeds and the sheer destructive force of their flow.

**Hazardous Areas** Debris flows start on steep slopes-slopes steep enough to make walking difficult. Once started, however, debris flows can travel even over gently sloping ground. The most hazardous areas are canyon bottoms, stream channels, areas near the outlets of canyons, and slopes excavated for buildings and roads.


A: Canyon bottoms, stream channels, and areas near the outlets of canyons or channels are particularly hazardous. Multiple debris flows that start high in canyons commonly funnel into channels. There, they merge, gain volume, and travel long distances from their sources.
B: Debris flows commonly begin in swales (depressions) on steep slopes, making areas downslope from swales particularly hazardous.
C: Roadcuts and other altered or excavated areas of slopes are particularly susceptible to debris flows. Debris flows and other landslides onto roadways are common during rainstorms, and often occur during milder rainfall conditions than those needed for debris flows on natural slopes.
D: Areas where surface runoff is channeled, such as along roadways and below culverts, are common sites of debris flows and other landslides.

*(Source: http://geohazards.cr.usgs.gov/factsheets/html_files/debrisflow/fs176-97.html)*

## WEB RESOURCES:

- http://www.csre.iitb.ac.in/rn/resume/landslide/lsl.htm Landslide Information System - Center of Studies in Resource Engineering IIT Mumbai.
- http://landslides.usgs.gov USGS National Landslide Hazards Program (NLHP)
- http://www.fema.gov/hazards/landslides/landslif.shtm Federal Emergency Management Agency FEMA, USA is tasked with responding to, planning for, recovering from and mitigating against disasters.
- http://ilrg.gndci.pg.cnr.it/ The International Landslide Research Group (ILRG) is an informal group of individuals concerned about mass earth movement and interested in sharing information on landslide research.

CHAPTER 5

# CYCLONE HAZARDS AND DISASTERS

**CYCLONES –**

a violent storm, often of vast extent, characterized by high winds rotating about a calm center of low atmospheric pressure. This center moves onward, often with a velocity of 50km an hour.

*29th October 1999, Super-cyclone with winds 260-300 km/hour hit the 140 km coast of Orissa with a storm surge that created the Bay-of-Bengal water level 9 metres higher than normal. The super storm traveled more than 250 km inland and within a period of 36 hrs ravaged more than 200 lakh hectares of land, devouring trees and vegetation, leaving behind a huge trail of destruction. The violent cyclone was merciless and giant, broke the backbone of Orissa state and killed thousands and devastated millions.*

*In the picture: Destruction caused by the 1999 Orissa supercyclone.*

## ONSET TYPE

They strike suddenly although it takes time to build up. They can be tracked on the development but accurate landfall is predictable barely few hours. The onset is extensive and often very destructive.

## WARNING

Low pressure and the development can be detected hours or days before its damage effects start. Satellite tracking can track the movement since the build up and the likely path is projected. Warning and evacuation is done along the projected path. It is difficult to predict the accuracy. Accurate landfall predictions can give only a few hours' notice to threatened populations. In addition, people generally opt to wait until the very last minute before abandoning their home and possessions. Deaths from drowning in the high tides and sudden flooding and material losses are therefore often very high.

The India Meteorological Department (IMD) issues warning against severe weather phenomena like tropical cyclones, heavy rains and snow, cold and heat waves, etc., which cause destruction of life and property. Cyclone warning is disseminated by several means such as satellite based disaster

warning systems, radio, television, telephone, fax, high priority telegram, public announcements and bulletins in press. Advancement in Information Technology in the form of Internet, Geograhical Information System (GIS), Remote Sensing, Satellite communication, etc. can help a great deal in planning and implementation of hazards reduction schemes.

## ELEMENTS AT RISK

All lightweight structures and those built of mud, wood, older buildings with weak walls and structures without proper anchorage to the foundations will be at great risk. Settlements located in low lying coastal areas will be vulnerable to the direst effects of the cyclones such as wind, rain and storm surge. Settlements in adjacent areas will be vulnerable to floods, mudslides or landslides due to heavy rains. Other elements at risk are fences, telephone & electricity poles, cables, light elements of structures – roofs, signboards, hoardings, coconut crowns, fishing boats & large trees.

*A helicopter turned turtle at the Bhubaneshwar airport during the cyclonic storm of 1999.*

## TYPICAL EFFECTS

First, in a sudden, brief onslaught, high winds cause major damage to infrastructure and housing, in particular fragile constructions. They are generally followed by heavy rains and floods and, in flat coastal areas by storm surge riding on tidal waves and inundating the land over long distances of even upto 15km inland..

*Physical damage* – structures will be damaged or destroyed by the wind force, flooding and storm surge. Light pitched roofs of most structures especially the ones fitted on to industrial buildings will suffer severe damage.

*A bridge destroyed by the high-velocity winds and floods during the cyclone.*

*Casualties and public heath* – caused by flooding and flying elements, contamination of water supplies may lead to viral outbreaks, diarrhea, and malaria.

*Water supplies* – Ground and piped water supply may get contaminated by flood waters

*Crops and food supplies* – high winds and rains will ruin the standing crop and food stock lying in low lying areas. Plantation type crops such as banana and coconut are extremely vulnerable. Salt from the sea water may be deposited on the agricultural land and increase the salinity. The loss of the crop may lead to acute food shortage.

*Communication* – severe disruption in the communication links as the wind may bring down the electricity and communication towers, electricity and telephone poles, telephone lines, antennas and satellite disk and broadcasting services. Transport lines (road and rail) may be curtailed. Relief materials may not reach the affected site.

## INDIAN CYCLONES

The coastal areas are subjected to severe wind storms and cyclonic storms. A full-grown cyclone is a violent whirl in the atmosphere 150 to 1000 km across, 10 to 15 km high. Gale winds of 150 to 250 kmph or more spiral around the center of very low pressure area. Torrential rains, occasional thunder and lightning flashes - join these under an overcast black canopy. Through these churned chaotic sea and atmosphere, the cyclone moves 300 to 500 km, in a day to hit or skirt along a coast, bringing with it storm surges as high as 3 to 12 metres, as if splashing a part of the sea sometimes up to 30 km inland leaving behind death and destructions. A storm surge is the sudden abnormal rise in the sea level caused by cyclone. The sea water flows across the coast as well as inland and then recedes back to the sea. Great loss of life and property takes place in the process.

***East Coast:*** Cyclones affect both the Bay of Bengal and the Arabian Sea. They are rare in Bay of Bengal from January to March. Isolated ones forming in the South Bay of Bengal move west north westwards and hit Tamil Nadu and Sri Lanka coasts. In April and May, these form in the South and adjoining Central Bay and move initially northwest, north and then recurve to the northeast striking the Arakan coasts in April and Andhra-Orissa-West Bengal-Bangla desh coasts in May. Most of the monsoon (June - September) storms develop in the central and in the North Bay and move west-north-westwards affecting Andhra-Orissa-West Bengal coasts. Post monsoon (October-December) storms form mostly in the south and the central Bay, recurve between 15 $^{O}$ and 18$^{O}$ N affecting Tamil Nadu-Andhra Orissa-West Bengal-Bangladesh coasts.

***West Coast:*** Cyclones do not form in Arabian Sea during the months of January, February and March and are rare in April, July, August and September. They generally form in southeast Arabian Sea and adjoining central Arabian Sea in the months of May, October, November and December and in east central Arabian Sea in the month of June. Some of the cyclones that originate in the Bay of Bengal travel across the peninsula, weaken and emerge into Arabian Sea as low pressure areas. These may again intensify into cyclonic storms. Most of the storms in Arabian Sea move in west-north-westerly direction towards Arabian Coast in the month of May and in a northerly direction towards Gujarat Coast in the month of June. In other months, they generally move northwest north and then recurve northeast affecting Gujarat-Maharashtra coasts; a few, however, also move west north westwards towards Arabian coast.

**The criteria followed by the Meteorological Department of India to classify the low pressure systems in the Bay of Bengal and in the Arabian Sea as adopted by the World Meteorological Organisation (WMO) are:**

| **Types of Disturbances** | **Associated wind speed in the Circulation** (1 knot = 1.85 km/hr) |
|---|---|
| 1. Low Pressure Area | Less than 17 knots ( < 31 kmph) |
| 2. Depression | 17 to 27 knots ( 31 to 49 kmph) |
| 3. Deep Depression | 28 to 33 knots ( 50 to 61 kmph) |
| 4. Cyclonic Storm | 34 to 47 knots ( 62 to 88 kmph) |
| 5. Severe Cyclonic Storm | 48 to 63 knots ( 89 to 118 kmph) |
| 6. Very Severe Cyclonic Storm | 64 to 119 knots ( 119 to 221 kmph) |
| 7. Super Cyclonic Storm | 120 knots and above ( 222 kmph and above) |

## HAZARD ZONES

The wind zone map illustrates the area vulnerable to high wind speeds. The macro-level wind speed zones of India have been formulated and published in IS 875 (Part-3) – 1987. There are six basic wind speeds considered for zoning, namely:

| | |
|---|---|
| 55m/s (198km/hr) | Very High Damage Risk Zone-A |
| 50m/s (180 km/hr) | Very High Damage Risk Zone-B |
| 47m/s (169.2 km/hr) | High Damage Risk Zone |
| 44m/s (158.4 km/hr) | Moderate Damage Risk Zone-A |
| 39m/s (140.4 km/hr) | Moderate Damage Risk Zone-B |
| 33m/s (118.8 km/hr) | Low Damage Risk Zone |

The cyclone affected areas of the country are classified in 50 and 55m/s zones. It is known that in certain events, the wind gusts could appreciably exceed the given basic wind speeds. For design of structures and classification of vulnerability and risk to buildings, the above macro-level zoning is considered as sufficient.

***Surge prone coasts of India***

Storm surge heights depend on the intensity of the cyclone, i.e., very high-pressure gradient and

| *Basic wind speed (m/s)* | *Color Scheme* |
|---|---|
| | |

*Wind Speed Zones of India bsed on IS: 875 (Part 3) Code*

consequent very strong winds and the topography of seabed near the point where a cyclone crosses the coast. Sea level also rises due to astronomical high tide. Elevation of the total sea level increases when peak surge occurs at the time of high tide. Vulnerability to storm surges is not uniform along Indian coasts.

The following segments of the ***East Coast of India*** are most vulnerable to high surges:

- North Orissa, and West Bengal coasts.
- Andhra Pradesh coast between Ongole and Machilipatnam.
- Tamil Nadu coast, south of Nagapatnam.

The ***West Coast of India*** is less vulnerable to storm surges than the east coast of India in terms of both the height of storm surge as well as frequency of occurrence. However, the following segments are vulnerable to significant surges:

- Maharashtra coast, north of Harnai and adjoining south Gujarat coast and the coastal belt around the Gulf of Bombay.
- The coastal belt around the Gulf of Kutch.

