

# **Natural Disasters – Exposure and Vulnerability**

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## **Introduction**

**D**uring the decade 1991 to 2000, globally there were 2557 natural disasters, which took a reported toll of 6,65,598 people. The figure is probably an underestimate. Famine reportedly killed 2,80,000 but well placed sources estimate that those who died in Democratic Peoples Republic of Korea alone, due to famine from 1995-98, may have numbered between 8,00,000 and 1.5 million. Of all those killed by natural disasters, 83 per cent were Asians. On an average, natural disaster accounted for 88 per cent of all deaths from disasters in the last decade.<sup>1</sup> Natural disasters worldwide inflict an average of US \$78.7 billion per year in damages.<sup>2</sup>

Some of the major worldwide disasters since last six years include Hurricane Mitch – 1998 which delivered a year's rainfall in Central America in a few hours causing vast mud slides down deforested slopes, killing 10,000 persons and making 2.5 million dependent on aid.<sup>3</sup> Worldwide epidemics of disease, drought, forest fires and floods accompanied meteorological phenomenon of El Nino and La Nina in 1997-98. Closer home, super cyclone of Orissa of 29 October 1999 killed over 10,000 people and Bhuj earthquake of 26 January 2001 devastated the state of Gujarat, killing over 20,000 people and affecting 16.04 million people. 1.2 million houses were damaged due to not following building codes. Malpa landslide in 1998 following uncontrolled deforestation of the foothills, which destabilised the soil on steep slopes highlighted the increasing trend in natural disasters.

If we do not protect the environment, the day is not far when climate changes will be among the most pervasive environmental

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events of the 21<sup>st</sup> century. The Inter-Governmental Panel on Climate Change of the United Nations Scientific Advisers, has reported that we can already see a 'discernible human influence on global climate'. The changes are likely to be gradual, with subtle shifts in average temperatures, rainfall and sea level. Climate changes will be manifested in a catalogue of disasters such as storms, droughts and floods unparalleled in recent times. The main uncertainty is where and when they will occur. Although global trends seem clear to scientists, predicting the effects of climate changes, at the national level is much more hazy and difficult to fathom.<sup>4</sup>

## Global Vulnerability Scenario

**Floods.** The floods can be coastal or riverine. The most serious effect of climatic changes will be in the coastal regions. Almost three billion people, about half the population of Earth live in coastal zones. 13 of the world's largest urban conglomerations are on coasts and population in these areas is increasing at double the global average.<sup>5</sup>

As greenhouse gases warm the earth's atmosphere, sea temperatures will rise, causing the world's oceans to expand. Increase in melting of snow and ice in hills will add to water in the oceans. This process is already underway. Worldwide the tides have crept up by an average of around 20 centimetres over the past century. The inhabitants of coastal zones are thus becoming more vulnerable to flooding. Almost three million people are made homeless by floods every year, many of them in coastal zones; 10 million are at constant risk of coastal flooding and 46 million could be hit by storm surges. Sea level is expected to rise upto 44 centimetres by 2080 with prediction of still further rise for next 500 years. The individual cities at risk include Tokyo and Shanghai (world's largest and fifth largest cities respectively), Lagos, Hong-Kong, Sydney, Bangkok, St Petersburg, Osaka, Hamburg and Venice. Most will try to build walls, dykes and barricades but costs will be astronomical. Protecting Netherlands, a small country from a 50 centimetre rise in sea level will cost three to five trillion US dollars and in Maldives present cost of protecting shoreline is US \$13000 per metre of coast.<sup>6</sup> The biggest threats are to river deltas and small low-lying islands. Bangladesh which is astride massive

river deltas of Brahmaputra and Ganges could lose most of its land, unless natural siltation processes occur fast enough to build the land ever higher. A large vulnerable population live on river deltas in India (Sunderban delta and Sir Creek), Pakistan, Mozambique and Vietnam.

