DISASTER MANAGEMENT

B. Tech VI semester

By

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COURSE OBJECTIVES:

The student will try to learn:

I. The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.

II. The knowledge on various types of environmental disasters and their impacts on human beings and nature.

III. The Different types of endogenous and exogenous hazards and their influence on human life and nature.

IV. The immediate response and damage assessment with information reporting and monitoring tools.

MODULE-I ENVIRONMENTAL HAZARDS AND DISASTERS

Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.

MODULE-II TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS

Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.

MODULE-III ENDOGENOUS HAZARDS

Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India, human adjustment, perception and mitigation of earthquake.

MODULE-IV EXOGENOUS HAZARDS

Exogenous hazards/ disasters, infrequent events, cumulative atmospheric hazards/ disasters;

Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation);

Droughts: Impacts of droughts, drought hazards in India, drought control measures, extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation, biological hazards/ disasters, population explosion.

MODULE-V EMERGING APPROACHES IN DISASTER MANAGEMENT

Emerging approaches in Disaster Management, Three Stages

1. Pre disaster stage(preparedness)
2. Emergency Stage
3. Post Disaster stage, Rehabilitation.

INTRODUCTION TO DISASTER

- **Disaster** can be defined as any occurrence that cause damage, ecological disruption, loss of human life, deterioration of health and health services on a scale, sufficient to warrant an extraordinary response from outside the affected community or area”. (W.H.O.)
- **Disaster** can be defined as an occurrence either nature or manmade that causes human suffering and creates human needs that victims cannot alleviate without assistance”. American Red Cross (ARC).
- **Hazard** is an event that has potential for causing injury/ loss of life or damage to property/environment.

Phases of Disaster

DISASTER MANAGEMENT CYCLE

- Disaster management aims to reduce, or avoid, the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery.

- Mitigation - Minimizing the effects of disaster.

  Examples: building codes and zoning; vulnerability analyses; public education.

- Preparedness - Planning how to respond.

  Examples: preparedness plans; emergency exercises/training;warning systems.

- Response - Efforts to minimize the hazards created by a disaster.

  Examples: search and rescue; emergency relief .

- Recovery - Returning the community to normal.

  Examples: temporary housing; grants; medical care.

Disaster Management

- Disaster management is how we deal with the human, material, economic or environmental impacts of said disaster, it is the process of how we "prepare for, respond to and learn from the effects of major failures".
- Often caused by nature, disasters can have human origins.
- Disaster occurs when a hazard impacts on vulnerable people.
- Combination of hazards, vulnerability and inability to reduce the potential negative consequences of risk results in disaster.

Types of Disasters:

Natural Disasters

- Naturally occurring physical phenomena caused either by rapid or slow onset events that have immediate impacts on human health and secondary impacts causing further death and suffering.
- Natural Disasters are characterized in relation to their magnitude or intensity, speed of onset, duration and area of extent e.g. earthquakes are of short duration and usually affect a relatively small region whereas droughts are slow to develop and fade away and often affect large regions.
- These disasters can be :
- Geophysical (e.g. Earthquakes, Landslides, Tsunamis and Volcanic Activity)
- Hydrological (e.g. Avalanches and Floods)
- Climatological (e.g. Extreme Temperatures, Drought and Wildfires)
- Meteorological (e.g. Cyclones and Storms/Wave Surges)
- Biological (e.g. Disease Epidemics and Insect/Animal Plagues)

- **Avalanche** (also called a **snow slide**) is a rapid downward flow of snow over a steep slope that occurs when a cohesive slab of snow lying upon a weaker layer of snow fractures and slides down a steep slope.
- **Landslide** is defined as the movement of a mass of rock, debris, or earth down a slope.
- Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity.
- The term "landslide" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth).
- Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types.

Volcanic Activity & Wild Fire

- **Volcanic activity** ranges from emission of gases, non-explosive **lava** emissions to extremely violent explosive bursts that may last many hours. The types of **eruptions** determine the relative volumes and types of volcaniclastic material and **lava** flows, consequently the shapes and sizes of **volcanoes**.
- W**ildfire**, **bushfire**, **wildland fire** or **rural fire** is an unplanned, unwanted, uncontrolled fire in an area of combustible vegetation starting in rural areas and urban areas.
- Depending on the type of vegetation present, a wildfire can also be classified more specifically as a forest fire, brush fire, bushfire (in Australia), desert fire, grass fire, hill fire, peat fire, prairie fire, vegetation fire, or veld fire.
- Many organizations consider **wildfire** to mean an unplanned and unwanted fire, while **wildland-fire** is a broader term that includes prescribed fire as well as wildland fire use.

Avalanches

Land slides

Volcanic Eruption

Wild Fires

Man-Made Disasters:

- Man-Made Disasters are events that are caused by humans which occur in or close to human settlements often caused as a results of Environmental or Technological Emergencies.

This can include:

- Environmental Degradation
- Pollution
- Accidents (e.g. Industrial, Technological and Transport usually involving the production, use or transport of hazardous materials)

- Some disasters can result from multiple hazards, or, more often, to a complex combination of both natural and man-made causes which involve a break-down of authority, looting and attacks on strategic installations, including conflict situations and war.

These can include:

- Food Insecurity
- Epidemics
- Armed Conflicts
- Displaced Populations

Complex Emergencies are typically characterized by :

- Extensive Violence
- Displacements of Populations
- Loss of Life
- Widespread Damage to both Societies and Economies
- Need for Large-scale, Humanitarian Assistance across Multiple Agencies
- Political and Military Constraints which impact or prevent Humanitarian Assistance
- Increased Security Risks for Humanitarian Relief Workers

ENVIRONMENTAL HAZARDS

- ENVIRONMENTAL HAZARDS An environmental hazard is a substance, state or event which has the potential to threaten the surrounding natural environment / or adversely affect people's health, including pollution and natural disasters such as storms and earthquakes

EXAMPLES :

- Air pollution
- Overpopulation
- Over-grazing of land or monocultures (not rotating crops and letting land lie fallow)
- Covering up land with concrete (this is both hostile to wildlife and causes run-off)
- Noise pollution
- Light pollution

Environmental Hazard:

- An event which has the potential to threaten the surrounding natural environment or adversely affect people's health, including pollution and natural disasters such as storms and earthquakes.
- It may include any single or combination of toxic chemical, biological, or physical agents in the environment, resulting from human activities or natural processes, that may impact the health of exposed objects, including pollutants such as heavy metals, pesticides, biological contaminants, toxic waste, industrial and home chemicals.

ENVIRONMENTAL DISASTERS

Environmental Disaster

- An **environmental disaster** or **ecological disaster** is defined as a catastrophic event regarding the natural **environment** that is due to human activity.
- These **disasters** have included deaths of wildlife, humans and plants, or severe disruption of human life or health, possibly requiring migration.
- Environmental disasters historically have affected agriculture, biodiversity including wildlife, the economy and human health. The most common causes include pollution that seeps into groundwater or a body of water, emissions into the atmosphere and depletion of natural resources, industrial activity or agricultural practices.

ENVIRONMENTAL DISASTERS

- The Impacts of Natural Hazards include Social, Economic and environmental effects.
- An environmental disaster or ecological disaster is a catastrophic event regarding the environment due to human activity.
- This distinguishes it from the concept of a natural disaster.
- It is also distinct from intentional acts of war such as nuclear bombings.

IMPACT OF HAZARDS

- IMPACT OF DISASTER Natural disaster is any inevitable event that affects the environment. It not only results in mass loss of human lives but also adversely affect the economy of the region. Natural disasters have long history of occurrence which cannot be predicted, nor can it be avoided.
- Many researchers state that that disaster is interrupted the state in which social fabric is disrupted and becomes dysfunctional to a greater or lesser extent. Many recent disaster e.g. tsunami in Indian ocean in 2004, earth quake in Pakistan in 2005, and Haiti earthquake in 2010 are thoroughly discussed in print and electronic media, yet our understanding of its economic impact and recovery plan is quiet premature.

Difference Between Environmental Hazards And Environmental Disaster

- **HAZARD**: A hazard is a situation where there is a threat to life, health, environment or property.
- **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.

- ENVIRONMENTAL STRESS :
- Environmental stress refers to physical, chemical, and biological constraints on the productivity of species and on the development of ecosystems. When the exposure to environmental stressors increases or decreases in intensity, ecological responses result.
- DISASTER MANAGEMENT:
- Disaster Management can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

Basic Mechanism Of Disaster Management :

DM involves a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for:

- Prevention of danger or threat of any disaster.
- Mitigation or reduction of risk of any disaster or its severity or consequences.
- Capacity building including research and knowledge management.
- Preparedness to deal with any disaster.
- Prompt response to any threatening disaster situation or disaster.
- Assessing the severity or magnitude of effects of any disaster.
- Evacuation, rescue and relief.
- Rehabilitation and reconstruction

DIFFERENT APPROACHES & RELATION WITH HUMAN ECOLOGY

- ECOLOGY • Ecology is the scientific analysis and study of interactions among living organisms and their environment.
- ECOSYSTEM • An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment, interacting as a system.
- HUMAN ECOLOGY • Human ecology is a study of the relationship between humans and their natural, social, and built environments.

The different approaches for disasters with human ecology are:

1. Ecosystem Approach

2. Landscape Approach

3. Perception Approach

1. **ECOSYSTEM APPROACH:** The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

DIFFERENT APPROACHES & RELATION WITH HUMAN ECOLOGY

- An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass (cause to takes place) the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

This Figure shows the Ecosystem Approach model assessment

Focus On The Relationships And Processes Within Ecosystem

- The many components of biodiversity control the stores and flows of energy, water and nutrients within ecosystems, and provide resistance to major perturbations. A much better knowledge of ecosystem functions and structure, and the roles of the components of biological diversity in ecosystems, is required, especially to understand:
- Ecosystem resilience and the effects to biodiversity loss (species and genetic levels) and habitat fragmentation; and
- Underlying causes of biodiversity loss; and
- Determinants of local biological diversity in management decisions.
- Functional biodiversity in ecosystems provides many goods and services of economic and social importance. While there is a need to accelerate efforts to gain new knowledge about functional biodiversity, ecosystem management has to be carried out even in the absence of such knowledge. The ecosystem approach can facilitate practical management by ecosystem managers (whether local communities or national policy makers).

LANDSCAPE APPROACH

- **Landscape**: A 'landscape' is a flexible concept without a clearly defined spatial entity or physical space. It includes natural features of the landscape, infrastructure, stakeholders and external forces that affect the physical area.

Landscape Approach:

The landscape approach is an interdisciplinary, cross- sectoral and holistic approach. For disaster risk reduction purposes, the approach facilitates an inclusive and participatory learning process for shared risk understanding and risk intervention scenario planning. An inclusive and participatory process allows for more innovative and integrated, and therefore more impactful, solutions to risk (e.g. ecosystem-based or hybrid measures and optimised initiatives on water governance as part of disaster risk management strategies and investments).

ECOSYSTEM APPROACH

- The ecosystem approach is a conceptual framework for resolving ecosystem issues. The idea is to protect and manage the environment through the use of scientific reasoning.
- This is possible as the ecosystem approach incorporates humans, the economy, and ecology to the solution of any given problem
- Another point of the ecosystem approach is preserving the Earth and its inhabitants from potential harm or permanent damage to the planet itself. With the preservation and management of the planet through an ecosystem approach, the future monetary and planetary gain are the by-product of sustaining and/or increasing the capacity of that particular environment.

Perception Approach

- Generally speaking, perception includes individuals’ subjectivity in terms of how they see or assess the characteristics of a phenomenon.
- Risk perception is vital to understanding what risks people consider to be acceptable, and what risk reduction programs have a better chance of being accepted.
- Risk perception is influenced by a variety of factors including the kind of information available and how that information is processed; the personality and emotional state of the perceiver; their personal experiences and prejudices; and socio-economic factors, to name but a few.
- Risk perception, risk tolerance, and high or low risk-taking behaviors are all interconnected.

Perception Approach

- The nature and consequences of a potential threat, as well as its proximity, also contribute to how it is perceived by society.
- In this era of social media, the media is vital to ensuring that disaster news is covered more objectively.

IMPACT OF HAZARDS

- Global scenario:
- In world 2% G.D.P(Gross Domestic Product) loss by disasters.
- World wide 4% deaths caused by disasters.
- In 2016 on disaster risk 171 countries report has taken, highly disaster risk country (highly vulnerable) is vanatau. it is a island country it is in pacific ocean.
- In world disaster risk India is in 77th place.

IMPACT OF HAZARDS

- India is a one of the worst disaster prone effected country in the world because
- 1) geo climatic conditions
- Himalayan region is dangerous for earthquakes and landslides
- East india dangerous for floods
- West india dangerous for droughts
- South india dangerous for floods and drought
- 2) topographical conditions
- Rapid populations growth
- industrilisation

IMPACT OF HAZARDS

- Urbanisation
- Environmental degradation
- October 29 is the national disaster day in india
- October 13 is international disaster risk reduction day
- October 8 is national disaster risk reduction day

Natural Disasters

- Types of Disasters:
- Natural Disasters
- Natural Disasters are naturally occurring physical phenomena caused either by rapid or slow onset events that have immediate impacts on human health and secondary impacts causing further death and suffering. These disasters can be :
- Geophysical (e.g. Earthquakes, Landslides, Tsunamis and Volcanic Activity)
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- Biological (e.g. Disease Epidemics and Insect/Animal Plagues)

Geophysical Hazards

Earthquakes :

- Earthquakes are **caused** by sudden tectonic movements in the Earth's crust. The main **cause** is that when tectonic plates, one rides over the other, causing earthquakes. The largest fault surfaces on Earth are formed due to boundaries between moving plates.
- **Earthquake**, any sudden shaking of the ground caused by the passage of seismic waves through Earth’s rocks.
- Seismic waves are produced when some form of energy stored in Earth’s crust is suddenly released.

Geophysical Hazards

- Earthquakes occur most often along geologic faults, narrow zones where rock masses move in relation to one another.
- The major fault lines of the world are located at the fringes of the huge tectonic plates”(large scale motion of the plates making up the earth’s lithosphere) that make up Earth’s crust.
- Earthquakes kill many people because they have no warning signs and find people unprepared.
- Despite efforts by governments to educate the masses on earthquake warning signs and preparedness, a lot has not been accomplished.
- Earthquakes are generated at lithosphere of earth crust.

What Causes Earthquakes?

- The earth’s crust is composed of solid core, mantle (consists of molten magma) and tectonic plates.
- Tectonic plates are constantly moving due to convection currents triggered by molten lava inside the earth’s crust.
- This constant movement leads to either the plates sliding against each other or drifting away from each other.
- These interactions and drifting apart of tectonic plates underneath the earth are perceived(become aware) by living organisms, humans included.

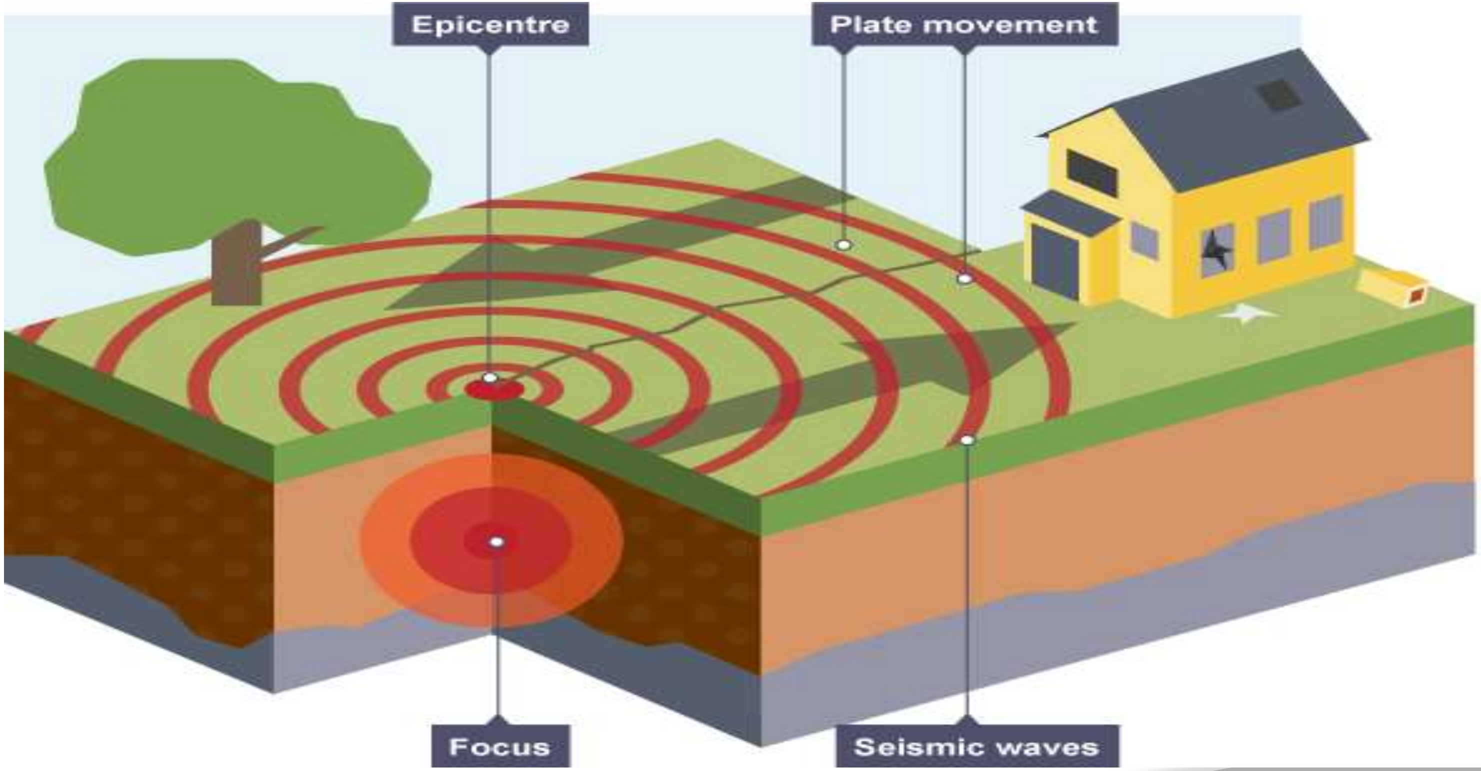
What Causes Earthquakes?

- When these plates move against each other, there is a point where they interact.
- In geological terminology, this meeting point is known as a fault line. This fault line is sometimes known as a fracture in the earth’s crust.
- The moment the plates begin to move, the potential energy, commonly known as stored energy, is released from the meeting point, known as the hypocenter.
- The outcome is an earthquake.

What Causes Earthquakes?

- On a few occasions, earthquakes have foreshocks. Foreshocks are a smaller version of earthquakes that occur in the same area as the bigger earthquakes that ensues(happen to occur afterwards). Up until now, scientists have not been able to tell whether an earthquake is a foreshock until the real earthquake occurs. The real or larger earthquake is known as the main shock. Main shocks, on numerous occasions, are followed by an aftershock. Aftershocks are a collection of small earthquakes that take place after the main earthquake. Depending upon the magnitude of the main shock, aftershocks may continue to happen for weeks, months or even years.
- For earthquakes to occur, energy is released from a focal point. This point is called the epicenter and usually found at shallow depths from the earth's surface. From the epicenter, seismic waves are produced and sent out in all directions. Seismic waves then travel at varying speeds depending on the kind of material they go through.

WHERE DO EARTHQUAKES HAPPEN?



WHERE DO EARTHQUAKES HAPPEN?

- **Focus:**
- Focus is the point on the fault where rupture occurs and the location from which seismic waves are released.
- **Epicenter:**
- Epicenter is the point on the earth’s surface that is directly above the focus, the point where an earthquake or underground explosion originates.
- **Fault Line:**
- A Fault line is the surface trace of a fault, the line of intersection between the earth’s surface.

Human Induced Earthquakes

- India has suffered four great earthquakes of magnitudes 8.5 and greater, in the past hundred years, inflicting heavy casualties and economic damage. Yet, human memory being short, it is generally not recognized that we continue to live under the long shadow of such future calamities. One of the ways to mitigate the destructive impact of earthquakes is to conduct a seismic hazard analysis and take remedial measures. Seismic hazard analysis consists of estimating various effects such as ground failure by faulting or soil liquefaction, ground shaking, tsunami generation etc. that might be caused by future earthquakes in a region.

Types of Earthquakes

- **1. Tectonic Earthquakes**
- The earth’s crust is composed of tectonic plates.
- These plates are capable of moving slowly and gradually.
- The movement of these plates occurs in different forms; towards each other, away from each other, sliding past each other or colliding with each other.
- A huge tremor (involuntary shaking or movement ,ranging from slight to severe) occurs when 2 moving tectonic plates slide over one another. This type of earthquake is known as a tectonic earthquake.
- Tectonic earthquakes are the most prevalent(wide spread) kinds of earthquakes in the world. Its magnitude may be small or large.
- Tectonic earthquakes have caused most of the planet’s mass destruction.
- Tremors triggered by tectonic earthquakes are always severe, and if their magnitude is high, they are capable of bringing down an entire city in seconds.

Types of Earthquakes

- **2. Volcanic Earthquakes:**
- Compared to tectonic earthquakes, volcanic earthquakes are less prevalent. They typically take place before or after an eruption. Volcanic earthquakes come in two forms: **long-period volcanic earthquakes** and **volcano-tectonic** earthquakes. Volcano-tectonic earthquakes usually happen after a volcanic eruption. During an earthquake, magma erupts from inside the earth's crust leaving a space behind. The space left after magma eruption must be filled. To fill it, rocks move towards the space resulting in severe earthquakes.
- On numerous occasions, magma blocks the vents during volcanic activity. This means that high pressure fails to be released. The buildup of pressure becomes unbearable and releases itself with a massive explosion. The massive explosion results in a ruthless earthquake.
- On the other hand, a long period of volcanic earthquake takes place after a volcanic eruption. Some days prior to the massive explosion, the magma inside the earth's crust experiences rapid changes in heat. The change in heat triggers seismic waves, resulting in an earthquake.

Types of Earthquakes

- **3. Explosion Earthquakes:**
- These are caused by nuclear explosions.
- They are, essentially, man triggered(encouraged) kind of earthquakes and represent the biggest impact of modern-day nuclear war.
- During the 1930s nuclear tests conducted by the United States, numerous small towns and villages were devastated as a result of this grave act.

Types of Earthquakes

- **4. Collapse Earthquakes:**
- These kinds of earthquakes are generally smaller and most commonly occur near underground mines.
- They are sometimes referred to as mine bursts.
- Collapse earthquakes are instigated(initiate) by the pressure generated within the rocks. This kind of earthquake leads to the collapse of the roof of the mine instigating more tremors.
- Collapse earthquakes are prevalent in small towns where underground mines are located.

Devastating Effects of Earthquakes

- **1. Damage to buildings:**
- High magnitude earthquakes can lead to a complete collapse of buildings. Debris from collapsing buildings is the main danger in the course of an earthquake because the falling effects of huge, heavy objects can be deadly to humans. High magnitude earthquakes result in the shattering of mirrors and windows, which also present danger to humans.
- **2. Damage to infrastructure:**
- Earthquakes can cause electricity lines to fall. This is dangerous because the exposed live wires can electrocute humans or start fires. Major earthquakes can cause rupturing of roads, gas lines, and water pipelines. Broken gas lines can cause gas to escape. Escaping gas can result in explosions and fires, which may be difficult to contain.
- **3. Landslides and rockslides :**
- When an earthquake occurs, large rocks and sections of earth located uphill can be dislodged, consequently, rolling rapidly down into the valleys. Landslides and rockslides can cause destruction and death to the people living downstream.

Devastating Effects of Earthquakes

- **4.Can result in floods:**
- High magnitude earthquakes can instigate cracking of dam walls, collapsing in the long run. This would send raging waters into nearby areas leading to massive flooding.
- **5. Earthquakes can trigger tsunamis:**
- A tsunami is a series of long high sea tremors sparked by an earthquake or volcanic eruptions under the sea.
- A tsunami can wipe out an entire surrounding coastal area population. A typical example is the March 11, 2011, earthquake and tsunami that struck the coast of Japan leaving more than 18,000 people dead in its wake.

Devastating Effects of Earthquakes

- **6. Leads to liquefaction:**
- Soil liquefaction occurs when a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress such as shaking during an earthquake or other sudden change in stress condition, in which material that is ordinarily a solid behaves like a liquid.
- Earthquakes are responsible for most of the liquefaction occurring across the world. A typical example of the liquefaction phenomenon is the earthquake of **1692 in Jamaica that resulted in the devastation of the town of Port Royal.**

How Are Earthquakes Measured

- Earthquakes are measured by the amount of force or energy they produced. This is done through the **Richter scale**. This tool was developed by Charles F. Richter of the California Institute of Technology.
- Many times you must have heard or read about this tool in the news or the internet. The Richter scale uses the information produced through **seismograph** to calculate the magnitude of the earthquake.
- The magnitude of an earthquake gives you an idea of the effect of an earthquake. **Earthquakes occurring above 7 on the Richter scale are known to have such devastating effect** and can cause severe damage to life and property.

How Are Earthquakes Measured

- **Earthquakes occurring below 3 on the Richter scale can't be felt**. **Earthquakes occurring between 3 and 6 are said to be of a mild type**.
- Countries like **Japan** are prone to earthquakes as they come in a **high seismic zone**. When an earthquake occurs in the sea, it paves way for Tsunami.
- One of the most devastating Tsunami occurred in the Indian Ocean on Dec. 26th, 2004.

Earthquake zones of India

- **Zone 5**:
- Zone 5 covers the areas with the **highest risk of suffering earthquakes.The** IS code assigns a zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. **The zone factor of 0.36** (the maximum horizontal acceleration that can be experienced by a structure) is indicative of effective (zero period) level earthquakes in this zone. It is referred to as the **Very High Damage Risk Zone**. The regions of Kashmir, the Western and Central Himalayas, North and Middle Bihar, the North-East Indian region, the Rann of Kutch and the Andaman and Nicobar group of islands fall in this zone.
- **Zone 4:**
- This zone is called the **High Damage Risk Zone**. The IS code assigns a **zone factor of 0.24** for Zone 4. Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, parts of the Indo-Gangetic plains (North Punjab, Chandigarh, Western Uttar Pradesh, Terai, North Bengal, the Sundarbans) and the capital of the country Delhi fall in Zone 4. In Maharashtra, the Patan area (Koynanagar) is also in Zone 4. In Bihar the northern part of the state in areas such as Raxaul, near the border of India and Nepal, is also in Zone 4.

Earthquake zones of India

- **Zone 3:**
- This zone is classified as a **Moderate Damage Risk Zone**. The IS code assigns a **zone factor of 0.16** for Zone 3. Several megacities like Chennai, Mumbai, Kolkata and Bhubaneshwar lie in this zone.
- **Zone 2:**
- This region is classified as the **Low Damage Risk Zone**. The IS code assigns a **zone factor of 0.10** for Zone 2.
- **Zone 1:**
- Since the current division of India into earthquake hazard zones does not use Zone 1, no area of India is classed as Zone 1.
- Future changes in the classification system may or may not return this zone to use.

Can Earthquakes Be Predicted?

- To date, scientists have not been able to predict earthquakes. Many modern techniques have been used, unfortunately, none of them has worked. If any such toll is built to predict earthquakes, many lives could be saved in the future.
- The only thing that you can do is to educate yourself about earthquake management and be vigilant(alert) in times of disasters. You can also do precautionary measures by buying properties that are not located in known earthquake-prone areas or fault lines. The occurrence of earthquakes can happen anytime and we will never be ready for it and the imminent(about to happen) danger it brings. But with earthquake preparedness measures and awareness, it can make you alert and quick in making sound decisions in times of danger.

Land slides

- **Landslide**, also called **landslip**, the movement down slope of a mass of rock, debris, earth, or soil (soil being a mixture of earth and debris). Landslides occur when gravitational and other types of shear stresses within a slope exceed the shear strength (resistance to shearing) of the materials that form the slope.
- Shear stresses can be built up within a slope by a number of processes. These include over steepening of the base of the slope, such as by natural erosion or excavation, and loading of the slope, such as by an inflow of water, a rise in the groundwater table, or the accumulation of debris on the slope’s surface. Short-term stresses, such as those imposed by earthquakes and rainstorms, can likewise contribute to the activation of landslides. Landslides can also be activated by processes that weaken the shear strength of a slope’s material.

Land slides

- Shear strength is dependent mainly on two factors: frictional strength, which is the resistance to movement between the slope material’s interacting constituent particles, and cohesive strength, which is the bonding between the particles.
- Coarse particles such as sand grains have high frictional strength but low cohesive strength, whereas the opposite is true for clays, which are composed of fine particles.

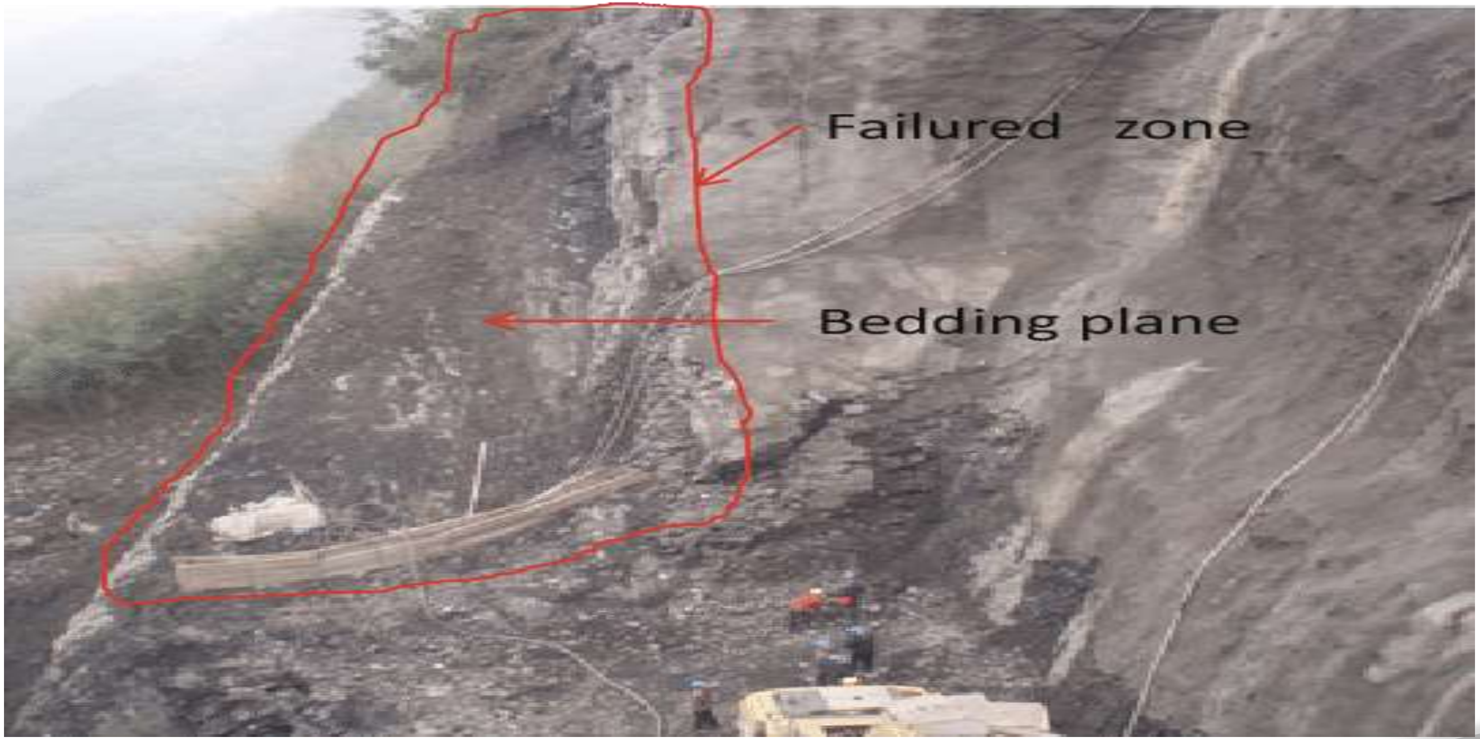
Types Of Landslides

- Landslides are generally classified by type of movement (slides, flows, spreads, topples, or falls) and type of material (rock, debris, or earth).
- Rockslides and other types of slides involve the displacement of material along one or more discrete shearing surfaces. The sliding can extend downward and outward along a broadly planar surface (a translational slide), or it can be rotational along a concave-upward set of shear surfaces (a slump).

