# UNIT II

# NATURAL DISASTERS

## What is natural disaster?

Natural hazards are hazards which occur due to natural phenomena (hazards with meteorological, geological, or even biological origin). Examples of natural hazards are cyclones, tsunamis, earthquake, and volcanic eruptions which are exclusively of natural origin. A natural disaster can cause loss of life or damage property and typically leaves some economic damage in its wake, the severity of which depends on the affected population's resilience (ability to recover) and also on the infrastructure available.

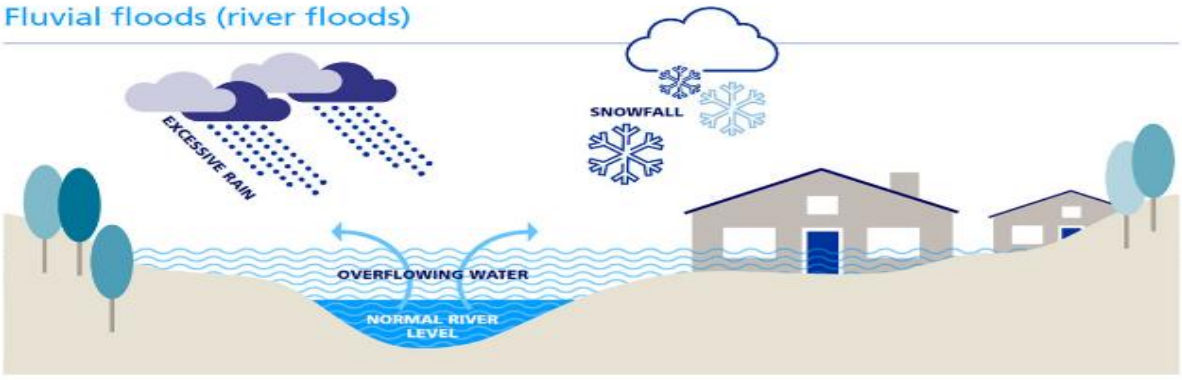
Each hazard has its own characteristics and to understand the significance and implications of various types of hazards, the basic understanding about the nature, causes and effects of each hazard type is required.

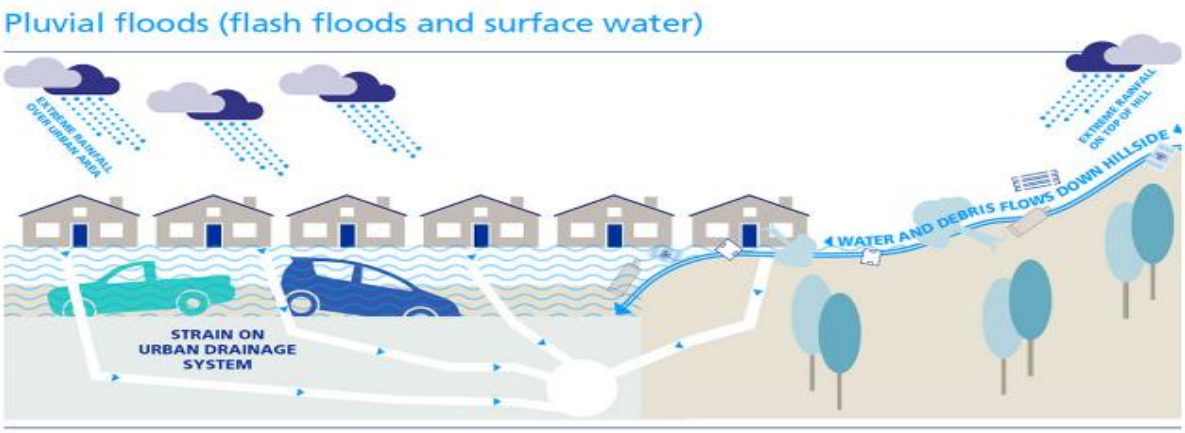
## Types of Natural Disaster

## 1. Floods

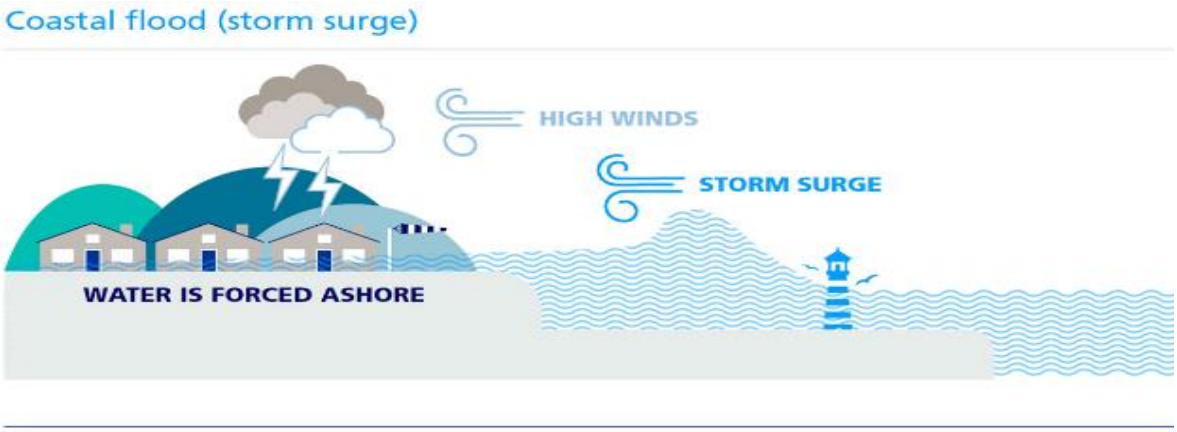
Flood is a state of high-water level along a river channel or on the coast that leads to inundation of land, which is not usually submerged. Floods may happen gradually and also may take hours or even happen suddenly without any warning due to breach in the embankment, spill over, heavy rains etc. There are different types of floods namely:

- **Flash flood**
- **Riverine flood**
- **Urban flood**






- ***A fluvial, or river flood***, occurs when the water level in a river, lake or stream rises and overflows onto the surrounding banks, shores and neighbouring land. The water level rise could be due to excessive rain or snowmelt.
- ***A pluvial flood*** occurs when an extreme rainfall event creates a flood independent of an overflowing water body.
- ***Surface water floods*** occur when an urban drainage system is overwhelmed and water flows out into streets and nearby structures. It occurs gradually, which provides people time to move to safe locations, and the level of water is usually shallow (rarely more than 1 meter deep). It creates no immediate threat to lives but may cause significant economic damage.
- ***Flash floods*** are characterized by an intense, high velocity torrent of water triggered by torrential rain falling within a short amount of time within the vicinity or on nearby elevated terrain. They can also occur via sudden release of water from an upstream levee or a dam. Flash floods are very dangerous and destructive not only because of the force of the water, but also the hurtling debris that is often swept up in the flow.




- ***Coastal flooding*** is the inundation of land areas along the coast by seawater. Common causes of coastal flooding are intense windstorm events occurring at the same time as high tide (storm surge), and tsunamis. The effects increase depending on the tide - windstorms that occur during high tide result in devastating storm surge floods. In this type of flood, water overwhelms low-lying land and often causes devastating loss of life and property.

## Causes for flood:

There are several causes of floods and differ from region to region. The causes may varyfrom a rural area to an urban area. Some of the major causes are:

a. Heavy rainfall

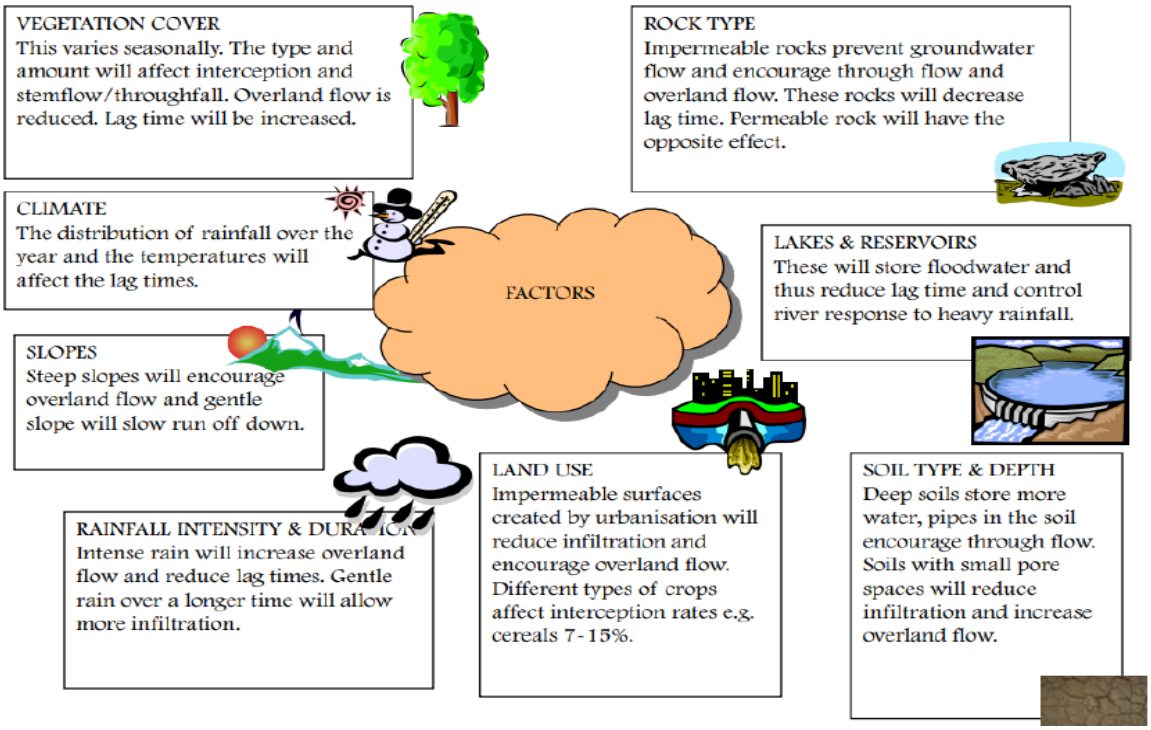
b. Heavy siltation of the river bed reduces the water carrying capacity of the rivers/stream.

c. Blockage in the drains lead to flooding of the area.

d. Landslides blocking the flow of the stream.

e. Construction of dams and reservoirs

f. In areas prone to cyclone, strong winds accompanied by heavy down pour along with storm surge leads to flooding.




