CHAPTER II

NATURAL HAZARDS’ TYPOLGY, AND
GLOBAL SCENARIO
NATURAL HAZARDS’ TYPOLOGY, AND GLOBAL SCENARIO

Generally the concept of natural ‘hazard’ and ‘disaster’ is more ambiguous though they are widely used intermingly. Distinction between these concepts would bring out a better understanding and will be useful to develop management activities. Usually hazard means the consequences of the unpredictable behaviour of the natural environmental systems, which affect on innocent, unprepared society. Burton et al. (1978) refer to hazard as the potential for harm that is brought about by interactions between people and nature or by interaction between people and technology. Similarly USGS has provided a definition i.e.a geological condition, process or potential event that poses a threat to the health, safety, or welfare of a group of citizens or the functions or economy of a community or a larger governmental entity. The World Bank specifies that a disaster is an extraordinary event of limited duration such as a natural disaster (e.g. earthquake) which causes serious dislocations to a country’s economy. Furthermore, the event causes the government to modify its economic priorities and progress substantially. Whereas, Smith (1989) defines, natural disasters is a catastrophic consequences of natural phenomenon or a combination of phenomena resulting in injury, loss of life or impact an a relatively large scale and some disruption to human activities. Joint Assistance Centre (1988) puts it clearly, as follows, the “Natural disasters ... mean damage to physical, social and economic components and qualities of the natural and man-made environment caused by an extreme natural phenomena ... and a situation demanding total integration of the rescue or life support systems available to official responsible for the grief stricken areas together with the communication and

transportation resources required to support the relief operation.\textsuperscript{6}

The above definitions clearly emphasise that natural events are not considered disaster unless they cause death or damage to humans. A severe earthquake that occurs in a barren or a remote or unpopulated region, may do nothing more than frighten the wildlife or remote landslides or of interest to seismologists, and nothing more. Therefore, the essence of a natural disaster event lies not only in the physical phenomenon but also relies on social, economic and other consequences. Nevertheless, the present research more often used the concept of natural disaster rather than natural hazard.

Natural Hazards, Typology and Characteristics

Generally, disasters can be divided as natural (such as earthquakes, floods, cyclones etc.) and man-made disasters (that is explosion, fire, nuclear accident and so on). As far as the man-made disasters are concerned they are beyond our capacity to control or reduce the impact. Whereas in the case of natural disasters we can reduce the effect by taking precautionary measures in advance, particularly before disaster occurs. Taking any such mitigation measures solely depends upon the typology and characteristics or dimension of natural hazards. Some of the typology of disaster are depicted in Figures 1 to 6. (See Page No.36 to 38.)

Characteristics

Natural disasters are also classified according to their characteristics. Indeed classifying natural disasters based on their characteristics is not only relevant to a systematic and conceptual study of disaster but such an approach also provides a better foundation for an efficient natural disaster management activities. As Dynes (1977) rightly put it: some characteristics of disaster not only influence the types of community tasks that are created but relate to the ability of a community to handle them.\textsuperscript{7}

\textsuperscript{6} Joint Assistance Centre, \textit{Natural Disaster}, (New Delhi, 1989), p. 88.
FIGURE 2.1: Typology of Hazards

THE SPECTRUM OF HAZARDS

NATURAL

QUASI-NATURAL
(Human Acentuated)

ANTHROPOGENIC
(Human Induce)

Geophysical

Lithsperic
Earthquakes
Volcanoes
Tsunamis

Geomorphological
Landsliding
Dune Migration
Saline Soils
Expensive

Meterorlogical
Fog, Snow, Hail,
Lightning,
Tornado,
Windstorm,
Tropical storm,
Temp. Extremes,
Drought

Biological

Funal

Macro
Termites
Rabbits
Locusts
Snakes

Micro
Bacterial
Protozoal
Viral Disease

Weeds
Poison
Hayfever
Water Hyacinth
Wheat stem Rust

Floral

Avalan Ching
Salinisation
Soil Erosion
Land Sliding
Global

Smog
Acidification
Desertification
Riverine flooding
Transport Hazards
Production Hazards
(explorations), Sabotage, war
Chemical Hazards
Nuclear Hazards

FIGURE 2.2: Natural Disaster Typology based on Origin

- Geothermal Based Origin
  1. Volcanic Eruptions
  2. Tsunamies
  3. Ground Deformations

- Wind Based Origin
  1. Storms
  2. Cyclones
  3. Tomatoes
  4. Hurricanes
  5. Typhoons
  6. Tidel Wages

- Water Based Origin
  1. Foods
  2. Droughts
  3. Cloud bursts
  4. Dam bursts
  5. Excessive rains

- Seismic Based Origin
  1. Earth quakes
  2. Tsunamies
  3. Avalanches
  4. Landslides
  5. Volcanoes

- Ecological Based Origin
  1. Flash floods and related landslides
  2. Mud slides
  3. Cavings


