Meaning and Definition of **Hazard and Disaster**

Hazard

A hazard is a situation where there is a threat to life, health, environment, or property. Earthquakes, floods, tsunamis, wildfires, landslides, droughts, and volcanic eruptions are natural hazards that cause a lot of destruction. They are natural phenomenon that take place without regard to humans and do not strike a place taking into account the built environment or the population. When any of these hazards takes place in an area that is desolate, it causes no harm to human lives or property. Hence, it is not called a disaster though technically it is the same phenomenon that would have raised an alarm had it taken place in an area that was thickly populated. It is clear then that a hazard is an event that has the potential to cause widespread destruction and loss of lives and property. But, when a hazard strikes an area that has no human population, though it still has destructive properties, it is not termed as a disaster.

When there are natural hazards, they cannot be prevented. But, we can certainly learn to live in harmony with nature by not taking steps that can turn hazards into major disasters. If one takes into account the cost that we finally pay when a disaster strikes and the cost of averting it, we come to a conclusion that it is prudent to be prepared rather than inviting the wrath of nature on a very large scale.

When it comes to hazards, there are several types of hazards. They are Physical (heat, noise, vibration), Chemical (leakages of chemical compounds, fires), Biological (parasites, viruses, bacteria), Psychological, and Radiation Hazards.

Disaster

A disaster is an event that completely disrupts the normal ways of a community. It brings on human, economical, and environmental losses to the community which the community cannot bear on its own. Earthquakes, floods, tsunamis, wildfires, landslides, droughts, and volcanic eruptions are termed as disasters when they occur in places that are heavily inhabited areas. Tornados and typhoons occur frequently in many parts of the world but are labeled as disasters only when they take place where there is built environment and human population.

There are factors that are manmade and that help in turning a hazard into a disaster. The way and the speed in which deforestation is taking place in many parts of the world have resulted in an increased frequency of floods that lead to widespread destruction. Earthquakes in seismic zones that are prone to them cannot be prevented but high concentration of human population and inadequately built houses that cannot withstand earthquakes lead to disasters at a very high level resulting in loss of valuable lives.

Also, for manmade disasters we can give examples such as fires, transport accidents, nuclear radiation, explosions, etc.

What is the difference between Hazard and Disaster?

• A hazard is a situation where there is a threat to life, health, environment or property.

• A disaster is an event that completely disrupts the normal ways of a community. It brings on human, economical, and environmental losses to the community which the community cannot bear on its own.

• Hazards are natural or manmade phenomenon that are a feature of our planet and cannot be prevented. In their dormant state, hazards just pose a threat to life and property.

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

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

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

Earthquake

Earthquakes are one of the most destructive of natural hazards. An earthquake occurs due to sudden transient motion of the ground as a result of release of elastic energy in a matter of few seconds. The impact of the event is most traumatic because it affects large areas, occurs all of a sudden and is unpredictable. They can cause large scale loss of life and property and disrupts essential services such as water supply, sewerage systems, communication and power, transport, etc. They not only destroy villages, towns and cities but the aftermath leads to destabilize the economy and social structure of the nation.

What is an Earthquake?

An earthquake is the movement or trembling of the ground produced by the sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, and collapse of caverns. Stress accumulates in response to tectonic forces until it exceeds the strength of the rock. The rock then breaks along a preexisting or new fracture called a fault. The rupture extends outward in all directions along the fault plane from its point of origin (focus). The rupture travels in an irregular manner until the stress is relatively equalized. If the rupture disturbs the surface, it produces a visible fault on the surface. Earthquakes are recorded by seismograph consisted of a seismometer, a shaking detector and a data recorder. The moment magnitude of an earthquake is conventionally reported, or the related and mostly obsolete Richter magnitude, with magnitude 3 or lower earthquakes being mostly imperceptible and magnitude 7 causing serious damage over large areas. Intensity of shaking is measured on the modified Mercalli scale. In India Medvedev-Sponheuer-Karnik scale, also known as the MSK or MSK-64, which is a macroseismic intensity scale, is used to evaluate the severity of ground shaking on the basis of observed effects in an area of the earthquake occurrence. Due to earthquake seismic waves are generated and measurements of their speed of travel are recorded by seismographs located around the planet.

Causes of Earthquakes

An Earthquake is a series of underground shock waves and movements on the earth's surface caused by natural processes within the earth's crust. To learn more about the occurrence of this event lets know more about the interior of the earth.

Earthquakes are caused by natural tectonic interactions within the earth's crust and it is a global phenomena. They may arise either due to the release of energy from the strained rock inside the

Earth or tectonic movements or volcanic activity. The sudden release of accumulated energy or stresses in the earth or sudden movement of massive land areas on the earth's surface cause tremors, commonly called earthquakes.

Seismic Waves Large strain energy released during an earthquake travel as seismic waves in all directions through the Earth's layers, reflecting and refracting at each interface. These waves are of two types - body waves and surface waves; the latter is restricted to near the Earth's surface. Body waves consist of Primary Waves (P-waves) and Secondary Waves (S-waves), and surface waves consist of Love waves and Rayleigh waves. Under P-waves, material particles undergo extensional and compressional strains along the direction of energy transmission, but under S-waves, oscillate at right angles to it. Love waves cause surface motions similar to that by S-waves, but with no vertical component. Rayleigh wave makes a material particles oscillate in an elliptic path in the vertical plane (with horizontal motion along direction of energy transmission).

Magnitude is a quantitative measure of the actual size of the earthquake. Professor Charles Richter noticed that (a) at the same distance, seismograms (records of earthquake ground vibration) of larger earthquakes have a bigger wave amplitude than those of smaller earthquakes; and (b) for a given earthquake, seismograms at farther distances have a smaller wave amplitude than those at close distances. This prompted him to propose the now commonly used magnitude scale, the Richter Scale. It is obtained from the seismograms and accounts for the dependence of waveform amplitude on epicentral distance. This scale is also called Local Magnitude scale. There are other magnitude scales, like the Body Wave Magnitude, Surface Wave Magnitude and Wave Energy Magnitude. These numerical magnitude scales have no upper and lower limits; the magnitude of a very small earthquake can be zero or even negative.

Intensity is a qualitative measure of the actual shaking at a location during an earthquake, and is assigned as Roman Capital Numerals. There are many intensity scales. Two commonly used ones are the Modified Mercalli Intensity (MM!) Scale and the MSK Scale. Both scales are quite similar and range from I (least perceptive) to XII (most severe). The intensity scales are based on three features of shaking - perception of people and animals, performance of buildings, and changes in natural surroundings. The distribution of intensity at different places during an earthquake is shown graphically using iso-seismals, lines joining places with equal seismic intensity.

What are the various types of earthquake?

Classification of earthquake is based on several parameters. Based on scale of magnitude (M), earthquake may be of the Micro (M < 3.5) or macro (M > 3.5) type.

 Depending upon the extent of energy released and strength of the ground shaking it may be of several types, like moderate, strong, very strong, great and very great earthquake.

 Depending up on the scale of damage, the earthquake may be of various types, such as Less damaging earthquake, Moderate damaging earthquake, and catastrophic earthquake.

 Depending upon the focal depth (h) of the event, it could be a shallow earthquake (d< 70 km); intermediate depth earthquake (70 < h < 300 km); the deep earthquake (300 < h < 700 km).

 Depending upon the location of events in different tectonic settings, earthquake may be of intra-plate, inter-plate, and sub-oceanic earthquake.

 Depending upon involvement of other agencies / phenomena with earthquake genesis, it may be of several types, such as Reservoir induced; Fluid-driven earthquake; Tsunamigenic earthquake, and volcanic earthquake.

 Depending upon the type of faulting involved during earthquake genesis, earthquake may be categorized into several categories, such as normal faulting, reverse faulting, thrust faulting, and mega-thrust earthquake.

 Depending upon the frequency content, the earthquake may be of Low-Frequency tremors or high – Frequency tremors.

 Depending upon the epicenter distance (distance between earthquake main shock and the recording stations), the earthquake may be classified into Local, Regional and Global earthquake.

Intensity scale:

It manifests the degree of damage, which gets diminished as we go away from the main shock source zone and the reverse is also true. Mercalli intensity scale The Mercalli intensity scale is a seismic scale used for measuring the intensity of an earthquake. It measures the effects of an earthquake, and is distinct from the moment magnitude usually reported for an earthquake (sometimes described as the obsolete Richter magnitude), which is a measure of the energy released. The intensity of an earthquake is not totally determined by its magnitude. The scale quantifies the effects of an earthquake on the Earth's surface, humans, objects of nature, and man-made structures on a scale from I (not felt) to XII (total destruction). Values depend upon the distance to the earthquake, with the highest intensities being around the epicentral area. Data gathered from people who have experienced the quake are used to determine an intensity value for their location. The Mercalli (Intensity) scale originated with the widely-used simple ten-degree Rossi-Forel scale which was revised by Italian vulcanologist, Giuseppe Mercalli in 1884 and 1906. In 1902 the ten-degree Mercalli scale was expanded to twelve degrees by Italian physicist Adolfo Cancani. It was later completely re-written by the German geophysicist August Heinrich Sieberg and became known as the Mercalli-Cancani-Sieberg (MCS) scale. The Mercalli-Cancani-Sieberg scale was later modified and published in English by Harry O. Wood and Frank Neumann in 1931 as the Mercalli-Wood-Neumann (MWN) scale. It was later improved by Charles Richter, the father of the Richter magnitude scale. The scale is known today as the Modified Mercalli scale (MM) or Modified Mercalli Intensity scale (MMI). Modified Mercalli Intensity Scale The lower degrees of the Modified Mercalli Intensity scale generally deal with the manner in which the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage.

INDIA - Basic Geography and Tectonic Features:

India lies at the northwestern end of the Indo-Australian Plate, which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries. This plate is colliding against the huge Eurasian Plate and going under the Eurasian Plate; this process of one tectonic plate getting under another is called subduction. A sea, Tethys, separated these plates before they collided. Part of the lithosphere, the Earth's Crust, is covered by oceans and the rest of the continents. The former can undergo subduction at great depths when it converges against another plate, but the latter is buoyant and so tends to remain close to the surface. When continents converge, large amounts of shortening and thickening takes place, like in the Himalayas and the Tibetan. Three chief tectonic sub-regions of India are the mighty Himalayas along the north, the plains of the Ganges and other rivers, and the peninsula. The Himalayas consist primarily of sediments accumulated over long geological time in the Tethys. The Indo-Gangetic basin with deep alluvium is a great depression caused by the load of the Himalayas on the continent. The peninsular part of the country consists of ancient rocks deformed in the past Himalayan-like collisions. Erosion has exposed the roots of the old mountains and removed most of the topography. The rocks are very hard, but are softened by weathering near the surface. Before the Himalayan collision, several tens of millions of years ago, lava flowed across the central part of peninsular India, leaving layers of basalt rock. Coastal areas like Kachchh show marine deposits testifying to submergence under the sea millions of years ago.

Seismic Zones of India

The varying geology at different locations in the country implies that the likelihood of damaging Earthquakes taking place in different locations are different. Thus, a seismic zone map is required to identify these regions. Based on the levels of intensities sustained during damaging past earthquakes, the 1970 version of the zone map subdivided India into five zones - I, II, III, IV and V. The maximum Modified Mercalli (MM) intensity of seismic shaking expected in these zones was V or less, VI, VII, VIII, and IX and higher, respectively. Parts of Himalayan boundary in the north and northeast, and the Kachchh area in the west were classified as zone V. The seismic zone maps are revised from time to time as more understanding is gained on the geology, the seismotectonics and the seismic activity in the country. The Indian Standards provided the first seismic zone map in 1962, which was later revised in 1967 and again in 1970. The map has been revised again in 2002, and it now has only four seismic zones - II, III, IV and V. The areas falling in zone II. Also, the seismic zone map in the peninsular region has been modified. Chennai city, now comes in seismic zone III as against in zone II in the 1970 version of the map. This 2002 seismic zone map is not the final word on the seismic hazard of the country, and hence there can be no sense of complacency in this regard

Can we predict Earthquakes?

With the present state of knowledge of science, it is not possible to predict earthquakes. It is so because the physics involved in earthquake genesis is very complex. The mechanism of earthquake generating processes is still not adequately understood us because of involvement of multi-component parameters in earthquake genesis. Earthquake forecasting and prediction is an active topic of geological research. Geoscientists are able to identify particular areas of risk and, if there is sufficient information, to make probabilistic forecasts about the likelihood of earthquakes happening in a specified area over a specified period. These forecasts are based on data gathered through global seismic monitoring networks, high-density local monitoring in knowing risk areas, and geological field work, as well as from historical records. Forecasts are improved as our theoretical understanding of earthquakes grows, and geological models are tested against observation. Long-term forecasts (years to decades) are currently much more reliable than short to medium-term forecasts (days to months). It is not currently possible to make deterministic predictions of when and where earthquakes will happen. For this to be possible, it would be necessary to identify a „diagnostic precursor" – a characteristic pattern of seismic activity or some other physical, chemical or biological change, which would indicate a high probability of an earthquake happening in a small window of space and time. So far, the search for diagnostic precursors has been unsuccessful. Most Geoscientists do not believe that there is a realistic prospect of accurate prediction in the foreseeable future, and the principal focus of research is on improving the forecasting of earthquakes.

Earthquake Early Warning

Earthquake early warning (EEW) can provide a few seconds to tens of seconds warning prior to ground shaking during an earthquake. Several countries, such as Japan, Taiwan, Mexico have adopted this methodology based on the fact that such warning can (1) rapidly detect the initiation of an earthquake, (2) determine the size (magnitude) and location of the event, (3) predict the peak ground motion expected in the region around the event, and (4) issued a warning to people in locations that may expect significant ground motion. Prediction of an earthquake is still a subject of speculations yet several schools of thoughts are available. In the effort to predict earthquakes, people have tried to associate an impending earthquake with such varied phenomena as seismicity patterns, electromagnetic fields, weather conditions and unusual clouds, radon or hydrogen gas content of soil or ground water, water level in wells, animal behavior, and the phases of the moon.

Mitigation measures

When an earthquake strikes a building is thrown mostly from side to side, and also up and down along with the building foundation the building structure tends to stay at rest, similar to a passenger standing on a bus that accelerates quickly. Building damage is related to the characteristics of the building, and the duration and severity of the ground shaking. Larger earthquakes tend to shake longer and harder and therefore cause more damage to structures.

Structural

No buildings can be made 100% safe against earthquake forces. Instead buildings and infrastructures can be made earthquake resistant to a certain extent depending upon serviceability requirements. Earthquake resistant design of buildings depends upon providing the building with strength, stiffness and inelastic deformation capacity, which are great enough to withstand a given level of earthquake-generated force. This is generally accomplished through the selection of an appropriate structural configuration and the careful detailing of structural members, such as beams and columns, and the connections between them. There are several different experimental techniques that can be used to test the response of structures to verify their seismic performance, one of which is the use of an earthquake shaking table (a shaking table, or simply shake table). This is a device for shaking structural models or building components with a wide range of simulated ground motions, including reproductions of recorded earthquakes time-histories.

Non-structural

The non-engineered traditional construction commonly practiced in different areas of the country depends greatly on the respective local context of the area. In other words the technologies vary significantly from area to area. These technologies have evolved and as a result have got optimized. In India an overwhelming majority of houses, are of non-engineered load bearing type. These structures, especially houses, have been traditionally built over the past century or longer, using the locally available materials and the locally practiced technologies that have been most common in the area, including stone, bricks, earth, lime and timber for walls, and clay tiles, stone or mud for roofing supported on under-structure made of local timber such as Teak, Acacia, Neem, Deodar, Pine and also Bamboo. In the recently built structures one also finds a mix of the traditional and new materials/technology such as cement, concrete and steel. The structures have a pitched roof or flat roof, and are single story or double story. After Bhuj earthquake, significant effort was taken to repair and strengthening of damaged buildings. A guideline for Repair and strengthening guide for earthquake damaged low rise domestic buildings in Gujarat is made.

