



**DISASTER MANAGEMENT:
[VULNERABILITY+HAZARD]÷CAPACITY=DISASTER
AND
CAPACITY÷[VULNERABILITY+ HAZARD]=CONTROL**

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ABSTRACT

The Red Cross and Red Crescent National Societies, supported by the International Federation, work with communities to reduce risk, mitigate the effects of, prepare to respond, respond to and recover from disasters. 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. The first people to respond to a disaster are those living in the local community. They are the first to start rescue and relief operations. The Red Cross and Red Crescent National Societies therefore focus on community-based disaster preparedness, which assists communities to reduce their vulnerability to disasters and strengthen their capacities to resist them. When the capacity of a community or country to respond and recover from a disaster is overwhelmed and upon request from the National Society, the International Federation uses its regional and international networks, assets and resources to bring assistance to the communities and National Red Cross Red Crescent Society which is assisting them. At an international level the International Federation advocates with Governments, international organizations and humanitarian donors for better practice and accountability in disaster management and greater respect of the dignity of the vulnerable people.

KEYWORDS: Vulnerability, Flood, Earthquake, Landslide, Blizzard, Drought, Avalanche, Landmine, Coastal erosion, Lahar, Sinkhole, Volcanic Eruption, Volcanic Ash, Volcanic magma, Volcanic lava, Hailstorm, Heat wave, Maelstrom, Hurricane Katrina, Extratropical Cyclone, Ice storm, Tornado, Flood, Famine, Wild fire, Tsunami, Swine flu, Bird flu, Radiological Hazard, CBRN.

INTRODUCTION

An **act of God** is a legal term for events outside human control, such as sudden natural disasters, for which no one can be held responsible. A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins. Vulnerability in this context can be defined as the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard. The concept is relative and dynamic. Vulnerability is most often associated with poverty, but it can also arise when people are isolated, insecure and defenseless in the face of risk, shock or stress. People differ in their exposure to risk as a result of their social group, gender, ethnic or other identity, age and other factors. Vulnerability may also vary in its forms: poverty, for example, may mean that housing is unable to withstand an earthquake or a hurricane, or lack of preparedness may result in a slower response to a disaster, leading to greater loss of life or prolonged suffering. The reverse side of the coin is capacity, which can be described as the resources available to individuals, households and communities to cope with a threat or to resist the impact of a hazard. Such resources can be physical or material, but they can also be found in the way a community is organized or in the skills or attributes of individuals and/or organizations in the community.^[1]

To determine people's vulnerability, two questions need to be asked: 1. To what threat or hazard are they vulnerable? 2. What makes them vulnerable to that threat or hazard?

Counteracting vulnerability requires

Reducing the impact of the hazard itself where possible (through mitigation, prediction and warning, preparedness); building capacities to withstand and cope with hazards; tackling the root causes of vulnerability, such as poverty, poor governance, discrimination, inequality and inadequate access to resources and livelihoods. Physical, economic, social and political

factors determine people's level of vulnerability and the extent of their capacity to resist, cope with and recover from hazards. Clearly, poverty is a major contributor to vulnerability. Poor people are more likely to live and work in areas exposed to potential hazards, while they are less likely to have the resources to cope when a disaster strikes. Risk is a function of the hazards to which a community is exposed and the vulnerabilities of that community. However, that risk is modified by the level of the local preparedness or capacity of the community at risk. It is expressed by the following notation: **Risk** \propto [**Hazard** \times **Vulnerability**] \div **Capacity**.

Types of Hazards	
<i>Natural</i>	Floods, earthquakes, landslides, drought, Avalanches, locust invasions
<i>Human-triggered</i>	Landmines, social, cultural and political factors, explosions, fires, technological (potential), hazardous materials and chemicals (potential), air accidents

Vulnerability Factors	
<i>Natural</i>	Highly seismic region, low rainfall, mountainous geography
<i>Human-triggered</i>	post-conflict socio-economic, physical and governance conditions
<i>Others</i>	Low literacy level, inaccessibility, transportation and communications, high poverty, low awareness, psycho-social trauma, unplanned re-development (urban)

Figure-1: Types of Hazards

In richer countries, people usually have a greater capacity to resist the impact of a hazard. They tend to be better protected from hazards and have preparedness systems in place. Secure livelihoods and higher incomes increase resilience and enable people to recover more quickly from a hazard. Disasters jeopardize development gains. Equally, development choices made by individuals, households, communities and governments increase or reduce the risk of disasters. Examples of potentially vulnerable groups include displaced populations who leave their habitual residence in collectives, usually due to a sudden impact disaster, such as an earthquake or a flood, threat or conflict, as a coping mechanism and with the intent to return; migrants who leave or flee their habitual residence to go to new places, usually abroad to seek better and safer perspectives; returnees – former migrants or displaced people returning to their homes; specific groups within the local population, such as marginalized, excluded or

destitute people; young children, pregnant and nursing women, unaccompanied children, widows, elderly people without family support, disabled persons. In a disaster, women in general may be affected differently from men because of their social status, family responsibilities or reproductive role, but they are not necessarily vulnerable. They are also resourceful and resilient in a crisis and play a crucial role in recovery. Gender analysis can help to identify those women or girls who may be vulnerable and in what way.^[2]

A disaster occurs when a hazard impacts on vulnerable people.

The combination of hazards, vulnerability and inability to reduce the potential negative consequences of risk results in disaster. A disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. In contemporary academia, disasters are seen as the consequence of inappropriately managed risk. These risks are the product of a combination of both hazard/s and vulnerability. Hazards that strike in areas with low vulnerability will never become disasters, as is the case in uninhabited regions. Developing countries suffer the greatest costs when a disaster hits – more than 95% of all deaths caused by hazards occur in developing countries and losses due to natural hazards are 20 times greater in developing countries than in industrialized countries.

Table-1: Classification of Disasters

General Classification		
Disaster Subgroup	Definition	Disaster Main Type
<u>Geophysical</u>	Events originating from solid earth	Earthquake, Volcano, Mass Movement (dry)
<u>Meteorological</u>	Events caused by short-lived/small to meso scale atmospheric processes (in the spectrum from minutes to days)	Storm
<u>Hydrological</u>	Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up	Flood, Mass Movement (wet)
<u>Climatological</u>	Events caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability)	Extreme Temperature, Drought, Wildfire
<u>Biological</u>	Disaster caused by the exposure of living organisms to germs and toxic substances	Epidemic, Insect infestation, Animal Stampede

Geophysical

Disaster Generic group	Disaster Sub-group	Disaster Main Type	Disaster Sub Type	Disaster Sub-sub Type	
Natural Disaster	Geophysical	Earthquake	Ground Shaking		
			Tsunami		
			Volcano		Volcanic eruption
			Mass Movement (dry)	Rock fall	Snow avalanche, Debris avalanche
				Avalanche	
				Landslide	
Subsidence	Sudden subsidence, Long-lasting subsidence				

Meteorological

Disaster Generic group	Disaster Sub-group	Disaster Main Type	Disaster Sub Type	Disaster Sub-sub Type
Natural Disaster	Meteorological	Storm	Tropical Storm, Extra-Tropical cyclone (winter storm)	
			Local/Convective storm	

Hydrological

Disaster Generic group	Disaster Sub-group	Disaster Main Type	Disaster Sub Type	Disaster Sub-sub Type	
Natural Disaster	Hydrological	Flood	General river flood, Flash flood, Storm surge/coastal flood		
			Mass Movement (wet)		Rock fall
			Landslide		Debris flow, Debris avalanche
			Avalanche		Snow avalanche, Debris avalanche
			Subsidence		Sudden subsidence, Long-lasting subsidence

Climatological

Disaster Generic group	Disaster Sub-group	Disaster Main Type	Disaster Sub Type	Disaster Sub-sub Type
Natural Disaster	Climatological	Extreme Temperature	Heat Wave	Frost
			Cold Wave	
			Extreme Winter Conditions	Snow Pressure, Icing, Freezing Rain, Debris avalanche
		Drought	Drought	
		Wild fire	Forest Fire, Land fires (grass, scrub, bush etc)	