FIGURE 2.3: Natural Disasters Classified as Exogenic, Endogenic & Anthropogenic

- Exogenic
  1. Floods
  2. Droughts
  3. Landslides
  4. Avalanches

- Endogenic
  1. Volcanoes
  2. Earthquakes

- Anthropogenic
  1. Subsidence
  2. Reservoir quakes
  3. Collapses of structures

FIGURE 2.4
Natural Disaster Typology based on Predictaibility

Unpredictable
1. Earthquake
2. Landslides
3. Avalanches

Predictable
1. Floods
2. Cyclone
3. Hurricanes
4. Typhoons
5. Storms
6. Tornadoes

Sudden Onset
(Period below two hours such as)
1. Earthquakes
2. Tsunamies
3. Volcanic eruptions
4. Nuclear accidents
5. Chemical spills
6. Forest Fires

Intermediate Onset
(Period between one and seven days)
1. Tropical Cyclones
2. River & Coastal
3. Wind storms

Long Onset Period
(between several we months)
1. Droughts
2. Famines
3. Climatic changes
(several decades)
4. Sea level fluctuations


FIGURE 2.5
Natural Disaster Typology based On-set Period

Intensive Class
1. Earthquakes
2. Tornadoes
3. Landslides
4. Hail
5. Volcanoes
6. Avalanches

Passive Class
1. Drought
2. Fog
3. Heat waves
4. Excessive Moisture
5. Air pollution
6. Snow

Compound Class
1. Flash floods
2. Revirine floods
3. Deltaic floods
4. Winds
5. Blizzards
6. Tsunamies
7. Sand
8. Dust storms

(Source: F.W. Kates, "Experiencing the Environment as Hazard", in Seymour. ed., p.139)
Essentially response to natural disaster agents is mostly influenced by two factors, the characteristics of disaster and secondly the capacity of community system to withstand a crisis situation and its management.

Regarding the characteristics of natural disaster agents, nine such traits have been identified. They include frequency, predictability, speed of onset, length of forewarning, duration and cause, scope of impact, destructive potential and controllability. All these characteristics are of much influence in natural disaster management activities. Based on this information a community can establish better prediction and warning system, and preparedness or take mitigation measures before disaster takes place.

**FREQUENCY:** Each type of natural hazard varies in its frequency and occurrence from region to region or place to place. Due to geographical factor certain location or areas tend to be affected by a particular or multiple hazards frequently.

<table>
<thead>
<tr>
<th>Type of disaster</th>
<th>Frequency or type of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>Random</td>
</tr>
<tr>
<td>Avalanche</td>
<td>Seasonal/diurnal: random</td>
</tr>
<tr>
<td>Earthquake</td>
<td>Log-normal</td>
</tr>
<tr>
<td>Landslide</td>
<td>Seasonal / irregular</td>
</tr>
<tr>
<td>Drought</td>
<td>Seasonal / irregular; binomial, gamma</td>
</tr>
<tr>
<td>Desertification</td>
<td>Progressive (threshold may be crossed)</td>
</tr>
<tr>
<td>Flood</td>
<td>Seasonal; markovian, gamma, Log-normal</td>
</tr>
<tr>
<td>Hurricane</td>
<td>Seasonal / irregular</td>
</tr>
<tr>
<td>Volcanic eruption</td>
<td>Irregular</td>
</tr>
<tr>
<td>Tornado</td>
<td>Seasonal, negative binomial</td>
</tr>
<tr>
<td>Windstorm</td>
<td>Seasonal / exponential</td>
</tr>
</tbody>
</table>


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9 R.R. Dynes,#7,pp.51-52.
Further each natural hazard generate a unique ensemble of physical effect which affect the inbuilt environment in different ways. For instance, residence located near or over faults are prone to earthquake disaster or communities habitation along coastal areas are more potential to tidal waves or hurricanes disaster. Therefore, identification of a specific natural disaster frequency patterns certainly provide valuable information to disaster management as this would give an opportunity to prepare against its impact in advance.

**CONTROLLABILITY:** Primarily controllability relates to longterm mitigation activities and mostly depend upon technology and scientific research. However, only certain natural agents can be controlled in a limited scale. For instance, flooding can be prevented or atleast it is possible to reduce it negative impacts by construction of embankments, dam and other similar structures. Similarly earthquake severity can be lessened through various structural and non-structural measures. Drought condition can be constrained by the introduction of ‘drought resistant’ seed varieties. Therefore, on a strength of technology, certain agents can be controlled considerably so as to avoid full impacts of a disaster.

Another important point to be noted is that similar types of disaster events producing similar levels of physical disruption can produce a disaster or crisis condition in one social context, and have no such effect in a different social setting. Therefore, it is possible that given two different communities, one with extensive crisis management mechanisms and other with few such resources, disaster agents with similar characteristics may produce a crisis in the latter system, but only an emergency situation in the former. Understanding such charactersitics is most important, to provide a clear insight about the various dimensions involved in natural disaster management.