Seismic retrofitting

Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes. With better understanding of seismic demand on the structures and with our recent experiences with large earthquakes near urban centers, the need of seismic retrofitting is well acknowledged

Guidelines for Earthquake Management

Central ministries and departments and the state governments will prepare DM plans, which will have specific components of earthquake management, based on these Guidelines. These plans will cover all aspects of the entire DM cycle, be reviewed and updated at periodic intervals and implemented through appropriate, well coordinated and time bound actions as laid down in these Guidelines. As most development activities, especially in high seismic risk areas, can enhance earthquake risk unless special efforts are made to address these concerns, all these agencies will make special efforts to ensure the incorporation of earthquake-resistant features in the design and construction of all new buildings and structures.

Earthquake Safety Tips

Before & during

 Make your house earthquake resistant and secure heavy furniture and objects.

 Choose a couple of family meeting places; pick easy to identify, open and accessible places that you can easily reach. Prepare to be self-sufficient for a minimum of three days.

 If inside, stay inside."DROP, COVER and HOLD! Drop under firm furniture. Cover as much of your head and upper body as you can. Hold onto the furniture. Move to an inside wall and sit with your back to the wall, bring your knees to your chest and cover your head. Stay away from mirror and window. Do not exit the building during the shaking.

 If outdoors, move to an open area away from all structures, especially buildings, bridges, and overhead power lines.

After

 Move cautiously, and check for unstable objects and other hazards above and around you. Check yourself for injuries.

 Anticipate aftershocks, especially if the shaking lasted longer than two minutes.

 Stay out of damaged buildings. Listen to the radio or watch local TV for emergency information and additional safety instructions.

Landslide

Landslides are simply defined as down slope movement of rock, debris and/or earth under the influence of gravity. This sudden movement of material causes extensive damage to life, economy and environment. It is the most common and universally accepted collective term for most slope movements of the massive nature. The term has sometimes been considered unsuitable as the active part of the word denotes sliding, whereas it connotes even movements without sliding like fall, topple, flow etc.

Parts of Landslides – Description of Features

Accumulation - The volume of the displaced material, which lies above the original ground surface

Crown – The practically undisplaced material still in place and adjacent to the highest parts of the main scarp

Depletion – The volume bounded by the main scarp, the depleted mass and the original ground surface

Depleted mass – The volume of the displaced material, which overlies the rupture surface but underlies the original ground surface

Displaced material – Material displaced from its original position on the slope by movement in the landslide. It forms both the depleted mass and the accumulation.

Flank – The undisplaced material adjacent to the sides of the rupture surface. Compass directions are preferable in describing the flanks, but if left and right are used, they refer to the flanks as viewed from the crown.

Foot – The portion of the landslide that has moved beyond the toe of the surface of rupture and overlies the original ground surface.

Head – The upper parts of the landslide along the contact between the displaced material and the main scarp.

Main body – The part of the displaced material of the landslide that overlies the surface of rupture between the main scarp and toe of the surface of rupture.

Main scarp – A steep surface on the undisturbed ground at the upper edge of the landslide, caused by movement of the displaced material away from undisturbed ground. It is the visible part of the surface of rupture.

Minor scarp – A steep surface on the displaced material of the landslide produced by the differential movement within the displaced material.

Original ground surface – the surface of the slope that existed before the landslide took place. Surface of separation – The part of the original ground surface overlain by the foot of the landslide

Surface of rupture – The surface that forms the lower boundary of the displaced material below the original ground surface.

Tip – The point of toe farthest from the top of the landslide.

Toe – The lower, usually curved margin of the displaced material of a landslide, it is the most distant part from the main scarp.

Top – The highest point of contact between the displaced material and the main scarp.

Toe of surface of rupture – The intersection (usually buried) between the lower part of the surface of rupture of a landslide and the original ground surface.

Zone of accumulation – The area of landslide within which the displaced material lies above the original ground surface.

Zone of depletion – The area of the landslide within which the displaced material lies below the original ground surface.

Landslide types

Based on process types, there are five types of landslides i.e. Fall, Topple, Slide, Spread, Flow and Subsidence.

Fall:

It is a very rapid to an extremely rapid movement which starts with a detachment of material from steep slopes such as cliffs, along a surface on which little or no shear displacement takes place. The material then descends through the air by free falling, bouncing or rolling onto the slopes below.

 The detachment of soil or rock from a steep slope along a surface on which little or no shear displacement takes place.

 Movement very rapid to extremely rapid.

 Free fall if slope angle exceeds 76 degrees and rolling at or below 45 degrees.

Topple:

It involves overturning of material. It is the forward rotation of the slope mass about a point or axis below the centre of gravity of the displaced mass. Topples range from extremely slow to extremely rapid movements.

 The forward rotation out of the slope of a mass or a rock about a point or axis below the centre of gravity of the displaced mass.

 Movement varies from extremely slow to extremely rapid.

 Driven by gravity and sometimes by water or ice in cracks in mass.

Slide:

Movement of material along a recognizable shear surface e.g. translational and rotational slides.

 Downslope movement of a soil or mass occurring dominantly on surfaces of or on relatively thin zones of intense shear strain.

 The sign of ground movement are cracks of the original ground.

Modes of Sliding: Translational / planar slides Wedge slides Rotational slide

Flow:

is a landslide in which the individual particles travel separately within a moving mass. Spatially continuous movement, in which surfaces of shear are shortlived, closely spaced and usually not preserved. Flows are differentiated from slides, on the basis of water content, mobility and evolution of the movement

Features for recognition of flows are i. Crown may have few cracks. ii. The main scarp typically has serrated or funnel shaped upper part; is long and narrow, bare and commonly striated. iii. Flanks are steep and irregular in the upper part; may have levees built up in the middle and lower parts. iv. The body has flowlines, follow drainage ways, is sinuous, and is very long compared to width. v. The toe spreads laterally in lobes; if dry, may have steep front.

Spread

- Sudden movement on water- bearing seams of sand or silt overlain by homogeneous clays or loaded by fills.

- May result from liquefaction or flow of softer material.

Slump: It is a type of rotational failure on the slopes. The trees bend or fall backwards on towards the slope.

Creep:

Very slow rates of slope movements, usually a few millimeter per year, that is imperceptible in nature) is covered under this category. However, one may find landslides that do not fall directly under any of these typical singular types of slope failures. Such landslides may be composite, complex or multi-tier.

Classification of Conditions/Factors responsible for Landslides

Some slopes are susceptible to landslides whereas others are not so. Many factors contribute to the instability of the slopes, but the main factors indicating stability conditions are relief, drainage, bedrock, regolith, vegetation, climate, earthquake, paleo-features and man-made conditions. The conditions/factors governing landslides can be classified as inherent (terrain) and external factors as given below:

a. Inherent or basic conditions

Geology Lithology Structure Hydrologic conditions and climate Vegetation

b. **External Factors/conditions** include precipitation, vibrations induced by earthquake / blasting / explosion, loading or unloading of slopes etc. These factors may actually produce two different types of changes, i.e. changes in stress conditions and changes in strength of materials. The different factors producing different changes are given below for illustration.

c. Factors producing unfavorable changes in conditions

Those that change stress conditions Erosion or deposition Fluctuation in water level Seismic vibrations Construction activity Cuttings Reservoir fluctuations Landuse practices

Those that change strength of materials Progressive softening of fissured clays Disintegration of granular rocks (freeze & thaw) Hydration of clay minerals Drying and cracking of clays Loss of cementitious material from coherent material by solution

d. Landslide's Driving Force

The principal driving force for any landslide is the gravitational force which tends to move out the mass due to the hill slope angle and its weight. The resisting forces preventing the mass from sliding down the slope are inversely proportional to the same hill slope angle and proportional to the friction angle of the material. Stability of the material resting on a slope will be reduced with an increased slope angle. In addition, the resisting forces can be significantly reduced in case of rain or earthquake vibrations.

Potential landslide risk indicators:

The following simple observations and inspection by community, municipal officials and property owners, may assist in assessing potential landslide hazards. It is important to note that some of these features can also be due to causes other than landslides, such as swelling clays.

- Saturated ground or seeps in areas that are not typically wet
- New cracks and scarps or unusual bulges in the ground, roads or pavements
- Movement of ancillary structures such as decks and patios in relation to a house
- Sticking doors and windows, and visible open spaces, indicating jambs and frames out of plumb
- Soil moving away from foundations
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines or retaining walls
- Sunken or displaced road surfaces
- Rapid increase in creek water levels, possibly accompanied by an increase in turbidity (soil content)
- Sudden decrease in creek water levels, though rain is still pouring or just recently stopped

- Springs, seeps or saturated ground in areas that are not typically wet
- Thorough cracks in walls, gaps between roof and wall etc.
- Damage to building elements

Landslides Risk Reduction Measures

Drainage Corrections:

The most important triggering mechanism for mass movements is the water infiltrating into the overburden during heavy rains and consequent increase in pore pressure within the overburden. Hence the natural way of preventing this situation is by reducing infiltration and allowing excess water to move down without hindrance. As such, the first and foremost mitigation measure is drainage correction. This involves maintenance of natural drainage channels, both micro and macro in vulnerable slopes.

Proper land use measures:

Adopt effective land-use regulations and building codes based on scientific research. Through land-use planning, discourage new construction or development in identifying hazard areas without first implementing appropriate remedial measures. Structural measures: Adopt remedial techniques (i.e., buttresses, shear keys, sub-drains, soil reinforcement, retaining walls, etc.) of existing landslides that are in close proximity to public structures.

Afforestation:

The afforestation program should be properly planned so the little slope modification is done in the process. Bounding of any sort using boulders, etc. has to be avoided. The selection of suitable plant species should be such that can with stand the existing stress conditions of the terrain.

Awareness generation:

Educate the public about signs that a landslide is imminent so that personal safety measures may be taken. Some of these signs include:

(i) Springs, seeps, or saturated ground in areas that have not typically been wet before.

(ii) New cracks or unusual bulges in the ground, street pavements or sidewalks.

(iii) Soil moving away from foundations, and ancillary structures such as decks and patios tilting and/or moving relative to the house.

(iv) Sticking doors and windows, and visible open spaces.

(v) Broken water lines and other underground utilities.

(vi) Leaning telephone poles, trees, retaining walls or fences.

(vii) Sunken or dropped-down road beds.

(viii) (viii) Rapid increase in a stream or creek water levels, possibly accompanied by increased turbidity (soil content).

(ix) Sudden decrease in creek water levels even though rain is still falling or just recently stopped.

Landslides Safety Tips:

Before and during:

 Avoid building houses near steep slopes, close to mountain edges, near drainage ways or along natural erosion valleys.

 Avoid going to places affected by debris flow. In mud flow areas, build channels to direct the flow around buildings.

 Stay alert and awake. Many deaths from landslides occur while people are sleeping.

 Listen for unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together.

 Move away from the landslide path or debris flow as quickly as possible.

 Avoid river valleys and low-lying areas. If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and notice whether the water changes from clear to muddy.

After:

 Go to a designated public shelter if you have been told to evacuate.

 Stay away from the slide area as there may be danger of additional slides.

 Check for injured and trapped persons near the slide, without entering the direct slide area.

Tsunami

Tsunamis and earthquakes happen after centuries of energy build up within the earth. A tsunami (in Japanese „tsu" means harbor and „nami" means wave) is a series of water waves caused by the displacement of a large volume of a body of water, usually an ocean. In the Tamil language it is known as "Aazhi Peralai". Seismicity generated tsunamis are the result of abrupt deformation of sea floor, resulting vertical displacement of the overlying water. Earthquakes occurring beneath the sea level, the water above the reformed area is displaced from its equilibrium position. The release of energy produces tsunami waves which have small amplitude but a very long wavelength (often hundreds of kilometer long). It may be caused by non-seismic event also such as a landslide or the impact of a meteor.

Characteristics:

Tsunami in the deep ocean may have very long wave length of hundred of kilometer and travels at about 800 km per hour, but an amplitude of only about 1 km. It remains undetected by ships in the deep sea. However, when it approaches the coast its wavelength diminishes, but amplitude grows enormously, and it takes very little time to reach its full height. The Computer model can provide tsunami arrival, usually within minutes of the arrival time. Tsunamis have great erosion potential, stripping beaches of sand, coastal vegetation and dissipating its energy through the destruction of houses and coastal structure.

How do landslides, volcanic eruptions, and cosmic collisions generate tsunamis?

A tsunami can be generated by any disturbance that displaces a large water mass from its equilibrium position. In the case of earthquake-generated tsunamis, the water column is disturbed by the uplift or subsidence of the sea floor. Submarine landslides, which often accompany large earthquakes, as well as collapses of volcanic edifices, can also disturb the overlying water column as sediment and rock slump downslope and are redistributed across the sea floor. Similarly, a violent submarine volcanic eruption can create an impulsive force that uplifts the water column and generates a tsunami. Conversely, supermarine landslides and cosmic-body impacts disturb the water from above, as momentum from falling debris is transferred to the water into which the debris falls. Generally speaking, tsunamis generated from these mechanisms, unlike the Pacific-wide tsunamis caused by some earthquakes, dissipate quickly and rarely affect coastlines distant from the source area. What happens to a tsunami as it approaches land? As a tsunami leaves the deep water of the open ocean and travels into the shallower water near the coast, it transforms. The tsunami's energy flux, which is dependent on both its wave speed and wave height, remains nearly constant. Consequently, as the tsunami's speed diminishes as it travels into shallower water, its height grows. Because of this shoaling effect, a tsunami, imperceptible at sea, may grow to be several meters or more in height near the coast. When it finally reaches the coast, a tsunami may appear as a rapidly rising or falling tide, a series of breaking waves, or even a bore.

Tsunami Information

Tsunamis are formed by a displacement of water - a landslide, volcanic eruption, or, as in this case, slippage of the boundary between two of the earth's tectonic plates - slabs of rock 50 to 650 feet (15 to 200 m) thick that carry the Earth's continents and seas on an underground ocean of much hotter, semi-solid material. The December 26 2004 mega tsunami was caused by slippage of about 600 miles (1,000 km) of the boundary between the India and Burma plates off the west coast of northern Sumatra. The convergence of other plates strains the area, and at the quake's epicenter, the India plate is moving to the northeast at 2 inches (5 cm) per year relative to the Burma plate. The aftershocks were distributed along the plate boundary from the epicenter to near Andaman Island. Tsunamis can travel up to 600 mph (965 km per hour), 521 knots) at the deepest point of the water, but slow as they near the shore, eventually hitting the shore at 30 to 40 mph (48 to 64 kph or 26 to 35 knots). The energy of the wave's speed is transferred to height and sheer force as it nears shore. The 7.3 magnitude aftershock might have been powerful enough to create further tsunamis, but did not.

Tsunami Terminology

Arrival Time:

Time of arrival of the first wave of a tsunami at a particular location.

Coastal Area:

The area of land behind the sea coast up to the zero inundation line during the estimated future tsunamis and beyond the coast in the sea requiring tsunami management; the area on the landward side of the mean water line and the area up to 5m. water depth on the seaward side of the mean water line.

Estimated Time of Arrival:

Computed arrival time of the first wave of a tsunami at the coast after the occurrence of specific major disturbance in the ocean like earthquakes, landslides, volcanic activity in the ocean, meteorite impact on the ocean surface, etc.

Far field Tsunami:

A tsunami capable of widespread destruction, not only in the immediate region of its generation, but across the entire ocean basin.

Green's Function:

A type of function used to solve inhomogeneous differential equations subject to boundary conditions.

Inundation Distance:

The distance that a tsunami wave penetrates onto the shore, measured horizontally from the mean water line. Intensity: Intensity is the degree of damage caused by a tsunami.

Local Tsunami or Near- field Tsunami:

A tsunami which has destructive effects (confined to coasts within 200 Kms of the Source with arrival time less than 30 minutes).

Near-Field Tsunami:

A tsunami from a nearby source, generally less than 200 km or associated with a short travel time of less than 30 minutes.

Regional Tsunami:

A tsunami capable of destruction in a particular geographic region, generally within about1000 km of its source. Regional tsunamis also occasionally have very limited and localized effects outside the region.

Tsunami:

A Japanese term meaning "harbour wave", derived from the characters "tsu" meaning harbour and "nami" meaning wave, to describe a system of ocean gravity waves having a long wave length and period (time between crests), formed as a result of large-scale disturbance of the sea caused by an earthquake.