**Brief History of Most Intense Cyclones (in particular from 1970 to 2001)**

| Date and Year | Observed/ Estimated Max. Wind After Landfall | Damage |
|---|---|---|
| | | **Over the Arabian Sea** |
| Oct 19-24, 1975 | 180 Kmph | 85 people died in the districts of Junagadh. Jamnager and Rajkot of Gujarat state. This Cyclone caused considerable damage to property (estimated to be about Rs. 75 Crores) |
| May 31 - June 5, 1976 | 167 Kmph | This Cyclone Caused damege to property which was estimated to be about Rs. 3 Crore. 4 Burges each. Containing Rs. 5 Lakh and 6 fishing boats were swept away. Mehsana, Bhavnagar, Kaira, Panchmahal, Rajkot and Broach districts of Gujarat State were most affected areas. |
| Nov 13-23, 1977 | 167 Kmph | Kerala and Laccadives were most affected areas due to this storm people killed. 72 .House damaged - 8400 and 620 fishing Vessels damaged in Kerala coast. Total loss was estimated to be about Rs 10 crores. |
| Nov 5-13, 1978 | 278 Kmph | Gujarat Cyclone Damage to property reported |
| Oct 28 - Nov3,1981 | 120 Kmph | Junagadh, Rajkot and Jamnagar of Gujarat state were most affected areas, Total loss of damage to property was estimated to be about Rs. 52 Crores. |
| Nov 4-9, 1982 | N/A | Saurastra Coast of Gujarat about 45 km east of Veraval was attected very much by this storm. 507 people died and 1.5 lakh livestock perished. |
| Nov 4-9, 1982 | 93 Kmph | 50 fisher men were reported missing in Gujarat Coast. |
| June 17-20, 1996 | 111 Kmph | 19 Districts of Gujarat State were affected 33 people died. 27964 pucca houses were destroyed total estimated loss was Rs.1803.52 lakh. |
| Oct 23-28, 1996 | 111 Kmph | Severe Cyclonic Storm over the Arabian sea. As the system did not cross the coast. No significant damage was reported. |
| June 4-10, 1998 | 167 Kmph | Gujarat & Rajasthan states were affected ** Porbanderof Gujarat state was the most affected areas. Loss incurred due to storm was estimated to be about Rs.1855.38 Crores in Kandla. |
| May 16-22, 1999 | 195 Kmph | This system caused severe damage in Kutch and Jamnagar district of Gujarat 453 people died. Loss of property estimated to about Rs. 80 Cr in Rajasthan one person died and 5104 cattle heads perished. 5133 houses were partially damaged. |
| | | **Over the Bay of Bengal** |
| Oct 1942 | 225 kmph | Over 10,000 people perished in the cyclone that hit Midnapore on October 14-15, 1942, during World War-II. |
| Nov 8-13, 1970 | 224 Kmph | Bangladesh Cyclone of which crossed Bangladesh coast in the night of 12th was one of the worst in recent times, with storm surges of 4 to 5 metres height at the time of high tides, and with 25 cm of rain in the areas, the inundation took toll of about 3,00,000 people. |
| Oct 26-31, 1971 | 185 Kmph | Balasore (Orissa) 10,000 people died and 1 million people rendered homeless |
| Nov 14-20, 1977 | 259 Kmph | Andhra Cyclone that crossed coast near Nizampatnam in the evening of 19th, took a toll of about 8,547 lives. The Ship Jagatswamini, which went right into the eye of the storm in the evening of 17th experienced maximum wind speed of 194 kmph. As the storm approached the coast, gale winds reaching 200 kmph lashed Prakasam Guntur, Krishna, East and West Godavari districts. Storm surge of 5 meters high inundated Krishna estuary and the coasts south of Machilipatnam. |
| Nov 9-14, 1984 | 213 Kmph | Sri Harikota (A.P.)604 people died |
| Nov 24-30, 1988 | 213 Kmph | 2000 people died. 6000 people missing in Bangladesh |
| Nov 1-9, 1989 | 235 Kmph | Kavali (A.P.)69 people died |
| May 4-9, 1990 | 235 Kmph | Machalipatnam 967 people died. |

| | | |
|---|---|---|
| Apr 25-30, 1991 | 235 Kmph | Bangladesh 1,38,882 people died. 1,39,054 people injured |
| Apr24-May2, 1994 | 215 Kmph | Bangladesh 184 people killed |
| May 15-19, 1997 | 230 Kmph | Teknaf Bangladesh, 155 people died. 9663 people injured |
| June 5 - 9, 1998 | 167 Kmph | Kandla Cyclone. 1680 people died |
| May 16-22, 1999 | 195 Kmph | Arabian Sea (crossed Sind coast of Pakistan). 454 people died and 5104 cattle heads perished in India. |
| Oct 15-19, 1999 | 170 Kmph | Gopalpur Cyclone – Orissa 198 people died, 402 persons injured. |
| Oct 25-29, 1999 | 260 Kmph | The Orissa SuperCyclone causec heavy destruction to coastal districts of Orissa. 9887 people died. 129.22 lakh people affected. |
| Nov 26-30 , 2000 | 189 kmph | Two states viz., Tamil Nadu and Pondicherry were mainly affected by this storm.The loss is mainly due to crop damage. Uprooting of big trees and partial damages to more than one thousand kuchha houses. 30,000, Plantain trees and 50,000 Plantain saplings got destroyed and 30,000 trees were Uprooted in Tamil Nadu state. In Pondicherry two persons lost their lives Damage to paddy Crops plantains, Coconut Plantation were the major loss in Pondicherry. |
| Dec 23-28, 2000 | 167 Kmph | Three districts of Tamil Nadu state were affected by this storm in the Ramnathanpuram district, 350 houses were damaged in thirunelveli. Houses damaged - 318. In Tutocorin houses damaged-318, Fishing boats, lost - 95, loss to crops - 281 hectares paddy crops destroyed, plaintain- 650 hectares and betal 80 hectares . |

## POTENTIAL FOR REDUCING HAZARD

Coastal belt plantation (green belt plantation along the coastal line in a scientific interweaving pattern) can reduce the effect of the hazard. Providing a cover through green belt sustains less damage. Forests act as a wide buffer zone against strong winds and flash floods. Without the forest the cyclone travel freely inland. The lack of protective forest cover allows water to inundate large areas and cause destruction. With the loss of the forest cover each consecutive cyclone can penetrate further inland. Flood protection measures can be taken to reduce the impact of flood hazards.

## MAIN MITIGATION STRATEGIES

**Hazard mapping** – Meteorological records of the wind speed and the directions give the probability of the winds in the region. Cyclones can be predicted several days in advance. The onset is extensive and often very destructive. Past records and paths can give the pattern of occurrence for particular wind speeds. A hazard map will illustrate the areas vulnerable to the cyclone in any given year. It will be useful to estimate the severity of the cyclone and various damage intensities in the region. The map is prepared with data inputs of past climatological records, history of wind speed, frequency of flooding etc.

**Land use control** designed so that least critical activities are placed in vulnerable areas. Location of settlements in the flood plains is at utmost risk. Siting of key facilities must be marked in the land use. Policies should be in place to regulate land use and enforcement of building codes. Vulnerable areas should be kept for parks, grazing or play grounds.

*Andhra Pradesh state wind and cyclone zone*

**Engineered structures** – structures need to be built to withstand wind forces. Good site selection is also important. Majority of the buildings in coastal areas are built with locally available materials and have no engineering inputs. Good construction practice should be adopted such as:

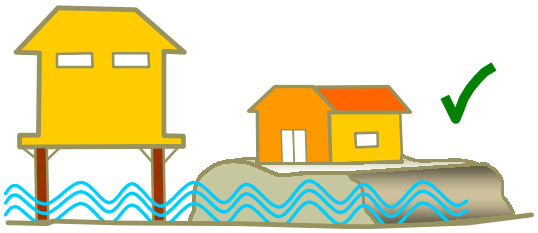
- Cyclonic wind storms inundate the coastal areas. It is advised to construct on stilts or on earth mound.
- Houses can be strengthened to resist wind and flood damage. All elements holding the structures need to be

*A shelter with special feature to withstand cyclones and floods. Traditional homes can be improved by building in disaster resistant features. Such homes could withstand cyclones with moderate speeds.*

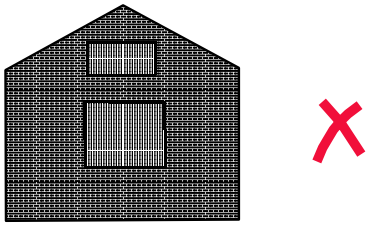
properly anchored to resist the uplift or flying off of the objects. For example, avoid large overhangs of roofs, and the projections should be tied down.

- A row of planted trees will act as a shield. It reduces the energy.
- Buildings should be wind and water resistant.
- Buildings storing food supplies must be protected against the winds and water.
- Protect river embankments. Communication lines should be installed underground.
- Provide strong halls for community shelter in vulnerable locations.

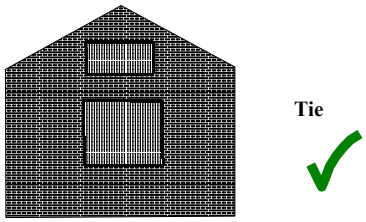
*Construction at ground level –risk of inundation*



*If natural elevation is not available construction on stilts or on artificially raised earth mounds*



*Large overhangs get lifted and broken.*




*Avoid large overhangs and use ties.*

**Flood management** – Flooding will result from a cyclonic storm. Storm surge will flood the coastal areas. Heavy rains will bring in flash floods. There are possibilities of landslides too. Flood mitigation measures could be incorporated (see section on floods for additional information).

**Improving vegetation cover** – improvement of the vegetation will increase water infiltaration capacity of the soil. The roots of the plants and trees will keep the soil intact and prevent erosion and slow runoff to prevent or lessen flooding. The use of tree planted in rows will act as a windbreak. *Coastal shelterbelt plantations* can be developed to break severe wind speeds. It minimizes devastating effects. The Orissa calamity has also highlighted the need for urgent measures like shelterbelt plantation along cyclone-prone coastal areas. Species chosen for this purpose should not only be able to withstand the impact of strong cyclonic winds, but also check soil erosion.

## COMMUNITY BASED MITIGATION

Construction of cyclone resistant houses and strengthening of existing houses can be done through community participation. Local engineers and masons can take part in the construction of the buildings in their area and demonstrate to the people about disaster resistant construction methods. Construction of multipurpose cyclone shelters in the vulnerable locations are desirable. During normal time these buildings can be used as schools or as community centres. In case of cyclones or floods, community can take shelter in these designed buildings. The local communities will be responsible for the maintenance and management of these community shelters. Protection measures need to be taken for the

***Coastal Shelterbelt Plantation Programme***

*The adverse impact of the super cyclone in the coastal districts of Orissa, has drawn attention to the need to take up, on an emergency basis, shelterbelt plantations. It is proposed to afforest the coastal areas in the country with suitable tree species to form a shelterbelt, under the Integrated Afforestation & Eco-Development Project Scheme (IAEPS). The proposed shelterbelt along the coastline will mitigate the impact of strong cyclonic winds and thus check soil erosion and inward sand drift, thereby protecting cultivated fields, houses and homesteads adjoining the coasts.*

*Picture showing Restoration of land: Plantation over reclaimed (back filled) area.*

livestock, the boats, fishing nets, household items and other possessions.

Other activities that can be taken up as part of the community based mitigation are construction of saline embankments for protection against sea water ingress, reforestation, conservation of green belt areas and participating in coastal shelterbelt plantation programme.

Community based mitigation activities relating to floods can also be taken up (for more details on community based mitigation on floods, refer the flood section for additional information).

## WEB RESOURCES:

- www.imd.ernet.in Indian Meteorological Department (IMD) provides all India weather report, end of monsoon season report, weather charts, satellite images, rainfall maps, earthquake reports and severe weather warnings. IMD provides cyclone warnings from the Area Cyclone Warning Centres (ACWCs) It has developed the necessary infrastructure to originate and disseminate the cyclone warnings at appropriate levels. It has made operational a satellite based communication system called Cyclone Warning Dissemination System for direct dissemination of cyclone warnings to the cyclone prone coastal areas.
- www.ndmindia.nic.in Natural Disaster Management India. Provides current news on Flood, Drought and Cyclones, Weather Links from NIC and weather conditions/temperatures on Indian Ocean (www.weather.nic.in).
- www.bmtpc.org/disaster.htm In order to bridge the gap between research and development and large scale application of new building material technologies, the erstwhile Ministry of Urban Development, Government of India, had established the Building Materials And Technology Promotion Council in July 1990.
- www.gsdma.org/cycpre.htm Link to Cyclone preparedness on the Gujarat State Disaster Management Authority website. The Government of Gujarat (GOG) established the Gujarat State Disaster Management Authority to co-ordinate the comprehensive earthquake recovery program.
- www.osdma.org website of Orissa State Disaster Mitigation Authority. The Government of Orissa established the Orissa State Disaster Management Authority to co-ordinate the comprehensive Orissa Super Cyclone recovery program. Visit the section 'Safety Tips' for cyclones and other hazards.
- www.tropmet.res.in The IITM functions as a national centre for basic and applied research in monsoon meteorology of the tropics in general with special reference to monsoon meteorology of India and neighborhood. Its primary functions are to promote, guide and conduct research in the field of meteorology in all its aspects.
- www.colorado.edu/hazards is an excellent site having a comprehensive coverage of disaster-related information organized in an easy to read way.
- www.wmo.ch World Meteorological Organization is an intergovernmental organization with a membership of 187 Member States and Territories. WMO is a specialized agency of the United Nations for meteorology (weather and climate), operational hydrology and related geophysical sciences.

***Multi-purpose Cyclone Shelters***

*Multi-purpose Cyclone Shelters of suitable designs have been constructed in vulnerable locations of coastal Orissa and Andhra Pradesh.*

***Multi-purpose Cyclone Shelters***

*Multipurpose Cyclone Shelter at Binchhanapalli (Ganjam). Vulnerable locations in coastal Orissa have been identified for constructing suitably designed Multi-purpose Cyclone Shelters. Local communities will be responsible for their maintenance and management*

CHAPTER 6

# FLOOD HAZARDS AND DISASTERS

**1** **2**

## FLOODS –

**is a temporary inundation of large regions as the result of an increase in reservoir, or of rivers flooding their banks because of heavy rains, high winds, cyclones, storm surge along coast, tsunami, melting snow or dam bursts.**

*In the picture:*
*1. Floods in Bihar, 2002*
*2. Assam Floods 2002*
*2,3 Flood in Assam, 2002*
*4 The air force dropped relief*

### ONSET TYPE

Floods may happen gradually and take hours, or can even happen suddenly due to breach of the structures, spillover etc. heavy downpour can cause flash floods in the region.