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10 OAS, Primer on Natural Hazards Management in Plannier, (Wasington, D.C., 1990), p. 10.
14 Ibid, # 4, p. 28.
However for all practical purpose, the elements of controllability is extremely limited in scope and application. Nevertheless advances in this direction certainly bring favourable implication for mitigating the impact of natural disasters.

**PREDICTABILITY:** Each natural disaster is distinguished by the scope it provides for prediction in beforehand. Despite the current level of achievement in science and technology, it is not possible to predict all type of natural agents with accuracy. But in many cases some prediction is possible with minimal level of accuracy.

Thus earthquake occurrence cannot be predicted in short term (though several efforts are under way) where as floods and hurricane can be predicted, however, it should be noted that it is not possible to forecast floods with greater accuracy than the hurricane landfalls. These clarifications are essential because such an information, whether or not, or to what extent a particular natural agent can be predicted, may provide a better base to government agencies to undertake necessary precautionary measures.

Predicting the time, place and severity of a natural disaster event saves many lives and reduce losses, when it is followed by timely and effectively dissemination of warning to the public. Even with a few minutes notice, individuals can act to save their lives.

**Mode of onset:** The mode of onset is a critical element which determine nature of preparatory measures as well as its scope and quality of post-impact responses. Indeed suddenly arising a natural disaster may provide limited scope for protective action, on the other hand gradually onsetting natural event gives reasonable opportunity for safety measures even during the period of impact.

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15 S. Vyas, #12, p.176.
16 OAS, #10, p.51.
17 R.R. Dynes, #7, p.52.
Table: 2.2 Duration of natural disasters

<table>
<thead>
<tr>
<th>Disaster</th>
<th>Time Scale</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightning</td>
<td>Very Sudden</td>
<td>Seconds</td>
</tr>
<tr>
<td>Earthquakes</td>
<td>Very Sudden</td>
<td>Minutes</td>
</tr>
<tr>
<td>Tornado</td>
<td>Sudden</td>
<td>Hours</td>
</tr>
<tr>
<td>Drought</td>
<td>Very Slow</td>
<td>Months</td>
</tr>
<tr>
<td>Floods</td>
<td>Not Sudden</td>
<td>Days to Week</td>
</tr>
<tr>
<td>Cyclone</td>
<td>Not Sudden</td>
<td>Days</td>
</tr>
<tr>
<td>Land Slides</td>
<td>Sudden</td>
<td>Hours to days</td>
</tr>
<tr>
<td>Flash Floods</td>
<td>Sudden</td>
<td>Days</td>
</tr>
<tr>
<td>Thunder Storms</td>
<td>Not Sudden</td>
<td>Hours</td>
</tr>
<tr>
<td>Dust Storms</td>
<td>Not Sudden</td>
<td>Hours</td>
</tr>
<tr>
<td>Hail Storms</td>
<td>Sudden</td>
<td>Hours</td>
</tr>
<tr>
<td>Forest Fires</td>
<td>Not Sudden</td>
<td>Hours</td>
</tr>
<tr>
<td>Heat and Cold waves</td>
<td>Slow</td>
<td>Weeks</td>
</tr>
<tr>
<td>Accidents</td>
<td>Very Sudden</td>
<td>Minutes</td>
</tr>
<tr>
<td>Epidemics</td>
<td>Slow</td>
<td>Months</td>
</tr>
</tbody>
</table>


The speed of onset of natural hazard is an important variable since it conditions warning time. Virtually, earthquakes, landslides, and flash floods give no chance for early warning, whereas less extreme tsunamis, which typically have warning period of minutes or hours.

For instance, the hurricane and floods known for its likelihood of occurrence for several hours or days in advance, also volcanoes can erupt suddenly but usually gives indications of an eruption weeks or months in advance\(^\text{18}\). But in the case of drought or desertification act slowly but steadily over a period of month or years. All these information are important in a proper natural disaster management activities\(^\text{19}\).

\(^{18}\) S.Vyas, #12,p.37.
\(^{19}\) A.Kreimer and Munisinghe, Managing Environment Degratation and Natural Disaster :An Over View,(Wasington,D.C.,1990),p.3.
Table :2.3 Duration of Impact and Length of forewarning

<table>
<thead>
<tr>
<th>Type of Disaster</th>
<th>Duration of Impact</th>
<th>Length of Forewarning (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquake</td>
<td>Seconds - Minutes</td>
<td>Minutes - years</td>
</tr>
<tr>
<td>Tornado</td>
<td>Seconds - Hours</td>
<td>Minutes</td>
</tr>
<tr>
<td>Land Slide</td>
<td>Seconds - decades</td>
<td>Seconds - years</td>
</tr>
<tr>
<td>Flood</td>
<td>Minutes - days</td>
<td>Minutes - days</td>
</tr>
<tr>
<td>Hurricane</td>
<td>Hours</td>
<td>Hours</td>
</tr>
<tr>
<td>Drought</td>
<td>Days-Months</td>
<td>Days-Weeks</td>
</tr>
<tr>
<td>Desertification</td>
<td>Years-decades</td>
<td>Month-years</td>
</tr>
<tr>
<td>Avalanche</td>
<td>Second-Minutes</td>
<td>Seconds-Years</td>
</tr>
<tr>
<td>Snow Storm</td>
<td>Hours</td>
<td>Hours</td>
</tr>
<tr>
<td>Lightning</td>
<td>Instant</td>
<td>Seconds-Hours</td>
</tr>
<tr>
<td>Wind Storm</td>
<td>Hours</td>
<td>Hours</td>
</tr>
<tr>
<td>Volcanic Eruption</td>
<td>Hours - years</td>
<td>Minutes - weeks</td>
</tr>
</tbody>
</table>