## Adverse Effects of flood

- The most important consequence of floods is the loss of life and property.
- Structures like houses, bridges; roads etc. get damaged by the gushing water, landslides triggered on account of water getting saturated, boats and fishing nets get damaged. There is huge loss to life and livestock caused by drowning.
- Lack of proper drinking water facilities, contamination of water (well, ground water, piped water supply) leads to outbreak of epidemics, diarrhoea, viral infection, malaria and many other infectious diseases.
- Flooding also leads to a large area of agricultural land getting inundated as a result there is a huge crop loss. This results in shortage of food, and animal fodder.
- Floods may also affect the soil characteristics. The land may be rendered infertile due to erosion of top layer or may turn saline if sea water floods the area.

## Methods to reduce impact of floods:

- Introduce better flood warning systems
- Modify homes and businesses to help them withstand floods
- Construct buildings above flood levels
- Tackle climate change
- Increase spending on flood defences
- Protect wetlands and introduce plant trees strategically
- Restore rivers to their natural courses
- Introduce water storage areas
- Improve soil conditions
- Put up more flood barriers

## Floods in India:

Floods occur in almost all the river basins of the country. Around 12 per cent (40 million hectare) of land in India is prone to floods.Most of the flood affected areas lie in the Ganga basin, Brahmaputra basin, the northwestern river basin, peninsular river basin and the coastal regions of Andhra Pradesh, Tamilnadu, orissa and Kerela. Assam, Uttar Pradesh, Bihar and Orissa are some of the states which

have been severely prone to floods. Our country receives an annualrainfall of 1200 mm, 85% of which is concentrated in 3-4 months i.e June to September. Due to the intense and periodic rain, most of the rivers of the country are fed with huge quantity of water, much beyond their carrying capacity. From 1961 to 2000 around 22,923 people were killed due to flood in India.

### Warning for Floods:

Flood forecasting and warning has been highly developed in the past two decades. With the advancement of technology such as satellite and remote-sensing equipments flood waves can be tracked as the waterlevel rises. Except for flash floods there is usually a reasonable warning period. Heavy precipitation will give sufficient warning of the coming river flood. High tides with high winds may indicate flooding in the coastal areas. Evacuation is possible with suitable monitoring and warning. Warning is issued by the Central Water Commission (CWC), Irrigation & Flood Control Department,and Water Resources Department. CWC maintains close liaison with the administrative and state engineering agencies, local civil authorities to communicate advance warning for appropriate mitigation and preparedness measures.

### Possible risk reduction measures for floods:

1. Mapping of the flood prone areas is a primary step involved in reducing the risk of the region
2. Land use control will reduce danger of life and property when waters inundate the floodplains and the coastal areas.
3. Construction of engineered structures in the flood plains and strengthening of structures to withstand flood forces and seepage.
4. Flood Control aims to reduce flood damage. This can be done by decreasing the amount of runoff with the help of reforestation (to increase absorption could be a mitigation strategy in certain areas), protection of vegetation, clearing of debris from streams and other water holding areas, conservation of ponds and lakes etc.

## 2. Drought

Drought is either absence or deficiency of rainfall from its normal pattern in a region for an extended period of time leading to general suffering in the society. It is interplay between demand that people place on natural supply of water and natural event that provides the water in a given geographical region. The state of Kerala which receives more than 3000 mm of rainfall every year is declared drought affected as it is insufficient to have two good crops. The more the imbalance in supply the higher is the drought.

The following will help explaining this general definition of the drought further.

- It is a slow on-set disaster and it is difficult to demarcate the time of its onset and the end.
- Any unusual dry period which results in a shortage of useful water.
- Drought is a normal, recurrent feature of climate. Climate is expected to show some aberrations and drought is just a part of it.

- Drought can occur by improper distribution of rain in time and space, and not just by its amount.
- Drought is negative balance between precipitation and water use (through evaporation, transpiration by plants, domestic and industrial uses etc) in a geographical region.

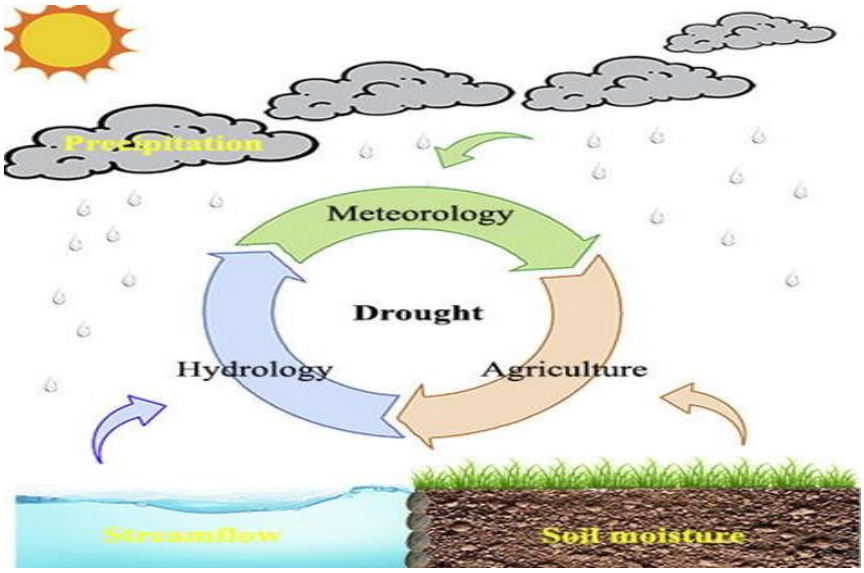
The effects of drought accumulate slowly over a considerable period of time.

## Causes of Drought:

Though drought is basically caused by deficit rainfall, which is a meteorological phenomenon, it manifests into different spheres because of various vulnerability factors associated with them. Some of these factors are human induced. Though drought is a natural disaster, its effects are made worst in developing countries by over population, over grazing, deforestation, soil erosion, excessive use of ground and surface water for growing crops, loss of biodiversity, pollution. We are using the fresh water faster than we are recharging our ground water.

## Types of droughts:

Drought proceeds in sequential manner. Its impacts are spread across different domains as listed below.




1. **Meteorological drought**

   Meteorological drought is simple absence/deficit of rainfall from the normal. It is the least severe form of drought and is often identified by sunny days and hot weather.

2. **Hydrological drought**

   Hydrological drought often leads to reduction of natural stream flows or ground water levels, plus stored water supplies. The main impact is on water resource systems.

3. **Agricultural drought**

   This form of drought occurs when moisture level in soil is insufficient to maintain average crop yields. Initial consequences are in the reduced seasonal output of crops and other related

production. An extreme agricultural drought can lead to a famine, which is a prolonged shortage of food in a restricted region causing widespread disease and death from starvation.

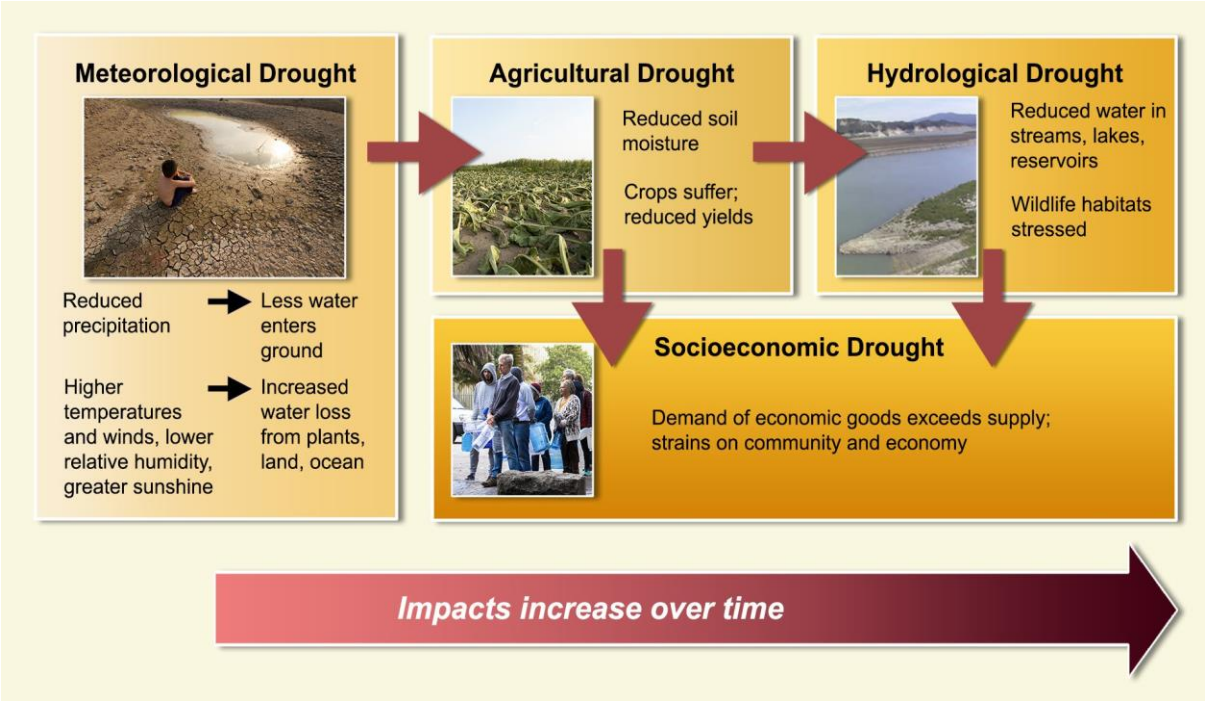
4. **Socio-economic drought**

   Socio-economic drought correlates the supply and demand of goods and services with the three above-mentioned types of drought. When the supply of some goods or services such as water and electricity are weather dependent then drought may cause shortages in supply of these economic goods.

