1) International Strategy for Disaster Reduction (ISDR)

• When IDNDR drew to an end, it was replaced and continued by the International Strategy for Disaster Reduction (ISDR).

• The ISDR aims to pursue the initiatives and cooperation agreed on during the IDNDR, and developing new mechanisms as well as pushing for further commitments from policy-makers.

• The overriding goal is to reduce human, social, economic and environmental losses due to natural hazards. The building of disaster resilient communities is a main objective.

Objectives

Recognizing that natural hazards can threaten any one of us, the ISDR builds on partnerships and takes a global approach to disaster reduction, seeking to involve every individual and every community towards the goals of reducing the loss of lives, the socio-economic setbacks and the environmental damages caused by natural hazards. The ISDR promotes the following four objectives as tools towards reaching disaster reduction for all:

• Increase public awareness to understand risk, vulnerability and disaster reduction globally

• Obtain commitment from public authorities to implement disaster reduction policies and actions

• Stimulate interdisciplinary and inter-sectoral partnerships, including the expansion of risk reduction networks

• Improve scientific knowledge about disaster reduction

ISDR Mission

• Catalyze, facilitate and mobilize the commitment and resources of national, regional and international stakeholders of the ISDR System to build the resilience of nations and communities to disasters through the implementation of the Hyogo Framework for Action.

2) International Decade for Natural Disaster Reduction (IDNDR)

• In 1984, during the 8th World Conference on Earthquake Engineering in San Francisco, Dr. Frank Press proposed an International Decade for Natural Hazard Reduction.

• In 1987, the United Nations General Assembly passed a resolution calling for a Decade--International Decade for Natural Disaster Reduction (IDNDR, 1990-2000).

What is the need for IDNDR???

• To encourage people to protect communities from natural disasters.

The objective of IDNDR is to reduce, through concerted international action-
• the loss of life,
• property damage and
• social and economic disruption caused by natural disasters
• -such as earthquakes, tsunamis, floods, landslides, volcanic eruptions, droughts, and other disasters of natural origin especially in developing countries.

Mission
• "improve each United Nations (UN) member country's capacity to prevent or diminish adverse effects from natural disasters and to establish guidelines for applying existing science and technology to reduce the impact of natural disasters"

IDNDR Goals
• Improve each country's capacity to mitigate the effects of natural disasters
• Devise appropriate guidelines and strategies for applying existing scientific and technical knowledge
• Encourage scientific and engineering endeavors aimed at closing critical gaps in knowledge
• Disseminate existing and new technical information
• Develop measures for the assessment, prediction, prevention, and mitigation of natural disasters

IDNDR works through IDNDR National Committees and Focal Points, which exist in 138 countries. The IDNDR Secretariat is in Geneva, Switzerland.
• The IDNDR Scientific and Technical Committee is an advisory body of 25 experts from various fields from around the world.
• A UN Inter-Agency Standing Committee on IDNDR meets regularly, as well as a contact group of Geneva-based diplomatic missions. A Global Forum of NGOs for Disaster Reduction was founded at the World Conference on Natural Disaster Reduction.

The IDNDR Programme Plan for 1997-2000 is built around five primary themes:
- Hazard, Vulnerability and Risk Assessment
- Early Warning Issues
- Disasters and Sustainable Development
- Political and Public Policy Commitment
- Shared Knowledge and Technology Transfer

• These themes serve to structure and focus an evaluation of the accomplishments of IDNDR, to assess remaining gaps, and to make proposals for concerted, effective application of disaster reduction strategies after the year 2000.

• The implementation of this plan is coordinated by the IDNDR Secretariat and implemented jointly through contributions of all partners in IDNDR.

• It was the first concerted effort for mankind to prevent the unnecessary loss of life from natural hazards.

• The decade provided a unique opportunity for the world community, in a spirit of global cooperation, to use the considerable existing scientific and technical knowledge to alleviate human suffering and enhance the security of sustainable societal and economic development.

• The decade greatly raised the public awareness; in particular, the awareness of governments of various countries.

• Fatalism is no longer acceptable and disaster could be reduced; governments have the responsibilities for security of their citizens, particularly from natural disasters.