Vulnerability Line:

Vulnerability line is a setback line to be demarcated on the coastal stretches, taking into account the vulnerability of the coast to natural and man-made hazards.

Tsunami in the Indian Sub-continent

In the past, a few devastating tsunamis have occurred in the Indian Ocean and in the Mediterranean Sea. The most significant tsunami in the region of the Indian Ocean was the one associated with the violent explosion of the volcanic island of Krakatoa in August 1883 which reportedly triggered a thirty metre high tsunami wave and killed 36,500 people in Java and Sumatra in Indonesia. Although not as frequent as in the Pacific Ocean, tsunamis generated in the Indian Ocean pose a great threat to all the countries of the region. Countries most vulnerable to tsunamis in the Indian Ocean region are: Indonesia, Thailand, India, Sri Lanka, Pakistan, Iran, Malaysia, Myanmar, Maldives, Somalia, Bangladesh, Kenya, Madagascar, Mauritius, Oman, Reunion Island (France), Seychelles, South Africa and Australia. Even though tsunamis occur very rarely in the Indian Ocean region, in the last 300 years, this region recorded 13 tsunamis and 3 of them occurred in the Andaman and Nicobar region for which the details of location of epicenter, death/damage caused etc. are not known. The three tsunamis which affected Andaman and Nicobar islands occurred on 19th August 1868, 31st December 1881 and 26th June 1941. The 1945 tsunami following an earthquake of magnitude 8.2 Ms in the Arabian Sea had a maximum run up of 13 metres in Pakistan and resulted in the death of 4,000 people. Overall, the run-up levels in the Indian Ocean tsunamis varied from 1 to 13 metres. In 1977, a strong earthquake of magnitude Ms 8.1 struck west of Sumba Island in Indonesia, but there were no reports of casualties in India due to this tsunami.

Tsunami Risk and Vulnerability in India

The Indian Ocean Tsunami on 26th December, 2004 which devastated the coastal communities in 14 countries, caused enormous loss of life and damage to property, assets and infrastructure in the coastal villages of Kerala, Tamil Nadu, Andhra Pradesh, Puducherry and the Andaman & Nicobar Islands. The tsunami risk and vulnerability which the coastal communities in India are exposed to, even by a distant high intensity earthquake in Indonesia, came as a shock and surprise to the unsuspecting public. The absence of an effective Tsunami Early Warning System (TEWS) and the last mile connectivity to disseminate alert and early warning messages to the coastal communities as well as the lack of public awareness and emergency response preparedness among the various stakeholder groups made the tsunami response more difficult and challenging. Most Tsunamis are caused by earthquakes (of magnitude more than 6.5 on the Richter Scale), with a vertical disruption of the water column generally caused by a vertical tectonic displacement of the sea bottom along a zone of fracture in the earth's crust which underlies or borders the ocean floor. Tsunamis are also generated by volcanic eruptions and submarine landslides, nuclear explosions, and even due to impact or fall of large size meteorites, asteroids, and comets from outerspace. Tsunamigenic zones that threaten the Indian Coast have been identified by considering the historical tsunamis, earthquakes, their magnitudes, location of the area relative to a fault, and also by tsunami modelling. Both the east and west coasts of India and the island regions are likely to be affected by tsunamis from the five potential source regions, viz., the Andaman-Nicobar-Sumatra island arc, Indo-Burmese zone, Nascent Boundary (in the central Indian Ocean), Chagos archipelago and the Makran subduction zone. Even though most people were not aware of the tsunami risk in India's coastal states, the Indian Ocean Tsunami of 26th December 2004 exposed the inherent vulnerabilities of the coastal communities in our 7516 km long coastline. The coastal population has been increasing steadily, mostly due to the expanding scope for exploitation of sea resources and economic activities propelled by increasing urbanization and industrialization in the coastal districts as well as increasing employment opportunities due to the unprecedented expansion in tourism-related activities. However, so far the efforts to strengthen the preparedness of the coastal communities to face the increasing threats of storm surges, sea level rise, coastal erosion, etc. have been often restricted to localized campaigns with very limited impact, in spite of the increasing disaster risk and vulnerability of the coastal communities.

The Tsunami Hazard and Its Assessment

Tsunamis are generated by large and rapid displacements of water, mainly from sudden and large scale changes in the configuration of the sea floor associated with fault displacement or gigantic underwater landslides, which could be mainly due to earthquakes. Till the Indian Ocean tsunami hit the Indian shores on 26th December 2004, people were not aware about the possible tsunami threat in India. Only a few tsunami events in the past have occurred in the Indian Ocean and some of them were highly destructive, causing inundation and flooding wiping out fishery business, disrupting tourism, polluting drinking water, damaging vegetation and crops, destroying shelters and damaging coastal navigation system making huge impact on the economy. It also caused widespread damage to jetties, harbours and coastal structures. Both East and West Indian shorelines are vulnerable to tsunami wave action. It has more than 2200 km shoreline which is heavily populated. For a tsunami to hit Indian coastline, it is necessary that a tsunamigenic earthquake of magnitude greater than 6.5 should occur. Actual tsunami hazard of a coastline depends on its bathymetry and coastal topography. Earthquakes generate tsunamis by vertical movement of the sea floor as in normal faulting or thrust faulting. If the sea floor movement is horizontal, tsunamis are not generated as in strike slip earthquake. However, it is equally possible that tsunamis are triggered also by marine landslides into or under the water surface. They can also be generated by volcanic activity and meteorite impacts, but such events are extremely rare. Tsunami hazard along a coastline is therefore a combination of all the potential sources of tsunamis that lie in the neighbouring sea or ocean. Tsunami velocity is dependent on the depth of water through which it travels, and is equal to the square root of depth times the gravitational acceleration. Tsunami waves travel at a speed of approximately 700 km/hr in 4000 m of water. In 10 m of water the velocity drops to about 36 km/hr. The Tsunami Hazard Area may be empirically defined using a deterministic approach, based upon the observed run-up and inundations during the Tsunami and the potential maximum wave heights for the scenario tsunamis. As found applicable, remote sensing and geographic information system (GIS) of the coastal areas may be used. For the terrestrial environment, the hazards may be presented as inundation levels, in terms of run-up heights at specified land contours. The definition of the tsunami hazard zones, as preliminary estimates, is given below. For Tsunami mitigation as well as development strategies in rural and urban areas, the coastal areas can be divided into four hazard zones, with zone 1 as the less dangerous zone and the zone 4 as the most dangerous zone.

The zones are defined as:

 Zone-1 maximum water depth 0-3 m

 Zone-2 maximum water depth 3-6 m

 Zone-3 maximum water depth 6-9 m

 Zone-4 maximum water depth > 9 m

Tsunami Preparedness

Warning System Components and Instruments

 A Network of Land-based Seismic Stations for earthquake detection and estimation of source parameters in the two known tsunamigenic zones (viz. Java-Sumatra-AndamanMyanmar belt and the North Arabian Sea) that would affect the Indian Ocean region and communicating the same to Early Warning Centre in near-real time.

 Detection of Tsunami generation through a network of 10-12 bottom pressure recorders (that could detect and measure a change in water level of 1 cm at water depths of up to 6 km of water) around these two tsunamigenic zones,

 Monitoring the progress of Tsunami and Storm Surges through a network of 50 real time tide gauges,

 Tsunami Modelling (addressing the inundation and amplification all along the coast and islands for different tsunami originating from different sources),

 Generating and updating a high resolution data base on bathymetry, coastal topography, coastal land use, coastal vulnerability as well as historic data base on Tsunami and Storm Surge to prepare and update Storm Surge/Tsunami hazard maps in 1:5,000 scale (for coastal areas within 1-3 km in general and for 10-25 km at selected areas near coastal water bodies), Setting up a dedicated National Early Warning

Centre (NEWC) for monitoring tsunamis and storm surges in India for operation on 24x7 basis and for generation of timely advisories, and

 Capacity building, training and education of all stakeholders on utilisation of the maps, warning and watch advisories.

Do's & Dont's

Before & During

 Find out if your home is in the danger zone.

 Know the height of your street/house above sea level and the distance from the coast.

 People living along the coast should consider an earthquake or strong ground rumbling as a warning signal.

 Try and climb a raised platform or climb the highest floor of any house or building which you might see.

 Make evacuation plans and a safe route for evacuation. Stay away from the beach.

 Never go down near the beach to watch the Tsunami.

 Listen to a radio or television to get the latest information and be ready to evacuate if asked to do so.

 If you hear an official warning, evacuate at once. Return home only after authorities advice it is safe to do so.

After

 Stay tuned to the battery-operated radio for the latest emergency information. Help injured and trapped persons.

 Stay away from flooded and damaged areas until officials say it is safe to return. Enter your home with caution.

 Use flashlight when entering damaged houses. Check for electrical short circuit and live wires.

 Check food supplies and test drinking water.

Important organizations in India

 Ministry of Home Affairs http://www.ndmindia.nic.in/

 CESS, (Centre for Earth Science Studies) http://www.cessind.org/

 GSI, (Geological Society of India) http://www.geosocindia.org/

 GSI, (Geological Survey of India) http://www.gsi.gov.in/

 IMD, (India Meteorological Department) http://www.imd.gov.in/

 NDMA, (National Disaster Management Authority) (India) http://ndma.gov.in/ndma/index.htm

 NGRI, (National Geophysical Research Institute) http://www.ngri.org.in/

 NICEE,(National Information Centre of Earthquake Engineering) http://www.nicee.org/

 www.seedsindia.org

 WIHG, (Wadia Institute of Himalayan Geology) http://www.wihg.res.in/

 Map of earthquakes in India http://www.mapsofindia.com/maps/india/majorearthquake.htm

 Indian standards on earthquake engineering http://www.bis.org.in/other/quake.htm

 Seismic codes in India http://www.nicee.org/IITK-GSDMA_Codes.php

1. Floods

Floods are among the most frequent and costly natural disasters. Conditions that cause floods include heavy or steady rain for several hours or days that saturate the ground. Flash floods occur suddenly due to rapidly rising water along a stream or low-lying area.

A flood is an excess of water (or mud) on land that's normally dry and is a situation where in the inundation is caused by high flow, or overflow of water in an established watercourse, such as a river, stream, or drainage ditch; or ponding of water at or near the point where the rain fell. This is a duration type event. A flood can strike anywhere without warning, occurs when a large volume of rain falls within a short time.

TYPES OF FLOODS

Flash Floods: Floods occurring within six hours, mainly due to heavy rainfall associated with towering cumulus clouds, thunderstorms, tropical cyclones or during passage of cold weather fronts, or by dam failure or other river obstruction. This type of flood requires a rapid localized warning system.

River Floods: Floods caused by precipitation over a large catchment‟s area, melting of snow or both. Built up slowly or on a regular basis, these floods may continue for days or weeks. The major factors of these floods are moisture, vegetation cover, depth of snow, size of the catchment‟s basin, etc.

Coastal Floods:- Floods associated with cyclonic activities like Hurricanes, Tropical cyclones, etc. generating acatastrophic flood from rainwater which often aggravate wind-induced storm and water surges along the coast.

Urban Flood: As land is converted from agricultural fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization decreases the ability to absorb water 2 to 6 times over what would occur on natural terrain. During periods of urban flooding, streets can become swift moving rivers, while basements can become death traps as they fill with water.

Ice Jam: Floating ice can accumulate at a natural or human-made obstruction and stop the flow of water thereby causing floods. Flooding too can occur when there the snow melts at a very faster rate.

Glacial Lake Outbursts Flood (GLOF): Many of the big glaciers which have melted rapidly and gave birth to the origin of a large number of glacier lakes. Due to the faster rate of ice and snow melting, possibly caused by the global warming, the accumulation of water in these lakes has been increasing rapidly and resulting sudden discharge of large volumes of water and debris and causing flooding in the downstream.

Characteristics of floods

Depth of water- Building foundations and vegetation will have different degrees of tolerance to bring inundated water.

Duration – Damage to structures, infrastructure vegetation related to duration l of time with water inundation.

Velocity – High velocities of flow create erosive forces, hydrodynamic pressure, which destroy foundation supports and may occur on floodplains or in the main river channel.

Frequency of occurrence – The frequency of occurrence measured over period of time determines types of construction or agricultural activities on the floodplain.

Seasonality – Flooding during a growing season destroy crops while cold weather, floods seriously affect the community.

Causes of floods

Inadequate capacity of the rivers to contain within their banks the high flows brought down from the upper catchment areas following heavy rainfall, leads to flooding. The tendency to occupy the flood plains has been a serious concern over the years. Because of the varying rainfall distribution, many a time, areas which are not traditionally prone to floods also experience severe inundation. Areas with poor drainage facilities get flooded by accumulation of water from heavy rainfall. Excess irrigation water applied to command areas and an increase in ground water levels due to seepage from canals and irrigated fields also are factors that accentuate the problem of water-logging. The problem is exacerbated by factors such as silting of the riverbeds, reduction in the carrying capacity of river channels, erosion of beds and banks leading to changes in river courses, obstructions to flow due to landslides, synchronisation of floods in the main and tributary rivers and retardation due to tidal effects.

The primary causes for Floods are:

- Intense rainfall when the river is flowing full.
- Excessive rainfall in river catchments or concentration of runoff from the tributaries and river carrying flows in excess of their capacities.
- Cyclone and very intense rainfall when the EL Nino effect is on a decline.
- Synchronization of flood peaks in the main rivers or their tributaries.
- Landslides leading to obstruction of flow and change in the river course.
- Poor natural drainage system.

Flood prone areas

India is one of the most flood prone countries in the world. The principal reasons for flood lie in the very nature of natural ecological systems in this country, namely, the monsoon, the highly silted river systems and the steep and highly erodible mountains, particularly those of the Himalayan ranges. The average rainfall in India is 1150 mm with significant variation across the country. The annual rainfall along the western coast and Western Ghats, Khasi hills and over most of the Brahmaputra valley amounts to more than 2500 mm. Most of the floods occur during the monsoon period and are usually associated with tropical storms or depressions, active monsoon conditions and break monsoon situations.

Floods occur in almost all rivers basins in India. The main causes of floods are heavy rainfall, inadequate capacity of rivers to carry the high flood discharge, inadequate drainage to carry away the rainwater quickly to streams/rivers. Ice jams or landslides blocking streams; typhoons and cyclones also cause floods. Flash floods occur due to high rate of water flow as also due to poor permeability of the soil. Areas with hardpan just below the surface of the soil are more prone to, floods as water fails to seep down to the deeper layers.

Brahmaputra, Ganga, Narmada, Tapti, Mahanadi, Krishna & Cauvery are the most flood prone areas. Survey by Rashtriya Barh Ayog in 1980 says that 40 million hectares areas are flood affected. Heavy rain in Himalayas during South west monsoon causes flood in the rivers of U.P., Bihar, W.Bengal & Assam while Central & Southern rivers get flooded by heavy rainfall due to depression in Bay of Bengal during south-west monsoon season. In most flood prone states, land depression, low-pressure areas are the two most important synoptic systems responsible for floods. In Bihar 100% and in U.P. 82% flood is caused due to land depression and well marked low pressure. In W.Bengal main reason for flood is cyclonic circulation. Whereas in Punjab, Gujarat, Rajasthan & Jammu & Kashmir the main reason is low pressure areas. Flood in Orissa and Andhra Pradesh is due to monsoon

Flood preparedness and measurement

Since ages, people have coped and learned to live with floods. They have generally settled in areas away from flood and have adapted agricultural practices which can sustain in flood waters. Traditional methods based on locally available resources have been used to minimize the damages during flood. With the increase in population, flood prone areas have been occupied and this is a principal factor in the huge losses presently seen. The various mitigation measures for flood can be categorized into structural and non structural measures.

Regulation and enforcement

Unplanned and unregulated developmental activities in the flood plains of the rivers and encroachments into the waterways have led to increase in flood losses as well as flood risk. The colossal loss of lives and property due to the flooding of the towns and cities and the areas which get flooded almost every alternate year is a recent phenomenon and effective steps are required for regulating unplanned growth in the flood plains and preventing encroachment in the waterways.