Types Of Landslides

- A translational slide typically takes place along structural features, such as a bedding plane or the interface between resistant bedrock and weaker overlying material.
- If the overlying material moves as a single, little-deformed mass, it is called a block slide. A translational slide is sometimes called a mud slide when it occurs along gently sloping, and the displaced mass is fluidized by an increase in pore water pressure.
- In a rotational slide the axis of rotation is roughly parallel to the contours of the slope.

Types Of Landslides



LANDSLIDES

- **COMMON TYPES OF LANDSLIDES**
- • Rotational slides • Translational slides • Rock Fall
- • Rock toppling • Lateral spreading • Debris flow
- **ROTATIONAL SLIDES** • A slide type landslide is a down-slope movement of material that occurs along a distinctive surface. If this slip surface is curved the slide said to be rotational. The slip surface of a rotational landslide tends to be deep.
- Rotational slides move along a surface of rupture that is curved and concave.
- **TRANSLATIONAL SLIDES** • A slide-type landslide is a down-slope movement of material that occurs along a distinctive surface of weakness such as a fault, joint or bedding plane. If the slip surface is straight then it is termed translational or planar.

LANDSLIDES

- **ROCK FALL** • A rock fall is the natural downward motion of a detached block or series of blocks with a small volume involving free falling, bouncing, rolling, and sliding. The mode of failure differs from that of a rockslide.
- **ROCK TOPPLING** • Rock toppling occurs when one or more rock units rotate about their base and Collapse.
- **LATERAL SPREADING** • Lateral spread or flow are terms referring to landslides that commonly form on gentle slopes and that have rapid fluid-like flow movement, like water. Lateral spreading occurs when the soil mass spreads laterally and this spreading comes with tensional cracks in the soil mass.
- **DEBRIS FLOWS** • Debris flows are geological phenomena in which water-laden masses of soil and fragmented rock rush down mountainsides, funnel into stream channels, entrain objects in their paths, and form thick, muddy deposits on valley floors.

Landslide Mitigation And Prevention

- Landslides pose a recurrent hazard to human life and livelihood in most parts of the world, especially in some regions that have experienced rapid population and economic growth.
- Hazards are mitigated mainly through precautionary means—for instance, by restricting or even removing populations from areas with a history of landslides, by restricting certain types of land use where slope stability is in question, and by installing early warning systems based on the monitoring of ground conditions such as strain in rocks and soils, slope displacement, and groundwater levels.

Landslide Mitigation And Prevention

- There are also various direct methods of preventing landslides; these include modifying slope geometry, using chemical agents to reinforce slope material, installing structures such as piles and retaining walls, grouting rock joints and fissures, diverting debris pathways, and rerouting surface and underwater drainage.
- Such direct methods are constrained by cost, landslide magnitude and frequency, and the size of human settlements at risk.

What Is a Tsunami?

- A tsunami is a series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean or a large lake. Earthquakes, volcanic eruptions and other underwater explosions above or below water all have the potential to generate a tsunami.
- The effects of a tsunami depend on the characteristics of the seismic event that generated the tsunami, the distance from its point of origin, its size (magnitude) and, at last, the configuration of the bathymetry (that is the depth of water in oceans) along the coast that the tsunami is approaching.

What Is a Tsunami?

- Imagine a giant wall of water growing out of the ocean, big enough to wipe out entire coastal towns and capable of killing hundreds of thousands of people caught in its path.
- This is the power created by a **tsunami**, which is a series of waves caused by an earthquake, underwater volcanic eruption, landslide or other abrupt disturbance.
- Tsunamis are capable of creating massive devastation when they hit land.
- The word tsunami comes from the Japanese language. The prefix 'tsu' means 'harbor' and the suffix 'nami' means 'wave.' Therefore, the word literally means '**harbor wave**.' In March of 2011, Japan was hit by a powerful tsunami that was triggered by a 9.0 magnitude earthquake.

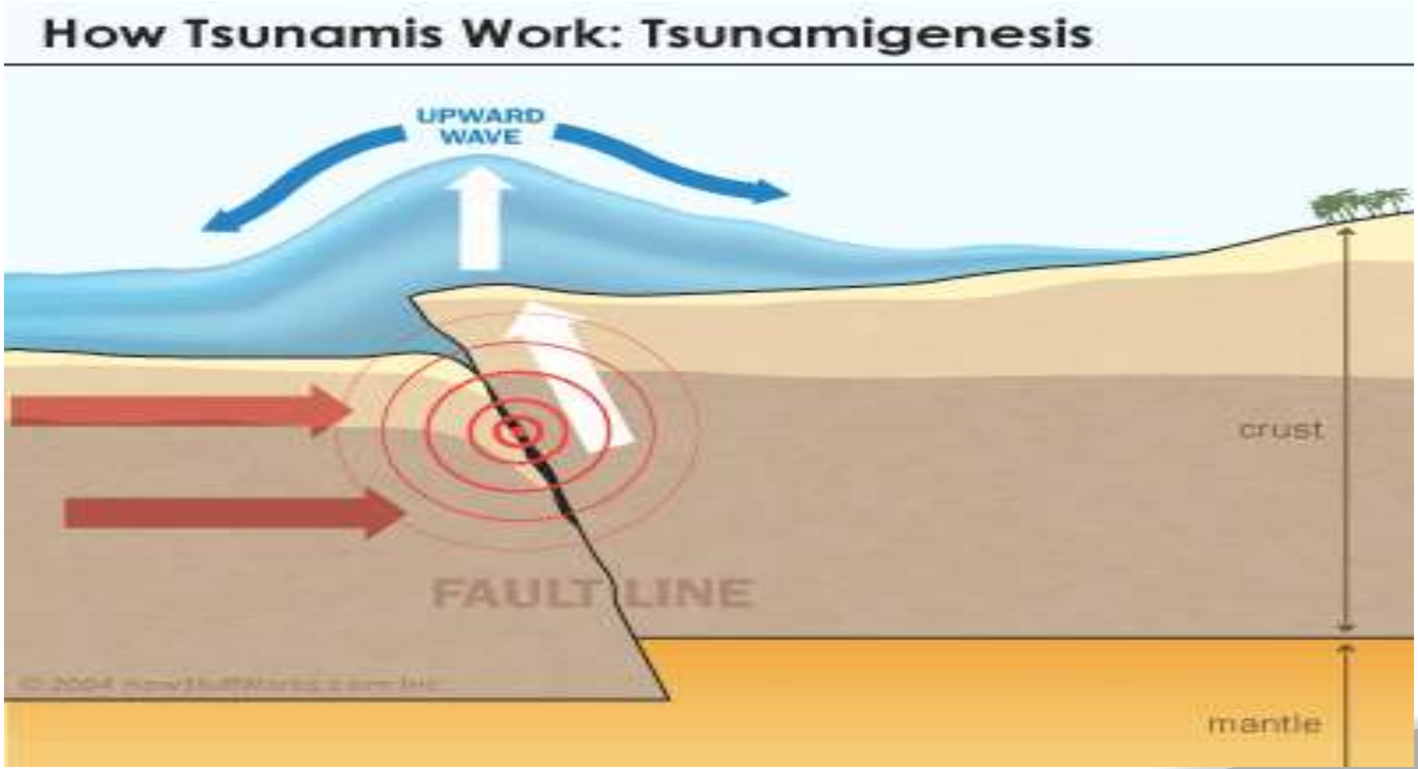
What Is a Tsunami?

- The tsunami killed more than 15,000 people and caused billions of dollars of damage, including damage to several nuclear reactors.
- The effects of a tsunami on a coastline can range from unnoticeable to devastating.

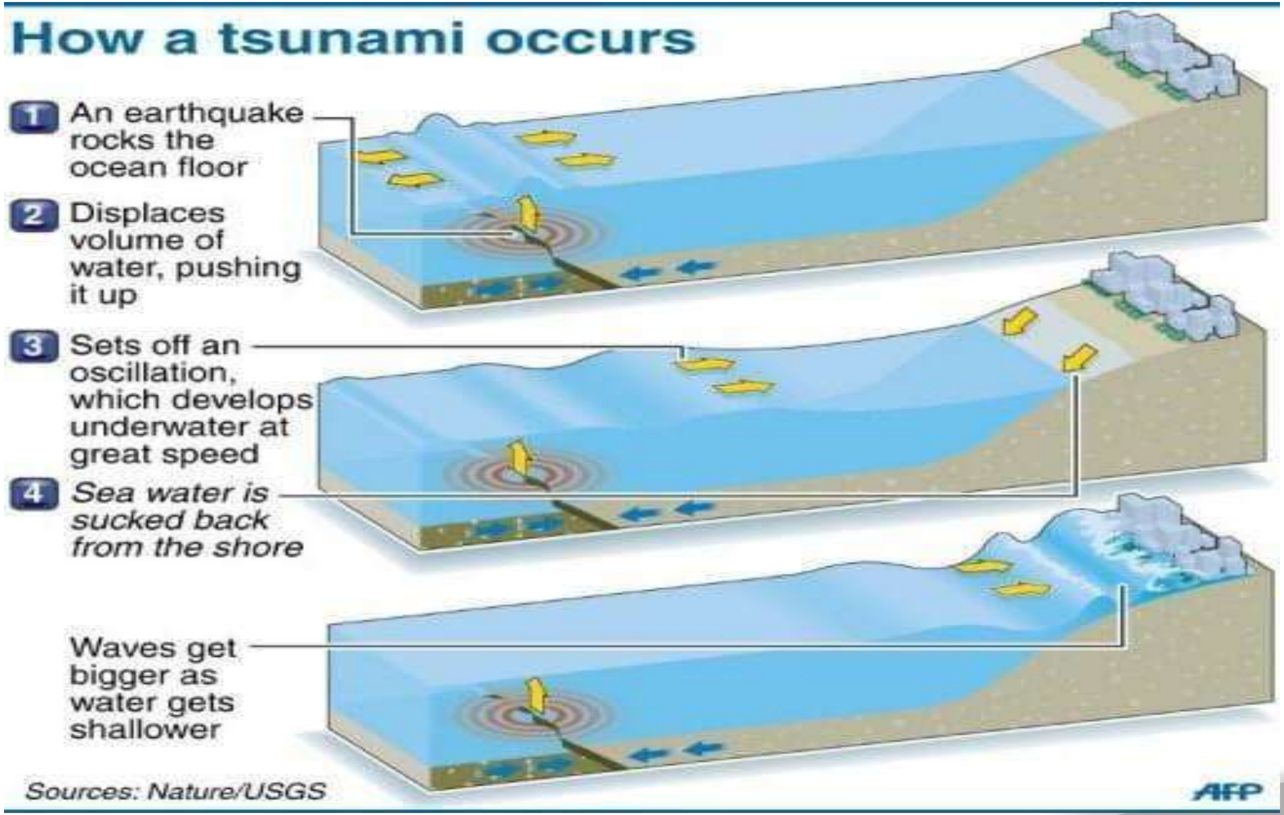
What Is a Tsunami?

- Tsunamis have long periods and can overcome obstacles such as gulfs, bays and islands. These tsunamis make landfall usually in the form of suddenly decreasing and then rapidly increasing water levels (not unlike a tidal bore) a combination of several large waves or bore-type waves. Generally tsunamis arrive, not as giant breaking waves, but as a forceful rapid increase in water levels that results in violent flooding.
- However, when tsunami waves become extremely large in height, they savagely attack coastlines, causing devastating property damage and loss of life. A small wave only 30 centi metres high in the deep ocean may grow into a monster wave 30m high as it sweeps over the shore. The effects can be further amplified where a bay, harbour, or lagoon funnels the waves as they move inland. Large tsunamis have been known to rise to over 100 feet!

What Is a Tsunami?



What Is a Tsunami?



Destruction

- The amount of energy and water contained in a huge tsunami can cause extreme destruction when it strikes land.
- The initial wave of a huge tsunami is extremely tall; however, most damage is not sustained by this wave. Most of the damage is caused by the huge mass of water behind the initial wave front, as the height of the sea keeps rising fast and floods powerfully into the coastal area. It is the power behind the waves, the endless rushing water that causes devastation and loss of life. When the giant breaking waves of a tsunami batter the shoreline, they can destroy everything in their path.
- Destruction is caused by two mechanisms: the smashing force of a wall of water traveling at high speed, and the destructive power of a large volume of water draining off the land and carrying all with it, even if the wave did not look large.

Destruction

- Objects and buildings are destroyed by the sheer weight of the water, often reduced to skeletal foundations and exposed bedrock. Large objects such as ships and boulders can be carried several miles inland before the tsunami subsides.
- Tsunami waves destroy boats, buildings, bridges, cars, trees, telephone lines, power lines - and just about anything else in their way.
- Once the tsunami waves have knocked down infrastructure on the shore they may continue to travel for several miles inland, sweeping away more trees, buildings, cars and other man made equipment.
- Small islands hit by a tsunami are left unrecognizable. Especially along a high seismic area, known as the Ring of Fire, tsunamis may have dramatic consequences as they hit less developed countries.

Destruction

- The buildings infrastructure in these poorer nations are not well built and cannot withstand the impact of the tsunami. Whole areas and towns are a picture of destruction as the tsunami leaves at trail devastation and misery behind it.
- **Disease**
- Tsunami waves and the receding water are very destructive to structures in the run-up zone. The areas close to the coast are flooded with sea water, damaging the infrastructure such as sewage and fresh water supplies for drinking.
- Flooding and contamination of drinking water can cause disease to spread in the tsunami hit areas. Illnesses such as malaria arise when water is stagnant and contaminated. Under these conditions it is difficult for people to stay healthy and for diseases to be treated, so infections and illnesses can spread very quickly, causing more death.

Environmental impacts

- Tsunamis not only destroy human life, but have a devastating effect on insects, animals, plants, and natural resources. A tsunami changes the landscape. It uproots trees and plants and destroys animal habitats such as nesting sites for birds. Land animals are killed by drowning and sea animals are killed by pollution if dangerous chemicals are washed away into the sea, thus poisoning the marine life.
- The impact of a tsunami on the environment relates not only to the landscape and animal life, but also to the man-made aspects of the environment. Solid waste and disaster debris are the most critical environmental problem faced by a tsunami-hit country.
- Recycling and disposal of this waste in an environmentally sensitive manner where possible (crushing concrete, bricks, etc. to produce aggregate for rebuilding and road reconstruction) are critical.

Environmental impacts

- Combined with the issue of waste is that of hazardous materials and toxic substances that can be inadvertently mixed up with ordinary debris. These include asbestos, oil fuel, and other industrial raw materials and chemicals. Rapid clean-up of affected areas can result in inappropriate disposal methods, including air burning and open dumping, leading to secondary impacts on the environment.
- Contamination of soil and water is the second key environmental impact of a tsunami. Salination of water bodies such as rivers, wells, inland lakes, and groundwater aquifers can occur in most cases. This also affects the soil fertility of agricultural lands, due to salination and debris contamination, which will affect yields in the medium and long term. Sewage, septic tanks and toilets are damaged contaminating the water supply.

Environmental impacts

- Last but not least, there may be radiation resulting from damage to nuclear plants, as it happened in Japan in March 2011. Since radiation exists for a long time, it has the capacity to inflict damage upon anything exposed to it. Radiation is most dangerous to animals and humans causing destruction as molecules loose their electrons. The damage caused by radiation to the DNA structure determines birth defects, cancers even death.

VOLCANOES

- A volcano is a rupture in the crust of a planetary- mass object, such as Earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. A volcano is a mountain that opens downward to a pool of molten rock below the surface of the earth. When pressure builds up, eruptions occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments.
- Eruptions can cause lateral blasts, lava flows, hot ash flows, mudslides, avalanches, falling ash and floods. Volcano eruptions have been known to knock down entire forests. An erupting volcano can trigger tsunamis, flash floods, earthquakes, mudflows and rock falls.

VOLCANOES

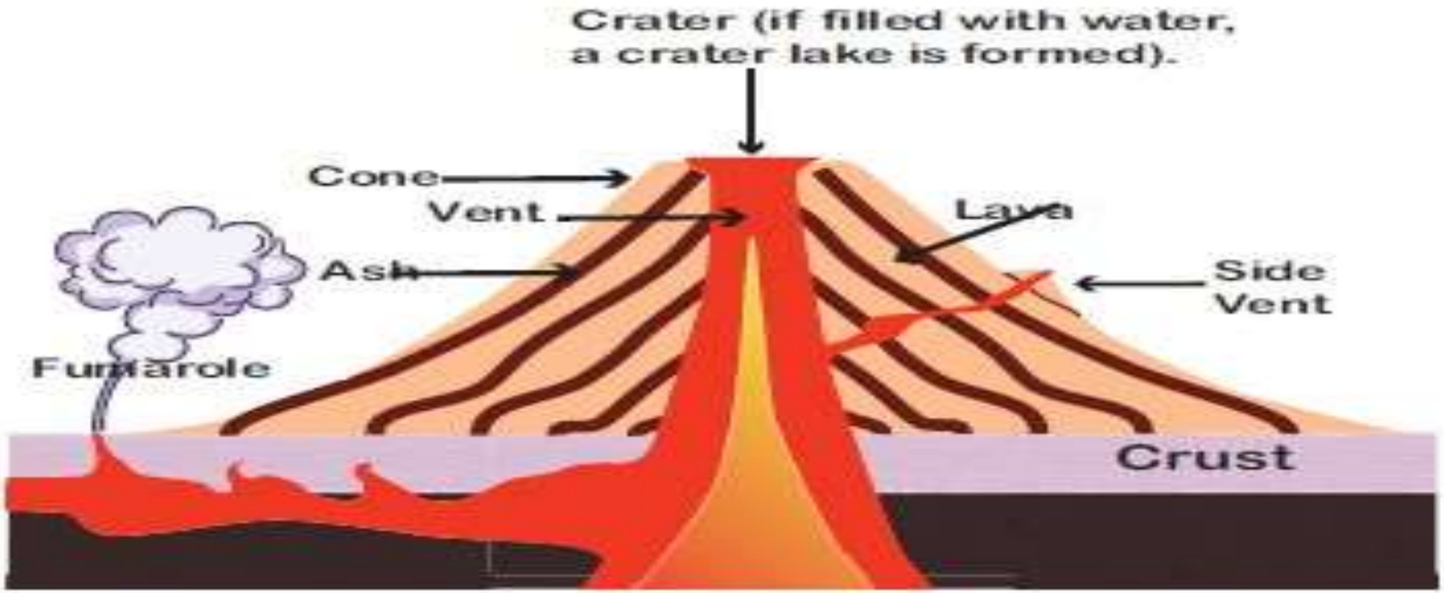


Figure 3.25 Volcano

VOLCANOES

- **How are volcanoes formed:**
- Volcanoes are formed, when magma form within the Earth's upper mantle works its way to the surface. At the surface, it erupts to form lava flows and ash deposits. Over time as the volcano continues to erupt, it will get bigger and more bigger.
- **DIFFERENT STAGES OF VOLCANOES:** Scientists have categorized volcanoes into three main categories: active, dormant, and extinct. An active volcano is one which has recently erupted and there is a possibility that it may erupt soon. A dormant volcano is one which has not erupted in a long time but there is a possibility it can erupt in the future. An extinct volcano is one which has erupted thousands of years ago and there’s no possibility of eruption.

VOLCANIC ERUPTION

- The Earth's crust is made up of huge slabs called plates.These plates sometimes move. The friction causes earthquakes and volcanic eruptions near the edges of the plates. The theory that explains this process is called plate tectonics.
- **PLATE TECTONICS** :The theory of plate tectonics is a interesting story of continents drifting from place to place breaking apart, colliding, and grinding against each other. The plate tectonic theory is supported by a wide range of evidence that considers the earth's crust and upper mantle to be composed of several large, thin, relatively rigid plates that move relative to one another. Sometimes the plates crash together, pull apart or sideswipe each other. When this happens, it commonly results in earthquakes.

How many volcanoes are there?

- There are more than 1500 active volcanoes on the Earth. We currently know of 80 or more which are under the oceans. Active volcanoes in INDIA are Barren Island(Andaman Nicobar Islands), Deccan Traps (West Central India), Baratang(Andaman Nicobar Islands), Dhinodhar Hills (Gujarat), Dhosi Hill (Haryana), Tosham Hills (Aravalli mountain)
- **DIFFERENT TYPES OF VOLCANOES** :On the **basis of nature of eruption and form** developed on the surface, they are classified into following types:
- Cinder cones
- Composite volcanoes
- Shield volcanoes and
- Lava volcanoes

How many volcanoes are there?

- **CINDER CONES** • Cinder cones are circular or oval cones made up of small fragments of lava from a single vent that have been blown into the air, cooled and fallen around the vent.
- **COMPOSITE VOLCANOES** • Composite volcanoes are steep-sided volcanoes composed of many layers of volcanic rocks, usually made from high-viscosity lava, ash and rock debris.
- **SHIELD VOLCANOES** • A shield volcano is a type of volcano usually built almost entirely of fluid lava flows. Shield volcanoes are volcanoes shaped like a bowl or shield in the middle with long gentle slopes made by basaltic lava flows. Basalt lava flows from these volcanoes are called flood basalts.

How many volcanoes are there?

- **LAVA DOMES** • Lava domes are formed when erupting lava is too thick to flow and makes a steep-sided mound as the lava piles up near the volcanic vent. The eruption of Mount St. Helens in 1980 was caused in part by a lava dome shifting to allow explosive gas and steam to escape from inside the mountain.
- **PUMICE** • Pumice is a light, porous volcanic rock that forms during explosive eruptions. It resembles a sponge because it consists of a network of gas bubbles frozen amidst fragile volcanic glass and minerals. All types of magma will form pumice.
- **RING OF FIRE** • The Pacific Ring of Fire is an area of frequent earthquakes and volcanic eruptions encircling the basin of the Pacific Ocean. The Ring of Fire has 452 volcanoes and is home to over 50% of the world's active and dormant volcanoes. Ninety percent of the world's earthquakes and 81% of the world's largest earthquakes occur along the Ring of Fire.

Types of Volcanoes

- Based on the **frequency of eruption**, there are three types of volcanoes:
- **1. Active Volcanoes:** Volcanoes which erupt frequently are called active volcanoes. Generally, their vent remains open. Mount Etna of Italy, Cotopaxi in Ecuador are some examples.
  2. Dormant Volcanoes: These volcanoes may not have erupted in the recent past but there is a possibility of eruption at any time. In other words, they may lie dormant awaiting active eruption anytime. Sometimes gases and steam come out of them. They cause great destruction to life and property once they become active again. Mt. Vesuvius of Italy and Mt. Fujiyama of Japan are examples.
- **3. Extinct Volcanoes:** These volcanoes have exhausted their energy and have not erupted during the known geological period. The vent of these volcanoes remains closed with solidified lava. The formations such as craters may be filled with water and crater lakes may be formed. The slopes of these landforms may be covered with vegetation. Popa in Myanmar and Mt. Kenya in eastern Africa are the examples of extinct volcano.

Distribution of Volcanoes across the World

- Most known volcanic activity and the earthquakes occur along converging plate margins and mid-oceanic ridges. The major regions of volcanic distributions are as follows.
- **1. Pacific Ring of Fire**
- Circum-Pacific region, popularly termed the ‘Pacific Ring of Fire’, has the greatest concentration of active volcanoes. Volcanic belt and earthquake belt closely overlap along the ‘Pacific Ring of Fire’. It is estimated to include two-thirds of the world’s volcanoes.
- **2. Mid Atlantic Region**
- The Mid Atlantic Region coasts has comparatively fewer active volcanoes but many dormant or extinct volcanoes, example. St. Helena, Cape Verde Islands and the Canary Islands. But the volcanoes of Iceland and the Azores are active.

Distribution of Volcanoes across the World

- **3. The Great Rift valley of Africa**
- In Africa some volcanoes are found along the East African Rift Valley. Kilimanjaro and Mt. Kenya are extinct volcanoes. The only active volcano in West Africa is Mt. Cameroon.
- **4. Mediterranean Region**
- Volcanoes of the Mediterranean region are mainly associated with the Alpine folds. Example, Mt. Vesuvius, Mt. Stromboli (known as the Light House of the Mediterranean Sea).
- **5. Other Regions**
- Elsewhere in the interiors of continents of Asia, North America and Europe active volcanoes are rare. There are no volcanoes in Australia.

Distribution of Volcanoes across the World

- **Volcanoes in India**
- There are no volcanoes in the Himalayan region of India. However, Barren Island, lying 135 km north-east of Port Blair became active in 1991 and 1995.
- However, the other volcanic island in Indian Territory is Narcondam (Andaman and Nicobar Islands) It is probably extinct. Its crater wall has been completely destroyed.

Effects of Volcanic Activities

- **Destructive effects of volcano**
- Showers of cinders and bombs can cause damage to life and properties. Sometimes ash can precipitate under the influence of rain and completely cover large areas.
- The volcanic gases pose potential hazard to people, animals; agriculture, while sulfur dioxide gas can lead to acid rain and air pollution.
- **Positive Effects of Volcanoes**
- Volcanism creates new landforms. Volcanic rocks yield very fertile soil upon weathering and decomposition.
- The Kimberlite rock of South Africa, the source of diamonds, is the pipe of an ancient volcano.
- In the vicinity of active volcanoes, waters in the depth are heated from contact with hot magma giving rise to springs and geysers. The Puga valley in Ladakh region and Manikaran (Himachal Pradesh) are promising spots in India for the generation of geothermal electricity.

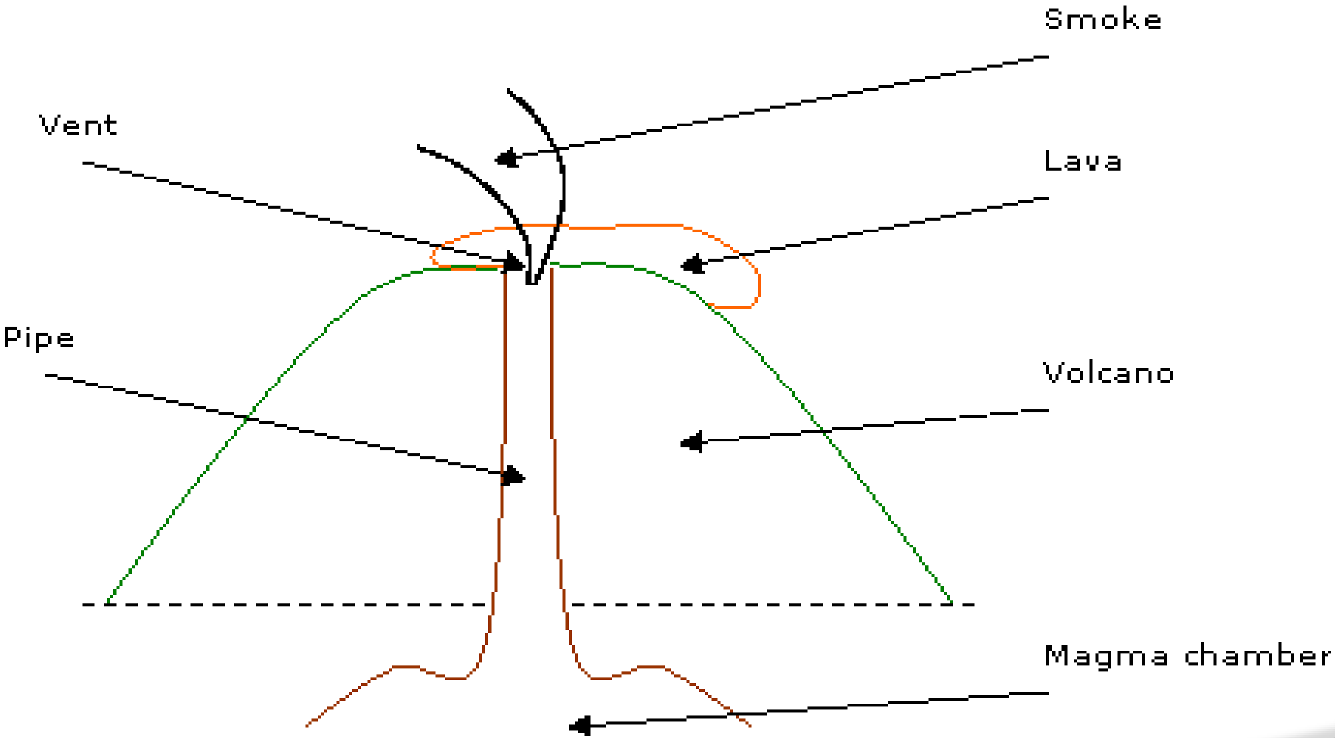
Causes of Volcanic Eruptions

- The following are the causes of volcanic eruptions:
- **Weak Zones in the Earth Crust:** The parts of the earth where two tectonic plates collide against or drift apart from each other are considered very weak. Volcanoes may erupt in such zones, for example, African and Eurasian plates.
- **Magma Saturated with Gases:** The magma, in the interior of the earth, is often found saturated with gases like carbon dioxide, and hydrogen sulfide. These gases together with water vapour make the magma highly explosive. Magma is forced out as lava on the surface of the earth due to the pressure exerted by these gases.

Environmental impact of volcanic eruptions

- **Environmental impact of volcanic eruptions:**
- On locations where tectonic plates diverge or converge, volcanoes can be found. A volcano consists of a deep magma chamber where magma accumulates, pipes that lead to surface vents, and the vents through which lava is emitted during a volcanic eruption. Volcanoes are often known to have a mountain-like shape.
- Volcanoes that have not erupted for some time are dormant, and volcanoes that have not erupted even in the distant past are called extinct. Volcanic activity and volcanic eruption is usually triggered by alterations of tectonic plates, resulting in landslides or earthquakes.

Environmental impact of volcanic eruptions



Environmental impact of volcanic eruptions

- There are different types of volcanic eruptions:

  \- **Phreatic**: explosion of steam, water, ash and rock as magma comes in contact with groundwater or surface water

  \- **Rhyolite flow**: high-silica lava (>68%)

  \- **Basalt flow**: low-silica lava (when the silica content is low, lava usually has a higher magnesium and iron content)

  \- **Pyroclastic flow**: fast-moving hot ash, gas and rock

  \- **Lahar**: mud flow of pyroclastic material into a river valley

  \- **Carbon dioxide emission**

Environmental impact of volcanic eruptions

- Volcanic eruptions can be extremely damaging to the environment, particularly because of a number of toxic gases possibly present in pyroclastic material. It typically consists mainly of water vapour, but it also contains carbon dioxide and sulphur dioxide gas.
- Other gases typically found in volcanic ashes are hydrogen sulphide, hydrogen chloride, hydrogen fluoride, carbon monoxide, and volatile metal chlorides.
- Carbon dioxide emitted from volcanoes adds to the natural greenhouse effect.
- Sulphur dioxides cause environmental problems, because they are converted to sulphuric acid in the stratosphere; the main cause of acid rain.
- Furthermore, sulphate aerosols are formed, which reflect solar radiation and absorb heat, thereby cooling the earth.

Environmental impact of volcanic eruptions

- Sulphate aerosols also take part in chemical reactions, forming ozone destructive material.
- An example of a volcanic eruption that caused substantial environmental damage is the Mount Pinatubo eruption in the Philippines.

Volcanic Eruption

- Volcanoes are ruptures in the crust of our planet Earth that allow hot gases, molten lava and some rock fragments to erupt by opening and exposing the magma inside.
- It is so hot deep within the earth that some rocks slowly melt and turn into a thick flowing matter known as magma.
- Since it is lighter than the solid rock around it, the magma rises and gets collected in magma chambers. Eventually, some magma pushes through fissures and vents in the earth’s surface. Hence, a volcanic eruption occurs and the erupted magma is known as lava.

Volcanic Eruption

- We need to understand the Earth's structure to know how volcanoes erupt.
- At the top lies the lithosphere, being the outermost layer that consists of the upper crust and mantle.
- The thickness of the crust ranges from 10km to 100km in mountainous locations and mainly consists of silicate rock.

Why Do Volcanoes Erupt?

