Asha Merin Jolly, Department of Geology & Environmental Science

Geological Disasters

Geologically related disasters deal with earthquakes, landslides, mudflows, sea erosion, dam bursts and dam failures, and mine fires. More than half of the area of the country lies in high to moderate seismic zones that could have damaging seismic intensity. The areas affected by landslides are also wide spread in the Himalayas.

Earthquakes

Although occurrence of an earthquake cannot be predicted precisely in terms of time or place, yet the seismic zones are very well drawn and careful planning, design and the appropriate measures can minimise the damaging effects. Earthquake is an unavoidable unpredictable infrequent phenomenon. Its parameters are its location, its destructive energy and the depth of its focus below ground level. Earthquakes destroy buildings and infrastructure with secondary effects, i.e., fires, embankment failure, release of poisonous gases, release of nuclear radiation, liquefaction etc. and the losses may sometimes be much more than as a direct consequence of earthquakes itself. Earthquake disaster mitigation planning must take both the primary and secondary effects into consideration.

For effective earthquake disaster mitigation,the pre-earthquake phase needs to be utilised for planning and implementing preventive measures on the one hand and working out preparedness activities on the other. Earthquake in itself is not a disaster. Disaster is caused due to failure of man made structures, lack of preparedness and awareness. So far, earthquake disaster mitigation efforts are mostly reactive.
Disaster prevention, mitigation and preparedness are better than disaster response. The first step towards the direction of disaster preparedness is risk assessment.There is a need to proceed from hazard assessment to vulnerability analysis and ultimately generation of earthquake risk maps/figures.

Earthquakes are being monitored by India Meteorological Department, Survey of India,National Geophysical Research Institute,Department of Earthquake Engineering,University of Roorkee and several other academic and research organisations. Macro level map has been prepared which helps in classifying the country into the earthquake hazard zones. The Vulnerability Atlas gives State and district-wise hazards to buildings and other infrastructure due to natural disasters. The disaster can be made much worse due to the vulnerability of the community itself. Vulnerability assessment of buildings, structures/infrastructure, lifelines, economy and people is to be undertaken.

Landslides and Mudflows

Landslides and other mass movements can be predicted and the damage minimised or even averted with proper and systematic studies and with the adoption of remedial measures. The mass movements occurring with fast speed are more dangerous, e.g., rock falls, since very often these occur without any warning or signs of distress. However landslides, land subsidence and creep are relatively slow processes and precautionary measures can be adopted in time to reduce the quantum of damage. Landslide studies are still being conducted in a somewhat disparate fashion by various scientific agencies. Cloudbursts and flash floods accompanied by heavy rainfall are the main cause of landslides in India. In the mountainous terrain such as the Himalayas, the landslides caused are due to structural features, geomorphic aspects or the

relation of slope with major fabric of rock mass. The natural damming of rivers by landslides is a significant hazard in many areas.

Landslides and Mudflow Mitigation and Response Plans

Measures of landslide control are avoidance, surface drainage, sub-surface drainage,supporters, excavation, river structural work,vegetation, blasting and hardening. Hazard identification, mapping and assessment to identify the existing or potential landslides using various techniques are important and involve zonation and risk evaluation.Each mass movement requires different site specific strategies. However, for minimizing the incidence of landslide and other mass movements some general suggestions including geotechnical survey, Landslide Hazard Zonation maps,involvement of people, basic knowledge, and education are the key issues.

Dam Bursts/Dam Failures

A dam burst releases large quantities of water causing disastrous damage to downstream installations, disrupting socio-economic activities causing loss of life with adverse ecological and environmental impacts. The frequency of dam failures has markedly decreased in the recent past. The structural stability of a dam can be threatened by floods, rockslides, landslides, earthquakes,deterioration of the heterogeneous foundation, poor quality of construction,differential settlement, improper management, and acts of war. Three types of earth embankment problems commonly found are seepage, slope stability and vegetation outgrowth. **Available studies indicate that extreme floods and uncertain geologic setting are the principal causes of dam breaches.** Furthermore, the earth fill dams have been involved in the largest number of failures, followed in order by gravity dams, rock fills, and multiple and single arches.