Capacity Development

The capacity development covers the aspects of flood education, target groups for capacity development, capacity development of professionals, training, research and development and documentation with respect to flood management. The proposals for strengthening the existing systems are also given therein. An action plan for capacity development has also been formulated.

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Flood Preparedness and Mitigation

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Flood response

An effective and prompt response to floods is very important for minimising the loss of lives and properties and providing immediate relief to the affected people. The role of communities and NGOs is vital in search, rescue and relief operations. Immediate medical assistance to the affected people and steps for prevention of outbreak of epidemics after the floods are essential components of flood response. As per provisions of the DM Act, 2005, the GOI has constituted National Disaster Response Force (NDRF) for the purpose of specialised response to disasters. Over and above this, a mechanism for coordinated approach and efforts are required for effective response.

Structural Measures

Embankments: This has been one of the major structural approaches in which the river is restricted to its existing course and prevented from overflowing the banks. Usually embankments are constructed with earth but at some places masonry and concrete walls are also used. However what is important is to note here that embankments are designed to provide a degree of protection against flood of a certain frequency and intensity or a maximum recorded flood depending on the location and economic justification. During recent times, divergent views have emerged concerning effectiveness of embankment. While there are serious concerns over their usefulness over a long time frame, there have also been arguments in favor such as providing only road communication during flood seasons and shelter in low lying areas. Studies on effectiveness of embankments conducted around the world, have pointed out some of the problems such as poor congestion in protected areas, silting of rivers which not only means rising river bed level and consequent decrease in carrying capacity but also depriving neighboring agricultural land from fertile soil and ground water recharge. There have also been concerns on the issue of embankment capacity to withstand erosion.

Dams, Reservoirs and other Water Storage Mechanism: Dams, reservoirs and other water storages, both natural and man-made, are an effective means for reducing the flood peaks in the rivers. The important role played by them in flood moderation and comprehensive mechanism for the operation and regulation of reservoirs, which takes into account the international, inter-state and inter-regional aspects. As large dams and reservoirs have potential for huge damage guidelines for ensuring safety thereof have also been detailed therein.

Channel Improvements: The aim of Channel Improvements is to increase the area of flow or velocity of flow or both to increase carrying capacity. Normally this measure involves high cost and there are also problems of topographical constraints to execute such a measure.

De-silting and Dredging of Rivers: The de-silting approach is still to be perfected in the sense that various committees and expert groups appointed by Government of India are yet to recommend this measure as an effective mitigation strategy. However, selective de silting and dredging of rivers at outfalls/confluences or local reaches can be adopted.

Drainage Improvement: This aims at construction of new channels or improving capacity of existing channels to decongest and prevent flooding. However, what is important is to ensure that such an approach do not cause congestion and flooding in downstream areas.

Diversion of Flood Water: This involves diverting all or part of flood water into natural or artificial constructed channels which may be within or outside the flood plain. The diverted water may or may not be returned to the river at a down stream. Usually effective to prevent flooding around cities, the flood spill channel for Srinagar and the supplementary drain in Delhi are examples of this approach.

<u>Catchments Area Treatment</u>

The aim in this approach is to provide protection to catchment areas through measures such as afforestation which minimize siltation of reservoirs and silt load in the rivers. This can be a very useful approach to control flood peaks and suddenness of run offs.

Sea Walls/Coastal Protection Works

The construction of Sea walls and other such work, try to prevent flooding from Sea water. These are highly cost intensive apart from the fact that complexity of sea behavior and other environmental aspects should also be considered.

Non-Structural Measures

Flood Plain Zoning: The basic idea here is to regulate land use in the flood plain in order to restrict the damages. It aims at determining the location and extent of areas for developmental activities so that damage is minimized. It lays down guidelines for various types of development so that adequate mitigation is built for the worst flood scenario. There can be different consideration for preparing flood plain zoning for example, one can locate parks, playgrounds etc. for area which have a up to 10 year frequency while prohibiting residential colonies, industries, etc. and allowing residential and other public utilities with specific design guidelines in areas which have a 25 year frequency.

Flood Forecasting and Warning: A nationwide flood forecasting and warning system is developed by Central Water Commission (CWC) and this initiative has also been supplemented by states who make special arrangements for strategically important locations in their states. The forecasts can be of different types such as forecast for water level (stage forecast), discharge (flow forecast) and area to be submerged (inundation forecast). The forecast when carries definite risk information is called warning. The flood forecasting services involve collection of hydrological data (gauge, discharge), meteorological data such as rainfall.

Flood Proofing: These are measures designed to minimize the impact when flood water comes such as raised platform for shelter to population, cattle etc., raised platform for drinking water hand pumps, bore wells above flood level, house/building architecture, provision for relocating vial installation such as communication, power etc.

Flood Safety Tips

Do's and Dont's (Before and During Floods)

- All your family members should know the safe routes to nearest shelter/raised pucca house.
- If your area is flood-prone, consider suitable flood resistant building materials.
- Keep dry food, drinking water and clothes ready. Drink preferably boiled water. Keep your food covered, don't take heavy meals.
- Do not let children and pregnant woman remain an empty stomach.
- Be careful of snakes, as snake bites are common during floods.

Do's and Dont's (After Floods)

- Pack warm clothing, essential medication, valuables, personal papers, etc. in waterproof bags, to be taken with your emergency kit.
- Raise furniture, clothing and valuable onto beds, tables and in attic.
- Turn off the main electricity power supply. Do not use electrical appliances, which have been in flood water.
- Do not get into water of unknown depth and current.
- Do not allow children to play in, or near flood water.

2. Drought

It is difficult to provide a precise and universally accepted definition of drought due to its varying characteristics and impacts across different regions of the world, such as rainfall patterns, human response and resilience, and diverse academic perspectives.

Drought is a temporary aberration unlike aridity, which is a permanent feature of climate. Seasonal aridity (i.e. a well-defined dry season) also needs to be distinguished from drought. Thus drought is a normal, recurrent feature of climate and occurs in all climatic regimes and is usually characterized in terms of its spatial extension, intensity and duration. Conditions of drought appear when the rainfall is deficient in relation to the statistical multi-year average for a region, over an extended period of a season or year, or even more.

Drought differs from other natural hazards such as cyclones, floods, earthquakes, volcanic eruptions, and tsunamis in that:

- No universal definition exists;
- Being of slow-onset it is difficult to determine the beginning and end of the event;
- Duration may range from months to years and the core area or epicentre changes over time, reinforcing the need for continuous monitoring of climate and water supply indicators;
- No single indicator or index can identify precisely the onset and severity of the event and its potential impacts; multiple indicators are more effective;
- Spatial extent is usually much greater than that for other natural hazards, making assessment and response actions difficult, since impacts are spread over larger geographical areas;
- Impacts are generally non-structural and difficult to quantify;

Impacts are cumulative and the effects magnify when events continue from one season or year to the next.

Types of Drought

Meteorological Drought is defined as the deficiency of precipitation from expected or normal levels over an extended period of time. Meteorological drought usually precedes other kinds of drought. According to the legend, meteorological drought is said to occur when the seasonal rainfall received over an area is less than 25% of its long-term average value. It is further classified as moderate drought if the rainfall deficit is 26–50% and *severe drought* when the deficit exceeds 50% of the normal.

Hydrological Drought is best defined as deficiencies in surface and subsurface water supplies leading to a lack of water for normal and specific needs. Such conditions arise, even in times of average (or above average) precipitation when increased usage of water diminishes the reserves. **Agricultural Drought**, usually triggered by meteorological and hydrological droughts, occurs when soil moisture and rainfall are inadequate during the crop growing season causing extreme crop stress and wilting. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth and the physical and biological properties of the soil. Agricultural drought thus arises from the variable susceptibility of crops during different stages of crop development, from emergence to maturity. In India, it is defined as a period of four consecutive weeks (of severe meteorological drought) with a rainfall deficiency of more than 50% of the long-term average (LTA) or with a weekly rainfall of 5 cm or less from mid-May to mid-October (the kharif season) when 80% of India‟s total crop is planted or six such consecutive weeks during the rest of the year (NRSC, Decision Support Centre).

Impacts of Drought

Drought produces wide-ranging impacts that span many sectors of the national economy. These impacts are felt much beyond the area experiencing physical drought. The complexity of these impacts arises because water is integral to our ability to produce goods and provide services. Drought produces both direct and indirect impacts. Direct impacts or primary impacts are usually physical / material and include reduced agricultural production; increased fire hazard; depleted water levels; higher livestock and wildlife mortality rates; and damage to wildlife and fish habitats. When direct impacts have multiplier effects through the economy and society, they are referred to as indirect impacts. These include a reduction in agricultural production that may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced purchasing capacity and demand for consumption, default on agricultural loans, rural unrest, and reduction in agricultural employment leading to migration and drought relief programmes. The more removed the impact from the cause, the more complex is the link to the cause. These multiplier effects are often so diffuse that it is very difficult to generate financial estimates of actual losses caused by a drought.

The impacts of drought are generally categorized as economic, environmental, and social:

Economic impacts refer to production losses in agriculture and related sectors, especially forestry and fisheries, because these sectors rely on surface and subsurface water supplies. It causes a loss of income and purchasing power, particularly among farmers and rural population dependent on agriculture. All industries dependent upon the primary sector for their raw materials would suffer losses due to reduced supply or increased prices. Drought thus has a multiplier effect throughout the economy, which has a dampening impact on employment, flow of credit and tax collections. If the drought is countrywide, macroeconomic indicators at the national level are adversely impacted.

Environmental impacts, such as lower water levels in reservoirs, lakes and ponds as well as reduced flows from springs and streams would reduce the availability of feed and drinking water and adversely affect fish and wildlife habitat. It may also cause loss of forest cover, migration of wildlife and their greater mortality due to increased contact with agricultural producers as animals seek food from farms and producers are less tolerant of the intrusion. A prolonged drought may also result in increased stress among endangered species and cause loss of biodiversity. Reduced streamflow and loss of wetlands may cause changes in the levels of salinity. Increased groundwater depletion, land subsidence, and reduced recharge may damage aquifers and adversely affect the quality of water (e.g., salt concentration, increased water temperature, acidity, dissolved oxygen, turbidity). The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape.

Social impacts arise from lack of income causing out migration of the population from the drought-affected areas. People in India seek to cope with drought in several ways which affect their sense of well-being: they withdraw their children from schools, postpone daughters‟ marriages, and sell their assets such as land or cattle. In addition to economic hardships, it causes a loss of social status and dignity, which people find hard to accept. Inadequate food intake may lead to malnutrition, and in some extreme cases, cause starvation. Access and use of scarce water resources generate situations of conflict, which could be socially very disruptive. Inequities in the distribution of drought impacts and relief may exacerbate these social tensions further.

Prevention and Preparedness

Prevention and Preparedness means predisaster activities designed to increase the level of readiness and improvement of operational and institutional capabilities for responding to a drought. Drought prevention and preparedness involve water supply augmentation and conservation (e.g. rainwater harvesting techniques), expansion of irrigation facilities, effective dealing with drought, and public awareness and education. Transport and communication links are a must to ensure supply of food and other commodities during and just after a drought. Successful drought management requires community awareness on the mitigation strategies, insurance schemes for farmers, crop contingency plans, etc.

Basic to drought management in the Indian context is the delineation of drought prone areas. At the block level, the following indicators are generally used.

Drought Prone Area Delineation

Criteria and data base:

- Rainfall (long term average - 30 to 50 yrs) (Short Term average – 5 to 10 years for giving real picture as a rainfall pattern may change over the period for e.g. Cherapunji);
- Cropping pattern (past 3 to 5 years);
- Available supplement irrigation (well, tank, ponds, ground water etc.);
- Satellite derived indicators (last 10 years);
- Soil map;
- Ground water availability map;
- Cattle population and fodder demand;
- Socio-economic data;
- Other water demands like for drinking, industrial use etc.; and
- Collection and creation of data base and spatial framework for analysis

Gradation of Drought Prone Areas (High, Moderate, Low): Areas should also be graded on the basis of degree of drought proneness since it would affect the steps required for greater preparedness. This would require multiple criteria approach that includes

- Sensitivity to Rainfall Variation;
- Frequency of Occurrence of Drought;
- Vulnerability of Community (people and livestock) to Drought

Monitoring of Drought

Having delineated drought prone areas and their gradation one could move on to the criteria for monitoring relevant indicators. The monitoring indicators will be:

- Rainfall and other associated weather parameters
- Crop health (based on satellite derived NDVI and field reports)
- Available ground water (variation in ground water table) and surface water resources
- Migration and impact on community

Observational Network

For such monitoring one would require a reasonably dense observational network.

- Automatic weather station (25 km x 25 km)
- Automatic rain-gauge (5 km x 5 km)
- Ground water table observation (5 km x 5 km in hard rock region and 10 km x 10 km in alluvial plains)
- Field reports from the block/mental level
- Satellite data of 50 m x 50 m resolution

Medium Range Weather Forecasting for Community Level Advisory

Numerical weather prediction has emerged as one of the important discipline requiring increasing computing power. To have accurate timely forecasts, state-of-art computers are used all over the world. Currently forecasting in India suffers from following constraints:

- The information is too general in terms of space and time while forecasting needs are at local level
- The timing does not match user needs;

- Information received from different sources transmit conflicting messages;

- The language is not clearly understood by users.

3. Cyclones

Tropical Cyclone (TC), also known as„Cyclone‟ is the term used globally to cover tropical weather systems in which winds equal or exceed „gale force‟ (minimum of 34 knot, i.e., 62 kmph). These are intense low pressure areas of the earth atmosphere coupled system and are extreme weather events of the tropics.

A tropical cyclone is a storm system characterised by a large low pressure centre and numerous thunderstorms that produce strong winds and flooding rain. Tropical cyclones feed on heat released when moist air rises, resulting in condensation of water vapour contained in the moist air. The term „tropical‟ refers to both the geographic origin of these systems, which form almost exclusively in tropical regions of the globe, and their formation in maritime tropical air masses. The term „cyclone‟ refers to such storms‟ cyclonic nature, with counter clockwise rotation in Northern Hemisphere and clockwise rotation in the Southern Hemisphere. Depending on its location and strength, a tropical cyclone is called by many other names, such as hurricane, typhoon, tropical storm, cyclonic storm, tropical depression and simply cyclone. While tropical cyclones can produce extremely powerful winds and torrential rain, they are also able to produce high waves and damaging storm surges. They develop over large bodies of warm water, and lose their strength if they move over land. This is the reason for coastal regions receiving a significant damage from a tropical cyclone, while inland regions are relatively safe from their effect. Heavy rains, however, can produce significant flooding inland, and storm surges can produce extensive coastal flooding up to 40 kilometres from the coastline. Although their effects on human populations can be devastating, tropical cyclones can also relieve drought conditions. They also carry heat and energy away from the tropics and transport it toward temperate latitudes, which make them an important part of the global atmospheric circulation mechanism. As a result, tropical cyclones help to maintain equilibrium in the earth‟s troposphere, and to maintain a relatively stable and warm temperature worldwide.

A strong tropical cyclone usually harbours an area of sinking air at the centre of circulation. This area is called „eye of the cyclone‟. Weather in the eye is normally calm and free of clouds, although sea may be extremely violent. The eye is normally circular in shape, and may vary in size from 3 km to 370 km in diameter. Surrounding the eye is the region called „Central Dense Overcast (CDO)‟, a concentrated area of strong thunderstorm activity. Curved bands of clouds and thunderstorms trail away from the eye in a spiral fashion. These bands are capable of producing heavy bursts of rain and wind, as well as tornadoes. If one were to travel between the outer edge of a hurricane to its centre, one would normally progress from light rain and wind, to dry and weak breeze, then back to increasingly heavier rainfall and stronger wind, over and over again with each period of rainfall and wind being more intense and lasting longer.

