



Natural and Manmade Disasters



What disasters would and could effect our community?



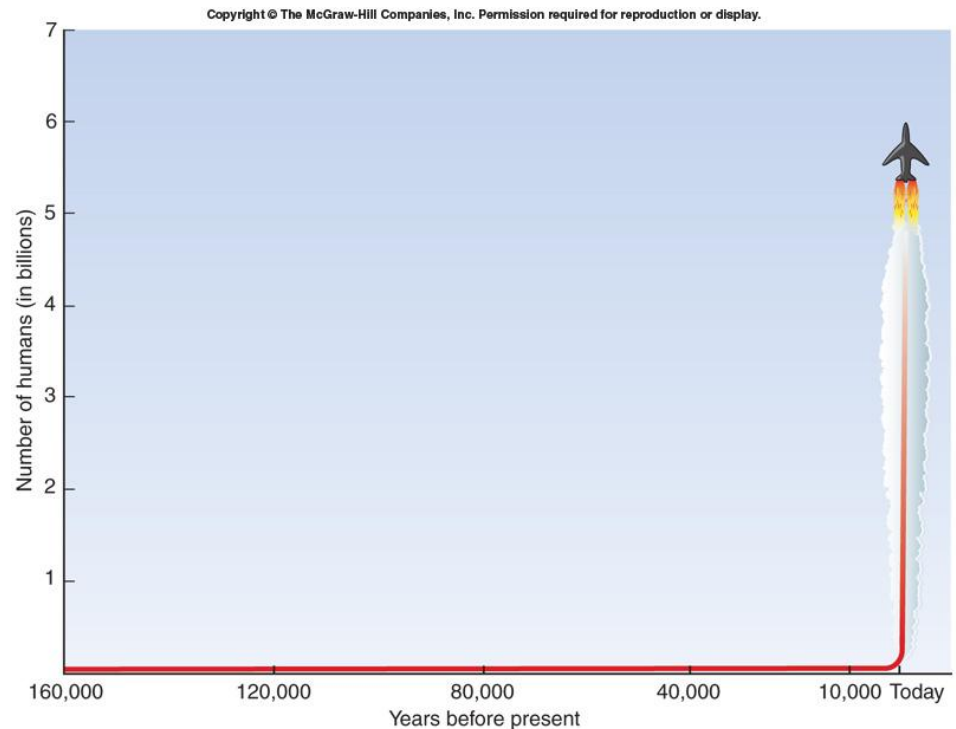
Types of Natural Disasters

- Earthquakes
- Floods
- Avalanche
- Tsunamis
- Winter Storms
- Wildfires
- Tornadoes
- Hurricanes
- Volcanoes



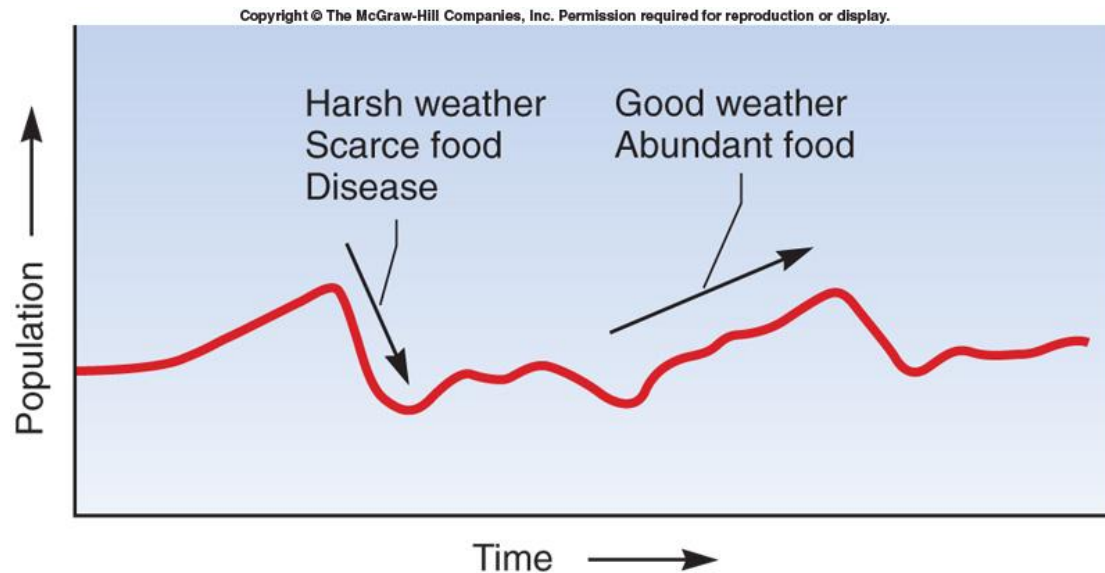
Overview of Human Population History

- Difficult to assess early human population growth
- Human species 'began' approximately **160,000 years ago**, with a **few thousand people**
- Human population has grown to **over 6.7 billion people in 2008**
- Growth rate is **exponential**



The Last 10,000 Years of Human History

- Flat population growth curve until 8,000 years ago
 - Agriculture established
 - Domestication of animals
 - Growth rate increased to 0.036%/year
- By 2,000 years ago, population ~200 million people
 - Better shelter, food, water supplies → faster population growth
 - Growth rate of 0.056%/year
- By 1750, population ~800 million people



The Last 10,000 Years of Human History

➤ By 1750, population ~800 million people

- Public health principles, causes of disease recognized
- Birth rates soared, death rates dropped