CAUSE OF DAMAGE:

Each natural disaster can be characterized based on its potential to cause damage. Further this distinction is also marked by the ‘nature of damage’ it can cause. For instance, fatal injuries due to building damages, drowning, electrification, water borne diseases are the chief causes of death during earthquake or cyclone. On the other hand deaths for instance during drought is resulted of malnutrition and disease. Further except for crops, land and cattle drought do not damage other property severly, while cyclones, floods and earthquakes occurrence obviously destroy all types of property and result in innumerable human loss.

SCOPE OF IMPACT:

The impact of a natural disaster depend upon many factors, such as time or day or night and day of week when the natural event occurs. It is also part of the vulnerability of those affected community. For instance, people may not take precautionary measure unless having of awarness and resources. Similarly the ability of

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20 D.E. Wenger, #8, p.37.
a community to protect itself relies on local social cohesion and proper or adequate institutional or infrastructure facilities.

The impact may be instantaneous in an earthquake (lasting seconds), Hurricane (hours), riverine flooding (weeks) or creeping disaster such as desertification (for decades). Further the impact can be divided into categories such as primary (i.e. earthquake), secondary (i.e. post earthquake fire) and composite (e.g. earthquake and tsunami).

**Table : 2.4 Primary and Secondary Impacts of Natural Hazards:**

<table>
<thead>
<tr>
<th>Natural Hazards</th>
<th>Primary phenomena</th>
<th>Secondary phenomena</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone</td>
<td>Strong winds</td>
<td>Flood and sea surge, Land slide, Water pollution</td>
</tr>
<tr>
<td></td>
<td>Heavy rains</td>
<td></td>
</tr>
<tr>
<td>Flood</td>
<td>Flooding</td>
<td>Water pollution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land slides, Erosion</td>
</tr>
<tr>
<td>Earthquake</td>
<td>Violent ground motion</td>
<td>Soil liquefaction, Fire, Flood, Land slide, Tsunami, Water pollution</td>
</tr>
<tr>
<td>Landslide</td>
<td>Ground Failure</td>
<td>Flooding via river damming, water pollution</td>
</tr>
<tr>
<td>Volcano</td>
<td>Lava Flow, Ash Fall, Volcanic gases, Pyroclastic flow / Surge</td>
<td>Debris flow, Air pollution, Water pollution, Ground Subsidence, Fire</td>
</tr>
</tbody>
</table>

(Source: The institute of civil Engineers, *Magacities*, 1975, p.4)

Described above are important characteristics of natural disaster agents. All these features provide valuable direction for the nature of administrative tasks that necessarily is to be performed. In fact each trait highlights certain fundamental elements, which determine the nature or orientation of response mechanism.

**SPATIAL - TEMPORAL PATTERN OF NATURAL DISASTERS**

Around the world more than 300 natural disasters occur every year, and about 250,000 lives are lost and more than 200 million people are directly affected (IFCRCS.

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One report indicates, between 1900 and 1976 an average of about 60,000 people were killed and 300 million injured and/or left homeless by natural disasters. Whereas between 1970 and 1985, disasters were only three types (wind storms, floods and earthquakes) and cost on an average US $18.8 million per day and between 1980 and 1985 disaster affected 216.8 million people or almost 5 per cent of the world population.

During the past decade alone natural disasters have been responsible for about 3 million deaths and have adversely affected at least 800 million people through rendering homeless, spreading diseases, and causing series of economic loss and other hardship including immediate loss in hundreds and billions of dollars.

The natural disasters is constantly increasing its damage on people and property. This pattern and trend can be seen from the below tables.

**Table :2.5 Natural Disaster with continent wise from 1969-1993**

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>AFRICA</th>
<th>AMERICA</th>
<th>ASIA</th>
<th>EUROPE</th>
<th>OCEANIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>KILLED</td>
<td>76,883</td>
<td>9,027</td>
<td>56,072</td>
<td>2,220</td>
<td>99</td>
<td>144,302</td>
</tr>
<tr>
<td>INJURED</td>
<td>1,013</td>
<td>14,944</td>
<td>27,023</td>
<td>3,521</td>
<td>100</td>
<td>46,404</td>
</tr>
<tr>
<td>AFFECTED</td>
<td>10,556,984</td>
<td>4,400,232</td>
<td>105,044,476</td>
<td>563,542</td>
<td>95,128</td>
<td>120,660,161</td>
</tr>
<tr>
<td>HOMELESS</td>
<td>172,812</td>
<td>360,964</td>
<td>3,980,608</td>
<td>67,278</td>
<td>31,562</td>
<td>4,613,274</td>
</tr>
</tbody>
</table>

(Source: IFRCRCS, World Disaster Report, 1995, p.99)

The impact of natural Disaster caused such as, killed, Injured, Affected, Homeless, continent-wise, 1969-93 can be seen from figure No. 2.7.