Classification of Tropical Cyclones

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

Type of Disturbances	Associated Wind Speed in the Circulation
Low pressure Area	Less than17 knots (<31 kmph)
Depression	17 to 27 knots (31 to 49 kmph)
Deep Depression	28 to 33 knots (50 to 61 kmph)
Cyclonic Storm	34 to 47 knots (62 to 88 kmph)
Severe Cyclonic Storm	48 to 63 knots (89 to 118 kmph)
Very Severe Cyclonic Storm	64 to 119 knots (119 to 221 kmph)
Super Cyclonic Storm	120 knots and above (222 kmph and above)

Destruction caused by Cyclones

There are three elements associated with cyclones which cause destruction during its occurrence. These are:

Strong Winds/Squall: Cyclones are known to cause severe damage to infrastructure through high speed winds. Very strong winds which accompany a cyclonic storm damages installations, dwellings, communications systems, trees etc., resulting in loss of life and property. Gusts are short but rapid bursts in wind speed are the main cause for damage. Squalls on the other hand,are longer periods of increased wind speed and are generally associated with the bands of thunderstorms that make up the spiral bands around the cyclone.

Torrential rains and inland flooding: Torrential rainfall (more than 30 cm/hour) associated with cyclones is another major cause of damages. Unabated rain gives rise to unprecedented floods. Rain water on top of the storm surge may add to the fury of the storm. Rain is a serious problem for the people which become shelter less due to cyclone. Heavy rainfall from a cyclone is usually spread over wide area and cause large scale soil erosion and weakening of embankments.

Storm Surge: A Storm surge can be defined as an abnormal rise of sea level near the coast caused by a severe tropical cyclone; as a result of which sea water inundates low lying areas of coastal regions drowning human beings and life stock, causes eroding beaches and embankments, destroys vegetation and leads to reduction of soil fertility.

Brief details about damages caused by wind of different speed during cyclones are as under

Wind Speed Intensity	Damages expected
Low Pressure Area	Less than 17 knots (<31 kmph)
Depression	17 to 27 knots (31 to 49 kmph)
Deep Depression	28 to 33 knots (50 to 61 kmph)
Cyclonic Strom	34 to 47 knots (62 to 88 kmph)
Severe Cyclonic Strom	48 to 63 knots (89 to 118 kmph)
Very Severe Cyclonic Strom	64 to 119 knots (119 to 221 kmph)
Super Cyclonic Strom	1120 knots and above (222kmph and above)

Cyclone warning system in India

The India Meteorological Department is responsible for providing tropical cyclone warnings in India. The tropical cyclone warning service is one of the most important functions of the India Meteorological Department and it was the first service undertaken by the Department which is more than 135 years old.

Safety Tips

Do's and Don'ts: Before and During

- Listen to radio or TV weather reports and alert everyone through a loud speaker or by going home to home.
- Identify safe shelter in your area. These should be cyclone resistant and also find the closest route to reach them.
- Keep your emergency kit and basic food supply, medicines, torch and batteries etc. ready.

- Doors, windows, roof and walls should be strengthened before the cyclone season through retrofitting and repairing. Store adequate food grains and water in safe places.

- Conduct Mock Drills for your family and the community.

- Do not venture into the sea. Stay Indoors under the strongest part of the house if not moved to the cyclone shelter.

- Remain indoors until advised that the cyclone has passed away.

- Do not go out till officially advised that it is safe. If evacuated, wait till advised to go back.

- Use the recommended route to return to your home. Do not rush.

- Be careful of broken powers lines, damaged roads and house, fallen trees etc.

Definition of Disaster Management

A disaster is any occurrence that causes widespread distress and destruction. The definition of disaster management isn't about stopping such an event when it occurs. Rather, it is about reducing the impact of these events on a company or community. When you don't create a plan to deal with disasters, you could end up having to deal with lost revenue and massive human casualties. Disaster management covers a whole range of events, including communication failures, public disorder, terrorism, natural disasters and artificial disasters like electrical fires and industrial sabotage.

For you to be able to avoid the loss of revenue, employees, clients and capital investments in your business, you should identify any potential risks faced by your business and anticipate them. That way, you will be able to take some measures to prevent them and to also prepare plans that will enable you to mitigate the impact of these disasters if they do eventually occur. You will be able to ensure the continuity of your business and reduce the loss of revenue. It is important that your organization has procedures in place to determine when it is safe to say a disaster has occurred and when the disaster management protocol should be initiated. That is the greatest importance of disaster management disaster is basically the difference between the sum total of the vulnerability a business or community has to a hazard and the actual occurrence of the hazard and the capacity of the community or business to handle that hazard.

The economic or social development of a business or community can be important components in the preparedness of that business or community for a disaster. However, these should be handled with caution, especially when all the risks aren't well known. While development can reduce the risk of a disaster, it can sometimes also increase that risk and even make it worse if it does occur. On the other hand, while it may seem like natural disasters push a business or community back in terms of development, sometimes they can also provide the impetus for the business or community to explore the development opportunities they hadn't considered before.

The term "disaster management" is used to cover all the aspects involved in planning for and responding to disasters. This includes the measures taken before the event happens and those taken after the event happens. Disaster management isn't just about responding to the event and providing relief to the sufferers. It is also about reducing the total negative impact of the event and preventing its reoccurrence or consequences in the future.

Three Major Goals of Disaster Management

The three major goals of disaster management are creating a more durable and effective recovery, planning proactively to mitigate the risks faced by a business and reducing the loss suffered via more effective planning and response efforts.

There are many types of crises, or types of disaster, that should be identified during the planning process in order to implement different disaster management strategies for each. There are eight types of disaster in total**:**

- Terrorist attacks
- Rumors
- Workplace violence
- Organizational misdeeds
- Malevolence
- Confrontation
- Technological crises
- Natural disasters

The process followed by emergency managers is fairly straightforward and common among all organizations. It helps them to anticipate the disaster, assess the severity of the disaster, respond to the disaster and recover from it in a timely, effective and durable manner.

There are five phases to disaster management:

1. The Prevention of the Disaster

This is the phase where the human hazard of the disaster is prevented. It is typically used when you are dealing with terrorist attacks and natural disasters. You will take preventive measures which are well designed to provide the people with some kind of permanent protection from the disaster in question. You should note that you can't prevent all kinds of disasters, especially natural disasters. However, you can and should mitigate the risk of anyone losing his life or suffering a major injury by planning for evacuation, planning for the environment and implementing proper design standards.

2. The Mitigation of the Disaster

This can be used for a variety of disaster types. Consider electrical disasters, for example. You could audit the power quality regularly and undertake maintenance processes that prevent any obvious but avoidable disaster from occurring. That way, you could prevent electrical fires or at least reduce the risk of them occurring. More than 85 percent of fires are actually caused by electrical malfunctions that could have been prevented by taking the right measures.

When you live an area prone to earthquakes, you could undertake some preventive measures, such as installing an earthquake valve that will shut off the supply of natural gas to a building in order to prevent a fire. You could also install seismic retrofits in houses and fit them with robust security systems. This may include mounting to the walls items such as water heaters, refrigerators, furniture and anything that is breakable. You can also add latches to the cabinets. If you live in an area that is prone to flooding, you might choose to build your house on stilts.

These mitigation measures can go a long way in reducing the negative impacts of disasters. It is best to be proactive long before the disaster hits.

3. Preparedness for the Disaster

This phase is about readying the equipment and processes that will be implemented in the event of a disaster. These will be used to mitigate the impact of the disaster if it finally strikes. They can also be used to facilitate efficient responses in the event of an emergency.

The steps taken to ensure proper preparedness include:

- Assessing the risks of the disaster
- Integrating environmental and social issues to the strategies and operations undertaken by your business
- Implementing systems and protocols that mitigate risks
- Creating plans for how you will respond to and recover from the disaster
- Undertaking disaster risk management. This is the application of management practices, procedures and policies to the process of identifying disaster risks and then analyzing them,

evaluating them, treating them and monitoring them. You can then undertake disaster risk reduction, which involves undertaking measures to reduce the losses brought on by these disasters by treating the vulnerability of people to hazards. For you to undertake disaster risk management successfully, you should start long before the disaster happens and continue long after the disaster has struck. It will also involve the learning of important lessons which help to prevent the occurrence of the disaster in the future.

4. Response to the Disaster

This phase is an elaborate version of search and rescue and focuses on handling the humanitarian needs that must be fulfilled post-event. It is all about the actions undertaken during the disaster and afterwards in order to reduce the negative impact of the disaster and to provide people with support and relief. It involves providing people with rescue, medical aid, shelter, water and food, among other things. It is often a coordinated process and involves supporting the affected population by helping them to reconstruct their physical structures and infrastructure and to help them restore their physical, economic, social and emotional well-being. It also involves rebuilding their businesses and providing them with counseling.

5. Recovering from the Disaster

This phase begins immediately after the disaster has subsided or when there is no longer an immediate threat to human life. The goal of this phase is to restore the normalcy that had prevailed in the population prior to the disaster in the quickest and most durable fashion.

How to Prepare for Disaster as a Company

There are various components to this process and they all work together to ensure that the company is well prepared for the disaster and that the company recovers from it in a timely and durable fashion.

1. The Assessment of Risk

Before you can plan for a disaster, you need to assess the risks involved in order to gain an intimate understanding of the environment and the circumstances under which you will be planning for that disaster. You should start by establishing the context in which the risk exists, identifying all of the potential risks involved and then analyzing them by determining the probability of their occurrence and the impact they would have. You can finally prioritize how the risks will be addressed and treat them appropriately.

You can't eliminate all risks. You can, however, minimize their impact by taking various measures. You will be helped in this by your own experiences, the practices that have been employed in the past by other companies that faced the same risks and technical measures you can undertake on your own.

2. The Planning Phase

Here you should develop contingency plans or update existing ones based on the experience you gained during a previous disaster. Planning for contingencies is effective when you include all the relevant actors in an emergency in a participatory process. You're planning forward, so you need to agree on potential scenarios, actions and response systems. The key, however, is that you have a plan to begin with.

3. Testing and Training

There are many ways you can carry out training. You could carry out tabletop exercises where you hold interactive discussions about the possible scenarios that could occur in a disaster. You could have drills where you mobilize resources in a limited fashion and test response strategies. Drills are often focused on a single component of a response plan. You could also conduct a comprehensive simulation of the entire response plan with all of its components.

Disaster Management Around the World

There are various trends around the world regarding how disaster management is approached.

- There is a focus on managing the risk of disaster in advance.
- Corporate donations are shifting from cash to other resources as well.
- Disaster preparedness is being integrated in development programs.
- Rapid emergency response teams and emergency units are being developed.
- Development banks and the private sector are becoming more involved.
- Professional guidelines and standards are being improved.
- Mitigation programs are being emphasized more than response programs.

Disaster management is something that is important to all of us, both companies and communities alike. As a business, you can take part in the global push to adopt better disaster management practices, not only to protect yourself but also to protect the community around you in the event of a disaster.

Disaster Risk

Risk is a technical concept, which is used by engineering and management specialists to arrive at an estimation of losses in the event of a disaster and the expected probability of its occurrence. Risk is precisely defined by the ISDR as "the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions". Conventionally, the notation expresses risk: Risk = Hazards x Vulnerability.

Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability. Risk is different from threat. Threat is a more abstract concept while risk is an expression of perceived threat in specific terms. Threat is a danger that has an extremely low probability of occurrence. For purposes of public policy, threat has to be articulated objectively in terms of risks, the probability of their occurrence and the damages involved in each specific case. For example, apprehension of terrorism was a threat in America. No policy could be devised to meet the threat, since threat had not been articulated as risks for the sake of preventive policy. Vulnerability is understood as system faults or weaknesses, which threat exploits to create the negative 'impact' known as disaster. Risk management involves minimising the vulnerabilities so as to reduce the impact of the threat. Risks are both inherent in social systems; are created, or exist due to inherent characteristics in the system. The ecological context is therefore significant in the understanding vulnerabilities of people in different cultures. Risk is sometimes taken to be synonymous with hazard, but risk has an additional implication of the probability of a particular hazard actually occurring. Risks are created due to excessive resource use that leads to serious degradation of the environment. Factors behind such intensified resource use are rapid population growth, market induced demand, greed of the rich and resource exploitative public policies such as mining for which rocks are blasted and poisonous substances are released in the environment. Invariable consequences are the disruption of conditions conducive to biophysical processes that ultimately harm the stability and sustainability of mountain environments. Presentation of Risk Risk is a matter of precise quantification. Risk may be expressed in terms of average expected losses from a given hazard to a given element at risk, over a specified future time period, for example, as; "25000 lives lost over a 30 year period or as 75000 houses experiencing heavy damage or destruction within 25 years or alternatively, on a probabilistic basis, as a 75% probability of economic losses to property, exceeding 50 million dollars, in the town of Puerto Neuvo, within the next ten years". The term specific risk is used to refer to risk or loss estimations of either type which are expressed as a proportion of the total; the first two examples might also be expressed as; 10% of the total population killed by natural hazards within 30 years or 50% of houses heavily damaged or destroyed in the next 25 years. Specific risk is also used for financial losses to property where is usually refers to the ratio if the cost of repair or reinstatement of the property to the total cost of replacement. Frequently, the shorter-term risk is used to refer to what are strictly 'specific risks.' Specific risk gives the average rate of loss or attrition rate. While this is useful for estimating losses over a long period of time it can give a misleading idea of the nature of risk from natural hazards. Most of the losses actually occur through infrequent single large events, rather than in the form of a slow continuous process of destruction. (Coburn, Sspence, Pomonis, Disaster Management Training Programme, 1994) Precise quantification of risk, however, is difficult. At best, a gross estimation of risk is possible, taking, for example, number of deaths and the number of people exposed to a hazard. Such crude estimates give only a limited idea of the likely damage from a hazard for different peoples at different places or even the probability of its occurrence. For example; "… the probability of being killed in an earthquake in Iran during any one year is obtained from the total number of killed by earthquakes in Iran this century (120,000) divided by 90 years. This gives an average of 1, 300 people killed annually. The population of Iran, currently (55 million) averaged over the past ninety years is less than 30 million, so the average probability of being killed in an earthquake is given as one in 23,000.6…" (Source: Disaster Management Training Programme, 1994) The assumption seems to be that everybody in Iran is equally at risk, which may not be true. Vulnerabilities of communities and regions within Iran will vary with differential physical (poor quality housing, etc.) socio economic vulnerability. Vulnerability Analysis entails assessing the loss of life and property from a particular hazard striking at a particular intensity. For example, x number of people are expected to be killed and property worth y destroyed if a cyclone strikes with strong winds at 130km/hr. 1.3.1 Risk Assessment and Evaluation Risk Management has two components (a) Risk Assessment (b) Risk Evaluation.