### WARNING

Flood forecasting and warning has become highly developed in the past two decades. With the advancement in the technology such as satellite and remote-sensing equipments flood waves can be tracked as they move downwards. Except for flash floods there is usually a reasonable warning period. Heavy precipitation will give sufficient warning of the coming river flood. High tides with high winds may indicate flooding in the coastal areas. Evacuation is possible with suitable monitoring and warning. Warning is issued by the Central Water Commission (CWC), Irrigation & Flood Control Department, and Water Resources Department. Flood forecasting activities started by CWC has about 132 Forecasting Stations to cover most of the interstate flood prone rivers besides inflow forecasts for 25 major reservoirs of the country. Over 6000 forecasts are issued by CWC every year with about 95% of the forecasts falling within the permissible range. CWC maintains close liaison with the administrative and state engineering agencies, local civil authorities to communicate advance warning for appropriate mitigation and preparedness measures.

***Flash floods*** defined as floods which occurs within six hours of the beginning of heavy rainfall, and are usually associated with cloud bursts, storms and cyclones requiring rapid localized warnings and immediate response if damage is to be mitigated. Wireless network and telephone connections are used to monitor flood conditions. In case of flash floods, warnings for timely evacuation may not always be possible.

## ELEMENTS AT RISK

Anything in the flood plains will get inundated. Buildings built of earth, weak foundations and water soluble materials will collapse endangering humans and their property. Basements of buildings are under risk. Utilities such as sewerage, water supply, communication lines, and power are put at risk. Food stock in the godowns, agricultural fields, salt pans, livestock, vehicles, machinery and equipments mounted on the ground, fishing boats are also put at risk.

## INDIAN FLOODS

Floods occur in almost all rivers basins of the country. Heavy rainfall, inadequate capacity of rivers to carry the high flood discharge, inadequate drainage to carry away the rainwater quickly to Streams/ Rivers are the main causes of floods. Ice jams or land slides blocking streams; typhoons and cyclones also cause floods. Excessive rainfall combined with inadequate carrying capacity of streams resulting in over spilling of banks is the cause for flooding in majority of cases. Rashtriya Barh Ayog (RBA) constituted by the Government of India in 1976 carried out an extensive analysis to estimate the flood-affected area in the country. RBA in its report (1980) has assessed the area liable to floods as 40 million hectares. It was determined by summing up the maximum area affected by floods in any one year in each state during the period from 1953 to 1978 for which data was analysed by the Ayog. This sum has been corrected for the area that was provided with protection at that time and for the protected area that got affected due to failure of protection works during the period under analysis to arrive at the total area liable to floods in the country as per break-up given below:

| State | Area liable to Floods (million Ha.) |
|---|---|
| 1. Andhra Pradesh | 1.39 |
| 2. Assam | 3.15 |
| 3. Bihar | 4.26 |
| 4. Gujarat | 1.39 |
| 5. Haryana | 2.35 |
| 6. Himachal Pradesh | 0.23 |
| 7. Jammu & Kashmir | 0.08 |
| 8. Karnataka | 0.02 |
| 9.Kerala | 0.87 |
| 10. Madhya Pradesh | 0.26 |
| 11. Maharashtra | 0.23 |
| 12. Manipur | 0.08 |
| 13. Meghalaya | 0.02 |
| 14. Orissa | 1.40 |
| 15. Punjab | 3.70 |
| 16. Rajasthan | 3.26 |
| 17. Tamil Nadu | 0.45 |
| 18. Tripura | 0.33 |
| 19. Uttar Pradesh | 7.336 |
| 20. West Bengal | 2.65 |
| 21. Delhi | 0.05 |
| 22. Pondichery | 0.01 |
| **Total** | **33.516** |

| Year | Flood Affected Area (Million Ha.) | Year | Flood Affected Area (Million ha.) |
|---|---|---|---|
| 1953 | 2.290 | 1954 | 7.490 |
| 1955 | 9.440 | 1956 | 9.240 |
| 1957 | 4.860 | 1958 | 6.260 |
| 1959 | 5.770 | 1960 | 7.530 |
| 1961 | 6.560 | 1962 | 6.120 |
| 1963 | 3.490 | 1964 | 4.900 |
| 1965 | 1.460 | 1966 | 4.740 |
| 1967 | 7.150 | 1968 | 7.150 |
| 1969 | 6.200 | 1970 | 8.460 |
| 1971 | 13.250 | 1972 | 4.100 |
| 1973 | 11.790 | 1974 | 6.700 |
| 1975 | 6.170 | 1976 | 11.910 |
| 1977 | 11.460 | 1978 | 17.500 (max) |
| 1979 | 3.990 | 1980 | 11.460 |
| 1981 | 6.120 | 1982 | 8.870 |
| 1983 | 9.020 | 1984 | 10.710 |
| 1985 | 8.380 | 1986 | 8.810 |
| 1987 | 8.890 | 1988 | 16.290 |
| 1989 | 8.060 | 1990 | 9.303 |
| 1991 | 6.357 | 1992 | 2.645 |
| 1993 | 11.439 | 1994 | 4.805 |
| 1995 | 5.245 | 1996 | 8.049 |
| 1997 | 4.569 | 1998* | 9.133 |
| 1999* | 3.978 | 2000* | 5.166 |
| 2001* | 3.008 | 2002* | 2.808 |
| ** Figures are tentative.* | | | |
| **The area affected by flood in the country from 1953 to 2000 is given in this table.** The annual average area affected is 7.181 million ha. | | | |

| | |
|---|---|
| Maximum flood affected area from Data for the period 1953-78 | 34 million ha. |
| Add Area protected till then (1978) | 10 million ha. |
| Deduct Area flooded due to failure of Protection works which might have Been added in the reported flooded Area | 4 million ha. |
| **Total Flood Prone Area in the Country** | 40 million ha. |

## HAZARD ZONES

The Vulnerability Atlas of India shows pictorially the areas liable to floods. The flood hazard map is based on the Flood Atlas of India brought out by the Central Water Commission, state wise marking both the areas which are liable to flooding as well as those which have been protected. The maps given in the Vulnerability Atlas of India show the district boundaries and the location of the district towns along with the rivers district wise identification of vulnerable areas will be easy.

Besides the problems of flooding in the river plains, heavy intensity rains could cause local; flooding in certain areas where the drainage is either naturally poor or the drains are choked due to various reasons such as careless dumping of refuse in the drains and lack of maintenance. Much of the flooding in the towns and cities occur due to such cases.

Under cyclonic winds in coastal areas, the sea coast of India can be flooded due to heavy down pour on the one hand and storm surge on the other. The depth of inland water inundation could be worked out by taking the storm surge heights.

*Map showing Flood Zones in India*

**Death Toll in major floods of India**

| Year | Number of people killed | Location |
|---|---|---|
| 1968 | 4,892 | (1) Rajasthan, Gujarat - (2) North-East, West Bengal, Assam |
| 1978 | 3,800 | North, Northeast |
| 1994 | 2,001 | Assam, Arunachal Pradesh, Jammu and Kashmir, Himachal, Punjab, Uttar Pradesh, Goa, Kerala, Gujarat states |
| 1961 | 2,000 | North |
| 1998 | 1,811 | Assam, Arunachal, Bihar, Kerala, Meghalaya, Punjab, Sikkim, Uttar Pradesh, West Bengal states |
| 1980 | 1,600 | Uttar Pradesh, Bihar, Gujarat, Kerala, Haryana |
| 1989 | 1,591 | Maharashtra, Andhra Pradesh, Gujarat |
| 1995 | 1,479 | Bihar, Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, West Bengal, Maharashtra |
| 1997 | 1,442 | Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Madyha Pradesh, Orissa, Punjab, Rajasthan, Sikkim, Uttar Pradesh, West Bengal states |
| 2000 | 1,290 | Gujarat, Andhra Pradesh, Assam, Arunachal Pradesh, Bihar, Himachal Pradesh, Kerala, Madhya Pradesh, Punjab, Uttar Pradesh, West Bengal |
| 1971 | 1,023 | North India |

## TYPICAL EFFECTS

*Physical damage* – structures damaged or collapsed by washing waters, landslide triggered on account of water getting saturated. Boats and fishing equipments may be lost or damaged in coastal areas.

*Road damage by floods*

*Bridge collapse in the Assam floods*

*Outbreak of encephalitis (transmitted by mosquitoes) comes with the floods*

*Casualties and pubic health* – people and livestock deaths caused by drowning, very few serious injuries. Outbreak of epidemics, diarrhea, viral infections, malaria.
*Water supplies* – contamination of water (wells, ground water, piped water supply). Clean water may be unavailable.
*Crops and food supplies* – sudden food shortage can be caused due to loss of entire harvest, spoiling of grains when saturated in water along with loss of animal fodder. The crop storage facilities and godowns may get submerged resulting in immediate food shortage. Floods may also affect the soil characteristics. The land may be rendered infertile due to erosion of top layer or may turn saline if sea water floods the area.

## POTENTIAL FOR REDUCING HAZARD

Embankments along the rivers, sea walls along the coasts may keep water away from the flood plains. Water flow can be regularized through construction of the reservoirs, check dams, alternate drainage channels/routes, increasing vegetation cover and by providing storm drains.

## MAIN MITIGATION STRATEGIES

**Mapping of the flood prone areas** is a primary step involved in reducing the risk of the region. Historical records give the indication of the flood inundation areas and the period of occurrence and the extent of the coverage. The basic map is combined with other maps and data to form a complete image of the floodplain. Warning can be issued looking into the earlier marked heights of the water levels in case of potential threat. In the coastal areas the tide levels and the land characteristics will determine the submergence areas. Flood hazard mapping will give the proper indication of water flow during floods.

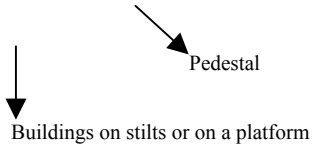
*Bihar state Flood Zone Map*

**Land use control** will reduce danger of life and property when waters inundate the floodplains and the coastal areas. The number of casualties is related to the population in the area at risk. It's better to reduce the densities in areas where neighborhoods are to be developed. In areas where people already have built their settlements, measures should be taken to relocate to better sites so as to reduce vulnerability. No major development should be permitted in the areas which are subjected to high flooding. Important facilities should be built in safe areas. In urban areas, water holding areas can be created in ponds, lakes or low-lying areas.

*Do not construct buildings in areas of turn of rivers, flood plains, or mudflows.*

**Construction of engineered structures** in the flood plains and strengthening of structures to withstand flood forces and seepage. The buildings should be constructed on a elevated area. If necessary build on stilts or platform.

**Flood Control** aims to reduce flood damage. This can be done by *Flood Reduction* by decreasing the amount of runoff by treatment like reforestation (to increase absorption could be a mitigation strategy in certain areas), protection of vegetation, clearing of debris from streams and other water holding areas, conservation of ponds and lakes etc. *Flood Diversion* include levees, embankments, dams and channel improvement. Dams can store water and can release water at a manageable rate. But failure of dams in earthquakes and operation of releasing the water can cause floods in the lower areas. *Flood Proofing* reduces the risk of damage. Measures include use of sand bags



*Construction in a flood prone area*

to keep flood water away, blocking or sealing of doors and windows of houses etc. Houses may be elevated by building on raised land. Buildings should be constructed away from water bodies.

**Flood Management** In India, systematic planning for flood management commenced with the Five Year Plans, particularly with the launching of National Programme of Flood Management in 1954. During the last 48 years, different methods of flood protection structural as well as non-structural have been adopted in different states depending upon the nature of the problem and local conditions. Structural measures include storage reservoirs, flood embankments, drainage channels, anti-erosion works, channel improvement works, detention basins etc. and non-structural measures include flood forecasting, flood plain zoning, flood proofing, disaster preparedness etc. The flood management measures undertaken so far have provided reasonable degree of protection to an area of 15.81 million hectares through out the country. The various flood management measures undertaken through the successive five year plans (upto 3/2000) are summarized below:

| | |
|---|---|
| *Flood embankments* | 33630 km |
| *Drainage channels* | 37904 km |
| *Towns protection works* | 2337 Nos. |
| *Villages raised* | 4713Nos. |

*Slum stilt houses in the outskirts of Dhaka city.*

## COMMUNITY BASED MITIGATION

Sedimentation clearance, reforestation programme, dike and flood wall construction can be taken as part of the community based mitigation programme. The community can participate in flood fighting by organizing work parties to repair embankments, pile sandbags and stockpile needed materials. Farming practices have to be flood compatible. Special varieties of seeds are available which can be harvested during the flood season. Houses constructed need to be flood resistant and multipurpose shelter should be constructed by the community. Banks of the earth can be raised and it can give shelter to the community as well as the livestock during the time of floods.