- The Earth’s mantle within the crust is classified into different sections depending on individual seismology.
- These include upper mantle, that ranges between 8 – 35 km to 410 km; transition zone ranges from 400 to 660 km; lower mantle lies between 660 – 2891 km.
- The conditions change dramatically from the crust in the mantle location. The pressures rise drastically and temperatures rise up to 1000 ^{o}C.
- This viscous and molten rock gets collected into large chambers within the Earth’s crust.

Why Do Volcanoes Erupt?

- Since magma is lighter than surrounding rock, it floats up towards the surface and seeks out cracks and weakness in the mantle. It finally explodes from the peak point of a volcano after reaching the surface. When it is under the surface, the melted rock is known as magma and erupts as ash when it comes up.
- Rocks, lava and ash are built across the volcanic vent with every eruption. The nature of the eruption mainly depends on the viscosity of the magma. The lava travels far and generates broad shield volcanoes when it flows easily. When it is too thick, it makes a familiar cone volcano shape. If the lava is extremely thick, it is capable of building up in the volcano and explode, known as lava domes.

Causes of Volcanic Activity

- The radioactive substances inside the earth keep generating a lot of heat through decomposition and chemical reactions. As a result the material in the earth's interior is in constant flux. This molten, semi-molten and sometimes gaseous material appears on earth at the first available opportunity.

Avalanches

- An **avalanche** is a sudden downhill movement of snow. It is a significant hazard to people living in, or visiting, glacial areas. A slab **avalanche** is the most dangerous form of movement. It can be **caused** by heavy snowfall.
- Avalanches occur when the snowpack starts to weaken and allows the buildup of snow to be released. Small avalanches are generally made up of ice, snow and air. The larger ones comprise of rocks, trees, debris and even mud that is resting on the lower slopes.
- snow slides are not random events that occur without any warning signs. Winter season is when they are most common, often brought on after a large storm in the area. Rainfall and sleet also tend to be responsible for avalanches in the summer and monsoon season.

Avalanches

- Types of Avalanches:
- To help in the understanding of avalanches, they have been classified into four types.

1. 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 snowpack is not very solid. Such avalanches have a single point of origin, from where they widen as they travel down the slope.

2. Slab Avalanches

- Loose Snow Avalanches, in turn, could cause a Slab Avalanche, which is characterized by 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.

Avalanches

- **3. Powder Snow Avalanches:**
- 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.
- **4. Wet Snow Avalanches:**
- 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 an understanding of avalanches has shown us that it can pick up speed with ease.

Avalanches

- **5. Icefall Avalanches :**
- When glaciers flow over a cliff(steep rock face), they form the ice equivalent of a waterfall or an icefall. Falling blocks of ice create an avalanche of ice, which often entrains snow below it or triggers slabs. Especially in big mountains, icefall avalanches can be large and travel long distances. Despite this, icefall avalanches kill few people compared to dry slabs that people trigger themselves.
- Most of the deaths from icefall avalanches occur to climbers in big mountains who just happen to be in the wrong place at the wrong time.

Avalanches

- **6. Glide Avalanches :**
- Glide occurs when the entire snowpack slowly slides as a unit on the ground, similar to a glacier. Don’t mistake glide for the catastrophic release of a slab avalanche that breaks to the ground. Glide is a slow process that usually occurs over several days. Glide occurs because melt water lubricates the ground and allows the overlying snowpack to slowly “glide” downhill.

Avalanches

- Usually, they don’t ever produce an avalanche, but occasionally they release catastrophically as a glide avalanche. So the presence of glide cracks in the snow does not necessarily mean danger.
- **7. Slush Avalanches:**
- They are unusual because they occur on very gentle slopes compared with other avalanches, typically 5-20 degrees, and they rarely occur on slopes steeper than 25 degrees.
- A typical slush avalanche occurs in impermeable permafrost soil, which allows water to pool up, and occurs during rapid saturation of a thin, weak snowpack. When water saturates the snowpack, it catastrophically loses its strength and the resulting slush often runs long distances on very gentle terrain.

Avalanches

- **Various Causes of Avalanches :**
- There is no one reason behind the development of avalanches. It was believed for long that the echo of a human voice in the mountains could dislodge enough snow to start one. Similarly, a person's weight can cause an avalanche too. The sudden addition of weight can fracture a weak area of snow. However, scientific understanding of avalanches shows us that there are many environmental factors at work.
- **1. Snowstorm and Wind Direction**
- Heavy snowstorms are more likely to cause Avalanches. The 24 hours after a storm are considered to be the most critical. Wind normally blows from one side of the slope of the mountain to another side. While blowing up, it will scour snow off the surface, which can overhang a mountain.

Avalanches

- **2. Heavy Snowfall**
- Heavy snowfall is the first since it deposits snow in unstable areas and puts pressure on the snowpack. Precipitation during the summer months is the leading cause of wet snow avalanches.
- **3. Human Activity**
- Humans have contributed to the start of many avalanches in recent years. Winter sports that require steep slopes often put pressure on the snowpack, which it cannot deal with. Combined with the heavy deforestation and soil erosion in mountain regions, it gives the snow little stability in the winter months.

Avalanches

- **4. Natural Causes**
- These include earthquakes and tremors since they can often create cracks in the snowpack. New snow or rain can cause built-up snow to loosen and fall down the side of a mountain. Sometimes the movement of animals has also been known to cause avalanches.
- **5. Vibration or Movement**
- The use of All Terrain Vehicles and Snowmobiles creates vibrations within the snow that it cannot withstand. Coupled with the gravitational pull, it is one of the quickest ways to cause an avalanche. The other artificial triggers are off-piste skiers, gunshots and construction work done with explosives, which tend to weaken the entire surrounding area.

Avalanches

- **6. Layers of Snow**
- There are conditions where snow is already in the mountains and has turned into ice. Then, fresh snow falls on top, which can easily slide down.
- **7. Steep Slopes**
- Layers of snow build-up and slide down the mountain at a faster rate as steep slopes can increase the speed of snow. A rock or piece of huge ice can shake the snow and cause it to come down.
- **8. Warm Temperature**
- Warm temperatures that can last several hours a day can weaken some of the upper layers of snow and cause it to slide down.

Effects of Avalanches

- As such, there is little damage to the overall ecological system due to avalanches. They are a part of nature and have been happening for thousands of years. However, they are a major natural hazard for the local human population.
- **1. Damage to Life and Property**
- A large number of casualties take place after avalanches hit heavily populated areas. Infrastructure is damaged, and the blockage caused impacts the livelihood of many. People who enjoy skiing, snowboarding and snowmobiling are at a greater risk of losing their lives. A powerful avalanche can even destroy buildings, and power supplies can be cut off.

Effects of Avalanches

- **2. 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 if found within 15 minutes have more than a 90 percent survival rate. The rate drops to around 30 percent if found after 35 minutes.
- **3. Flash floods(rapid flood in low lying areas)**
- When an avalanche occurs, it brings down all the debris with it and can cause havoc in low lying areas. Flash floods are seen to happen after avalanches, which is a long term problem many villagers and townspeople have to deal with. They can also change weather patterns and cause crop failure in farms present in the lower fields.

Effects of Avalanches

- **4. Property and Transportation**
- Avalanches can completely destroy whatever is on its pathways such as houses, cabins and shacks. This force can also cause major damage to ski resorts as well as ski lift towers near or on the mountain. Avalanches also can cause roads and railroad lines to close. A large amount of snow can cover entire mountain passes and travel routes with cars and trains traveling on these routes.
- **5. Utilities and Communication**
- Avalanches can affect humans 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.

Effects of Avalanches

- **6. Economic Impact**
- An avalanche can block anything in its path and even restrict the normal movement of traffic. Various ski resorts depend on tourists to run their business successfully. Ski resorts and other businesses are forced to close until the avalanche decreases, and weather conditions become suitable.
- **7. Crop Failure**
- If the snow from an avalanche accumulates on farmland located at the lower altitudes, it can completely destroy the crop, causing crop failure and heavy economic losses for the farm.

Floods

- A **flood** is an overflow of water that submerges land that is usually dry. Floods are an area of study in the discipline of hydrology. They are the most common and widespread natural severe weather event.
- Floods can look very different because flooding covers anything from a few inches of water to several feet. They can also come on quickly or build gradually.
- There are five types of floods. They include:
- River Flood
- Coastal Flood
- Storm Surge
- Inland Flooding
- Flash Flood

Floods

- **What is River Flooding?**
- A **river flood** occurs when water levels rise over the top of river banks. This flooding can happen in all river and stream channels. This includes everything from small streams to the world's largest rivers.
- River floods can happen suddenly or slowly. Sudden river flooding events occur more often on smaller rivers, rivers with steep valleys, rivers that flow for much of their length over impermeable terrain, and normally dry channels.
- On the other hand, low-rising river floods typically occur in large rivers with large catchment areas. In case you didn't know this already, a **catchment area** is any area of land where precipitation collects and runs off into a common outlet.

- **What is Coastal Flooding?**
- A **coastal flood** is the inundation of normally dry land areas along the coast with seawater.
- **Causes of Coastal Flooding**
- Coastal flooding is typically a result of a combination of sea tidal surges, high winds, and barometric pressure.
- These conditions typically come from storms at sea like:
- Tropical cyclones
- Tsunami
- Higher-than-average tides

Floods

- **What is Storm Surge?**
- **Storm surge** is an abnormal rise in water level in coastal areas over and above the regular astronomical tide.
- **Causes of Storm Surge**
- Storm surge is always a result meteorological storms that cause higher than normal tides on the coast. There are three parts of a storm that create this surge. They are:
- Wind
- Waves
- Low atmospheric pressure

Floods

- An **inland flood** is flooding that occurs inland or not in a coastal area. Therefore, coastal flooding and storm surge are not inland floods.
- **Causes of Inland Flooding**
- Rainfall is almost always to blame for inland floods. Rain causes inland flooding in two ways. It can happen with steady rainfall over several days or it can happen because of a short and intense period of rainfall.
- Snowmelt also causes inland floods, although rainfall is a more common cause.
- Another way inland flooding happens is when water ways get blocked by debris, ice, or dams.
- **More on Inland Floods**
- Inland floods are often worse in urban areas because there isn't anywhere for the water to go. The following urban features can create urban flooding or make inland floods worse:

Floods

- Paved roads and streets
- Low-capacity drainage equipment
- Dense buildings
- Low amounts of green space
- **What is a Flash Flood?**
- A **flash flood** is flooding that begins within 6 hours, and often within 3 hours, of heavy rainfall (or other cause).
- **What Causes Flash Floods?**
- Flash floods can happen for several reasons.
- Most flash floods happen after extremely intense rainfall from severe thunderstorms over a short period of time (normally 6 hours or less). There are two key elements to determine is flash flooding is likely:
- Rainfall rate
- Rainfall duration
- Flash floods also happen when damns break, when levees fail, or when an ice jam releases a large amount of water.

Flood Causes & Effects

- No matter what type of flood you’re dealing with, they are generally caused by the same key factors and there are always negative effects.
- In this section, we’ll cover the basic causes and effects of flooding to help you better understand this dangerous meteorological and hydrological phenomenon. If you read through the above section on types of floods, you might just want to skip down to flooding effects.

Flood Causes & Effects

- **What Causes Flooding?**
- As we mentioned above, there are plenty of different causes of flooding. While different flood types typically have different causes, most floods are caused by one of the following activities.
- **Heavy rainfall** is the simplest cause of flooding. When there is too much rain or it happens too fast, there just isn't a place for it to go. This can result in floods like flash flooding.
- **Overflowing rivers** are another cause of floods. You don't necessarily need heavy rains though to experience river flooding. As we mentioned before, river flooding can happen when there is debris in the river or dams that block the flow of the water.
- Speaking of dams, **broken dams** are another cause of flooding. Older infrastructure can fail when heavy rains come and water levels rise. When dams break, they unleash torrents of water on unsuspecting households. This is part of what happened when Hurricane Katrina hit New Orleans in 2005.

Flood Causes & Effects

- **Storm surge and tsunamis** also cause flooding. Storm surges from hurricanes and other tropical systems can cause sea levels to rise and cover normally dry coastal areas in several feet of water. Tsunamis on the other hand are giant waves caused by earthquakes or underwater volcanic eruptions. As these waves move inland, they build height and can push a lot of water inland in coastal areas.
- **Channels with steep banks** are also to blame for flooding. Flooding often occurs when there is fast runoff into lakes, rivers, and other basins. This is often the case with rivers and other channels that feature steep sides.
- **A lack of vegetation** can cause flooding. Vegetation can help slow runoff and prevent flooding. When there is a lack of vegetation, there is little to stop water from running off and overflowing river banks and streams.
- **Melting snow and ice** is another common reason for flooding. When a large amount of snow and/or ice melts quickly, it often doesn't have somewhere to go except low-lying areas.
- These aren't all the reasons that flooding can happen, but they are some of the most common.

Flooding Effects

- Loss Of Lives
- Property Damage
- Economic Impacts
- Psychosocial Flooding

Droughts

- A drought is a reduction in precipitation over an extended period. This creates a water shortage that damages crops, livestock, and the environment. Since droughts adversely impact the agricultural industry, those that depend on the commodities from the industry suffer as well. Food becomes more scarce and demand exceeds supply. Prices go up, and the commodities markets waiver.
- If the economy is already in a state of depression or recession, a drought can increase that state. Climate change can also amplify the effects of a drought. A drought can further cause damage by increasing the risk of large-scale wildfires, and can cause populations to begin tapping into their emergency reserves of water—the aquifers that collect water underground.

Droughts

- Drought is a temporary situation in which there is the rainfall is below normal that leads to water shortage. Even though it doesn’t affect much initially, it has serious consequences. The precipitation becomes low which affects the ground and surface water. The entire area dries up and cracks are formed on the ground. This situation can last for months and sometimes even years. It comes under the category of natural disaster owing to changes in climate and global warming.

TYPES OF DROUGHT

- **Agricultural drought** : this is type of drought in which the moisture level in the atmosphere minimizes which in turn affects the soil moisture. This in turn affects the agricultural productivity. The produce becomes considerably low which widens the gap between demand and supply of food.
- **Meteorological drought** : This occurs due to the change in weather patterns due to drastic changes. The humidity increases, the rainfall becomes low, the temperature rises, water shortage and dry winds are the common characteristics of meteorological drought.

TYPES OF DROUGHT

- **Hydrological drought** : this is a type of drought in which there is considerable decrease in the level of water in lakes, ponds and rivers due to less rainfall and increase in temperature. Prolonged metrological drought can lead to hydrological drought.
- **Socioeconomic drought** : This occurs due to the gap between the demand and supply of goods and commodities increases owing to shift in meteorological and hydrological drought. This can also happen due to increase in population and decrease in the amount of rainfall.

CAUSES OF DROUGHT

- **Low rainfall** : the main reason for drought is low or lack of rainfall. If a region or area goes for a long period of time without much rainfall, water deficiency occurs in that area. So thus this area comes under the category of drought.
- **Global warming** : due to excessive emission of green house gases, the composition of the atmosphere changes leading to the increase in temperature thus causing global warming. The temperature rise leads dry spells and wildfires. Thus global warming adds up to drought.

CAUSES OF DROUGHT

- **Human causes** : humans play a major role in maintaining water table. Human activities like construction, urbanization and deforestation has had negative impact on the environment and climate. There is considerable decrease in the level of water table owing to excessive evaporation due to heat. Cutting down of trees for roadways, airways and construction of buildings have considerably reduced the water holding capacity of the soil. Overall the soil loses its credibility resulting in dry spells.
- **The surface water flow dries easily** : due the excessive irrigation and construction of hydro electric dams, the water that flows in the downstream reduces. Rivers, lakes and streams are the main source of downstream. Due to these human activities, the surface water may even evaporate leading to drought.

EFFECTS OF DROUGHT

- **Desertification** : this is a situation in which the soil becomes incapable due to its infertility and becomes bare land. Over grazing can also lead to desertification. Apart from all these, severe drought can also lead to desertification of the land and it becomes unsuitable for any vegetation. The possibility of survival of any vegetation is impossible.
- **Water bodies dry up** : because of drought, the water bodies like lake, rivers, ponds and streams dries up quickly. The natural habitat gets disturbed. The wildlife, aquatic life, forests and all gets endangered due to this process. The entire ecosystem and the natural life cycle get disrupted.
- **Reduction in crop yields** : during drought, the agricultural yields reduce considerably. This increases the gap between the demand and supply of crops. The farmers have to incur a huge loss i.e. pay more for the labor with fewer outcomes in yields.

EFFECTS OF DROUGHT

- **Migration and death of animals** : due to drought in an areas, the animals are forced to leave their habitat and move to new areas where there is water and food. As far as animals are concerned, it is very difficult for them to adjust to newer environment. It can also lead to the death of many animals because of the loss in natural biodiversity.
- **Monetary loss** : the monetary loss incurred during a drought is very high. The loss is incurred by businesses, families, government and even individuals at lower levels.
- **Waterborne diseases spread** : the quality of the water decreases due to water scarcity. The available clean water will not be sufficient for drinking and cooking purposes. Chemicals and impurities mixed with the water will be widely used owing to the spread of waterborne diseases like cholera and typhoid.

EFFECTS OF DROUGHT

- **Migration of people** : people are force to migrate to better conditions at the time of drought. This mainly affects the livelihood of the poor farmers who wholly depend upon their agriculture for a living. Because of the loss incurred, the family has to undergo through a lot of stress and strain which leads them to do other jobs. Elderly people, children and women are the most affected during a drought.
- **Malnutrition and deaths** : many people die during drought because of hunger and malnutrition(deficiencies). The major reason behind this is the non availability of food. Such situations are usually seen in poorer countries.

EFFECTS OF DROUGHT

- **Hydroelectric power becomes expensive** : because of the dry spells and lowered water levels in dams and rivers that were used to generate hydro electricity, more energy should be utilized for the same. So the power generated at a cheaper rate has to be given t a higher rate due to shortage of water. Due to the huge loss in incurred by the energy industries that utilize hydroelectric power.

Wild fires

- A wildfire, wild land fire or rural fire is an uncontrolled fire in an area of combustible vegetation occurring in rural areas. Depending on the type of vegetation present, a wildfire can also be classified more specifically as a brush fire, bushfire (in Australia), desert fire, forest fire, grass fire, hill fire, peat fire, vegetation fire, or veld fire”

Various Causes of Wildfires

- **1. Human Beings**

  Human beings are the number one cause of wildfires in the United States. Many of these wildfires are caused by cigarette butts being left on the land, campfires that have been left unmonitored, as well as intentional acts of arson(willfully causing damage). 90% of the wildfires in the U.S. are caused by people. Below are a few of the man-made causes of wildfires.

- **2. Burning Debris:** It is pretty common to burn yard waste in many places. While it is legal to do so, it may cause fires at many places when things go out of hand. Winds play a major role in wildfires. They can cause flames of burning debris to spread into forests or farms or fields.

Various Causes of Wildfires

- **Campfires:** Camping can be of great fun for both young and old age people. campfires can put things out of control and can cause wildfires. It is therefore recommended to choose a safe location for a campfire that is away from ignitable objects and is stocked with a bucket of water and a shovel.

- **Equipment Failure or Engine Sparks:** A running engine can spew hot sparks when things go wrong. Car crashes have been known to start fires quickly and that is why it is common to see firefighters rush to the scene in anticipation of a fire. Small engine sparks can give way to high flames if that vehicle is operating in a field or a forest.

Various Causes of Wildfires

- **Cigarettes:** Cigarettes are another common cause of wildfires. It is common for people to throw the cigarette bud on the ground knowing that it is still burning. Smokers must understand that small negligence on their part can cause a huge impact on the environment and surrounding areas.
- **Fireworks:** Fireworks are fun to shoot off but special care needs to be taken when they are in the hands of amateurs. Fireworks must be avoided even when there is a small chance that they could start a wildfire. If not handled properly that may end up as flames in unwanted territory.

Arson: Arson is the act of setting fire to property, vehicles, or any other thing with the intention to cause damage. A person who commits this crime is called an arsonist. Arson is sometimes done by people to their own property in order to receive compensation. Arson may account for 30% of all wildfire cases.

2. Mother Nature

- Mother nature is responsible for 10% of wildfires in the United States.
- **Lightning:** lightning can cause wildfires, especially the type of lightning called “hot lightning”, which can last for a relatively long time. When it strikes, it can produce a spark that can set off a forest or a field.
- **Volcanic Eruption:** Hot burning lava, from volcanic eruptions, also causes wildfires.

Devastating Effects of Wildfires

- 1.**Wildfires take away homes, wildlife, as well as vegetation**. All of the inhabitants of the wildlife environment now are found homeless. People often lose their houses as well if the fires are close enough to human housing. Vegetation is now obsolete if this area is near a farm or near the food of other inhabitants. Millions of dollars are spent repairing these damages and re-building homes and areas of vegetation.
- 2. The soil in the area of the wildfire has been completely destroyed. The soils in the forest are made with decaying nutrients and debris that have a lot of natural ingredients that help make the earth what it is. When a wildfire hits this soil it becomes too hot and **all of those nutrients are gone for good**.

Devastating Effects of Wildfires

- **Animals lose** their lives. It is a sad but true fact that birds, squirrels, rabbits, and other wildlife animals are no longer a part of this great earth
- **Trees and plants** are gone as well. Trees and plants help to produce oxygen in the world. The fewer trees and plants there is the less clean air we have to breathe. With no plants or trees, the animals that did survive no longer have anything to eat.
- Large amounts of smoke are released into the air which makes it difficult to breathe and also **causes air pollution**.

Devastating Effects of Wildfires

- Unfortunately, some **human lives are also lost in wildfires**. Typically people who are fighting the fire lose their lives trying to save others.
- Ash and smoke can cause **serious health problems to humans** who suffer from allergies and other medical problems. This same smoke and ash have the ability to permanently damage the lungs and the throat.
- Incomes and **jobs are lost for workers** in the agricultural field whose field crops and animals were destroyed by the wildfire. When people are out of work the economy suffers which makes it difficult to recover.

Devastating Effects of Wildfires

- There will be **restricted recreational areas** that will not be able to be accessed until the area is clear of debris and is determined to be safe to inhabit or visit.
- The loss of animals has the ability to also create **extinction for certain animals** and other creatures of the forest.

Extreme temperatures (heat wave, cold wave and extre winter conditions)

- **Heat Waves**
- A **heat wave** is a prolonged period of excessively hot and sometimes also humid weather relative to normal climate patterns of a certain region.
- Heat kills by pushing the human body beyond its limits. In extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature.
- Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. Older adults, young children, and those who are sick or overweight are more likely to succumb to extreme heat.

Extreme temperatures (heat wave, cold wave and extre winter conditions)

- Conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in urban areas may be at greater risk from the effects of a prolonged heat wave than those living in rural areas. Also, asphalt and concrete store heat longer and gradually release heat at night, which can produce higher nighttime temperatures known as the "urban heat island effect."

Extreme temperatures (heat wave, cold wave and extre winter conditions)

- **Cold waves, winter storms and extreme winter conditions**

  A **cold wave** can be both a prolonged period of excessively cold weather and the sudden invasion of very cold air over a large area. Along with frost it can cause damage to agriculture, infrastructure, property.

- Cold waves, **heavy snowfall** and **extreme cold** can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia(the condition of having abnormal).

Cyclones

- **Cyclones** are wind storms accompanied with heavy rainfall at low-pressure areas. They are **caused** due to a continuous process of rising of hot air over the ocean surface.
- **Regional names of cyclone**
- **1. Typhoons** – China Sea
- **2. Tropical Cyclones**- Indian Ocean
- **3. Hurricanes-**Caribbean Sea
- **4. Tornadoes**-USA
- **5. Wily Willies**- Northern Australia
- **6. Baguio**- Philippines
- **7. Taifu**- Japan

Cyclones

- A cyclone describes a weather system characterized by swirling winds around a low-pressure center; wind direction around the low is counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere. Coming in a wide variety of sizes and settings, cyclones cause some of the most dramatic and outright violent weather on the planet, including the tropical cyclones known as hurricanes and typhoons. The science behind cyclones will help you understand why, where and how this weather phenomena exists.

How does a cyclone form?

- cyclones are formed in the low-pressure area. The topography and the intensity as well as frequency of cyclones that could strike a coast decide the vulnerability of the place.
- The temperature difference between the warm, rising and the cooler environment led to the rise of air to become buoyant and then moves to upward. Then the high-pressure area fills the air in the low-pressure area. This cycle continues as warm air rises and a low-pressure area filled with cool air. They build up over a period of time. The warm, moist air rises and cools the water in the air and forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean’s heat and water evaporating from the ocean surface.

How does a cyclone form?

- There are six factors responsible for the formation of the cyclone:
- (1) Sufficient warm temperature at sea surface
- (2) atmospheric instability
- (3) impact area of Coriolis force so that low pressure can be developed
- (4) high humidity in the lower to middle levels of the troposphere
- (5) a pre-existing low-level focus or disturbance
- (6) low vertical wind shear.

Types of Cyclone

- **1. Tropical Cyclone:** It occurs over tropical ocean regions. it is two types- Hurricanes and typhoons. Hurricanes are found in the Atlantic and Northeast Pacific, whereas typhoons are found in the Northwest Pacific. On the basis of intensity and wind speed, this cyclone is classified into five categories- 1, 2, 3, 4 or 5. Category 5 has a wind speed of 155 mph or above.
- **2. Polar Cyclone:** Cyclones in polar regions(area around north pole or south pole) such as Greenland, Siberia and Antarctica are cyclones. In winter months, polar cyclones are generally heavier than tropical cyclones. These storms, as you can see, really prefer the colder weather! In fields areas, they are not very common and happen very less often that’s why the harm they do is generally quite minimal.

Types of Cyclone

- **3. Meso cyclone:** It is a vortex of air within a convective storm. It is the air that rises and rotates around a vertical axis, usually in the same direction as low-pressure systems in a given hemisphere. These types of cyclones are accompanied by the rotating air within the thunderstorm.
- A mesocyclone is when the portion of a thunderstorm cloud begins to spin, eventually leading to a tornado. Meso' implies' centre,' which we can regard as the midpoint between one weather form and the other. All tornadoes originate from the snow of the thunderstorm, but not all parts of the thunderstorm create tornadoes.
- Part of that cloud has to spin in order for a tornado to occur, and while you can't really see this happening, it's the intermediate or 'meso' step from regular cloud to the dangerous spinning cloud running along the ground.

Types of Cyclone

- **First category:** Wind speeds ranging from 90 to 125 km / h, some noticeable harm to buildings and trees.

  Second category: Wind rates ranging from 125 to km / h, housing harm and important crop and forest harm.

  Third category: Wind rates ranging from 165-224 km / h, structural harm to houses, comprehensive damage to plants and uprooted trees, upgraded cars, and building devastation.

  Fourth category: Wind rates ranging from 225 to 279 kilometres per hour, power failure and significant harm to towns and towns.

  Fifth category: Wind speeds exceeding 280 km / h, extensive harm.

What causes cyclone?

- Cyclones are centred on areas of low atmospheric pressure, usually over warm ocean waters near the equator.
- The warm moist air over the ocean rises from the surface in the upward direction, resulting in the formation of the low-pressure zone over the surface.
- Air from the surrounding region, with higher pressure, pushes into the low-pressure area. The cool air becomes warm and moist and rises again, thus the cycle continues. As the warm air rises, the moisture in the air cools thus leading to the formation of cloud.
- The whole system grows gradually and becomes fast with time. As a result of this, an eye is created in the centre, which is the low-pressure centre into which the high-pressure air flows from above, thus creating a cyclone.

Effects of Cyclone

- Tropical cyclones trigger serious rainfall and landslides. They cause serious damage to towns and villages. Also, they destroy coastal companies, such as shipyards and oil well.
- When these hurricanes blow far inland, human settlements are causing a lot of devastation.
- They trigger a lot of crop damage and destroy plenty of forests.
- They are disturbing the entire civic lives, particularly when they kill electricity and telephone lines.
- Torrential rains often accompany these cyclones, which trigger flooding.
- Not only do they cause a lot of damage to assets, but also to people's lives. Civic installations are being dismantled.

Cyclone Prone area in India

- India is highly vulnerable to natural hazards like earthquakes, floods, drought, cyclones and landslides. According to the meteorological department, there are 13 coastal states and Union Territories in India are Cyclone prone region. Four states like West Bengal, Andhra Pradesh, Odisha, Tamil Nadu-and one UT Puducherry on the east coast and Gujarat on the west coast are more vulnerable.

Cyclone Warning System in India

- The India Meteorological Department is the nodal agency in India is responsible for meteorological observations, weather forecasting and seismology. A cyclone in the Bay of Bengal is predicted by the Area Cyclone Warning Centres (ACWC) and in the Arabian Sea is predicted by the Cyclone Warning Centre (CWC). Both ACWC and CWC sent their report to the coordinating centre, i.e., National Cyclone Warning Centre (NCWC).
- According to the meteorological department, there are 13 coastal states and Union Territories in India are Cyclone prone region. Four states like West Bengal, **Andhra Pradesh**, **Odisha**, Tamil Nadu-and one UT Puducherry on the east coast and Gujarat on the west coast are more vulnerable.

List of cyclones in India in 2019-20

- The year 2020 marked the first pre-monsoon cyclone in a century-- Cyclone Amphan. Another Cyclone, Nisarga has hit the financial capital of India today and is the second pre-monsoon cyclone after Amphan. As per IMD, India could witness many other pre-monsoon cyclones in the coming years. In 2019, North Indian Ocean cyclone season was the most active cyclone season ever recorded in Northern India. Below is the list of cyclones that hit the Indian states in 2019-2020.

List of cyclones in India in 2019-20

- **1. Cyclone Nisarga**
- Cyclone Nisarga is the second pre-monsoon cyclone that has emerged from the Arabian Sea and is expected to hit Goa, Maharashtra and Gujarat. Cyclone Nisarga has hit Alibag in Mumbai and is expected to weaken in 6 hours.
- **2. Cyclone Amphan**
- Cyclone Amphan was a powerful tropical cyclone which led to the destruction of lives and property in the states of Odisha and West Bengal. Cyclone Amphan was the first pre-monsoon super cyclone of this century and emerged from the Bay of Bengal.
- **3. Cyclone Kyarr**
- Cyclone Kyarr was the second strongest tropical cyclone since cyclone Gonu in 2007. Cyclone Kyarr developed in the Arabian Sea and moved towards the Gulf of Aden from the Indian coast. It hit the Western India, Oman, UAE, Socotra and Somalia.

List of cyclones in India in 2019-20

- **4. Cyclone Maha**
- Cyclone Maha was an extremely severe cyclonic storm which became very intense while moving parallel to the Indian coast. The cyclone weakened when it approached Gujarat. Cyclone Maha made landfall near Gujarat as a depression which weakened afterwards.
- **5. Cyclone Vayu**
- Cyclone Vayu emerged from the Arabian Sea and was a very severe cyclonic storm which caused moderate damage to lives and property in the state of Gujarat. Cyclone Vayu was the strongest cyclone that hit the state since the 1998 Gujarat Cyclone. Along with India, cyclone Vayu also affected Maldives, Pakistan and Oman.
- **6. Cyclone Hikka**
- Cyclone Hikka emerged fro the Arabian Sea and turned intense and hit Oman. In 2019, 4 cyclones emerged from the Arabian Sea-- Kyarr, Maha, Vayu and Hikka.

List of cyclones in India in 2019-20

- **7. Cyclone Fani**
- Cyclone Fani was the strongest tropical storm that hit Odisha since the 1998 Odisha Cyclone. Cyclone Fani emerged from the Indian Ocean and caused huge destruction of lives and property in Odisha, West Bengal, Andhra Pradesh and East India. Outside India, it hit Bangladesh, Bhutan and Sri Lanka.
- **8. BOB 03**
- A depression formed in the Bay of Bengal and Indian Meteorological Department named in BOB 03. The very next day after the identification, the BOB 03 hit the north Odisha-West Bengal coastline and caused huge destruction of the lives and property.
- **9. Cyclone Bulbul**
- Cyclone Bulbul was a very severe cyclonic storm that hit the West Bengal in India. It caused huge rainfall, floods, etc. causing destruction to lives and property. Outside India it hit Bangladesh.

What is storm surge?

- Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by a storm's winds pushing water onshore. The amplitude of the storm surge at any given location depends on the orientation of the coast line with the storm track; the intensity, size, and speed of the storm; and the local bathymetry.
- Storm tide is the total observed seawater level during a storm, resulting from the combination of storm surge and the astronomical tide. Astronomical tides are caused by the gravitational pull of the sun and the moon and have their greatest effects on seawater level during new and full moons—when the sun, the moon, and the Earth are in alignment. As a result, the highest storm tides are often observed during storms that coincide with a new or full moon.