## Effects of drought:

In general, all those elements that are primarily dependent on water are most affected. It affects the rain fed crops and then slowly creeps into the irrigated crops. People who are dependent on agriculture and areas where the other livelihood opportunities are least developed are greatly affected. The herdsman, landless labourer, subsistence farmers, women, children and farm animals are the most vulnerable groups.

Drought, different from any other natural disaster, does not cause any structural damages. As the meteorological drought turns into hydrological drought, the impacts start appearing first in agriculture which is most dependants on the soil moisture. Irrigated areas are affected much later than the rain fed areas. However, regions surrounding perennial rivers tend to continue normal life even when drought conditions are prevailing around. The impacts slowly spread into social fabric as the availability of drinking water diminishes, reduction in energy production, ground water depletion, food shortage, health reduction and loss of life, increased poverty, reduced quality of life and social unrest leading to migration. The following Figure 1 shows the effect of drought.



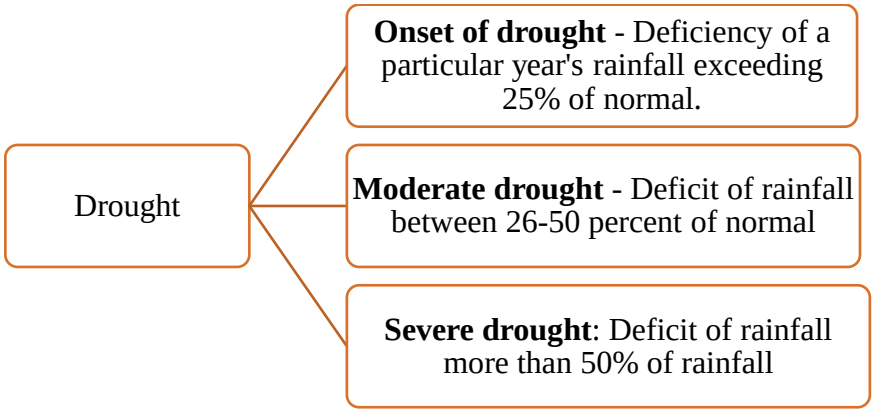
## Vulnerability factors for drought:

Some of the vulnerability factors to drought are listed below:

- Low soil moisture holding capacity
- Absence of irrigation facilities
- Poor water management
- Deforestation
- Over grazing
- Water consuming cropping patterns
- Excessive ground water draft
- Soil erosion
- Population growth and urbanization
- Industrialization
- Global warming

## Important fact about drought:

Cherapunji in Meghalaya, which was said to receive highest rainfall in the world, is now reeling under acute drinking water problem. This is because of water runoff, denudation and no storage facilities.




## Drought risk in India:

- Around 68 percent of India’s total area is drought prone to drought.
- 315 out of a total of 725 Talukas in 99 districts are drought prone.
- 50 million people are annually affected by drought.
- In 2001 more than eight states suffered the impact of severe drought.
- In 2003 most parts of Rajasthan experienced the fourth consecutive year of drought.

## Possible risk reduction measures for drought:

1. Public Awareness and education
2. Drought Monitoring

3. Water supply augmentation and conservation
4. Expansion of irrigation
5. Livelihood planning
6. Drought planning

## 3. Cyclones

Cyclone is a region of low atmospheric pressure surrounded by high atmospheric pressure resulting in swirling atmospheric disturbance accompanied by powerful winds blowing in anticlockwise direction in the Northern Hemisphere and in the clockwise direction in the Southern Hemisphere. They occur mainly in the tropical and temperate regions of the world. Cyclones are known by different names in different parts of the world as follows:


- **Typhoons** in the Northwest Pacific Ocean west of the dateline
- **Hurricanes** in the North Atlantic Ocean, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean.
- **Tropical cyclones** - the Southwest Pacific Ocean and Southeast Indian Ocean.
- **Severe cyclonic storm** - the North Indian Ocean
- **Tropical cyclone** - the Southwest Indian Ocean
- **Willie-Willie** in Australia
- **Tornado** in South America

## General characteristics of cyclone:

Cyclones in India are moderate in nature. Some of the general characteristics of a cyclone are:

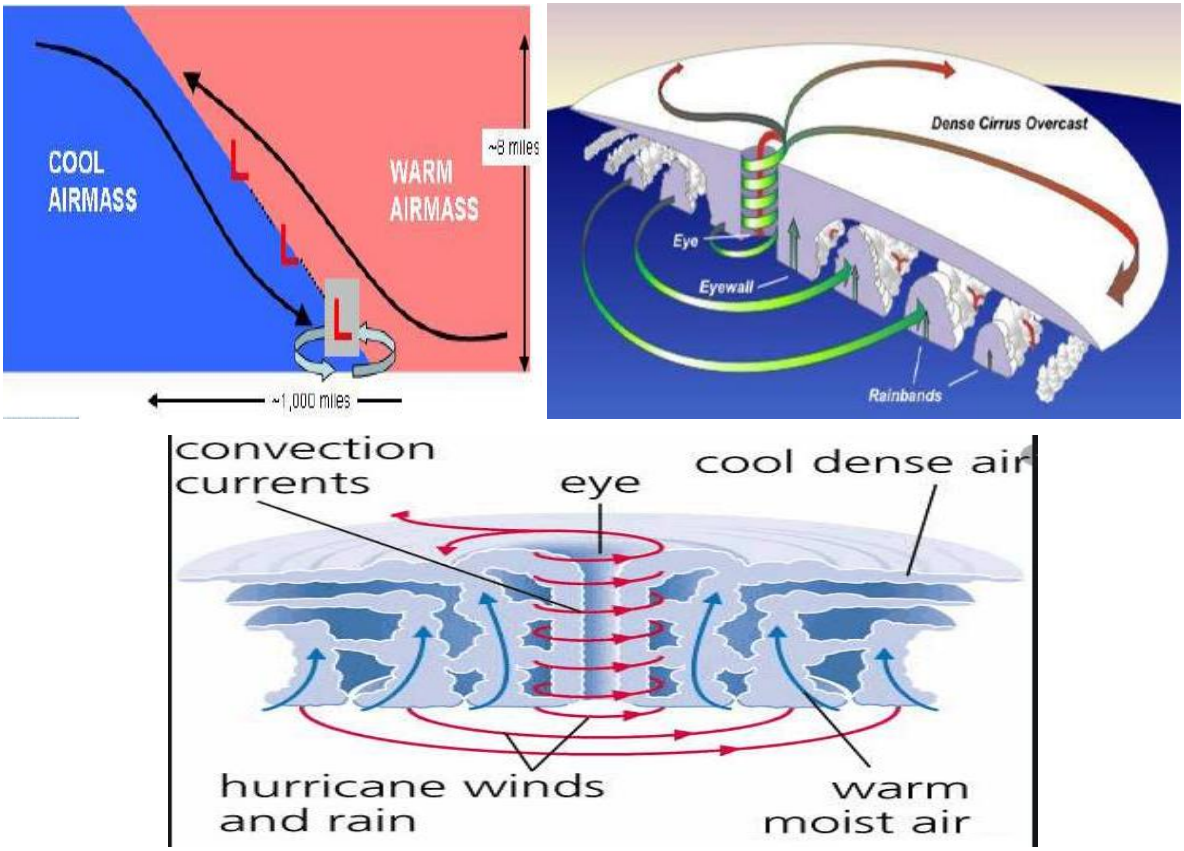
1. Strong winds
2. Exceptional rain
3. Storm surge

Cyclones are generally accompanied bystrong winds which cause a lot of destruction. In some cases, it is accompanied by heavy downpour and also the rise in the sea which intrudes inland thereby causing floods.

On 29th October 1999, Super-cyclone with wind speed of 260-300 km/hour hit the 140 kilometer coast of Orissa with a storm surge created in the Bay-of-Bengal with water level 9 metres higher than normal. The superstorm travelled more than 250 km inland and within a period of 36 hrs ravaged more than 200 lakh hectares of land, devouring trees and vegetation, leaving behind a huge trail of destruction. The violent cyclone was merciless and broke the backbone of Orissa's economy and killed thousands and devastated millions.

## Formation of Cyclones:

Generally, the development of a cyclone covers three stages as follow:




**Stage 1: Formation and initial development state:**

Four atmospheric/ oceanic conditions are necessary for the formation of a cyclone namely:

- A warm sea temperature in excess of 26 degree centigrade, to a depth of 60 meters, which provides abundant water vapour in the air by evaporation.
- High relative humidity (degree to which the air is saturated bywater vapor) of the atmosphere to a height of about 7000 meters, facilitates condensation of water vapor into droplets and clouds, releases heat energy and induces drop in pressure.
- Atmospheric instability (an above average decrease of temperature with altitude) encourages considerable vertical cumulus cloud convection when condensation of rising air occurs.
- A location of at least 4-5 latitude degrees from the Equator allow the influence of the force due to the earth's rotation (Coriolis force) to take effect in inducing cyclonic wind circulation around low pressure centers.

**Stage 2: Fully matured:**

The main feature of a fully mature tropical cyclone is a spiral pattern of highly turbulent giantcumulus thundercloud bands. These bands spiral inwards and form a dense highly active central cloud core which raps around a relatively calm zone. This is called the "eye" of a cyclone. The eye looks like a black hole or a dot surrounded by thick clouds. The outer circumference of the thick cloud is called the 'eye wall'.

