Water induced disasters, Flood Hazard Mapping & Koshi flood disaster of Nepal

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Seminar Organizers

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1. Introduction

Nepal is the mountainous land lucked country having complex geographic feature. The country has total area of 147181 sq. km. and population of about 27 million. It is lying between the China on the north and India on the rest sides. Almost 75% of the country is covered with mountains. Hills, mountains and Terai (flat land) are the three regions and climate varies from alpine, temperate monsoon to subtropical monsoon respectively. About 51% population are in hills and mountains where as 49% are in terai zone.

Figure 1 Map of Nepal

Nepal has enormous water resources. About 6000 rivers and rivulets drain Nepal. Perennial sources of water originating from the mountains and high intensity of rainfall (average annual rainfall is 1700 mm) contributes to an average annual surface water flow of approximately 224.7 billion m^3 or in terms of flow rate, it is 7,125 m^3/sec. Major sources of water are glaciers, rivers, lakes, rainfall, ponds, groundwater etc. We suffer frequently from various types of water induced disasters such as flood, landslide, erosion, debris flows, glacial lake outburst, drought and epidemic. Nepal lies in a region of seismic active zone. Steep slope, fragile topography, variable climatic conditions and active tectonic processes have made her vulnerable to various types of natural disasters. This phenomenon causes losses of life and property every year. A wide range of physiological, geological, meteorological and demographic factors contribute to the vulnerability of the country to disasters. In addition, other man-made factors such as rapid population growth, unplanned settlement, environmental degradation, global warming, lack of public awareness, slow economic development and low literacy rate have also made us vulnerable to various types of natural disasters.

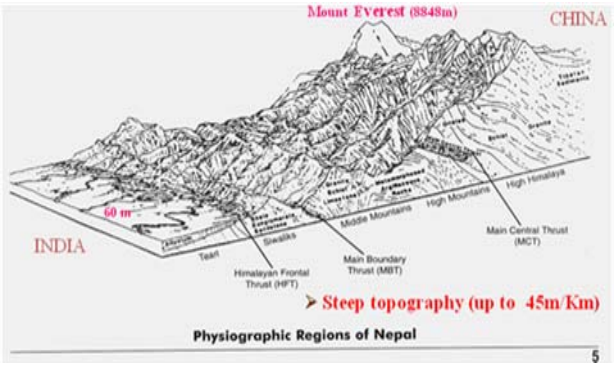

Figure 2 Physiographic regions of Nepal

2. Disaster mitigation Act and policies in Nepal

Many acts and policies have been formulated so far for disaster mitigation activities. The Natural Disaster Relief Act, 1982 of Government of Nepal is the first Act and it has recognized earthquake, fire, storm, flood, landslide, heavy rainfall, drought, famine and epidemics as disaster. This Act defines natural disaster relief work as any relief work to be carried out in the area affected or likely to be affected by the natural disaster in order to remove the grief and inconvenience caused to the people, to rehabilitate the victims of the natural disaster, to control and prevent the natural disasters in order to prevent loss of life and property.

Ministry of Home Affairs has to work as the apex body in relation to disaster management in Nepal. Formulation of national policies and their implementation, preparedness and mitigation of disaster, immediate rescue and relief works, data collection and dissemination, collection and distribution of funds and resources are the vital functions of the Ministry. It has its network throughout the country to cope with the natural disasters. The Chief District Officers in the districts act as the crisis managers at the time of natural disasters.