Biological hazards

- Biological hazards are organic substances that present a threat to the health of people and other living organisms.
- **Types of biological hazards**

  Biological hazards include:
- viruses
- toxins from biological sources
- fungi
- pathogenic micro-organisms
- bio-active substances.
- Worldwide, around 320,000 workers die each year from communicable diseases caused by work-related exposure to biological hazards

Biological hazards

- **Factors affecting the growth of micro organisms in foods:**
- The temperature values for microbial growth depend on the type of microorganism. For example, psychrotrophs such as Listeria monocytogenes grow at refrigeration temperature (4°C or 39°F), while thermotrophs can grow at higher temperatures (45°C or 113°F).
- The pH(potential of hydrogen) of a product is related to the acidity or alkalinity of the product. The pH of products affects the growth of bacteria. Most bacteria grow in a pH range between 5 and 9.
- The Water Activity (aw) refers to the water available in the product. The more water available, the better bacteria will grow. Table 1 shows the impact of water activity on bacterial spoilage.

Biological hazards

aw of product	Bacterial Spoilage	Examples
>0.90	spoils easily	fresh vegetables, fresh meat, processed meat, milk, fish
0.78-0.90	susceptible to spoilage	dry cheeses, flour, cakes, beans, cereals
<0.78	little bacterial spoilage but mould may grow	rolled oats, dried fruits, caramels, dehydrated foods

Control and prevention

- The most effective way to control biological hazards is by prevention. The implementation of Good Manufacturing Practices (GMPs) and Hazard Analysis and Critical Control Point (HACCP) will help prevent biological hazards in your facility. GMPs ensure hazards associated with personnel and environment are controlled during food production. HACCP controls hazards that may be present in ingredients and packaging materials and also those that occur during food processing, packaging and storage.
- **Processing strategies to control biological hazards:**
- effective thermal processing used as a kill step (ex: cooking, pasteurization)

Control and prevention

- use of appropriate process controls: – storage temperatures (ex: cooler, freezer) – processing parameters (ex: temperature and time for cooking, water activity during dehydration) – adequate cooling system
- effective cleaning and sanitizing procedures
- use of food technologies to prevent the growth of bacteria or other biological hazards: – packaging techniques (ex: use of vacuum packaging, modified atmosphere packaging) – preservatives – processing techniques (ex: dehydration)

Levels of biohazard

- The United States Centers for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard, Level 1 being minimum risk and Level 4 being extreme risk.
- **Biohazard Level 1:** Bacteria and viruses
- **Biohazard Level 2:** Bacteria and viruses that cause only mild disease to humans
- **Biohazard Level 3:** Bacteria and viruses that can cause severe to fatal disease in humans, but for which vaccines or other treatments exist
- **Biohazard Level 4:** Viruses that cause severe to fatal disease in humans, and for which vaccines or other treatments are *not* available

Manmade Disasters

- **Man-made disasters** have an element of human intent, negligence, or error involving a failure of a **man-made** system, as opposed to natural **disasters** resulting from natural **hazards**. Such **man-made disasters** are crime, arson, civil disorder, terrorism, war, biological/chemical threat, cyber-attacks, etc.
- Man-made disasters can include hazardous material spills, fires, groundwater contamination, transportation accidents, structure failures, mining accidents, explosions and acts of terrorism. There are actions that we can take to prepare to react appropriately to these events. The key to acting appropriately to these man-made threats is to find out what you need to do and what you need to have in advance of a man-made emergency and to prepare to respond appropriately.

Manmade Disasters

- Hazardous materials are chemicals that if accidentally released can cause damage to the environment and health. Many chemicals that used in industry, agriculture, medical research, and in our homes can become hazardous if properly used. Many hazardous materials are transported by rail or road and can be subject to accidental release.
- **Industrial Accidents**
- Mines, factories, and other industrial centers have been at the heart of some of history's worst accidents. These places can contain volatile materials, or undergo immense structural stress due to the labor conducted there. In worst case scenarios, these sites can suffer from explosions or collapses, leading to loss of life and potential environmental damage.

Manmade Disasters

- **Transportation Accidents**
- Anyone who's driven a car knows that getting from point A to point B can sometimes be dangerous. Errors in judgement, minor technical malfunctions, and even the interference of animals can cause serious problems. When these problems occur with mass transit vehicles like trains, those problems can be disastrous.
- **Nuclear & Chemical Disasters**
- Though they've been infrequent since the discovery of nuclear fission in the 1930s, there have been a few instances where attempts to harmness nuclear power have gone horribly awry. These disasters can leave miles of land uninhabitable for decades, or even centuries. Leaks of dangerous chemicals can have a similar effect, though these are generally less severe.

Manmade Disasters

- **Terrorism**
- Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom. Terrorists often use threats to create fear among the public to try to convince citizens that their government is powerless to prevent terrorism and to get immediate publicity for their causes.
- Acts of terrorism range from threats of terrorism, assassinations, kidnappings, hijackings, bomb scares and bombings, and cyber attacks (computer-based), to the use of chemical, biological, and nuclear weapons.

Manmade Disasters

- **Bomb Threats**
- If you receive a bomb threat, get as much information from the caller as possible. Keep the caller on the line and record everything that is said. Then notify the police and the building management if applicable.
- If you are notified of a bomb threat, do not touch any suspicious packages. Clear the area around suspicious packages and notify the police immediately. In evacuating a building, don't stand in front of windows, glass doors or other potentially hazardous areas. Do not block sidewalk or streets to be used by emergency officials or others still exiting the building.

Manmade Disasters

- **Suspicious Parcels & Letters**
- Be wary of suspicious packages and letters. They can contain explosives, chemical or biological agents. Be particularly cautious at your place of employment.

Manmade Disasters

The 9 deadliest manmade disasters in the past 50 years

- The Bhopal disaster of 1984 has been called the worst industrial accident in history.
- The Gulf War oil spill in 1991 was the largest oil spill.
- The Camp Fire of 2018 was California's deadliest wildfire.
- he United Nations' World Environment Day on June 5 hopes to raise awareness and spur action to protect the environment and prevent disaster from striking.
- Unfortunately, accidents happen. Oil spills, poisonous-gas leaks, and out-of-control wildfires have caused devastating damage to the environment and those who live in it.
- Here are nine environmental disasters from the past 50 years that wreaked havoc on humans, animals, and the environment.

The 9 deadliest manmade disasters in the past 50 years

- **Seveso disaster — 1976**
- A cloud containing a kilogram of TCDD, a carcinogenic byproduct of the trichlorophenol used to produce hand soaps, leaked from a chemical plant in Meda, Italy, in 1976, settling over the towns of Meda and Seveso.
- Over 700 people were evacuated and 77,000 animals were killed as a precaution to prevent chemicals from poisoning the food chain. Many children in the area developed chloracne, a skin condition caused by overexposure to halogenated aromatic compounds often reported by military veterans.

The 9 deadliest manmade disasters in the past 50 years

- **Love Canal — 1978**
- From 1942 to 1953, the Hooker Chemical Co. used a canal in Love Canal, New York, to dispose of 21,000 tons of toxic chemical waste. In 1978, The New York Times reported that chemicals from the canal had leaked into people's homes, yards, and school playgrounds after years of heavy rainy seasons created toxic puddles.
- **Bhopal gas leak — 1984**
- The Bhopal disaster has been called the worst industrial accident in history. In 1984, 45 tons of poisonous methyl isocyanate gas leaked from an insecticide plant in Bhopal, India. Thousands of people died immediately. A total of between 15,000 and 20,000 people died, and a half million people survived with respiratory and eye problems.

The 9 deadliest manmade disasters in the past 50 years

- **Chernobyl disaster — 1986**
- On April 26, 1986, a nuclear reactor in the town of Chernobyl, Ukraine, blew up, leaving nuclear remnants that affected people in a 200-mile radius for decades to come, Business Insider previously reported. The Chernobyl nuclear disaster forced 350,000 people to be evacuated over fears of radiation poisoning. It's still considered one of the worst nuclear-reactor disaster in history.
- **Exxon Valdez oil spill — 1989**
- When the Exxon Valdez oil tanker hit the coast of Prince William Sound, Alaska, 11 million gallons of oil spilled across 1,300 miles and devastated wildlife populations in the area.
- According to the National Park Service, 250,000 seabirds, 2,800 sea otters, 300 harbor seals, 250 bald eagles, 22 killer whales, and billions of salmon died because of pollution from the spill.
- Congress passed the Oil Pollution Act in 1990 outlining procedures for responding to similar disasters.

The 9 deadliest manmade disasters in the past 50 years

- **Asbestos in Libby, Montana — 1990**
- Since 1919, 400 people have died and almost 3,000 have become sick because of toxic asbestos dust from vermiculite mining in Libby, Montana. The mining company W.R. Grace and Co. had also distributed vermiculite, often used as insulation for the construction of buildings, around playgrounds and backyards in Libby.
- The mine was shut down in 1990, and the EPA declared a public health emergency in 2008. Cleaning up the tainted vermiculite required deconstructing homes, businesses, and other buildings.

The 9 deadliest manmade disasters in the past 50 years

- **Gulf War oil spill — 1991**
- The Gulf War oil spill was the largest oil spill. Between 5 and 10 million barrels of oil spilled into the Persian Gulf, killing 30,000 birds and reducing the breeding success of some species by half, according to CNN.
- **Jilin chemical plant explosions — 2005**
- Six people died, 70 were injured, and tens of thousands had to be evacuated when explosions at a petrochemical plant rocked through Jilin, China.
- Chemicals seeped into China's Songhua River, then into the Amur River at the China-Russia border, where benzene levels were measured at 108 times as high as standard safety levels, and eventually into the Pacific Ocean.
- A blockage in one of the plant's nitration towers caused the explosions, according to World Atlas.

The 9 deadliest manmade disasters in the past 50 years

The 9 deadliest manmade disasters in the past 50 years

- **The Camp Fire — 2018**
- The Camp Fire of 2018 was California's deadliest wildfire. Eighty-five people died and 19,000 buildings were destroyed, according to The New York Times. The town of Paradise was incinerated.
- The cause of the fire was found to be power lines owned by Pacific Gas & Electric.

The 9 deadliest manmade disasters in the past 50 years

Planetary Disasters

- PLANETARY DISASTERS • The disasters that are existing or occurring in inner space of a planet are called as terrestrial or planetary disasters.
- ENDOGENOUS HAZARDS • Hazards which originate inside the surface of the earth are termed as endogenic hazards. • E.g. Volcanoes, Earthquake
- EARTHQUAKE • An earthquake (also known as a quake, tremor or temblor) is is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to the people around and destroy whole cities.

Planetary Disasters

- **VOLCANOES** • A volcano is a rupture in the crust of a planetary- mass object, such as Earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. A volcano is a mountain that opens downward to a pool of molten rock below the surface of the earth. When pressure builds up, eruptions occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments.
- Eruptions can cause lateral blasts, lava flows, hot ash flows, mudslides, avalanches, falling ash and floods. Volcano eruptions have been known to knock down entire forests. An erupting volcano can trigger tsunamis, flash floods, earthquakes, mudflows and rock falls.

Planetary Disasters

- EXOGENOUS HAZARDS • Hazards which originate above the surface of the earth (in the atmosphere) are called exogenous hazards. • E.g. Drought, Rainfall, Snowfall, Winds, Hailstorm
- CLASSIFICATIONS The exogenous disasters are classified into 3 ways:
- • Atmospheric Disasters
- • Hydrospheric Disasters
- • Lithospheric Disasters

Planetary Disasters

- ATMOSPHERIC DISASTERS • Atmospheric Disasters that originate in the atmosphere of the earth are called atmospheric hazards. These include cyclones, tornadoes, droughts, thunderstorms etc. Drought, Rainfall, Snowfall, Winds, Hailstorm
- HYDROSPHERIC DISASTERS • Those natural hazards that are related to water in the atmosphere are termed as Hydrospheric hazards. These include Wave Currents, Tsunamis, Floods.
- LITHOSPHERIC HAZARDS • Lithospheric hazards are those natural hazards that occur near to the surface of the earth. It includes the following hazards: Landslides, weathering, erosion, avalanches, sinkholes.

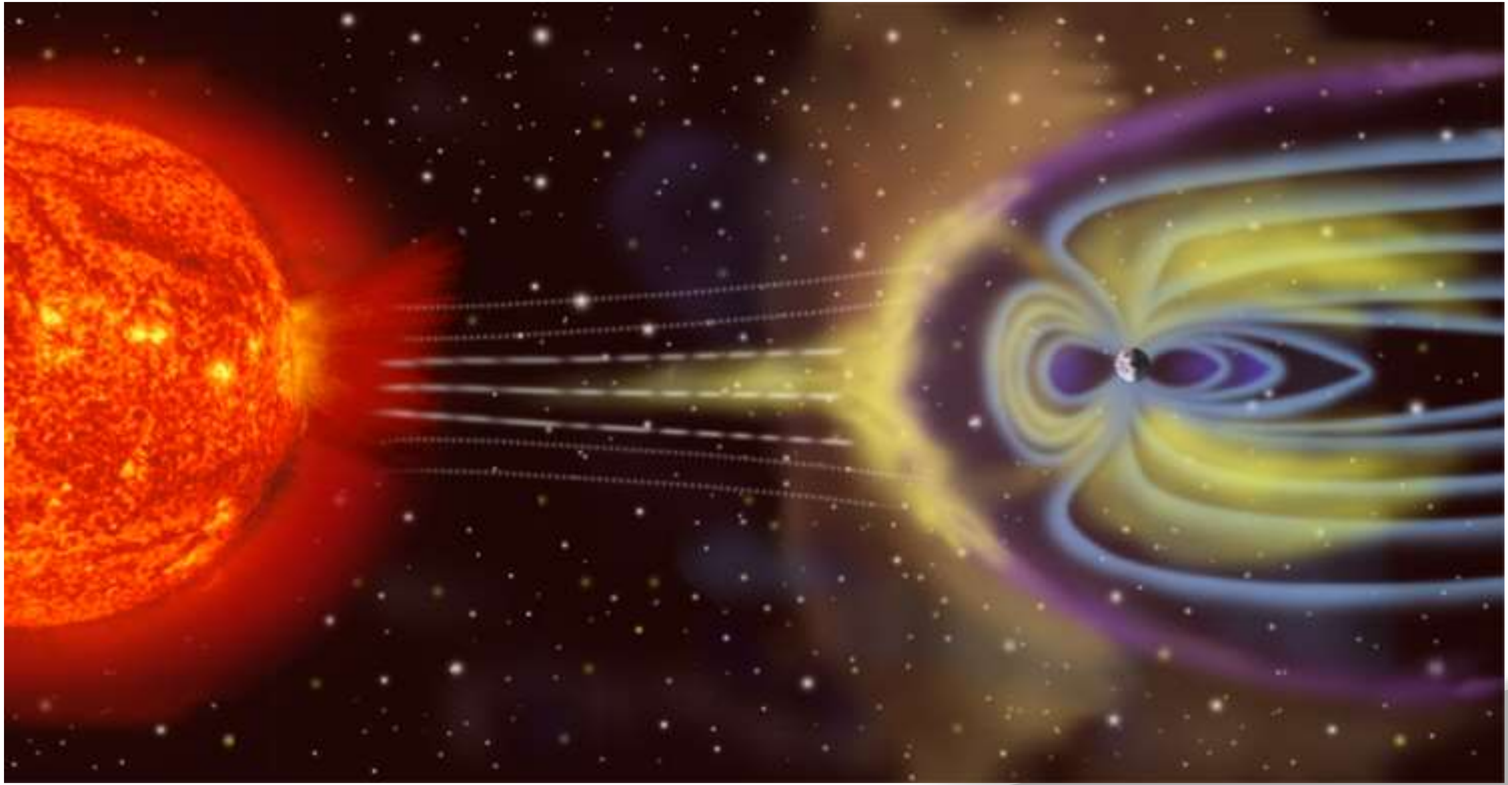
Extra Planetary Disasters

- The disasters that are existing or occurring in outer space beyond a planet, especially away from the planet Earth are called as extra terrestrial or extra planetary disasters.
- The extra planetary disasters is caused by collision of celestial bodies(**Celestial bodies** or **heavenly bodies** are objects in space such as the sun, moon, planets, and stars. They form a part of the vast universe we live in and are usually very far from us) and resultant falling of debris on the earth’s surface. The examples of extra planetary disasters are magnetic storms, catastrophic earth changes, meteorite impacts and impact from near earth objects.
- GEOMAGNETIC STORMS • A geomagnetic storm (commonly referred to as a solar storm) is a temporary disturbance of the Earth's magnetosphere caused by a solar wind shock wave and/or cloud of magnetic field that interacts with the Earth's magnetic field.

Extra Planetary Disasters

- The increase in the solar wind pressure initially compresses the magnetosphere. The solar wind's magnetic field interacts with the Earth’s magnetic field and transfers an increased energy into the magnetosphere.
- During the main phase of a geomagnetic storm, electric current in the magnetosphere creates a magnetic force that pushes out the boundary between the magnetosphere and the solar wind.
- **EFFECTS OF GEOMAGNETIC STORM** • Disruption of electrical systems • Communications • Navigation systems • Satellite hardware damage • Mains electricity grid • Geologic exploration • Pipelines • Radiation hazards to humans • Effect on animals

Extra Planetary Disasters



Extra Planetary Disasters

- METEORITE IMPACTS • Meteorites are naturally occurring objects in space which are generally remnants of asteroids and comets. They have been categorized into three types,
- 1. Stone Meteorites
- 2. Iron Meteorites
- 3. Stony-iron Meteorites
- When such extra planetary objects strike the earth's surface, then it forms a bowl-shaped depression with a raised on the following factors, size of the impacting object, velocity of the impacting object and angle at which the object strikes like earth's surface.

Extra Planetary Disasters

- Effects of meteorite impacts The effects of an impact of a large extra terrestrial object on the earth's surface are,
- Massive earthquake
- Widespread wildfires
- Blocking of solar radiation due to large quantities of dust in the atmosphere.
- Decrease in the rate of photosynthesis in plants leading to disruption of all ecosystems.
- Acidification of water

MODULE-III
Endogenous Hazards

Endogenous Hazards

Hazards which originate inside the surface of the earth are termed as endogenic hazards.

E.g. Volcanoes, Earthquake

EARTHQUAKE : An earthquake (also known as a quake, tremor or temblor) is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to the people around and destroy whole cities.

Endogenous Hazards

- The seismicity or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time.
- At the Earth's surface, earthquakes manifest themselves by shaking and sometimes displacement of the ground. When the epicenter of a large earthquake is located offshore, the seabed may be displaced sufficiently to cause a tsunami.

WHY DO EARTHQUAKES HAPPEN?

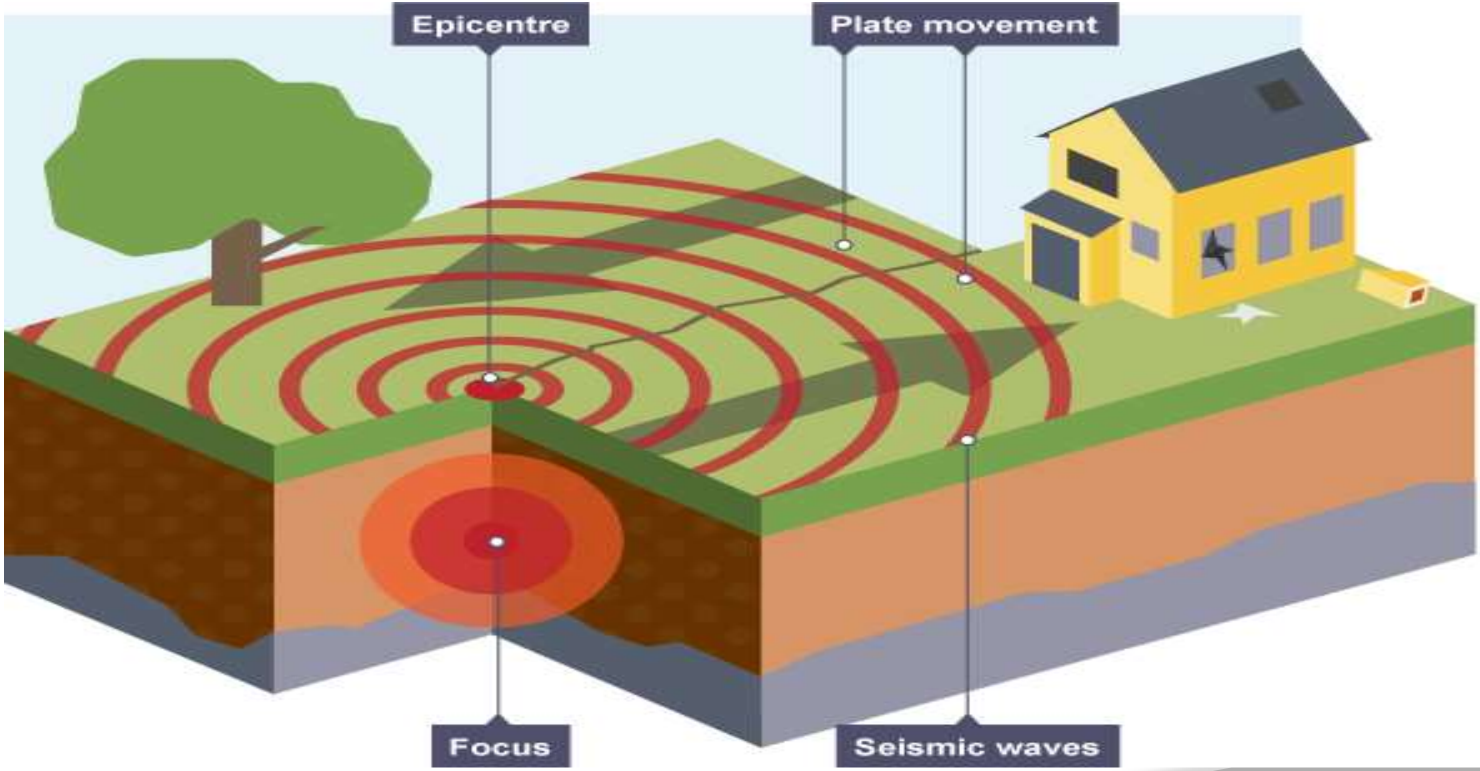
- Earthquakes are usually caused when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake. When two blocks of rock or two plates are rubbing against each other, they stick a little. They don't just slide smoothly; the rocks catch on each other. The rocks are still pushing against each other, but not moving.
- After a while, the rocks break because of all the pressure that's built up. When the rocks break, the earthquake occurs. During the earthquake and afterward, the plates or blocks of rock start moving, and they continue to move until they get stuck again. The spot underground where the rock breaks is called the focus of the earthquake. The place right above the focus (on top of the ground) is called the epicenter of the earthquake.

WHERE DO EARTHQUAKES HAPPEN?

- Most earthquakes occur along the edge of the oceanic and continental plates. The earth's crust is made up of several pieces, called plates. The plates under the oceans are called oceanic plates and the rest are continental plates. The plates are moved around by the motion of a deeper part of the earth (the mantle) that lies underneath the crust.
- These plates are always bumping into each other, pulling away from each other, or past each other. Earthquakes usually occur where two plates are running into each other or sliding past each other.

WHERE DO EARTHQUAKES HAPPEN?

WHERE DO EARTHQUAKES HAPPEN?



WHERE DO EARTHQUAKES HAPPEN?

For example:

- If you throw stone in a pond of still water , series of waves are produced on the surface of water , these waves spread out in all directions from the point where the stone strikes the water.
- similarly, any sudden disturbances in the earth’s crust may produce vibration in the crust which travel in all direction from point of disturbances.

WHERE DO EARTHQUAKES HAPPEN?

Focus:

- Focus is the point on the fault where rupture occurs and the location from which seismic waves are released.

Epicenter:

- Epicenter is the point on the earth's surface that is directly above the focus, the point where an earthquake or underground explosion originates.

Fault Line:

- A Fault line is the surface trace of a fault, the line of intersection between the earth's surface.

MEASUREMENT OF EARTHQUAKE

- The impact of an earthquake will be measured by using a seismometer. A seismometer detects the vibrations caused by an earthquake. It plots these vibrations on a seismograph. The strength, or magnitude, of an earthquake is measured using the Richter scale. The Richter scale is numbered 0- 10.
- Earthquakes measuring just one or two on the scale are very common and can happen everyday in places like San Francisco. These earthquakes are so small that people cannot feel them, they can only be picked up by a seismometer.Earthquakes measuring around 7 or 8 on the Richter scale can be devastating. The earthquake in China's south-western Sichuan province in May 2008 measured 7.8 on the Richter scale.

What Causes Earthquakes?

- On a few occasions, earthquakes have foreshocks. Foreshocks are a smaller version of earthquakes that occur in the same area as the bigger earthquakes that ensues(happen to occur afterwards). Up until now, scientists have not been able to tell whether an earthquake is a foreshock until the real earthquake occurs. The real or larger earthquake is known as the main shock.Main shocks, on numerous occasions, are followed by an aftershock. Aftershocks are a collection of small earthquakes that take place after the main earthquake. Depending upon the magnitude of the main shock, aftershocks may continue to happen for weeks, months or even years.
- For earthquakes to occur, energy is released from a focal point. This point is called the epicenter and usually found at shallow depths from the earth's surface. From the epicenter, seismic waves are produced and sent out in all directions. Seismic waves then travel at varying speeds depending on the kind of material they go through.

Types of Earthquakes

1. Tectonic Earthquakes

- The earth’s crust is composed of tectonic plates.
- These plates are capable of moving slowly and gradually.
- The movement of these plates occurs in different forms; towards each other, away from each other, sliding past each other or colliding with each other.
- A huge tremor (involuntary shaking or movement ,ranging from slight to severe) occurs when 2 moving tectonic plates slide over one another. This type of earthquake is known as a tectonic earthquake.
- Tectonic earthquakes are the most prevalent(wide spread) kinds of earthquakes in the world. Its magnitude may be small or large.
- Tectonic earthquakes have caused most of the planet’s mass destruction.
- Tremors triggered by tectonic earthquakes are always severe, and if their magnitude is high, they are capable of bringing down an entire city in seconds.

Types of Earthquakes

2. Volcanic Earthquakes:

- Compared to tectonic earthquakes, volcanic earthquakes are less prevalent. They typically take place before or after an eruption. Volcanic earthquakes come in two forms: **long-period volcanic earthquakes** and **volcano-tectonic** earthquakes. Volcano-tectonic earthquakes usually happen after a volcanic eruption. During an earthquake, magma erupts from inside the earth's crust leaving a space behind. The space left after magma eruption must be filled. To fill it, rocks move towards the space resulting in severe earthquakes.
- On numerous occasions, magma blocks the vents during volcanic activity. This means that high pressure fails to be released. The buildup of pressure becomes unbearable and releases itself with a massive explosion. The massive explosion results in a ruthless earthquake.
- On the other hand, a long period of volcanic earthquake takes place after a volcanic eruption. Some days prior to the massive explosion, the magma inside the earth's crust experiences rapid changes in heat. The change in heat triggers seismic waves, resulting in an earthquake.

Types of Earthquakes

3. Explosion Earthquakes:

- These are caused by nuclear explosions.
- They are, essentially, man triggered(encouraged) kind of earthquakes and represent the biggest impact of modern-day nuclear war.
- During the 1930s nuclear tests conducted by the United States, numerous small towns and villages were devastated as a result of this grave act.

Types of Earthquakes

4. Collapse Earthquakes:

- These kinds of earthquakes are generally smaller and most commonly occur near underground mines.
- They are sometimes referred to as mine bursts.
- Collapse earthquakes are instigated(initiate) by the pressure generated within the rocks. This kind of earthquake leads to the collapse of the roof of the mine instigating more tremors.
- Collapse earthquakes are prevalent in small towns where underground mines are located.

Devastating Effects of Earthquakes

1. Damage to buildings:

- High magnitude earthquakes can lead to a complete collapse of buildings. Debris from collapsing buildings is the main danger in the course of an earthquake because the falling effects of huge, heavy objects can be deadly to humans. High magnitude earthquakes result in the shattering of mirrors and windows, which also present danger to humans.

2. Damage to infrastructure:

- Earthquakes can cause electricity lines to fall. This is dangerous because the exposed live wires can electrocute humans or start fires. Major earthquakes can cause rupturing of roads, gas lines, and water pipelines. Broken gas lines can cause gas to escape. Escaping gas can result in explosions and fires, which may be difficult to contain.

3. Landslides and rockslides :

- When an earthquake occurs, large rocks and sections of earth located uphill can be dislodged, consequently, rolling rapidly down into the valleys. Landslides and rockslides can cause destruction and death to the people living downstream.

Devastating Effects of Earthquakes

4.Can result in floods:

- High magnitude earthquakes can instigate cracking of dam walls, collapsing in the long run. This would send raging waters into nearby areas leading to massive flooding.

5. Earthquakes can trigger tsunamis:

- A tsunami is a series of long high sea tremors sparked by an earthquake or volcanic eruptions under the sea.
- A tsunami can wipe out an entire surrounding coastal area population. A typical example is the March 11, 2011, earthquake and tsunami that struck the coast of Japan leaving more than 18,000 people dead in its wake.

6. Leads to liquefaction:

- Liquefaction is a phenomenon where the soil becomes saturated and loses it strength. When sediments consisting of high water content are subjected to constant trembling(moving), water pressure held in the sediment pores slowly increases.
- Ultimately, the sediments lose almost all cohesive strength and start acting like liquids. Buildings and other structures built on top of this liquefied soil overturn or sink into the ground.
- Earthquakes are responsible for most of the liquefaction occurring across the world. A typical example of the liquefaction phenomenon is the earthquake of **1692 in Jamaica that resulted in the devastation of the town of Port Royal.**

How Are Earthquakes Measured

- Earthquakes are measured by the amount of force or energy they produced. This is done through the **Richter scale**. This tool was developed by Charles F. Richter of the California Institute of Technology. Many times you must have heard or read about this tool in the news or the internet. The Richter scale uses the information produced through **seismograph** to calculate the magnitude of the earthquake.

- The magnitude of an earthquake gives you an idea of the effect of an earthquake. **Earthquakes occurring above 7 on the Richter scale are known to have such devastating effect** and can cause severe damage to life and property.

- **Earthquakes occurring below 3 on the Richter scale can't be felt**. **Earthquakes occurring between 3 and 6 are said to be of a mild type**. Countries like **Japan** are prone to earthquakes as they come in a **high seismic zone**. When an earthquake occurs in the sea, it paves way for Tsunami. One of the most devastating Tsunami occurred in the Indian Ocean on Dec. 26th, 2004.

Earthquake zones of India

Zone 5:

- Zone 5 covers the areas with the highest risk of suffering earthquakes.The IS code assigns a zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. The zone factor of 0.36 (the maximum horizontal acceleration that can be experienced by a structure) is indicative of effective (zero period) level earthquakes in this zone. It is referred to as the Very High Damage Risk Zone. The regions of Kashmir, the Western and Central Himalayas, North and Middle Bihar, the North-East Indian region, the Rann of Kutch and the Andaman and Nicobar group of islands fall in this zone.
- Generally, the areas having trap rock or basaltic rock are prone to earthquakes.

Zone 4:

- This zone is called the High Damage Risk Zone. The IS code assigns a zone factor of 0.24 for Zone 4. Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, parts of the Indo-Gangetic plains (North Punjab, Chandigarh, Western Uttar Pradesh, Terai, North Bengal, the Sundarbans) and the capital of the country Delhi fall in Zone 4. In Maharashtra, the Patan area (Koynanagar) is also in Zone 4. In Bihar the northern part of the state in areas such as Raxaul, near the border of India and Nepal, is also in Zone 4.

Earthquake zones of India

Zone 3:

- This zone is classified as a Moderate Damage Risk Zone. The IS code assigns a zone factor of 0.16 for Zone 3. Several megacities like Chennai, Mumbai, Kolkata and Bhubaneshwar lie in this zone.

Zone 2:

- This region is classified as the Low Damage Risk Zone. The IS code assigns a zone factor of 0.10 for Zone 2.