➤ 1810: ~1 billion

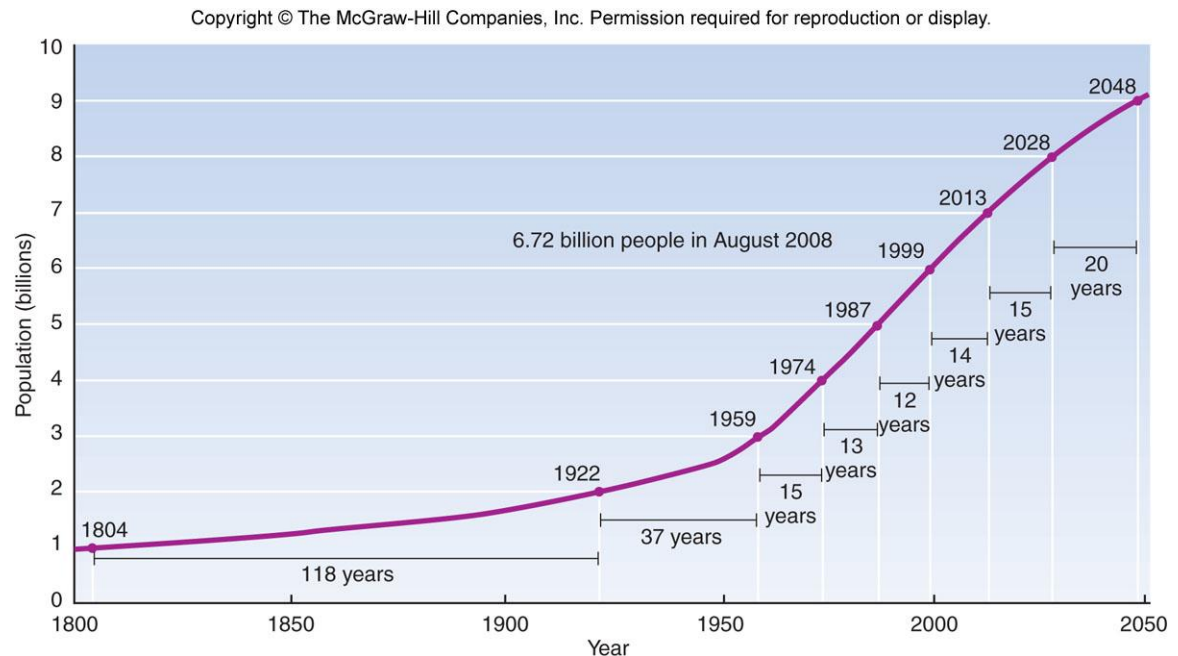
➤ 1925: ~2 billion

➤ 1960: ~3 billion

➤ 1974: ~4 billion

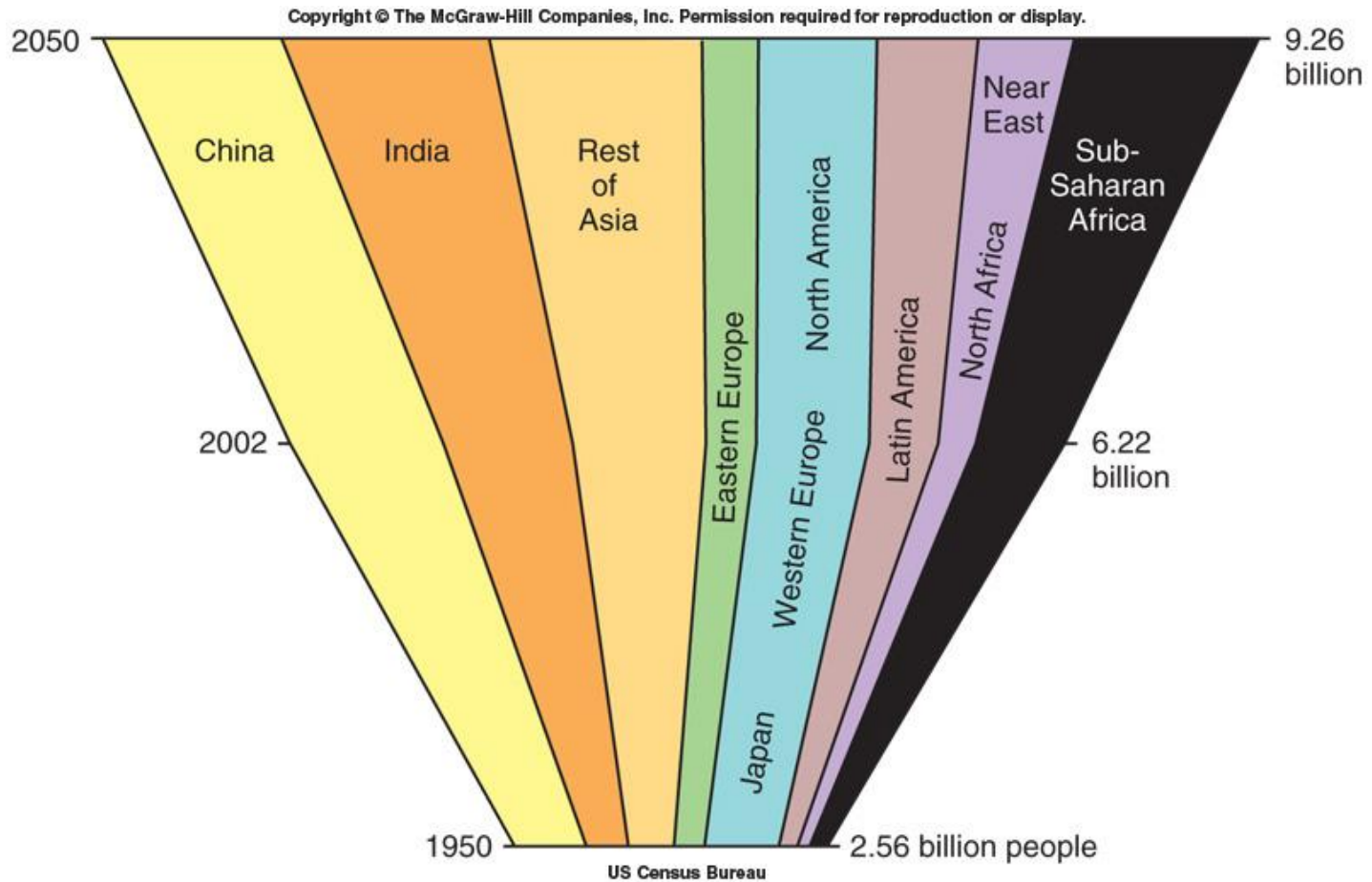
➤ 1987: ~5 billion

➤ 1999: ~6 billion



➤ By 2028, projected population ~8 billion

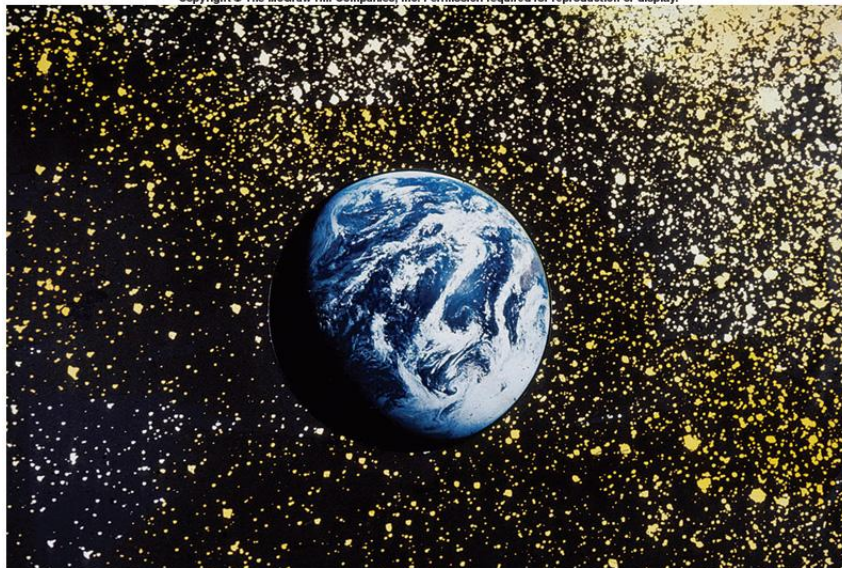
Future World Population



Carrying Capacity

➤ How many people can Earth support?

- Calculations of **carrying capacity** vary considerably
- Increasing amounts of food can be produced
- People can migrate from areas of famine or poverty to less crowded or wealthier areas



- BUT Earth's resources are finite, so solutions are temporary



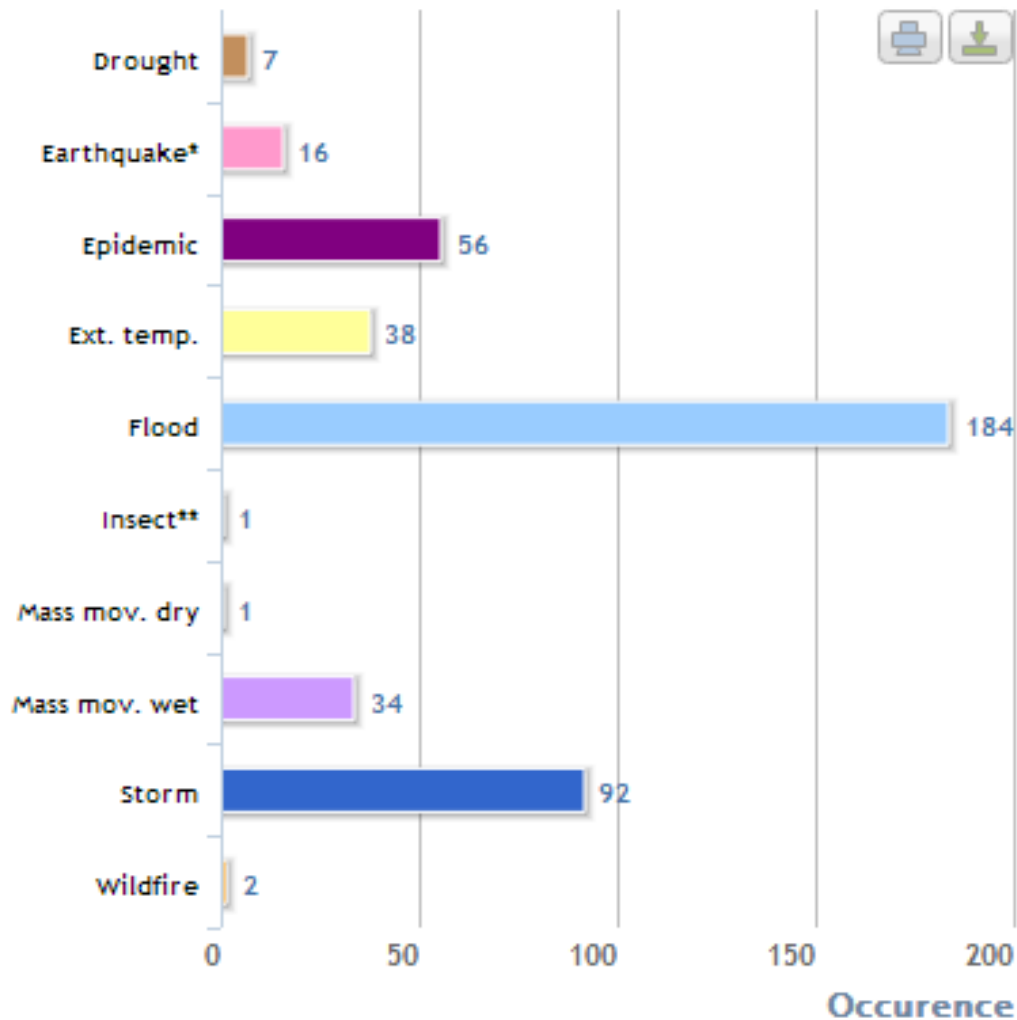
India - Disaster Statistics

Natural Disasters from 1980 – 2010 Overview

- ▶ No of events:431
- ▶ No of people killed:143,039
- ▶ Average killed per year:4,614
- ▶ No of people affected:1,521,726,127
- ▶ Average affected per year:49,087,940
- ▶ Economic Damage (US\$ X 1,000):48,063,830
- ▶ Economic Damage per year (US\$ X 1,000):1,550,446



Natural Disaster Occurrence Reported



Average Disaster Per Year

Drought:	0.23
Earthquake*:	0.52
Epidemic:	1.81
Extreme temp:	1.23
Flood:	5.94
Insect infestation:	0.03
Mass mov. dry:	0.03
Mass mov. wet:	1.10
Volcano:	...
Storm:	2.97
Wildfire:	0.06



Top 10 Natural Disasters Reported

Affected People