As regards river floods, dams, dykes and infrastructure constructed on low lying areas may be susceptible to sudden changes and surprises and increased frequency or intensity of extreme climatic events. In smaller countries, the assets at risk from flooding have a value greater than 10 per cent of the gross domestic product (GDP).

**Drought.** Global warming is likely to cause more deserts as evaporation rates increase. On the fringes of the deserts, rivers are likely to dry up and crops will fail as droughts intensify. In atmosphere which is richer in carbon dioxide, crops will be able to make more efficient use of water and yield will be more. There is likely to be an acceleration of desertification.

Diminished rainfall in arid regions will damage underground water reserves, many of them already suffering serious over-abstraction. Many scientists are envisaging dramatic reductions in the flows of many rivers that are vital to the water supplies of the countries through which they flow. It is predicted that the Indus, which waters the world's largest irrigation system in Pakistan, will lose 43 per cent of its flow. Rivers Niger, Sutlej, Ravi and Ganges could meet the same fate. All the above is to happen in next 50 to 100 years when the levels of atmospheric carbon dioxide double. Water wars at community level and between nations are predicted.

**Communicable Diseases.** Long summers and heatwaves cause increased death rates from heart and lung diseases. Air pollution and pollen in the atmosphere could become more deadliest in hotter temperatures. Paul Epstein of Harvard Medical School has predicted doubling in heat related deaths by 2020 and much larger increase by 2050. Hot and humid weather has already increased the range of infectious tropical diseases such as malaria, dengue, yellow fever, schistosomiasis and river blindness to areas where they are not currently endemic and where locals have no

immunity. By 2100, 60 per cent of world's population is likely to be living in potential malarial zones.

**Global Warming and El Nino Effect.** The effect of global warming will be felt most seriously by the developing countries due to following reasons :-

- (a) The increased incidence of extreme climatic events is likely to be evident in the tropical areas, where most developing countries are located.
- (b) Developing countries are more dependent on natural resources such as forest and soils, that will be disrupted by climate change.
- (c) Developing nations are less able to invest in adapting to changing climate and have less robust institutions and infrastructures for handling the consequences.

El Nino is a periodic natural event. It has become more frequent and intense in the last 20 years and there is evidence to suggest that it could be due to global warming. If that be so, El Nino could become a semi-permanent feature of the world's weather system. Even if it does not become that permanent, events in the world during late 1990s indicated the instability of the world's weather systems and its capacity to switch modes, heralding extreme weather on unsuspecting communities. For in the 12 El Nino months from summer of 1997 to summer of 1998, the world experienced some of the most intense and widespread fires ever recorded. Forests burned from Brazil to Borneo, Peru to New Guinea and Florida to Sardinia. Indonesia's rain forests got no rains and dry weather turned the forests into world's largest pile of firewood. In South America, floods made half a million Peruvians homeless along a coastline that often had no rains for years at a time. In northern Tibet, the worst snow in 50 years starved or froze to death hundreds of herders. It is predicted that disasters which have a cycle of 100 years, could soon have 'return period' of 25 years.

**Urbanisation.** World is becoming increasingly urban. In last 40 years while overall the population has doubled, its urban

population has increased five-fold. Cities will in near future become home for half of world's population. In theory, cities provide secure environment from the vagaries of natural hazards, however it depends upon the quality of construction and emergency services, which cities can provide. As per World Disaster Report 1998, International Federation of Red Cross and Red Crescent Societies have found, that increasing number of people it helps, are caught up in natural disasters afflicting urban areas. The more serious crises frequently occur in large number of small cities and towns where majority of new urban citizens live. But rich developed nations are not immune. More than 6000 people died in Kobe earthquake of 1995 in Japan. Cities have special risk of disaster due to density of their population. A disaster such as earthquake or landslide will find, at a specific point more people in its path. The Pacific rim, referred to by geologists as the 'ring of fire', due to its propensity for earthquakes and volcanoes, is the most rapidly urbanising area on earth. The destruction of natural ecosystems in urban areas find them vulnerable to disasters. Landslides and floods are intensified due to denuding of forests on periphery of cities and blockage of natural drainage channels. Compacted and concreted earth is unable to absorb flood.