• The decade once again proved that international and regional cooperation is extremely important for minimizing the losses during the disasters, in particular for developing countries.

• Decade taught the scientific and technical professionals that their roles in reducing natural disasters are especially important.

• Scientists and engineers have been playing significant roles in creating new knowledge, upgrading and applying existing knowledge, transferring effective technology to those at risk and educating people and governmental decision-makers in coping with potential disasters.

• Scientists and engineers working in the field of natural hazards further understand that all their activities are linking with minimizing the natural disasters.

• An integrated approach and all measures towards minimizing losses must be prepared before the occurrence of the disasters.

• Through the Decade, it has been proved that an integrated approach, including 4P (Planning, Prediction, Preparedness, and Prevention) and 4R (Rescue, Relief, Recovering and Reconstruction), is extremely effective in reducing disasters.

• It is widely recognized that the objectives of IDNDR could not be fully reached through one Decade. However, the spirit of the Decade will last forever and under the light of the Decade scientists and engineers will dedicate themselves towards a much safer 21st Century.

3) Hazard Vs Disaster

• Hazards are always prevalent, but the hazard becomes a disaster only when there is greater vulnerability and less of capacity to cope with it.

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

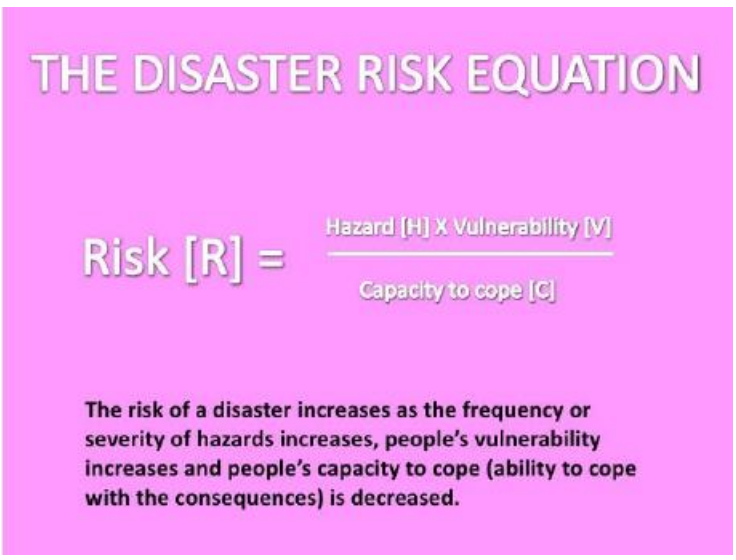
• A disaster is an event that completely disrupts the normal ways of a community. It brings on human, economical, and environmental losses to the community which the community cannot bear on its own.

• 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.

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

Variables such as Causes, Frequency, Duration of the Impact, Speed of Onset, and Scope of the Impact, Destructive Potential and Human Vulnerability etc determine the difference.



4) Types, causes, nature and effect of disasters

Types of disasters

• Natural, Man-made or Human-induced

• Disasters occur in varied forms

– Some are predictable in advance

– Some are annual or seasonal

– Some are sudden and unpredictable

• Factors leading to a Disaster

– Meteorological, Geological, Ecological or Environmental, Technological Etc.

Types	Hazards	
Geological Hazards	1. Earthquake 2. Tsunami 3. Volcanic eruption	4. Landslide 5. Dam burst 6. Mine Fire
Water & Climatic Hazards	1. Tropical Cyclone 2. Tornado and Hurricane 3. Floods 4. Drought 5. Hailstorm	6. Cloudburst 7. Landslide 8. Heat & Cold wave 9. Snow Avalanche 10. Sea erosion
Environmental Hazards Biological	1. Environmental pollutions 2. Deforestation 1. Human / Animal Epidemics 2. Pest attacks	3. Desertification 4. Pest Infection 3. Food poisoning 4. Weapons of Mass Destruction

Types	Hazards	
Chemical, Industrial and Nuclear Accidents	1. Chemical disasters 2. Industrial disasters	3. Oil spills/Fires 4. Nuclear
Accident related	1. Boat / Road / Train accidents / air crash Rural / Urban fires Bomb /serial bomb blasts 2. Forest fires	3. Building collapse 4. Electric Accidents 5. Festival related disasters 6. Mine flooding