Risk Assessment is understood as "the methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend." "The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios…."(I.S.D.R.) Risk evaluation entails assessment of proposed risk reduction measures from the point of view of cost efficiency. Efficiency is examined by means of cost-benefit comparisons, which imply assessing benefits procured or expected to be procured from a measure against costs likely to be incurred. Assessment has significant administrative implications in that precise understanding of the underlying process of a hazard enables formulation of targeted risk reduction policies. Precise quantification of risk is often difficult in the absence of adequate data and proper analyses techniques. Moreover, certain areas are multi-hazard prone, which poses challenge for risk assessment. Risk reduction policy for such areas requires risk assessments regarding each type of hazard to arrive at an estimation of losses involved. Besides, risks are not amenable to simple quantification in that intangible factors are involved that cannot be easily identified and quantified. Disaster risk is seen as a function of the hazard, exposure and vulnerability, denoted by the mathematical function: Disaster Risk = function (hazard, exposure, vulnerability where “exposure” refers to the element which is affected by natural disasters, people and/or property. To reduce disaster risk, it is important to bring down the level of vulnerability and to contain ‘exposure’ by relocating populations and property away from the hazardous zones (Wisconsin Disaster management Center). Risk Perception Risk perception is understood as the ‘awareness’ of risk, which differs in different cultures/societies. Poor countries, with other more pressing problems, do not attach much priority to disaster mitigation. General level of awareness among people regarding the significance of disaster mitigation and preparedness is also quite low. Consequently, there is less interest articulation for policy in this area. On the other hand, risk perception is found to be quite high in the developed world where much effort has been put into disaster mitigation efforts, though vulnerability is low as compared to developing countries. The role of the media is significant in creating ‘awareness ’regarding disaster management among people, particularly those ‘at risk.’ Risk perception depends on certain subjective and objective factors. Risk Perception depends on four specific factors: Exposure: actual quantitative risk level, as articulated through risk assessments Familiarity: personal experience, which makes one alive to the dangers of disasters Dread: horror of the disasters’ scale and consequences, which makes policy imminent

Preventability: belief in prevention methods, which leads to disaster mitigation policies. (DMTP, 1994)

Risk Identification In a general way, political representatives informally undertake/attempt risk assessments by way of informed/subjective judgements as part of daily governance to justify legislations in foreign policy, the judicial reform, law enforcement, etc. Risk assessments are now being conducted in more sophisticated ways, particularly in the field of environmental legislation. Risk has to be 'empirically' ascertained, for which subjective biases arising due to cultural or ideological inclinations need to be kept out of policy judgements. The best example of risk assessment comes from the insurance industry where "insurers have well-defined roles of actuary, underwriter, agent, auditor and adjustor." Each of these is an assessor in somewhat different circumstances or stages of the insuring, reinsuring, adjustment, recovery and claims payment processes. Hence, risk assessment is a continuous process of 'articulation', which needs to be undertaken periodically at every stage/, phases in said activity/process. Objectivity of the risk assessment depends on the availability of adequate and timely data. Lack of the same has inhibited risk assessments. Risks are divided into 'systematic' and 'cumulative' (K. Smith, 1996). In a 'systematic' risk, the cause and effect phenomenon underlying a disaster is 'immediate' and 'direct' on the global system and results from production related policies, for example, global warming due to emission of greenhouse gases. In cumulative risks, the relation is indirect, entailing long-term consequences; and resulting due to policies in disregard of environment protection lead to accumulation and compounding of risks over time, for example, groundwater depletion, soil depletion, deforestation, etc. The effect of bad policy affects the global system, which suggests that commitment to sustainable development has to be equal in the developing and the developed world. A technical evaluation process is usually undertaken, commonly called hazard assessment, vulnerability analysis, and risk analysis for risk articulation. These are structured analytical procedures for identifying hazards and estimating the probability of their occurrence and anticipating consequences. These estimations are compared in relation to a standard criterion in order to decide whether or not an action is desirable to reduce the probability of damage or to protect the people, property, or environment. Realistically, it is necessary also to consider to what extent perceived constraints of time and resources might slow down the application of desirable countermeasures. In the case of extreme events and very high level of damage, such as dam break or nuclear power plant accident, the risk is ascertained/ estimated by the number of persons affected (victims, injured, etc.) and / or the damage in monetary terms that can be expected on an average per year. Risk is also linked to fragility. Fragility denotes the stage of deterioration to a point where damage will occur. Fragility reflects the properties of human-ecosystem interactions. It may be defined as " the sensitivity of a particular ecosystem to human induced perturbations and its resilience to such perturbations."

Vulnerability

Vulnerability gives the extent to which a community is affected by a disaster. It involves the measure of 'resilience' and 'coping capacity' of a community in the face of disasters. Vulnerability is an 'inclusive' concept in that vulnerability of a particular community to a particular type of disaster (flood or earthquake) is a resultant of a number of factors; including physical factors, (geographical perspective) social (sociological perspective) and economic factors (income and employment, involving micro and macroeconomic policy), besides institutional or administrative, which are essentially governance related issues. The process of vulnerability has been evidenced as proceeding along phases such as; root causes, dynamic pressures that translate these into active problems, which are a result of a priori decision-making in governance related matters over time, for example, drought in a dry land area, leading to a famine in the absence of disaster mitigation efforts. Social scientists and climate scientists often mean different things when they use the term "vulnerability". Social scientists tend to view vulnerability as representing the set of socioeconomic factors that determine people's ability to cope with stress or change (Allen, 2003); climate scientists often view vulnerability in terms of the likelihood of occurrence and impacts of weather and climate related events. Related terms are fragility, stability, resilience and sensitivity of a system. These are the constituents of 'vulnerability'. Resilience and coping capacity develop over time as a result of proactive government policies. Stability is the balance, which is disturbed by events such as disasters; hence restoring balance means correcting distortions. Stability depends on fragility; or the weakness of the system owing to physical characteristics of its ecology; sensitivity refers to the extent of alteration that is brought about due to exogenous pressures exerted by events such as a disasters. Though disaster related, these are standard sustainable development terminology. Vulnerability Identification Vulnerability identification implies examining the root causes of vulnerability that could lie in technological, physical, or socio economic conditions and addressing the same through empirical research and policy. Identification of vulnerability is challenging in that complex processes interact in resultant vulnerability of a system or a specific region/ people(s). Tackling vulnerability involves both short- term and long-term mitigation measures in that the problem of vulnerability is essentially a problem of development. The solution lies in developmental planning, which addresses the problems of poverty, class and gender discrimination, public health, education and hygiene on a sustained basis. Vulnerability is studied in detail in subsequent Units in the course. The international community pioneered by the United Nations has attempted to analyse disasters overtime and prepare an inventory of causes that lead to them, the extent of damage suffered, what and how mitigation needs to be applied, and where, successfully. Vulnerability assessment is a subset of risk assessment, which analyses differential vulnerability of communities in differential areas of disaster impact (such as increasing or decreasing degree of hazard proneness). An attempt should be made at redefining disasters in a dynamic and integrated perspective, integrating socio-cultural, developmental and ecological outlooks. The desirables in an academic analysis of vulnerability with the practical perspective of policy design would include: Development of an integrated perspective, taking into account socio-cultural, developmental and ecological perspectives to develop a comprehensive framework of disaster mitigation; and Risk Assessment and Vulnerability Analysis Emphasis on poverty alleviation and community empowerment, sustainability of livelihoods through grass roots democracy through local governance.

VULNERABILITY FACTORS

As has been rightly pointed out, "The study of the vulnerability of human and natural systems to climate change and variability, and of their ability to adapt to changes in climate hazards, is a relatively new field of research that brings together experts from a wide range of fields, including climate science, development studies, disaster management, health, geography, policy development and economics, to name but a few areas. There is need for an integrating framework to bring together these diverse traditions in a coherent yet flexible fashion, allowing researchers to assess vulnerability, and the potential for adaptation in a wide variety of different contexts"(IPCC, 2001). Both natural and man-made factors contribute to vulnerability. Some of the contributing factors are discussed below: Population Displacement Population displacement is both a cause and a consequence of disaster. There is evidence of positive correlation between poverty and economic inequality and rural to urban migrations, in that more the level of poverty and income inequality, more is the extent of rural to urban migrations. The phenomenon is most observed in poor third world countries where the poor migrate from rural to urban areas in search of livelihoods. The social order remains basically 'oligarchic'/ 'oligopolistic' in that inequality in income and wealth distribution persists over time. System change through 'soft' democratic options, such as legislation and rhetoric is not successful as entrenched powers are hard to reconcile to socialist ideas. Result has been corruption and implementation hurdles, more specifically at the implementation change. This largely explains why land reforms and social forestry legislations have not met with expected success. While the size of agricultural holdings has gradually reduced, 'exploitation' of the small and marginal framers at the hands of rich and the resourceful farmers has persisted. Frequent droughts have compounded existing problems. The cumulative effect of such conditions has been mass migration of rural folk to urban metropolitan towns. In the last decade, issues related to natural disasters and development-led population displacement and resettlement and rehabilitation have generated considerable debate. Focus on population displacement, direct and indirect, resulting from five natural and human processes wherein data and information is still far from adequate. These processes are natural disasters, urbanisation and industrialisation, natural resource development, agricultural transformation and infrastructure expansion. There is also a concern that especially vulnerable social groups, including women, ethnic minorities, and landless people have generally suffered more than others from displacements. On the other hand, population displacement is also a consequence of disasters. In the event of disasters, large-scale displacement of populations from affected areas takes place, which leads to temporary to permanent loss of livelihood for people. Small-scale industries and micro enterprises are particularly hit. Much work has not been done on providing insurance against disasters to people residing in hazard prone areas. Though some initiatives have been taken, all disasters have not yet been covered properly and resource mobilisation also is far from adequate (Dhar, 2002). Relocation options have also to be carefully weighed so as not to result in unintended consequences that negate the very purpose of the exercise. Unintended consequences as different forms of vulnerability that might be induced because of relocation for example, loss of livelihood for small businessmen because of increased distance from urban commercial centers. Urbanisation Rural to urban migration has led to unmanageable urbanisation and urban congestion that has forced human and physical capital extension in high-risk zones. Consequently, the loss potential of hazards has gone up. Urbanisation has brought in its wake, growth of informal settlements, unsafe living conditions, disease, class conflict and social capital depletion as some segments have been socially and economically marginalised. Globalisation has also contributed in many ways to increasing the vulnerability of the urban poor by creating 'uncertain' employment though the obvious impact seems to be betterment of life and better opportunities for all. Though urbanisation is a worldwide phenomenon, it is more pronounced in the third world, because of the above recounted factors. As per the 1991 census figures, (provisional) 217 million out of 844 million persons lived in 4,689 cities and towns in India. In terms of proportion, slightly more than one- fourth of the country's population lived in urban areas. Corresponding figures from the first census of the present century (that is, the 1901 census) indicate that 25.8 million persons, that is, one-tenth of the total population lived in 1,917 cities and towns. It thus shows that while the number and proportion of total population living in cities and towns has more than doubled, urban population itself has increased by more than eight times during the last 90 year period (Jain, Ghosh, 2005). About 25 per cent of the world's population lives in areas of high risk from natural disasters. Most of these people are in poor regions, where vulnerability arises from poverty, discrimination and lack of democratic functioning hampers the development process. The poorest people often have little choice but to live in unsafe settings, whether it is urban shanties or degraded rural environments. In terms of loss of life and relative economic impact, disasters hit hardest where poverty stricken people are concentrated. In less developed countries, rural inhabitants outnumber people in the urban areas. Even then, now there are more urban dwellers in the third world than in Europe, North America and Japan combined. Metropolitan cities are growing at a faster rate. It is estimated that in urban squatter settlements, population densities may reach as high as ten times of present level. Many buildings are erected on steep slopes or flood prone land, exposed to strong winds and landslides without suitable material or construction skills. In highly populated rural areas, population density can exceed 1000 per km² and life is a recurrent struggle to secure cultivable land. Many people are landless and disadvantaged by land tenure systems, which deny them access to the means to support themselves. Migration also has significant cultural impact, besides the more obvious, physical dislocation of populations in that mass migrations introduce communities to alien cultural practices which disturb the cultural homogeneity of the community. In extreme conditions they cause civil strife. Different building practices and construction technologies may be introduced, which might be unsuited to the requirements/ cultural ethos and practices of those particular area/ inhabitants. Besides, administrative and political problems are caused due to the influx of refugees, which disturbs the political and social matrix of the region, like the influx of Bangladeshi refugees in India, following the 1971 war. Epidemics and congestion are other administrative problems caused due to mass influx of refugees.Gender Vulnerability due to Gender is a result of accretion of unfair social practices over time, which has caused disempowerment of women in social economic and political spheres. Gender inequality in social, economic and political spheres has resulted in vast differences between men and women in emergency situations, concerning matters such as, household decisions about use of relief assets, voluntary relief and recovery work, access to evacuation shelter and relief goods, and employment in disaster planning, relief and recovery programs among other areas of concern in disaster relief. Disaster mitigation as also response policy, particularly concerning control over relief resources have to factor this component in decision- making with a view to making it more equitable and on the whole, more effective. Economic Factors Positive correlation has been evidenced between poverty, disasters and environmental degradation. Relative vulnerability of people is comparatively much higher in third world countries than in the developed world. As per United Nations estimates, although least developed countries show less physical exposure to hazards (11%) they account for far greater number of casualties, (53%). On the other side, the most developed countries represent more (15%) physical exposure to hazards and account for significantly less (1.8%) victims. The inference drawn is that the magnitude of disaster suffered is directly correlated to the level of development, which explains largely the fact of the Third World accounting for significantly more losses than the developed countries. This difference is shown by a list of disaster events and fatalities over 1960-81. Japan suffered 43 earthquakes and other disasters and lost 2,700 people that mean 63 deaths per disaster. Peru suffered 31 disasters with 91,000 dead, a vast majority lost in the single event of the 1970 earthquake. The world economy functions and works against the poor who have little opportunity to process and market what they produce and are largely dependent on the imports from the industrialised nations for manufactured goods which are quite often unstable. The poor regions have little opportunity to process and market what they produce and are dependent on the import from the industrialised nations of manufactured goods, which are often highly priced or tied to aid packages. The progressive hardship for the small-scale farmer, combined with a foreign debt burden that may be many times the normal annual export earnings, takes resources away from long-term development in a process that has been described as a transfusion of blood from the sick to the healthy. The cycle is reinforced when natural disaster destroys local products and undermines incentives for investment. Major disasters, such as the droughts, disrupt and destroy local economies and bring about shortages in neighbouring regions resulting in innumerable international refugees and stimulate aid programmes to the extent that the consequences of environmental hazards are truly global. Poverty situation increases vulnerability to disasters and contributes in enabling poverty. In order to facilitate sustainable development, it is essential to eliminate this vicious circle. Sustainable development, with emphasis on the long-term and intergenerational aspects enables us to face challenges. Compatibility between economic growth and sustainable development demands a method to measure the kind of growth that encompasses all important aspects pertaining to quality of life, such as human exposure to risk situations and lifestyles. While all countries may be confronted with natural hazards, the poorer developing countries, in particular, are disproportionately vulnerable to hazards. Disasters can bring poor communities to even greater poverty, as households may be forced into increased debt to rebuild homes and meet basic needs. There is also the paradox that the economic aid that may flow to a country for devastation by a natural disaster will be recorded as an increase in GDP, thus hiding the real economic situation in the recovery phase. Effects of disasters on poorer developing nations are long-lasting and cause excessive disruption in the GDP (United Nations, 2004). The effects are more severe than in developed countries, often depleting scarce financial resources and diverting important funds towards post-disaster relief. Poor nations have been known to sanction activities like forest clearance for commercial activities and export of hardwood, since sizeable numbers of their population depend on such activities for livelihood. Unsustainable agricultural practices followed in developing countries, particularly by small and marginal farmers harm the environment. The poor are forced to live in high-risk zones that increase their vulnerability (Ayson, 1999). Poverty is not a single dimensional economic concept. Poverty affects the 'positioning' of the affected segment in relation to the 'haves', which is a situation of political disempowerment, economic deprivation and social marginalisation. As has been recently reported, relief and rehabilitation assistance does not reach the backward sections of society adequately. During the recent tsunami, it was found that society in coastal areas comprises generally farmers and fishermen who have strict social hierarchies. This differentiation was reflected in relative access of communities to relief provisions. Affirmative state action as per constitutional provisions (Article 14, 15(1) 15(4), and Article 21(right to life) would have be enforced to ameliorate the iniquitous situation. Directive Principles of State Policy, namely Article 39 (a) (right to livelihood) 41(public assistance in cases of 'undeserved want') and 47 (raise the level of nutrition) reaffirm the obligation of the state to protect livelihoods of those discriminated against. It is proposed that risk reduction strategies targeting poverty should involve local institutions more meaningfully and focus on providing alternate livelihood options to the poor and providing safe working environment by reducing occupational hazards which increase the vulnerability of the poor to hazardous events (Ayson, 1999). Geographical Factors Global warming threatens to disrupt agriculture in developing countries though most greenhouse gas emission has taken place from the developed world. Global warming has particularly increased the vulnerability of coastal areas, especially small island development states (SIDS) in that sea level rise will threaten the fragile eco system of these regions, raising the frequency and intensity of natural hazards like tsunamis, cyclones, floods and storm surges. Coastal zones, wetlands and coral reefs are likely to be harmed which act as natural buffers against hazards like cyclones. The magnitude of disasters is also likely to be greater because of the increased pace of infrastructure development that has taken place in these regions in the last few years, owing to population pressure and growing attractiveness of these regions from the point of view of tourism (UNDP, 2002). SIDS are subject to excessively high impacts from natural hazards and disasters. As has been noted, "they are particularly vulnerable to tsunamis, tropical cyclones, which can in one go negate years of development effort. Numerous small island developing states are facing water scarcity. Drought, sea-level rise and natural disasters have a profound impact on fragile freshwater lenses in SIDS. Water availability is also climate-sensitive. Countries such as the Bahamas that traditionally depended almost totally on groundwater, now also have to use desalination, which contributes to their vulnerability. In addition, the economies of many SIDS are dominated by agriculture and tourism. Agriculture can cause degradation of water quality by agro-chemicals as well as harm the coral reefs; tourist hotels use excessive quantities of water; and wastewater discharges from towns and hotels, are damaging fragile coastal and marine ecosystems on which these islands rely" (Herrmann, et al.). Livestock Vulnerability Livestock at times is the poor man's only asset. Unlike other forms of property, livestock loss is irreplaceable. The contingent issue here is immediate provision of alternate occupation, which is the most difficult part of rehabilitation. Shortage of food affects livestock before it starts to affect human beings. Malnutrition and disease reduce their productive capacity, which results in reduced income for the farmer. Diseases among livestock also spread during disasters. These still remain less considered aspects of disaster management. Insurance is the best option but it still needs to be duly considered in India. Vulnerability factors would be discussed in detail in subsequent units.