**Stage 3: Weakening or decay:**

A tropical cyclone begins to weaken as soon as its source of warm moist air is abruptly cut off. This is possible when the cyclone hits the land, on the cyclone moves to a higher altitude or when there is the interference of another low pressure.

Depending on their track on the warm tropical sea and proximity to land a cyclone may last for less than 24 hours to more than 3 weeks. On an average the life cycle of a cyclone (a cyclone to complete these three stages mentioned above) takes six days. The longest cyclone is typhoon John which lasted for 31 days (August to September, 1994 in the north east and north west pacific basins).

## Cyclones in India:

Cyclones vary in frequency in various parts of the world. The 7516.6 kilometers long Indian coastline is the earth's most cyclone battered stretch of the world. Around 8 per cent of the total land area in India is prone to cyclones. About two-third of the cyclones that occur in the Indian coastline occur in the Bay of Bengal. The states which are generally affected in the east coast are West-Bengal, Orissa, Andhra Pradesh; Tamil Nadu and on the west coast Gujarat, Maharashtra, Goa, Karnataka and Kerala.

## Adverse Effects of Cyclone:

- Strong winds, torrential rains and flooding cause a huge loss to life and property. The 1999 Super Cyclone of Orissa killed more than 10,000 precious lives with women and children greatly affected.
- Apart from loss to life there is a huge loss to infrastructures like houses built of mud, older buildings with weak walls, bridges, settlements in low lying areas.

- High winds cause major damage to infrastructure and housing, in particular fragile constructions.
- Cyclone is also followed by heavy rains and floods and, in flat coastal areas by storm surge riding on tidal waves and inundating the land over long distances of even upto 15 kilometer inland.
- Physical damage - Structures will be damaged or destroyed by the wind force, flooding and storm surge. Light pitched roofs of most structures especially the ones fitted on to industrial buildings will suffer severe damage
- Casualties and public heath – Flooding, flying elements and contamination of water supplies may lead to viral outbreaks, diarrhoea and malaria.
- Water supplies – Ground and pipe water supply may get contaminated by flood waters.
- Crops and food supplies – High winds and rain ruin the standing crop and food stock lying-in low-lying areas. Plantation type crops such as banana and coconut are extremely vulnerable. Salt from the sea water may get deposited on the agricultural land and increase the salinity. The loss of the crop may lead to acute food shortage.
- Communication – Severe disruption occurs in the communication links as the wind may bring down the electricity and communication towers, telephone poles, telephone lines, antennas and satellite disk and broadcasting services. Transport lines (road and rail) may be curtailed. Lack of proper communication affects effective distribution of relief materials.

**Possible risk reduction measures for cyclone:**

1. Coastal belt plantation
2. Hazard mapping
3. Land use control
4. Engineered structures
5. Flood management
6. Improving vegetation cover

# 4. Earthquakes

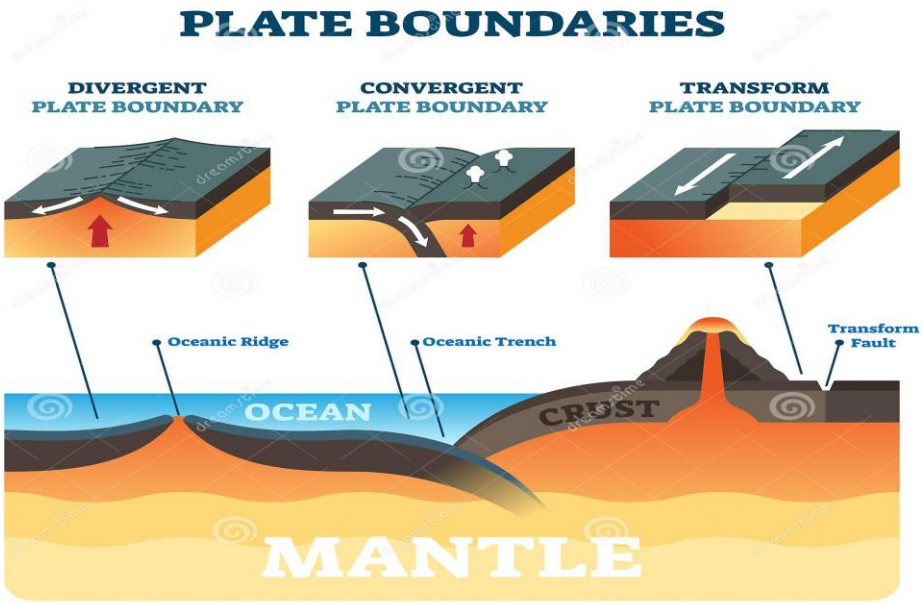
Earthquake is one of the most destructive natural hazards. They may occur at any time of the year, day or night, with sudden impact and little warning. They can destroy buildings and infrastructure in seconds, killing or injuring the inhabitants. Earthquakes not only destroy the entire habitation but may de-stabilize the government, economy and social structure of the country.

What is an earthquake? It is the sudden shaking of the earth crust. The impact of an earthquake is sudden and there is hardly any warning, making it impossible to predict.

Cause of Earthquake:

The earth’s crust is a rocky layer of varying thickness ranging from a depth of about 10kilometers under the sea to 65 kilometers under the continents. The crust is not one piece but consists of portions

called ‘plates’ which vary in size from a few hundred to thousands of kilometers. The ‘theory of plate tectonics’ holds that the plates ride up on the more mobile mantle, and are driven by some yet unconfirmed mechanisms, perhaps thermal convection currents. When these plates contact each other, stress arises in the crust. These stresses can be classified according to the type of movement along the plate’s boundaries:

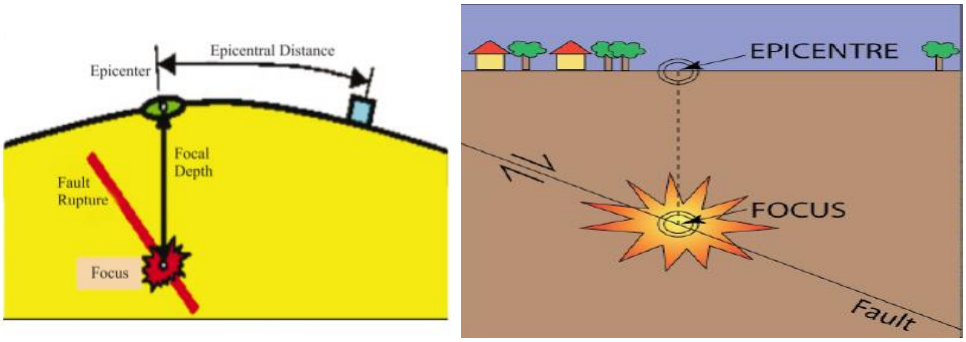



a) pulling away from each other - Divergent

b) pushing against one another - Convergent

c) sliding sideways relative to each other - Transformational

All these movements are associated with earthquakes. The areas of stress at plate boundaries which release accumulated energy by slipping or rupturing are known as 'faults'. The theory of 'elasticity' says that the crust is continuously stressed by the movement of the tectonic plates; it eventually reaches a point of maximum supportable strain. A rupture then occurs along the fault and the rock rebounds under its own elastic stresses until the strain is relieved. The fault rupture generates vibration called seismic waves, which radiates from the focus in all directions. The point of rupture is called the 'focus' and may be located near the surface or deep below it. The point on the surface directly above the focus is termed as the 'epicenter' of the earthquake. The distance of the building from the epicenter decides the impact of ground vibration on that particular building during earthquake.




## General characteristics:

Earthquake vibrations occur in a variety of frequencies and velocities. The actual rupture process may last for a few seconds to as long as one minute for a major earthquake. The ground shaking is caused by 'body waves' and 'surface wave'. Body waves penetrate the body of the earth and vibrate fast whereas surface waves vibrate the ground horizontally and vertically. Surface waves cause swaying of tall buildings and slight waves motion in bodies of water even at great distances from the epicenter. Earthquakes can be of three types based on the focal depth:

1. Deep Earthquake - 300 to 700 kms from the earth surface
2. Medium - 60 to 300 kms
3. Shallow - less than 60 kms

The deep focus earthquakes are rarely destructive because by the time the waves reach the surface the impact reduces. Shallow focus earthquakes are more common and are extremely damaging because of their proximity to the surface.

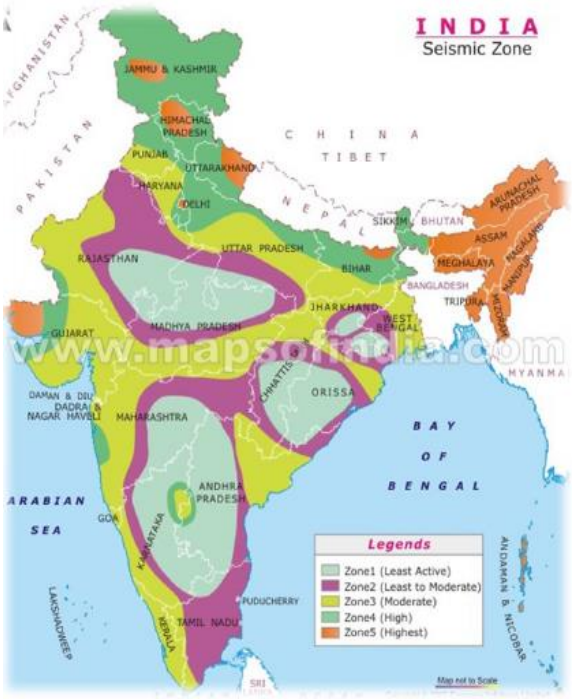
Earthquakes can be described by the use of two distinctively different scales of measurement demonstrating magnitude and intensity. Earthquake magnitude is measured by using seismograph that continuously records ground vibration. Earthquake intensity scale measures the effects of an earthquake where it occurs and Modified Mercalli Scale is used. Modified Mercalli Scale expresses the intensity of earthquake effect on people, structure and earth's surface in values from I to XII.