Biological

Disaster Generic group	Disaster Sub-group	Disaster Main Type	Disaster Sub Type	Disaster Sub-sub Type
Natural Disaster	Biological	Epidemic	Viral Infections, Diseases, Bacterial Infections, Diseases, Parasitic Infectious Diseases, Fungal Infections, Diseases, Prion Infectious Diseases	
			Insect infestation	Grasshopper/Locust/Worms
			Animal Stampede	

Natural Hazards: A natural hazard is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Various phenomena like earthquakes, landslides, volcanic eruptions, floods, hurricanes, tornadoes, blizzards, tsunamis and cyclones are all natural hazards that kill thousands of people and destroy billions of dollars of habitat and property each year. However, the rapid growth of the world's population and its increased concentration often in hazardous environments has escalated both the frequency and severity of disasters. With the tropical climate and unstable land forms, coupled with deforestation, unplanned growth proliferation, non-engineered constructions which make the disaster-prone areas more vulnerable, tardy communication and poor or no budgetary allocation for disaster prevention, developing countries suffer more

or less chronically from natural disasters. Asia tops the list of casualties caused by natural hazards. A natural disaster is a major adverse event resulting from natural processes of the Earth; examples include floods, volcanic eruptions, earthquakes, tsunamis and other geologic processes. A natural disaster can cause loss of life or property damage and typically leaves some economic damage in its wake, the severity of which depends on the affected population's resilience, or ability to recover. An adverse event will not rise to the level of a disaster if it occurs in an area without vulnerable population. In a vulnerable area, however, such as San Francisco and Nepal, an earthquake can have disastrous consequences and leave lasting damage, requiring years to repair.

In 2012, there were 905 natural disasters worldwide, 93% of which were weather-related disasters. Overall costs were US\$170 billion and insured losses \$70 billion. 2012 was a moderate year. 45% were meteorological (storms), 36% were hydrological (floods), 12% were climatological (heat waves, cold waves, droughts, wildfires) and 7% were geophysical events (earthquakes and volcanic eruptions). Between 1980 and 2011 geophysical events accounted for 14% of all natural catastrophes. A natural hazard is a naturally occurring event that might have a negative effect on people or the environment. Natural hazard events can be grouped into two broad categories.

Geophysical Hazards: This encompasses geological and meteorological phenomena such as earthquakes, coastal erosion, volcanic eruption, cyclonic storms and drought. Biological hazards can refer to a diverse array of disease and infestation. Other natural hazards such as floods and wildfires can result from a combination of geological, hydrological and climatic factors. Many geophysical hazards are interrelated; for example, submarine earthquakes can cause tsunamis and hurricanes can lead to coastal flooding and erosion. It is possible that some natural hazards are intertemporally correlated as well. A concrete example of the division between a natural hazard and a natural disaster is that the 1906 San Francisco earthquake was a disaster, whereas living on a fault line is a hazard.^[3]

Classifications:**Figure-2: Avalanche and Earthquake**

Avalanche: An avalanche occurs when a large snow (or rock) mass slides down a mountainside. An avalanche is an example of a gravity current consisting of granular material. In an avalanche, lots of material or mixtures of different types of material fall or slide rapidly under the force of gravity. Avalanches are often classified by the size or severity of consequences resulting from the event. During World War I, an estimated 40,000 to 80,000 soldiers died as a result of avalanches during the mountain campaign in the Alps at the Austrian-Italian front. Many of the avalanches were caused by artillery fire.

Earthquake: An earthquake is a phenomenon that results from a sudden release of stored energy that radiates seismic waves. At the Earth's surface, earthquakes may manifest with a shaking or displacement of the ground; when the earthquake occurs on the seafloor, the resulting displacement of water can sometimes result in a tsunami. Most of the world's earthquakes (90% and 81% of the largest) take place in the 40,000-km-long, horseshoe-shaped zone called the circum-Pacific seismic belt, also known as the Pacific Ring of Fire, which for the most part bounds the Pacific Plate.

Many earthquakes happen each day, few of which are large enough to cause significant damage. An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. At the Earth's surface, earthquakes manifest themselves by vibration, shaking and sometimes displacement of the ground. The vibrations may vary in magnitude. Earthquakes are caused mostly by slippage within geological faults, but also by other events such as volcanic activity, landslides, mine blasts and nuclear tests. The underground point of origin of the earthquake is called the *focus*. The point directly above the focus on the surface is called the *epicenter*. Earthquakes by themselves rarely kill people or wildlife. It is usually

the secondary events that they trigger, such as building collapse, fires, tsunamis (seismic sea waves) and volcanoes that are actually the human disaster. Many of these could possibly be avoided by better construction, safety systems, early warning and planning.^[4] An **earthquake** (also known as a **quake**, **tremor** or **temblor**) is the perceptible shaking of the surface of the Earth, which can be violent enough to destroy major buildings and kill thousands of people. The severity of the shaking can range from barely felt to violent enough to toss people around. Earthquakes have destroyed whole cities. They result from the sudden release of energy in the Earth's crust that creates seismic waves. The **seismicity**, **seismism** or **seismic activity** of an area refers to the frequency, type and size of earthquakes experienced over a period of time. Earthquakes are measured using observations from seismometers. The moment magnitude is the most common scale on which earthquakes larger than approximately 5 are reported for the entire globe. The more numerous earthquakes smaller than magnitude 5 reported by national seismological observatories are measured mostly on the local magnitude scale, also referred to as the Richter magnitude scale. These two scales are numerically similar over their range of validity. Magnitude 3 or lower earthquakes are mostly almost imperceptible or weak and magnitude 7 and over potentially causes serious damage over larger areas, depending on their depth. The largest earthquakes in historic times have been of magnitude slightly over 9, although there is no limit to the possible magnitude. The most recent large earthquake of magnitude 9.0 or larger was a 9.0 magnitude earthquake in Japan in 2011 (as of March 2014), and it was the largest Japanese earthquake since records began. Intensity of shaking is measured on the modified Mercalli scale. The shallower an earthquake, the more damage to structures it causes, all else being equal.

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. Earthquakes can also trigger landslides, and occasionally volcanic activity.

In its most general sense, the word *earthquake* is used to describe any seismic event — whether natural or caused by humans — that generates seismic waves. Earthquakes are caused mostly by rupture of geological faults, but also by other events such as volcanic activity, landslides, mine blasts, and nuclear tests. An earthquake's point of initial rupture is

called its focus or hypocenter. The epicenter is the point at ground level directly above the hypocenter.



Figure-3: Coastal erosion and Lahar

Coastal erosion: Coastal erosion is a physical process by which shorelines in coastal areas around the world shift and change, primarily in response to waves and currents that can be influenced by tides and storm surge. Coastal erosion can result from long-term processes as well as from episodic events such as tropical cyclones or other severe storm events.

Lahar: A lahar is a type of natural event closely related to a volcanic eruption and involves a large amount of material originating from an eruption of a glaciated volcano, including mud from the melted ice, rock and ash sliding down the side of the volcano at a rapid pace. These flows can destroy entire towns in seconds and kill thousands of people and form flood basalt. This is based on natural events.

Landslide: A landslide is a mass displacement of sediment, usually down a slope.

Sinkholes: A sinkhole is a localized depression in the surface topography, usually caused by the collapse of a subterranean structure such as a cave. Although rare, large sinkholes that develop suddenly in populated areas can lead to the collapse of buildings and other structures.



Figure-4: Landslide and Sinkhole

Volcanic eruption: A volcanic eruption is the point in which a volcano is active and releases its power and the eruptions come in many forms. They range from daily small eruptions which occur in places like Kilauea in Hawaii, to megacolossal eruptions (where the volcano expels at least 1,000 cubic kilometers of material) from super volcanoes like Lake Taupo (26,500 years ago) and Yellowstone Caldera. According to the Toba catastrophe theory, 70 to 75 thousand years ago, a supervolcanic event at Lake Toba reduced the human population to 10,000 or even 1,000 breeding pairs, creating a bottleneck in human evolution. Some eruptions form pyroclastic flows, which are high-temperature clouds of ash and steam that can travel down mountainsides at speed exceeding an airliner. Volcanoes can cause widespread destruction and consequent disaster in several ways. The effects include the volcanic eruption itself that may cause harm following the explosion of the volcano or the fall of rock.