Damages caused depends on

- geographical location
- Climate
- Degree of vulnerability
- Disaster: French word "Desastre" - 'des' meaning bad + 'aster' meaning star. Thus the term refers to 'Bad or Evil star'.
- "A serious disruption in the functioning of the community or a society causing wide spread- material, economic, social or environmental losses which exceed the ability of the affected society to cope using its own resources".
- hazard + vulnerability + insufficient capacity = disaster
- the economically disadvantaged
- racial and ethnic minorities
- the uninsured
- low-income children
- the elderly
- the homeless
- those with chronic health conditions, including severe mental illness

The vulnerability of these individuals is enhanced by race, ethnicity, age, sex and factors such as income, insurance coverage and absence of a usual source of care.

Their health and healthcare problems intersect with social factors, including housing, poverty, and inadequate education.

Effects:

Impacts of disaster on life, property and environment

- No. of deaths depends on the differences in the vulnerability and preparedness
- Increased deforestation- global warming, extreme weather conditions like floods, cyclones, tornadoes and droughts
- Risk for technological disasters
- Affects human health- outbreak of epidemics, communicable diseases
- Hazard to sanitation and drinking water systems
- Respiratory illness, inhalation of toxic gases
- Psychological effects
- People become shelter-less

5) Flood:

"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"

Causes:

 Flooding may occur as an overflow of water from water bodies, such as a river or lake in which the water overtops or breaks levees resulting in some of that water escaping its usual boundaries.

 Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel, particularly at bends or meanders in the waterway.

 Some floods develop slowly, while others such as flash floods, can develop in just a few minutes and without visible signs of rain.

 Floods can happen on flat or low-lying areas when the ground is saturated and water either cannot run off or cannot run off quickly enough to stop accumulating.

 Floods can also occur if water falls on an impermeable surface, such as concrete, paving or frozen ground, and cannot rapidly dissipate into the ground.

Types of floods:

Areal Flash floods

Localized heavy rain from a series of storms moving over the same area can cause areal flash flooding when the rate of rainfall exceeds the drainage capacity of the area.

Riverine

River flows may rise to floods levels at different rates, from a few minutes to several weeks, depending on the type of river and the source of the increased flow.

Estuarine and coastal

Flooding in estuaries is commonly caused by a combination of sea tidal surges caused by winds and low barometric pressure, which can be associated by high upstream river flow.

Coastal areas may be flooded by storm events at sea, resulting in waves over-topping defences or in severe cases by tsunami or tropical cyclones

Urban flooding

Urban flooding is the flooding of land or property in a built environment, particularly in more densely populated areas, caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers.

Catastrophic

Catastrophic flooding is usually associated with major infrastructure failures such as the collapse of a dam, but they may also be caused by damage sustained in an earthquake or volcanic eruption.

Effects:

 Loss of life, damage to buildings and other structures, including bridges, sewerage systems, roadways, and canals.

 Damage to roads and transport infrastructure

 Floods also frequently damage power transmission

 Leads to loss of drinking water treatment and water supply. It may also cause the loss of sewage disposal facilities.

 Lack of clean water combined with human sewage in the flood waters raises the risk of waterborne diseases.

 Flood waters typically inundate farm land, making the land unworkable and preventing crops from being planted or harvested.

 Economic hardship due to a temporary decline in tourism, rebuilding costs, or food shortages leading to price increases is a common after-effect of severe flooding.

 The impact on those affected may cause psychological damage to those affected, in particular where deaths, serious injuries and loss of property occur.

Drought:

A drought is a period of unusually dry weather that persists long enough to cause environmental or economic problems, such as crop damage and water supply shortages. A drought can last for months or years.

• 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.

• Drought is a normal, recurrent feature of climate. 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 in a geographical region.

• It is a slow on-set disaster and it is difficult to demarcate the time of its onset and the end. The effects of drought accumulate slowly over a considerable period of time.