Disaster	Date	Affected (no. of people)	
Drought	1987	300,000,000	
Drought	2002	300,000,000	
Flood	1993	128,000,000	
Drought	1982	100,000,000	
Drought	2000	50,000,000	
Flood	2002	42,000,000	
Flood	1982	33,500,000	
Flood	2004	33,000,000	
Flood	1995	32,704,000	
Flood	1980	30,000,023	

Top 10 Natural Disasters Reported

Killed People

Disaster	Date	Killed (no. of people)
Earthquake*	2001	20,005
Earthquake*	2004	16,389
Storm	1999	9,843
Earthquake*	1993	9,748
Epidemic	1984	3,290
Epidemic	1988	3,000
Storm	1998	2,871
Extreme temp.	1998	2,541
Flood	1994	2,001
Flood	1998	1,811



Top 10 Natural Disasters Reported

Economic Damages

Disaster	Date	Cost (US\$ X 1,000)	
Flood	1993	7,000,000	
Flood	2006	3,390,000	
Flood	2005	3,330,000	
Earthquake*	2001	2,623,000	
Flood	2004	2,500,000	
Storm	1999	2,500,000	
Flood	2005	2,300,000	
Storm	1990	2,200,000	
Flood	2009	2,150,000	
Storm	1996	1,500,300	



- Disasters are ubiquitous but most large scale disasters occur in cancer and tropic of Capricorn geographical region which encompasses most of the developing nations.
- Due to the geography and topography, India has faced serious large scale natural disasters like droughts, cyclones and earthquakes.
- The available statistics also show that the number of disasters per year is increasing but also the number of people affected and killed is also rising.