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FIGURE 2.7: The Impact Of Natural Disasters With Continent-Wise 1969-93

KILLED

INJURED

AFFECTED

(Source: IFRCRCs, World Disaster Report, 1995)
Table: 2.6 Disasters with a Natural Trigger from 1969-1993

<table>
<thead>
<tr>
<th>DISASTERS</th>
<th>AFRICA</th>
<th>AMERICA</th>
<th>ASIA</th>
<th>EUROPE</th>
<th>OCEANIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHQUAKE</td>
<td>40</td>
<td>125</td>
<td>225</td>
<td>167</td>
<td>83</td>
<td>640</td>
</tr>
<tr>
<td>DROUGHT AND FAMINE</td>
<td>277</td>
<td>49</td>
<td>83</td>
<td>15</td>
<td>14</td>
<td>438</td>
</tr>
<tr>
<td>FLOOD</td>
<td>149</td>
<td>357</td>
<td>599</td>
<td>123</td>
<td>138</td>
<td>1366</td>
</tr>
<tr>
<td>LANDSLIDE</td>
<td>11</td>
<td>85</td>
<td>93</td>
<td>19</td>
<td>10</td>
<td>218</td>
</tr>
<tr>
<td>HIGHWIND</td>
<td>75</td>
<td>426</td>
<td>637</td>
<td>210</td>
<td>203</td>
<td>1551</td>
</tr>
<tr>
<td>VOLCANO</td>
<td>8</td>
<td>27</td>
<td>43</td>
<td>16</td>
<td>4</td>
<td>98</td>
</tr>
<tr>
<td>OTHER</td>
<td>219</td>
<td>93</td>
<td>186</td>
<td>91</td>
<td>4</td>
<td>593</td>
</tr>
</tbody>
</table>

(Source: IFRCRCS, World Disaster Report, 1995, p.99)

FIGURE: 2.8 - MAJOR NATURAL DISASTERS AROUND THE WORLD, 1969-93

* Other include: avalanche, cold wave, heat wave, insect infestation, and tsunami.
Table: 2.7 Average estimated damage by region and by disasters with a natural trigger from 1989 to 1993 in thousand US$.

<table>
<thead>
<tr>
<th>DISASTERS</th>
<th>AFRICA</th>
<th>AMERICA</th>
<th>ASIA</th>
<th>EUROPE</th>
<th>OCEANIA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHQUAKE</td>
<td>179,200</td>
<td>1,851,700</td>
<td>11,131,228</td>
<td>920,720</td>
<td>1,251,100</td>
<td>15,133,800</td>
</tr>
<tr>
<td>DROUGHT AND FAMINE</td>
<td>0</td>
<td>1,621,000</td>
<td>54,200</td>
<td>2,188,600</td>
<td>0</td>
<td>3,863,800</td>
</tr>
<tr>
<td>FLOOD</td>
<td>415,810</td>
<td>17,526,195</td>
<td>72,575,976</td>
<td>63,878,000</td>
<td>5,800</td>
<td>154,401,781</td>
</tr>
<tr>
<td>LANDSLIDE</td>
<td>0</td>
<td>25,400</td>
<td>215,400</td>
<td>24,100</td>
<td>0</td>
<td>249,900</td>
</tr>
<tr>
<td>HIGHWIND</td>
<td>453,401</td>
<td>50,328,047</td>
<td>32,008,177</td>
<td>104,777,960</td>
<td>2,414,610</td>
<td>189,984,195</td>
</tr>
<tr>
<td>VOLCANO</td>
<td>0</td>
<td>10,000</td>
<td>220,448</td>
<td>0</td>
<td>0</td>
<td>230,448</td>
</tr>
<tr>
<td>OTHER</td>
<td>47,000</td>
<td>306,651</td>
<td>956,000</td>
<td>978,999</td>
<td>0</td>
<td>2,288,650</td>
</tr>
</tbody>
</table>

(Source: IFRCRCS, World Disaster Report, 1995, p.99)

*Death and injuries:* Most of the deaths are accounted for by hurricanes, which affected an average of 6.3 million people each year, earthquake (1.8 million), and floods (44 million).

FIGURE: 2.9 THE TREND OF NATURAL DISASTERS CAUSED DEATHS AND INJURIES 1967-90

(Source: D.E. Alexander, A., Survey of the field of Natural Hazards and Disaster Studies, in, Carrara, A. and Guzzetti, F. (eds), Geographical information systems in assessing natural hazards, 1995)
The African region is dominated by starvation in major droughts, while Asian results from many different phenomena. In the present century alone four earthquakes have killed 6,00,000 people in China. Elsewhere in the continent disasters are highly repetitive. For instance, earthquakes, volcanic eruptions, mudflows and typhoon cause an average of 10.9 disaster per year in the Philippines, 8.6 in India, 6.3 in China, 5.6 in Indonesia, and 4.0 in Bangladesh (ADM, 1993) 27.

