Hazard Mapping: Definition and Techniques

According to UNDRO (United Nations Disaster Relief Co-ordinator) hazard mapping is the process of establishing geographically where and to what extent particular phenomenon is likely to pose a threat to people, property, infrastructure and economic activities. It is the process of identifying and displaying the spatial variation of hazard events or physical conditions. For example, potential ground shaking, flood plains, hazardous material sites, climate zones etc. The main objective is to provide the residents with the information on the range of possible damage and the disaster prevention activities. It cannot stop a disaster. However, the effective use can stop the magnitude of disaster. Flood maps, landslides map, shake maps are specific types of hazard map. There are two types of hazard map:

(a) Resident – Educating Type: The main objective of this map is to inform the residents of that particular area about the risk.

(b) Administrative Information Type: The main objective of this map is to inform the administration so that the maps can be used in warning and evacuation system.

Probability of hazard occurrence varies from place to place.

The use of mapping to synthesize data on natural hazards and to combine these with socioeconomic data facilitates analysis. It improves communications among participants in the hazard management process and between planners and decision-makers. Two important techniques in use are

1. Multiple hazard mapping and
2. Critical facilities mapping

1. Multiple Hazard Mapping (MHM):

This is usually carried out with new development in mind. Valuable information on individual natural hazards in a study area may appear on maps with varying scales, coverage, and detail, but these maps are difficult to use in risk analyses due to the inability to conveniently overlay them on each other for study. Information from several of them can be combined in a single map to give a composite picture of the magnitude, frequency, and area of effect of all the natural hazards.

• Regional scale hazard mapping uses 1:100,000 to 1:250,000. These are useful during planning stages of regional development.

• Urban land use planners may need medium scale hazard maps of 1: 10,000 to 1:25,000.

• Site investigation for infrastructure projects may require large scale hazard maps of 1:1,000 to 1:5,000.

The multiple hazard map (MHM; also called a composite, synthesis, or overlay map) is an excellent tool for fomenting an awareness of natural hazards and for analyzing vulnerability and risk, especially when combined with the mapping of critical facilities. Its benefits include the following:

• Characteristics of the natural phenomena and their possible impacts can be synthesized from different sources and placed on a single map.

• It can call attention to hazards that may trigger others (as earthquakes or volcanic eruptions trigger landslides) or exacerbate their effects.

• A more precise view of the effects of natural phenomena on a particular area can be obtained. Common mitigation techniques can be recommended for the same portion of the study area.

• Sub-areas requiring more information, additional assessments, or specific hazard-reduction techniques can be identified.

• Land-use decisions can be based on all hazard considerations simultaneously.

The use of a multiple hazard map also has several implications in emergency preparedness planning:

• It provides a more equitable basis for allocating disaster-planning funds.

• It stimulates the use of more efficient, integrated emergency preparedness response and recovery procedures.

• It promotes the creation of cooperative agreements to involve all relevant agencies and interested groups.

The base map upon which to place all the information is the first consideration. It is usually selected during the preliminary mission. If at all possible, it is best to use an existing map or controlled photograph rather than go through the difficult and time-consuming process of creating a base map from scratch.

The scale used for an MHM depends on the hazard information to be shown, availability of funds and the scale of the base map. If a choice of scales is available, then the following factors should be considered:

• Number of hazards to be shown

• Hazard elements to be shown

• Range of relative severity of hazards to be shown.

• Area to be covered.

• Proposed uses of the map.

Much hazard information will be in forms other than maps, and not readily understandable by laymen. It must be "translated" for planners and decision-makers and placed on maps. The information should explain how a hazard may adversely affect life, property, or socioeconomic activities, and must therefore include location, likelihood of occurrence (return period), and severity. If some of this information is missing, the planning team must decide whether it is feasible to fill the gaps. Development and investment decisions made in the absence of these data should be noted.

Despite the importance of multiple hazard maps in the integrated development planning process, planners and decision-makers must remember that the credibility, accuracy, and content of an MHM are no better than the individual hazard information from which it was compiled. Furthermore, since it contains no new information - it is merely a clearer presentation of information previously compiled - the clarity and simplicity of the map is the key to its utility.

2. Critical Facilities Mapping (CFM)

This is carried out for development within existing infrastructure in mind. The term "critical facilities" means all man-made structures or other improvements whose function, size, service area, or uniqueness gives them the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed or damaged or if their services are repeatedly interrupted.

The primary purpose of a critical facilities map (CFM) is to convey clearly and accurately to planners and decision-makers the location, capacity, and service area of critical facilities. An extensive number of such facilities can be presented at the same time. Also, when combined with a multiple hazard map, a CFM can show which areas require more information, which ones require different hazard reduction techniques, and which need immediate attention when a hazardous event occurs. Some of the benefits of a CFM are:

• The uniqueness of service of facilities in the area (or lack of it) is made clear.

• Facilities that may require upgrading and expansion are identified.

• The impact of potential development on existing infrastructure can be assessed before a project is implemented.

• Any need for more (or better) hazard assessment becomes apparent.

3. Combining critical facilities maps and multiple hazard maps

There are many advantages in combining a CFM, with a MHM, and integrating both into the development planning process. For example, if a critical facility is found to be in a hazardous area, planners and decision-makers are alerted to the fact that in the future it may confront serious problems. Its equipment, use and condition can then be analyzed to evaluate its vulnerability.

If appropriate techniques to reduce any vulnerability are incorporated into each stage of the planning process, social and economic disasters can be avoided or substantially lessened. Avoiding hazardous areas, designing for resistance, or operating with minimal exposure, can make new critical facilities less vulnerable. Mitigation strategies for existing critical facilities include relocation, strengthening, retrofitting, adding redundancy, revising operations, and adopting emergency preparedness, response, and recovery programs.

The benefits obtained by combining a CFM and an MHM include:

• Project planners and decision-makers are made aware of hazards to existing and proposed critical facilities prior to project implementation.

• The extent to which new development can be affected by the failure or disruption of existing critical facilities as a consequence of a natural event can be determined.

• More realistic benefit-cost ratios for new development are possible.

• Sub-areas requiring different assessments, emergency preparedness, immediate recovery, or specific vulnerability reduction techniques can be identified.

Mapping techniques and tools

Community knowledge: A simple mapping of local experience can be achieved using local knowledge. Tools used in rural development activities such as; **Participatory Rural Appraisal (PRA**) and **Rapid Rural Appraisal (RRA)** can be very useful in this work. The method is cost effective and the outcome reflects the local perception of hazard. The information can overlay local contour maps.

Surveys on historic events: There may be reports compiled on historic events, which may focus on varying issues depending on its original purpose. However they may contain useful information.

Scientific investigation and research: Usually carried out through teamwork with experts from an array of different disciplines. For example, landslide hazard mapping would require skills of geologists, geo-technical engineers, geomorphologists, topohraphy and so on.

Data over large areas for extensive time periods are collected. These are multidisciplinary studies and each discipline would provide tools and techniques, which become more sophisticated and more accurate over time.

Computer modeling using such data has opened up new vistas for hazard prediction. **Geographic Information Systems (GIS) modeling** from Remotely Sensed data are one outstanding example.

In India, the monitoring of hazards is carried out by many important organizations in the country. The seismic occurrence and cyclone hazard monitoring is done by India Meteorological Department (IMD) and flood monitoring by the Central Water Commission. Geological Survey of India and Department of Earthquake Engineering, IIT Roorkee has also made important contributions. India has state wise earthquake hazards map, wind and cyclone hazards maps and flood hazards map. All these maps are available in the BMTPC website.