***Khash Dhalai Flood Shelter.***
*Flood shelters like this are just one example of how communities can protect themselves from the worst of the floods. Banks of earth are raised by up to 5 metres and cover an area of several kilometres. The people dig a huge pond in the middle and use this earth to raise the ground. Whenever the floods come, people can bring their livestock, possessions – even their homes – to safety. The pond in the middle becomes an important source of food, as it is used to farm fish.*

## WEB RESOURCES:

- www.cwc.nic.in website of the Central Water Commission of India, (CWC) of India.
- http://wrmin.nic.in website of the Ministry of Water Resources, GoI.
- www.imd.ernet.in Indian Meteorological Department (IMD) provides all India weather report, end of monsoon season report, weather charts, satellite images, rainfall maps, earthquake reports and severe weather warnings.
- www.ndmindia.nic.in Natural Disaster Management India. Provides current news on Flood, Drought and Cyclones, Weather Links from NIC and weather conditions/temperatures on Indian Ocean (www.weather.nic.in).

www.nih.ernet.in India National Institute of Hydrology perform tasks such as Ground water zone mapping, Flood plain mapping, land use, salinity, sedimentation, Soil erosion, water-logging etc.

***Mobile homes***
*Families build specially designed homes made of jute canes. During the floods they can be dismantled and taken to higher ground.*

CHAPTER 7

# DROUGHT HAZARDS AND DISASTERS

*1*

**DROUGHT-**
is an insidious natural hazard that 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.

*In the picture:*
*1. Drought affected communities praying God for rainfall.*
*2. Drought forces people to walk miles in search of drinking water.*
*3. Crop failure is a common phenomenon when drought strikes. Watch the scanty vegetation in the background.*

## ONSET TYPE AND WARNING

Drought is a **slow-onset** disaster and as it is difficult to demarcate the time of its onset and end. Falling rainfall levels, falling groundwater levels, drying wells, rivers and reservoirs, and poor agricultural production warn the onset of drought. According to the Indian Meteorological Department, the country is said to be drought affected when the overall **rainfall deficiency** is more than 10 per cent of the long period average and more than 20 per cent of the country area is affected by such drought conditions.

## ELEMENTS AT RISK

Drought impacts mostly rainfed crops to start with and subsequently the irrigated crops. Areas with minimum of alternative water sources to rainfall (ground and canal water supplies), areas subjected to drastic environmental degradation such as denuded forest lands and altered ecosystems, and areas where livelihoods alternative to agriculture are least developed are most vulnerable to drought. The herdsman, landless laborers, subsistence farmers, the women, children, and farm animals are the most vulnerable groups affected by the drought conditions.

| |
|---|
| Precipitation |
| Groundwater |
| Reservoirs |
| Canals |
| Soil moisture |
| Ponds/tanks |

| |
|---|
| Agriculture |
| Domestic |
| Industry |
| Natural vegetation |
| Recreation |
| Wild life |

*A simple way of finding drought vulnerability of a region is to calculate the balance between different sources and users of water.*

## TYPICAL EFFECTS

Drought, different from other natural disasters, do not cause any structural damages. The typical effects include loss of crop, dairy, timber (forest fires), and fishery production; increase in energy demand for pumping water; reduced energy production; increased unemployment, loss of biodiversity, reduced water, air, and landscape quality; groundwater depletion, food shortage, health reduction and loss of life, increased poverty, reduced quality of life, and social unrest leading to migration.

## MAIN MITIGATION STRATEGIES

**Drought monitoring** is continuous observation of rainfall situation, water availability in reservoirs, lakes, rivers and comparing with the existing water needs of various sectors of the society.

*Rooftop rainwater harvesting: Roof acts as catchment draining the water to a cistern.*

**Water supply augmentation and conservation** through rainwater harvesting in houses and farmers' fields increases the content of water available. *Water harvesting* by either allowing the runoff water from all the fields to a common point (e.g. Farm ponds, see the picture) or allowing it to infiltrate into the soil where it has fallen (*in situ*) (e.g. contour bunds, contour cultivation, raised bed planting etc) helps increase water availability for sustained agricultural production.

Expansion of **irrigation** facilities reduces the drought vulnerability. **Land use** based on its capability helps in optimum use of land and water and can avoid the undue demand created due to their misuse.

*Farm ponds collected the rainwater and helped in escaping the drought impacts in Karnool District of Andhra Pradesh.*

**Livelihood planning** identifies those livelihoods which are least affected by the drought. Some of such livelihoods include increased off-farm employment opportunities, collection of non-timber forest produce from the community forests, raising goats, and carpentry etc.

**Drought planning**

The basic goal of drought planning is to improve the effectiveness of preparedness and response efforts by enhancing monitoring, mitigation and response measures. Planning would help in effective coordination among state and national agencies in dealing with the drought. Components of drought plan include establishing drought taskforce which is a team of specialists who can advise the government in taking decision to deal with drought situation, establishing coordination mechanism among various agencies which deal with the droughts, providing crop insurance schemes to the farmers to cope with the drought related crop losses, and public awareness generation.

**Public awareness and education**

Educating the masses on various strategies you learned above would help in effective drought mitigation. This includes organizing drought information meetings for the public and media, implementing water conservation awareness programs in the mass media like television, publishing and distributing pamphlets on water conservation techniques and agricultural drought management strategies like crop contingency plans and rainwater harvesting and establishing drought information centers for easy access to the farmers.

A watershed showing collection of water to common point. *ImageSource: http://www.4j.lane.edu*

**Watersheds: For water supply augmentation & conservation**

Watersheds are the geographic areas where the water flows to a common point. To mitigate the drought impact, all kinds of soil and water conservation measures are taken up with the involvement of the local communities. This approach helped these areas to manage efficiently the soil, vegetation, water and other resources. By conserving scarce water sources and improving the management of soil and vegetation, watersheds have the potential to create conditions conducive to higher agricultural productivity while conserving natural resources.

**Checkdams (Bhanadaras)**

These are check dams or diversion weirs built across rivers. A traditional system found in Maharashtra, their presence raises the water level of the rivers so that it begins to flow into channels. They are also used to impound water and form a large reservoir. Where a bandhara was built across a small stream, the water supply would usually last for a few months after the rains.

*Source: http://www.rainwaterharvesting.org*

**What a mitigation approach can do? A success story**

*Ralegan, before drought mitigation efforts* *Ralegan, after drought mitigation efforts*

The people of Ralegan Siddhi in Maharashtra transformed the dire straits to prosperity. Twenty years ago the village showed all traits of abject poverty. It practically had no trees, the topsoil had blown off, there was no agriculture and people were jobless. Anna Hazare, one of the India's most noted social activists, started his movement concentrating on trapping every drop of rain, which is basically a *drought mitigation* practice.

So the villagers built check dams and tanks. To conserve soil they planted trees. The result: from 80 acres of irrigated area two decades ago, Ralegan Siddhi has a massive area of 1300 acres under irrigation. The migration for jobs has stopped and the per capita income has increased ten times from Rs.225 to 2250 in this span of time.

The entire effort was only people's enterprise and involved no funds or support from the Government.

Drought affected villagers working on the construction of a 'check dam' as part of a government cash for work programme. The dam is constructed in a dry river bed and is intended to collect the monsoon rains and replenish the water table.

A government relief site in Kutch, western Gujarat. Drought hit villagers are employed as daily laborers constructing water catchment which are a series of interconnecting grids which capture rainwater preventing the run off of the monsoon rains.

**WEB RESOURCES:**

http://dmc.kar.nic.in/default.htm; www. watershedindia.net; www.rainwaterharvesting.org; www.drought.unl. edu;

CHAPTER 8

# FOREST FIRE HAZARDS AND DISASTERS

**FOREST FIRE –**
**Forest Fire/Wild Fire is one of the destructive natural forces known to mankind. While sometimes caused by lightning, nine out of ten wildfires are human-caused. "Wild Fire" is the term applied to any unwanted and unplanned fire burning in forest, shrub or grass.**

*(Left) A forest fire in the Badai forest area near Shimla.*
*(Right) June 5 2003 - A forest fire rages near the village of Dwarahat in Uttaranchal State.*

## INTRODUCTION

As per the latest state of forests report of the Forest Survey of India, the actual forest cover of India is 19.27% of the geographic area, corresponding to 63.3 million ha. Only 38 million ha of forests are well stocked (crown density above 40%). This resource has to meet the demand of a population of 950 million people and around 450 million cattle. As such, country has to meet the needs of 16% of the world's population from 1% of the world forest resources. The same forest has also to cater for 19% of the world cattle population. The forests of the country are therefore, under tremendous pressure.

Forest fires are a major cause of degradation of India's forests. About 90% of the forest fires in India are created by humans. The normal fire season in India is from the month of February to mid June. India witnessed the most severe forest fires in the recent time during the summer of 1995 in the hills of Uttaranchal & Himachal Pradesh. The fires were very severe and attracted the attention of whole nation. An area of 677,700 ha was affected by fires.

## WILDFIRE STATISTICS

In India there are no comprehensive data to indicate the loss to forests in terms of area burned, values, and volume and regeneration damaged by fire. The available forest fire statistics are not reliable because they under estimate fire numbers and area burned. The reason behind this is attributed to the fear of accountability. However, Forest Survey of India in a country-wide study in 1995 estimated that about 1.45 million hectares of forest are affected by fire annually. According to an assessment of the Forest Protection Division of the Ministry of Environment and Forests, Government of India, 3.73 million hectares of forests are affected by fires, annually in India.

*Estimate (in %) of Forest Survey of India of the extent of forest fire incidences in India*

The Forest Survey of India, data on forest fire attribute around 50% of the forest areas as fire prone. This does not mean that country's 50% area is affected by fires annually. Very heavy, heavy and frequent forest fire damages are noticed only over 0.8%, 0.14% and 5.16% of the forest areas respectively.Thus, only 6.17% of the forests are prone to severe fire damage. In the absolute term, out of the 63 million ha. of forests, an area of around 3.73 million ha can be presumed to be affected by fires annually.

In India there are very few cases of fire due to natural causes. The majority of the forest fires (99 percent) in the country are human caused. It is widely acknowledged that most of these fires are caused by the people deliberately and have a close relationship to their socio-economic conditions. Grazing, shifting cultivation, and collection of minor forest products by villagers are major causes of fires in India. Carelessness of the picnickers, travellers, and campers are also responsible for forest fires.

## FOREST FIRE DAMAGES IN INDIA

*A large fraction of rural people in India are living in forest lands or are dependent on forest use.*

Forest fires are a major cause of degradation of India's forests. While statistical data on fire loss are weak, it is estimated that the proportion of forest areas prone to forest fires annually ranges from 33% in some states to over 90% in others. Forest Fires cause wide ranging adverse ecological, economic and social impacts. In a nutshell, fires cause:

- Loss of valuable timber resources and depletion of carbon sinks
- Degradation of water catchment areas resulting in loss of water
- Loss of biodiversity and extinction of plants and animals
- Loss of wild life habitat and depletion of wild life
- Loss of natural regeneration and reduction in forest cover and production

*Forest grazing is an important source of income. Burning of forest understorey at the peak of the dry season helps to stimulate grass growth before the monsoon rains break.*

- Global warming resulting in rising temperature
- Loss of carbon sink resource and increase in percentage of $CO_2$ in the atmosphere
- Change in micro climate of the area making it unhealthy living conditions
- Soil erosion affecting productivity of soils and production
- Ozone layer depletion
- Health problems leading to diseases
- Indirect affect on agricultural production: Loss of livelihood for the tribals as approximately 65 million people are classified as tribals who directly depend upon collection of non-timber forest products from the forest areas for their livelihood.

Various regions of the country have different normal and peak fire seasons, which normally vary from January to June. In the plains of northern and central India, most of the forest fires occur between February and June. In the hills of northern India fire season starts later and most of the fires are reported between April and June. In the southern part of the country, fire season extends from January to May. In the Himalayan region, fires are common in May & June.