**FIGURE : 2.10 THE TREND OF MAJOR DISASTER IN SOUTH ASIA**

![Diagram showing the trend of major disaster in South Asia](image)

(Source: IFRCRCS, World Disaster Report, 1995)

About 84.7 per cent of the world total of surviving disaster victims are to be found in Asia. Further ratio of deaths to injury also vary widely with each source of disaster, that as from 53.4 per cent of all casualties in earthquakes to less than 1 per cent in tsunamis and cold weather hazards (IFRCRCS, 1993) 28.

28 IFRCRCS, #25, p.125.
THE TREND OF WORLD'S EARTHQUAKE PROBLEM

On an average, about 200 large magnitude earthquakes occurs in a decade about 20 each year. As the world's population increases and areas previously almost uninhabited become increasingly settled, the propensity for earthquakes to cause damage increases. Infact in the begining of century, less than one in three earthquake occurred, however these numbers has gradually increased throughout the centuruy, roughly in line with the world population until in the 1990, two earthquakes in every three now occurred (DHA, Geneva, 1992).

FIGURE 2.11 THE TREND OF EARTHQUAKE PROBLEM

(Source: Coburn and Spence: Earthquake Protection, 1992)

EARTHQUAKE RISK IN DEVELOPING & DEVELOPED COUNTRIES

Effect on lives: During the century, earthquake caused deaths support the projection that earthquakes will increasingly affect population of developing countries more than those of developed countries. The figure 2.12 shows that in the period 1900 to 1949, the ratio in number of earthquake caused deaths in developing countries to the number in developed countries is about 3 to 1 ratio, while over the period 1950 to 1988, the
ratio increased to more than 9 to 1.  

**FIGURE 2.12 THE TREND OF EARTHQUAKE DEATHS BETWEEN DEVELOPED AND DEVELOPING COUNTRIES, 1990-1992**

![Diagram showing trend of earthquake deaths between developed and developing countries, 1900-1949 and 1950-1992.]


However, caution must be taken in comparing the number of deaths in different geographical regions, time periods and normal statistics variation. This generalisation is in accordance with the consequences of the 1988 Spitak earthquake in Armenia and the 1989 Loma prieta earthquake in California killing only 63 people (The US National Report, 1994).

The disparity between the number of earthquake caused deaths in developing countries could be explained by many factors including differences in population density and distribution, difference in earthquake frequency and its response practice, differences in construction, design and practice. In the period of 1900 to 1949 the average number of fatalities per earthquake in developing and developed countries were effectively indistinguishable, each about 12,000 whereas in the period of 1950 to 1992, the average number of fatalities per earthquake in developing countries remained about 12,000, but the figure for developed countries was reduced by a factor of 10 to about 1200.

Another report from UNESCO indicates fatalities due to earthquake compose

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31 Ibid., p. 5.
more than 50 per cent of total fatalities, and for the Asian and Pacific ocean region this number reaches 85 per cent. For instance, in China alone, there were 240,000 fatalities during the Tang-Shan earthquake in 1976.\textsuperscript{32} Even in south Asia region is also not far from this situation. The figure 2.13 - clearly indicate the frequent recurrence of earthquake and its impact of increase in death rates.

FIGURE : 2.13 LIVES LOST IN SOME MAJOR EARTHQUAKE IN SOUTH ASIA

![Bar chart showing lives lost in some major earthquakes in South Asia.]

(Source : Report on SAARC seminar on Disaster Management', SAARC Technical committee, National Institute of Rural Development, Rajendranagar, Hyderabad, 1987)

This report clearly emphasise that many of the megacities in these countries are located in earthquake hazard areas. If a major earthquake strikes these megacities in the future,

\textsuperscript{32} Y. Kitaguwa, "Coordination and Integration of International Projects on Risk Assessment in Mega Cities", \textit{World Conference on Natural Disaster Reduction}, May 23-24, Yokahama, (Japan, 1994), p. 52
both life and property damage would be immeasurable. Therefore, it is critical that all earthquake prone countries should try to mitigate earthquake disasters. Unfortunately such mitigation in most of these countries has not yet started.

**EFFECT ON ECONOMY:** The fiscal impact of earthquake is also growing, particularly in developing countries. The figure 2.14 shows that the economic cost of earthquakes, world-wide.