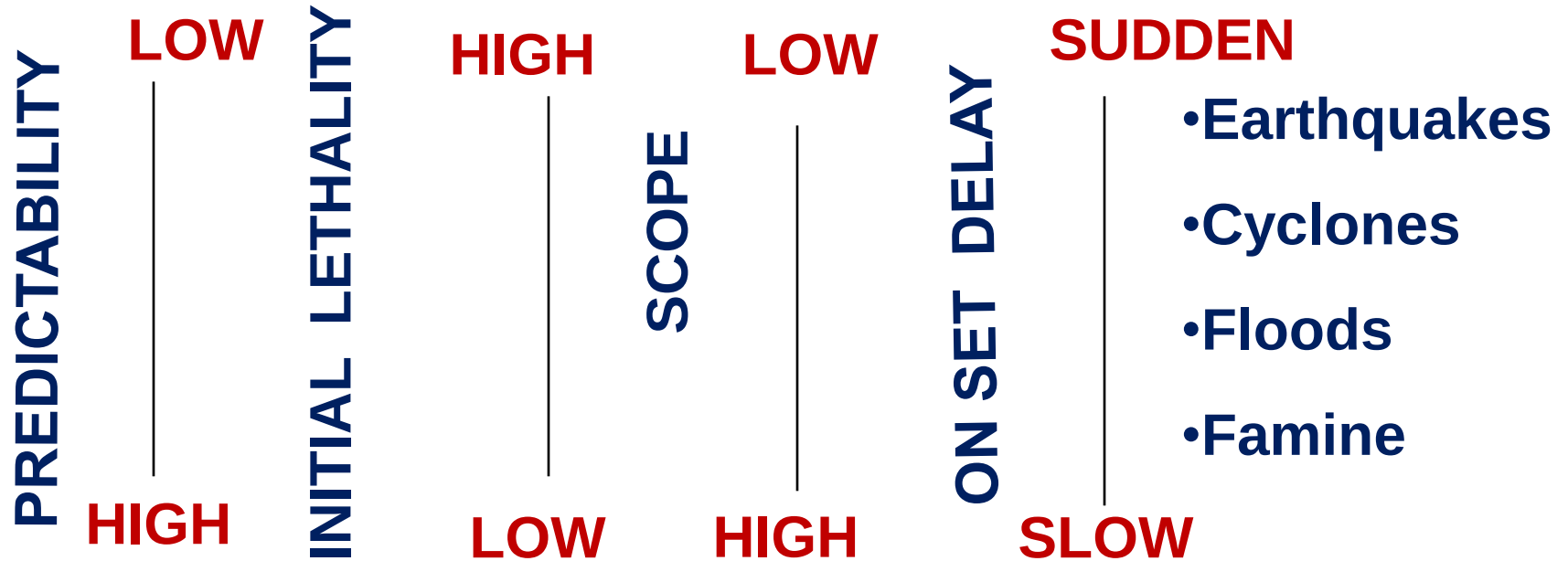
Major Disasters in Known History of India

S. NO.	Name of Event	Year	Fatalities
1.	Bengal Earthquake	1737	300,000
2.	Bengal Cyclone	1864	60,000
3.	The Great Famine of Southern India	1876-1878	5.5 million
4.	Maharashtra Cyclone	1882	100,000
5.	The Great Indian famine	1896-1897	1.25 million to 10 million
6.	Kangra earthquake	1905	20,000
7.	Bihar Earthquake	1934	6,000
8.	Bengal Cyclone	1970	500,000 (include Pakistan & Bangladesh)
9.	Drought	1972	200 million people affected
10.	Andhra Pradesh Cyclone	1977	10,000
11.	Latur Earthquake	1993	7,928 death and 30,000 injured
12.	Orissa Super Cyclone	1999	10,000
13.	Gujarat Earthquake	2001	25,000
14.	Indian Ocean Tsunami	2004	10,749 deaths 5,640 persons missing
15.	Kashmir Earthquake	2005	86000 deaths (include Kashmir & Pakistan)





CHARACTERISTICS OF NATURAL DISASTERS



- The last century has added a new ecological dimension to the definition of a disaster.
- We then have newer man made disasters on our hands which include chemical Disasters like Bhopal Gas Tragedy of 1984, oil spills, air water and soil pollution.
- Developing countries have been facing the brunt more than the developed ones because they have less physical and financial resources.
- India as the second largest populated country with 1.2 billion population has a large share of all types of disasters.



- It is **virtually impossible to prevent most disaster.**
- Nevertheless, **we can forestall or alleviate many of their worst effect** by anticipating them and by **being prepared.**
- The greatest number of disasters occur in those countries that are **already most adversely affected by ill-health and poor economic conditions.**



- Disasters disrupt progress and destroy the outcome of developmental efforts over several years, often pushing nations in quest for progress back by several decades.
- Thus, efficient reduction of disaster risks, rather than mere response to their occurrence, has in recent times, received increased attention both within India and abroad.
- With a vision to build a safe and disaster resilient India, the Government has adopted a holistic, proactive, multi-hazard oriented and technology driven strategy by promoting a culture of prevention, mitigation, preparedness and response.