Zone 1:

- Since the current division of India into earthquake hazard zones does not use Zone 1, no area of India is classed as Zone 1.
- Future changes in the classification system may or may not return this zone to use.

Can Earthquakes Be Predicted?

- To date, scientists have not been able to predict earthquakes. Many modern techniques have been used, unfortunately, none of them has worked. If any such toll is built to predict earthquakes, many lives could be saved in the future.
- The only thing that you can do is to educate yourself about earthquake management and be vigilant(alert) in times of disasters. You can also do precautionary measures by buying properties that are not located in known earthquake-prone areas or fault lines. The occurrence of earthquakes can happen anytime and we will never be ready for it and the imminent(about to happen) danger it brings. But with earthquake preparedness measures and awareness, it can make you alert and quick in making sound decisions in times of danger.

Distribution of Earthquakes

- Earth's major earthquakes occur mainly in belts coinciding with the margins of tectonic plates.
- The most important earthquake belt is the **Circum-Pacific Belt**, which affects many populated coastal regions around the Pacific Ocean—for example, those of New Zealand, New Guinea, Japan, the Aleutian Islands, Alaska, and the western coasts of North and South America.
- The seismic activity is by no means uniform throughout the belt, and there are many branches at various points.
- Because at many places the Circum-Pacific Belt is associated with volcanic activity, it has been popularly dubbed the "Pacific Ring of Fire."

Distribution of Earthquakes

The Pacific Ring of Fire accounts for about 68 per cent of all earthquakes.

- A second belt, known as the **Alpine Belt (Himalayas and Alps)**. The energy released in earthquakes from this belt is about 15 per cent of the world total.
- The mid-world mountain belt (Alpine Belt) extends parallel to the equator from Mexico across the Atlantic Ocean, the Mediterranean Sea from Alpine-Caucasus ranges to the Caspian, Himalayan mountains and the adjoining lands.
- There also are striking connected belts of seismic activity, mainly along oceanic ridges—including those in the Arctic Ocean, the Atlantic Ocean, and the western Indian Ocean—and along the **rift valleys of East Africa**.

Human Induced Earthquakes

- In the areas of **intense mining activity,** sometimes the roofs of underground mines collapse causing minor tremors. These are called **collapse earthquakes.**
- Ground shaking may also occur due to the explosion of chemical or nuclear devices. Such tremors are called **explosion earthquakes.**
- The earthquakes that occur in the areas of large reservoirs are referred to as reservoir **induced earthquakes.**

Human Induced Earthquakes

- India has suffered four great earthquakes of magnitudes 8.5 and greater, in the past hundred years, inflicting heavy casualties and economic damage. Yet, human memory being short, it is generally not recognized that we continue to live under the long shadow of such future calamities. One of the ways to mitigate the destructive impact of earthquakes is to conduct a seismic hazard analysis and take remedial measures. Seismic hazard analysis consists of estimating various effects such as ground failure by faulting or soil liquefaction, ground shaking, tsunami generation etc. that might be caused by future earthquakes in a region.

Preventive And Mitigation Measures Of Earthquakes

- When 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.
- For better understanding of all the possibilities of earthquake risk reduction, it is important to classify them in terms of the role that each one of them could play. Therefore, in the pre-earthquake phase, preparedness, mitigation and prevention are concepts to work on. Post-disaster, immediate rescue and relief measures including temporary sheltering soon after an earthquake until about 3 months later and re-construction and re-habilitation measures for a period of about six months to three years need to follow.

Preventive And Mitigation Measures Of Earthquakes

Structural : No buildings can be made 100% safe against earthquake forces. Instead buildings and infrastructures can be made earthquake resistant to 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.

Preventive And Mitigation Measures Of Earthquakes

Nonstructural : For getting the structural measures implemented with due earnestness, honesty of purpose and sense of compulsion host of non-structural measures in the form of policies guidelines and training have to be provided.

- Policy decisions about construction of structures with due approval from specified authorities have to be taken. The building codes etc have to be suitably formulated/amended and appropriately detailed and legal implications properly stated.
- Guidelines both for earthquake-resistant constructions as well as for retrofitting have to be formulated with specifications about site selection, foundation, construction, materials and workmanship making involvement of specialist architects, trained engineer and masons mandatory.

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 structures and with our recent experiences with large earthquakes near urban centres, the need of seismic retrofitting is well acknowledged.

Long-term measures :

- Re-framing buildings codes, guidelines, manuals and byelaws and their strict implementation. Tougher legislation for highly seismic areas.
- Incorporating earthquake resistant features in all buildings at high-risk areas.
- Making all public utilities like water supply systems, communication networks, electricity lines etc. earthquake-proof. Creating alternative arrangements to reduce damages to infrastructure facilities.
- Constructing earthquake-resistant community buildings and buildings (used to gather large groups during or after an earthquake) like schools, dharamshalas, hospitals, prayer halls, etc., especially in seismic zones of moderate to higher intensities.

Pre-Disaster Preventive Measures

- Supporting R&D in various aspects of disaster mitigation, preparedness and prevention and post-disaster management.
- Evolving educational curricula in architecture and engineering institutions and technical training in polytechnics and schools to include disaster related topics.
- **Medium term measures**:
- Retrofitting of weak structures in highly seismic zones.
- Preparation of disaster related literature in local languages with dos and don'ts for construction.
- Getting communities involved in the process of disaster mitigation through education and awareness.
- Networking of local NGOs working in the area of disaster management.

Post-Disaster Preventive Measures

- Maintenance of law and order, prevention of trespassing, looting etc.
- Evacuation of people.
- Recovery of dead bodies and their disposal.
- Medical care for the injured.
- Supply of food and drinking water.
- Temporary shelters like tents, metal sheds etc.
- Repairing lines of communication and information.
- Restoring transport routes.
- Quick assessment of destruction and demarcation of destroyed areas, according to the grade of damage.
- Cordoning off severely damaged structures that are liable to collapse during aftershocks.

VOLCANOES

- A volcano is a rupture in the crust of a planetary- mass object, such as Earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. A volcano is a mountain that opens downward to a pool of molten rock below the surface of the earth. When pressure builds up, eruptions occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments.
- Eruptions can cause lateral blasts, lava flows, hot ash flows, mudslides, avalanches, falling ash and floods. Volcano eruptions have been known to knock down entire forests. An erupting volcano can trigger tsunamis, flash floods, earthquakes, mudflows and rock falls.

VOLCANOES

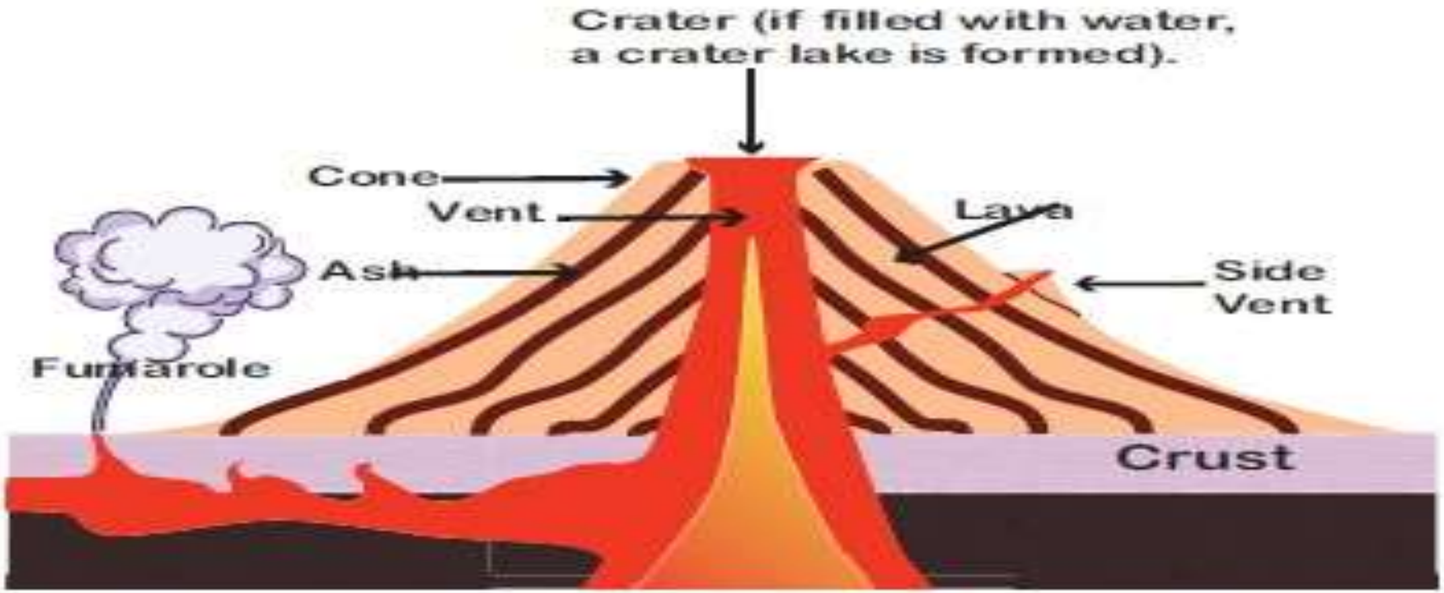


Figure 3.25 Volcano

VOLCANOES

- **How are volcanoes formed:**
- Volcanoes are formed, when magma form within the Earth's upper mantle works its way to the surface. At the surface, it erupts to form lava flows and ash deposits. Over time as the volcano continues to erupt, it will get bigger and more bigger.
- **DIFFERENT STAGES OF VOLCANOES:** Scientists have categorized volcanoes into three main categories: active, dormant, and extinct. An active volcano is one which has recently erupted and there is a possibility that it may erupt soon. A dormant volcano is one which has not erupted in a long time but there is a possibility it can erupt in the future. An extinct volcano is one which has erupted thousands of years ago and there’s no possibility of eruption.

VOLCANIC ERUPTION

- The Earth's crust is made up of huge slabs called plates.These plates sometimes move. The friction causes earthquakes and volcanic eruptions near the edges of the plates. The theory that explains this process is called plate tectonics.
- **PLATE TECTONICS** :The theory of plate tectonics is a interesting story of continents drifting from place to place breaking apart, colliding, and grinding against each other. The plate tectonic theory is supported by a wide range of evidence that considers the earth's crust and upper mantle to be composed of several large, thin, relatively rigid plates that move relative to one another. Sometimes the plates crash together, pull apart or sideswipe each other. When this happens, it commonly results in earthquakes.

How many volcanoes are there?

- There are more than 1500 active volcanoes on the Earth. We currently know of 80 or more which are under the oceans. Active volcanoes in INDIA are Barren Island(Andaman Nicobar Islands), Deccan Traps (West Central India), Baratang(Andaman Nicobar Islands), Dhinodhar Hills (Gujarat), Dhosi Hill (Haryana), Tosham Hills (Aravalli mountain)
- **DIFFERENT TYPES OF VOLCANOES** :On the **basis of nature of eruption and form** developed on the surface, they are classified into following types:
- Cinder cones
- Composite volcanoes
- Shield volcanoes and
- Lava volcanoes

How many volcanoes are there?

- **CINDER CONES** • Cinder cones are circular or oval cones made up of small fragments of lava from a single vent that have been blown into the air, cooled and fallen around the vent.
- **COMPOSITE VOLCANOES** • Composite volcanoes are steep-sided volcanoes composed of many layers of volcanic rocks, usually made from high-viscosity lava, ash and rock debris.
- **SHIELD VOLCANOES** • A shield volcano is a type of volcano usually built almost entirely of fluid lava flows. Shield volcanoes are volcanoes shaped like a bowl or shield in the middle with long gentle slopes made by basaltic lava flows. Basalt lava flows from these volcanoes are called flood basalts.

How many volcanoes are there?

- **LAVA DOMES** • Lava domes are formed when erupting lava is too thick to flow and makes a steep-sided mound as the lava piles up near the volcanic vent. The eruption of Mount St. Helens in 1980 was caused in part by a lava dome shifting to allow explosive gas and steam to escape from inside the mountain.
- **PUMICE** • Pumice is a light, porous volcanic rock that forms during explosive eruptions. It resembles a sponge because it consists of a network of gas bubbles frozen amidst fragile volcanic glass and minerals. All types of magma will form pumice.
- **RING OF FIRE** • The Pacific Ring of Fire is an area of frequent earthquakes and volcanic eruptions encircling the basin of the Pacific Ocean. The Ring of Fire has 452 volcanoes and is home to over 50% of the world's active and dormant volcanoes. Ninety percent of the world's earthquakes and 81% of the world's largest earthquakes occur along the Ring of Fire.

Types of Volcanoes

- Based on the **frequency of eruption**, there are three types of volcanoes:
- **1. Active Volcanoes:** Volcanoes which erupt frequently are called active volcanoes. Generally, their vent remains open. Mount Etna of Italy, Cotopaxi in Ecuador are some examples.
  2. Dormant Volcanoes: These volcanoes may not have erupted in the recent past but there is a possibility of eruption at any time. In other words, they may lie dormant awaiting active eruption anytime. Sometimes gases and steam come out of them. They cause great destruction to life and property once they become active again. Mt. Vesuvius of Italy and Mt. Fujiyama of Japan are examples.
- **3. Extinct Volcanoes:** These volcanoes have exhausted their energy and have not erupted during the known geological period. The vent of these volcanoes remains closed with solidified lava. The formations such as craters may be filled with water and crater lakes may be formed. The slopes of these landforms may be covered with vegetation. Popa in Myanmar and Mt. Kenya in eastern Africa are the examples of extinct volcano.

Distribution of Volcanoes across the World

- Most known volcanic activity and the earthquakes occur along converging plate margins and mid-oceanic ridges. The major regions of volcanic distributions are as follows.
- **1. Pacific Ring of Fire**
- Circum-Pacific region, popularly termed the ‘Pacific Ring of Fire’, has the greatest concentration of active volcanoes. Volcanic belt and earthquake belt closely overlap along the ‘Pacific Ring of Fire’. It is estimated to include two-thirds of the world’s volcanoes.
- **2. Mid Atlantic Region**
- The Mid Atlantic Region coasts has comparatively fewer active volcanoes but many dormant or extinct volcanoes, example. St. Helena, Cape Verde Islands and the Canary Islands. But the volcanoes of Iceland and the Azores are active.

Distribution of Volcanoes across the World

- **3. The Great Rift valley of Africa**
- In Africa some volcanoes are found along the East African Rift Valley. Kilimanjaro and Mt. Kenya are extinct volcanoes. The only active volcano in West Africa is Mt. Cameroon.
- **4. Mediterranean Region**
- Volcanoes of the Mediterranean region are mainly associated with the Alpine folds. Example, Mt. Vesuvius, Mt. Stromboli (known as the Light House of the Mediterranean Sea).
- **5. Other Regions**
- Elsewhere in the interiors of continents of Asia, North America and Europe active volcanoes are rare. There are no volcanoes in Australia.

Distribution of Volcanoes across the World

- **Volcanoes in India**
- There are no volcanoes in the Himalayan region of India. However, Barren Island, lying 135 km north-east of Port Blair became active in 1991 and 1995.
- However, the other volcanic island in Indian Territory is Narcondam (Andaman and Nicobar Islands) It is probably extinct. Its crater wall has been completely destroyed.

Effects of Volcanic Activities

- **Destructive effects of volcano**
- Showers of cinders and bombs can cause damage to life and properties. Sometimes ash can precipitate under the influence of rain and completely cover large areas.
- The volcanic gases pose potential hazard to people, animals; agriculture, while sulfur dioxide gas can lead to acid rain and air pollution.
- **Positive Effects of Volcanoes**
- Volcanism creates new landforms. Volcanic rocks yield very fertile soil upon weathering and decomposition.
- The Kimberlite rock of South Africa, the source of diamonds, is the pipe of an ancient volcano.
- In the vicinity of active volcanoes, waters in the depth are heated from contact with hot magma giving rise to springs and geysers. The Puga valley in Ladakh region and Manikaran (Himachal Pradesh) are promising spots in India for the generation of geothermal electricity.

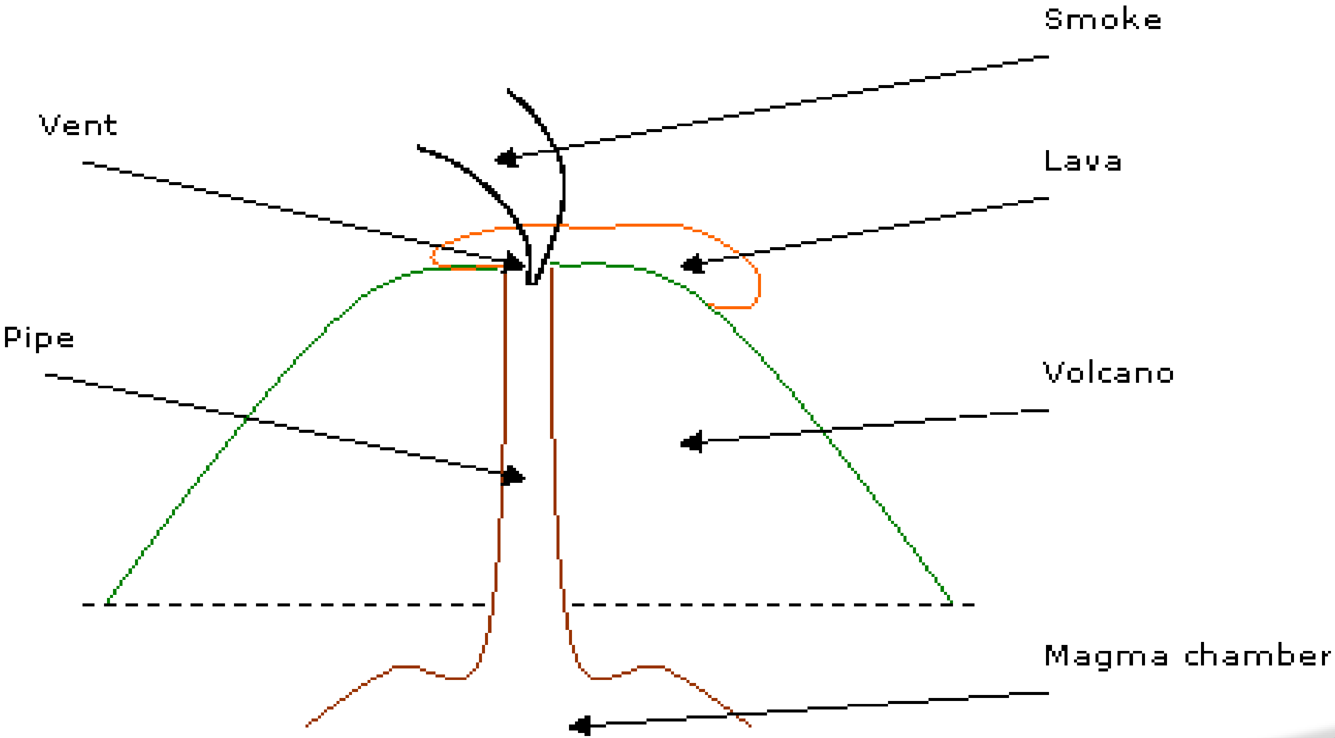
Causes of Volcanic Eruptions

- The following are the causes of volcanic eruptions:
- **Weak Zones in the Earth Crust:** The parts of the earth where two tectonic plates collide against or drift apart from each other are considered very weak. Volcanoes may erupt in such zones, for example, African and Eurasian plates.
- **Magma Saturated with Gases:** The magma, in the interior of the earth, is often found saturated with gases like carbon dioxide, and hydrogen sulfide. These gases together with water vapour make the magma highly explosive. Magma is forced out as lava on the surface of the earth due to the pressure exerted by these gases.

Environmental impact of volcanic eruptions

- **Environmental impact of volcanic eruptions:**
- On locations where tectonic plates diverge or converge, volcanoes can be found. A volcano consists of a deep magma chamber where magma accumulates, pipes that lead to surface vents, and the vents through which lava is emitted during a volcanic eruption. Volcanoes are often known to have a mountain-like shape.
- Volcanoes that have not erupted for some time are dormant, and volcanoes that have not erupted even in the distant past are called extinct. Volcanic activity and volcanic eruption is usually triggered by alterations of tectonic plates, resulting in landslides or earthquakes.

Environmental impact of volcanic eruptions



Environmental impact of volcanic eruptions

- There are different types of volcanic eruptions:

  - **Phreatic**: explosion of steam, water, ash and rock as magma comes in contact with groundwater or surface water

  - **Rhyolite flow**: high-silica lava (>68%)

  - **Basalt flow**: low-silica lava (when the silica content is low, lava usually has a higher magnesium and iron content)

  - **Pyroclastic flow**: fast-moving hot ash, gas and rock

  - **Lahar**: mud flow of pyroclastic material into a river valley

  - **Carbon dioxide emission**

Environmental impact of volcanic eruptions

- Volcanic eruptions can be extremely damaging to the environment, particularly because of a number of toxic gases possibly present in pyroclastic material. It typically consists mainly of water vapour, but it also contains carbon dioxide and sulphur dioxide gas.
- Other gases typically found in volcanic ashes are hydrogen sulphide, hydrogen chloride, hydrogen fluoride, carbon monoxide, and volatile metal chlorides.
- Carbon dioxide emitted from volcanoes adds to the natural greenhouse effect.
- Sulphur dioxides cause environmental problems, because they are converted to sulphuric acid in the stratosphere; the main cause of acid rain.
- Furthermore, sulphate aerosols are formed, which reflect solar radiation and absorb heat, thereby cooling the earth.

Environmental impact of volcanic eruptions

- Sulphate aerosols also take part in chemical reactions, forming ozone destructive material.
- An example of a volcanic eruption that caused substantial environmental damage is the Mount Pinatubo eruption in the Philippines.

MODULE-IV
Exogenous Hazards

Exogenous Hazards

- Hazards which originate above the surface of the earth (in the atmosphere) are called exogenous hazards. • E.g. Drought, Rainfall, Snowfall, Winds, Hailstorm

  CLASSIFICATIONS:

- The exogenous disasters are classified into 3 ways:
- • Atmospheric Disasters
- • Hydrospheric Disasters
- • Lithospheric Disasters
- **ATMOSPHERIC DISASTERS** • Atmospheric Disasters that originate in the atmosphere of the earth are called atmospheric hazards. These include cyclones, tornadoes, droughts, thunderstorms etc. Drought, Rainfall, Snowfall, Winds, Hailstorm

Exogenous Hazards

- **DROUGHTS** • A drought is a period of below-average precipitation in a region; resulting in prolonged shortages in the water supply, whether atmospheric, surface water or ground water. A drought can last for months or years, or may be declared after as few as 15 days.
- It can have a substantial impact on the ecosystem and agriculture of the affected region and harm to the local economy. • Annual dry seasons in the tropics significantly increase the chances of a drought developing and subsequent bush fires. Periods of heat can significantly worsen drought conditions by hastening evaporation of water vapour.
- **RAINFALL** • Rain is liquid water in the form of droplets that have condensed from atmospheric water vapour and then becomes heavy enough to fall under gravity. Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth. It provides suitable conditions for many types of ecosystems, as well as water for hydroelectric power plants and crop irrigation.

Exogenous Hazards

- **SNOWFALL** • Snow refers to forms of ice crystals that precipitate from the atmosphere (usually from clouds) and undergo changes on the Earth's surface. It pertains to frozen crystalline water throughout its life cycle, starting when, under suitable conditions, the ice crystals form in the atmosphere, increase to milli metre size, precipitate and accumulate on surfaces, then metamorphose in place, and ultimately melt, slide or sublimate away. Snowstorms organize and develop by feeding on sources of atmospheric moisture and cold air.
- **WINDS** • Wind disasters (WDs) contribute to tremendous physical destruction, injury, loss of life, and economic damage. The effects of WDs may not be limited to wind damage, as concurrent heavy rains and flooding often wreak additional havoc. While there is some evidence pointing towards increasing number of destructive wind phenomena over the last few decades, these findings are at least partly due to the fact that our observational capabilities and recording of such events have improved markedly, leading to greater public awareness of severe weather events worldwide.

Exogenous Hazards

- **HAILSTROMS** • A hailstorm is precipitation in the form of balls or lumps of clear ice and compact snow. It is not known for sure how hailstones form and grow. We do know that they are spherical or irregularly spherical and usually vary in diameter up to 1/2 in. (1.3 cm); in rare cases hailstones having diameters up to 5 in. (12.7 cm) have been observed. Hail causes much damage and injury to crops, livestock, property, and airplanes.
- **HYDROSPHERIC DISASTERS** • Those natural hazards that are related to water in the atmosphere are termed as Hydrospheric hazards. These include Wave Currents, Tsunamis, Floods.
- **WAVE CURRENT** • An wave current is a seasonal directed movement of seawater generated by forces acting upon this mean flow, such as breaking waves, wind, the Coriolis effect, cabbeling, temperature and salinity differences, while tides are caused by the gravitational pull of the Sun and Moon. Depth contours, shoreline configurations, and interactions with other currents influence a current's direction and strength. Therefore, ocean currents are primarily horizontal water movements.

Exogenous Hazards

- **TSUNAMI** • A Tsunami, also known as a seismic sea wave or as a tidal wave, is a series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean or a large lake. Tsunamis can be caused by undersea earth quakes.
- **FLOODS** • A flood is an overflow of water that submerges land. Flood as a temporary covering by water of land which is usually not covered by water. Flooding may result from the volume of water within a body of water, such as a river or lake, which overflows causing the result that some of the water escapes its usual boundaries.
- While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, it is not a significant flood unless the water covers land used by man like a village, city or other inhabited area, roads, expanses of farmland, etc.
- **LITHOSPHERIC HAZARDS** • Lithospheric hazards are those natural hazards that occur near to the surface of the earth. It includes the following hazards: Landslides, weathering, erosion, avalanches, sinkholes.

Exogenous Hazards(Landslides)

- A landslide, also known as a landslip or Mudslide, is a form of mass wasting that includes a wide range of ground movements, such as rockfalls, deep failure of slopes, and shallow debris flows. Landslides can occur underwater, called a submarine landslide, coastal and onshore environments.
- Factor of Safety(F) : F = Resisting Force(R) / Driving Force(D)
- When, $F < 1$ = landslide occur
- Resisting forces (R) preventing the mass from sliding down the slope are inversely proportional to the same hill slope angle and directly proportional to the frictional angle of the material.
- Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability.

LANDSLIDES

- **CAUSES**
- Landslides occur when the slope changes from a stable to an unstable condition. A change in the stability of a slope can be caused by a number of factors, acting together or alone.
- **Natural causes of landslides include**:
- Groundwater (pore water) pressure acting to destabilize the slope
- weakening of a slope through saturation by snow melting, glaciers melting, or heavy rain.
- Landslides that are caused by human activities, such as
- deforestation, cultivation and construction, which destabilize the already fragile slopes.
- vibrations from machinery or traffic
- blasting
- earthwork which alters the shape of a slope, or which imposes new loads on an existing slope

LANDSLIDES

- **COMMON TYPES OF LANDSLIDES**
- • Rotational slides • Translational slides • Rock Fall
- • Rock toppling • Lateral spreading • Debris flow
- **ROTATIONAL SLIDES** • A slide type landslide is a down-slope movement of material that occurs along a distinctive surface. If this slip surface is curved the slide said to be rotational. The slip surface of a rotational landslide tends to be deep. • Rotational slides move along a surface of rupture that is curved and concave.
- **TRANSLATIONAL SLIDES** • A slide-type landslide is a down-slope movement of material that occurs along a distinctive surface of weakness such as a fault, joint or bedding plane. If the slip surface is straight then it is termed translational or planar.

LANDSLIDES

- **ROCK FALL** • A rock fall is the natural downward motion of a detached block or series of blocks with a small volume involving free falling, bouncing, rolling, and sliding. The mode of failure differs from that of a rockslide.
- **ROCK TOPPLING** • Rock toppling occurs when one or more rock units rotate about their base and Collapse.
- **LATERAL SPREADING** • Lateral spread or flow are terms referring to landslides that commonly form on gentle slopes and that have rapid fluid-like flow movement, like water. Lateral spreading occurs when the soil mass spreads laterally and this spreading comes with tensional cracks in the soil mass.
- **DEBRIS FLOWS** • Debris flows are geological phenomena in which water-laden masses of soil and fragmented rock rush down mountainsides, funnel into stream channels, entrain objects in their paths, and form thick, muddy deposits on valley floors.

WEATHERING

- **WEATHERING** • Weathering is the breaking down of rocks, soil, and minerals as well as wood and artificial materials through contact with the Earth's atmosphere, water, and biological organisms.
- **TYPES OF WEATHERING** • Weathering is of two types:
- Physical Weathering
- Chemical Weathering
- **PHYSICAL WEATHERING** • Physical weathering, also called mechanical weathering or disaggregation, is the class of processes that causes the disintegration of rocks without chemical change.
- **CHEMICAL WEATHERING** • Chemical weathering changes the composition of rocks, often transforming them when water interacts with minerals to create various chemical reactions. Chemical weathering is a gradual and ongoing process as the mineralogy of the rock adjusts to the near surface environment.

- **AVALANCHES** • An avalanche (also called a snow slide) is a rapid flow of snow down a sloping surface.
- Avalanches are typically triggered in a starting zone from a mechanical failure in the snowpack (slab avalanche) when the forces on the snow exceed its strength but sometimes only with gradually widening (loose snow avalanche).
- **EROSION** • In earth science, erosion is the action of surface processes (such as water flow or wind) that removes soil, rock, or dissolved material from one location on the Earth's crust, and then transport it away to another location.
- **SINKHOLES** • A sinkhole, also known as a cenote, swallow hole, or doline , is a depression or hole in the ground caused by some form of collapse of the surface layer.

Exogenous hazards/ disasters

- **Infrequent events**: Cyclones , lightning , hailstorms
- **Cyclones**: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)
- Hurricanes and **typhoons** are the same **storm** types as "**tropical cyclones**" (the **local** name for **storms** which originate in the Caribbean and China Sea region respectively). A **tropical cyclone** is a non-frontal **storm** system that is characterized by a low pressure center, spiral rain bands and strong winds.

Cyclones

- **Cyclones** are wind storms accompanied with heavy rainfall at low-pressure areas. They are **caused** due to a continuous process of rising of hot air over the ocean surface.
- **Regional names of cyclone**
- **1. Typhoons** – China Sea
- **2. Tropical Cyclones**- Indian Ocean
- **3. Hurricanes-**Caribbean Sea
- **4. Tornadoes**-USA
- **5. Wily Willies**- Northern Australia
- **6. Baguio**- Philippines
- **7. Taifu**- Japan

Cyclones

- A cyclone describes a weather system characterized by swirling winds around a low-pressure center; wind direction around the low is counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere. Coming in a wide variety of sizes and settings, cyclones cause some of the most dramatic and outright violent weather on the planet, including the tropical cyclones known as hurricanes and typhoons. The science behind cyclones will help you understand why, where and how this weather phenomena exists.