**FIGURE 2.14 THE ECONOMIC COST OF EARTHQUAKES DISASTERS WORLD-WIDE FROM - 1960 TO 1990**


Earthquakes-caused fiscal losses representing a greater percentage of developing countries’ gross national product (GNP) than do such losses in developed countries. For instance, El Salvador’s 1986 earthquake caused US $1.5 billion worth of damage which represented 31 per cent of the country’s GNP. The 1972 Managu earthquake cost

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33 B.E. Tucker, et. al., #29, p. 5.
US $ 5 billion and represented 40 per cent of Nicaragua’s GNP. In contrast, Italy’s 1980 earthquake caused US $ 10 billion worth of damage, yet this figure represented only 7 per cent of the GNP; similarly the Loma prieta earthquake in the US caused US $ 8 billion worth of damage which represented just 0.2 per cent of the country’s GNP and 6 per cent of the Gross Regional Product of the San Francisco bay area.\textsuperscript{34} Even, the current estimation of the damage due to the January 17, 1994 Northridge (Los Angeles) earthquake is 30 billion which constituted less than 1 per cent of the US’s GNP.\textsuperscript{35}

**EARTHQUAKE HAZARD MITIGATION ACTIVITIES IN DEVELOPED AND DEVELOPING COUNTRIES**

Even though earthquake pose a great mortal and financial threat to the developing world, the majority of the world’s resources devoted to earthquake hazard mitigation are focussed on the developed countries such as United States, Western Europe and Japan. It was estimated that only 2 per cent of earthquake mitigation research and development is spent on developing countries, on the contrary, rest is spent by the developed countries.\textsuperscript{36}

The figure 2.15 shows the unusual and striking measure of the disparity between earthquake threat and earthquake mitigation effort in developing countries and developed countries. For the developing countries, the ratio has approximately constant over the last five decades whereas for developed countries, this number has increased nearly 400-fold.\textsuperscript{37}

The trends on the below figure are clearly evidence the increse of the number, size and impact of earthquake disaster in developing and developed countries.

\textsuperscript{34} The US National Report, #30, p. 12.  
\textsuperscript{35} D.E. Alexander, #27, p. 9.  
\textsuperscript{36} D. Alexander, #11, p. 330.  
\textsuperscript{37} B.E. Tucker, et. al., #29, pp. 5-7.
Natural Disaster And Vulnerability

The significant increase of natural disaster vulnerability cannot be blamed for the physical forces alone, then the increase of vulnerability may influence by many other reasons.

*Population Increase*: World population in the early 1990s was 5.67 billion. It is set to grow to 7.27 billion by 2015 and if it fails to stabilise in the ensuing year may reach 12.5 billion by 2050. Population increase translates the demand for more pressure upon land, or more specifically to the occupation and cultivation of more land which are subject to natural hazards. Because of that many countries are most vulnerable to natural disasters and data indicates their population doubling time is less than 50 years. For instance, it is 29 years in Bangladesh and 34 years in India, the table 2.8 can explain properly.

38 D.E. Alexander, #27, pp. 3-4.
<table>
<thead>
<tr>
<th>Country</th>
<th>Mean annual death toll in disasters 1967-91</th>
<th>Mean annual number of people affected by disasters 1967-91</th>
<th>1992 population (10^6)</th>
<th>Urban % of population</th>
<th>Population growth (% yr)</th>
<th>Population doubling time (yrs)</th>
<th>Population under 15 yrs old (%)</th>
<th>Per capita GDP (1990 US$)</th>
<th>Economic growth rate (%)</th>
<th>Maternal infant mortality (per 100,000 live births)</th>
<th>Calorie intake (Kcal per person per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>40,408</td>
<td>11,438,863</td>
<td>111.4</td>
<td>14</td>
<td>2.4</td>
<td>29</td>
<td>44</td>
<td>180</td>
<td>4.0</td>
<td>120</td>
<td>1925</td>
</tr>
<tr>
<td>China</td>
<td>12,755</td>
<td>22,279,966</td>
<td>1,165.8</td>
<td>26</td>
<td>1.3</td>
<td>53</td>
<td>28</td>
<td>370</td>
<td>5.0</td>
<td>34</td>
<td>2637</td>
</tr>
<tr>
<td>India</td>
<td>5,044</td>
<td>59,161,135</td>
<td>882.6</td>
<td>26</td>
<td>2.0</td>
<td>34</td>
<td>36</td>
<td>300</td>
<td>4.5</td>
<td>91</td>
<td>2104</td>
</tr>
<tr>
<td>Peru</td>
<td>4,140</td>
<td>500,937</td>
<td>22.85</td>
<td>70</td>
<td>2.2</td>
<td>32</td>
<td>39</td>
<td>898</td>
<td>3.9</td>
<td>89</td>
<td>2277</td>
</tr>
<tr>
<td>Russia (CSI)</td>
<td>1,376</td>
<td>57,954</td>
<td>149.3</td>
<td>74</td>
<td>0.2</td>
<td>301</td>
<td>23</td>
<td>N.D.</td>
<td>N.D.</td>
<td>30</td>
<td>N.D.</td>
</tr>
<tr>
<td>USA</td>
<td>837</td>
<td>28,447</td>
<td>255.5</td>
<td>70</td>
<td>0.8</td>
<td>89</td>
<td>22</td>
<td>21,800</td>
<td>1.0</td>
<td>7</td>
<td>3644</td>
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<tr>
<td>Italy</td>
<td>250</td>
<td>78,080</td>
<td>58.0</td>
<td>72</td>
<td>0.1</td>
<td>1,363</td>
<td>17</td>
<td>14,600</td>
<td>2.0</td>
<td>8</td>
<td>3571</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>57</td>
<td>310</td>
<td>57.8</td>
<td>90</td>
<td>0.3</td>
<td>257</td>
<td>19</td>
<td>15,000</td>
<td>0.8</td>
<td>6</td>
<td>3259</td>
</tr>
</tbody>
</table>