*Frequent surface fire, cattle grazing and trampling impacts characterize the mountain forests in the Himalayan foothills and mountains of Northern India. This site in Uttar Pradesh has been repeatedly burned and is subjected to severe erosion damage. The old generation of pine trees (Pinus roxburghii) is fire tolerant but is lacking regeneration and a higher mixed proportion of fire-susceptible broadleaved trees, e.g. oaks (Quercus spp.). In the long run the multiple stresses by fire, cattle, and fuelwood cutting will lead to the complete destruction of these forests.*

## OPERATIONAL FIRE MANAGEMENT SYSTEMS AND ORGANIZATIONS

According to the Constitution of India, the central and state governments in the country are enabled to legislate on forestry issues. The implementation part of the forest policy/programmes lies with the state government. Thus, fire prevention, detection, and suppression activities are the responsibility of the state governments' forestry departments. The policy, planning, and financing are the primary responsibility of the Central Government. There is generally no separate department for carrying out forest fire management in the states. The regular staff of the forest departments in the states carries out various activities of forest fire management. During forest fire seasons in some of the divisions, fire watchers are recruited by the state governments as a special provision. At the central level, the Ministry of Environment and Forests is the ministry responsible for forest conservation and protection. Forest fire management is administered by the "Forest Protection Division" of the Ministry, which is headed by a Deputy Inspector General of Forests. The Ministry is implementing a plan called "Modern Forest Fire Control Methods" in India under which state governments are provided financial assistance for fire prevention and control. This assistance is being used by the state governments for procuring hand tools, fire resistant clothes, firefighting tools, radios, fire watch towers, fire finders, creation of fire lines, research, training, and publicity on firefighting.

*Modern forest fire control in India involves the use of adapted technologies, including fire-proof safety clothing.*

## COMMUNITY INVOLVEMENT

In India, Joint Forest Management (JFM) Committees have been established at the village level to involve people in forest protection and conservation. At present there are 36,165 JFM committees throughout the country, covering an area of more than 10.24 million hectares. These JFM committees also have been given responsibilities to protect the forests from fires. For this purpose, the Modern

Forest Fire Control plan is being revised and JFM is being made an integral component of the forest fire prevention strategy. Use of aircraft and helicopters has not been very cost effective in the fire management program and the Air Operation Wing is being closed down. For emergency purposes, however, a provision for hiring aircraft for transportation of crews and water is being maintained. The Government of India has issued national forest fire prevention and control guidelines. Salient features of the guidelines include identification of vulnerable areas on maps, creation of a data bank on forest fires, evolving fire dangers, fire forecasting system, provisions for a crisis management group, involvement of JFM committees, and efficient enforcement of legal provisions.

## PUBLIC POLICIES CONCERNING FIRE

*India's National Forest Policy (1988)* presents a visionary strategy for forest conservation and management and emphasizes protection of forests against encroachment, fire, and grazing. It states that "The incidence of forest fires in the country is high. Standing trees and fodder are destroyed on a large scale and natural regeneration annihilated by such fires. Special precautions should be taken during the fire season. Improved and modern management practices should be adopted to deal with forest fire". This policy provides a positive step towards protection of forests from fire. The legal and policy framework exists in support of fire protection in the country.

## ROLE OF EDUCATION

*Nature camp participants. Nagarahole Conservation Education Project, an education project of WCS, India Program*

A lack of understanding of the value of the wildlife reserves among most local people and their consequent hostility towards reserve protection enforcement are identified as a major problem to be addressed at most wildlife reserves in India. Arson by local people is a frequent form of backlash against law enforcement by park staff in national parks and wildlife sanctuaries in our country. Such hostility makes law enforcement difficult and often renders the reserve staff ineffective. Therefore, educating local people through outreach activities is very important

*Young minds participate in an anti forest fire campaign. Nagarahole Wildlife Conservation Education Project (NAWICOED) is an education project undertaken at Nagarahole supported by WCS, India Program. Started in 1994 NAWICOED is a community project with the explicit goal of supporting stronger law enforcement in Nagarahole.*

## THE NEEDS OF THE FIRE MANAGEMENT

The incidence of forest fires in the country is on the increase and more area is burned each year. The major cause of this failure is the piecemeal approach to the problem. Both the national focus and law

*Public education and information on forest fire in India.*

and the technical resources required for sustaining a systematic forest fire management programme are lacking in the country. Important forest fire management elements like strategic fire centres, coordination among Ministries, funding, human resource development, fire research, fire detection system by using satellite images, fire management, and extension programmes are missing. Taking into consideration the serious nature of the problem, it is necessary to make some major improvements in the forest fire management strategy for the country.

The Ministry of Environment and Forests (MOEF), Government of India, has prepared a National Master Plan for Forest Fire Control. This plan proposes to introduce a well-coordinated and integrated fire-management programme that includes the following components:

- Prevention of human-caused fires through education and environmental modification. It will include silvicultural activities, engineering works, people participation, and education and enforcement. It is proposed that more emphasis be given to people participation through Joint Forest Fire Management for fire prevention.
- Prompt detection of fires through a well coordinated network of observation points, efficient ground patrolling, and communication networks. Remote sensing technology is to be given due importance in fire detection. For successful fire management and administration, a National Fire Danger Rating System (NFDRS) and Fire Forecasting System are to be developed in the country.
- Fast initial attack measures.
- Vigorous follow up action.
- Introducing a forest fuel modification system at strategic points.
- Firefighting resources.

Each of the above components plays an important role in the success of the entire system of fire management. Special emphasis is to be given to research, training, and development.

*Source: 1. Fire Situation in India (IFFN No. 26 - January 2002, p. 23-27) contribution submitted by: Vinod K. Bahuguna, Ministry of Environment and Forests and Satendra Singh, Ministry of Rural Development.*
*2. Forest Fire Prevention and Control Strategies in India (IFFN No. 20 - March 1999,p. 5-9) by: Vinod K. Bahuguna, Deputy Inspector General of Forests, Ministry of Environment and Forests, New Delhi.*
*3.* Wildlife Conservation Society (WCS), India Program. (*Source: http://www.wcsindia.org/index.htm)*
*4. Forest fires in India: policy initiatives for community participation [International Forestry Review **4**(2), 2002], by V.K. BAHUGUNA Inspector General of Forest & A. Upadhyay Assistant Inspector General of Forests, MoEF, New Delhi*

## WEB RESOURCES:

http://www.envfor.nic.in/ website of Ministry of Environment and Forests.
http://www.teriin.org/jfm/jfm.htm website of - The Energy and Resources Institute. (Documentation of the JFM programme, Tamil Nadu).
http://www.iifm.org/databank/index.html Forest Information Service - a comprehensive Internet information bank on forest and related resources in India and around the world, prepared by Indian Institute of Forest Management, Bhopal.

*A large fraction of India's deciduous and semi-deciduous forests is characterized by open and frequently burned stands. To reduce water stress the deciduous trees shed their leaves during the dry season. These fuels, together with the grass layer, allow the development of low- and medium-intensity surface fires almost every year. Many open forests are even affected by fire twice or three times per year.*

*Medium-intensity surface fire in an open Southern Tropical Dry Deciduous forest near Chandrapur, Maharashtra.*

CHAPTER 9

# CHEMICAL AND INDUSTRIAL ACCIDENTS

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

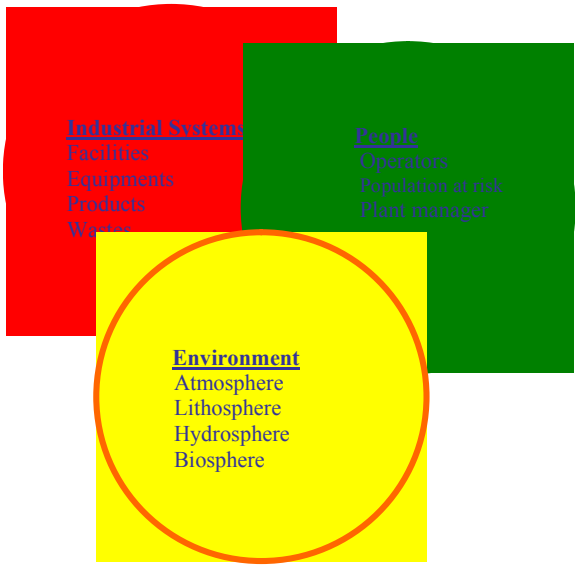
- *The fire spreading in the industry and the residential areas nearby*
- *Heat conditions*
- *Chemical gas leak (poisonous)*
- *Combustion of various products and heat waves*
- *Low oxygen levels*
- *Falling of structural elements and machinery*
- *Contamination of the nearby environment (land, water and air)*

*In the picture: (Left) The killer MIC plant, (Right Top) Ruins of the Union Carbide Pesticide Factory – Toxic Gas Release, (Right bottom) Slogans on factory wall.*

*Bhopal Chemical Gas leak Disaster (2-3 December 1984) one of the worst industrial disasters of all time occurred in Bhopal. The tragedy was a technological accident in which 45Tonnes of highly poisonous methyl isocyanate (MIC) gas along with Hydrogen Cyanide and other reaction products leaked out of the pesticide factory of Union Carbide into the night air of Bhopal at around 12.30 a.m. The official death toll reached 3,598 in 1989. Thousands, who survived, however, face a fate worse than death.*

## ONSET TYPE and WARNING

Onset in case of industrial disaster can be either rapid (minutes or hours) or sudden (no warning) depending on the nature of occurrence. As there is a series of processes and reactions involved the onset may vary accordingly. Release of chemicals may be because of human error, technological failure or natural activities which include geological activity like earthquakes, natural fires, floods etc. The industrial facility should have monitoring and warning systems for fire and building up of dangerous conditions. Explosion in some of the cases can be anticipated.




**Components of Industrial Hazard**

## ELEMENTS AT RISK

The industrial set up and its near environment is under immediate threat. Employees of the work place, residents of nearby settlements, livestock, and crops in the nearby vicinity are at risk. The environment which includes land, water and air will get polluted. Hazardous substance released into the air or water can travel long distances and

cause contamination of air, water supply and land, making it uninhabitable for humans. Large scale disasters will threaten the ecological system.

## TYPICAL EFFECTS

*Physical Damage* – Damage to structures and infrastructure. In case of explosion, fire, or release of toxins in the air the geographical spread can be high.

*Casualties* – Many people may be killed, injured and would require immediate treatment. The routes of exposure in chemical accidents are inhalation, eye exposure, skin contact and ingestion. Health effects are described in terms of the system or organ getting affected and may include cancer, heart failure, brain damage, disfunction of immune system, deformation, genetic disorders, congenital (present since birth) disorders etc. Fire can spread to a large area and may cause deaths by burns and asphyxiation.

*Environmental* – Contamination of air, water, land, and standing crops may occur. Particular areas may become uninhabitable due to the damage caused to the environment.

*23 Dec 2003, **Gas Well Blowout** in Gao Qiao, Chongqing, China. 243 people died, 9,000 were injured, and 64,000 were evacuated. Many of the confirmed dead were children or elderly people who were unable to flee after the explosion. Those who did not escape in time suffered burns to their eyes, skin and lungs from the gas. (Source: www.uneptie.org)*

## POSSIBLE RISK REDUCTION MEASURES

***Hazard Mapping*** – inventories and maps of storage locations of toxins or hazardous substances along with the possible characteristics should be displayed and known to all. The community staying in the immediate vicinity should be aware of 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 an accident occurs. Hazard map should determine possible zone getting affected and safe route for evacuation should be marked.

***Land use planning*** – densely populated residential areas should be separated far away from industrial areas. A buffer zone (green belt) should separate the industrial and the residential zone.

***Community preparedness*** – The community should be aware of the hazardous installations and know how to combat the situation. The local community has to be informed about the response steps to be taken in case of an accident. Community members should monitor the pollution levels of the industry and participate in mock drills.

Bhopal, showing the area affected by the leakage of toxic gas. *(Source:www.unu.edu/unupress/unupbooks/uu21le/uu21le07.jpg)*

***Other possible risk reduction measures***: Maintain the wind flow diagram of the region, improve fire resistance and warning systems, improve fire fighting and pollution dispersion capabilities, develop emergency relief and evacuation planning for employees and nearby settlements, limit storage capacity of the toxic substances, insurance for industries and safety legislation

## WEB RESOURCES

http://sdnp.delhi.nic.in Sustainable Development Networking Programme India support decision-makers and key stakeholders from all sectors of civil society on issues related to sustainable human development

www.lpaindia.org Loss Prevention Association of India Ltd. (LPA) is engaged in promoting safety and loss control through education, training and consultancy.