Preparedness on Disaster due to Dam Failure

The failure of dams causes economic losses that transcend immediate property damages and loss of life. Predicting the consequences of dam breach is the primary step in dam safety programme. Preparation of inundation maps under postulated failure can be made a statutory requirement. However; disaster planning, compensation for loss, and penalties should also receive legislative attention. Dam safety program should consist of evaluation of hydrologic,subsurface, hydraulic, and stability conditions.

Prevention and Mitigation of Disaster due to Dam failure

Programs of disaster management/mitigation encompass a wide range of options ranging from issuance of flood warnings to reduction of flooding to actual evacuation. The effectiveness of these programs depends, to a large extent, on the accuracy of flood forecasting and management and cooperation between the public and respective agency.

Mine Fires

Mine fires are caused due to spontaneous heating of coal and carbonaceous matter in the rocks. In coal mines the fires could be underground fires which have remained underground or may become surface fires,fires in coal benches in open cast mines, fires in overlying rock mass, fires in overburden dumps or fires in coal stacks. Such fires in the coalfields not only consume huge quantity of coal but also do not permit exploitation of coal in adjoining areas and in underlying coal seams. Combating mine fires, specially the underground fires that have remained underground.

The information needed during preparedness is: zonation of existing coal mine fire affected regions, modelling/ simulation of potential land subsidence and related impact, assessment of loss of property/energy; for warning/prediction it is real time monitoring of coal fires,prediction of spread and depth, pollution extent; for relief it is delineation of affected areas, ways to arrest spread of fire, support to affected population, and for rehabilitation it is long-term measures to control spread,awareness creation among public, relocation of affected people. Mine Fire Hazard Assessment is by mine fire monitoring, hazard estimation and mapping.

Chemical/Industrial/Nuclear Disasters

The Sub-Group, set up by the HPC, covered Chemical & Industrial Disasters, Forest Fires,Oil Spill Fires, Mine Fires and Nuclear Disasters. In the area of organisational structure and the mode of response activation an Integrated Crisis Management Plan (ICMP) has been evolved based on a synthesis of different approaches and on the Crisis Alert System established for chemical accidents. The Standard Operating Procedure (SOP) of the ICMP is based on the Trigger Mechanism i.e. a chain of response actions is triggered off as soon as a disaster is reported. As per the SOP, different emergencies have to be scaled and the response would be based on the level of the triggering event. SOP also lays down a uniform Crisis Management Plan to help the Government Authorities to act more efficiently and promptly to any impending and occurring disaster in India and its neighbouring areas.Th plan include actions like

- ***Identification of Triggering Incidents/Events***
- ***Classification of the Disasters Based on their Magnitude***
- ***Identification of Signal/Warning Mechanism***
- ***Identification of Authorities/Team***
- ***Members and their Response Time***
- ***Developing Incident Specific Emergency Procedures After identification***
- ***Establishing Communication Network***

Biological Disasters

Disasters related to this sub-group are biological disasters and epidemics, pest attacks, cattle epidemics and food poisoning.Our response mechanism to diseases which are forgotten or considered as conquered as well as the vulnerability of the population even to infections which respond favourably to most of the widely available antimicrobial agents such as plague needs to be strengthened. We have virtually no infrastructure, tools or expertise to contain them. Handling exotic pathogens warrants suitable infrastructure, notably, high containment laboratories of bio-safety level 3 and 4; recruitment of highly committed,dedicated and trained professionals; continuous availability of diagnostic reagents; enhancement of skills at various echelons of health professionals in early identification of such infections,investigation of outbreaks and institution of specific control measures. The impact of Transboundary Animal Diseases (TAD) causes constant loss to livestock production. Current system of surveillance and mechanism to control the outbreak of endemic diseases are through the National Programme for Surveillance of Communicable Diseases.
Action Plan for Disaster Management could be dealt effectively only if there is a disaster plan well integrated in the system and there is mechanism of post disaster evaluation. Disaster Stage actions needed is for Public

Health Control Measures. Post disaster stage evaluation is most important step in disaster management in order to rectify deficiencies in management and to record the entire operation for future guidance.

Short term planning would involve early detection of a crisis situation caused by micro-organisms within existing resources and infrastructure. A long term plan would be put into operation as soon as the existing inadequacies are overcome. New infrastructure that need to be created are containment laboratories with adequate bio-safety measures.Existing technical expertise and infrastructure in large number of laboratories across the nation can easily be harnessed towards the national cause.