In cities, high-rise and concrete buildings are vulnerable to earthquakes. The saying that 'earthquakes do not kill people; buildings do', is so apt in urban areas. 80 per cent of deaths in earthquakes are from collapsing buildings. In the Armenian Earthquake of 1988, most of 100,000 people who died were in concrete city buildings. Similar is case of Bam earthquake in Iran of 2003 in which 43,000 people perished, mostly due to buildings.

Half of the population in metropolitan cities of developing world are in unplanned and often illegal colonies. These are set up in areas known to be vulnerable to floods, landslides or industrial accidents. Most buildings are not disaster resistant.

Diseases like tuberculosis, human immunodeficiency virus (HIV)/ acquired immune deficiency syndrome (AIDS) and cholera spread faster in densely populated urban areas, especially those that attract migrants carrying exotic diseases. Incidence of respiratory infections such as pneumonia and tuberculosis is more

pronounced in urban areas. Breakdown of sanitation is another major factor in spread of water borne diseases. Encroachment of urban areas into once forested environments has been linked to increase in diseases like malaria and dengue fever.

**Ecological Degradation.** The loss of natural vegetation, particularly forests, is a major cause of preventable natural disaster. Deforestation especially in upland mountains reduces the soil's ability to absorb rainwater. A single tree can absorb 200 litres of water or more per hour. The soil it holds in place may absorb even more. If the tree is removed, that water runs off the land into gullies and rivers or all too frequently through human settlements. The impact of the rain on the ground and loss of binding tree roots are responsible for causing instability of hill slopes that in turn leads to landslides. Moreover the material that gets washed downhill during landslides is absorbed as silt in river, raising river beds and resulting in flood risks.

### **Emergency Response and Distribution at International Level**

If the international agencies have to come to aid of people in increasing natural and economic disasters, they will have to work more closely with local organisations. Floods, earthquakes, landslides, cyclones all require urgent and immediate help. Search and Rescue assessment, medical relief, shelter, food and water are needed within hours and days not weeks and months. Unlike humanitarian crises associated with war, refugee movement or famine needs, natural disasters are sudden and total. Interventions of foreign relief agencies should be guided not by what they are capable of providing, but by rapid and accurate means of assessing real needs in conjunction with local administration. Similarly local agencies need to learn how to access and interact with the international humanitarian system. More frequent disasters may also force changes in the way agencies are financed. Almost all humanitarian funding comes on an adhoc basis as a response to appeals. The UN uses a Consolidated Appeal Process (CAP) to pull together the emergency financial requirements of its agencies. The CAP accounts for about half of all international humanitarian assistance. What is needed is not tinkering with the system but a more radical look at how international humanitarian assistance is

financed. There is also need for more regional sharing of humanitarian burden.

### Vulnerability in Indian Context

Table 1 compares disasters in continents and countries. India is very disaster prone.

**TABLE 1 : COMPARISON OF PEOPLE KILLED/ AFFECTED IN LAST TWO DECADES**

Serial Number	Number of people reported killed or affected by disasters	COMPARISON			
		ASIA	INDIA	CHINA	USA
1.	Total number of people killed	1981-1990	1,80,951	29,639	20,232
		1991-2000	598,290	59,132	35,289
2.	Total number of people affected	1981-1990	1,253,032,261	669,359,908	282,789,695
		1991-2000	1,888,223,647	432,402,751	1,124,008,730
3.	Annual average of people reported killed	1981-1990	18,095	2964	2023
		1991-2000	59,829	5913	3529
4.	Annual average of people reported affected	1981-1990	1,25,303,226	66,935,991	28,278,970
		1991-2000	1,88,822,365	43,240,275	1,12,400,873