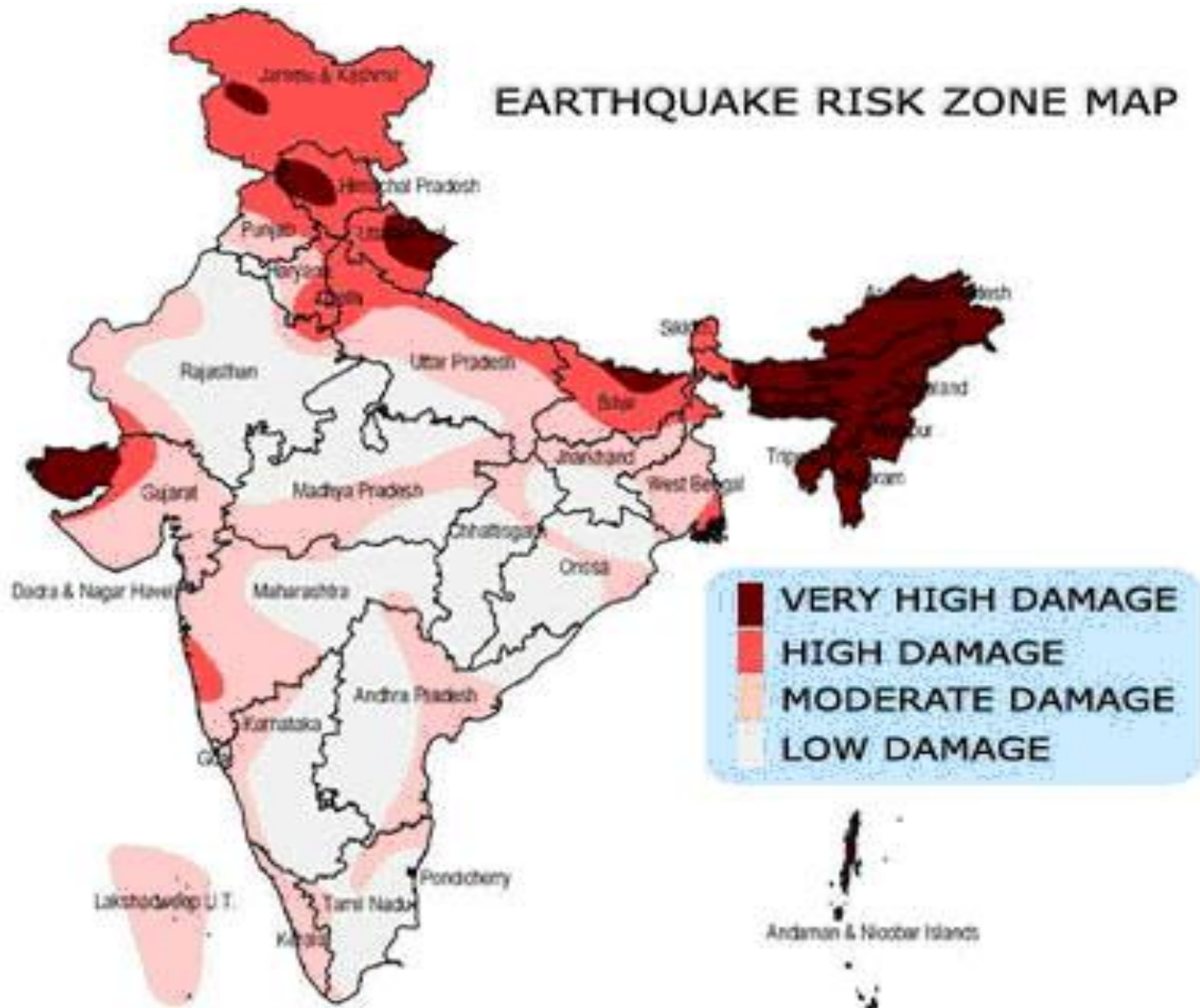


Natural disasters

- Earthquake: India is having a high risk towards Earthquakes. More than 58 per cent of India's land area is under threat of moderate to severe seismic hazard.
- During the last 20 years, India has experienced 10 major earthquakes that have resulted in more than 35,000 deaths.
- Of the earthquake-prone areas, 12% is prone to very severe earthquakes, 18% to severe earthquakes and 25% to damageable earthquakes.
- The biggest quakes occur in the Andaman and Nicobar Islands, Kutch, Himachal and the North-East. The Himalayan regions are particularly prone to earthquakes.



EARTHQUAKE RISK ZONE MAP



Earthquake in Gujarat



Earthquake in Gujarat



Earthquake in Gujarat



Floods

- About 30 million people are affected annually. Floods in the Indo–Gangetic–Brahmaputra plains are an annual feature.
- On an average, a few hundred lives are lost, millions are rendered homeless and several hectares of crops are damaged every year.
- Nearly 75% of the total rainfall occurs over a short monsoon season (June – September). 40 million hectares, or 12% of Indian land, is considered prone to floods.
- Floods are a perennial phenomenon in at least 5 states - Assam, Bihar, Orissa , Uttar Pradesh and West Bengal.
- On account of climate change, floods have also occurred in recent years in areas that are normally not flood prone.
- In 2006, drought prone parts of Rajasthan experienced floods.



Droughts

- Drought is another recurrent phenomenon which results in widespread adverse impact on vulnerable people's livelihoods and young children's nutrition status.
- About 50 million people are affected annually by drought. Of approximately 90 million hectares of rain-fed areas, about 40 million hectares are prone to scanty or no rain.
- Although a slow onset emergency, and to an extent predictable emergency, drought has caused severe suffering in the affected areas in recent years, including effects on poverty, hunger, and unemployment.