Elements of Disaster Management

Preparedness, Response, Recovery & Prevention/Mitigation

Disaster/emergency planning for records and information should be a planned approach for the prevention of records and information loss, preparedness and response to the emergency events affecting records and information, recovery of records and information, and necessary processes and equipment for business continuity following the event.

The recovery phase includes the implementation of short-term activities that restore vital records and information while restoring normal business operating procedures and practices. This phase includes assessing damage, stabilization and salvage techniques, and restoration of records, information and equipment, and resumption of operations.

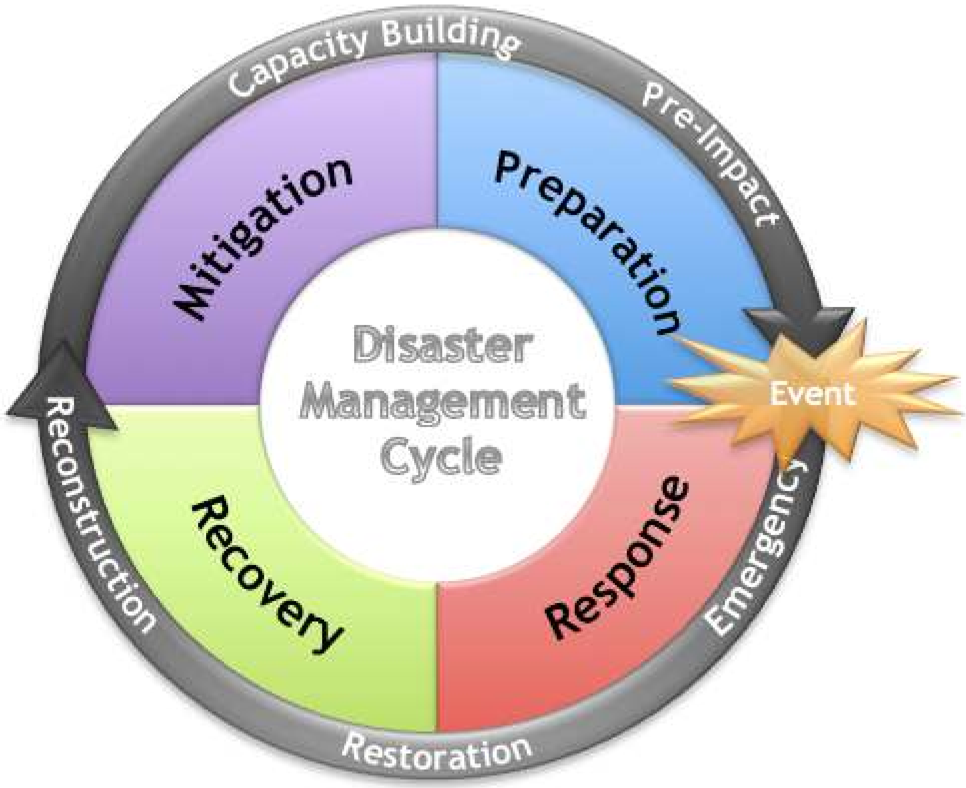
The prevention/mitigation phase involves: establishing a vital records program, completing risk management processes, and developing a disaster prevention plan.

The four primary phases are:

1. **Preparedness** - First, prepare to protect yourself, others and items of great importance in the event an emergency/disaster occurs.
2. **Response** - When there is an actual occurrence, administer first aid or get medical attention for victims if necessary. Attend to other emergency procedures that must take place in order to lessen the impact.
3. **Recovery** - After things are under control, begin the clean up or repair any damage and if necessary, call in professional restoration services.

4. **Mitigation** - Finally, ask how this disaster, accident did or emergency happen and how can any problems that occurred in handling the incident be lessened.

What is disaster management cycle?



It is an ongoing process by which governments, civil (and military) society plan for and reduce the impact of disasters, react during and immediately following a disaster, and take steps to recover after a disaster has occurred.There are variations to the cycle but the most common version is the 4 phases of disaster cycle:

- Mitigation:involves implementing measures for preventing future threat of disaster and/or minimizing their damaging effects of unavoidable threat. It requires hazard risk analysis and the application of strategies to reduce the likelihood that hazards will become disasters, such as flood-proofing homes or having flood/fire insurance, following safety standards of building materials and appliances. This phase (and the whole cycle disaster management cycle), includes the shaping of public policies and plans that either modify the causes of disasters or mitigate their effects on people, property, and infrastructure.

- Disaster preparedness: preparedness efforts include plans or preparations made in advance of an emergency that help individuals and communities get ready to either respond or to recover. It aims to achieve a satisfactory level of readiness to respond to any emergency situation through programs that strengthen the technical and managerial capacity of governments, organizations, and communities. These measures can be described as logistical readiness to deal with disasters and can be enhanced by having response mechanisms and procedures, rehearsals, developing long-term and short-term strategies, public education and building early warning systems. The preparations may include the stocking of reserve food and water, the gathering and screening of willing community volunteers, or citizens education &evacuation plan, holding disaster drills, and installing smoke detectors, mutual aid agreements, development of hospital disaster plans, emergency medical service plans, etc.
- Disaster response: Disaster response work includes any actions taken in the midst of or immediately following an emergency, including efforts to save lives and to prevent further property damage. Ideally, disaster response involves putting already established disaster preparedness plans into motion. It's what the public typically thinks of when imagining a disaster: Flashing lights, evacuation, search and rescue, and sheltering victims. Healthcare and psychosocial intervention response starts here. The focus in the response phase is on meeting the basic needs of the victims until sustainable community has been achieved. This phase may still continue even when recovery phase can already be started.
- Disaster recovery:Recovery involves restoring, rebuilding, and reshaping the impacted area. It starts after damages have been assessed and adequate response effort is achieved and on-going. It involves actions to return the affected community to its pre-disaster state or better. As the emergency is brought under control, the affected population is capable of undertaking a growing number of activities aimed at restoring their lives and the infrastructure that supports them. Recovery activities continue until all systems return to normal or better. These measures, both short and long term, aim to return vital life-support systems to minimum operating standards;

such as temporary housing, public information, health and safety education; continued health monitor and care, reconstruction of vital facilities; counseling programs; grants, and it may include economic impact studies.

In reality, there is no clear distinct point at which these 4 phases change throughout the cycle. There can be opportunities during the recovery period to improve prevention and increase preparedness, thus reducing vulnerability. Recovery can start when the response phase is still on-going. A smooth transition from recovery to mitigation is ideal. The disaster management cycle is just the typical flow of events. When disaster strikes response is prioritized, mitigation can't start yet. When disaster hasn't yet happened, mitigation - preparedness start and there is nothing to respond yet. But the lines between each following cycles blur.To some degree, the cycle flows in such flexible order.

Disaster Response

Disaster response is the second phase of the disaster management cycle. It consists of a number of elements, for example; warning/evacuation, search and rescue, providing immediate assistance, assessing damage, continuing assistance and the immediate restoration or construction of infrastructure (i.e. provisional storm drains or diversion dams).The aim of emergency response is to provide immediate assistance to maintain life, improve health and support the morale of the affected population. Such assistance may range from providing specific but limited aid, such as assisting refugees with transport, temporary shelter, and food, to establishing semi-permanent settlement in camps and other locations. It also may involve initial repairs to damage or diversion to infrastructure. The focus in the response phase is on putting people safe, prevent need disasters and meeting the basic needs of the people until more permanent and sustainable solutions can be found. The main responsibility to address these needs and respond to a disaster lies with the government or governments in whose territory the disaster has occurred. In addition, Humanitarian organizations are often strongly present in this phase of the disaster management cycle, particularly in countries where the government lacks the resources to respond adequately to the needs.

Definition

A "disaster", noun, is defined as a calamitous event, especially one occurring suddenly and causing great loss of life, damage or hardship such as a flood, aircraft crash or an angry person. "Response" is defined (in this context) as: Noun: An answer or reply, as in words or in some action.The Business Dictionary provide a more comprehensive definition for "disaster response"; Aggregate of decisions and measures to (1) contain or mitigate the effects of a disastrous event to prevent any further loss of life and/or property, (2) restore order in its immediate aftermath, and (3) re-establish normality through reconstruction and re-rehabilitation shortly thereafter. The first and immediate response is called emergency response.

Objectives for disaster response are:

- Saving and protecting human life;
- Relieving suffering;
- Containing the emergency – limiting its escalation or spread and mitigating its impacts;
- Providing the public and businesses with warnings, advice and information;
- Protecting the health and safety of responding personnel;
- Safeguarding the environment;
- As far as reasonably practicable, protecting property;
- Maintaining or restoring critical activities;
- Maintaining normal services at an appropriate level;
- Promoting and facilitating self-help in affected communities;
- Facilitating investigations and inquiries (e.g. by preserving the scene and effective records management);
- Facilitating the recovery of the community (including the humanitarian assistance, economic, infrastructure and environmental impacts);
- Evaluating the response and recovery effort; and
- Identifying and taking action to implement lessons identified.

The response phase includes the mobilization of the necessary emergency services and first responders in the disaster area. This is likely to include a first wave of core emergency services, such as firefighters, police and ambulance crews.

Response actions may include activating the Emergency Operations Center (EOC), evacuating threatened populations, opening shelters and providing mass care, emergency rescue and medical care, firefighting, and urban search and rescue. Response begins when an emergency event is imminent or immediately after an event occurs. Response encompasses the activities that address the short-term, direct effects of an incident. Response also includes the execution of the Emergency Operations Plan and of incident mitigation activities designed to limit the loss of life, personal injury, property damage, and unfavorable outcomes. As indicated by the situation, response activities include:

- Applying intelligence and other information to lessen the effects or consequences of an incident.
- Increasing security operations.
- Continuing investigations into the nature and source of the threat.
- Ongoing public health and agricultural surveillance and testing processes, immunizations, isolation, or quarantine.
- Specific law enforcement operations aimed at preempting, interdicting, or disrupting illegal activity, and apprehending actual perpetrators and bringing them to justice.
- Restoring critical infrastructure (e.g., utilities).
- Ensuring continuity of critical services (e.g., law enforcement, public works). In other words, response involves putting preparedness plans into action.

One of the first response tasks is to conduct a situation assessment. Local government is responsible for emergency response and for continued assessment of its ability to protect its citizens and the property within the community. To fulfill this responsibility, responders and local government officials must conduct an immediate rapid assessment of the local situation.

Disaster Recovery

Recovery involves returning affected people's lives back to normal state after disaster occurs. The recovery phase starts after the immediate threat to human life has subsided. The immediate goal of the recovery phase is to bring the affected area back to normalcy as quickly as possible. During reconstruction it is recommended to consider the location or construction material of the property.

The most extreme home confinement scenarios include war, famine and severe epidemics and may last a year or more. Then recovery will take place inside the home. Planners for these events usually buy bulk foods and appropriate storage and preparation equipment, and eat the food as part of normal life. A simple balanced diet can be constructed from vitamin pills, whole-meal wheat, beans, dried milk, corn, and cooking oil.Vegetables, fruits, spices and meats, both prepared and fresh-gardened, are included when possible. Professional emergency managers can focus on government and community preparedness, or private business preparedness. Training is provided by local, state, federal and private organizations and ranges from public information and media relations to high-level incident command and tactical skills. In the past, the field of emergency management has been populated mostly by people with a military or first responder background. Currently, the field has become more diverse, with many managers coming from a variety of backgrounds other than the military or first responder fields. Educational opportunities are increasing for those seeking undergraduate and graduate degrees in emergency management or a related field. There are over 180 schools in the US with emergency management-related programs, but only one doctoral program specifically in emergency management.

Professional certifications such as Certified Emergency Manager (CEM)and Certified Business Continuity Professional (CBCP)are becoming more common as professional standards are raised throughout the field, particularly in the United States. There are also professional organizations for emergency managers, such as the National Emergency Management Association and the International Association of Emergency Managers. This phase begins after the immediate response has ended. Recovery may last even for months or years. The purpose of disaster management is reduction of harm to human life, property and the environment. But the capacity to carry out this mission varies from country to country. This is due to cultural, political, economic and social situations in different countries. It is understood that no nation however rich and evolved is immune completely from disasters. Only thing is that some countries are more capable than others in addressing the adversities of disasters. The DM cycle indicated are generalizations. The order in which the actions are taken up generally get intermixed. For example, recovery may start along with response and preparation and mitigation may go hand in hand and so on.As the emergency is brought under control, the affected population is capable of undertaking a growing number of activities aimed at restoring their lives and the infrastructure that supports them. There is no distinct point at which immediate relief changes into recovery and then into long-term sustainable development. There will be many opportunities during the recovery period to enhance prevention and increase preparedness, thus reducing vulnerability. Ideally, there should be a smooth transition from recovery to on-going development. Recovery activities continue until all systems return to normal or better. Recovery measures, both short and long term, include returning vital life-support systems to minimum operating standards; temporary housing; public information; health and safety education; reconstruction; counselling programs; and economic impact studies. Information resources and services include data collection related to rebuilding, and documentation of lessons learned.

Rehabilitation and Reconstruction

Rehabilitation and reconstruction are at the heart of disaster recovery phase. The rehabilitation and reconstruction activities, which follow the disaster response stage, aim at achieving long-term recovery. At this stage, the role of the community and self-help groups becomes paramount since they can make or mar the crucial link between disaster response and disaster recovery. It also needs to be kept in view that the entire rehabilitation and reconstruction process has to be attuned towards developmental goals.Rehabilitation and reconstruction operations are integral to disaster recovery. They provide a direct ‘connect’ between disaster response and long-term development. The two activities, however, do not have similar connotation. Rehabilitation involves restoring local services related to the provision of immediate needs. It implies a systematic return to predisaster status. It refers to actions taken in the aftermath of a disaster to enable basic services to resume functioning, assist victims' self-help efforts to repair physical damage, restore community facilities, revive economic activities and provide support for the psychological and social well-being of the survivors. It focuses on enabling the affected population to resume more or less normal patterns of life. It may be considered as a transitional phase between immediate relief and major long-term development. Reconstruction, on the other hand, represents long-term development assistance, which could help people in the affected areas to rebuild their lives and meet their present and future needs. It takes into account reduction of future disaster risks. Rehabilitation may not necessarily restore the damaged structures and resources in their previous form or location. It may include the replacement of temporary arrangements established as part of emergency response or the up-gradation of infrastructure and systems from pre-disaster status. For instance, following a damaging hurricane, the rehabilitation of the power lines would aim to restore the system as rapidly as possible so that the essential services would continue to function, whereas, reconstruction of the power lines would aim to rebuild the rehabilitated system to a higher or safer standard than before, so that the future risks to the power lines from a similar damaging event could be reduced. Reconstruction must be fully integrated into long-term developmental plans, taking into account future disaster risks and possibilities to reduce them by incorporating appropriate measures. As we have mentioned before, the term recovery is used to embrace both the rehabilitation and reconstruction activities. Both the activities may be required in the aftermath of disaster. One does not essentially exclude the other.