(Source : Emergency Event Database, Centre for Research on Epidemiology of Disaster (EM-DAT, CRED) University of Lauvain, Belgium and World Disaster Report 2001)

In India out of 35 states and union territories, states 27 are disaster prone. The country is highly vulnerable to natural disasters like droughts, floods, cyclones, avalanches, forest fires and landslides. Gujarat and West Bengal are prone to four disasters i.e. earthquakes, cyclones, floods and drought, five states face three types of disasters, thirteen states two types of disasters and seven states are prone to single disaster. There has been increasing trend in life and property loss due to natural catastrophes. Unplanned and non-scientific development and increasing rush for cities and towns has caused serious threat to human population in these urban areas. Facts about the adverse

impact of natural disasters in India are highlighted below :-

- (a) **Floods.** River floods are most frequent and often most devastating. 12 per cent of the country is prone to floods. 85 per cent of country's average rainfall of 1200 mm takes place within four months of monsoons. This fact combined with inflow of water in northern rivers from Nepal and Tibet results in some areas like Assam and North Bihar getting flooded each year. Floods are most frequent in the Ganga – Brahmaputra – Meghna basin, which carry 60 per cent of nations total river flow.
- (b) **Earthquakes.** They are considered most dangerous and hazardous, due to their sudden impact with no virtual warning. 57 per cent of total area of the country is vulnerable to seismic activity of varying intensities. Most of the fault lines and resultant vulnerable areas are located in Himalayan and sub-Himalayan regions, Gujarat and the Andaman and Nicobar Islands.
- (c) **Droughts.** 16 per cent of country's total area is drought prone and approximately 50 million people are annually affected by droughts. With good monsoon in the past decade the frequency of droughts has been brought down. They have become less severe, resulting only in the loss of livelihood and not much loss to lives.
- (d) **Cyclones.** India has a long coast line which is exposed to tropical cyclones. The Bay of Bengal accounts for 90 per cent of cyclones. Cyclones originating from Arabian Sea affect Gujarat coast only.
- (e) **Landslides.** Heavy deforestation and environment degradation, especially in hilly regions, result in landslides becoming common annual phenomenon in Himalaya and Western Ghats. Three per cent of the total area in India is susceptible to landslides.

## Vulnerability

Vulnerability is of two kinds – physical and socio-economic. Physical vulnerability relates to physical location of people and

elements at risk eg, buildings and infrastructure and their proximity to the hazard. It also includes technical capacity of buildings and structures to resist the forces acting upon them during a hazardous event. Socio-economic vulnerability means people in weaker position within social fabric have least capacity to absorb or avoid the impact of hazards. These differences in capacities are exemplified in risk analysis. Its effect is seen to be directly proportionate to the poverty gap and poverty intensity in society and location as it is this group who live in large numbers concentrated in marginal areas (unstable slopes and flood plains) with little infrastructure and fewer resources to cope with such disasters. Research in earthquake-affected people indicates that single parent families, women, handicapped people, children and aged are particularly vulnerable. The capacity to recover from a disaster will depend on income levels, savings and social support systems. The vulnerability facets peculiar to Indian conditions are given below :-

- (a) **Support Infrastructure.** The support infrastructure, which is vital for quick response and recovery of affected area, is most vulnerable to damages. The basic facilities like roads, railways, electric power supply, telecommunication are fragile and fail to deliver goods in peak time. They remain out of action for longer duration mainly due to lack of maintenance and repairs.
- (b) **Habitat Sector.** Non-compliance of the existing building codes, poor quality of construction from unskilled masons and its little know-how in rural areas are main causes for human and property losses.
- (c) **Demographic Pressures.** With increase in population, the pressures build up and affect all development related works. This has chain reaction to quality of work and compromise on hygienic living conditions, little preventive and mitigatory measures and resultant more losses to human lives and material.
- (d) **Deforestation.** As indicated earlier, deforestation in India has resulted in weakening of the soil binding force, leading to increased land slides and floods. This also damages forest cover and causes harm to wild life.