Figure-5: Volcanic Eruption and Volcanic Ash

Second, lava may be produced during the eruption of a volcano. As it leaves the volcano, the lava destroys many buildings, plants and animals it encounters. Third, volcanic ash generally meaning the cooled ash - may form a cloud and settle thickly in nearby locations. When

mixed with water this forms a concrete-like material. In sufficient quantity ash may cause roofs to collapse under its weight but even small quantities will harm humans if inhaled. Since the ash has the consistency of ground glass it causes abrasion damage to moving parts such as engines. The main killer of humans in the immediate surroundings of a volcanic eruption is the pyroclastic flows, which consist of a cloud of hot volcanic ash which builds up in the air above the volcano and rushes down the slopes when the eruption no longer supports the lifting of the gases. It is believed that Pompeii was destroyed by a pyroclastic flow. A lahar is a volcanic mudflow or landslide. The 1953 Tangiwai disaster was caused by a lahar, as was the 1985 Armero tragedy in which the town of Armero was buried and an estimated 23,000 people were killed.^[5]

A specific type of volcano is the supervolcano. According to the Toba catastrophe theory, 75,000 to 80,000 years ago a supervolcanic event at Lake Toba reduced the human population to 10,000 or even 1,000 breeding pairs, creating a bottleneck in human evolution. It also killed three-quarters of all plant life in the northern hemisphere. The main danger from a supervolcano is the immense cloud of ash, which has a disastrous global effect on climate and temperature for many years.



Figure-6: Volcanic Lava and Volcanic Magma

Several **types of volcanic eruptions**—wherein lava, tephra (ash, lapilli, volcanic bombs and blocks) and assorted gases are expelled from a volcanic vent or fissure—have been distinguished by volcanologists. These are often named after famous volcanoes where that type of behavior has been observed. Some volcanoes may exhibit only one characteristic type of eruption during a period of activity, while others may display an entire sequence of types all in one eruptive series. There are three different meta types of eruptions. The well-observed are magmatic eruptions, which involve the decompression of gas within magma that propels

it forward. Phreatomagmatic eruptions are another type of volcanic eruption, driven by the compression of gas within magma, the direct opposite of the process powering magmatic activity. The last eruptive metatype is the phreatic eruption, which is driven by the superheating of steam via contact with magma; these eruptive types often exhibit no magmatic release, instead causing the granulation of existing rock.^[6]

Volcanic eruptions arise through three main mechanisms:

- Gas release under decompression causing magmatic eruptions
- Thermal contraction from chilling on contact with water causing phreatomagmatic eruptions
- Ejection of entrained particles during steam eruptions causing phreatic eruptions.



Figure-7: Volcanic Lava

There are two types of eruptions in terms of activity, explosive eruptions and effusive eruptions. Explosive eruptions are characterized by gas-driven explosions that propel magma and tephra. Effusive eruptions, meanwhile, are characterized by the outpouring of lava without significant explosive eruption. Volcanic eruptions vary widely in strength. On the one extreme there are effusive Hawaiian eruptions, which are characterized by lava fountains and fluid lava flows, which are typically not very dangerous. On the other extreme, Plinian eruptions are large, violent and highly dangerous explosive events. Volcanoes are not bound to one eruptive style and frequently display many different types, both passive and explosive, even the span of a single eruptive cycle. Volcanoes do not always erupt vertically from a single crater near their peak, either. Some volcanoes exhibit lateral and fissure eruptions. Notably, many Hawaiian eruptions start from rift zones and some of the strongest Surtseyan eruptions develop along fracture zones. Scientists believed that pulses of magma mixed together in the chamber before climbing upward—a

process estimated to take several thousands of years. But Columbia University volcanologists found that the eruption of Costa Rica's Irazú Volcano in 1963 was likely triggered by magma that took a nonstop route from the mantle over just a few months.

Meteorological hazards

Blizzard: A blizzard is a severe winter storm icy and windy conditions characterized by low temperature, strong wind and heavy snow. Blizzards are severe winter storms characterized by heavy snow and strong winds. When high winds stir up snow that has already fallen, it is known as a ground blizzard. Blizzards can impact local economic activities, especially in regions where snowfall is rare. The Great Blizzard of 1888 affected the United States, when many tons of wheat crops were destroyed, and in Asia, 2008 Afghanistan blizzard and the 1972 Iran blizzard were also significant events.

Drought: Scientists warn that global warming and climate change may result in more extensive droughts in coming years. These extensive droughts are likely to occur within the African continent due to its very low precipitation levels and high climate. Drought is unusual dryness of soil, resulting in crop failure and shortage of water for other uses, caused by significantly lower rainfall than average over a prolonged period. Hot dry winds, shortage of water, high temperatures and consequent evaporation of moisture from the ground can contribute to conditions of drought. Well-known historical droughts include the 1997–2009 Millennium Drought in Australia led to a water supply crisis across much of the country. As a result, many desalination plants were built for the first time. In 2011, the State of Texas lived under a drought emergency declaration for the entire calendar year and severe economic losses. The drought caused the Bastrop fires.^[7]



Figure-8: Blizzard and Drought

Hailstorm: A hailstorm is a natural hazard where a thunderstorm produces numerous hailstones which damage the location in which they fall. Hailstorms can be especially devastating to farm fields, ruining crops and damaging equipment. Hailstorms are falls of rain drops that arrive as ice, rather than melting before they hit the ground. A particularly damaging hailstorm hit Munich, Germany, on July 12, 1984, causing about 2 billion dollars in insurance claims.



Figure-9: Hailstorm and Heat wave

Heat wave: A heat wave is a hazard characterized by heat which is considered extreme and unusual in the area in which it occurs. Heat waves are rare and require specific combinations of weather events to take place and may include temperature inversions, katabatic winds, or other phenomena. There is potential for longer-term events causing global warming, including stadial events (the opposite to glacial "ice age" events), or through human-induced climatic warming. Heat waves: A heat wave is a period of unusually and excessively hot weather. The worst heat wave in recent history was the European Heat Wave of 2003. A summer heat wave in Victoria, Australia, created conditions which fuelled the massive bushfires in 2009. Melbourne experienced three days in a row of temperatures exceeding 40°C (104°F) with some regional areas sweltering through much higher temperatures. The bushfires, collectively known as "Black Saturday", were partly the act of arsonists. The 2010 Northern Hemisphere summer resulted in severe heat waves, which killed over 2,000 people. It resulted in hundreds of wildfires which causing widespread air pollution and burned thousands of square miles of forest.

Maelstrom: A maelstrom is a very powerful whirlpool. It is a large, swirling body of water with considerable downdraft. There are virtually no documented accounts of large ships

being sucked into a maelstrom, although smaller craft and swimmers are in danger. Tsunami-generated maelstroms may even threaten larger crafts.

Cyclonic storm

Hurricane Katrina: Hurricane, tropical cyclone and typhoon are different names for the same phenomenon: a cyclonic storm system that forms over the oceans. It is caused by evaporated water that comes off of the ocean and becomes a storm. The Coriolis effect causes the storms to spin and a hurricane is declared when this spinning mass of storms attains a wind speed greater than 74 mph (119 km/h). Hurricane is used for these phenomena in the Atlantic and eastern Pacific Oceans, tropical cyclone in the Indian and typhoon in the western Pacific.^[8]



Figure-10: Maelstrom and Hurricane Katrina

Tropical cyclones: Cyclone, tropical cyclone, hurricane and typhoon are different names for the same phenomenon, which is a cyclonic storm system that forms over the oceans. The deadliest hurricane ever was the 1970 Bhola cyclone; the deadliest Atlantic hurricane was the Great Hurricane of 1780 which devastated Martinique, St. Eustatius and Barbados. Another notable hurricane is Hurricane Katrina, which devastated the Gulf Coast of the United States in 2005.^[9]



Figure-11: Extra tropical Cyclone and Ice storm

Extra tropical cyclones: Extra tropical cyclones, sometimes called mid-latitude cyclones, are a group of cyclones defined as synoptic scale low pressure weather systems that occur in the middle latitudes of the Earth (outside the tropics) not having tropical characteristics, and are connected with fronts and horizontal gradients in temperature and dew point otherwise known as "baroclinic zones". As with tropical cyclones, they are known by different names in different regions (nor'easter, Pacific Northwest windstorms, European windstorm, East Asian-northwest Pacific storms, sudestada and Australian east coast cyclones). The most intense extratropical cyclones cause widespread disruption and damage to society, such as the storm surge of the North Sea flood of 1953 which killed 2251 people in the Netherlands and eastern England, the Great Storm of 1987 which devastated southern England and France, and the Columbus Day Storm of 1962 which struck the Pacific Northwest.