CHAPTER 10

# OTHER TYPES OF HAZARDS AND DISASTERS

## E P I D E M I C S

**AN EPIDEMIC–**

**is defined as the occurrence of an illness or other health-related event that is clearly in excess of unexpected occurrence**

*In the picture: Top (Left) - Bubonic plague spread by fleas on rat. Top (Right) - Male Xenopsylla cheopis (oriental rat flea) engorged with blood. This flea is the primary vector of plague in most large plague epidemics in Asia, Africa, and South America. Both male and female fleas can transmit the infection. Bottom (Left) - Pneumonic plague sufferers in our country. Bottom (Right) - Plague outbreak in India reported in Newsweek, 1996.*
*The Surat plague outbreak killed 56 people nationwide. This outbreak served as a chilling reminder of how rapid urbanization and deterioration of the urban environment can bring people into contact with forgotten disease vectors.*

### ONSET TYPE and WARNING

The onset of an epidemic can be either rapid or sudden and this depends on several factors. An epidemic can be anticipated by the rise in number of people suffering from a particular disease. In some cases an epidemic can be anticipated or predicted by an increase in the vector breading sites or in the death of the disease carriers (say plague is carried by the flea on rodents).

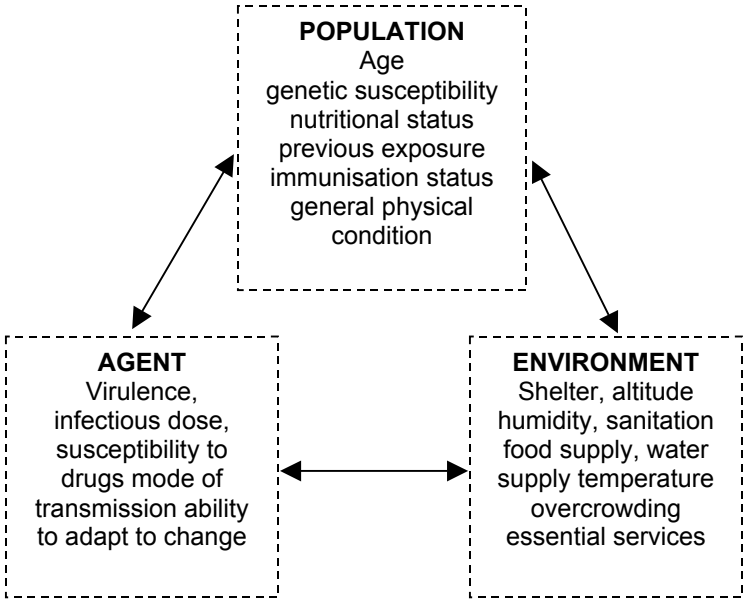
### BASIC PRINCIPLES

A disease **epidemic** or **outbreak** is the occurrence of cases of a particular disease in excess of the expected, therefore, demanding that emergency control measures be implemented.
The threat of communicable disease outbreaks *is* greater after a disaster than in non-emergency situations, particularly when large populations have been displaced. However, an epidemic or outbreak will only occur if the equilibrium between the population's susceptibility (host or reservoir), the virulence of

the infectious agent (bacteria, viruses, parasites, or fungi or their products) and the environment that promotes the exposure (refer to the figure below) is upset.

## CAUSES

The main cause for an epidemic is the pathogen (virus, bacteria, protozoa or rarely fungi). Reports of outbreaks of communicable diseases are increasing in number and reported in many of the national dailies. This is because of a number of reasons. For instance poor sanitary conditions may contaminate food and water and also suffice the environment for breeding conditions for the vector. Other factors include the seasonal changes that favour the breeding of an insect vector such as mosquito in the rainy season, exposure of non-immune persons say tourists and migrants, poverty, overcrowding etc. Poverty is one of the major factor contributing to the vulnerability. Impact of natural disasters on the environment also leads to outbreak of epidemic. Part of the increase in the number of outbreaks is due to exposure of unreported cases of diseases as a result of better reporting and increased coverage of health services.




*Equilibrium between the Population, Infectious Agent, and the Environment*

## ELEMENTS AT RISK

Population or a particular community is under risk. It can be localized or pandemic (spread across countries).

## TYPICAL EFFECTS

Epidemics cause illness and death. There are other secondary effects such as disruption in the society and economic losses. Vulnerability is high among those are poorly nourished, people living in unhygienic sanitary conditions, poor water supply, individuals who do not have an access to the health services or those who have weak immune systems. The outbreak of an epidemic in situations where already a natural calamity has struck will cause life threatening situations.

## POTENTIAL RISK REDUCTION MEASURES

**Structuring the health services** is important to have clear understanding of roles and responsibilities of the public health system. Organizational preparedness and the coordination mechanism is required right from the State and District to the sub center level which is manned by the Village Health Nurses or the Health Workers.

**Contingency Plan** for response should be prepared after identifying the epidemics that are likely to occur in the region. Early warning system through a surveillance system is the primary requirement so as to have an effective response and prevent any outbreaks. For this, surveillance need to be carried out at a regular basis through the routine surveillance system by involving the health tier system. Maps of all the health facilities in the region with an inventory of drugs and vaccines, laboratory set ups, list of number of doctors and supporting staff etc. need to be kept ready and updated at regular intervals.

**Training** need to be given to so as to build the capacity at all levels. Training will help to cope better during the emergency response period for epidemics.

**Personnel protection** through vaccination is an effective mitigation strategy and will protect the persons at risk.

Common sources of infection carriers can be tackled by many measures. Strategies included are improving the sanitary conditions, drive to check and fumigate breeding places of any vector (source of infection), improving disposal methods of waste, disinfecting the water source etc.

## WEB RESOURCES

http://mohfw.nic.in; http://icmr.nic.in/wel.htm; http://indmed.nic.in/; www.who.int/en/; www.cdc.gov

# H E A T  W A V E S

## A HEATWAVE–

**is a complex phenomenon resulting from a certain combination of temperature, huimidity, air movement and duration. Simply stated, a heatwave is an extended period of very high summer temperatures with the potential to adversely affect communities.**

*Heatwave claims several lives at different locations across the country. News report as on Oct 2004 put across fierce heat wave that left at least 622 dead over the past week as unseasonably dry winds push temperatures to sweltering levels in southern India. The deadly conditions, causing temperatures to soar as high as 46 degrees Celsius and above, have affected mainly the most vulnerable populations: the poor, elderly and outdoor workers, such at street vendors and farmers. Nearly 100 others have suffered heat-related deaths in the northern states of Punjab, Haryana and Orissa.*

## HEATWAVE DANGERS AND EFFECTS

**Human Effects:** in many parts of the country and the world, every summer thousands of people suffer from heat stress when the bodies absorb more heat than they can dispel. Unless prompt preventive/treatment is received, they suffer the serious or even fatal consequences of heat stroke. Regardless of these statistics, heat wave is probably the most under-rated of all natural hazards. The level of discomfort experienced in warm, moist tropical and sub-tropical conditions is determined by a range of climatic variables, principally air temperature, humidity and wind; as well as cultural variables including clothing, occupation and accommodation; and physiological variables such as health, fitness, age and the level of becoming accustomed. The main factor involved in the degree to which we feel uncomfortable in such conditions is not so much because we feel hot, but rather we sense how difficult it has become for us to lose body heat at the rate necessary to keep our inner body temperature close to $37^{o}$ C.

The body responds to this stress progressively through three stages:

• *heat cramps* – muscular pains and spasms caused by heavy exertion. Although heat cramps are the least severe stage they are an early signal that the body is having trouble with the heat;

• *heat exhaustion* – typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases causing a decrease of flow to vital organs. This results in mild shock with the symptoms of cold, clammy and pale skin together with fainting and vomiting. If not treated the victim may suffer heat stroke;

• *heat stroke* – is life threatening. The victims temperature control system, which produces sweating to cool the body, stops working. The body temperature may exceed $40.6^{O}$ C potentially causing brain damage and death if the body is not cooled quickly. *(Source: American Red Cross Website)*

**Agriculture:** animals suffer the same way as humans do., particularly when left without shade and adequate water. During heatwaves, especially in times of drought, livestock losses can be very high.

Plants, crops and vegetables are also subject to the effects of the heat. The damage to the standing crops is a common feature during such events.

**Infrastructure:** it is observed that during heatwaves railway lines can expand to the point where they buckle and cause derailments of trains. Road damage can also occur, where bitumen melting and concrete expanding and cracking occur. This may lead to disruption of traffic.
**Utilities and services:** Water and electricity consumption services increase rapidly during severe heat conditions, often causing shortages. This causes extra demands on electricity and water supplies.

## FORECASTING AND WARNINGS

The National Centre for Medium Range Weather Forecasting (NCMRWF) of Department of Science of Technology is the premier institution in India to provide Medium Range Weather Forecasts through deterministic methods and to render Agro Advisory Services (AAS) to the farmers. Advice will be included in the weather forecasts advising of the dangers of heat stress.

Agricultural Meteorology Division, India Meteorological Department(IMD), Pune looks into minimizing the impact of adverse weather on crops and to make use of crop-weather relationships to boost agricultural production. The Agricultural Meteorology Division was established at Pune in 1932 and from its inception the Division supports and participates in multi-disciplinary activities in this field. It is also the centre for research programmes in agricultural meteorology and has field units in various parts of the country. Besides, forecasts and advisories for farmers are issued by IMD's Forecasting Offices located at different State capitals.

## COMMUNITY AWARENESS

There appears to be a significant lack of community awareness of the risks associated with heat wave, even though several parts of the country experience such events with some regularity. It is a widely overlooked, even unknown, killer. It is ideal to create awareness among the communities and ask them to take suitable precautionary steps during the peak summer months. Media and Community education can be launched prior to the onset of the heatwave conditions.

## WEB RESOURCES

http://imdagrimet.org/ Website of Agricultural Meteorology Division, IMD, Pune
http://www.ncmrwf.gov.in/ Website of National Centre for Medium Range Weather Forecasting
http://www.imd.ernet.in/ website of India Meteorological Department

# U R B A N S T R U C T U R E F I R E S

Fires are very dangerous. It is an event of something burning and is often destructive taking up toll of life and property. It is observed that more people die in *fires* than in cyclones, earthquakes, floods and all other natural disasters combined.
The most common human-caused hazard is fire in large occupied buildings and in slums built of combustible materials. Causes can be accidental or deliberate, but unless structures are built to safe fire standards as mentioned in the National Building Code, and sound emergency procedures are used, heavy loss of life can result.

There are numerous causes of Fire. It could be
1. *Heating sources* are often causes of Fire. Space heaters, electric heaters

and fireplaces should be used with caution.
2. *Cooking accidents* are a major cause of home fires and cause us a lot of concern. Fires can result due to unattended cooking or due to mechanical failure of the stove or any cooking equipment.
3. *Electrical wiring* can cause a fire if it is not large enough to carry the load being supplied. Overheating of electrical appliances, poor wiring connections, use of unauthorized appliances, multi-point adaptors can result in fires starting.
4. *Rubbish and Waste Materials* that are left to accumulate can easily contribute to the spread of fire; they are also a place for malicious fires to be started. Make sure that you remove all waste materials from the workplace on a regular basis and place them in a suitable container located in a safe position outside the building premises. Do not burn rubbish on bonfire, even if it is thought safe to do so. They can easily get out of control and spread fire to nearby buildings or structures.
5. *Combustible Materials* such as packing materials, glues, solvents, flammable liquids or gases stored in work place can be extremely dangerous. It is recommended to store materials both in terms of required quantity and in a secure area outside the premises.
6. *Hazardous Materials* such as paints, solvents, adhesive, chemicals or gas cylinders should be kept in separate storage areas and well away from any sources of ignition.
7. *Arson and Deliberate Fire Setting* is also a cause.
8. *Smoking* is also a major cause of fire.

## WEB RESOURCES

www.ifeindia.org; www.fire-wind.net;

# T R A N S P O R T  A C C I D E N T S

Road network is laid for better connectivity and service but at the same time the number of accidents is also on the rise. The main causes are the violation of traffic regulations, speeding, drunk driving and poor maintenance of the vehicle and the roads. All these reasons add to the rising number of accidents and road fatalities.
India has one of the highest accident rates in the world. Every year more than 300.000 accidents are reported. Fatality rate is as high as 60,000. Studies on accidents, the world over, have shown that the human factor is responsible for a majority of accidents.

In India, vehicle users are the causative factor, in 70% of the road accidents. Pedestrians are responsible for 4.1% of the road accidents and poor condition of the roads accounts for about 0.4% of the accidents. It is evident, that nearly 80% of the accidents occur due to bad driving habits and human error.

Many factors govern the safety of passenger in an aircraft. It include technical problems, fire, landing and take off conditions, the environment an airline operates in (mountainous terrain or frequent storms), factors like airport security in cases of hijackings, bombing attempts etc.