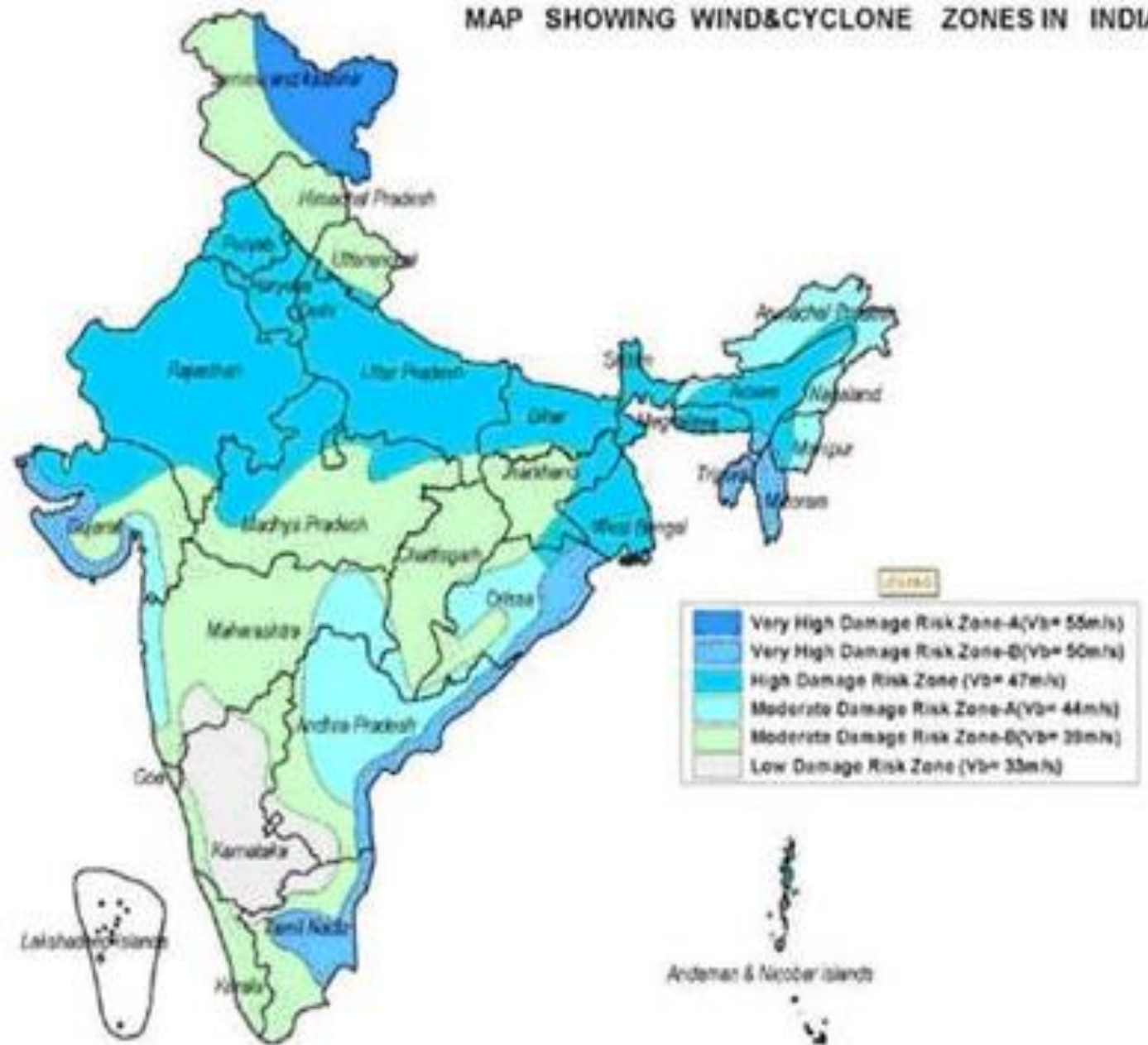


Cyclones

- About 8% of the land is vulnerable to cyclones of which coastal areas experience two or three tropical cyclones of varying intensity each year.
- Cyclonic activities on the east coast are more severe than on the west coast.
- The Indian continent is considered to be the worst cyclone-affected part of the world, as a result of low-depth ocean bed topography and coastal configuration.
- The principal threat from a cyclone are in the form of gales and strong winds; torrential rain and high tidal waves/storm surges.
- More cyclones occur in the Bay of Bengal than in the Arabian Sea and the ratio is approximately 4:1.
- An analysis of the frequency of cyclones on the east and west coasts of India.



MAP SHOWING WIND & CYCLONE ZONES IN INDIA



Landslide

- In the hilly terrain of India including the Himalayas and North East India, landslides have been a major and widely spread natural disasters that often strike life and property and occupy a position of major concern.
- One of the worst tragedies took place at Malpa Uttarkhand (UP) on 11th and 17th August 1998 when nearly 380 people were killed when massive landslides washed away the entire village.



Avalanche

- An Avalanche is a movement of snow, ice and rock down a mountainside. Avalanches happen very suddenly and can move as fast as a racing car up to 124mph. Avalanches are river like speedy flow of snow or ice descending from the mountain tops.
- Avalanches are very damaging and cause huge loss to life and property.
- In Himalayas, avalanches are common
- Avalanches can be caused by
 - ✓ snow melting quickly
 - ✓ snow freezing, melting then freezing again
 - ✓ someone skiing a
 - ✓ loud noise or an earth tremor