## Adverse effects of earthquake:

Physical damage**:**Damage occurs to human settlement, buildings, structures and infrastructure, especially bridges, elevated roads, railways, water towers, pipelines, electrical generating facilities. Aftershocks of an earthquake can cause much greater damage to already weakened structures. Secondary effects include fires, dam failure and landslides which may block water ways and also cause flooding. Damage may occur to facilities using or manufacturing dangerous materials resulting in possible chemical spills. There may also be a breakdown of communication facilities. The effect of an earthquake is diverse. There are large number of casualties because of the poor engineering design of the buildings and close proximity of the people. About 95 per cent of the people who are killed or who are affected by the earthquake is because of the building collapse. There is also a huge loss to the public health system, transport and communication and water supply in the affected areas.

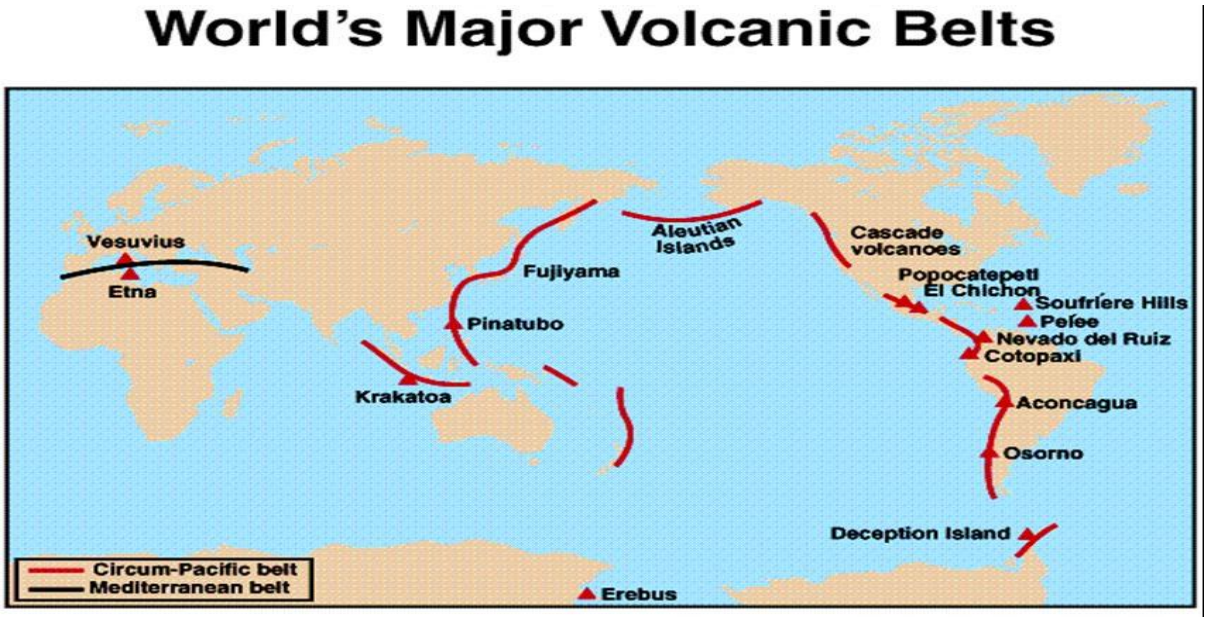
## Earthquakes in India:

India falls quite prominently on the 'Alpine - Himalayan Belt'. This belt is the line along which the Indian plate meets the Eurasian plate. This being a convergent plate, the Indian plate is thrusting underneath the Eurasian plate at a speed of 5 cm per year. The movement gives rise to tremendous stress which keeps accumulating in the rocks and is released from time to time in the form of earthquakes. The seismic zoning map of India is divided into four zones namely Zone II, III, IV and V.




## Distribution of Earthquakes:

Shocks of the past confined with two large geographical belts

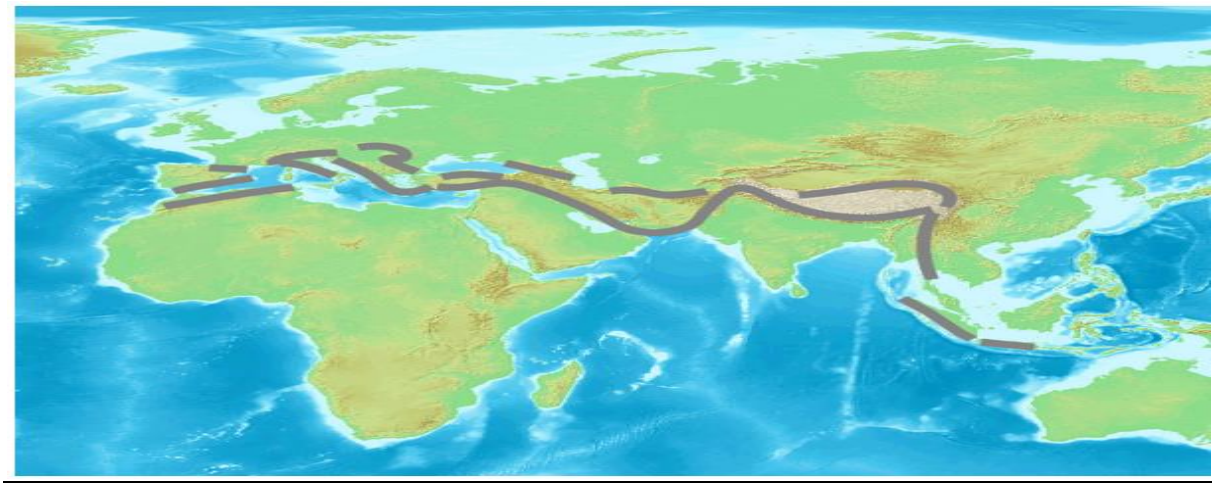


- ***The Circum-Pacific belt***

The Pacific Ring of Fire/Rim of Fire is a string of volcanoes and sites of seismic activity around the edges of the Pacific Ocean. The tectonic activity along the Ring of Fire results in about 90% of the world's earthquakes, including the Valdivia Earthquake of Chile in 1960, the strongest ever recorded earthquake at 9.5 out of 10 on the Richter Scales


- ***The Mediterranean Belt***

The Alpide belt or Alpine-Himalayan orogenic belt is a seismic belt and orogenic belt that includes an array of mountain ranges extending for more than 15,000 km along. It is the second most seismically active region in the world, after the circum-Pacific belt (the Ring of Fire), with 17% of the world's largest earthquakes.



**Possible risk reduction measures for Earthquake:**


1. Community preparedness (Drop, Cover and Hold)
2. Planning
3. Public education
4. Engineered structures

# 5. Landslides

The term' landslide' includes all varieties of mass movements of hill slopes and can be defined as the downward and outward movement of slope forming materials composed of rocks, soils, artificial fills or combination of all these materials along surfaces of separation by falling, sliding and flowing, either slowly or quickly from one place to another. Although the landslides are primarily associated with mountainous terrains, these can also occur in areas where an activity such as surface excavations for highways, buildings and open pit mines takes place. They often take place in conjunction with earthquakes, floods and volcanoes. At times, prolonged rainfall causing landslide may block the flow of river for quite some time. The formation of river blocks can cause havoc to the settlements downstream on its bursting.

**Landslide Hazard** refers to the potential of occurrence of a damaging landslide within a given area; such damage could include loss of life or injury, property damage, social and economic disruption, or environmental degradation.

**Landslide Vulnerability** reflects the extent of potential loss to given elements (or set of elements) within the area affected by the hazard, expressed on a scale of 0 (no loss) to 1 (total loss); vulnerability is shaped by physical, social, economic and environmental conditions.

**Landslide Risk** refers to the probability of harmful consequences-the expected number of lives lost, persons injured, extent of damage to property or ecological systems, or disruption of economic activity –within a landslide prone area. The risk may be individual or societal in scope, resulting from an interaction between the hazard and individual or societal vulnerability.

## Causes of Landslides:

There are several causes of landslide. Some of the major causes are as follows:

1. Geological Weak material: Weakness in the composition and structure of rock or soil may also cause landslides.

2. Erosion: Erosion of slope toe due to cutting down of vegetation, construction of roads might increase the vulnerability of the terrain to slide down.

3. Intense rainfall: Storms that produce intense rainfall for periods as short as several hours or have a more moderate intensity lasting several days have triggered abundant landslides. Heavy melting of snow in the hilly terrains also results in landslide.