Causes:

 Drought is an extended period when a region notes a deficiency in its water supply whether surface or underground water.

 Generally, this occurs when a region receives consistently below average precipitation.

 Generally, rainfall is related to the amount and dew point of water vapour carried by regional atmosphere, combined with the upward forcing of the air mass containing that water vapour. If these combined factors do not support precipitation volumes sufficient to reach the surface, the result is a drought.
 Human activities can directly trigger exacerbating factors such as over farming, excessive irrigation, deforestation, and erosion adversely impact the ability of the land to capture and hold water.
 Activities resulting in global climate change are expected to trigger droughts with a substantial impact on agriculture throughout the world, and especially in developing nations.

Effects:

Periods of droughts can have significant environmental, agricultural, health, economic and social consequences.
 Diminished crop growth or yield productions and carrying capacity for livestock
 Dust storms, when drought hits an area suffering from desertification and erosion
 Famine due to lack of water for irrigation
 Habitat damage, affecting both terrestrial and aquatic wildlife.
 Hunger, drought provides too little water to support food crops.
 Malnutrition, dehydration and related diseases
 Mass migration, resulting in internal displacement and international refugees
 Reduced electricity production due to reduced water flow through hydroelectric dams.
 Shortages of water for industrial users.
 War over natural resources, including water and food

Types of droughts:

1. **Meteorological drought** is brought about when there is a prolonged period with less than average precipitation. Meteorological drought usually precedes the other kinds of drought.
2. **Agricultural droughts** are droughts that affect crop production or the ecology of the range. This condition can also arise independently from any change in precipitation levels when soil conditions and erosion triggered by poorly planned agricultural endeavors cause a shortfall in water available to the crops.
3. **Hydrological drought** is brought about when the water reserves available in sources such as aquifers, lakes and reservoirs fall below the statistical average. Hydrological drought tends to show up more slowly because it involves stored water that is used but not replenished.
4. **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.

Cyclone

• Cyclone is a region of low atmospheric pressure surrounded by high atmospheric pressure resulting in swirling atmospheric disturbance.

• This is 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

• Typhoons - the Northwest Pacific Ocean west of the dateline

• Hurricanes - the North Atlantic Ocean, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean.

• Tropical cyclones - the Southwest Pacific Ocean and South-east Indian Ocean.

• Severe cyclonic storm (the North Indian Ocean) & Tropical cyclone (the South-west Indian Ocean)

• Willie-Willie - Australia

• Tornado - South America

General Characteristics of cyclones

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

• 1. Strong winds

• 2. Exceptional rains

• 3. Storm surge

Cyclones are generally accompanied by strong 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 there by causing floods.

Development of a cyclone

The development of a cyclone covers **three** stages namely

a) 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 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 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 to take effect in inducing cyclonic wind circulation around low pressure centers.

b) Fully matured:

• The main feature of a fully mature tropical cyclone is a spiral pattern of highly turbulent giant cumulus thundercloud bands. These bands spiral inwards and form a dense highly active central cloud core which wraps 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'.**

c) 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, or the cyclone moves to a higher altitude or when there is 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).

Typical adverse effects

• High winds cause major damage to infrastructure and housing. They are generally followed by heavy rains and floods and, in flat coastal areas by 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 – caused by flooding and flying elements, contamination of water supplies may lead to viral outbreaks, diarrhea, and malaria.

• Water supplies – Ground and pipe water supply may get contaminated by flood waters.

• Crops and food supplies – high winds and rains 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 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.

6) Earthquakes:

Earthquakes are sudden violent movement of the earth's surface and tectonic plates of the ocean which may cause great damage. Tectonic plates are pieces of the Earth's crust and uppermost mantle, together referred to as the lithosphere. The shaking or trembling caused by the sudden release of energy usually associated with faulting or breaking of rocks continuing adjustment of position results in aftershocks.
The point within Earth where faulting begins is the focus, or hypocenter. The point directly above the focus on the surface is the epicenter

• Seismic waves are waves of energy that travel through the Earth's layers, and are a result of an earthquake, explosion, or a volcano that gives out low-frequency acoustic energy.

