Paper name: Environmental Geography and Disaster Management

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Topic: Vulnerability Analysis

Concept and Definition

Vulnerability can be defined as ***"the extent to which a community, structure, service, or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrain or a disaster prone area".***

The World Conference on Disaster Reduction, 2005 (WCDR) has adopted the following definition of vulnerability: "***Vulnerability denotes the conditions determined by physical, social, economic and environmental factors or processes, which increase susceptibility of a community to the impacts of hazards. Vulnerability is thus the probability of being damaged, destroyed or lost because of a natural hazard***". Vulnerability is far from being a static process; it is a dynamic process that keeps on changing the probability of process of loss and damage of all the elements exposed to disasters".

The concept of vulnerability therefore implies a measure of risk combined with the level of social and economic ability to cope with the resulting event in order to resist major disruption or loss. This susceptibility and vulnerability to each type of threat will depend on their respective differing characteristics. The 1993 Marathwada earthquake in India left over 10,000 dead and destroyed houses and other properties of 200,000 households. However, the technically much more powerful Los Angeles earthquake of 1971 (taken as a benchmark in America in any debate on the much-apprehended seismic vulnerability of California) left over 55 dead.

Elements of Disaster Vulnerability

Vulnerability to a particular natural hazard or disaster comprises a set of components which help in the identification and determination of nature and types of disasters. Such vulnerability elements or components or factors include the following:

1) Hazard/disaster name, such as earthquake, cyclones, volcanic eruption, floods droughts,, avalanches, landslides, tsunami, etc.

2) Spatial unit such as a particular locality, a region, a country, etc. For example, flood plains, coastland, mountain slope, ice caps, islands, etc.
3) Vulnerable community, such as human community, plant community (a forest fire may destroy a large chunk of valuable forest are), animal community, both terrestrial and marine, including micro-organisms.
4) Speed of hazard, such as rapid onset of a natural hazard (for example, tsunami, earthquake occurence, lava flow, tornado, etc.) slow onset of a natural hazard (for rxampls, drought, sea level rise, etc.).
5) Duration of hazard, short-period quick impacts (for example, tsunami, tornado, seismic events, etc.), long period slow but widespread impacts (for example, floods, droughts, sea level rise, etc.).
6) Resistibility of materials of physical structures such as different types of buildings in varying locations (for example, hillslopes, flood plains, low coastlands, etc.), bridges, roads, rail tracks, etc.

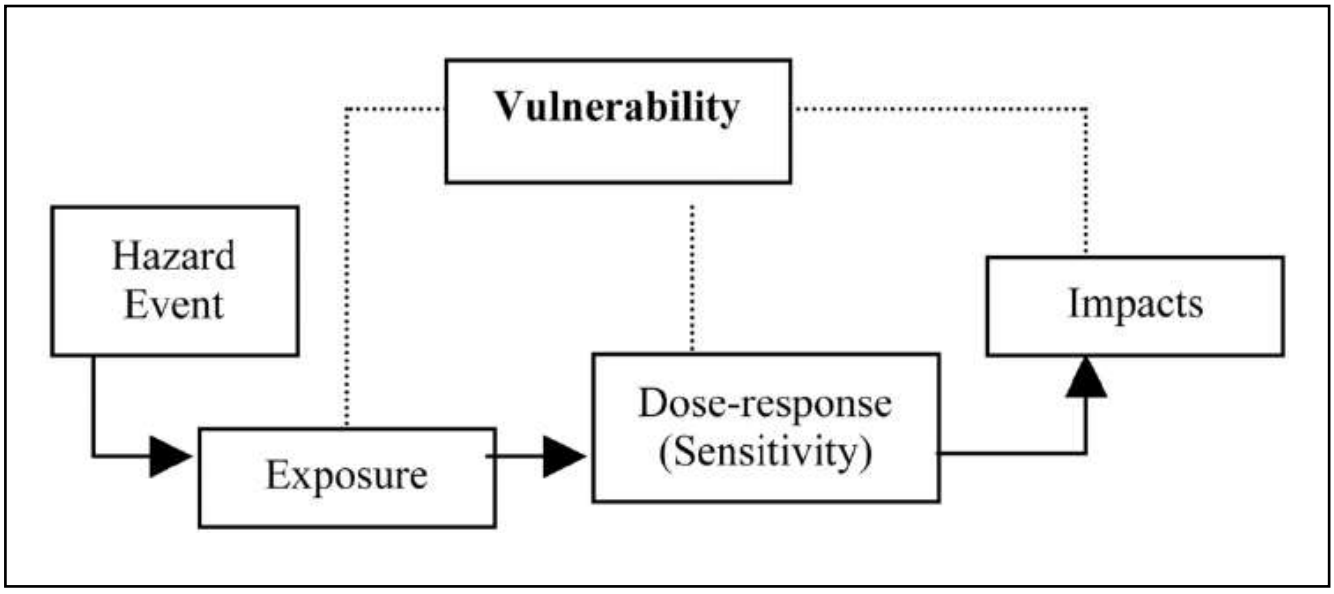

Fig.: Vulnerability-hazard model (Turner *et. al*, 2003)