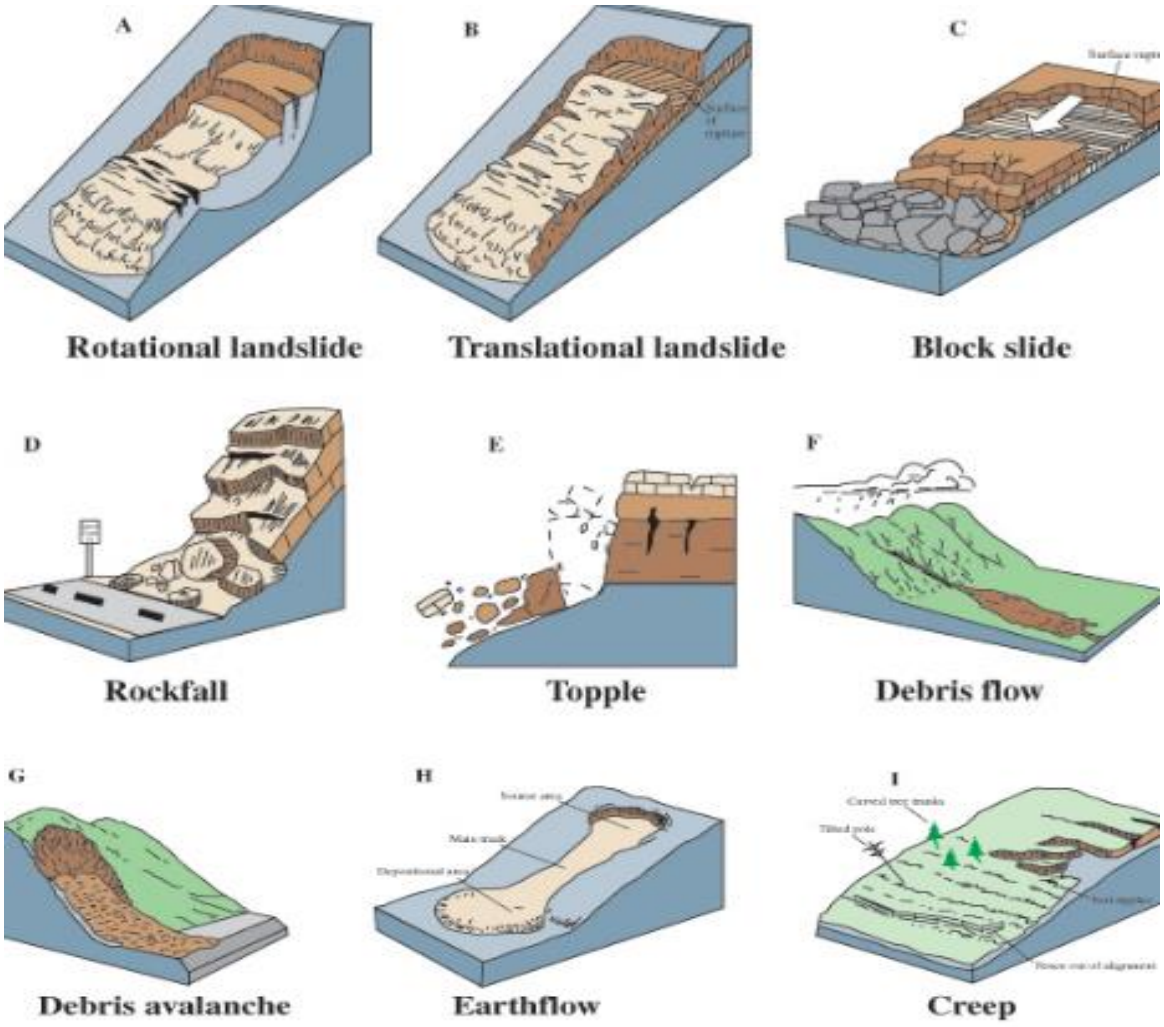
4. Human Excavation of slope and its toe, loading of slope/toe, draw down in reservoir, mining, deforestation, irrigation, vibration/blast, Water leakage from services.

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

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

## Type of Landslides:

The common types of landslides are described below. These definitions are based mainly on the work of Varnes:



**Falls:** Abrupt movements of materials that become detached from steep slopes or cliffs, moving by free-fall, bouncing, and rolling.

**Flows:** General term including many types of mass movement, such as debris flow, debris avalanche, lahar, and mudflow.

**Creep:** Slow, steady downslope movement of soil or rock, often indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences.

**Debris flow:** Rapid mass movement in which loose soils, rocks, and organic matter combine with entrained air and water to form slurry that then flows down slope, usually associated with steep gullies.

**Debris avalanche:** A variety of very rapid to extremely rapid debris flow

**Mudflow:** Rapidly flowing mass of wet material that contains at least 50 per cent sand, silt, and clay-sized particles.

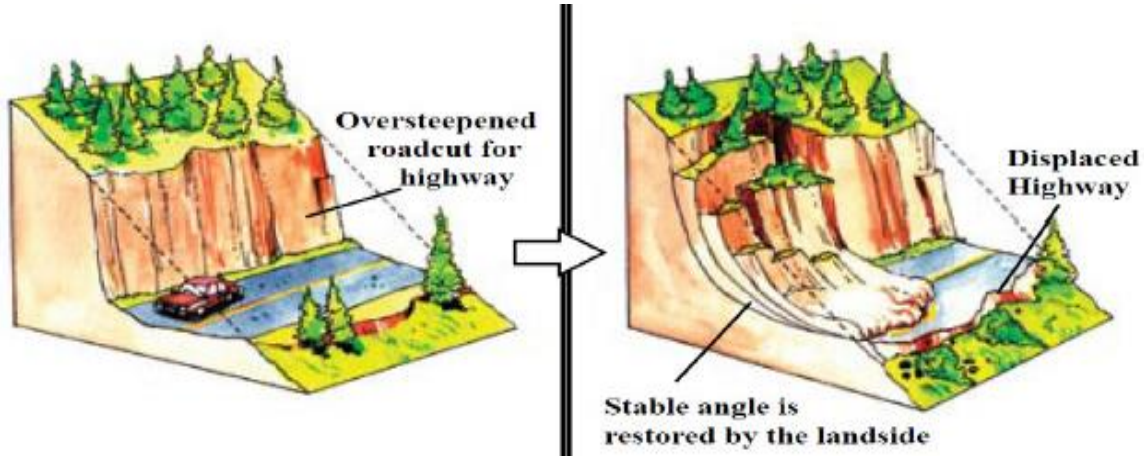
**Lateral spreads:** Often occur on very gentle slopes and result in nearly horizontal movement of earth materials. Lateral spreads usually are caused by liquefaction, where saturated sediments (usually sands and silts) are transformed from a solid into a liquefied state, usually triggered by an earthquake.

**Slides**: Many types of mass movement are included in the general term "landslide." The two major types of landslides are rotational slides and translational landslides.

**Topple**:A block of rock that tilts or rotates forward and falls, bounces, or rolls down the slope.\

## Adverse Effects of Landslide:

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

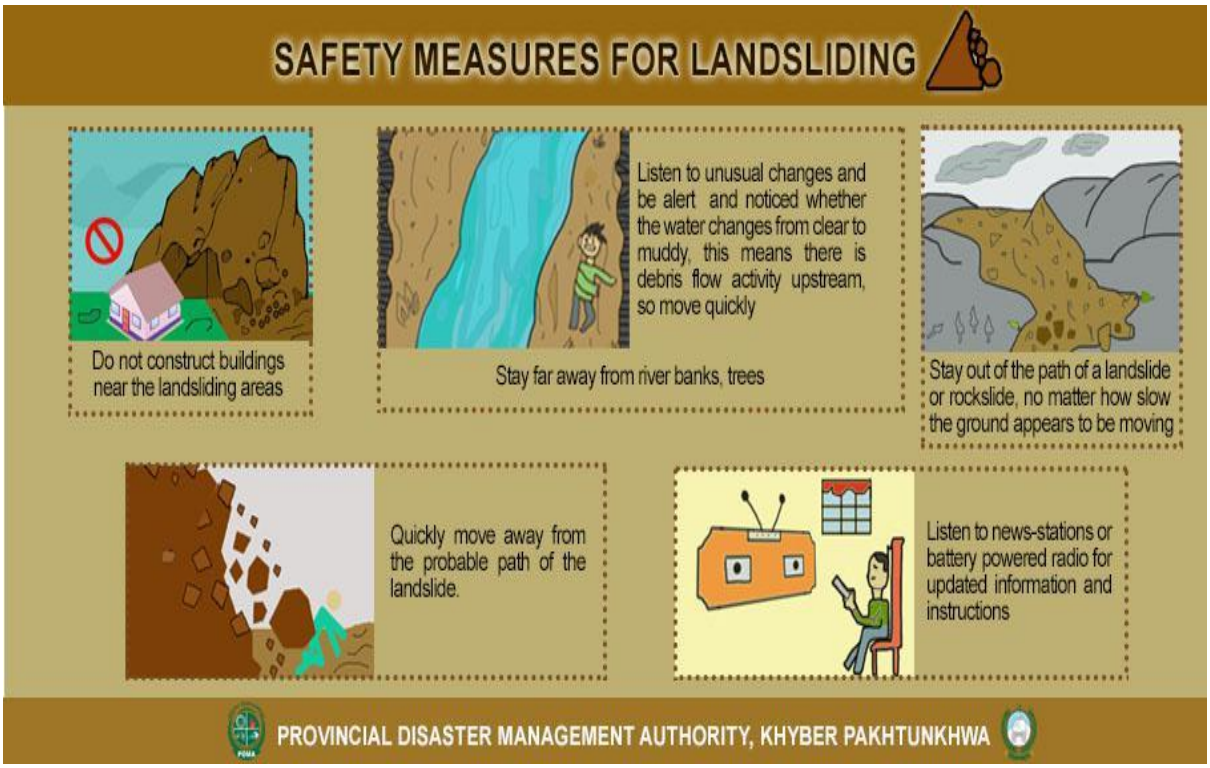


## Landslides in India:

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

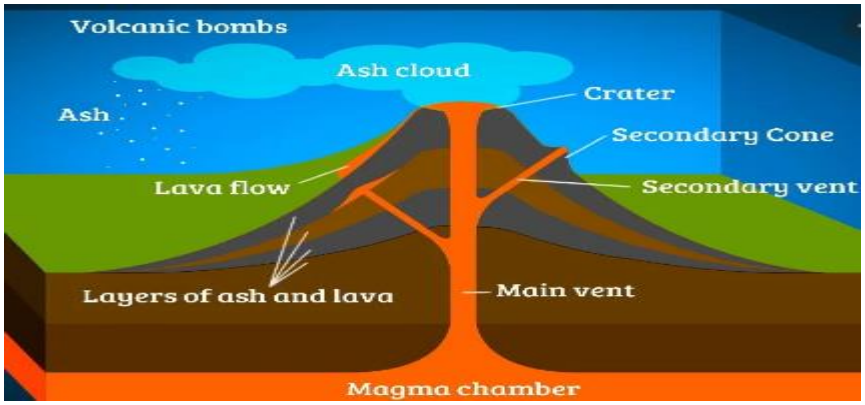
## Possible risk reduction measures for Landslide:

1. Hazard mapping
2. Construction of retaining wall
3. Land use practices
4. Surface Drainage Control Works
5. Engineered structures
6. Increasing vegetation cover
7. Insurance



# 6. Volcanic Eruption

Volcanoes which are likely to constitute a disaster threat are internationally well documented and, in many cases, monitored for possible activity. Usually, therefore, major eruptions can be predicted.