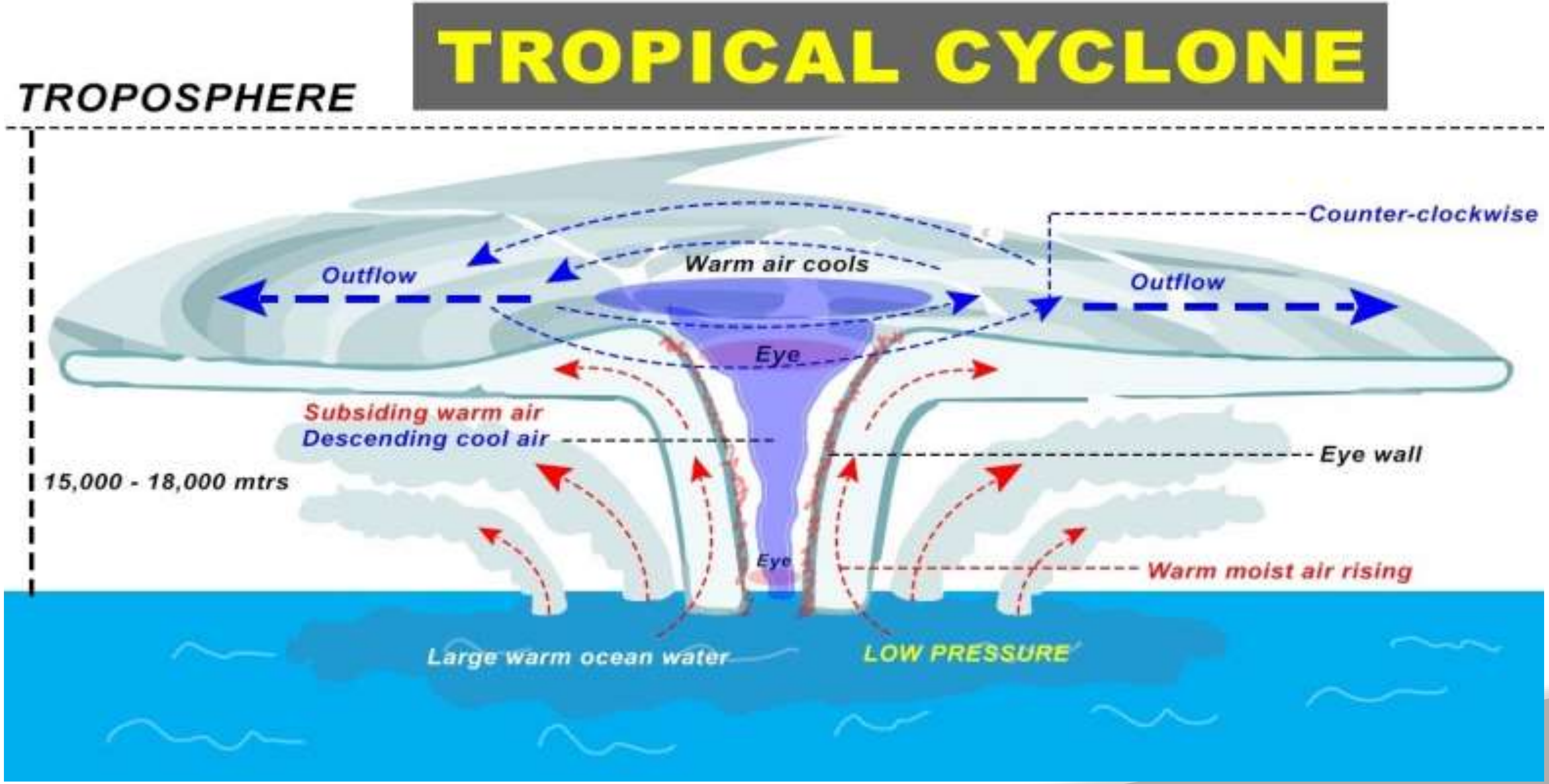
How does a cyclone form?

- cyclones are formed in the low-pressure area. The topography and the intensity as well as frequency of cyclones that could strike a coast decide the vulnerability of the place.
- The temperature difference between the warm, rising and the cooler environment led to the rise of air to become buoyant and then moves to upward. Then the high-pressure area fills the air in the low-pressure area. This cycle continues as warm air rises and a low-pressure area filled with cool air. They build up over a period of time. The warm, moist air rises and cools the water in the air and forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the ocean surface.

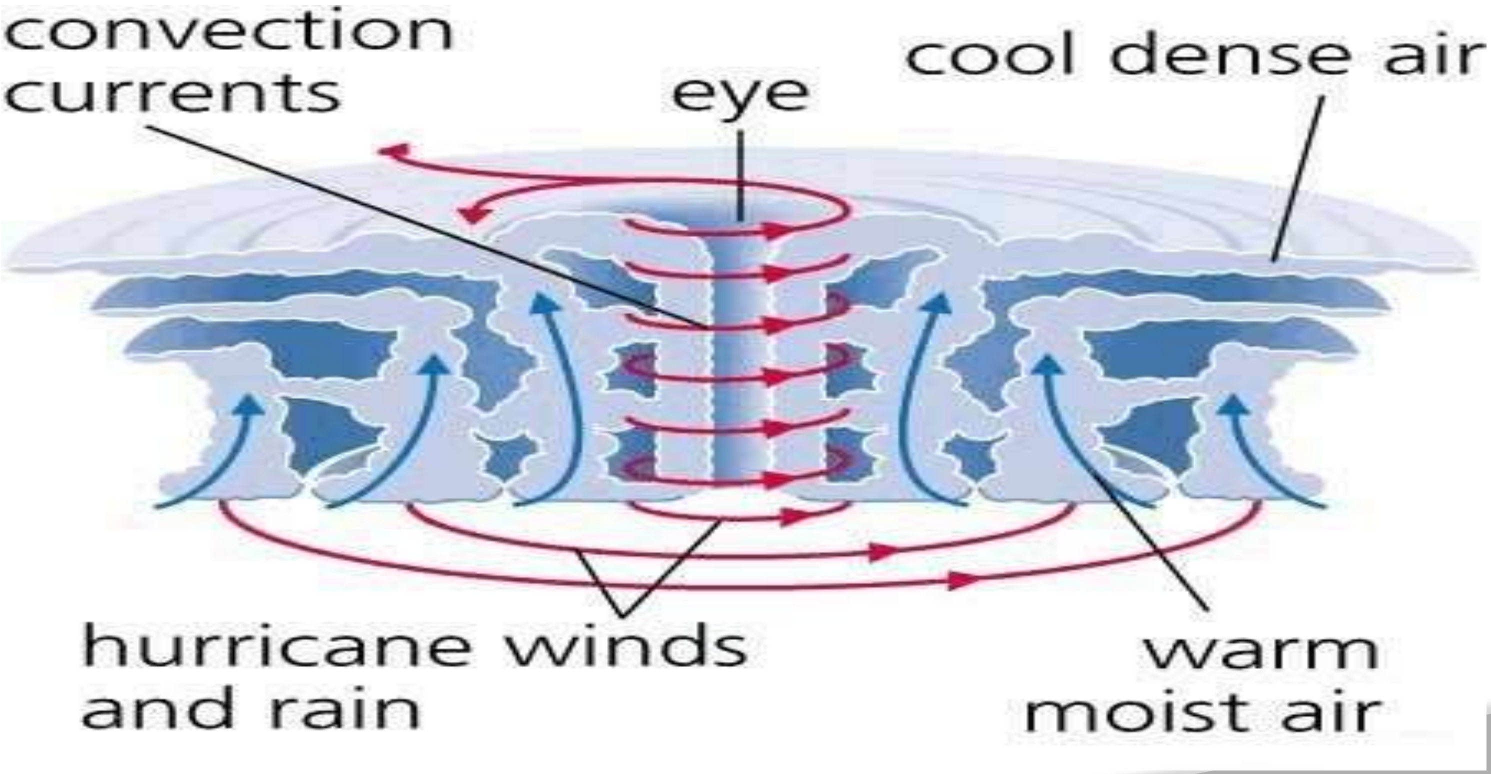
What causes cyclone?

- Cyclones are centred on areas of low atmospheric pressure, usually over warm ocean waters near the equator.
- The warm moist air over the ocean rises from the surface in the upward direction, resulting in the formation of the low-pressure zone over the surface.
- Air from the surrounding region, with higher pressure, pushes into the low-pressure area. The cool air becomes warm and moist and rises again, thus the cycle continues. As the warm air rises, the moisture in the air cools thus leading to the formation of cloud.
- The whole system grows gradually and becomes fast with time. As a result of this, an eye is created in the centre, which is the low-pressure centre into which the high-pressure air flows from above, thus creating a cyclone.

How does a cyclone form?



How does a cyclone form?



How does a cyclone form?

- There are six factors responsible for the formation of the cyclone:
- (1) Sufficient warm temperature at sea surface
- (2) atmospheric instability
- (3) impact area of Coriolis force so that low pressure can be developed
- (4) high humidity in the lower to middle levels of the troposphere
- (5) a pre-existing low-level focus or disturbance
- (6) low vertical wind shear.

Types of Cyclone

- **1. Tropical Cyclone:** It occurs over tropical ocean regions. it is two types- Hurricanes and typhoons. Hurricanes are found in the Atlantic and Northeast Pacific, whereas typhoons are found in the Northwest Pacific. On the basis of intensity and wind speed, this cyclone is classified into five categories- 1, 2, 3, 4 or 5. Category 5 has a wind speed of 155 mph or above.
- **2. Polar Cyclone:** Cyclones in polar regions(area around north pole or south pole) such as Greenland, Siberia and Antarctica are cyclones. In winter months, polar cyclones are generally heavier than tropical cyclones. These storms, as you can see, really prefer the colder weather! In fields areas, they are not very common and happen very less often that's why the harm they do is generally quite minimal.

Types of Cyclone

- **First category:** Wind speeds ranging from 90 to 125 km / h, some noticeable harm to buildings and trees.

  Second category: Wind rates ranging from 125 to km / h, housing harm and important crop and forest harm.

  Third category: Wind rates ranging from 165-224 km / h, structural harm to houses, comprehensive damage to plants and uprooted trees, upgraded cars, and building devastation.

  Fourth category: Wind rates ranging from 225 to 279 kilometres per hour, power failure and significant harm to towns and towns.

  Fifth category: Wind speeds exceeding 280 km / h, extensive harm.

Tropical Cyclone

- A **tropical cyclone** is a rapidly rotating storm system characterized by a low-pressure center, a closed low-level atmospheric circulation, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain and/or squalls.
- Depending on its location and strength, a tropical cyclone is referred to by different names, including **hurricane** , **typhoon** , **tropical storm**, **cyclonic storm**, **tropical depression**, or simply **cyclone**.
- A hurricane is a tropical cyclone that occurs in the Atlantic Ocean and northeastern Pacific Ocean, and a typhoon occurs in the northwestern Pacific Ocean; in the south Pacific or Indian Ocean, comparable storms are referred to simply as "tropical cyclones" or "severe cyclonic storms".

Tropical Cyclone

- "Tropical" refers to the geographical origin of these systems, which form almost exclusively over tropical seas. "Cyclone" refers to their winds moving in a circle, whirling round their central clear eye, with their winds blowing counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. The opposite direction of circulation is due to the Coriolis effect.
- Tropical cyclones typically form over large bodies of relatively warm water. They derive their energy through the evaporation of water from the ocean surface, which ultimately recondenses into clouds and rain when moist air rises and cools to saturation.
- This energy source differs from that of mid-latitude cyclonic storms, such as nor'easters and European windstorms, which are fueled primarily by horizontal temperature contrasts.

Tropical Cyclone

- Tropical cyclones are typically between 100 and 2,000 km (62 and 1,243 mi) in diameter. Every year tropical cyclones impact various regions of the globe including the Gulf Coast of North America, Australia, India and Bangladesh.
- **Destructions of tropical cyclones:**
- We often hear the news regarding large-scale devastation caused by earthquakes and cyclones. The death tolls are usually very high in the regions primarily hit by the calamity. Cyclones result in the destruction of houses, buildings, transportation, electricity and death of livestock. Ever wondered how a calamity such as a cyclone affects the lives of a living being inhabiting that region.

Destruction Caused by Tropical Cyclones

- The destruction caused by cyclones depends on its intensity, location, and size. In forest regions, the trees get uprooted and canopies get affected. In coastal regions, the banks and embankments get eroded. In deserts, the sand dunes get reshaped whereas in mountainous regions mudslides and landslides occur. When a cyclone hits a region, the hazards resulting from the hit can be divided into three types:
- **Primary Hazards**
- **Secondary Hazards**
- **Tertiary Hazards**

Destruction Caused by Tropical Cyclones

- Primary Hazards:
- Primary hazards include strong winds, heavy rains, and storms. The sea level rises abnormally near the coasts as a result of which the low-lying areas near the coastal regions get submerged, drowning humans, their live stocks, and their inhabitations, destroying vegetation and soil fertility. Very strong winds damage the houses, trees, communication systems etc, resulting in huge loss of life and property.
- Secondary Hazards:
- Secondary hazards include floods, fire, and freshwater flooding. Heavy and prolonged rains cause floods in rivers which cause submergence of the nearby inhabited regions, erosion of valuable farming lands and destruction of buildings. Strong winds in forest regions result in forest fires which spread with the intensity of cyclonic winds.

Destruction Caused by Tropical Cyclones

- Tertiary Hazards:
- Tertiary hazards include diseases caused due to stagnant water, water poisoning and increase in prices of goods and resources.
- Sometimes all the above hazards occur simultaneously because of which the relief operations become difficult. As the water level rises in the streets, transportation and communication in rescue operations and clean-up efforts become extremely difficult.
- The death tolls due to cyclones are very high. Nearly two million people have died globally due to cyclones and their effects. Despite their devastating effects, the cyclones of low intensity are beneficial as they bring rain to dry areas and move heat from the tropical regions. They are sometimes useful in the field of navigation.

Effects of Cyclone

- Tropical cyclones trigger serious rainfall and landslides. They cause serious damage to towns and villages. Also, they destroy coastal companies, such as shipyards and oil well.
- When these hurricanes blow far inland, human settlements are causing a lot of devastation.
- They trigger a lot of crop damage and destroy plenty of forests.
- They are disturbing the entire civic lives, particularly when they kill electricity and telephone lines.
- Torrential rains often accompany these cyclones, which trigger flooding.
- Not only do they cause a lot of damage to assets, but also to people's lives. Civic installations are being dismantled.

Cyclone Prone area in India

- India is highly vulnerable to natural hazards like earthquakes, floods, drought, cyclones and landslides. According to the meteorological department, there are 13 coastal states and Union Territories in India are Cyclone prone region. Four states like West Bengal, Andhra Pradesh, Odisha, Tamil Nadu-and one UT Puducherry on the east coast and Gujarat on the west coast are more vulnerable.

Cyclone Warning System in India

- The India Meteorological Department is the nodal agency in India is responsible for meteorological observations, weather forecasting and seismology. A cyclone in the Bay of Bengal is predicted by the Area Cyclone Warning Centres (ACWC) and in the Arabian Sea is predicted by the Cyclone Warning Centre (CWC). Both ACWC and CWC sent their report to the coordinating centre, i.e., National Cyclone Warning Centre (NCWC).
- According to the meteorological department, there are 13 coastal states and Union Territories in India are Cyclone prone region. Four states like West Bengal, **Andhra Pradesh**, **Odisha**, Tamil Nadu-and one UT Puducherry on the east coast and Gujarat on the west coast are more vulnerable.

Cumulative Atmospheric Hazards/ Disasters

- Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation)
- A **flood** is a situation in which water temporarily covers land where it normally doesn't. This water comes from the sea, lakes, rivers, canals or sewers. It can also be rainwater. **Floods** can be described according to speed (flash **flood**), geography or **cause** of **flooding**.

Floods

A **flood** is an overflow of water that submerges land that is usually dry. Floods are an area of study in the discipline of hydrology. They are the most common and widespread natural severe weather event.

Floods can look very different because flooding covers anything from a few inches of water to several feet. They can also come on quickly or build gradually.

There are five types of floods. They include:

1. River Flood
2. Coastal Flood
3. Storm Surge
4. Inland Flooding
5. Flash Flood

Floods

1. What is River Flooding?

- A **river flood** occurs when water levels rise over the top of river banks. This flooding can happen in all river and stream channels. This includes everything from small streams to the world's largest rivers.
- River floods can happen suddenly or slowly. Sudden river flooding events occur more often on smaller rivers, rivers with steep valleys, rivers that flow for much of their length over impermeable terrain, and normally dry channels.
- On the other hand, low-rising river floods typically occur in large rivers with large catchment areas. In case you didn't know this already, a **catchment area** is any area of land where precipitation collects and runs off into a common outlet.

Floods

2. What is Coastal Flooding?

- A **coastal flood** is the inundation of normally dry land areas along the coast with seawater.

  Causes of Coastal Flooding
- Coastal flooding is typically a result of a combination of sea tidal surges, high winds, and barometric pressure.
- These conditions typically come from storms at sea like:
- Tropical cyclones
- Tsunami
- Higher-than-average tides

3. What is Storm Surge?

- **Storm surge** is an abnormal rise in water level in coastal areas over and above the regular astronomical tide.

Causes of Storm Surge

- Storm surge is always a result meteorological storms that cause higher than normal tides on the coast. There are three parts of a storm that create this surge. They are:
- Wind
- Waves
- Low atmospheric pressure

4. What is Inland flood?

- An **inland flood** is flooding that occurs inland or not in a coastal area. Therefore, coastal flooding and storm surge are not inland floods.

Causes of Inland Flooding

- Rainfall is almost always to blame for inland floods. Rain causes inland flooding in two ways. It can happen with steady rainfall over several days or it can happen because of a short and intense period of rainfall.
- Snowmelt also causes inland floods, although rainfall is a more common cause.
- Another way inland flooding happens is when water ways get blocked by debris, ice, or dams.

More on Inland Floods

- Inland floods are often worse in urban areas because there isn't anywhere for the water to go. The following urban features can create urban flooding or make inland floods worse:

Floods

- Paved roads and streets
- Low-capacity drainage equipment
- Dense buildings
- Low amounts of green space

Floods

5. **What is a Flash Flood?**

- A **flash flood** is flooding that begins within 6 hours, and often within 3 hours, of heavy rainfall (or other cause).

Causes of Flash Floods

- Flash floods can happen for several reasons.
- Most flash floods happen after extremely intense rainfall from severe thunderstorms over a short period of time (normally 6 hours or less). There are two key elements to determine is flash flooding is likely:
- Rainfall rate
- Rainfall duration
- Flash floods also happen when damns break, when levees fail, or when an ice jam releases a large amount of water.

Flood Causes & Effects

- No matter what type of flood you’re dealing with, they are generally caused by the same key factors and there are always negative effects.
- In this section, we’ll cover the basic causes and effects of flooding to help you better understand this dangerous meteorological and hydrological phenomenon. If you read through the above section on types of floods, you might just want to skip down to flooding effects.

Flood Causes & Effects

What Causes Flooding?

- As we mentioned above, there are plenty of different causes of flooding. While different flood types typically have different causes, most floods are caused by one of the following activities.
- **Heavy rainfall** is the simplest cause of flooding. When there is too much rain or it happens too fast, there just isn’t a place for it to go. This can result in floods like flash flooding.
- **Overflowing rivers** are another cause of floods. You don’t necessarily need heavy rains though to experience river flooding. As we mentioned before, river flooding can happen when there is debris in the river or dams that block the flow of the water.
- Speaking of dams, **broken dams** are another cause of flooding. Older infrastructure can fail when heavy rains come and water levels rise. When dams break, they unleash torrents of water on unsuspecting households. This is part of what happened when Hurricane Katrina hit New Orleans in 2005.

Flood Causes & Effects

- **Storm surge and tsunamis** also cause flooding. Storm surges from hurricanes and other tropical systems can cause sea levels to rise and cover normally dry coastal areas in several feet of water. Tsunamis on the other hand are giant waves caused by earthquakes or underwater volcanic eruptions. As these waves move inland, they build height and can push a lot of water inland in coastal areas.
- **Channels with steep banks** are also to blame for flooding. Flooding often occurs when there is fast runoff into lakes, rivers, and other basins. This is often the case with rivers and other channels that feature steep sides.
- **A lack of vegetation** can cause flooding. Vegetation can help slow runoff and prevent flooding. When there is a lack of vegetation, there is little to stop water from running off and overflowing river banks and streams.
- **Melting snow and ice** is another common reason for flooding. When a large amount of snow and/or ice melts quickly, it often doesn't have somewhere to go except low-lying areas.

Flooding Effects

These aren't all the reasons that flooding can happen, but they are some of the most common.

- **Loss Of Lives**
- **Property Damage**
- **Economic Impacts**
- **Psychosocial Flooding**

Flooding Effects

- Flood is a term used to denote an enormous amount of water. When there is an outflow of water in a place, it is said to be flooded.
- The situation caused when the water becomes uncontrollable is said to be flooded. The flood may take different forms such as in the form of heavy rainfall when there is a breaking of the dam.
- Furthermore, the melting of snow also leads to flooding. Floods lead to an overfull and huge spread of water but are not considered safe for the purpose of drinking. Thus floods bring with them a number of diseases such as typhoid, cholera and many others. Here, we shall discuss the various causes of floods.

Flooding Effects

Causes of Floods:

- Flood is usually a result of natural causes. It may also be caused by man-made factors. It causes huge damage to life and property. There are many different causes leading to flooding. Some prominent among them include:

Massive Rainfall

- Drainage systems and the effective infrastructure design aid during heavy rains. They help the drainage of excess water into reservoirs in an easy way. But in cases of heavy rainfall, the systems stop working. Thus flood is caused.

Overflowing of the Rivers

- The people living along the river always have a risk of life from the overflowing of the Rivers. To prevent such a situation, a string of dams are built. However, if these dams are not managed properly, they may cause flooding and huge damage.

Flooding Effects

Collapsed Dams

- In the event of huge rainfall, the dams built begin to collapse. Thus, causing the flood situation to become even critical for the people living around.

Snowmelt

- At the time of the high melting of snow due to heavy precipitation and other factors, the situation of flooding arises. Adopting sustainable measures for heavy precipitation can help in dealing with the flooding situation.

Deforestation

- The cutting of trees in a reckless manner i.e. deforestation is also a major cause of man-made flooding. Trees prevent soil erosion and also the loss of crops. The vegetation is also enriched as a result of more and more trees. This also blocks the massive flow of rain, thus preventing flooding.

Flooding Effects

Climate change

- The climatic changes caused due to human practices also add to the risk of flooding. Human beings cut trees in a large number, thus affecting the process of photosynthesis. Thus increased level of carbon-di-oxide in the atmosphere cause changes in climate posing threats of natural disasters like floods etc.

Emission of Greenhouse Gases

- The burning of fossil fuels, the industrial influences, the pollution all is depleting the level of the ozone layer and increasing the level of greenhouse gases, becoming a major cause of man-made flooding.

Other Factors

- The broken supply lines cause the outflow of water but lead to less damage. Also, there is water flow from the washing machines. Furthermore, overflow from dishwashers worsens the situation. Also, the lack of proper sewage systems adds to the destruction of this natural disaster.

Flooding Effects

- Thus, a flood can be caused both due to natural causes as well as it can be a human-made flood.
- Flood causes a huge loss of life and property. Waterborne diseases spread as a result of Floods causing health problems. Moreover, the destruction of roadways and infrastructure facilities, the disturbance of ecosystems, improper sewage systems all demand serious efforts of adopting sustainable measures.
- Taking steps such as afforestation, decreased the emission of harmful gases into the atmosphere could help. Also, enrichment of vegetation, fewer deeds causing pollution and treatment of sewage could be useful ways to combat the situation.

Flood Hazards In India

Indian flood hazards

- Floods are the most common natural disaster in India.
- The heavy south west monsoon rain cause the Himalayan river basin distend their banks, often flooding surrounding areas.
- It results heavy losses both economic and lives

History of Indian Flood hazards

- In October 1943, Madras (Now Chennai) – flood occurred due to excessive rain that continued 6 days and overflow Coovum and Adhyar river
- On 4th august 1979, the Machchu-2 dam situated on the Machchu river burst, thus flooding the town of Morbi in the Rajkot district in Gujarat. In this flood about 1800 to 2500 people lost their lives.

Flood Hazards In India

- 1987, Bihar flood occurred due to over flow of the Koshi river, which claimed life of 1399 human, 302 animals and public property worth INR Rs. 68 billion
- 26 July 2005, Mumbai receive 994 mm rainfall in a day. It cause a huge flood killed at least 5000 people and property loss was estimated at Rs. 540cr
- June 2015 Gujarat flood, wide spread flood in North Gujarat resulting more than 70 deaths.
- 2016 Assam Flood: heavy rain in July last resulted in flood effected 1.8 million people and flooding the kajiranga national park killing around 200 wild animals.

Flood Prone Region in India

- 1. The basin of Himalayan rivers. E.g.- Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Bihar, West Bengal, Assam etc
- 2. North Western river basin.
- 3. The central peninsula river basin like Godavari, Krishna, pennar and, Cauvery river basin

Overview of Uttarakhand

- Uttarakhand has a total land area of 53,584sqkm of which 94% is mountaneous.
- Most of the area is covered by himalayan peaks and glaciers.
- Two major rivers(Ganga and yamuna) originate from the glaciers of uttarakhand Uttarakhand Flood.

Flood Prone Region in India

Flooding In Uttarakhand

- From 15 to 18 June 2013, Indian state of Uttarakhand and adjoining area received heavy rainfall, which was about 375 percent more than the benchmark rainfall during a normal monsoon. 16th and 17th June,2013 The Day of Destruction happened in history of UTTRAKHAND.
- The massive rainfall and cloud burst events were happening at multiple places, including in Bhagirathi basin, Assiganga basin, Mandakini Basin, Badrinath region, other places in Alaknanda region from 15 June 2013 to around 18 June 2013. •This lead to melting of Chorabari Glacier at the height of 3800 metres, and eruption of the Mandakini River which led to heavy floods near Kedar Dome, Rudraprayag district, Uttarakhand, Himachal Pradesh.

Flood Prone Region in India

- In October 1943, Madras (now Chennai) saw the worst flood to hit the city. Flood occurred due to excessive rains that lasted for 6 days and overflowed Coovum and the Adyar rivers. Damage caused to life and property was immense however estimate figure is unknown. the flood left thousands of people homeless.
- On 11 August 1979, the Machchu-2 dam situated on the Machchhu River burst, thus flooding the town of Morbi in the Rajkot district of Gujarat.Exact figure of loss of lives is unknown, but it is estimated between 1800 and 2500 people.
- In 1987, Bihar state of India witnessed one of its worst floods till then. Flood occurred due to overflow of the Koshi river; which claimed lives of 1,399 humans, 302 animals and public property worth INR ₹68 billion (US$950 million).

Flood Prone Region in India

- In 1988, Punjab experienced its first flood when all the rivers in Punjab overflowed.
- In July 1993, flash floods killed 530 people across the seven to eight states of India.
- Heavy rains across the state of Maharashtra, including large areas of the metropolis Mumbai on 26 July 2005 killed at-least 1,094 people. The day is still remembered as the day *Mumbai came to a standstill*, as the city faced worst ever rain. Mumbai International Airport remained closed for 30 hours, Mumbai-Pune Expressway was closed for 24 hours with public property loss was estimated at ₹550 crore (US$77 million).
- June 2013 North Indian floods: Heavy rain due to a burst of a cloud caused severe floods and landslides on the North Indian states, mainly Uttarakhand and nearby states. More than 5,700 people were presumed dead.

Flood Prone Region in India

- June 2015 Gujarat flood: Heavy rain in June 2015 resulted in widespread flood in Saurashtra region of Gujarat resulting in more than 70 deaths. The wild life of Gir Forest National Park and adjoining area was also affected.
- July 2015 Gujarat flood:Heavy rain in July 2015 resulted in widespread flood in north Gujarat resulting in more than 70 deaths.
- 2015 South Indian floods:Heavy rain in Nov-Dec 2015 resulted in flooding of Adyar, Cooum rivers in Chennai, Tamil Nadu resulting in financial loss and human lives.
- 2016 Assam floods: Heavy rains in July–August resulted in floods affecting 1.8 million people and flooding the Kaziranga National Park killing around 200 wild animals.

Flood Prone Region in India

- 2017 Gujarat flood: Following heavy rain in July 2017, Gujarat state of India was affected by the severe flood resulting in more than 200 deaths.
- August 2018 Kerala Flood: Following high rain in late August 2018 and heavy Monsoon rainfall from August 8, 2018, severe flooding affected the Indian state of Kerala resulting over 445 deaths.
- August 2019 Indian floods including 2019 Kerala floods: Following high rain in late July and early August 2019, series of floods that affected over nine states in India. The states of Kerala, Madhya Pradesh, Karnataka, Maharashtra and Gujarat were the most severely affected.
- Brahmaputra floods
- 2020 Assam floods

Preventive Measures Of Floods

In any flooding or potential flooding event, the following actions should be taken:

- Protecting your home
- Elevate the furnace, water heater, and electric panel if susceptible to flooding
- Install check valves in sewer traps to prevent floodwater from backing up into your home.
- Seal walls in basements with waterproofing compounds to avoid seepage.
- Keep an adequate supply of food, candles and drinking water in case you are trapped inside your home.

When a flood is imminent

- Listen to designated radio/TV emergency alert systems for emergency instructions.
- Secure/bring in outdoor furniture or other items that might float away and become a potential hazard.
- Move valuable items and papers/documents to upper floors.

Preventive Measures Of Floods

During a flood

- Seek higher ground. Do not wait for instructions.
- Be aware of flash flood areas such as canals, streams, drainage channels.
- Be ready to evacuate.
- If instructed, turn off utilities at main switches and unplug appliances - do not touch electrical equipment if wet.
- If you must leave your home, do not walk through moving water. Six inches of moving water can knock you off your feet. Use a stick to test depth.
- Do not try to drive over a flooded road. If your car stalls, abandon it immediately and seek an alternate route.

After a flood:

- Stay away from flood water - do not attempt to swim, walk or drive through the area
- Be aware of areas where water has receded. Roadways may have weakened and could collapse.
- Avoid downed power lines and muddy waters where power lines may have fallen.
- Do not drink tap water until advised by the Health Unit that the water is safe to drink.
- Once flood waters have receded you must not live in your home until the water supply has been declared safe for use, all flood-contaminated rooms have been thoroughly cleaned and disinfected, adequate toilet facilities are available, all electrical appliances and heating/cooling systems have been inspected, food, utensils and dishes have been examined, cleaned or disposed of, and floor drains and sumps have been cleaned and disinfected.

Droughts

What is a drought?

A drought is defined as "a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area." -Glossary of Meteorology (1959).

In easier to understand terms, a drought is a period of unusually persistant dry weather that persists long enough to cause serious problems such as crop damage and/or water supply shortages. The severity of the drought depends upon the degree of moisture deficiency, the duration, and the size of the affected area.

Droughts

There are actually four different ways that drought can be defined.

Meteorological-a measure of departure of precipitation from normal. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.

Agricultural-refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop.

Hydrological-occurs when surface and subsurface water supplies are below normal.

Socioeconomic-refers to the situation that occurs when physical water shortages begin to affect people.

Impacts Of Droughts

- **Desertification** : this is a situation in which the soil becomes incapable due to its infertility and becomes bare land. Over grazing can also lead to desertification. Apart from all these, severe drought can also lead to desertification of the land and it becomes unsuitable for any vegetation. The possibility of survival of any vegetation is impossible.
- **Water bodies dry up** : because of drought, the water bodies like lake, rivers, ponds and streams dries up quickly. The natural habitat gets disturbed. The wildlife, aquatic life, forests and all gets endangered due to this process. The entire ecosystem and the natural life cycle get disrupted.
- **Reduction in crop yields** : during drought, the agricultural yields reduce considerably. This increases the gap between the demand and supply of crops. The farmers have to incur a huge loss i.e. pay more for the labor with fewer outcomes in yields.

Impacts Of Droughts

- **Migration and death of animals** : due to drought in an areas, the animals are forced to leave their habitat and move to new areas where there is water and food. As far as animals are concerned, it is very difficult for them to adjust to newer environment. It can also lead to the death of many animals because of the loss in natural biodiversity.
- **Monetary loss** : the monetary loss incurred during a drought is very high. The loss is incurred by businesses, families, government and even individuals at lower levels.
- **Waterborne diseases spread** : the quality of the water decreases due to water scarcity. The available clean water will not be sufficient for drinking and cooking purposes. Chemicals and impurities mixed with the water will be widely used owing to the spread of waterborne diseases like cholera and typhoid.

Impacts Of Droughts

- **Migration of people** : people are force to migrate to better conditions at the time of drought. This mainly affects the livelihood of the poor farmers who wholly depend upon their agriculture for a living. Because of the loss incurred, the family has to undergo through a lot of stress and strain which leads them to do other jobs. Elderly people, children and women are the most affected during a drought.
- **Malnutrition and deaths** : many people die during drought because of hunger and malnutrition(deficiencies). The major reason behind this is the non availability of food. Such situations are usually seen in poorer countries.

Impacts Of Droughts

- **Hydroelectric power becomes expensive** : because of the dry spells and lowered water levels in dams and rivers that were used to generate hydro electricity, more energy should be utilized for the same. So the power generated at a cheaper rate has to be given t a higher rate due to shortage of water. Due to the huge loss in incurred by the energy industries that utilize hydroelectric power.