Types of rehabilitation

Since social, cultural, economic and political factors provide the contours of a thorough recovery plan, we could deduce that there are three major types of rehabilitation, namely, physical, social and psychological.

Physical rehabilitation is a very important facet of rehabilitation. It includes reconstruction of physical infrastructure, such as, houses, buildings, railways, roads, communication network, water supply, electricity etc. It also comprises short-term and long-term strategies towards watershed management, canal irrigation, social forestry, crop stabilisation, and alternative cropping techniques, job creation, employment generation and environmental protection. It involves policies for agricultural rehabilitation, rehabilitation of artisans and small businessmen as well as rehabilitation of animal husbandry. The short-term and long-term physical rehabilitation measures should take into view: provision for subsidies, farm implements, fertilizers etc., establishment of seed banks, grain banks and fodder banks, scope of employment generation, availability of livelihood generation and alternative technologies, along with development of houses and infrastructure. This type of rehabilitation is economic in nature and is broadly geared towards an alternative livelihood approach that can enable the communities to withstand the disaster aftermath. Developmental measures involve expenditure. These relate to collection of information, hiring of specialist staff, implementation and evaluation of development programmes. However, these developmental costs should try to reduce the economic, social and political costs that are likely to be incurred in the event of a disaster. For a systematic physical rehabilitation plan, the economic environment of a disaster-affected area needs to be kept in view. Attention needs to be given to disaster-resistant house construction. Earthquake resistant buildings must be planned on sites of hard bedrock. The sites chosen should not be steep, narrow and clayey. They should not be anywhere near loose sands and heavy faulting areas. Cyclone shelters should not be planned at low elevation land, which lacks natural outlet to discharge water. Land at the foot of slopes should also be avoided for cyclone resistant housing. To guard against landslides, recovery plan should include planning for houses that are stable and away from areas near quarrying activity. Flood resistant reconstruction planning must focus on areas that are not low lying. Wetlands, lagoon mouths, edges of island, lake, flood plains, downstream banks, and narrow gorges should be avoided. Rehabilitation and reconstruction package must also incorporate acquisition of land for relocation sites, adherence of land use planning, flood plain zoning, retrofitting or strengthening of undamaged houses, and construction of model houses. Thus, disasterresistant housing will have to be systematically included in physical rehabilitation plan. It should comprise identification of hazard prone areas, vulnerability and risk assessment of buildings, outlining of disaster scenarios, technical guidelines for hazard resistant construction and adoption of technical-legal regime.

Social rehabilitation is an important part of disaster recovery, but this dimension is often assumed to be a community function and neglected in most post-disaster programs. As we are all aware, disasters can render some groups such as the elderly, orphans, single parents with young children, etc., much more vulnerable to disaster aftermath due to lack of adequate support. In the post-disaster phase, family support systems can break down due to physical and mental trauma resulting from losses of life and property, physical dislocation, and migration of some members of disaster affected communities.

Guiding principles of rehabilitation and reconstruction

Treating Communities as Heterogeneous

Striking a Balance between Economic, Social and Psychological Needs

Focusing on Key Issues

Encouraging Flexibility and Adaptiveness

Promoting Systematic Damage Assessment

Ensuring Financial Recovery

Developing Disaster-resistant Buildings

Upholding the Norms of Equity and Social Justice

Endorsing Sustainable Development and Alternative Livelihood Strategies.

MITIGATION AND PREPAREDNESS

Mitigation is a type of long-term, pre-disaster planning which involves sustained expenditures on structural and non-structural efforts to reduce or eliminate future risks. Mitigation plans and activities are, in practice, usually medium to long term, and mitigation is the cornerstone of emergency management since it is an example where thinking ahead pays off in the long run. Terminologically, mitigation is related to two other concepts of long-term planning: reconstruction and preparedness. Reconstruction means repair or rebuilding, and preparedness means getting ready or practicing to respond. Mitigation means to lessen the effects or take action toward the building and putting together of certain structures and plans so that the impact of any future disaster will be ameliorated, or eliminated, if possible. Amelioration means to change things for the better, and impact can be understood as the consequences, or the likelihood of something happening in the first place, if the latter is theoretically possible.Some simple examples of mitigation activities that an emergency manager might do include: promoting flood insurance, urging the structural redesign of buildings, raising or moving homes from flood zones, or just making sure there are appropriate building codes within certain communities. Mitigation planning involves an assessment of the threats facing a community, such as the likelihood of a terrorist attack, and an assessment of possible targets.Mitigation planning is an ongoing process, with continual reassessments as necessary to ensure proper preparedness. Some experts argue that there is such a thing as post-disaster mitigation, and that pre-disaster mitigation ought to be called prevention. The usual division of mitigation into two (2) categories -- (1) structural and (2) non-structural (Alexander 2002) -- is intended to denote the importance of integrated planning in mitigation; that is, the kind of planning which efficiently balances a combination of engineering solutions (like moving homes) with political solutions (like changing the zoning abatements for a community). Some solutions only have a short window of opportunity to capitalize on public and political support. Non-structural solutions are often brought in when engineering solutions have become very costly and/or have not resulted in a substantial reduction in losses. Evacuation planning is sometimes considered a type of non-structural mitigation.The trick to successful grant-writing for mitigation purposes involves two essential ingredients: (1) involving a wide range of community stakeholders into the planning process; and (2) carrying out a comprehensive risk and vulnerability assessment. While there are many issues (including conflict of interest issues) surrounding the involvement of stakeholders in mitigation planning, this lecture will concentrate primarily on risk assessment.

A primer on risk assessment

There are many definitions of risk. Risk is the product of danger or threat that a physical impact would occur, the vulnerability of the people, buildings threatened, and their degree of exposure to perceived danger. A couple of quick definitions include risk as “the potential interaction of hazard and vulnerability for a given exposure of the items at risk" or "the likelihood of a given threat attacking a vulnerability and the resulting impact." Risk analysis involves a comparison of different risks, investigation of their causes, and the context of overall societal risks. Risk can be mathematically expressed as the evaluation of hazard, vulnerability and probabilities, the likelihood of damage or loss multiplied by the number of items at risk; e.g., buildings and personnel. Mitigation of risk is a function carried out by all people since collectively and individually we live in a risk/threat universe.

Minimizing risk is the fundamental reason why individuals and organizations carry out security measures. All security related activities are a part of risk management. Risk assessment is the determination of acceptable levels of risk. Any kind of analysis that ties-in specific threats to specific assets with an eye toward determining the costs and/or benefits of protecting that asset is called risk assessment. Risk is usually a calculated assumption made based on past occurrences. Threat, on the other hand (as opposed to risk), is constant. Any person, act, or object that poses a danger to security is called a THREAT. Any kind of policy, procedure, or action that recognizes, minimizes, or eliminates a threat is called a countermeasure, and if a countermeasure becomes fairly automated, it is usually called a control. Controls play an important role in threat analysis. Risk assessment, however, is directed more toward vulnerabilities than threats. VULNERABILITY is any kind of asset that is mission-critical or essential to vital functions, and anything short of being called a vulnerability is just called a weakness. The following diagram illustrates the commonsense foundations of risk assessment in risk management.RISK ANALYSIS is the systematic study of risk conditions and the probable impacts of future events, incidents and disasters. It involves comparison of different risks, investigation of their causes and refinement of estimates with longer-term or more precise data. One assumption inherent in most risk analysis is that there must be some concern for the overall context of societal risks. In fact, those who argue that terrorist mitigation is "different" usually make the point that the context to be concerned about is the impact of counterterrorism on civil liberties. However, there are larger concerns, as any urban planner knows. An area may be susceptible to floods and landslides, but there are also risks from car accidents or aviation crashes, from specific diseases or environmental conditions, and from unemployment or crime. A needs analysis should be done. Comparison of all the possible risks is essential in risk analysis, and comparison may reveal that certain risks are much less significant than others, no matter how important they seemed when viewed in isolation. Risks that the analyst believes are relatively insignificant and must be tolerated are called "residual" risks. The following is a checklist for various hazards that pose risks.Quantitative methods are frequently used to do risk analysis. Casual investigation, simulations, and rigorous research methods may help clarify why risks exist and indicate the means by which they can be reduced. The analysis of data on risk levels can transform a vague qualitative idea of risk into a more precise quantitative, probabilistic one. A full-fledged probabilistic approach (Bedford & Cooke 2001) involves sophisticated notions of release (rate at which the hazard strikes), exposure (vulnerability of populations per unit time), dose rate (impact per person), and background levels (inherent natural risk levels). However, simpler methods exist which take advantage of logical extensions on most definitions of risk. For example, most calculations are done with specific risks as a function of the likelihood of a hazardous event (sometimes called the threat probability) times the impact of the event (the scope of impact factor). The likelihood of a hazardous event is the most important factor to have rigorous data on because impact is often simply calculated as scope (how many people). Calculating the likelihood of a hazardous event, or its "threat probability," is a matter of odds-comparison with other risks. Vulnerability analysis also makes use of odds-ratios or likelihoods. A basic rule of thumb is that threats are always examined on the basis of their likelihood, and impacts are always evaluated on the basis of their scope. Vulnerability is essentially determined in the same way as "relative risk" except that for "threats," the motivations and resources of an attacker (if human) must be considered along with a range of ways to circumvent security around a target. The range of attacks to be considered on a target ("what if" scenarios or penetration tests) should begin with simple "brute force" or "front door" attacks and then progress to "insider" or "sophisticated" attacks which are not generally known. The average, or mean, likelihood of success (across all attack scenarios) usually determines the likelihood of threat. Vulnerability is then simply the product of this times the expected impact (or scope).

Threat analysis involves scope but also involves calculating the likelihood of precisely knowing the threat source (source identification). There are man-made sources, natural sources, and common or combined sources of threats. Intelligence for source identification can sometimes be had using open-source methods, like examining the media, but it behooves the threat analyst to examine as many intelligence sources as possible. Sometimes, a record of previous attacks that fit the modus operandi become the sole basis for source identification, but more generically (and in the non-human context), any circumstance that has the potential to cause harm should be considered a threat-source. If the threat-source is already known, all that's needed is to assess the scope of impact along various vulnerabilities (and this is called impact analysis, by the way). It should be remembered that without a vulnerability, a threat-source does not present a risk, so threat analysis assumes that vulnerability analysis has already been done. Threat analysis goes beyond vulnerability analysis by looking at weaknesses in the control mechanisms or countermeasures for identified threats. Control weaknesses may be technical, operational, or management-related, and it might be best to admit here that assessment of control weaknesses is often a subjective matter of judgment, although in recent years, there has been a tendency to evaluate control by the principles of information assurance and security, for which there are five (availability, integrity, authentication, confidentiality, and non-repudiation).

Reciprocal aid

One area where more extensive work is needed is the area of reciprocal aid. Reciprocal aid (or mutual aid) agreements are formal agreements with neighboring jurisdictions to furnish mutual or reciprocal aid. A reciprocal aid agreement should specify several things very clearly and, if necessary, in separate form for each of the jurisdictions involved. Exactly what is to he provided in given circumstances should be spelled out in terms of manpower, equipment, vehicles and supplies, as appropriate. The duration of such external assistance should be specified, along with any limitations to be placed on it. Unless the financial burden of supplying reciprocal aid is deemed to be roughly equal between the parties, arrangements may have to be spelled out for financial compensation. It may also be appropriate to state the conditions in which mutual aid is not expected to be furnished. Finally, there are cases in which mutual aid is best mapped out at a conference attended by various jurisdictions, in order to ensure that the assistance is efficiently planned, rather than provided for in a series of bilateral agreements that tend to duplicate resources or lead to imbalances. According to Alexander (2002), sociologists have classified five (5) organizations that operate in disasters:

Adapting organizations retain their original structure and complement of personnel, but adapt their operations to the needs of the disaster; thus, a local-government council may form a relief committee.

Expanding organizations increase their complement in order to cope with the disaster, perhaps by taking on volunteer workers, canceling leave of permanent personnel, calling in consultants, or increasing the hours of part- time workers.

Extending organizations increase the range of their activities to cover needs generated by the disaster; thus, a construction company may be involved in structural mitigation and urban search-and-rescue activities.

Emerging organizations are horn out of the situation created by the disaster and the emergence of people with latent gifts of organization and leadership; for example, victims and survivors may form an association to represent their needs more effectively. (Thus, what sociologists call a disaster subculture is born among the affected group.)

Redundant organizations have no role to play during disaster and are usually abandoned by their members for the duration of the emergency. These may include sporting or cultural societies, although occasionally they adapt their functions and find a role in the emergency.

PREPAREDNESS

Preparedness in the field of emergency management can best be defined as "a state of readiness to respond to a disaster, crisis, or other emergency situation." General, or long-term preparedness encompasses the marshalling of resources in the areas of prediction, forecasting and warning against disaster events. It also involves education and training initiatives, and planning to evacuate vulnerable populations from threatened areas. It often takes place against a background of attempts to increase public and political awareness of potential disasters and to garner support for increased funding of mitigation efforts. Short-term preparedness means to prepare for certain disasters once they have begun or begin to occur. In this latter sense, preparedness means to prepare as much as possible for known disasters, and the best preparations are always about what we know best. The best preparation is to get ready, plan, organize, set up, and practice some drill or test. Good preparedness means proper planning, resource allocation, training, and simulated disaster response exercises. It is important to conduct exercises to ensure that skills, equipment, and other resources can be effectively coordinated when an emergency occurs. Exercises also provide a good opportunity to identify organizational and departmental shortcomings and take corrective action before an actual event takes place. Airports, hospitals, and other healthcare facilities must conduct an exercise once every 2 years to maintain their certification or license to operate, and many employers are required by OSHA (Occupational Safety and Health Administration to have an emergency action plan that is in accordance with OSHA Guidelines for Emergency Response in the Workplace. The NRC (Nuclear Regulatory Commission) requires nuclear power plants test their disaster plans yearly, and conduct a full-scale exercise every two years. The U.S. Department of Justice - Office for Domestic Preparedness maintains HSEEP (Homeland Security Exercise & Evaluation Program) which is "both policy and doctrine" for how state-level Departments of Homeland Security ought to engage in exercise planning and management.

There are five (5) kinds of exercises that can be conducted in the name of emergency preparedness: (1) orientation; (2) drill; (3) tabletop exercise; (4) functional exercise; and (5) full-scale exercise. The difference between the last two is that a full-scale exercise usually involves people playing the role of victims, and the word "scenario" is usually applied to any exercise which has lots of enhancements or props to make it seem realistic. Good planning for the exercise may take up to three months prior to the event, but recommendations or "lessons learned & Best Practices" should be finished no later than three weeks afterwards. An exercise doesn't really "end" with a fixed stopping point until the person or persons playing the role of evaluator have collected enough information. The simplest example of a preparedness exercise would be an evacuation drill, or more precisely, an orientation on the location of fire escape exits. The NFPA (National Fire Protection Association) sells manuals on how to conduct evacuation drills. A good drill would include the routes people should take, where stockpiles of medical supplies are stored, how emergency and medical personnel should deploy, and a test of hospital capability to handle certain patients or injuries. Advanced disaster simulations or scenarios can be done utilizing the National Guard Bureau's J5 (IA) Unit, or any of the state National Guard units which have an elite WMD-CST (weapons of mass destruction, civil support team). The National Response Center, staffed 24 hours a day by the Coast Guard, is the place where elite training is done, and the lessons learned from many training exercises, including the biannual TOPOFF (Top Officials), can be found at the National Response Team site. FEMA also supports simulation exercises, and in fact has a Master Curriculum Guide at the EMI (Emergency Management Institute) website, and also collects "Smart Practices" that exemplify good local preparedness activities. Some of the points learned from conducting disaster simulations at the national or international level include the following:

Expect shortages of needed supplies, parts, and vaccines

Expect communications interoperability problems

Don’t make unified command overly complicated or formal

Prepare to deal with issues associated with sharing of (sensitive) information

Better notification and alert procedures may be needed

Clearly, emergency response drills and simulation exercises are worth the effort. Exercises help evaluate an organization’s capability to execute one or more portions of its response plan or contingency plan, and research has shown that people generally respond to an emergency in the way that they have trained.