• Two types of waves:
– Body waves
• P and S
– Surface waves
• R and L
• Body waves
– P or primary waves
• fastest waves
• travel through solids, liquids, or gases
• compressional wave, material movement is in the same direction as wave movement
– S or secondary waves
• slower than P waves
• travel through solids only
• shear waves - move material perpendicular to wave movement
• Surface Waves
– Travel just below or along the ground's surface
– Slower than body waves; rolling and side-to-side movement
– Especially damaging to buildings

~80% of all earthquakes occur in the circum-Pacific belt
– most of these result from convergent margin activity
– ~15% occur in the Mediterranean-Asiatic belt
– remaining 5% occur in the interiors of plates and on spreading ridge centers
– more than 1,50,000 quakes strong enough to be felt are recorded each year.

Effects

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

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

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

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

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

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

Tsunami

• Tsunami is a series of water waves caused by the displacement of a large volume of a body of water. It is a Japanese word meaning "harbour wave".

• These waves originate from undersea or coastal seismic activity, landslides, and volcanic eruptions.

• 26th December, 2004, a massive earthquake of Magnitude 9.0 hit Indonesia generating Tsunami waves in South-east Asia & eastern coast of India.

• Height of tsunami waves ranged from 3 – 10 m affecting a total coastal length of 2260 km in the states of Andhra Pradesh, Tamil Nadu, Kerala & UTs of Pondicherry, Andaman & Nicobar Islands.

• Tsunami waves travelled up to a depth of 3 km from the coast, killing more than 10,000 people & affected more than lakh of houses leaving behind a huge trail of destruction.

• If the earthquake or under water land movement is near the coast then tsunami may strike suddenly.

• If the earth movement is far in the sea then it may take few minutes to hours before striking the coast.

• The onset is extensive and often very destructive.

Why does this happen?

• When an earthquake occurs, the energy travels outward in all directions.

• For the epicenter, the energy causes a sea wave to move away at great speed.

• Tsunami can be generated when the sea floor abruptly deforms and vertically displaces the overlying water.

Causes

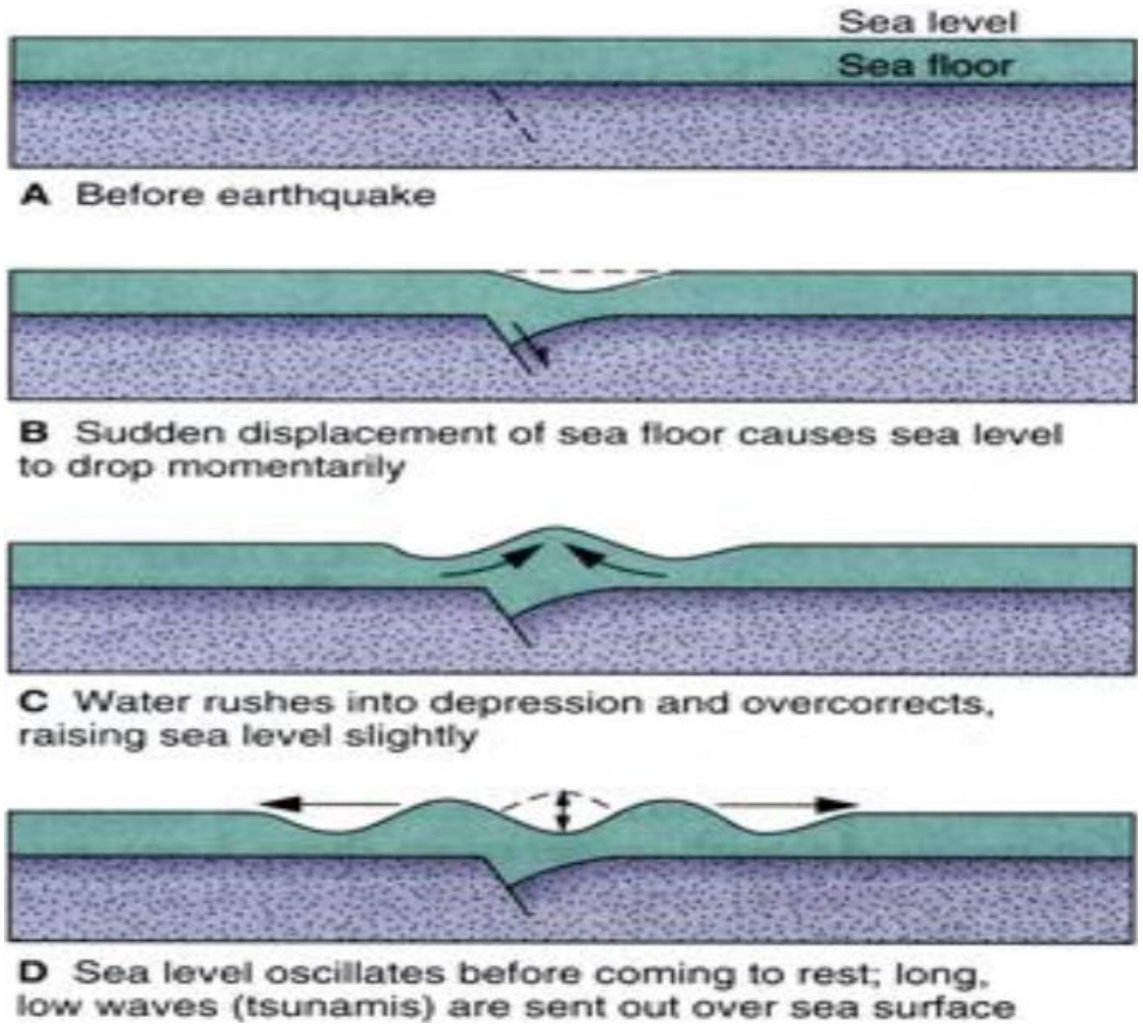
The general causes of Tsunamis are geological movements.
It is produced in *three major ways*.