*Source: wwcw.the-week.com*

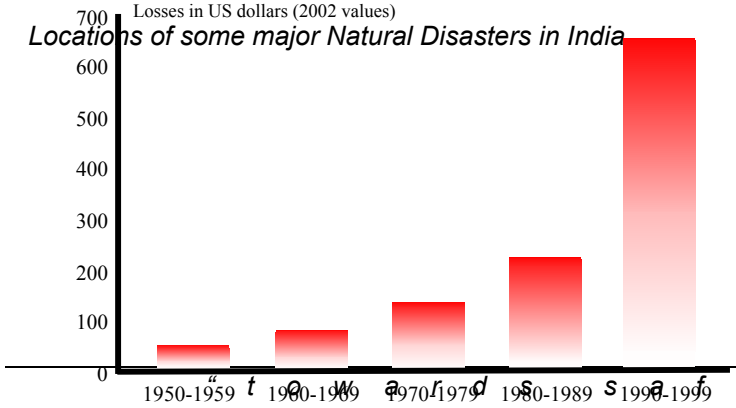
The most common types of rail accident are derailment due to lack of maintenance, aging infrastructure, collateral hazards (ground shaking during an earthquake, rock fall on tracks after a landslide etc causing damage to railway tracks) human error or sabotage. Various type of dangerous cargo are also transported such as fuel oil products, etc.
*In the picture*, bogies of the derailed Bangalore Express lying on the tracks near Pendakal station, 250 km south of Hyderabad, on Dec 21 2002. 20 persons were killed and 80 injured, 24 of them seriously.

CHAPTER 11

# EFFECTS OF NATURAL HAZARD ON ECONOMY & DEVELOPMENT

Earthquake, Gujarat
26 Jan 2001, 13805
lives lost

Tsunami, 26 Dec 2004,
more than 10000 lives lost




*Locations of some major Natural Disasters in India*

**Source: Munich Re**

*Economic Losses due to Natural Disasters from 1950 -2000*

While no country in the world is entirely safe, lack of capacity to limit the impact of hazards remains a major burden for developing countries. An estimated 97% of natural disaster related deaths each year occur in developing countries and, although smaller in absolute figures, the percentage of economic loss in relation to the Gross National Product (GNP) in developing countries far exceeds the ones in developed countries.

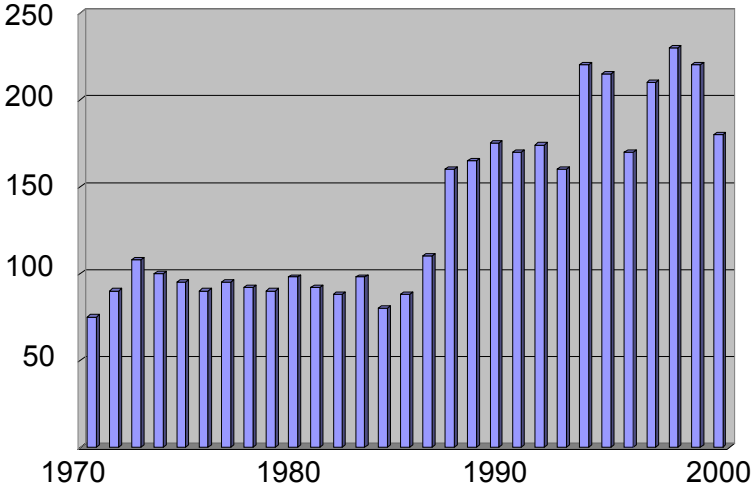
Natural disasters are a potentially serious shock to an economy. The United Nations estimated the total cost of disasters worldwide during the 1980s at $120 billion (in constant (1990) US dollars). Moreover, there is clear evidence of a rising trend, with total costs increasing from $70 billion in the 1970s and $40 billion in the 1960s.
These figures are typically based on only the direct, visible, financial impacts of a disaster such as damage to homes, hospitals, schools, factories, infrastructure and crops.

The true costs of disasters, taking into account less quantifiable effects such as the loss of personal belongings or jobs, widening trade or government budget deficits, or the increasing scale & depth of poverty, are even higher.

## VULNERABILITY

Vulnerability to disasters is a function of human action and behavior. It describes

the degree to which a socio-economic system or physical assets are either susceptible or resilient to the impact of natural hazards. It is determined by a combination of several factors, including awareness of hazards, the condition of human settlements and infrastructure, public policy & administration, the wealth of a given society and organized abilities in all fields of disaster and risk management.



*Source: Hazard, Risk and Disaster – Bill McGuire*

*Natural disaster trends worldwide:1971 - 2000*

Lack of awareness among the public and decision-makers about factors and human activities that contribute to environmental degradation and disaster vulnerability are aggravating these trends.

There is a close correlation between the trends of increased demographic pressure especially in developing countries, and particularly in least developed countries, escalated environmental degradation, increased human vulnerability and the intensity of the impact of hazards. For example, river and lake floods are aggravated or even caused by deforestation, which causes erosion and clogs rivers, siltation of riverbeds and other factors. Poverty and hazard vulnerability is integrally linked and mutually reinforcing.

The accelerated, and often uncontrolled, growth of cities has contributed to the ecological transformation of their immediate surroundings (pressure on scarce land, deforestation, etc.) In addition, the lack of appropriate drainage systems and/or sealing (use of concrete and asphalt) increase the volume and speed of rainfall runoff thus making many cities more vulnerable to flash floods.

Recent catastrophic earthquakes highlight other key deficiencies and trends in the approach to disaster risk reduction, such as a poor understanding by decision makers of seismic related risk, as well as the tendency of some builders, to use the cheapest designs and construction materials to increase short-term economic returns on their investment.

## ECONOMIC VULNERABILITY

The degree of severity and nature of impact of a disaster depend on a range of factors. These include the type of hazard, the size of the economy and its economic structure, and the sectors affected by the disaster.

Looking at hazard types, we see that droughts do not damage buildings or physical structures but their lengthy duration creates other problems: for example, agricultural households may be forced into considerable debt following the loss of crops & livestock.

In contrast, sudden-onset disasters such as floods or earthquakes have a direct impact on infrastructure and productive facilities and resources, as well as on social resources and infrastructure, especially housing.

The economic costs of disasters can be broken down into three types.

**Direct costs**

- relate to the capital cost of assets (such as buildings, other physical infrastructure, raw materials and the like) destroyed or damaged in a disaster. Crop losses are often included in such calculations.

**Indirect costs**

- refer to the damage to the flow of goods and services. They include, for example, lower output from factories that have been destroyed or damaged; loss of sales income due to damaged infrastructure such as roads and ports; and the costs associated with having to purchase more expensive materials or other inputs where normal - cheaper - sources of supply are affected. They also include the costs of medical expenses and lost productivity arising from increased disease, injury and death.

**Secondary effects**

- concern the short- and long-term impacts of a disaster on overall economic performance. These may include deterioration in external trade and government budget balances, the reallocation of planned government spending and increased indebtedness. Disasters can also affect the pattern of income distribution or the scale and incidence of poverty.

Some sectors of the economy are more vulnerable to hazards than others. Most obviously, the agricultural sector is potentially vulnerable, implying that countries which rely heavily on agriculture may be particularly threatened by hazards. However, even here, the types of crops cultivated and techniques for growing them play a role in determining the scale of vulnerability. As the Philippines has learnt to its expense, new hybrid varieties of coconut trees, while giving high yields, are much more vulnerable to typhoons than traditional varieties which have longer root systems and so are better able to withstand very strong winds.

## DEVELOPED & DEVELOPING COUNTRIES

As one moves along the spectrum from developing to highly developed economies, the nature of a disaster's impact alters. The absolute cost of physical damage increases, but its relative cost (as a proportion of national or local wealth) decreases; and the number of lives lost also declines. The rise in the cost of disasters reflects increase in the quality and quantity of property and infrastructure. Wealthier countries can also afford increasingly sophisticated early warning and communications systems, allowing people more time to move to safe places and resulting in fewer deaths and injuries.

## ECONOMIC LOSS AS AN INDICATOR OF DISASTER IMPACT

Economic losses are often reported with reference to only the direct losses from infrastructure and assets destroyed during large-scale disasters. They seldom take into account the economic implications of reduced levels of production linked to damage in productive assets or infrastructure that in turn access to raw materials, energy labour or markets.

The use of economic loss indicator of disaster impact on development varies for different natural hazards. For example, earthquakes often appear to trigger the most expensive disasters, but losses are concentrated. Individual floods may not record large losses, but total human impact may be higher. Asian countries experience the greatest collective economic losses to disaster.

| | Economic Development | Social Development |
|---|---|---|
| **Disaster Limits Developments** | Destruction of fixed assets. Loss of production capacity, market access or material inputs. Damage to transport, communications or energy infrastructure. Erosion of livelihoods, savings & physical capital. | Destruction of health or education infrastructure and personnel. Death, disablement or migration of key social actors leading to an erosion of social capital. |
| **Development causes disaster risk** | Unsuitable development practices that create wealth for some at the expense of unsafe working or living conditions for others or degrade the environment. | Development paths generating cultural norms that promote social isolation or political exclusion. |
| **Development reduces disaster risk** | Access to adequate drinking water, food, waste management and a secure dwelling increases people's resiliency. Trade and technology can reduce poverty. Investing | Building community cohesion, recognizing excluded individuals or social groups (such as women)and providing opportunities for greater |

| | | |
|---|---|---|
| | in financial mechanisms and social security can cushion against vulnerability. | involvement in decision-making, enhanced educational and health capacity increases resiliency. |

## DISASTER LIMITS ECONOMIC DEVELOPMENT

Disasters can wipe out the grains of economic development. Catastrophic disasters result in the destruction of fixed assets and physical capital, interruption of production and trade, diversion and depletion of savings and public and private investment. While absolute level of economic loss are greater in developed countries due to the far higher density and cost of infrastructure and production levels, less-developed countries suffer higher levels of relative loss when seen as a proportion of Gross Domestic Product (GDP).

At the local level, disasters can seriously impact household livelihoods and push already vulnerable groups into poverty. The loss of income earners, through death or injury, the interruption of production or access to markets and the destruction of productive assets, such as home-based workshops, are all examples of ways in which disasters affect local & household economies. The capacity of a household or local community to absorb the impact and recover from a major natural hazard will be seriously limited if already weakened overtime by a series of smaller-scale losses.

## DISASTER LIMITS SOCIAL DEVELOPMENT

A population that has weakened and depleted by natural disaster, particularly when it coincides with losses from malnutrition etc., will be less likely to have the organizational capacity to maintain irrigation works, bunds in fields for water harvesting, hillslope terraces, shelter belts. Without these social assets communities become more vulnerable.

In addition to the loss of social assets themselves, there are many examples of disaster events destroying the gains of the health, sanitation, drinking water, housing and education sectors that underpin social development. Examples include the Kutch-Bhuj earthquake in 2001, which completely damaged district hospital, 992 primary schools & 18 secondary schools; or the cyclone that hit Orissa, India in 1999, which led to the contamination of drinking water wells and damaged many schools in the direct impact of a single event.
Women suffer additional stresses in disaster situations and also bear a disproportionate burden of the additional domestic & income-generating work necessary for survival following a disaster event. When women are exposed to additional stresses, the level of social development is reduced.

## DEVELOPMENT PROJECTS

Projects should take into account risk assessment at the appraisal stage. Environmental Impact Reviews should systematically include a section on hazard proneness and consider disaster reduction measures where appropriate, with particular regard to the protection of lifeline infrastructure and critical facilities. In rural programmes and drought prone areas, specific regard should be given to food-security and promotion of agriculture techniques and inter-cropping that reduce hazard-related agriculture losses. Disaster reduction policies and measures need to be implemented, with a two-fold aim: to enable societies to be resilient to natural hazards while ensuring that development efforts do not increase the vulnerability to these hazards.

CHAPTER 12

# ROLE OF POLICY MAKERS IN DISASTER RISK REDUCTION

*Disaster risk management* falls under global trends of causing policymakers to rethink the institutional setup of governments, and the roles and responsibilities of different levels of government in achieving developmental objectives. Actors such as local governments, municipal authorities and local communities play an increasingly important role in emerging national disaster risk management systems.

There is a wide variety of ways in which disaster risk can be reduced as part of development policies. These involve institutional reforms, improved analytical and methodological capabilities, education, awareness, financial planning and political commitment. Disaster reduction is aimed at motivating societies at risk to become engaged in the conscious management of risk and reduction of vulnerability. This must expand beyond traditional response (Relief & Rehabilitation) to defense against the impact of natural hazards, as an ongoing process that does not focus on singular disaster events.