Vulnerability Typology

On the basis of elements of hazard/disaster vulnerability, the following vulnerability types may be identified:

1) **Individual hazard vulnerability**

i) volcanic vulnerability,
ii) seismic vulnerability,
iii) tsunami vulnerability,
iv) hurricane vulnerability,
v) tornado vulnerability,
vi) cyclone vulnerability,
vii) typhoon vulnerability,
viii) flood vulnerability,
ix) drought vulnerability,
x) landslide vulnerability,
xi) El Nino vulnerability, etc.

2) Spatial vulnerability (vulnerable area)

i) local area vulnerability (vulnerable locality),
ii) regional vulnerability (vulnerable region),
iii) country vulnerability (vulnerable country),
iv) global vulnerability, such as sea level rise, etc.

3) Infrastructural vulnerability

i) vulnerable water supply system
ii) vulnerable transport system
iii) vulnerable communication system
iv) vulnerable electricity supply system

4) Community vulnerability

If the aforesaid vulnerability types are combined, these may be grouped into the following two categories:

1) Physical vulnerability
2) Social vulnerability

Physical Vulnerability

Physical vulnerability relates to the physical location of people, their proximity to the hazard zone and standards of safety maintained to counter the effects. For example, people are

only vulnerable to a flood because they live in a flood-prone area. Physical vulnerability also relates to the technical strength of buildings and structures to resist the forces acting upon them during a hazard event. The Indian subcontinent can be primarily divided into three geophysical regions with regard to vulnerability, broadly, as, the Himalayas, the Plains and the Coastal areas. The topographic and climatic characteristics of each region make them susceptible to different type of disasters (study along with map given in the text).

Socio-economic Vulnerability

The degree to which a population is affected by a calamity will not purely lie in the physical components of vulnerability but in contextual, relating to the prevailing social and economic conditions and its consequential effects on human activities within a given society.

Disparate capacities of people are exposed during disasters, which explains differential vulnerability/losses, which are explained in disaster literature as socio-economic vulnerabilities. Disaster effects are seen to be directly proportionate to the poverty gap and poverty intensity in the society/location as it is the poor that normally live in high concentration in marginal areas (unstable slopes, flood plains) with little infrastructure and fewer resources to cope. Research in areas affected by earthquakes indicates that single parent families, women, handicapped people, children and the aged are the particularly vulnerable social groups.

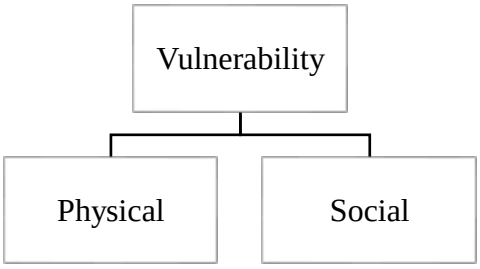

Fig.: Types of vulnerability

Bad land use planning in seismic and flood prone zones; unplanned and inadequate developmental activity in high- risk areas is a cause for increased losses during disasters. One million houses are damaged annually in India apart from high human, social and other losses. Urban growth and concentration of limited resources are realities of our times, while the rural sector faces lack of access. This compounds the problems of disaster vulnerability, especially

during earthquakes. Informal settlements that house most of the urban and rural poor give way easily to physical stress, during earthquakes and floods, causing large scale fatalities during disasters such as earthquakes and floods. Single scale event fast turns into a compound phenomenon as the infrastructure gives way, leading to fire breaks, deaths due to electrocution, besides making response ever more difficult.

Following steps are imperative for the vulnerability assessment and preparedness in high-risk zones:

- Identification of various hazard prone areas. Preparation of detailed vulnerability profiles, mapping food insecurity, aviation hazard, landslide hazard etc.
- Vulnerability and risk assessment of buildings.
- Developing disaster damage scenarios.
- Developing technical guidelines for hazard resistant constructions.
- Upgrading of hazard resistance of existing housing stock by *Retrofitting*, and
- Crafting techno-legal regime to be adopted for infrastructure development.

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