Ice storm: An ice storm is a particular weather event in which precipitation falls as ice, due to atmosphere conditions. It causes damage.

Tornado: A tornado is a natural disaster resulting from a thunderstorm. Tornadoes are violent, rotating columns of air which can blow at speeds between 50 mph (80 km/h) and 300 mph (480 km/h) and possibly higher. Tornadoes can occur one at a time, or can occur in large tornado outbreaks associated with super cells or in other large areas of thunderstorm development. Waterspouts are tornadoes occurring over tropical waters in light rain conditions.

A tornado is a violent, dangerous, rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of acumulus cloud. It is also referred to as a *twister* or a *cyclone*, although the word cyclone is used in meteorology in a wider sense, to refer to any closed low pressure circulation.^[10]



Figure-12: Tornado

Tornadoes come in many shapes and sizes, but are typically in the form of a visible condensation funnel, whose narrow end touches the earth and is often encircled by a cloud of debris and dust. Most tornadoes have wind speeds less than 110 miles per hour (177 km/h), are approximately 250 feet (80 m) across and travel a few miles (several kilometers) before dissipating. The most extreme tornadoes can attain wind speeds of more than 300 mph (480 km/h), stretch more than two miles (3 km) across and stay on the ground for dozens of miles (perhaps more than 100 km).

Climate change: Climate change is a long-term hazard which can increase or decrease the risk of other weather hazards and also directly endangers property due to sea level rise and biological organisms due to habitat destruction.

Geomagnetic storm: Geomagnetic storms can disrupt or damage technological infrastructure and disorient species with magnetoreception.

Water spout: A tornado formed over water. Check Water spout.

Wildfire: Wildfire is a fire that burns in an uncontrolled and unplanned manner. Wildfires can result from natural occurrences such as lightning strikes or from human activity.

Disease: Disease is a natural hazard that can be enhanced by human factors such as urbanization or poor sanitation. Disease affecting multiple people can be termed an outbreak or epidemic. In some cases, a hazard exists in that a human-made defense against disease could fail, for example through antibiotic resistance.^[11]

Hydrological disasters

Flood: A flood results from an overflow of water beyond its normal confines of a body of water such as a lake, or the accumulation of water over land areas. A flood is an overflow of water that "submerges" land. The EU Floods Directive defines a flood as a temporary covering by water of land not normally covered by water. In the sense of "flowing water", the word may also be applied to the inflow of the tides. 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.

A **flood** is an overflow of water that submerges land which is usually dry. The European Union (EU) Floods Directive defines a flood as a covering by water of land not normally covered by water. In the sense of "flowing water", the word may also be applied to the inflow of the tide. Flooding may occur as an overflow of water from water bodies, such as a river or lake, in which the water overtops or breaks levees, resulting in some of that water escaping its usual boundaries, or it may occur due to an accumulation of rainwater on saturated ground in an a real flood. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, these changes in size are unlikely to be considered significant unless they flood property or drown domestic animals.^[12]



Figure-13: Flood and Tsunami

Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel, particularly at bends or meanders in the waterway. Floods often cause damage to homes and businesses if they are in the natural flood plains of rivers. While riverine flood damage can be

eliminated by moving away from rivers and other bodies of water, people have traditionally lived and worked by rivers because the land is usually flat and fertile and because rivers provide easy travel and access to commerce and industry. Some floods develop slowly, while others such as flash floods, can develop in just a few minutes and without visible signs of rain. Additionally, floods can be local, impacting a neighborhood or community, or very large, affecting entire river basins.

Benefits

Floods (in particular more frequent or smaller floods) can also bring many benefits, such as recharging ground water, making soil more fertile and increasing nutrients in some soils. Flood waters provide much needed water resources in arid and semi-arid regions where precipitation can be very unevenly distributed throughout the year and kills pests in the farming land. Freshwater floods particularly play an important role in maintaining ecosystems in river corridors and are a key factor in maintaining floodplain biodiversity. Flooding can spread nutrients to lakes and rivers, which can lead to increased biomass and improved fisheries for a few years. For some fish species, an inundated floodplain may form a highly suitable location for spawning with few predators and enhanced levels of nutrients or food. Fish, such as the weather fish, make use of floods in order to reach new habitats. Bird populations may also profit from the boost in food production caused by flooding. Periodic flooding was essential to the well-being of ancient communities along the Tigris-Euphrates Rivers, the Nile River, the Indus River, the Ganges and the Yellow River among others. The viability of hydropower, a renewable source of energy, is also higher in flood prone regions.^[13]

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 earthquakes and volcano eruptions as the one caused by the 2004 Indian Ocean earthquake, or by landslides such as the one which occurred at Lituya Bay, Alaska. The 2004 Indian Ocean earthquake created the Boxing Day tsunami, and on March 11, 2011, a tsunami occurred near Fukushima, Japan and spread through the Pacific.

Wildfires are large fires which often start in wildland areas. Common causes include lightning and drought but wildfires may also be started by human negligence or arson. They can spread to populated areas and can thus be a threat to humans and property,

as well as wildlife. Notable cases of wildfires were the 1871 Peshtigo Fire in the United States, which killed at least 1700 people, and the 2009 Victorian bushfires in Australia. Earthquakes, volcanic eruptions and other underwater explosions (including detonations of underwater nuclear devices), landslides, glacier calvings, meteorite impacts and other disturbances above or below water all have the potential to generate a tsunami. In being generated by the displacement of water, a tsunami contrasts both with a normal ocean wave generated by wind and with tides, which are generated by the gravitational pull of the Moon and the Sun on bodies of water. Tsunami waves do not resemble normal sea waves, because their wavelength is far longer. Rather than appearing as a breaking wave, a tsunami may instead initially resemble a rapidly rising tide, and for this reason they are often referred to as *tidal waves*. Tsunamis generally consist of a series of waves with periods ranging from minutes to hours, arriving in a so-called "wave train". Wave heights of tens of meters can be generated by large events. Although the impact of tsunamis is limited to coastal areas, their destructive power can be enormous and they can affect entire ocean basins; the 2004 Indian Ocean tsunami was among the deadliest natural disasters in human history with at least 230,000 people killed or missing in 14 countries bordering the Indian Ocean.^[14]

Catastrophic: Catastrophic flooding is usually associated with major infrastructure failures such as the collapse of a dam, but they may also be caused by drainage channel modification from a landslide, earthquake or volcanic eruption. Examples include outburst floods and lahars.

Limnic eruptions: A limnic eruption occurs when a gas, usually CO₂, suddenly erupts from deep lake water, posing the threat of suffocating wildlife, livestock and humans. Such an eruption may also cause tsunamis in the lake as the rising gas displaces water. Scientists believe landslides, volcanic activity, or explosions can trigger such an eruption. To date, only two limnic eruptions have been observed and recorded. In 1984, in Cameroon, a limnic eruption in Lake Mono uncaused the deaths of 37 nearby residents, and at nearby Lake Nyos in 1986 a much larger eruption killed between 1,700 and 1,800 people by asphyxiation.^[15]



Figure-14: Famine

Biological disasters

Famine: A famine is a widespread scarcity of food, caused by several factors including crop failure, population unbalance, or government policies. This phenomenon is usually accompanied or followed by regional malnutrition, starvation, epidemic, and increased mortality. Nearly every continent in the world has experienced a period of famine throughout history. Some countries, particularly in sub-Saharan Africa, continue to have extreme cases of famine. Famine had been a recurrent feature of life in the Indian sub-continental countries of India, Pakistan and Bangladesh, and reached its numerically deadliest peak in the late 18th and 19th centuries. Historical and legendary evidence names some 90 famines in 2,500 years of history. There are 14 recorded famines in India between the 11th and 17th centuries. Famines in India resulted in more than 60 million deaths over the course of the 18th, 19th, and early 20th centuries. The last major famine was the Bengal famine of 1943. A famine occurred in the state of Bihar in December 1966 on a much smaller scale and in which "Happily, aid was at hand and there were relatively few deaths". The drought of Maharashtra in 1970–1973 is often cited as an example in which successful famine prevention processes were employed. Famines in British India were severe enough to have a substantial impact on the long term population growth of the country in the 19th and early 20th centuries. Indian agriculture is heavily dependent on climate: a favourable southwest summer monsoon is critical in securing water for irrigating crops. Droughts, combined with policy failures, have periodically led to major Indian famines, including the Bengal famine of 1770, the Chalisa famine, the Doji bara famine, the Great Famine of 1876–78, and the Bengal famine of 1943. Some commentators have identified British government inaction as contributing factors to the severity of famines during the time India was under British rule. Famine largely ended by the

start of 20th century with the Bengal famine of 1943 being an exception related to complications during World War II. The 1883 Indian Famine Codes, transportation improvements, and changes following independence have been identified as furthering famine relief. In India, traditionally, agricultural labourers and rural artisans have been the primary victims of famines. In the worst famines, cultivators have also been susceptible.