(Source: World Research Institute 1994)
Marginalization: The vulnerability of disaster is unevenly distributed around the world, even unevenly apportioned within countries. Because of military economic repression, political and social polarization, ethnic or religious dominance and subjugation have conspired to marginalize groups of people, lost their rights to political determination and socio-economic development. Such groups may occupy most hazardous areas, with least protection against natural disasters. For instance, the Favelas in Riodejanero and the barriers of Caracas.\(^\text{39}\)

Some of the world economic development activities have been situated in natural hazard risk areas, where not only the development process takes place but population also increases tremendously. In many such areas, tsunamis, earthquakes or floods cause major economic losses, and often of life.

For instance, in the USA, population of Florida, the past Andrew hurricane caused US $ 15.5 billion in insured loss, with timely evacuation reduce the death toll to a mere 32 (NOAA, 1993)\(^\text{40}\) whereas in the case of 1991 cyclone surge in Bangladesh, killed some 1,45,000 residents of costal chars or sand backs and damaged value at US $ 1,285 million (Khalil, 1993).\(^\text{41}\)

Poverty: There is a reinforcing cycle of poverty which is exacerbated by the frequent and repeated experience of natural disasters. As the environmental management expert have noted some of the most serious and pervasive environmental problems facing developing countries tend to be both a cause and effects of poverty.\(^\text{42}\) Importantly poverty increases vulnerability to natural disasters and natural disasters contribute to the continuation of poverty. If the cycle is never broken through the prevention or mitigation measures of disaster impacts, there is little prospects for effective long term sustainable

\(^{39}\) Blaikie, et al., *At Risk: Natural Hazards, People, Vulnerability and Disaster*, (London, 1994), p. 320

\(^{40}\) NOAA, Natural Disaster Survey Report: Hurricane Andrew, South Florida and Louisiana, (Maryland, 1993), p. 131.


development. Therefore, Wisner (1993) argues that the elimination of poverty is a long
term goal which requires social justice and equity, income and resources distribution,
possibly the creation of a social or family wages and economic democracy. Therefore,
disaster mitigation need not wait for the achievement of such goals.

It is clear that most of the natural disasters occur in poorer countries and
specifically the people who suffer from disasters are mostly from poor people of any
society. One study estimated that 95% of deaths which are the result of natural
disasters occur among the 66% of the world’s population that lives in the poorer
countries. For instance, in the USA, Northridge earthquake disaster death toll is
while in Peru, with similar natural hazard occurrence, caused the death rate is about
2,900. Further, though natural events cause loss of life and property damage in every
country, but the similar event may cause higher burden on relatively poor economic
base of a country. It is estimated that the loss of GNP due to disaster is twenty times greater
than wealthier countries. On the other hand, economic losses from disasters may be
absolutely higher in wealthier countries but when compared with nations GNP it is only a
meagre percentage.

Developments: Development can increase disaster proneness when development
projects, are planned without recognition of local hazards many directly contribute to
enhance the disaster potential. For example projects to construct human settlements in
earthquake prone areas without an adequate understanding on the seismic activity in the

43 M.B. Anderson, Analyzing the costs and benefits of Natural Disasters. Responses in the context of
45 J.J. Warford. “ Environmental management and Economic policy in Developing Countries”, in,
46 See, M.B. Anderson, Analysing the costs and Benefits of Natural Disasters Response in the context
Development, (World Bank, 1990), p.3.
47 M.B. Anderson, “A reconceptualization of the linkage between disasters and development”. Disasters
48 R.F. Curtis, “ Natural Disasters and the Development process: A Discussion of issues” Office of
p.1.
area or without inclusion of earthquake resistant building techniques. Even development itself sometimes leads indirectly to an increase in disaster probability. For example, populations have moved to urban areas for productive employment, but because of lack of planning they may inhabit land which are susceptible to earthquake disasters.

In addition sometimes development projects are undertaken without regard for natural disaster potential, may either scarce development resources are frequently inefficiently allocated, and or investment of money on a project later wiped out by a natural disaster such as earthquakes or landslides. Even more common experience is that when natural disaster occurs it certainly interrupts ongoing development programmes and diverts resources from the originally planned use to other immediate pressing problem.

50 R.F. Curtis, p.4
51 J.R. Jovel, Economic and Social consequences of Natural Disasters in Latin America and the Caribbean, United Nations Economic Commission for Latin America and the Caribbean, (Chile, N.11) p.18.