• The most common of these is fault movement on the sea floor, accompanied by an ***earthquake***.

• The second most common cause of tsunamis is a ***landslide*** either occurring underwater or originating above the sea and then plunging into the water.

• The third major cause of tsunamis is ***volcanic activity***. The flank of a volcano, located near the shore or underwater, may be uplifted or depressed similar to the action of a fault. Or, the volcano may actually explode.

• Tsunamis are caused by events that drastically and suddenly shift a large volume of water.



Tsunami waves differs from ordinary ocean waves, which are produced by wind blowing over water. The tsunamis travel much faster than ordinary waves. Compared to normal wave speed of 100 kilometers per hour, tsunami in the deep water of the ocean may travel the speed of a jet airplane - 800 kilometers per hour. And yet, in spite

of their speed, tsunami increases the water height only 30-45cm and often passes unnoticed by ships at sea. As wave gets into shallow water, bottom of wave drags along ocean floor. Top of wave still moving fast: can cause cresting of wave, and breaking onto shore.

Effects

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

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

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

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

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

Avalanche

• Large mass of rock debris or snow that moves rapidly down a mountain slope, sweeping and grinding everything in its path. Snow cover on a slope tends to slide down because of gravity.

• An avalanche begins when a mass of material overcomes frictional resistance of the sloping surface, often after its foundation is loosened by spring rains or is rapidly melted by warm, dry wind.

• Vibrations caused by loud noises, such as artillery, thunder, or blasting can create an avalanche. Avalanches usually occur in January, February, March. They can also occur in April when everything thaws.

Causes

• Conditions affecting stability include the gravitational force component of the snow and resisting forces, such as the frictional resistance of the slope or the anchoring effect of shrubs.

• In general, avalanches are caused when this balance is lost and when the forces exceed the resistance. They are rarely observed closely since they normally occur during a short time period of one or two minutes.

• **Major Causes** - can be classified into prime/fixed factors and variable/exciting factors, such as weather conditions and the weight of the snow cover.

• Avalanches occur when these factors are combined. The types and scale of avalanches can differ depending on the combination of these various factors and their scale.