## Effects of Volcanic Eruption:

- Volcanic blast can destroy structures and environmental surrounds, and also cause fires, possibly including forest fires.
- Land surface cracking, resulting from volcanic explosion, may affect buildings and other structures.
- Lava flow can bury buildings and crops. It may also cause fires and render land unusable.
- Ash, in its airborne form, can affect aircraft by ingestion into engines.
- Ground deposit of ash may destroy crops and also affect land use and water supplies.
- Ash may also cause respiratory problems.
- Mud flows may arise from associated heavy rain.

## Possible risk reduction measures:

- Land-use regulations
- Lava control systems
- Developing a monitoring and warning system
- Evacuation plans and arrangements
- Relocating the population
- Public awareness and education programs.

## Special problems areas for disaster management:

- Access during eruption.
- Timely and accurate evacuation decision(s).
- Public apathy, especially if there is a history of false alarms or small eruptions. Thus, it may be difficult to maintain public awareness and also to implement evacuation plans.
- Control of incoming sightseers when evacuation programs are being implemented.

# 7. Tsunami

**(Seismic Sea Wave) Characteristics**:

The velocity of the wave depends on the depth of water where the seismic disturbance occurs. Initial wave velocity may be as high as 900 kilometer per hour (kph), slowing to approximately 50 kph as the wave strikes land.

- Warning time depends on the distance from the point of wave origin.
- Speed of onset varies
- Impact on a shoreline can be preceded by a marked recession of normal water level prior to the arrival of a wave. This can result in a massive outgoing tide, followed by the incoming tsunami wave. People may be trapped when they investigate the phenomenon of the outgoing tide and then be struck by the incoming wave.
- The tsunami wave can be very destructive; wave heights of 30 meters have been known.
- Impact can cause flooding; saltwater contamination of crops, soil, and water supplies; and destruction of or damage to buildings, structures, and shoreline vegetation.

**Possible risk reduction measures for Tsunami:**

- Optimum arrangements for receipt and dissemination of warning
- Evacuating threatened communities from sea level/low-level areas to high ground, if sufficient warning is available
- Land-use regulations (but these are likely to be difficult to implement if the tsunami risk is perceived as rare)
- Public awareness and education programs.

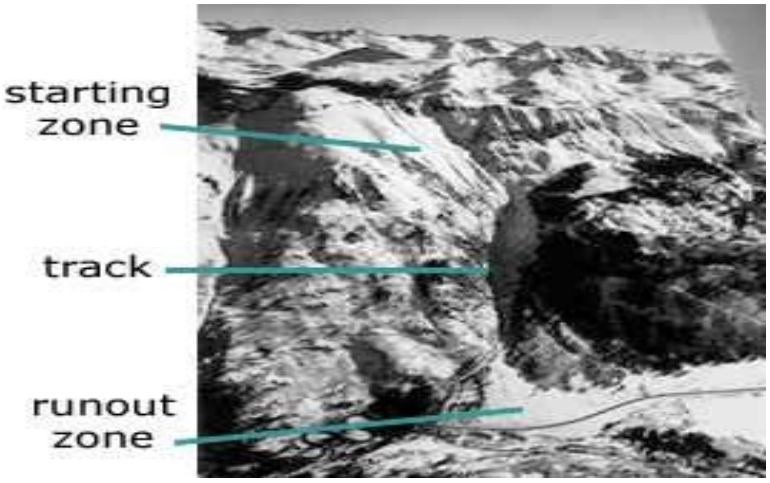
**Special problem areas for disaster management:**

- Timely dissemination of warning because of the possible short period between receipt of warning and the arrival of the tsunami wave
- Effective evacuation time-scale
- Search and rescue
- Recovery problem may be extensive and costly because of severe destruction and damage.

# 8. Avalanches

An avalanche (also called a snowslide) is an event that occurs when a cohesive slab of snow lying upon a weaker layer of snow fractures and slides down a steep slope. Avalanches are typically triggered in a starting zone from a mechanical failure in the snowpack when the forces of the snow exceed its strength but sometimes only with gradual widening. After initiation, avalanches usually accelerate rapidly and grow in mass and volume as they entrain more snow. If the avalanche moves

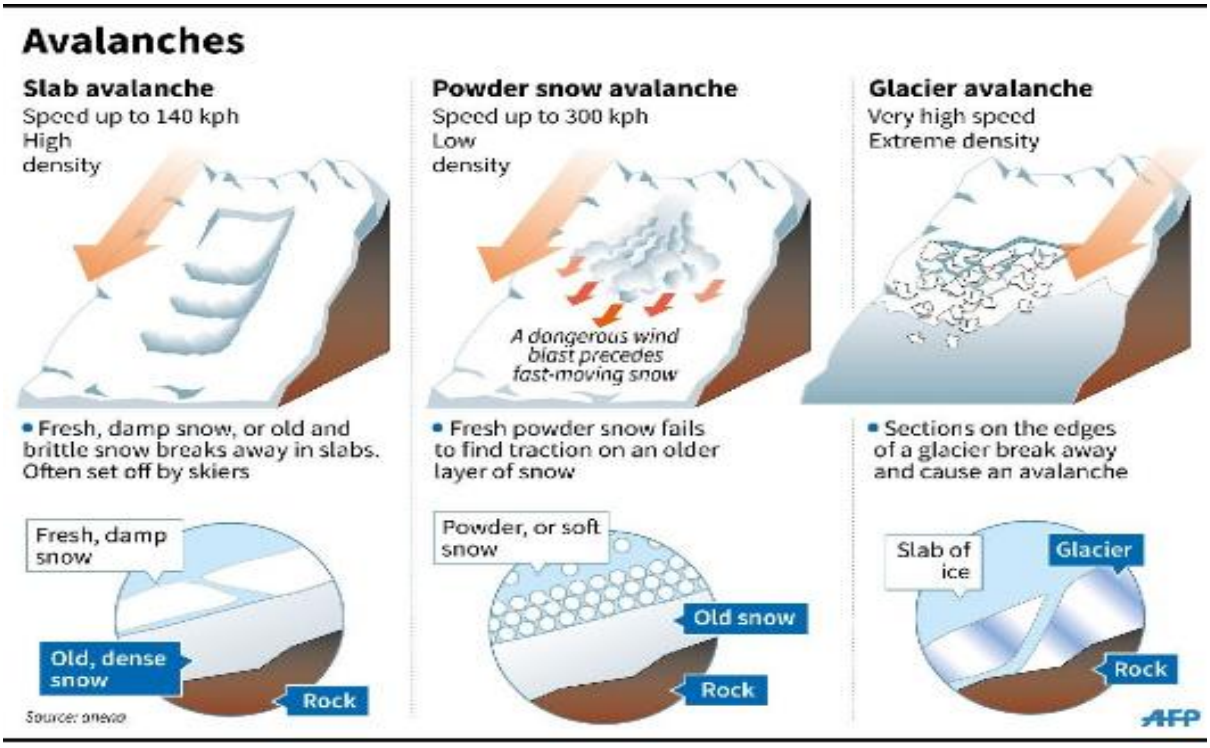
fast enough, some of the snow may mix with the air forming a powder snow avalanche, which is a type of gravity current. Slides of rocks or debris, behaving in a similar way to snow, are also referred to as avalanches. There are many different types of avalanches including snow, ice, rock and soil.




An avalanche has three main parts

1) The ***starting zone*** is the most volatile area of a slope, where unstable snow can fracture from the surrounding snow cover and begin to slide.
2) The ***avalanche track*** is the path or channel that an avalanche follows as it goes downhill.
3) The ***runout zone*** is where the snow and debris finally come to a stop. Similarly, this is also the location of the deposition zone, where the snow and debris pile the highest.

## Types of Avalanches:



1. ***Surface Avalanche*** that occurs when a layer of snow with different properties slides over another layer of snow. For example, when a layer of dry loosely packed snow slides over a dense layer of wet snow.
2. The other common avalanche is known as a ***Full-Depth Avalanche*** which, as it's name would lead you to believe, occurs when an entire snow cover, from the earth to the surface, slides over the ground.
3. ***Loose Snow Avalanches:*** First of these are the Loose Snow Avalanches. They are common on steep slopes and are seen after a fresh snowfall. Since the snow does not have time to settle down fully or has been made loose by sunlight, the snow-pack is not very solid. Such avalanches have a single point of origin, from where they widen as they travel down the slope.
4. Loose Snow Avalanches in turn could cause a ***Slab Avalanche***, which are characterized by a the fall of a large block of ice down the slopes. Thin slabs cause fairly small amounts of damage, while the thick ones are responsible for many fatalities.
5. ***Powder Snow Avalanches*** are a mix of the other forms, Loose Snow and Slab. The bottom half of this avalanche consists of a slab or a dense concentration of snow, ice and air. Above this is a cloud of powdered snow, which can snowball into a larger avalanche as it progresses down the slope. The speed attained by this avalanche can cross 190 miles per hour and they can cross large distances.
6. Finally, there are ***Wet Snow Avalanches***. These are quite dangerous as they travel slowly due to friction, which collects debris from the path fairly easily. The avalanche comprises of water and snow at the beginning, but understanding of avalanches has showed us that it can pick up speed with ease.

## Causes for Avalanches:

There are three main factors that contribute to causing an avalanche.