Health disasters

Epidemics: An epidemic (**Swine flu**) is an outbreak of a contractible disease that spreads through a human population. A pandemic is an epidemic whose spread is global. There have been many epidemics throughout history, such as the Black Death. In the last hundred years, significant pandemics include the 1918 Spanish flu pandemic (killing an estimated 50 million people worldwide), the 1957–58 Asian flu pandemic, and the AIDS pandemic, which began in 1959. The 1968–69 Hong Kong water flu pandemic, the 2002-3 SARS pandemic, and the H1N1 Influenza (Swine Flu)

Pandemic in 2009–2010 were also significant cases. The 2009 flu pandemic or swine flu was an influenza pandemic, and the second of the two pandemics involving H1N1 influenza virus (the first of them being the 1918 flu pandemic), albeit in a new version. First described in April 2009, the virus appeared to be a new strain of H1N1 which resulted when a previous triple re-assortment of bird, swine and human flu viruses further combined with a Eurasian pig flu virus, leading to the term "swine flu". Unlike most strains of influenza, H1N1 does not disproportionately infect adults older than 60 years; this was an unusual and characteristic feature of the H1N1 pandemic. Even in the case of previously very healthy people, a small percentage will develop pneumonia or acute respiratory distress syndrome (ARDS). This manifests itself as increased breathing difficulty and typically occurs 3–6 days after initial onset of flu symptoms. The pneumonia caused by flu can be either direct viral pneumonia or a secondary bacterial pneumonia. In fact, a November 2009 New England Journal of Medicine article recommends that flu patients whose chest X-ray indicates pneumonia receive both antiviral and antibiotics. In particular, it is a warning sign if a child (and presumably an adult) seems to be getting better and then relapses with high fever, as this relapse may be bacterial pneumonia.

Despite being informally called "swine flu", the H1N1 flu virus cannot be spread by eating pork or pork products; similar to other influenza viruses, it is typically contracted by person to person transmission through respiratory droplets. Symptoms usually last 4–6 days.

Antivirals (oseltamivir or zanamivir) were recommended for those with more severe symptoms or those in an at-risk group.

The pandemic began to taper off in November 2009, and by May 2010, the number of cases was in steep decline. On 10 August 2010, the Director-General of the WHO, Margaret Chan, announced the end of the H1N1 pandemic and announced that the H1N1 influenza event has moved into the post-pandemic period. According to the latest WHO statistics (as of July 2010), the virus has killed more than 18,000 people since it appeared in April 2009, however they state that the total mortality (including deaths unconfirmed or unreported) from the H1N1 strain is "unquestionably higher".



Figure-15: Swine flu and Bird flu pandemics

Critics claimed the WHO had exaggerated the danger, spreading "fear and confusion" rather than "immediate information". The WHO began an investigation to determine whether it had "frightened people unnecessarily". A flu follow-up study done in September 2010, found that "the risk of most serious complications was not elevated in adults or children." In a 5 August 2011 PLoS ONE article, researchers estimated that the 2009 H1N1 global infection rate was 11% to 21%, lower than what was previously expected. However, by 2012, research showed that as many as 579,000 people could have been killed by the disease, as only those fatalities confirmed by laboratory testing were included in the original number, and meant that many of those without access to health facilities went uncounted. The majority of these deaths occurred in Africa and Southeast Asia. Experts, including the WHO, have agreed that an estimated 284,500 people were killed by the disease, much higher than the initial death toll.^[16]

Avian influenza — known informally as avian flu or **Bird flu** — refers to "influenza caused by viruses adapted to birds." The type with the greatest risk is highly pathogenic avian influenza (HPAI). "Bird flu" is a phrase similar to "swine flu," "dog flu," "horse flu," or

"human flu" in that it refers to an illness caused by any of many different strains of influenza viruses that have adapted to a specific host. All known viruses that cause influenza in birds belong to the species influenza A virus. All subtypes (but not all strains of all subtypes) of influenza A virus are adapted to birds, which is why for many purposes avian flu virus is the influenza A virus. (Note, however, that the "A" does not stand for "avian"). Adaptation is not exclusive. Being adapted toward a particular species does not preclude adaptations, or partial adaptations, toward infecting different species. In this way, strains of influenza viruses are adapted to multiple species, though may be preferential toward a particular host. For example, viruses responsible for influenza pandemics are adapted to both humans and birds. Recent influenza research into the genes of the Spanish flu virus shows it to have genes adapted to both birds and humans, with more of its genes from birds than less deadly later pandemic strains. While its most highly pathogenic strain (H5N1) had been spreading throughout Asia since 2003, avian influenza reached Europe in 2005, and the Middle East, as well as Africa, the following year. On January 22, 2012, China reported its second human death due to bird flu in a month following other fatalities in Vietnam and Cambodia. Companion birds in captivity and parrots are highly unlikely to contract the virus, and there has been no report of a companion bird with avian influenza since 2003. Pigeons do not contract or spread the virus. 84% of affected bird populations are composed of chicken and farm birds, while the 15% is made up of wild birds according to capture-and-release operations in the 2000s, during the SARs pandemic. The first deadly Canadian case was confirmed on January 3, 2014. On December 2, 2014, two turkey farms in British Columbia, Canada, had been placed under quarantine after the Canadian Food Inspection Agency confirmed an avian flu outbreak.

Space disaster: Impact events

Asteroids that impact the Earth have led to several major extinction events, including one that created the Chicxulub crater 64.9 million years ago and associated with the demise of the dinosaurs. Scientists estimate that the likelihood of death for a living human from a global impact event is comparable to death from airliner crash. One of the notable impact events in modern times was the Tunguska event in June 1908.

Solar flare: A solar flare is a phenomenon where the sun suddenly releases a great amount of solar radiation, much more than normal. Some had known solar flares include the X20

event on August 16, 1989 and a similar flare on April 2, 2001. The most powerful flare ever recorded occurred on November 4, 2003 (estimated at between X40 and X45).^[17]