Item	Description	Factor
Prime factors	Topographic factors	• Inclination of slope • Shape of slope • Location (ridge line or toe of slope) • Orientation of slope
	Vegetation factors	• Vegetation cover and height of trees • Vegetation cover and its thickness
Exciting factor	Weather factors	• Depth of snow cover • Depth of snowfall • Wind velocity • Atmospheric and snow temperatures
	Other factors	• Increase in weight of snow cover because of snow dropping from cornices or snow covers • Vibrations such as earthquake or the sound of gunfire

Types of avalanches:

There are three different types of avalanches

1. A dry snow avalanche consists of powdery snow and air that can move faster than 100 mph.
2. A wet snow avalanche is a mass of partially melted snow that moves slower than a dry snow avalanche.
3. A slab avalanche is when a portion of snow breaks loose as a slab and splits into pieces as it slides.

7) Case study- Gujarat Bhuj earthquake

• The **2001** on 26 January, India's 52nd Republic Day, at 08:46 AM local time an earthquake occurred and lasted for over two minutes. The epicentre was about 9 km south-southwest of the village of Chobari in Kutch District of Gujarat, India.

• The earthquake reached 7.7 on the magnitude scale and had a maximum felt intensity of X (*Intense*) on the Mercalli intensity scale.

• The earthquake killed around 20,000 people injured another 167,000 and destroyed nearly 400,000 homes.

Tectonic setting

• Gujarat lies about 400 km from the plate boundary between the Indian Plate and the Eurasian Plate, but the current tectonics is still governed by the effects of the continuing continental collision along this boundary.

• During the collision with Eurasia the area has undergone shortening, involving both reactivation of the original rift faults and development of new low-angle thrust faults.

• The related folding has formed a series of ranges, particularly in central Kutch.

• The 2001 Gujarat earthquake was caused by movement on a previously unknown south-dipping fault, trending parallel to the inferred rift structures.

Effects

• The final death toll in Kutch was 12,300. Bhuj was totally devastated.

• Considerable damage also occurred in Bhachau and Anjar with hundreds of villages flattened in Taluka of Anjar, Bhuj & Bhachau.

• Over a million structures were damaged or destroyed, including many historic buildings and tourist attractions.

• The quake destroyed around 40% of homes, eight schools, two hospitals and 4 km of road in Bhuj. In Ahmedabad, as many as 50 multi-storied buildings collapsed and several hundred people were killed.

• Total property damage was estimated at $5.5 billion.

• In Kutch, the quake destroyed about 60% of food and water supplies and around 2,58,000 houses - 90% of the district's housing stock.

• The biggest setback was the total demolition of the Bhuj Civil hospital. The Indian military provided emergency support which was later augmented by the International Federation of Red Cross and Red Crescent Society.

• A temporary Red Cross hospital remained in Bhuj to provide care while a replacement hospital was built.

Orissa super cyclone- Case study

• 29th October 1999, Super-cyclone with wind speed of 260-300 km/hour hit the 140 km coast of Orissa with a storm surge created in the Bay-of-Bengal with water level 9 meters higher than normal.

• It was the strongest tropical cyclone ever recorded in the North Indian Ocean. It was also the deadliest tropical cyclone in the Indian Ocean and deadliest Indian storm since 1971.

• It was a tropical depression formed over the Malay Peninsula on October 25. It moved to the northwest and became a tropical storm on October 26. It continued to strengthen into a cyclone on October 27. On October 28, it became a severe cyclone with a peak of 160 mph (260 km/h) winds. It hit India the next day as a 155 mph (250 km/h) cyclone. It caused the deaths of about 10,000 people, and heavy to extreme damage in its path of destruction.

• The superstorm travelled more than 260 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.

• Tens of thousands of families from the coastal districts were forced to evacuate their homes before the storm's arrival.

• The cyclone dumped heavy torrential rain over southeast India, causing record breaking flooding in the low-lying areas. The storm surge destroyed 17,110 km²

• Approximately 275,000 homes were destroyed leaving 1.67 million people homeless. A total of 9,803 people officially died from the storm.

• The number of domestic animals fatalities was around 2.5 million. The high number of domestic animal deaths may have possibly had to do with around 5 million farmers losing their livelihood.

• The damage across fourteen districts in India resulted from the storm was approximately $4.5 billion (1999 USD, $5.1 billion 2005 USD).