- If the steepness of the terrain is between 35 to 45 degrees, is shady, has a convex shape and has a rock or slab base with little vegetation the chance of an avalanche is extremely high.
- Weather is another main factor where everything from temperature to wind and rain can loosen the material pack and cause an avalanche.
- For a snow avalanche, the snow itself can contribute to the probability of an avalanche. If there is a large amount of new, unbounded snow with little compaction and a large crystal size, the snow can cause an avalanche all by itself.

## Adverse effects of Avalanches:

- Death or Injury - The biggest way in which avalanches affect people is by causing death or injury. The force from an avalanche can easily break and crush bones causing serious injury.

Asphyxiation is the most common cause of death, followed by death from injury and lastly by hypothermia. People buried in the avalanche have more than a 90 percent survival rate if found within 15 minutes. The rate drops to around 30 percent if found after 35 minutes.

- Property and Transportation - Avalanches can completely destroy houses, cabins and shacks on its pathway. This force can also cause major damage to ski resorts near or on the mountain, as well as ski lift towers. Avalanches also can cause roads and railroad lines to close. The large amount of snow can cover entire mountain passes and travel routes. Car and trains that may be traveling on these routes can be completely wiped out or buried.
- Utilities and Communication - Another way that these disasters affect humans is by damaging utilities and communication. The power from these snow waves can completely destroy pipelines carrying gas or oil, thus causing leaks and spillage. Broken power lines can cause a disruption in electricity and cause thousands of people to go without power. Communication fields, such as telephone and cable lines, could go silent causing a panic and a delay in response time and rescue.

### Possible risk reduction measures for Avalanches:

- Minimizing the number of people on a slope helps reduce the stress on the surface; although for safety reasons one should never be on a slope alone.
- Traversing, or cutting across a slope, should be kept to a minimum as traffic will help to compromise the surface strength.
- Finally, always be able to recognize danger and consider an alternative route to prevent starting an avalanche.
- Avalanche zoning
- Artificial Triggering
- Afforestation
- Structural Defenses

## 9. Heat and Cold Wave

### Heat Wave:

A heat wave is a period of excessively hot weather, which may be accompanied by high humidity, especially in oceanic climate countries. While definitions vary, a heat wave is usually measured relative to the usual weather in the area and relative to normal temperatures for the season. Temperatures that people from a hotter climate consider normal can be called a heat wave in a cooler area if they are outside the normal climate pattern for that area.

The World Meteorological Organization, defines a heat wave as 5 or more consecutive days of prolonged heat in which the daily maximum temperature is higher than the average maximum

temperature by 5 °C (9 °F) or more. However, some nations have come up with their own criteria to define a heat wave.

## Causes for Heat Wave:

- Heat waves form when high pressure aloft strengthens and remains over a region for several days up to several weeks. This is common in summer (in both Northern and Southern Hemispheres) as the jet stream 'follows the sun'.
- Surface winds could blow from the hot continental interior towards the coastal zone, leading to heat waves there, or from a high elevation towards low elevation, enhancing the subsidence and therefore the adiabatic warming.
- In the Eastern United States, a heat wave can occur when a high-pressure system originating in the Gulf of Mexico becomes stationary just off the Atlantic Seaboard.
- In the Western Cape Province of South Africa, a heat wave can occur when a low pressure offshore and high-pressure inland air combine to form a Bergwind. The air warms as it descends from the Karoo interior, and the temperature will rise about 10 °C from the interior to the coast.
- Global warming boosts the probability of extreme weather events, like heat waves, far more than it boosts more moderate events.

## Effects of heat wave:

- Severe heat waves have caused catastrophic crop failures
- Thousands of deaths from hyperthermia (Hyperthermia – heart stroke)
- Widespread power outages due to increased use of air conditioning.
- A heat wave is considered extreme weather that can be a natural disaster, and a danger because heat and sunlight may overheat the human body.
- Psychological and sociological effects
- Wildfires
- Physical damage – Heat waves can cause roads and highways to buckle and melt, water lines to burst and power transformers to detonate, causing fires

Heat waves can usually be detected using forecasting instruments so that a warning call can be issued.

## Cold Wave:

A cold wave (known in some regions as a cold snap or cold spell) is a weather phenomenon that is distinguished by a cooling of the air. Specifically, as used by the U.S. National Weather Service, a cold wave is a rapid fall in temperature within a 24-hour period requiring substantially increased protection to agriculture, industry, commerce, and social activities. The precise criterion for a cold wave is determined by the rate at which the temperature falls, and the minimum to which it falls. This minimum temperature is dependent on the geographical region and time of year.In the United States, a

cold spell is defined as the national average high temperature dropping below 20 °F (−7 °C).A cold wave of sufficient magnitude and duration may be classified as a cold air outbreak.

### Causes for Cold Wave:

Cold waves generally are capable of occurring at any geological location and are formed by large cool air masses that accumulate over certain regions, caused by movements of air streams. Cold waves affect much larger areas than blizzards, ice storms, and other winter hazards. The “wave” in cold wave is apparent in the upper-air flow (the jet stream), which is usually amplified into a strong ridge-trough pattern during a major cold outbreak.

### Effects of cold wave:

- A cold wave can cause death and injury to livestock and wildlife.
- Cold spells are associated with increased mortality rates in populations around the world.Both cold waves and heat waves cause deaths, though different groups of people may be susceptible to different weather events.
- Extreme winter cold often causes poorly insulated water pipelines and mains to freeze.
- Demand for electrical power and fuels rises dramatically during such times, even though the generation of electrical power may fail due to the freezing of water necessary for the generation of hydroelectricity.
- Cold waves that bring unexpected freezes and frosts during the growing season in mid-latitude zones can kill plants during the early and most vulnerable stages of growth, resulting in crop failure.

## 10. Global Warming

Global warming relates to the increase in the average temperature of the Earth's surface that has been observed in recent years, and it is projected to continue. It is debated as to whether this is a natural occurrence or whether human activity has impacted or accelerated it.

### Green House Effect:

The greenhouse effect is the process by which absorption and emission of infrared radiation by gases in the atmosphere are purported to warm a planet's lower atmosphere and surface. Naturally occurring greenhouse gases have a mean warming effect of about 33 °C (59 °F). The major greenhouse gases are water vapour, which causes about 36–70 percent of the greenhouse effect; carbon dioxide ($CO_2$), which causes 9–26 percent; methane ($CH_4$), which causes 4–9 percent; and ozone ($O_3$), which causes 3–7 percent. Clouds also affect the radiation balance, but they are composed of liquid water or ice and so have different effects on radiation from water vapour.

## Causes of Global Warming:

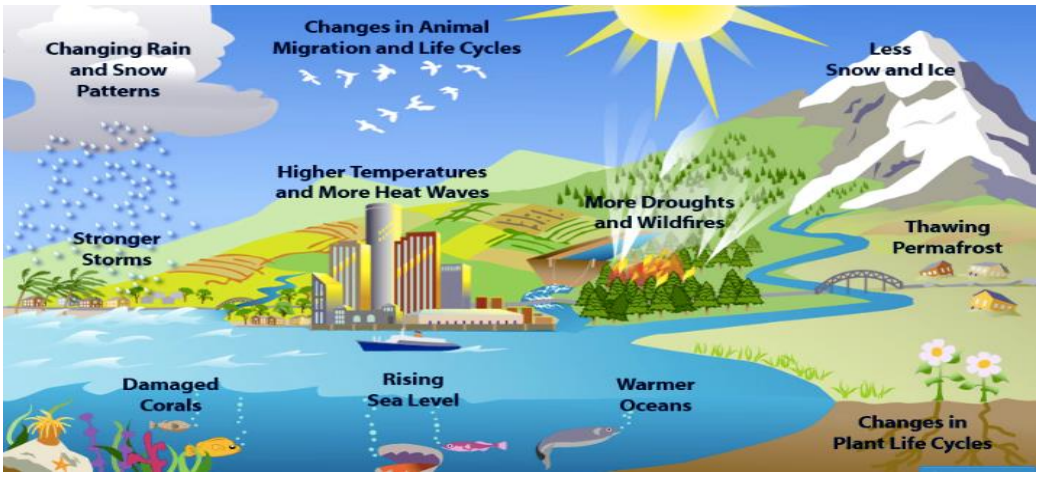
Global warming is caused by several things, which include man-made or anthropogenic causes, and global warming is also caused by natural causes

Natural causes are causes that are created by nature. One natural cause is a release of methane gas from arctic tundra and wetlands. Methane is a greenhouse gas and a very dangerous gas to our environment. A greenhouse gas is a gas that traps heat in the earth's atmosphere. Another natural cause is that the earth goes through a cycle of climate change. This climate change usually lasts about 40,000 years.

Pollution is one of the biggest man-made problems. Pollution comes in many shapes and sizes. Burning fossil fuels is one thing that causes pollution. Fossil fuels are fuels made of organic matter such as coal, or oil. When fossil fuels are burned they give off a green house gas called $CO_2$. When you dig up the fossil fuels you dig up the methane as well letting it escape into the atmosphere.

## Effects of Global Warming:

- Higher temperatures will cause a melting of ice in Greenland and Antarctica. This will accelerate the rise of sea level. the global average sea level has risen, ocean heat content has increased, and snow cover and ice extent have decreased, which threatens to inundate low-lying island nations and coastal regions throughout the world.
- Global warming is having a significant impact on hundreds of plant and animal species around the world.
- The ozone layer protects the Earth from the ultraviolet rays sent down by the sun. If the ozone layer is depleted by human action, the effects on the planet could be catastrophic.



## Precautions to Global Warming:

- Useless usage of AC's and Refrigerators should be stopped because from them harmful rays cfc's are emitted which results in depletion of ozone layer and from that hole UV rays of Sun comes to the earth and cause many diseases to both animals and plants i.e. Skin cancer etc. ,
- CNG and hydrogen operated vehicles should be used, more no. of trees should be planted,
- Chimneys in the Industries should be upgraded so that most of the effluents should get filtered down there.