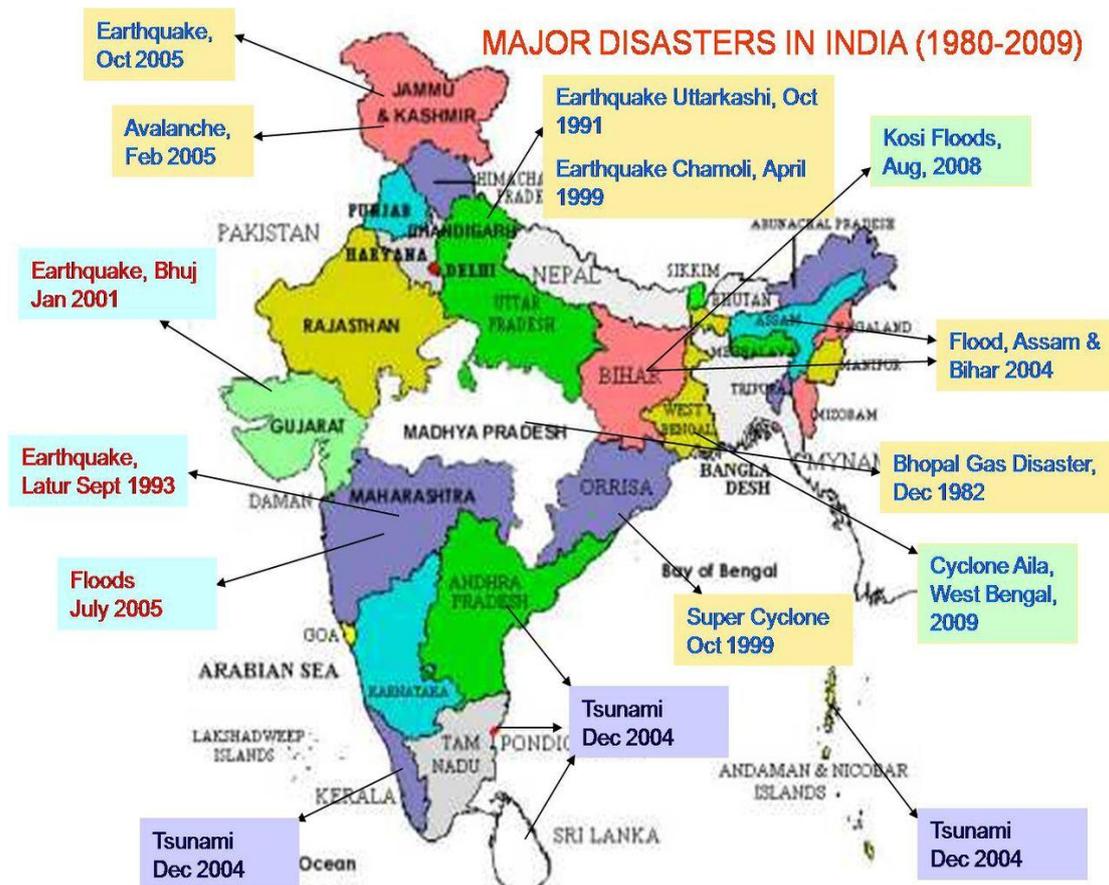


Figure-16: Natural disasters in India

Natural disasters in India, many of them related to the climate of India, cause massive losses of Indian life and property. Droughts, flash floods, cyclones, avalanches, landslides brought on by torrential rains, and snowstorms pose the greatest threats. A natural disaster might be caused by earthquakes, flooding, volcanic eruption, landslides, hurricanes etc. In order to be classified as a disaster it will have profound environmental effect and/or human loss and frequently incurs financial loss. Other dangers include frequent summer dust storms, which usually track from north to south; they cause extensive property damage in North India and deposit large amounts of dust from arid regions. Hail is also common in parts of India, causing severe damage to standing crops such as rice and wheat. The Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident in India, considered the world's worst industrial disaster. It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh. Over 500,000 people were exposed to methyl isocyanate (MIC) gas and other chemicals.



Figure-17: Bhopal Disaster

The toxic substance made its way into and around the shanty towns located near the plant. Estimates vary on the death toll. The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release. A government affidavit in 2006 stated that the leak caused 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries. Others estimate that 8,000 died within two weeks, and another 8,000 or more have since died from gas-related diseases. The initial effects of exposure were coughing, severe eye irritation and a feeling of suffocation, burning in the respiratory tract, blepharospasm (abnormal contraction or twitch of the eyelid), breathlessness, stomach pains and vomiting. People awakened by these symptoms fled away from the plant. Those who ran inhaled more than those who had a vehicle to ride. Owing to their height, children and other people of shorter stature inhaled higher concentrations. Thousands of people had died by the following morning. Primary causes of deaths were choking, reflexogenic circulatory collapse and pulmonary oedema. Findings during autopsies revealed changes not only in the lungs but also cerebral oedema, tubular necrosis of the kidneys, fatty degeneration of the liver and necrotising enteritis. The stillbirth rate increased by up to 300% and neonatal mortality rate by around 200%.

Landslides are common in the Lower Himalayas. The young age of the region's hills result in labile rock formations, which are susceptible to slippages. Rising population and development pressures, particularly from logging and tourism, cause deforestation. The result is denuded hillsides which exacerbate the severity of landslides; since tree cover impedes the downhill flow of water. Parts of the Western Ghats also suffer from low-intensity landslides. Avalanches occurrences are common in Kashmir, Himachal Pradesh, and Sikkim.

Floods are the most common natural disaster in India. The heavy southwest monsoon rains cause the Brahmaputra and other rivers to distend their banks, often flooding surrounding areas. Though they provide rice paddy farmers with a largely dependable source of natural irrigation and fertilization, the floods can kill thousands and displace millions. Excess, erratic, or untimely monsoon rainfall may also wash away or otherwise ruin crops. Almost all of India is flood-prone, and extreme precipitation events, such as flash floods and torrential rains, have become increasingly common in central India over the past several decades, coinciding with rising temperatures. Mean annual precipitation totals have remained steady due to the declining frequency of weather systems that generate moderate amounts of rain. Intertropical Convergence Zone, may affect thousands of Indians living in the coastal regions. Tropical cyclogenesis is particularly common in the northern reaches of the Indian Ocean in and around the Bay of Bengal. Cyclones bring with them heavy rains, storm surges, and winds that often cut affected areas off from relief and supplies. In the North Indian

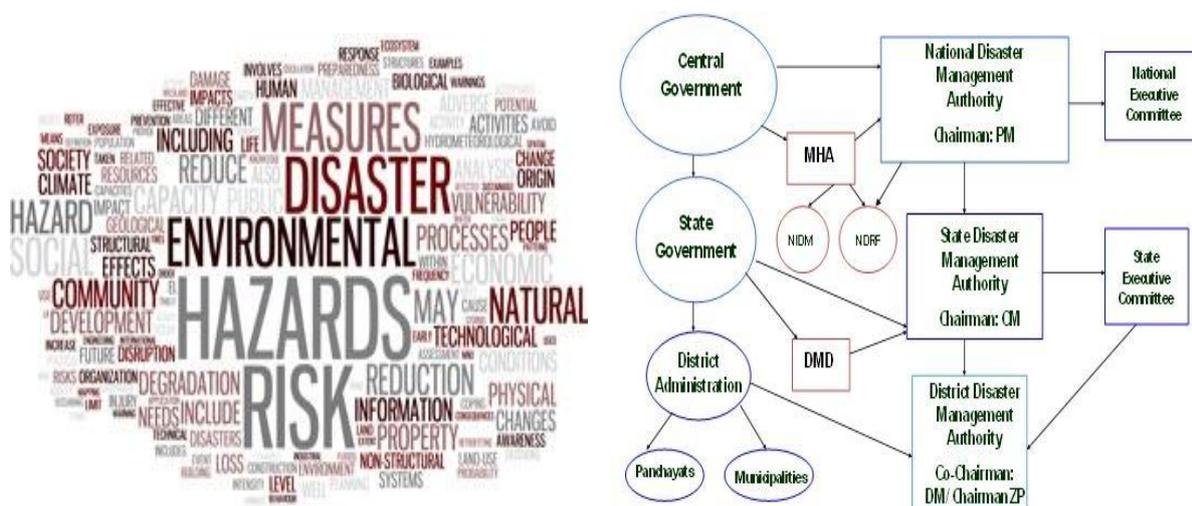


Figure-18: Disaster/Hazard Executive Committee

Ocean Basin, the cyclone season runs from April to December, with peak activity between May and November. Each year, an average of eight storms with sustained wind speeds greater than 63 kilometers per hour (39 mph) form; of these, two strengthen into true tropical cyclones, which have sustained gusts greater than 117 kilometers per hour (73 mph). On average, a major (Category 3 or higher) cyclone develops every other year.^[18]

During summer, the Bay of Bengal is subject to intense heating, giving rise to humid and unstable air masses that produce cyclones. Many powerful cyclones, including the 1737 Calcutta cyclone, the 1970 Bhola cyclone, the 1991 Bangladesh cyclone and the 1999 Odisha cyclone have led to widespread devastation along parts of the eastern coast of India and

neighboring Bangladesh. Widespread death and property destruction are reported every year in exposed coastal states such as Andhra Pradesh, Orissa, Tamil Nadu, and West Bengal. India's western coast, bordering the more placid Arabian Sea, experiences cyclones only rarely; these mainly strike Gujarat and, less frequently, Kerala.