Based on the lessons from the International Decade for Natural Disaster Reduction (IDNDR, 1990-99) four overriding objectives have been formulated in order to effectively reduce the impact of disasters, as the guiding principles for the International Strategy for Disaster Reduction. These overall objectives set the stage for the course of action for Governments, regional bodies and civil society organizations:

- **Obtaining the commitment from public authorities**. This objective needs to be addressed through an increased inter-sectoral coordination at all levels, risk management strategies, the allocation of appropriate resources including development of new funding mechanisms. Disaster reduction should be dealt with as a separate policy issue as well as cross cutting in relevant fields of government (public works, rural development, health, agriculture, food security, environment, etc.) aiming at policy integration among the various sectors.
- **Increasing public awareness and public participation** on how to reduce vulnerability to hazards. This involves programmes related to formal and non- formal education and needs to be addressed through public information, education and multi-disciplinary professional training.
- **Stimulating inter-disciplinary and inter-sectoral partnerships** and the expansion of risk reduction networking amongst governments at national and local levels, greater involvement of the legislators, private sector, academic institutions, NGOs and community-based organizations (CBOs). This calls for strong coordination mechanisms, such as appropriate institutional structures for disaster management, preparedness, emergency response and early warning, as well as the incorporation of disaster reduction concerns in national/state planning processes. Efforts to link natural resource management with disaster reduction should also be encouraged.
- **Fostering better understanding and knowledge of the causes of disasters** through the transfer and exchange of experience and greater access to relevant data and information. The issues to be addressed in this context are the assessment and analysis of socio-economic impacts of disasters, disaster databases, coping strategies of different social groups, early warning processes, as well as the promotion of scientific research, valuing of indigenous knowledge and the development and transfer of knowledge and technologies.
- **The causes and impacts of natural hazards** some times occur in a number of neighbouring States, highlighting the need for a harmonized approach in the management of such a

phenomenon. Efficiency can be optimized via exchange of experiences amongst states and constructive dialogue amongst stakeholders via participatory processes. Prioritization of tasks in the various phases of disaster management (prevention, preparedness, response, rehabilitation and recovery) has to be agreed upon to cope with such situations.

## COURSE FOR SPECIFIC ACTION

The policy makers can play a very vital role for fulfillment of the objectives outlined above. The following areas should be considered as key elements for development actions:

1. **To help create the legislative instruments** in the State for framing of Disaster Management Policy.

2. **Capacity building and strengthening of institutional arrangements** at all levels to address risk reduction as an ongoing function, including disaster reduction related legislation, covering land- use regulation, building codes and reinforced links to environmental protection. Capacity building at State level needs to include the development of an integrated disaster risk management plan that covers areas of risk assessment, early warning systems, training programmes, as well as emergency response management, recovery resources, including the strengthening of community based organizations. It also includes the increased capacity and sectoral synergies for sustainable management of forest and water-resources.

3. Development of **public educational programmes** and campaigns on the relationships between sustainable development, natural hazards, vulnerabilities and disaster to enhance disaster reduction measures. The process starts in schools with educational programmes including curricula revision, teachers training and development of resource centres. It needs to expand to all levels of society by training efforts, with special emphasis on professionals and community based leaders and organizations.

4. Creating and implementing **comprehensive urban development strategies and land use plans**, which provide a number of opportunities to mitigate damages caused by hazards. As location is the key factor, which determines the level of risk associated with a hazard, land- use plans and mapping should be used as tools to identify the most suitable usage for vulnerable areas (e.g., location of buildings, roads, power plants, storage of fuels). Local governments need to play an increasing role with regard to factors such as building standards, land and property markets, land and housing taxation, planning processes and infrastructure construction and management.

5. **Legally mandate building codes: -** To improve resistance to the effects of natural hazards, better building practices are essential. Until there are building codes with the force of law, they will not be taken seriously by the construction industry. Such codes must incorporate modern technical standards.

6. **Enforce codes effectively:-** Legally mandating codes is not enough; they must be enforced. Great care should be exercised in selecting the enforcement system for the codes, since some are easier to ignore, manipulate, or corrupt than others.

7. **To help develop techno-financial regime.**
   - Allotment of some percentage development funds for disaster mitigation.
   - To earmark some percentage of Local Area Development Funds for retrofitting of lifeline buildings (like schools, hospitals etc.).

ANNEXURE A

# DISASTER MANAGEMENT – INSTITUTIONAL ARRANGEMENTS IN INDIA

The institutional and policy mechanisms for carrying out response, relief and rehabilitation have been well-established since Independence. These mechanisms have proved to be robust and effective insofar as response, relief and rehabilitation are concerned. The changed policy/approach, however, mandates a priority to pre-disaster aspects of mitigation, prevention and preparedness and new institutional mechanisms are being put in place to address the policy change.

## CENTRAL LEVEL

Although the primary responsibility for disaster management is of the concerned state Governments, the Central Government plays a key role for providing financial and logistic support in case of major disasters and co-ordinate the effort of all Central Ministries/Departments/Organizations. Cabinet Committee on Natural Calamities is placed at the apex level. The scope of the Committee has also been enlarged so as to address mitigation and preparedness measures also.

Cabinet Secretary, who is the highest executive officer, heads the National Crisis Management Committee (NCMC). Secretaries of all the concerned Ministries/Departments as well as organizations are the members of the Committee. The NCMC gives direction to the Crisis Management Group as deemed necessary. The Secretary, Ministry of Home Affairs is responsible for ensuring that all developments are brought to the notice of the NCMC promptly. The NCMC gives direction to any Ministries/Departments/ Organizations for specific action needed for meeting the crisis situation.

The Central Relief Commissioner in the Ministry of Home Affairs is the Chairman of the Crisis Management Group (CMG) consisting of senior officers (called nodal officers) from various concerned Ministries. The CMG's functions are to review every year contingency plans formulated by various Ministries/Departments/Organizations in their respective sectors, measures required for dealing with a natural disaster, coordinate the activities of the Central Ministries and the State Governments in relation to disaster preparedness and relief and to obtain information from the nodal officers on measures relating to the above. The CMG, in the event of a disaster, meets frequently to review the relief operations and extend all possible assistance required by the affected States to overcome the situation effectively. The Resident Commissioner of the affected state is also associated with such meetings.

Mitigation, preparedness and response are multi-disciplinary functions, involving a number of Ministries/Departments. Institutional mechanisms which would facilitate this inter-disciplinary approach are being put in place. It is proposed to create Disaster/Emergency Management Authorities, both at the National and State levels, with representatives from the relevant Ministries/Departments to bring about this coordinated and multi-disciplinary with experts covering a large number of branches. The National Emergency Management Authority is proposed to be constituted. The organization will be multi-disciplinary with experts covering a large number of branches. The National Emergency Management Authority is proposed as a combined Secretariat/Directorate structure – a structure which will be an integral part of the Government while, at the same time, retaining the flexibility of a field organization.

The Authority will be responsible for:

- Providing necessary support and assistance to State Governments by way of resource data, macro-management of emergency response, specialized emergency response teams, sharing of disaster related data base etc.
- Coordinating/mandating Government's policies for disaster reduction/mitigation
- Ensuring adequate preparedness at all levels in order to meet disasters
- Coordinating response to a disaster when it strikes
- Assisting the Provincial Government in coordinating post disaster relief
- Coordinating resources of all National Government Department/agencies involved.
- Monitor and introduce a culture of building requisite features of disaster mitigation in all development plans and programmes.
- Any other issues of work, which may be entrusted to it by the Government.

## STATE LEVEL

The States have also been asked to set up Disaster Management Authorities under the Chief Minister with Ministers of relevant Departments as members. 11 States and UTs – Tamil Nadu, Arunachal Pradesh, Uttaranchal, Orissa, Gujarat, Kerala, Nagaland, Rajasthan, Delhi, A&N administration and Chandigarh Administration have notified the authority. The other States are in the process of setting up similar authorities.

**Re-structuring of the Relief Department in the States:** At the State level, the work of post calamity relief was being handled by the Departments of Relief & Rehabilitation. The Government of India is working with the State Governments to restructure the Departments of Relief & Rehabilitation into Departments of Disaster Management with an enhanced area of responsibility to include mitigation and preparedness apart from their present responsibilities of relief and rehabilitation. The changeover has already happened in 11 States/UTs - Andhra Pradesh, Arunachal Pradesh, Bihar, Himachal Pradesh, Rajasthan, Tamil Nadu, Uttaranchal, Nagaland, Andaman & Nicobar Administration, Sikkim and Lakshadweep. The change is under process in other States.

The States have been advised to restructure/re-group the officers/staff within the Department of Disaster Management with definite functions to pursue the holistic approach to disaster management. The four functional groups to be assigned with specific tasks within the departments are as indicted below:-

- Functional Group 1: Hazard Mitigation
- Functional Group 2: Preparedness and Capacity Building
- Functional Group 3: Relief and Response
- Functional Group 4: Administration and Finance

## DISTRICT LEVEL

At the district level, the District Magistrate who is the chief coordinator will be the focal point for coordinating all activities relating to prevention, mitigation and preparedness apart from his existing responsibilities pertaining to response and relief. The District Coordination and Relief Committee is being reconstituted/ re-designated into Disaster Management Committees with officers from relevant departments being added as members. Because of its enhanced mandate of mitigation and prevention, the district heads of the departments engaged in development are now being included in the Committee so that mitigation and prevention is mainstreamed into the district plan. The existing system of drawing up preparedness and response plans will continue. There will, however, also be a long term mitigation plan. District Disaster Management Committees have already been constituted in 256 districts and are in the process of being constituted in the remaining districts.

## BLOCK/TALUKA LEVEL

Similarly, sub-divisional and Block/Taluka level Disaster Management Committees are also being constituted. At the village level Disaster Management Committees and Disaster Management Teams are

being constituted. Each village in multi-hazard prone district will have a Disaster Management Plan. The process of drafting the plans at all levels has already begun. The Disaster Management
Committee which draws up the plans consists of elected representatives at the village level, local authorities; Government functionaries including doctors/paramedics of primary health centres located in the village, primary school teachers etc. The plan encompasses prevention, mitigation and preparedness measures. The Disaster Management Teams at the village level will consist of members of youth organizations like Nehru Yuvak Kendra Sanghathan (NYKS) and National Service Scheme (NSS) and other nongovernmental organizations as well as able bodied volunteers from the village.
The teams are provided basic training in evacuation, evacuation, search and rescue, first aid trauma counseling etc. The Disaster Management Committee will review the disaster management plan at least once in a year. It would also generate awareness among the people in the village about dos' and don'ts for specific hazards depending on the vulnerability of the village. A large number of village level Disaster Management Committees and Disaster Management Teams have already been constituted.

ANNEXURE B

# LIST OF RESOURCE INSTITUTIONS

**National Institute of Disaster Management *(NIDM)***
(Ministry of Home Affairs)
I.P. Estate, Ring Road
New Delhi - 110002
Tel.Fax : 91-11-23702442
http://www.nidm.net/

**Bureau of Indian Standards *(BIS)***
Manak Bhavan
9 Bahadur Shah Zafar Marg
New Delhi 110 002, India
Tel : 23230131, 23233375, 23239402 (10 lines)
Fax : 23234062, 23239399, 23239382
Email: info@bis.org.in
www.bis.org.in

**Building Materials and Technology Promotion Council *(BMTPC)***
Core 5 -A, First Floor ,
India Habitat Centre, Lodi Road
New Delhi- 110 003
Tel. 91-11-24638096, 24638097, 24651243, 24636759 Fax: 91-11-24642849
E-mail: info@bmtpc.org
www.bmtpc.org

**India Meteorological Department *(IMD)***
Mausam Bhawan,
Lodhi Road,
New Delhi-110003
http://www.imd.ernet.in/

**Department of Science & Technology**
Technology Bhavan,
New Mehrauli Road, New Delhi - 110016
Tel: 91-11-26567373, 26962819
Fax: 91-11-26864570, 26862418
Email: dstinfo@alpha.nic.in
http://dst.gov.in/

**National Institute of Hydrology**
Jal Vigyan Bhawan,
Roorkee - 247 667 (Uttaranchal)
Tel: 91 - 1332 – 272106/272123
Email: root@nih.ernet.in

**Indian Council of Agricultural Research**
Krishi Bhavan, Dr. Rajendra Prasad Road,
New Delhi-110 001
Email: gsi_chq@vsnl.com
http://www.icar.org.in/

**Geological Survey of India**
27 Jawaharlal Nehru road,
Kolkata 700016.
Tel: 91-33-22861641/65/73/72
91-33-22861656
http://www.gsi.gov.in/

**Indian Institute of Remote Sensing**
National Remote Sensing Agency
Dept. of Space, Govt. of India
4, Kalidas Road,
Dehradun - 248 001
Tel: 91 - (0)135 - 2744583
91 - (0)135 - 2741987, 2748041
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