Drought Hazards occurred in India

- About 42% of India’s land area is facing drought, with 6% exceptionally dry--four times the spatial extent of drought last year, according to data for the week ending March 26, 2019, from the Drought Early Warning System (DEWS), a real-time drought monitoring platform.
- Andhra Pradesh, Bihar, Gujarat, Jharkhand, Karnataka, Maharashtra, parts of the North-East, Rajasthan, Tamil Nadu and Telangana are the worst hit. These states are home to 500 million people, almost 40% of the country’s population.
- While the central government has not declared drought anywhere so far, the state governments of Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Odisha and Rajasthan have declared many of their districts as drought-hit.

Drought Hazards In India

- Before monsoon, which is still far away, the next two or three months are going to be difficult in many of these regions," Vimal Mishra, associate professor at the Indian Institute of Technology (IIT), Gandhinagar, and the developer of DEWS, told **India Spend**.
- Failed monsoon rains are the primary reason for the current situation. The North-East monsoon, also known as 'post-monsoon rainfall' (October-December) that provides 10-20% of India's rainfall, was deficient by 44% in 2018 from the long-term normal of 127.2 mm, as per data from the India Meteorological Department (IMD). This compounded the rainfall deficit in the South-West (SW) monsoon (June-September) that provides 80% of India's rainfall, which fell short by 9.4% in 2018--close to the 10% deficit range when the IMD declares a drought.

Drought Hazards In India

- India has experienced widespread drought every year since 2015, Mishra said, with the exception of 2017. As the El Nino--the unusual warming of the equatorial Pacific Ocean that makes Indian summers warmer and reduces rainfall--looms over the 2019 SW monsoon, pre-monsoon showers (March-May) this year have also been deficient. India has received 36% less rainfall than the long-term average between March 1 and March 28, 2019, as per IMD data. The southern peninsular region recorded the lowest, a deficit greater than 60%.
- Lower rainfall has reduced water levels in reservoirs across the country. The amount of water available in the country's 91 major reservoirs has gone down 32 percentage points over five months to March 22, 2019. In 31 reservoirs of southern states, water level has gone down by 36 percentage points over five months.

Drought Control Measures

A proactive approach for enhancing drought resilience is composed of three important pillars:

1. Drought monitoring and early warning systems
2. Vulnerability and risk assessment
3. Drought risk mitigation measures

1. Drought monitoring and early warning systems

- A drought can be defined in several ways. A **meteorological drought**, for example, occurs when rains do not transpire, whereas a **hydrological drought** occurs when a lack of rainfall continues long enough to empty rivers and lower water tables. **Agricultural drought** begins when a lack of water kills crops and livestock, affecting locals' survival.
- The timing of declaring a drought can often be very subjective and highly political. Forecast mechanisms require quality data and local knowledge to understand how dry conditions will impact water and food supplies. Unfortunately, these predictions are often unreliable and action is not taken until it is too late.

2. Vulnerability and risk assessment:

- Occasionally, depending on the location, less rain can be compensated for by access to underground water, manmade reservoirs or moisture stored in soils across forested watersheds. Elsewhere, without these buffers in place, drought rapidly escalates into shriveled crops, dead livestock and, in some cases, hunger and death. No amount of early warning will work without action to protect the most vulnerable; therefore, the second aspect of drought management deals with risk assessment of vulnerable sectors, population groups and regions.

3. Drought risk mitigation measures

- There are practical measures that can be taken starting immediately. Both measures and actions – also called drought risk management options – that either build greater resilience to drought or reduce the impacts of drought when it occurs can be deployed. These measures concern all sectors affected by drought, based on their vulnerabilities. However, working with nature and understanding the necessary combination of measures is particularly important for agriculture and for sectors reliant on the availability of water and ecosystems services.

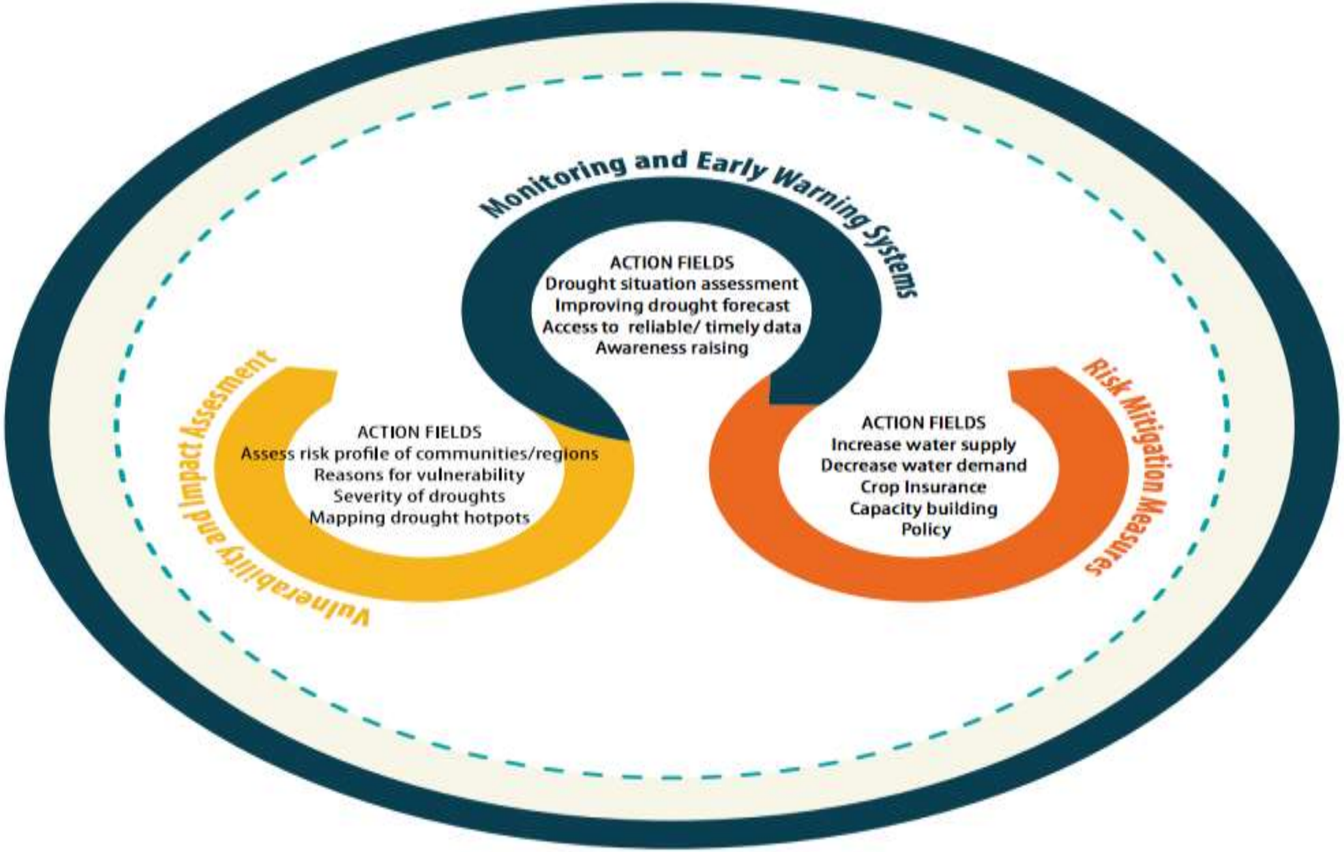
Drought Control Measures

Drought management:

The management of drought needs a paradigm shift.

- The time is ripe for countries to develop and implement effective national drought policies that include all three pillars of drought action. Countries need to recognize that the traditional approach of responding to drought is not viable any more; it has proved to be ineffective far too often.
- In many countries, drought awareness is limited and institutional capacities need to be strengthened by promoting public awareness and strengthening capacities of both the citizens and institutions especially at the local level: farmers, pastoralists and all those actors and stakeholders involved in decision making. Local citizens and institutions, in particular, need help to identify and disseminate good practices that work in local conditions.

Drought Control Measures



Physical Hazards/Disasters

Physical hazards

- High or low Temperature.
- Noise.
- Radiation (ionizing & non-ionizing).
- Vibration.
- Atmospheric Pressure changes.
- Electricity.

Physical Hazards/Disasters

- **Physical Hazards**
- Mechanical Hazards
- Chemical Hazards
- Electric Shock Hazards
- Physical Hazards defined as “A factor within the environment that can harm the body without necessarily touching it.”
- are conditions or situations that can cause the body physical harm or intense stress. - can be both natural and human made elements
- Heat and Cold - The common physical hazard in most industries is heat. The direct effect of heat exposure are burns, heat exhaustion, heat stroke and heat cramps. The indirect effects are decreased efficiency, increased fatigue and enhanced accident rates.

Physical Hazards/Disasters

- **Light** - The acute effects of poor illumination(lighting) are eye strain, headache, eye pain, lachrymation(the flow of tears), congestion(An abnormal or excessive accumulation of a body fluid) around cornea(transparent part of the eye that covers the front portion of the eye) and the chronic effects on health includes "miner's nystagmus(rapid involuntary movements of the eyes)". Exposure to excessive brightness is associated with discomfort, annoyance and visual fatigue. Noise - Auditory effects consist of temporary or permanent hearing loss where as non- auditory effects include nervousness, fatigue, interference with speech etc.
- **Vibration** - Vibration affects hands and arms. After some months or years of exposure, the fine blood vessels of the fingers may be increasingly sensitive to spasm(sudden involuntary contraction of a muscle).

Physical Hazards/Disasters

- **Ultra Violet Radiation** - Occupational exposure to UV radiation occurs mainly in arc welding. Such radiations affect the eye, causing intense conjunctivitis and keratitis(inflammation of the cornea of the eye).
- **Ionizing Radiation** - Ionizing radiations are finding increased application in medicine and industry. X-rays and radioactive isotopes are widely used. The radiation hazards compromises of genetic changes, malformation, cancer, leukemia, ulceration and in extreme cases the death.
- Abrasive Blasting, Cash-in-transit activities, Construction Work, Demolition Work ,Electrical risks, Excavation Work Facilities, Falling Objects, Flood Recovery, Hazardous manual tasks, High risk work Overhead and Underground electric lines.

Soil Erosion

- Soil erosion is the displacement of the upper layer of soil; it is a form of soil degradation. This natural process is caused by the dynamic activity of erosive agents, that is, water, ice, snow, air, plants, animals, and humans.
- Erosion, whether it is by water, wind or tillage(mechanical manipulation of the soil for the purpose of crop production affecting significantly the soil characteristics such as soil water conservation, soil temperature, infiltration and evapotranspiration processes.), involves three distinct actions – soil detachment, movement and deposition.
- Topsoil, which is high in organic matter, fertility and soil life, is relocated elsewhere "on-site" where it builds up over time or is carried "off-site" where it fills in drainage channels. Soil erosion reduces cropland productivity and contributes to the pollution of adjacent watercourses, wetlands and lakes.

Causes Soil Erosion

- Soil erosion can be a slow process that continues relatively unnoticed or can occur at an alarming rate, causing serious loss of topsoil. Soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinisation and soil acidity problems are other serious soil degradation conditions that can accelerate the soil erosion process.

Water Erosion

- The widespread occurrence of water erosion combined with the severity of on-site and off-site impacts have made water erosion the focus of soil conservation efforts.

Causes Soil Erosion

The rate and magnitude of soil erosion by water is controlled by the following factors:

1. Rainfall and Runoff

- The greater the intensity and duration of a rainstorm, the higher the erosion potential. The impact of raindrops on the soil surface can break down soil aggregates and disperse the aggregate material. Lighter aggregate materials such as very fine sand, silt, clay and organic matter are easily removed by the raindrop splash and runoff water; greater raindrop energy or runoff amounts are required to move larger sand and gravel particles.

- Soil movement by rainfall (raindrop splash) is usually greatest and most noticeable during short-duration, high-intensity thunderstorms. Although the erosion caused by long-lasting and less-intense storms is not usually as spectacular or noticeable as that produced during thunderstorms, the amount of soil loss can be significant, especially when compounded over time.

Causes Soil Erosion

- Surface water runoff occurs whenever there is excess water on a slope that cannot be absorbed into the soil or is trapped on the surface. Reduced infiltration due to soil compaction, crusting or freezing increases the runoff. Runoff from agricultural land is greatest during spring months when the soils are typically saturated, snow is melting and vegetative cover is minimal.

2. Soil Erodibility

- Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Texture is the principal characteristic affecting erodibility, but structure, organic matter and permeability also contribute. Generally, soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion.

Causes Soil Erosion

- Sand, sandy loam and loam-textured soils tend to be less erodible than silt, very fine sand and certain clay-textured soils.
- Tillage and cropping practices that reduce soil organic matter levels, cause poor soil structure, or result in soil compaction, contribute to increases in soil erodibility. As an example, compacted subsurface soil layers can decrease infiltration and increase runoff. The formation of a soil crust, which tends to "seal" the surface, also decreases infiltration.
- On some sites, a soil crust might decrease the amount of soil loss from raindrop impact and splash; however, a corresponding increase in the amount of runoff water can contribute to more serious erosion problems.

- Past erosion also has an effect on a soil's erodibility. Many exposed subsurface soils on eroded sites tend to be more erodible than the original soils were because of their poorer structure and lower organic matter. The lower nutrient levels often associated with sub soils contribute to lower crop yields and generally poorer crop cover, which in turn provides less crop protection for the soil.

3. Slope Gradient and Length

- The steeper and longer the slope of a field, the higher the risk for erosion. Soil erosion by water increases as the slope length increases due to the greater accumulation of runoff. Consolidation of small fields into larger ones often results in longer slope lengths with increased erosion potential, due to increased velocity of water, which permits a greater degree of scouring (carrying capacity for sediment).

Causes Soil Erosion

4. Cropping and Vegetation

- The potential for soil erosion increases if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of runoff water and allows excess surface water to infiltrate.
- The erosion-reducing effectiveness of plant and/or crop residues depends on the type, extent and quantity of cover. Vegetation and residue combinations that completely cover the soil and intercept all falling raindrops at and close to the surface are the most efficient in controlling soil erosion (e.g., forests, permanent grasses). Partially incorporated residues and residual roots are also important as these provide channels that allow surface water to move into the soil.

Causes Soil Erosion

- The effectiveness of any protective cover also depends on how much protection is available at various periods during the year, relative to the amount of erosive rainfall that falls during these periods. Crops that provide a full protective cover for a major portion of the year (e.g., alfalfa or winter cover crops) can reduce erosion much more than can crops that leave the soil bare for a longer period of time (e.g., row crops), particularly during periods of highly erosive rainfall such as spring and summer.
- Crop management systems that favour contour farming and strip-cropping techniques can further reduce the amount of erosion. To reduce most of the erosion on annual row-crop land, leave a residue cover greater than 30% after harvest and over the winter months, or inter-seed a cover crop (e.g., red clover in wheat, oats after silage corn).

5. Tillage Practices

- The potential for soil erosion by water is affected by tillage operations, depending on the depth, direction and timing of plowing, the type of tillage equipment and the number of passes. Generally, the less the disturbance of vegetation or residue cover at or near the surface, the more effective the tillage practice in reducing water erosion. Minimum till or no-till practices are effective in reducing soil erosion by water.
- Tillage and other practices performed up and down field slopes creates pathways for surface water runoff and can accelerate the soil erosion process. Cross-slope cultivation and contour farming techniques discourage the concentration of surface water runoff and limit soil movement.

Forms Of Soil Erosion

- **Sheet Erosion**
- Sheet erosion is the movement of soil from raindrop splash and runoff water. It typically occurs evenly over a uniform slope and goes unnoticed until most of the productive topsoil has been lost. Deposition of the eroded soil occurs at the bottom of the slope or in low areas. Lighter-coloured soils on knolls(a small hill), changes in soil horizon thickness and low crop yields on shoulder slopes and knolls are other indicators.
- **Rill Erosion**
- Rill erosion results when surface water runoff concentrates, forming small yet well-defined channels. These distinct channels where the soil has been washed away are called rills when they are small enough to not interfere with field machinery operations. In many cases, rills are filled in each year as part of tillage operations.

Sheet Erosion

Rill Erosion

Forms Of Soil Erosion

- **Gully Erosion**
- Gully erosion is an advanced stage of rill erosion where surface channels are eroded to the point where they become a nuisance factor in normal tillage operations.
- There are farms in Ontario that are losing large quantities of topsoil and subsoil each year due to gully erosion. Surface water runoff, causing gully formation or the enlarging of existing gullies, is usually the result of improper outlet design for local surface and subsurface drainage systems.
- The soil instability of gully banks, usually associated with seepage of groundwater, leads to sloughing(removing) and slumping (caving-in) of bank slopes. Such failures usually occur during spring months when the soil water conditions are most conducive to the problem.

Gully Erosion

Forms Of Soil Erosion

- Gully formations are difficult to control if corrective measures are not designed and properly constructed. Control measures must consider the cause of the increased flow of water across the landscape and be capable of directing the runoff to a proper outlet. Gully erosion results in significant amounts of land being taken out of production and creates hazardous conditions for the operators of farm machinery.
- **Bank Erosion**
- Natural streams and constructed drainage channels act as outlets for surface water runoff and subsurface drainage systems. Bank erosion is the progressive undercutting, scouring and slumping of these drainage ways. Poor construction practices, inadequate maintenance, uncontrolled livestock access and cropping too close can all lead to bank erosion problems.

Forms Of Soil Erosion

- Poorly constructed tile outlets also contribute to bank erosion. Some do not function properly because they have no rigid outlet pipe, have an inadequate splash pad or no splash pad at all, or have outlet pipes that have been damaged by erosion, machinery or bank cave-ins.
- The direct damages from bank erosion include loss of productive farmland, undermining of structures such as bridges, increased need to clean out and maintain drainage channels and washing out of lanes, roads and fence rows.

Bank Erosion

Factors Of Soil Erosion

- **The rate and magnitude of soil erosion by water is controlled by the following factors:**
- Rainfall and Runoff.
- **Soil** Erodibility.
- Slope Gradient and Length.
- Cropping and Vegetation.
- Tillage Practices.
- Sheet **Erosion**.
- Rill **Erosion**.
- Gully **Erosion**.

Factors Of Soil Erosion

- **On-Site**
- The implications of soil erosion by water extend beyond the removal of valuable topsoil. Crop emergence, growth and yield are directly affected by the loss of natural nutrients and applied fertilizers. Seeds and plants can be disturbed or completely removed by the erosion. Organic matter from the soil, residues and any applied manure, is relatively lightweight and can be readily transported off the field, particularly during spring thaw conditions. Pesticides may also be carried off the site with the eroded soil.
- Soil quality, structure, stability and texture can be affected by the loss of soil. The breakdown of aggregates and the removal of smaller particles or entire layers of soil or organic matter can weaken the structure and even change the texture. Textural changes can in turn affect the water-holding capacity of the soil, making it more susceptible to extreme conditions such as drought.

Factors Of Soil Erosion

- **Off-Site**
- The off-site impacts of soil erosion by water are not always as apparent as the on-site effects. Eroded soil, deposited down slope, inhibits or delays the emergence of seeds, buries small seedlings and necessitates replanting in the affected areas. Also, sediment can accumulate on down-slope properties and contribute to road damage.
- Sediment that reaches streams or watercourses can accelerate bank erosion, obstruct stream and drainage channels, fill in reservoirs, damage fish habitat and degrade downstream water quality. Pesticides and fertilizers, frequently transported along with the eroding soil, contaminate or pollute downstream water sources, wetlands and lakes. Because of the potential seriousness of some of the off-site impacts, the control of "non-point" pollution from agricultural land is an important consideration.

Factors Of Soil Erosion

- **Wind Erosion**
- Wind erosion occurs in susceptible areas of Ontario but represents a small percentage of land – mainly sandy and organic or muck soils. Under the right conditions it can cause major losses of soil and property.
- Soil particles move in three ways, depending on soil particle size and wind strength – suspension, saltation and surface creep.

Factors Of Soil Erosion

Factors Of Soil Erosion

- **Soil Erodibility**
- Very fine soil particles are carried high into the air by the wind and transported great distances (suspension). Fine-to-medium size soil particles are lifted a short distance into the air and drop back to the soil surface, damaging crops and dislodging more soil (saltation). Larger-sized soil particles that are too large to be lifted off the ground are dislodged by the wind and roll along the soil surface (surface creep). The abrasion that results from windblown particles breaks down stable surface aggregates and further increases the soil erodibility.

Factors Of Soil Erosion

- **Soil Surface Roughness**
- Soil surfaces that are not rough offer little resistance to the wind. However, ridges left from tillage can dry out more quickly in a wind event, resulting in more loose, dry soil available to blow. Over time, soil surfaces become filled in, and the roughness is broken down by abrasion. This results in a smoother surface susceptible to the wind. Excess tillage can contribute to soil structure breakdown and increased erosion.
- **Climate**
- The speed and duration of the wind have a direct relationship to the extent of soil erosion. Soil moisture levels are very low at the surface of excessively drained soils or during periods of drought, thus releasing the particles for transport by wind. This effect also occurs in freeze-drying of the soil surface during winter months. Accumulation of soil on the leeward side of barriers such as fence rows, trees or buildings, or snow cover that has a brown colour during winter are indicators of wind erosion.

Factors Of Soil Erosion

- **Unsheltered Distance**
- A lack of windbreaks (trees, shrubs, crop residue, etc.) allows the wind to put soil particles into motion for greater distances, thus increasing abrasion and soil erosion. Knolls and hilltops are usually exposed and suffer the most.
- **Vegetative Cover**
- The lack of permanent vegetative cover in certain locations results in extensive wind erosion. Loose, dry, bare soil is the most susceptible; however, crops that produce low levels of residue (e.g., soybeans and many vegetable crops) may not provide enough resistance. In severe cases, even crops that produce a lot of residue may not protect the soil.
- The most effective protective vegetative cover consists of a cover crop with an adequate network of living windbreaks in combination with good tillage, residue management and crop selection.

Factors Of Soil Erosion

- **Effects of Wind Erosion**
- Wind erosion damages crops through sandblasting of young seedlings or transplants, burial of plants or seed, and exposure of seed. Crops are ruined, resulting in costly delays and making reseeding necessary. Plants damaged by sandblasting are vulnerable to the entry of disease with a resulting decrease in yield, loss of quality and market value. Also, wind erosion can create adverse operating conditions, preventing timely field activities.
- Soil drifting is a fertility-depleting process that can lead to poor crop growth and yield reductions in areas of fields where wind erosion is a recurring problem. Continual drifting of an area gradually causes a textural change in the soil. Loss of fine sand, silt, clay and organic particles from sandy soils serves to lower the moisture-holding capacity of the soil. This increases the erodibility of the soil and compounds the problem.
- The removal of wind-blown soils from fence rows, constructed drainage channels and roads, and from around buildings is a costly process. Also, soil nutrients and surface-applied chemicals can be carried along with the soil particles, contributing to off-site impacts. In addition, blowing dust can affect human health and create public safety hazards.

Factors Of Soil Erosion

- **Tillage Erosion**
- Tillage erosion is the redistribution of soil through the action of tillage and gravity . It results in the progressive down-slope movement of soil, causing severe soil loss on upper-slope positions and accumulation in lower-slope positions.
- This form of erosion is a major delivery mechanism for water erosion. Tillage action moves soil to convergent areas of a field where surface water runoff concentrates. Also, exposed subsoil is highly erodible to the forces of water and wind.
- Tillage erosion has the greatest potential for the "on-site" movement of soil and in many cases can cause more erosion than water or wind.

Factors Of Soil Erosion

Factors Of Soil Erosion

- **Effects of Tillage Erosion**
- Tillage erosion impacts crop development and yield. Crop growth on shoulder slopes and knolls is slow and stunted due to poor soil structure and loss of organic matter and is more susceptible to stress under adverse conditions. Changes in soil structure and texture can increase the erodibility of the soil and expose the soil to further erosion by the forces of water and wind.
- In extreme cases, tillage erosion includes the movement of subsurface soil. Subsoil that has been moved from upper-slope positions to lower-slope positions can bury the productive topsoil in the lower-slope areas, further impacting crop development and yield.

Factors Of Soil Erosion

- Research related to tillage-eroded fields has shown soil loss of as much as 2 m of depth on upper-slope positions and yield declines of up to 40% in corn. Remediation for extreme cases involves the relocation of displaced soils to the upper-slope positions.

Conservation Measures

- The adoption of various soil conservation measures reduces soil erosion by water, wind and tillage.
- Tillage and cropping practices, as well as land management practices, directly affect the overall soil erosion problem and solutions on a farm.
- When crop rotations or changing tillage practices are not enough to control erosion on a field, a combination of approaches or more extreme measures might be necessary.
- For example, contour plowing, strip-cropping or terracing may be considered. In more serious cases where concentrated runoff occurs, it is necessary to include structural controls as part of the overall solution – grassed waterways, drop pipe and grade control structures, rock chutes, and water and sediment control basins.

Chemical hazards/disasters

- There are many types of **hazardous chemicals**, including neurotoxins, immune agents, dermatologic agents, carcinogens, reproductive toxins, systemic toxins, asthmagens, pneumoconiotic agents, and sensitizers. These **hazards** can cause physical and/or health risks.
- **Health Hazards:** Example
- **Hepatotoxins:** Trichlorethylene; chemical found ...
- **Corrosives:** Sulfuric acid; used to manufacture ...
- **Carcinogens:** Benzene; used to make lubricants

Chemical hazards/disasters

- Chemical substances that have the ability to create a physical or health hazard are considered hazardous. Due to their properties chemical hazardous substances may be, but are not limited to being toxic, explosive, flammable, self-reactive, oxidizing, or corrosive. Exposure to these substances by different routes including inhalation, dermal absorption, or ingestion can lead to adverse health effects, enhancing the need to know about the hazards associated to these substances beforehand.
- Chemical agent information is needed for emergency response and recovery workers to appropriately plan for risks resulting from possible chemical incidents. Several organizations have developed information databases, including short-term and long-term criteria, each with specific purposes, exposure scenarios, and severity of adverse health effects considered in their development.

Chemical hazards/disasters

- A hazard is generally anything that can hurt you or make you ill.
- Hazardous chemical A material that has physical or chemical characteristic of potential for causing harm
- human injury,
- damage to property,
- damage to environment
- or some combination of these is known as hazardous chemical.
- Chemical Hazard The undesired effects which are caused with the absorption of hazardous chemicals by the human body- are called chemical hazards. The hazardous chemicals alone in concentration, or when mixed with other chemical substance, can cause injury, disease or death.

Chemical hazards/disasters

- Types Of Chemical Hazard
- Health Hazard
- Physical Hazard
- PHYSICAL HAZARD:
- Flammable gases • Flammable aerosols
- Oxidizing gases • Gases under pressure
- Flammable liquids • Flammable solids
- Self-reactive substances and mixtures
- Pyrophoric liquids contact with water, • emit flammable gases
- Oxidizing liquids • Oxidizing solids • Organic peroxides • Corrosive to metals • Combustible dusts • Pyrophoric gases

Chemical hazards/disasters

- HEALTH HAZARD • Acute toxicity • Skin corrosion/irritation • Serious eye damage/eye irritation • Respiratory or skin sensitization • Germ cell mutagenicity • Carcinogenicity • Reproductive toxicity • Specific target organ toxicity – single exposure • Specific target organ toxicity – repeated exposure • Aspiration hazard • Bio hazardous infectious materials
- Types Of Chemical Hazard Naturally Occurring Chemicals Ex. Mycrotoxin, Pyrrolizidine Alkaloides Intentionally Added Chemicals Ex. Preservatives: Nitrite and Sulfiting agents. Unintentionally Or Incidentally Added Chemicals Ex. Pesticides, Lead, Arsenic, Mercury.
- WHMIS Workplace Hazardous Materials Information System Goals- Prevent Health Hazards Reduce Accidents

Chemical hazards/disasters

- The effect a certain chemical depends on several factors • The routes of entry - The physical properties of the substances - Work practices - The nature of the exposure - Combined exposures - The susceptibility of workers - Toxicity
- Effect Of Chemicals - Causing irritation - Allergies - Lack of oxygen - Systemic poisoning - Cancer - Damage to the unborn fetus - Effects on the future generations - Pneumoconiosis (Dusty lung)
- Controlling Chemical Hazards in the Workplace • Reduce or eliminate the use of hazardous chemicals whenever possible. • Maintain adequate ventilation systems to reduce concentrations of airborne chemicals. • Practicing good personal hygiene (e.g. washing hands) and maintaining regular workplace cleaning routines. • Learn how to avoid carrying hazardous substances home.

Chemical hazards/disasters

- Introduce administrative controls to minimize exposure to chemicals (e.g. rotate workers through different jobs or locations. • Perform maintenance work in off-hours so that accidental release of toxic substances will affect fewer workers). • Use personal protective equipment and devices. • Maintain equipment in good order to prevent leaks and breakdowns that may release toxic substances.
- General Tips for Chemical Safety now how to protect yourself from the health hazards of the chemicals you use. read the warning labels on any chemical before you use it. remember that an unlabeled chemical is a dangerous one. ever sniff or smell an unlabeled chemical. always follow the directions and precautions listed on th bel. lways dispose of a chemical properly.

Chemical hazards/disasters

- **TOXICOLOGY**
- "All substance are poisons"; there is none, which is not a poison. The dose differentiates a poison and a remedy.
- Sources of Toxin: • Environment • Food/Feed/Water • Drugs
- **Environment** :Air Pollution, Carbonemonoxide,Nitrogenoxides,Smoke,Poor Ventilation, Ammonia, Hydrogen Sulfide, Volatile Compounds, Chlorine, Hydrocarbon fuels
- Toxicity is the degree to which a substance can damage an organism. Toxicity can refer to the effect on a whole organism, such as an animal, bacterium, or plant as well as the effect on a substructure of the organism, such as a cell (cytotoxicity) or an organ such as the liver (hepatotoxicity). Toxicity is the capacity of a chemical compound to produce injury.

Chemical hazards/disasters

- Some possible outcomes of Toxicant: - Death after a short period of time- Acute toxicity - Cancer / mutation in DNA - Skin / eye irritation - Fertility problems - Carcinogenicity / mutagenicity - Reproduction effects - Sudden heart failure and death
- Types of Toxicity
- Acute toxicity
- Sub-acute toxicity
- Sub-chronic toxicity Chronic toxicity
- Conditions of strong poisoning 1. High temperature 2. Deep or rapid breathing 3. Long working hours 4. Combination of two or more poisonous substance

NUCLEAR EXPLOSIONS

- A nuclear explosion is an explosion that occurs as a result of the rapid release of energy from a high- speed nuclear reaction.
- The driving reaction may be nuclear fission(**Fission** is the splitting of a heavy, unstable nucleus into two lighter nuclei), nuclear fusion(**fusion** is the process where two light nuclei combine together releasing vast amounts of **energy**)or a multistage cascading combination of the two, though to date all fusion-based weapons have used a fission device to initiate fusion, and a pure fusion weapon remains a hypothetical device.
- Atmospheric nuclear explosions are associated with mushroom clouds, although mushroom clouds can occur with large chemical explosions.
- It is possible to have an air-burst nuclear explosion without these clouds. Nuclear explosions produce radiation and radioactive debris.

NUCLEAR EXPLOSIONS

- Nuclear disasters generally occur in nuclear reactors which are used to generate electric power. Accidents can occur during transportation of nuclear waste or during temporary storage of spent radioactive fuel at nuclear power plants.
- • Strontium-90, Uranium-235, Cesium-137 are some examples of radio active materials
- **CAUSES OF NUCLEAR HAZARDS** • Nuclear disasters occur as a result of release of massive amount of radiation and radio active material into the environment. They have the greatest damage potential, over a wide geographical area, often leading to mass destruction of human civilization.

NUCLEAR EXPLOSIONS

Nuclear disasters and accidents usually occur in nuclear reactors that are used to generate electric power. Some of the major causes :

- Release of massive amounts of radiation and radioactive material
- Improper transportation of nuclear waste has potential risk of pollution and environmental contamination.
- Improper storage of spent radioactive fuel at nuclear power plants.
- Non-standard operations, mismanagement of nuclear reactors
- Poor instrumentation
- Lack of well-trained staff
- Unreliable Instruments
- Errors in operation procedures
- Spills & Leaks from nuclear industry, medical radiology and defense activities

CHERNOBYL DISASTER

- The disaster at the Chernobyl nuclear power plant in north-central Ukraine on April 26, 1986 is considered as one of the greatest nuclear accidents of all time. On the fateful day, one of the reactors of the nuclear power plant exploded and released thirty to forty times the radioactivity of the atomic bombs dropped on Hiroshima and Nagasaki.
- About 30 people were killed immediately, including 28 from radiation exposure, 209 cases were treated for acute radiation poisoning. Large areas of Ukraine, Russia and beyond were contaminated with radioactive material in varying degrees. A second explosion caused burring of 1200 tonnes of graphite for nine days and releasing of radioactive material into the environment. About 5000 tonnes of boron, dolomite, sand, clay and lead were dropped on the flames bursting out of the graphite moderator in an effort to put off the blaze and control the release of radioactive particles.