In terms of damage and loss of life, Cyclone 05B, a supercyclone that struck Orissa on 29 October 1999, was the worst in more than a quarter-century. With peak winds of 160 miles per hour (257 km/h), it was the equivalent of a Category 5 hurricane. Almost two million people were left homeless; another 20 million people life was disrupted by the cyclone. Officially, 9,803 people died from the storm; unofficial estimates place the death toll at over 10,100.

The Red Cross and Red Crescent societies define disaster management as the organisation 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.

Types of disasters

There is no country that is immune from disaster, though vulnerability to disaster varies. There are four main types of disaster.

Natural disasters: including floods, hurricanes, earthquakes and volcano eruptions that have immediate impacts on human health and secondary impacts causing further death and suffering from (for example) floods, landslides, fires, tsunamis.

Environmental emergencies: including technological or industrial accidents, usually involving the production, use or transportation of hazardous material, and occur where these materials are produced, used or transported, and forest fires caused by humans.

Complex emergencies: involving a break-down of authority, looting and attacks on strategic installations, including conflict situations and war.

Pandemic emergencies: involving a sudden onset of contagious disease that affects health, disrupts services and businesses, brings economic and social costs. Any disaster can interrupt essential services, such as health care, electricity, water, sewage/garbage removal, transportation and communications. The interruption can seriously affect the health, social

and economic networks of local communities and countries. Disasters have a major and long-lasting impact on people long after the immediate effect has been mitigated. Poorly planned relief activities can have a significant negative impact not only on the disaster victims but also on donors and relief agencies. So it is important that physical therapists join established programmes rather than attempting individual efforts.^[19]

Manmade disaster

Anthropogenic hazards or **human-made hazards** can result in the form of a **human-made disaster**. In this case, *anthropogenic* means threats having an element of human intent, negligence, or error; or involving a failure of a human-made system. This is as opposed to natural hazards that cause natural disasters. Either can result in huge losses of life and property as well as damage to peoples' mental, physical and social well-being.

In New Delhi, the capital of India, the frequency of traffic collisions is 40 times higher than the rate in London, the capital of the United Kingdom. Traffic collision-related deaths increased from 13 per hour in 2008 to 14 per hour in 2009. More than 40 per cent of these casualties are associated with motorcycles and trucks. The most accident-prone time on Indian roads is during the peak hour at afternoon and evening. According to road traffic safety experts, the actual number of casualties may be higher than what is documented, as many traffic accidents go unreported. Moreover, victims who die some time after the accident, a span of time which may vary from a few hours to several days, are not counted as car accident victims. The frequency of traffic collisions in India is amongst the highest in the world. A National Crime Records Bureau (NCRB) report revealed that every year, more than 135,000 traffic collision-related deaths occur in India. The Campaign against Drunken Driving (CADD) is an organization founded by Prince Singhal which is campaigning against driving under the influence. The IRF asserts that people in India's political sphere do not have the will to curb traffic accidents. CSIR - Central Road Research Institute has developed an online accident recording portal. The main purpose of this portal is to encourage people to report the accidents they see. A group of Indian Researchers have developed a low-cost device which prevents automobile drivers from receiving or making cell phone calls when at wheel, but allows calls to other passengers in the vehicle.



Figure-19: Road Disaster and Train Disaster

A train wreck or train crash is a type of disaster involving one or more trains. Train wrecks often occur as a result of miscommunication, as when a moving train meets another train on the same track; or an accident, such as when a train wheel jumps off a track in a derailment; or when a boiler explosion occurs. Train wrecks have often been widely covered in popular media and in folklore. A head-on collision between two trains is colloquially called a "cornfield meet" in the US. For a fatal train wreck, the possible sentences are either life imprisonment without the possibility of parole, or even the death penalty. The willful wrecking of a train is punishable by death or life imprisonment without parole by the United States federal government.



Figure-20: Stampede Disaster and Aviation Disaster

A stampede is an act of mass impulse among herd animals or a crowd of people in which the herd (or crowd) collectively begins running with no clear direction or purpose. Species associated with stampede behavior include cattle, elephants, blue wildebeests, walrus, wild horses, rhinoceros, and humans. Human stampedes most often occur during religious pilgrimages and professional sporting and music events, as these events tend to involve a

large number of people. They also occur in times of panic (e.g. as a result of a fire or explosion) as people try to get away. However, more common causes are when the crowd are trying to get toward something as in the former examples, because the crowd is so big that those in the back continue pushing forward not knowing that those in the front are being crushed.

Deaths from human stampedes occur primarily from compressive asphyxiation and not trampling. This is referred to as crowd crush. The compressive force occurs from both horizontal pushing and vertical stacking. An aviation accident is defined by the Convention on International Civil Aviation Annex 13 as an occurrence associated with the operation of an aircraft, which takes place between the time any person boards the aircraft with the intention of flight until all such persons have disembarked, where a person is fatally or seriously injured, the aircraft sustains damage or structural failure or the aircraft is missing or is completely inaccessible. If the accident where the aircraft is destroyed or severely damaged so that it must be written off, it is further defined as a hull loss accident.

Arson is the criminal intent of setting a fire with intent to cause damage. The definition of arson was originally limited to setting fire to buildings, but was later expanded to include other objects, such as bridges, vehicles, and private property. Arson is the greatest recorded cause of fire. Some human-induced fires are accidental: failing machinery such as a kitchen stove is a major cause of accidental fires.

Industrial hazards: Industrial disasters occur in a commercial context, such as mining accidents. They often have an environmental impact. The Bhopal disaster is the world's worst industrial disaster to date, and the Chernobyl disaster is regarded the worst nuclear accident in history. Hazards may have longer-term and more dispersed effects, such as dioxin and DDT poisoning.

Fire: A wildfire is an uncontrolled fire in an area of combustible vegetation that occurs in the countryside area. Other names such as brush fire, bush fire, forest fire, desert fire, grass fire, hill fire, peat fire, vegetation fire, and veldfire may be used to describe the same phenomenon depending on the type of vegetation being burned, and the regional variant of English being used. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the

cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire. Bush fires, forest fires and mine fires are generally started by lightning, but also by human negligence or arson. They can burn thousands of square kilometers. If a fire intensifies enough to produce its own winds and "weather", it will form into a firestorm. A good example of a mine fire is the one near Centralia, Pennsylvania. Started in 1962, it ruined the town and continues to burn today. Some of the biggest city-related fires are The Great Chicago Fire, The Peshtigo Fire (both of 1871) and the Great Fire of London in 1666.



Figure-21: Wild fire

Casualties resulting from fires, regardless of their source or initial cause, can be aggravated by inadequate emergency preparedness. Such hazards as a lack of accessible emergency exits, poorly marked escape routes, or improperly maintained fire extinguishers or sprinkler systems may result in many more deaths and injuries than might occur with such protections.^[20]

Hazardous materials

Radiation contamination: When nuclear weapons are detonated or nuclear containment systems are otherwise compromised, airborne radioactive particles (nuclear fallout) can scatter and irradiate large areas. Not only is it deadly, but it also has a long-term effect on the next generation for those who are contaminated. Ionizing radiation is hazardous to living things, and in such a case much of the affected area could be unsafe for human habitation. During World War II, United States troops dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki. As a result, the radiation fallout contaminated the cities' water supplies, food sources, and half of the populations of each city were stricken with disease. In the Soviet Union, the Mayak industrial complex (otherwise known as Chelyabinsk-40 or

Chelyabinsk-65) exploded in 1957. The Kyshtym disaster was kept secret for several decades. It is the third most serious nuclear accident ever recorded. At least 22 villages were exposed to radiation and resulted in at least 10,000 displaced persons. In 1992 the former soviet union officially acknowledge the accident. Other Soviet republics of Ukraine and Belarus suffered also when a reactor at the Chernobyl nuclear power plant had a meltdown in 1986. To this day, several small towns and the city of Chernobyl remain abandoned and uninhabitable due to fallout.