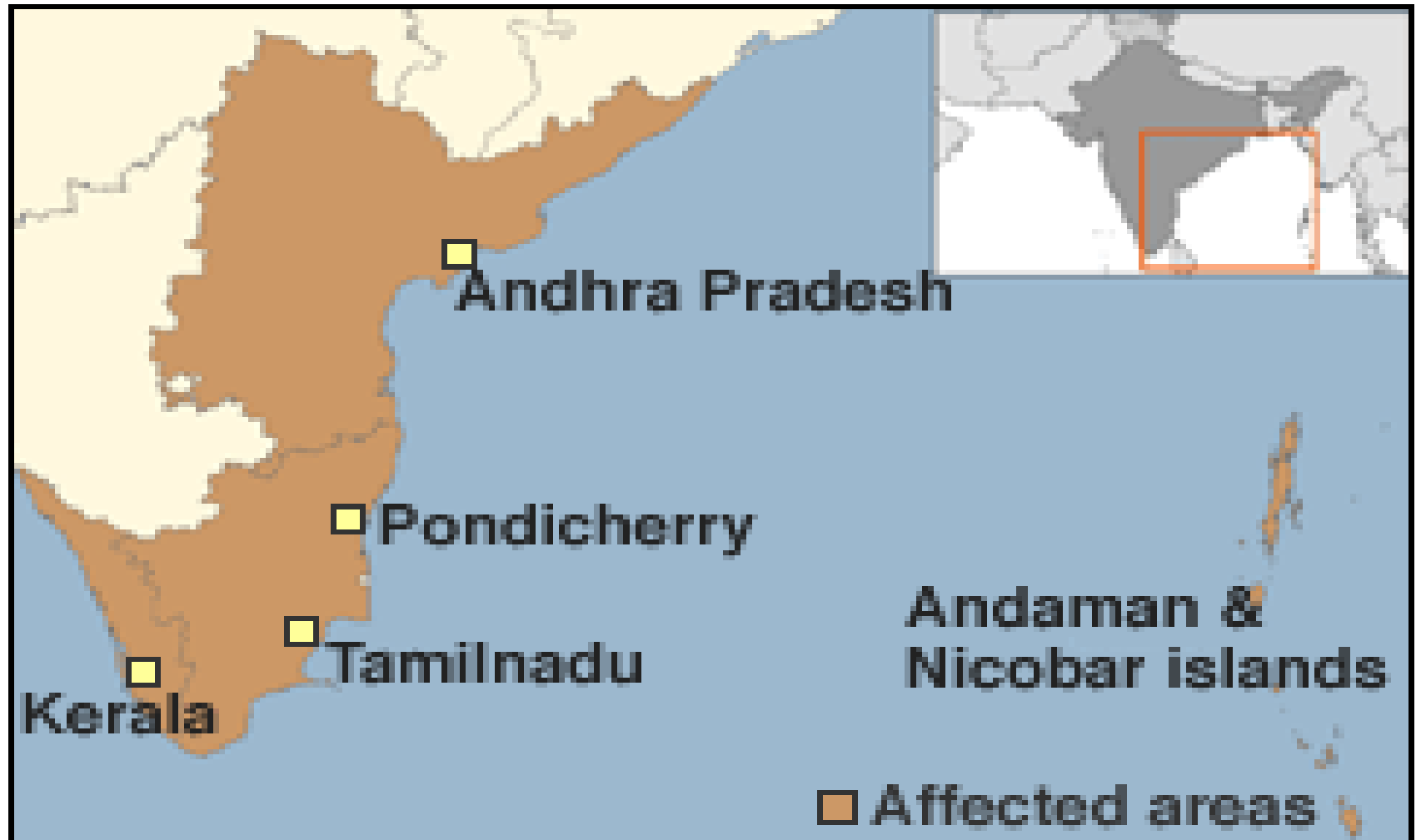


Tsunami

- Form as a result of earthquakes, volcanoes, or landslides under the ocean
- Waves grow taller as they reach the coast
- Four out of Five occur in the Ring of Fire
- Over 200,000 people killed in the 26/12/05 Indian Ocean tsunami



Tsunami affected Indian territory



TSUNAMI



TSUNAMI



TSUNAMI



Tornadoes

- ▶ Rotating, funnel-shaped clouds from powerful thunderstorms
- ▶ Winds up to 300 MPH capable of producing major damage
- ▶ More occur in the United States than anywhere else in the world; they occur in every state in America.



Effects of Tornadoes in Alabama



Tuscaloosa County: December 16, 2000

Hurricanes

- ▶ Massive severe storms occurring in the tropics
- ▶ Winds greater than 75 MPH
- ▶ Clouds & winds spin around the eye
- ▶ Produce heavy rains, high winds, large waves, and spin-off tornadoes



Effects of Hurricanes



Hurricane Frederick - 1979



Hurricane Ivan 2005

Volcanoes

- ▶ More than 500 active volcanoes in the world; over half in the Ring of Fire
- ▶ Pressure builds below the earth's surface producing eruptions of lava, rock, and volcanic gases



Effects of Tsunamis



**Indian Ocean Tsunami –
December 26, 2005**



Winter Storms

- ▶ May include snow, ice storms, sleet, freezing rain, and extremely cold temperatures
- ▶ Most deaths occur in automobiles
- ▶ Storms may cause widespread power outages



Wildfires

- ▶ Fires can burn out of control in areas of forest or bush land. Fires are caused by lightning, sparks of electricity or careless people. Wind may blow a bushfire to areas where people live.
- ▶ Occur in forests, grasslands, and wooded areas
- ▶ Most common causes: lightning and human accidents
- ▶ Burn more than 4 million acres in the U.S. each year



MAN MADE DISASTERS

TYPES OF MAN MADE DISASTERS

- ▶ NUCLEAR ACCIDENTS
- ▶ CHEMICAL DISASTERS
- ▶ BIOLOGICAL DISASTERS
- ▶ GLOBAL WARMING
- ▶ TERRORIST ATTACKS
- ▶ POLLUTION



NUCLEAR DISASTERS

- ▶ One of the scariest things about nuclear power is when something goes wrong and an accident occurs. Radiation is released into the environment and people get hurt
- ▶ Two of the most famous nuclear accidents occurred at the Three Mile Island reactor 2 in the United States and the Chernobyl reactor 4 in the former Soviet Union. In this text we will discuss these two disasters, along with correcting a few common misconceptions about nuclear accidents.
- ▶ Nuclear weapons are thus, far more destructive and harmful to the society than any other weapon. Many countries in the world have developed nuclear energy. The developed countries reiterate that nuclear energy will be used only for PEACEFUL PURPOSES. We can only hope this to be true, lest we face another Hiroshima and Nagasaki situation.



NUCLEAR DISASTERS

- ▶ Nuclear radiation keeps on showing its effect for a considerable period of time even after its explosion.
- ▶ In case of a nuclear explosion, nothing much can be done. Some precautions however may be taken.
- ▶ We should stay inside keeping doors and windows shut to protect ourselves against nuclear radiation.
- ▶ Nuclear activity may affect our health and cause nausea, giddiness, vomiting etc., and for that medical help should be taken



Chemical disasters

- ▶ By their nature, the manufacture, storage, and transport of chemicals are accidents waiting to happen. Chemicals can be corrosive, toxic, and they may react, often explosively. The impacts of chemical accidents can be deadly, for both human being-environment.
- ▶ Chemical weapons are also weapons of mass destruction. Sometimes handling of hazardous chemicals in an irresponsible way can cause much destruction.
- ▶ Chemical disasters are also caused by industrial accidents. The poisonous gases spread in the atmosphere and the people who inhale the same air face dangerous consequences



Chemical disasters

- ▶ Those industries, which use hazardous chemicals or produce such chemicals, should have contingency action plan to help people if such a disaster takes place.
 - ▶ Such industries should have timely warning systems so that people can immediately take safety measures such as locking their houses and taking the family and animals away to a safe place.
 - ▶ Stringent safety measures and checkups in the factory and critical analysis of the working condition of the factory will help to take timely measures to check any disaster
-



Biological disasters

- ▶ Biological disaster spreads through the organism that is developed in the form of BACTERIA or MICROBES. Biological agent spread fast in the environment and then makes an attack on the human beings. The people inhale these microbes. When these microbes find themselves a host body, they start affecting the immune systems of the body. Microbes' also entire human body through open wounds or cuts.
- ▶ The attack of these microbes is generally slow but once they are spread in the body, it becomes different to control them. It takes the life of the affected persons. Many a time, it becomes difficult to diagnose the illness caused by these microbes and it proves to be fatal.



Global warming

- ▶ **Global warming** is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation. Since the early 20th century, Earth's mean surface temperature has increased by about 0.8 °C (1.4 °F), with about two-thirds of the increase occurring since 1980.
- ▶ Warming of the climate system is unequivocal, and scientists are more than 90% certain that it is primarily caused by increasing concentrations of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation.
- ▶ The effects of an increase in global temperature include rise in sea levels and a change in the amount and pattern of precipitation, as well as a probable expansion of subtropical deserts.