(e) **Unscientific Development.** Development programmes that go into promoting development at the local level have been left to the general exercise of planning. There is a need to integrate disaster mitigation efforts at local level with the general exercise of planning and a more supportive environment created for initiatives towards managing of disasters.

(f) **Faulty Agricultural Practices and Grazing.** The agriculture practices like 'jhooming' (slash and burn), excess use of pesticides, denuding forest and grazing land for agriculture, have only enhanced the impact of disasters.

(g) **Dams and Reservoir Construction.** Construction of dams at more height than the acceptable limits affect the ecology of the area and disasters like earthquake and excessive rains could cause devastation.

(h) **Climate Change.** Climate change world over especially global warming is having effect on India too, with disasters multiplying at double the pace.

(i) **Industrialisation and Urbanisation.** Industrialisation brings in small townships, which come up on available land and not as per vulnerability assessment. These neo-urban areas are congested and more prone to disasters.

## Way Ahead

Having analysed the vulnerabilities in the global and Indian contexts, next action is to find out the possible remedies so that vulnerability can be minimised, by taking mitigatory action and preparing the community and the nation, to face the hazards. The recommendations are given under the following steps: -

(a) **Step 1: The Political Commitment at National, State, District and Local levels.** The politician, bureaucracy, non-governmental organisations and community have to work in tandem for capacity building in disaster preparedness.

(b) **Step 2: Risk Assessment.** The aim is to balance the known risks against available resources and preparedness.

This process starts with assessment of potential disaster risks through a combination of hazard mapping and vulnerability analysis. Risk assessment can be done in the following manner :-

(i) **Hazard Mapping (HM).** HM is done to establish geographical areas that are susceptible to a particular or set of disasters. Hazard information gathered includes location, frequency, duration and severity. This has been done in certain states only. Other states need to be coaxed to make a hazardous map of their respective vulnerable districts. Geographical Information System (GIS) should be made use of in HM.

(ii) **Vulnerability Analysis.** This involves process of estimating the vulnerability to potential disasters and hazards of specified elements at risk. These include social, economic, natural and physical environmental factors. Vulnerability analysis is always a site and area specific process and should be done on the basis of districts.

(iii) **Resource Assessment.** When potential losses have been estimated, a further assessment is needed of the resources or 'capacities' existing, to improve disaster mitigation and preparation.

(c) **Step 3: Improvement in Infrastructure.** Once the weaknesses are known, to reduce hazard impact for example, building flood protective embankment or walls, creating and managing dam storage, community grain stores and so on can be created. Similarly, regulating the emergency services like water and electricity can be done to reduce the loss of life and property while assisting relief and rehabilitation.

(d) **Step 4: Development versus Disasters.** Development without taking into consideration the vulnerability and potential hazard, could lead to disasters. All new buildings should be disaster resistant as per vulnerability of the area and old buildings should be suitably retrofitted. Priority need to be given to schools, hospitals, community and office buildings.

Implementation of building codes need to take community along. The exodus to urban areas need to be checked by developing the rural sector, making it more attractive by creating employment. There is also need to promote risk sharing and transfer mechanisms (insurance schemes) for reconstruction by involving the private sector.

(e) **Step 5: Training and Rehearsals.** Objectives and need based training capsules for stake holders are needed. The training alone will not fill the gap until it is practised on ground once a year at least. The lessons learnt during such mock exercises should be analysed impartially and remedial measures taken.

## Conclusion

Natural disasters are on the increase as has been established from the analysis of global and Indian contexts. We may not be able to wish away hazards but interventions by Government, non governmental organisations, private sector and community can certainly ensure that by identifying the vulnerable areas and taking mitigatory steps and due preparation, the hazards are prevented from becoming disasters.

## References

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