Impacts of the nuclear disaster

- Nearly, 45% of children have experience with thyroid exposure to radiation. • In order to protect the children from radiation exposure, the top soil from the school yards have been removed, the walls of the school building have been cleaned, and the gutters have been cleared of the mud as well.
- • Reports from WHO indicate that the Agricultural Products, milk and seafood have been contaminated with radioactive material. • The nation may be struggled to find effective methods to monitor health, protect its food supply from contamination and complicated poster disaster clean up.

SEDIMENTATION

- Sedimentation is the tendency for particles in suspension to settle out of the fluid in which they are entrained and come to rest against a barrier.
- This is due to their motion through the fluid in response to the forces acting on them: these forces can be due to gravity, centrifugal acceleration, or electromagnetism.
- In geology, sedimentation is often used as the opposite of erosion.
- In that sense, it includes the termination of transport by siltation or true bed load transport.
- Settling is the falling of suspended particles through the liquid, where as sedimentation is the termination of the settling process.

SEDIMENTATION

- Sedimentation may pertain to objects of various sizes, ranging from large rocks in flowing water to suspensions of dust and pollen particles to cellular suspensions to solutions of single molecules such as proteins and peptides.
- Even small molecules supply a sufficiently strong force to produce significant sedimentation.

SEDIMENTATION PROCESSES

- Sedimentation is the process of allowing particles in suspension in water to settle out of the suspension under the effect of gravity.
- The particles that settle out from the suspension become sediment, and in water treatment is known as sludge. When a thick layer of sediment continues to settle, this is known as consolidation.
- When consolidation of sediment, or sludge, is assisted by mechanical means then this is known as thickening.
- Different aspects in sedimentation process The sedimentation process comprises the following aspects:
    1. Erosion
    2. Transportation
    3. Deposition
    4. Compaction & Cementation

SEDIMENTATION PROCESSES

1. **EROSION** • The term erosion refers to the process of weathering, corrosion or abrasion of a material to form smaller particles. • The smaller units thus formed are relocated by water, wind, ice, animals or humans. • The top soil, organic material and other valuable natural resources are removed by the process of erosion.

2. **TRANSPORTATION** • The sediment particles move under the action of the force of gravity and/ or the movement of fluid in which the sediment is entrained by a variety of sediment transport process, such as rolling, sliding, jumping and suspension. • The sediment transport is due to the movement in the fluid occurs in water bodies such as rivers, lakes, oceans and sea, due to currents and tides and in glaciers under the influence of wind.

SEDIMENTATION PROCESSES

3. **DEPOSITION** • The sediment particles carried by wind, water or ice are laid down near the banks or the shores. • The sediments carried by flowing water, for instance, a stream are deposited when the velocity of the flowing water decreases. • The large sediment particles are deposited near the shore, whereas the smaller sediment particles settle away from the shore.

4. **COMPACTION & CEMENTATION** • The deeply buried sediments are under pressure because of the weight of overlying layers, which causes the grains to pack tightly. This is Compaction. Cementation involves the sticking of the sediment particles together with the help of cementing minerals such as calcium carbonate, silicon dioxide, iron oxides and clay minerals. This is similar to the cement binding the sand grains in a brick layer's mortar.

GLOBAL SEDIMENTATION PROBLEMS

- Damage of agricultural land because the harmful materials in sediments reduce the fertility and productivity of soils.
- Sediments deposited in fertile plains hamper surface drainage.
- Its deposition in stream channels lowers the flood carrying capacity therefore, causing more frequent overflows.
- Sediment deposition affects the quality of water and its suitability for human consumption.
- Loss of important or sensitive aquatic habitat. Decrease in fishery resources.
- Loss of recreation attributes such as boating, fishing, swimming etc.,
- Corals have been observed to be intolerant to sediments as it affects the physical and biological processes, which hampers their existence.

GLOBAL SEDIMENTATION PROBLEMS

Sediments threaten a nation’s economy. Sedimentation of reservoirs have the following impacts,

- Loss of Hydroelectric power generation.
- Loss of Irrigation production.
- Loss of Flood control benefits.
- Increasing in dredging costs of hydroelectric reservoirs.
- Loss of revenues from tourism and recreational activities.

Corrective measures of Erosion & Sedimentation

- Effective erosion & sedimentation control measures can be accomplished only when the soil surface is protected from the erosive forces of wind, rain & runoff.

Some of the techniques for best management practices of erosion control are:

1. **MULCHING**: In this method, organic material is applied to soil surface to conserve soil moisture, prevent surface compaction and erosion of top soil, control of weeds, etc.,
2. **SILT FENCES**: Silt fences are constructed usually at the construction site. They act like dams to trap the sediment and allow water to leave the site.
3. **BERMS** : Berms are narrow, earthen ridges built across roads to allow water to leave the site.

Corrective measures of Erosion & Sedimentation

- **GEOTEXTILE ROLL** • They are known as filter fabrics. These are highly permeable, synthetic textile material used to prevent erosion of soil. It acts like a filter, allows water to move from the soil while the soil is retained.
- **BRUSH MATTRESS** • It is also referred as brush mat. It is a revegetation technique that provide protection to stream banks or slopes from soil erosion.
- **GABIONS** • These are structures filled with bricks, boulders and stones, used for stabilization and retention of soil. They are of three types namely gabion basket, gabion mattress and sack gabion.
- **TREE REVETMENT** • In this method, trees are anchored along the banks of a stream. The erosion of soil, sand and silt decrease, which get deposited along the bank.
- **SODDING** • Layers of soil containing grass and plant roots are placed as a thick mat over an area of exposed soil as an effective erosion control measure.

Biological hazards

- Biological hazards are organic substances that present a threat to the health of people and other living organisms.

Types of biological hazards

Biological hazards include:

1. viruses
2. toxins from biological sources
3. fungi
4. pathogenic micro-organisms
5. bio-active substances.

Worldwide, around 320,000 workers die each year from communicable diseases caused by work-related exposure to biological hazards

Biological hazards

Factors affecting the growth of micro organisms in foods:

- The temperature values for microbial growth depend on the type of microorganism. For example, psychrotrophs such as Listeria monocytogenes grow at refrigeration temperature (4°C or 39°F), while thermotrophs can grow at higher temperatures (45°C or 113°F).
- The pH(potential of hydrogen) of a product is related to the acidity or alkalinity of the product. The pH of products affects the growth of bacteria. Most bacteria grow in a pH range between 5 and 9.
- The Water Activity (aw) refers to the water available in the product. The more water available, the better bacteria will grow. Table 1 shows the impact of water activity on bacterial spoilage.

Biological hazards

aw of product	Bacterial Spoilage	Examples
>0.90	spoils easily	fresh vegetables, fresh meat, processed meat, milk, fish
0.78-0.90	susceptible to spoilage	dry cheeses, flour, cakes, beans, cereals
<0.78	little bacterial spoilage but mould may grow	rolled oats, dried fruits, caramels, dehydrated foods

Control and prevention

- The most effective way to control biological hazards is by prevention. The implementation of Good Manufacturing Practices (GMPs) and Hazard Analysis and Critical Control Point (HACCP) will help prevent biological hazards in your facility. GMPs ensure hazards associated with personnel and environment are controlled during food production. HACCP controls hazards that may be present in ingredients and packaging materials and also those that occur during food processing, packaging and storage.
- **Processing strategies to control biological hazards:**
- effective thermal processing used as a kill step (ex: cooking, pasteurization)

Control and prevention

- use of appropriate process controls: – storage temperatures (ex: cooler, freezer) – processing parameters (ex: temperature and time for cooking, water activity during dehydration) – adequate cooling system
- effective cleaning and sanitizing procedures
- use of food technologies to prevent the growth of bacteria or other biological hazards: – packaging techniques (ex: use of vacuum packaging, modified atmosphere packaging) – preservatives – processing techniques (ex: dehydration)

Levels of biohazard

- The United States Centers for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard, Level 1 being minimum risk and Level 4 being extreme risk.

  Biohazard Level 1: Bacteria and viruses

  Biohazard Level 2: Bacteria and viruses that cause only mild disease to humans

  Biohazard Level 3: Bacteria and viruses that can cause severe to fatal disease in humans, but for which vaccines or other treatments exist

  Biohazard Level 4: Viruses that cause severe to fatal disease in humans, and for which vaccines or other treatments are *not* available

Population Explosion

- Population explosion refers to the rapid and dramatic rise in world population that has occurred over the last few hundred years. Between 1959 and 2000, the world's population increased from 2.5 billion to 6.1 billion people. According to United Nations projections, the world population will be between 7.9 billion and 10.9 billion by 2050.
- At the current rate of growth, **India's population** is likely to peak by 2047 at about 1.61 billion and then decline to 1.03 billion by 2100. However, were it to meet UN Sustainable Goal Development targets, the peak would be earlier and see a **population** decline to 929 million.

Population Explosion

- In the past, infant and childhood deaths and short life spans used to limit popula-tion growth. In today's world, thanks to improved nutrition, sanitation, and medical care, more babies survive their first few years of life.
- The combination of a continuing high birth rate and a low death rate is creating a rapid population increase in many countries in Asia, Latin America and Africa and people generally lived longer.
- Over-population is defined as the condition of having more people than can live on the earth in comfort, happiness and health and still leave the world a fit place for future generations.1 What some people now believe that the greatest threat to the future comes from overpopulation.

Population Explosion

- It took the entire history of humankind for the population to reach 1 billion around 1810. Just 120 years later, this doubled to 2 billion people (1930); then 4 billion in 1975 (45 years).
- The number of people in the world has risen from 4.4 billion people in 1980 to 5.8 billion today. And it is estimated that the population could double again to nearly 11 billion in less than 40 years.
- This means that more people are now being added each day than at any other time in human history.

Population Explosion

- Looking ahead, world population is projected to exceed 6 billion before the year 2000. And according to a report by the United Nation Population fund, total popu-lation is likely to reach 10 billion by 2025 and grow to 14 billion by the end of the next century unless birth control use increases dramatically around the world within the next two decades.
- Both death rates and birth rates have fallen, but death rates have fallen faster than birth rates. There are about 3 births for each death with 1.6 births for each death in more developed countries (MDCs) and 3.3 births for each death in less de-veloped countries(LDCs). The world's population continues to grow by 1 billion people every dozen years.

Population Explosion

- On one hand, some politicians call for countries, especially MDCs to increase their population size to maintain their economic growth and military security.
- On the other hand, critics denote that one out of five people living here today is not properly supported and believe that the world is already limited in resources.
- These critics maintain that slowing world population growth is one of the most urgent issues Those who believe that the world is overpopulated argue that if we don't sharply lower birth rates, we are raising death rates by default.

The Causes Of Rapid Population Growth

- Until recently, birth rates and death rates were about the same, keeping the population stable. People had many children, but a large number of them died before age five.6 During the Industrial Revolution, a period of history in Europe and North America where there were great advances in science and technology, the success in reducing death rates was attributable to several factors:
- (1) in-creases in food production and distribution,
- (2) improvement in public health (water and sanitation), and
- (3) medical technology (vaccines and antibiotics), along with gains in education and standards of living within many developing nations..

The Causes Of Rapid Population Growth

- Without these attributes present in many children's lives, they could not have survived common diseases like measles or the flu.
- People were able to fight and cure deadly germs that once killed them. In addition, because of the technology, people could produce more and different kinds of food.
- Gradually, over a period of time, these discoveries and inventions spread throughout the world, lowering death rates and improving the quality of life for most people.

The Causes Of Rapid Population Growth

Food Production Distribution

- The remarkable facts about the last 150 years has been the ability of farmers to increase food production geometrically in some places.
- Agricultural practices have improved in the United States in the last two centuries. Much of the world experi-enced agricultural success, especially in the last 50 years. Between 1950 and 1984, for example, the amount of grain harvested worldwide increased from 631 million tons to 1.65 billion tons.
- This represents a gain of 2.6 times at a time when the world population increased by only 1.9 times.9In more recent years, the technology has produced a broader variety of tech-niques: new kinds of seed, chemical fertilizers, pesticides, and more sophisticated machinery.

The Causes Of Rapid Population Growth

- The use of technology has made possible the rapid expansion of agri-culture in the United States and other MDCs and LDCs. The use of pesticides in LDCs, for example was expected to increased between 400 to 600% in the last 25 years of the twentieth century.

Improvement in Public Health

- People have concerns about surviving daily living, such as meeting basic needs: food, water, and housing. First, access to safe drinking water was related to the incidence of epidemic diseases such as cholera and child survival. Less than 50% of the population had access to safe drinking water before 1990. By 1990, access to safe drinking water had increased by 75 per cent. But between 1990 and 2000 the numbers of people without access to safe water are projected to increase.

The Causes Of Rapid Population Growth

- An increasing number of countries both developed and develop-ing are approaching the limits of sustainable water use based on their own re-newable resources.
- the pressure to provide adequate housing increases as the population grows. More than half of the developing world's population will be living in urban areas by the end of the century. This growth outstrips the capacity to provide housing and services for others. In some countries, finding a place to live is hard, especially for women. Some women and children are forced to live in the poorest community where they are open to exploitation and abuse.
- The priorities for getting rid of poverty, improving food supply, ending malnu-trition, and providing adequate housing coincide at all points with those required for balanced population growth.

The Causes Of Rapid Population Growth

Conquest of Disease

- The biggest population story of the last hundred years has been the conquest of disease. Scientists have learned a great deal about the ways to prevent and cure many types of disease.
- Thus, millions of people who would have died of disease a century ago are more likely to live to old age. The most effective tools in the con-quest of disease have been improved knowledge about nutrition, vaccinations, bet-ter public health practices and the development of new medicines.
- In the late 80s, a baby born in Iceland was 32 times more likely to live to the age of one year as a baby born in Afghanistan.

The Causes Of Rapid Population Growth

- The major reason for this large differ-ence in survival rate is nutrition. When young children get enough of the right kinds of food, they are likely to live to be adults.
- In many nations the people know about proper nutrition for young children and adults. Unfortunately, in many LCDs the people lack the money and skills that would allow them to use the knowledge about nutrition they already have.

The Consequences Of Rapid Population Growth

- Rapid human population growth has a variety of consequences. Population grows fastest in the world's poorest countries.
- High fertility rates have historically been strongly correlated with poverty, and high childhood mortality rates. Falling fertility rates are generally associated with improved standards of living, increased life expectancy, and lowered infant mortality.
- Overpopulation and poverty have long been associated with increased death, and disease.
- People tightly packed into unsanitary housing are inordinately vulnerable to natural disasters and health problems.However, most of the world's 1.2 billion desperately poor people live in less developed countries (LDCs).

The Consequences Of Rapid Population Growth

- Poverty exists even in MDCs. One in five Soviet citizens reportedly lives below the country's official poverty line.
- In the United States, 33 million people - -one in eight Americans are below the official poverty line.
- The rapid expansion of population size observed since the end of World War II in the world's poorest nations has been a cause of their poverty.
- Poverty is a condition of chronic deprivation and need at the family level. 28 Poverty, is a major concern of humankind, because poverty everywhere reduces human beings to a low level of existence.
- Poor people lack access to enough land and income to meet basic needs. A lack of basic needs results in physical weak-ness and poor health.

The Consequences Of Rapid Population Growth

- Poor health decreases the ability of the poor to work and put them deeper into poverty.
- Instead of allowing poverty to persist, it is important to limit our number be-cause in dense populations too many lack adequate food, water, shelter, education and employment.
- High fertility, which has been traditionally associated with pros-perity, prestige, and security for the future, now jeopardizes chances for many to achieve health and security.
- Rich and poor countries alike are affected by population growth, though the population of industrial countries are growing more slowly than those of develop-ing one.

The Consequences Of Rapid Population Growth

- At the present growth rates, the population of economically developed countries would double in 120 years.
- The Third World, with over three quarters of the world's people, would double its numbers in about 33 years.
- This rapid doubling time reflects the fact that 37 percent of the developing world's population is under the age of 15 and entering their most productive childbearing years.
- In the Third World countries (excluding China), 40 percent of the people are under 15; in some African countries, nearly half are in this age group.

Population Explosion

Actions And Strategies That Can Be Developed To Solve These Problems:

- There is controversy over whether population growth is good or bad. Over-population and continuing population growth are making substantial contributions to the destruction of Earth's life support systems.
- In the past, human populations have rarely been subject to explosion. In numbers.
- The powerful long-term momentum that is built into the human age structure means that the effects of fertility changes become apparent only in the future.
- For these reasons, it is now conventional practice to use the technology of population projection as a means of better understanding the implications of trends.

Population Explosion

- Population projections represent the playing out into the future of a set of assumptions about future fertility and mortality rates.
- More public education is needed to develop more awareness about population issues. Facts like the size or the growth rate of the human population should be in the head of every citizen.
- Schools should inform students about population issues in order for them to make projections about the future generations.

Population Explosion

- Action plans and strategies can be developed to increase public understanding of how rapid population growth limits chances for meeting basic needs.
- The spirit of open communication, and empowerment of individual women and men will be key to a successful solution to many population problems.
- Collective vision about health care, family planning and women's education at the community level build a basis for action.
- The creation of action plans help to meet challenges to find coop-erative solutions. Free and equal access to health care, family planning and educa-tion are desirable in their own right and will also help reduce unwanted fertility.

Population Explosion

- Teachers, as well as students can use the information super highway to gain knowledge about other countries' population and resources.
- Teachers can help students with problems and decision making on a daily basis. The investigation of world population will raise the level of awareness, so that we can learn to handle problems based on data. This data can help us to analyze our situations in a practical way.
- Teachers, students, parents and other stakeholders can look for trends in the population explosion. They can hold community meetings at school to discuss how this issue presents a challenge to the big picture of human population on the planet "Earth".

Population Explosion In India

- In **India**, **population explosion** is the result of high birth rate. High birth rate reduces health and welfare of women. Frequent pregnancy without having a gap is hazardous to the health of the mother and the child. This leads to high death rate among women in the reproductive age due to early marriage.
- Persons are means as well as ends of economic development. They are an asset if in adequate strength and prove to be a liability if excess in strength.
- Population has crossed the optimum limit in India and has become a liability.
- So problem of population explosion in India has proved to be a big hindrance in the success of economic planning and development.

Following are the main effects of population explosion:

1. Problem of Investment Requirement:

- Indian population is growing at a rate of 1.8 percent per annum. In order to achieve a given rate of increase in per capita income, larger investment is needed. This adversely affects the growth rate of the economy.
- In India, annual growth rate of population is 1.8 percent and capital output ratio is 4:1. It means that in order to stabilize the existing economic growth rate (4 X 1.8) = 7.2 percent of national income must be invested.

Population Explosion In India

2. Problem of Capital Formation:

- Composition of population in India hampers the increase in capital formation. High birth rate and low expectancy of life means large number of dependents in the total population. In India 35 percent of population is composed of persons less than 14 years of age. Most of these people depend on others for subsistence. They are unproductive consumers. The burden of dependents reduces the capacity of the people to save. So the rate of capital formation falls.

3. Effect on per Capita Income:

- Large size of population in India and its rapid rate of growth results into low per capita availability of capital. From 1950-51 to 1980-81. India's national income grew at an average annual rate of 3.6 percent per annum.

- But per capita income had risen around one percent. It is due the fact that population growth has increased by 2.5 percent.

4. Effect on Food Problem:

- Rapid rate of growth of population has been the root cause of food problem.

Shortage of food grains hampers economic development in two ways:

- (a) People do not get sufficient quantity of food due low availability of food which affects their health and productivity. Low productivity causes low per capita income and thus poverty.
- (b) Shortage of food-grains obliges the under-developed countries to import food grains from abroad. So a large part of foreign exchange is spent on it. So development work suffers. So rise in population causes food problem.

Population Explosion In India

- **5. Problem of Unemployment:**
- Large size of population results in large army of labour force. But due to shortage of capital resources it becomes difficult to provide gainful employment to the entire working population. Disguised unemployment in rural areas and open unemployment in urban areas are the normal features of an under developed country like India.
- **6. Low Standard of Living:**
- Rapid growth of population accounts for low standard of living in India. Even the bare necessities of life are not available adequately. According to Dr. Chander Shekhar population in India increases by about 1.60 crore. It requires 121 lakh tonnes of food grains, 1.9 lakh metres of cloth and 2.6 lakh houses and 52 lakh additional jobs.

- **7. Poverty:**
- Rising population increases poverty in India. People have to spend a large portion of their resources for bringing up of their wards. It results into less saving and low rate of capital formation. Hence improvement in production technique becomes impossible. It means low productivity of labour.
- **8. Burden of Unproductive Consumers:**
- In India, a large number of children are dependent. Old persons above the age of 60 and many more in the age group of 15-59 do not find employment. In 2001, working population was 39.2 percent while 60.8 percent are unproductive workers. This high degree of dependency is due to high rate of dependent children. This dependency adversely affects effective saving.

Population Explosion In India

- **9. Population and Social Problems:**
- Population explosion gives rise to a number of social problems. It leads to migration of people from rural areas to the urban areas causing the growth of slum areas. People live in most unhygienic and insanitary conditions.
- Unemployment and poverty lead to frustration and anger among the educated youth. This leads to robbery, beggary, prostitution and murder etc.
- The terrorist activities that we find today in various parts of the country are the reflection of frustration among educated unemployed youth. Overcrowding, traffic congestions, frequent accidents and pollution in big cities are the direct result of over-population

Population Explosion In India

10. More Pressure on Land:

- Rising rate of population growth exerts pressure on land. On the one hand, per capita availability of land goes on diminishing and on the other, the problem of sub-division and fragmentation of holdings goes on increasing. It adversely affects the economic development of the country.

11. Impact on Maternity Welfare:

- In India, population explosion is the result of high birth rate. High birth rate reduces health and welfare of women. Frequent pregnancy without having a gap is hazardous to the health of the mother and the child. This leads to high death rate among women in the reproductive age due to early marriage. Hence to improve the welfare and status of women in our society, we have to reduce the birth rate.

12. Pressure on Environment:

- Population explosion leads to environmental degradation. Higher birth rate brings more pollution, more toxic wastes and damage to biosphere. Briefly speaking, population explosion hinders the economic development. It should be controlled effectively.

MODULE –V
EMERGING APPROACHES IN DISASTER MANAGEMENT

Emerging approaches in Disaster Management

1. Pre- disaster stage (preparedness)
2. Emergency Stage (Disaster Phase or Phase of Catastrophe)
3. Post Disaster stage (Rehabilitation/ Recovery Stage)

EDUCATION ON DISASTERS

- Education on disasters is a process of learning, that creates an overall perspective about the knowledge and awareness of the impending disasters.
- It is an effective means of sensitizing the society about different types of disasters, develop skills and expertise to mitigate its occurrence.

Emerging Approaches In Disaster Management

- The general public must have the awareness and knowledge about the hazards through information, education, education and communication to prepare them for disaster mitigation.

National Disaster Management Act

- The Disaster Management Act, 2005, (23 December 2005) No. 53 of 2005, was passed by the Rajya Sabha, the upper house of the Parliament of India on 28 November, and by the Lok Sabha, the lower house of the Parliament, on 12 December 2005. It received the assent of The President of India on 9 January 2006.
- The Disaster Management Act, 2005 has 11 chapters and 79 sections.
- The Act extends to the whole of India.
- The Act provides for "the effective management of disasters and for matters connected therewith or incidental thereto.

Emerging Approaches In Disaster Management

Pre-disaster stage includes,

1. Preparedness Phase (Phase of readiness)

2. Mitigation Phase (Prevention Phase)

PRE–DISASTER STAGE

- This phase involves planning to respond immediately in anticipating of a disaster.
- This includes awareness about emergency exercises or training in various methods of safely vacating the disaster – stricken areas and first – aid measures.
- Such awareness programs must also strengthen the technical and managerial capacity of governments, organization and communities to minimize the mortality and property loss and enhance disaster response operations.
- Installation of disaster warning systems, emergency communication system, emergency personnel/contact lists, plenty of food reserves, equipment, water, medicines and other necessities must be maintained

Emerging Approaches In Disaster Management

ASPECTS

- • Phase of readiness includes the following aspects:
- • Hazard zone mapping
- • Hazard forecasting, warning and prediction
- • Disaster preparedness plan
- • Preparedness through information, Education & Communication

MITIGATION PHASE

- • It is the second aspect of pre-disaster stage
- • These people may begin to think about the measures needed to minimize the effects of similar kind of probable disaster in future.
- • For instance, an earthquake that would have damaged improperly constructed houses or a tsunami that would have washed away the houses in coastal line.

Emerging Approaches In Disaster Management

- In such situations, people begin to build stronger buildings that can sustain the impact of earthquake and encourage the development of green belt by planting more trees along the coastal line to reduce the impact of tsunami waves on the land.

Measures essential for effective disaster mitigation include

- • Construction of disaster resistant houses
- • Decreasing the population pressure in hazard sensitive zones
- • Land-use control
- • High standard of engineering design of built structures
- • Promotion of fire resistant structures
- • Relocation of existing settlements or infrastructure

Emerging Approaches In Disaster Management

GUIDELINES FOR MITIGATION OF DISASTER

- • Early Warning Symptoms
- • Land use zoning
- • Building codes
- • Incentives
- • Provision of assets at subsidized rates
- • Increase public awareness

ROLE OF TECHNOLOGY

- • Mapping
- • Aerial Photography and Remote Sensing
- • Communications
- • Information Management

Emerging Approaches In Disaster Management

Organizations which involved in research and mitigation of disasters

- • International Council for Scientific Unions (ICUS) Aim:-
- • Promote international science for welfare of man kind and society
- • Encourage interaction of scientists from various disciplines
- • Encourage the scientific community across the globe to participate in the international scientific activities.

World Federation of Engineering Organizations (WFEO)

- • To give importance to the engineering disciplines.
- • To encourage practical applications of engineering
- • To facilitate engineering knowledge internationally

EMERGENCY STAGE

- • The emergency stage (disaster phase or the phase of catastrophe) is the stage at which the crisis. This phase results in great damage to life, property, environment and health of living beings. The affected people are in a stage of profound shock.
- • All efforts are put forth to minimize the problems created by a disaster. These include providing assistance to the affected population with transport, food and shelter and temporary repairs to damaged infrastructures.
- • Thus, the main objective of the response phase is to meet the basics needs of population affected with disasters until some sustainable arrangement is made for them.

Emerging Approaches In Disaster Management

POST - DISASTER STAGE

- • This Stage (recovery or rehabilitation phase) focuses at restoring normalcy in the lives of people and the infrastructure that include temporary shelters, reconstruction of damaged infrastructure, proper information to the public, educating people about the health and safety, post trauma counselling programs by training volunteers to counsel every victim of disaster as they need intensive mental support to facilitate recovery.

Phases Of Disaster Management

- **Disaster Preparedness**
- **Disaster Impact**
- **Disaster Response**
- **Disaster Recovery**
- **Disaster Mitigation**
- Disaster preparedness - is ongoing multi sectoral activity. Integral part of the national system responsible for developing plans and programmes for disaster management, prevention, mitigation, response, rehabilitation and reconstruction.

Phases Of Disaster Management

Disaster Preparedness Co-ordination of a variety of sectors to carry out-

- Evaluation of the risk.
- Adopt standards and regulations.
- Organize communication and response mechanism.
- Ensure all resources- ready and easily mobilized.
- Develop public education programmes.
- Coordinate information with news media.
- Disaster simulation exercises.

Phases Of Disaster Management

- Medical Preparedness & Mass Casualty Management Developing and capacity building of medical team for Trauma & psycho-social care, Mass casualty management and Triage.
- Determine casualty handling capacity of all hospitals.
- Formulate appropriate treatment procedures.
- Involvement of private hospitals. Indentify health care centers that can function as a medical units. Identify structural integrity and approach routes.
- Disaster Response Immediate reaction to disaster as the disaster is anticipated, or soon after it begins in order to assess the needs, reduce the suffering, limit the spread and consequences of the disaster, open up the way to rehabilitation.

Phases Of Disaster Management

By-

- Mass evacuation
- Search and rescue
- Emergency medical services
- Securing food and water
- Maintenance of Law & Order

Phases Of Disaster Management

Disaster Impact & Response

- Medical and Public Health response
- • Pre-hospital emergency services –
- Linkage to govt. incident command system.
- External medical services and extrication workers.

Search and Rescue teams.

- • Assessment of immediate health needs.
- • Identification of medical & health resources.
- • Temporary field treatment Prompt and proper treatment to save lives.

Phases Of Disaster Management

Medical and Public Health response Patient distribution & evacuation

- • Triage: French word meaning selection & classification Assigning priority for treatment and transport on the basis of severity of injuries & likelihood of survival when resources are insufficient for all to be treated immediately.
- • Tagging- for both patients and dead Bodies
- • Medical transportation Ground, Air and Heli ambulance Mobile surgical teams, Mobile hospitals. Red High Priority Yellow Medium priority Black Dead or moribund Patients Green Ambulatory Patients TRIAGE
- Medical and Public Health response Food safety and Water Safety Animal control- Deadbodies can foul water, Zoonotic diseases.

Phases Of Disaster Management

- Vector control- Mosquito and Rodents Communicable disease control: Measles, diarrheal diseases, ARI, and malaria Breakdown in environmental safeguards. Crowding of persons in camps, Malnutrition. Waste management Temporary latrines Chemical toileting Sewage disposal damage. Immunization – Mass immunization its not recommended,
- Medical and Public Health response Management of hazardous agent exposure Particular matter Also Infectious agents if hospital or scientific laboratories damaged Mental health Specialized psychological triage and treatment significant in terrorism. Information Behavioral Contagion handling Risk communication
- Consequences of Disaster Health - Physical – Entanglement, Injuries, Disabilities, Coma ,Death. Psychological- Cognitive, Behavioral, Social. Structural Damage – to variable extent. Ecological- Changes in eco system. Economical-Financial losses.

Phases Of Disaster Management

- **Symptoms after disaster Physiological Symptoms** • Fatigue • Shock symptoms • Profuse sweating • Fine motor tremors • Chills • Teeth grinding • Muscle aches • Dizziness Cognitive Symptoms • Memory loss • Distractibility • Reduced attention span • Decision making difficulties • Calculation difficulties • Confusing trivial with major issues Emotional Symptoms • Anxiety • Feeling overwhelme Grief • Depression • Anticipation of harm to self or others • Irritability Behavioral Symptoms • Insomnia • Substance abuse • Gallows humor • Gait change • Ritualistic behavior • Hyper vigilance • Unwillingness to leave scene
- **Factors which may affect reactions Disaster Related Factors** • Lack of warning • Scope of the event • Abrupt contrast of scene • Personal loss or injury • Type of disaster • Traumatic stimuli • Nature of the destructive agent • Human error • Time of occurrence • Lack of opportunity for effective action • Environment (temperature, humidity, pollution…) Host Related Factors • Health • Disabled, Invalid • Medical problems • Social • Lack of support network- Divorced, Widowed

Phases Of Disaster Management

- • Cultural: language barriers • Demographic • Age: younger and older have more difficulties • Sex: more stress in women, but more resilient • Past History • Traumatic events • Mental illness or emotional problems
- **Communicable Diseases after Disasters Pre existing Diseases in the Population** : dysentery, cholera, measles, tuberculosis, malaria, intestinal parasites, scabies, skin infections. Ecological Changes :
- Altered ecology- vector borne and water borne diseases
- Living conditions - plague, louse borne typhus and relapsing fever.
- Stray animals and wild animal displacement- rabies. Damage to public Utilities : Water supplies & sewage disposal disrupted.

Phases Of Disaster Management

Communicable Diseases after Disasters Population Movements :

- Introduction of new disease or vector.
- In settlements - diarrheal diseases , measles, viral hepatitis, whooping cough, malaria etc.

Interruption in Public Health Services :

- Disruption of curative and preventive services.
- Interrupted vector control - malaria, dengue
- Interrupted immunization - measles, whooping cough, and diphtheria.

Altered Individual Resistance to diseases :

- Malnutrition increases susceptibility to diseases .