Global warming

- ▶ Warming is expected to be strongest in the Arctic and would be associated with the continuing retreat of glaciers, permafrost and sea ice.
- ▶ Other likely effects of the warming include a more frequent occurrence of extreme-weather events including heat waves, droughts and heavy rainfall, ocean acidification and species extinctions due to shifting temperature regimes.
- ▶ Effects significant to humans include the threat to food security from decreasing crop yields and the loss of habit from industrialized nations



TERRORIST ATTACKS

- ▶ **terrorist attack** - a surprise attack involving the deliberate use of violence against civilians in the hope of attaining political or religious aims
- ▶ terrorist act can be defined as the calculated use of violence (or the threat of violence) against civilians in order to attain goals that are political or religious or ideological in nature; this is done through intimidation or coercion or instilling fear



Worst terrorist attacks

- ▶ Mumbai terrorist attack is also referred to as November 26 or 26/11 and this terrorist attack targeted India's largest city Mumbai. It was actually a series of 10 coordinated shooting and bombing attacks across Mumbai by Islamic terrorists who are believed to have come from Pakistani Seawaters and backed by ISI, Pakistani secret service agency. It affected the Indo-Pak relation immensely and the bilateral relations were debilitated which have never returned to normalcy since
 - ▶ There was a series of coordinated attacks by Al-Qaeda on America on September 11, 2001. Four commercial passenger jet airliners were hijacked by 19 Al-Qaeda members and they intentionally steered two of the planes towards the Twin Towers of World Trade Center, consequently bringing them down to earth.
 - ▶ The third airliner was crashed into The Pentagon in Virginia, just outside Washington, D.C. and the fourth one crashed into a field near Shanksville in rural Pennsylvania. There were no survivors from any of the flights. This event triggered many changes in the world as a whole and was the beginning of a very horrendous film for the humans across the globe because humans had to pay a very heavy price of this terrorist attack and this fact is conspicuous from the current state of affairs
-



Pollution

- ▶ **Pollution** is the introduction of contaminants into the natural environment that cause adverse change.^[1] Pollution can take the form of chemical substances or energy such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source pollution. The Blacksmith Institute issues an annual list of the world's worst polluted places. In the 2007 issues the ten top nominees are located in Azerbaijan, China, India, Peru, Russia, Ukraine and Zambia.
-



FORMS OF POLLUTION

The major forms of pollution are listed below along with the particular contaminant relevant to each of them:

- **Air pollution:-** the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter, or fine dust is characterized by their micro meter size PM_{10} to $PM_{2.5}$.
- **Light pollution:-** includes light trespass, over-illumination and astronomical interference.
- **Littering:-** the criminal throwing of inappropriate man-made objects, unremoved, on to public and private properties.
- **Noise pollution:-** which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.



FORMS OF POLLUTION

- **Soil contamination** occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons.
 - **Radioactive contamination**, resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment.
 - **Thermal pollution**, is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.
 - **Visual pollution**, which can refer to the presence of overhead power lines, motorway billboards, scarred landforms (as from strip mining), open storage of trash, municipal solid waste or space debris.
 - **Water pollution**, by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides); waste disposal and leaching into groundwater; eutrophication and littering.
-



Man-made Environmental Disasters

Can knowledge of Probabilistic methods minimize them?

The Relevance

- ▶ **Bhopal Disaster had its 20th Anniversary**
- ▶ A lot of Man-made disasters are caused by 'errors'
- ▶ Uncertainty analyses/ Error Analysis/ Probabilistic Methods/Risk Management can all help to reduce the chance
- ▶ We'll talk about one Man-made Environmental Disasters:
Bhopal Disaster (India)



Bhopal Disaster

- ▶ Gas Leak on December 3, 1984 – MIC (Methyl Iso Cyanate)
- ▶ 8000 people died, 50,000 injured
- ▶ Gas leaked from a Union Carbide Plant at night



Main effect: Pulmonary Edema, skin and eye damage (total blindness)

Secondary effect: Bronchitis, Bronchial pneumonia

People fled from the poison gas in the middle of the night



A Bhopal Victim

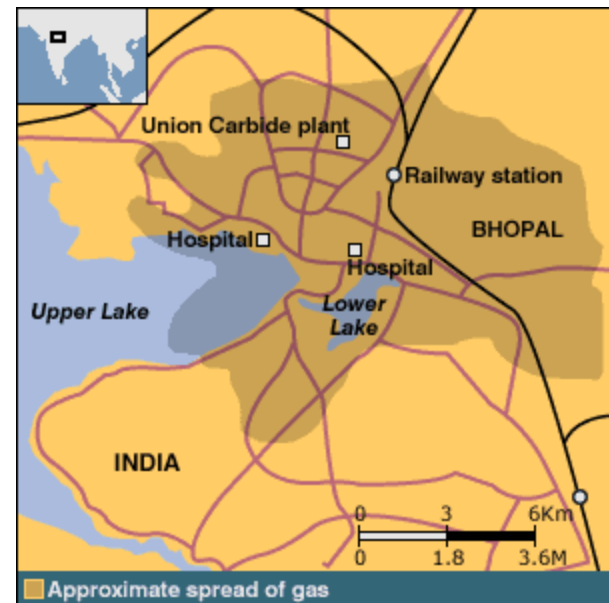
How it Happened

- ▶ In the middle of the night. People fast asleep (many on the streets)
- ▶ 40 tonnes of MIC leaked from Union Carbide Plant



The Plant

Union Carbide still maintains
'Sabotage' as the cause:
'Someone' put water in the boiler to
trigger a set of reactions



Source: BBC

Here's One Story

- ▶ Bhopal station was filling with panicking passengers fleeing the fumes
- ▶ Station Manager Mr. Dastagir was sensing something wrong (note: no one yet knew what was going on)
- ▶ The next train was scheduled to depart 20 minutes later
- ▶ He ordered the train to leave immediately (early)
- ▶ Incoming trains were all diverted
- ▶ It was Catch 22 situation. Uncontaminated passengers incoming to Bhopal could not be put at risk.
- ▶ Yet, those in Bhopal wanted to flee the fumes boarding as many trains.



Cont'd.

- ▶ The station had instead become a scene of misery and death all around.
- ▶ Mr. Dastagir's action saved many lives. Unfortunately he's a forgotten Hero (died a year spending most of his remaining life in hospitals