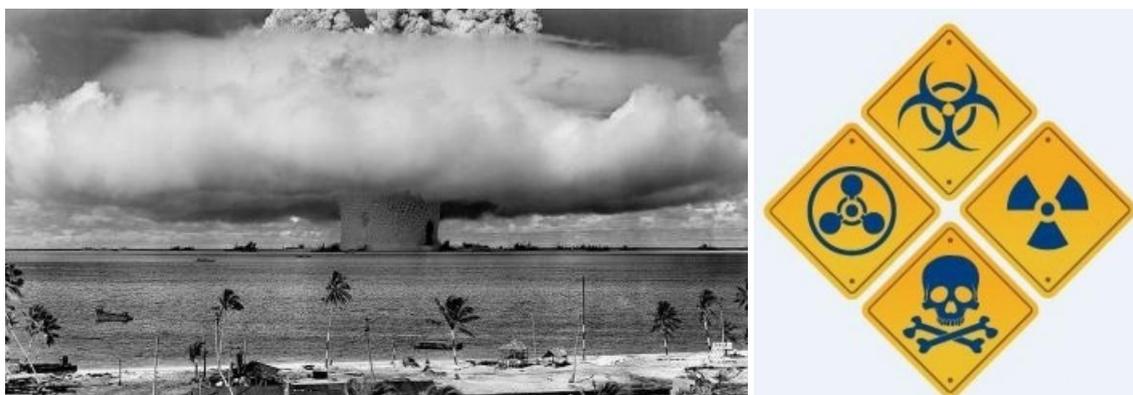


Figure-22: Radiological Hazard and CBRN

Planning for the possibility of a CBRN event may be appropriate for certain high-risk or high-value facilities and governments. Examples include Saddam Hussein's Halabja poison gas attack, the Sarin gas attack on the Tokyo subway and the preceding test runs in Matsumoto, Japan 100 kilometers outside of Tokyo and Lord Amherst giving smallpox laden blankets to Native Americans.^[21] The Chasnala mining disaster was a disaster that happened on 27 December 1975 in a coal mine in Chasnala near Dhanbad in the Indian state of Jharkhand. An explosion in the mine followed by flooding killed 372 miners. When a roof of coal caved in, 7 million imperial gallons (32,000 m³) of water per minute flooded into the mine. The miners were trapped under a mountain of debris and drowned when the water surged into the mine. The Indian Iron and Steel Company (IISCO), which owned the mine, said it conformed to international standards.



Figure-23: Chasnala Mining Disaster and Chernobyl Nuclear Power Plant Disaster

The Chernobyl disaster (also referred to as Chernobyl or the Chernobyl accident) was a catastrophic nuclear accident that occurred on 26 April 1986 at the Chernobyl Nuclear Power Plant in Ukraine (then officially the Ukrainian SSR), which was under the direct jurisdiction of the central authorities of the Soviet Union. An explosion and fire released large quantities of radioactive particles into the atmosphere, which spread over much of the western USSR and Europe. The Chernobyl disaster was the worst nuclear power plant accident in history in terms of cost and casualties. It is one of only two classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale, the other being the Fukushima Daiichi nuclear disaster in 2011. The battle to contain the contamination and avert a greater catastrophe ultimately involved over 500,000 workers and cost an estimated 18 billion rubles. During the accident itself, 31 people died, and long-term effects such as cancers are still being investigated.^[22]

CONCLUSION

Disaster prevention: These are activities designed to provide permanent protection from disasters. Not all disasters, particularly natural disasters, can be prevented, but the risk of loss of life and injury can be mitigated with good evacuation plans, environmental planning and design standards. In January 2005, 168 Governments adopted a 10-year global plan for natural disaster risk reduction called the Hyogo Framework. It offers guiding principles, priorities for action, and practical means for achieving disaster resilience for vulnerable communities.

Disaster preparedness: These activities are designed to minimise loss of life and damage – for example by removing people and property from a threatened location and by facilitating timely and effective rescue, relief and rehabilitation. Preparedness is the main way of reducing the impact of disasters. Community-based preparedness and management should be a high priority in physical therapy practice management.

Disaster relief: This is a coordinated multi-agency response to reduce the impact of a disaster and its long-term results. Relief activities include rescue, relocation, providing food and water, preventing disease and disability, repairing vital services such as telecommunications and transport, providing temporary shelter and emergency health care.

Disaster recovery: Once emergency needs have been met and the initial crisis is over, the people affected and the communities that support them are still vulnerable. Recovery activities include rebuilding infrastructure, health care and rehabilitation. These should blend with development activities, such as building human resources for health and developing policies and practices to avoid similar situations in future.

Disaster management is linked with sustainable development, particularly in relation to vulnerable people such as those with disabilities, elderly people, children and other marginalised groups. Health Volunteers Overseas publications address some of the common misunderstandings about disaster management.

REFERENCES

1. Barton, Allen H. *Communities in Disaster: A Sociological Analysis of Collective Stress Situations*, Doubleday, 1st edition., 1969.
2. Susanna M. Hoffman, Susanna M. & Anthony Oliver-Smith, authors & editors. *Catastrophe and Culture: The Anthropology of Disaster*, School of American Research Press, 1st edition., 2002.
3. Dunnavan, G. M.; Diercks, J. W. "An Analysis of Super Typhoon Tip (October 1979)". *Monthly Weather Review.*, 1980; 108(11): 1915.
4. Alexander, David. *Principles of Emergency planning and Management*, Oxford University Press, 1 edition 2002.
5. Emanuel, K.; Sobel, A. "Response of tropical sea surface temperature, precipitation, and tropical cyclone-related variables to changes in global and local forcing". *Journal of Advances in Modeling Earth Systems.*, 2013; 5(2): 447.
6. Bell, M. M.; Montgomery, M. T.; Emanuel, K. A. "Air–Sea Enthalpy and Momentum Exchange at Major Hurricane Wind Speeds Observed during CBLAST". *Journal of the Atmospheric Sciences.*, 2012; 69(11): 3197.
7. Kahneman, D. y Tversky, A. "Choices, Values and frames". *American Psychologist.*, 1984; 39(4): 341–350.

8. Woolnough, S. J.; Slingo, J. M.; Hoskins, B. J. "The Relationship between Convection and Sea Surface Temperature on Intraseasonal Timescales". *Journal of Climate.*, 2000; 13(12): 2086.
9. Aguirre, B. E & Quarantelli, E. H. (2008). "Phenomenology of Death Counts in Disasters: the invisible dead in the 9/11 WTC attack". *International Journal of Mass Emergencies and Disasters.*, 2008; 26(1): 19–39.
10. Wilson, H. "Divine Sovereignty and The Global Climate Change debate". *Essays in Philosophy.*, 2010; 11(1): 1–7
11. Uscher-Pines, L. "Health effects of Relocation following disasters: a systematic review of literature". *Disasters.*, 2009; 33(1): 1–22.
12. Rappaport, Edward N. "Atlantic Hurricane Season of 1997" (PDF). *Monthly Weather Review.*, 1999; 127(9): 2012.
13. Scheper-Hughes, N. "Katrina: the disaster and its doubles". *Anthropology Today.*, 2005; 21(6): 2765-78.
14. Phillips, B. D. "Disaster as a Discipline: The Status of Emergency Management Education in the US". *International Journal of Mass-Emergencies and Disasters.*, 2005; 23(1): 111–140.
15. Mileti, D. and Fitzpatrick, C. "The causal sequence of Risk communication in the Parkfield Earthquake Prediction experiment". *Risk Analysis.*, 1992; 12: 393–400.
16. Korstanje, Maximiliano E. "Swine Flu in Buenos Aires: Beyond the Principle of Resilience", *International Journal of Disaster Resilience in the Built Environment*, 2001; 2(1): 59–73.
17. Wu, M. C.; Chang, W. L.; Leung, W. M. "Impacts of El Niño–Southern Oscillation Events on Tropical Cyclone Landfalling Activity in the Western North Pacific". *Journal of Climate.*, 2004; 17(6): 1419.
18. <http://restoreyoureconomy.org/disaster-overview/types-of-disasters/>
19. Quarantelli E.L. "Where We Have Been and Where We Might Go", *What is a Disaster?: a Dozen Perspectives on the Question*, London, Routledge, 1 edition., 1998; 146-159.
20. Blaikie, Piers, Terry Cannon, Ian Davis & Ben Wisner. *At Risk – Natural hazards, people's vulnerability and disasters*, Wiltshire: Routledge, 2003.
21. <http://www.differencebetween.com/difference-between-natural-disaster-and-vs-man-made-disaster/>
22. <http://www.ask.com/science/difference-between-natural-human-made-disasters-5f04560d0f5c0e45>