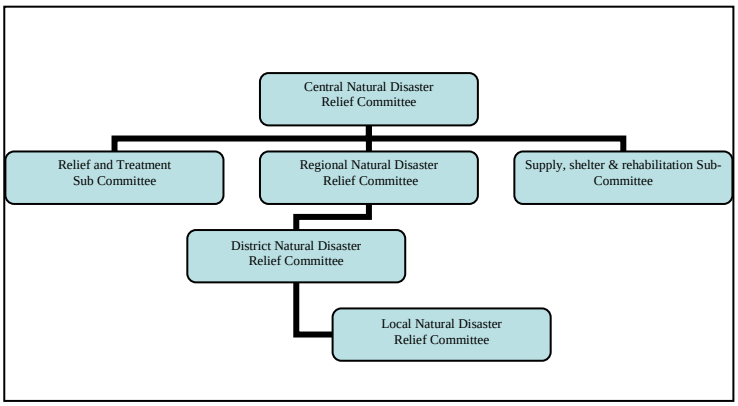

Figure 3 Disaster Relief Committee

Some others related act and regulation formulated so far for disaster management are as follows:

- Natural Calamity Relief Act 1982 (Amended in 1982 & 1992)
- Water Resources Act 1992
- National Action Plan on Disaster reduction 1996
- Environmental Protection Act 1996
- Local self governance act (LSGA, 1999)
- National Water Resource Strategy, 2002
- National Water Plan, 2005
- Three Year Interim Plan (2008-2010)

3. Water induced disaster

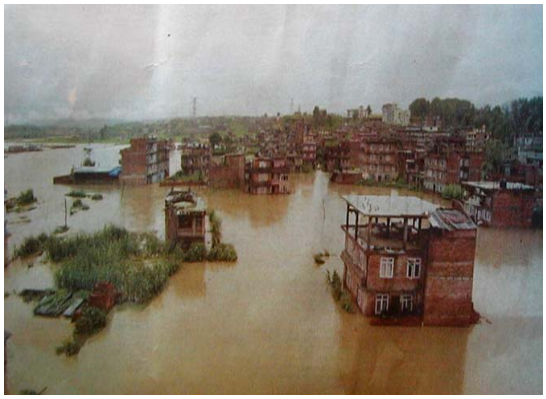

Figure 4 Flood in Kathmandu valley

Floods, landslides and debris flow, avalanches and glacier lake outburst flood (GLOF) are the main water induced disasters in Nepal. Floods, landslides and debris flow are often interrelated. Some landslides are triggered by riverbank erosion, and some flash floods are aggravated by landslides in the areas adjoining riverbanks. Both these phenomena occur during the monsoon season. Debris flow is another serious natural disaster which occurs frequently. Glacial lake outburst floods (GLOF) are common in the Himalayan region. GLOF are triggered by a wide range of global warming, hydrological and seismic factors.

Figure 5 Landslide at Naubise raod

Disastrous flash floods usually occur in Nepal when landslides or debris block a river for several hours and the water are then released suddenly, inundating areas downstream. Continuous heavy rainfall may also cause flash floods in many rivers originating in hilly regions. Flash floods may also be cussed by an avalanche, snowstorm or cloudburst. A significant number of landslides estimated at over 12,000 occur each year. Intense monsoon rainfall causes floods in many parts of the country every year. Altogether, water induced disasters causes average annual loss of 309 lives and affects 27654 families. Fatal causalities, injuries, missing of people, damages of properties, human sufferings, disruption of socio-economic life and overall environmental degradation in the country are the result of these water-induced disasters in Nepal. Floods and landslides occur every year which is not only causing losses of human lives and physical property but also adversely affecting the development process of the country.

4. Concerned organizations & situation of *Flood Hazard mapping*

As already mentioned; Ministry of Home Affairs works as the nodal body for overall disaster management in Nepal. For water-induced disaster prevention works, Department of Water-induced Disaster Prevention (DWIDP) is established in year 2000 under the Ministry of Water Resources, Nepal with co-operation of Japan International co-operation Agency (JICA). Its overall goal is "To contribute in achieving the national goal of poverty alleviation through minimizing the human casualties and damage of infrastructures due to water induced disasters by the appropriate management and conservation of rivers and river basins of Nepal".

Water Resources Strategy of Nepal has also recommended DWIDP as the lead agency and has given a clear mandate to implement the activities like hazard risk assessment and mapping to achieve the strategic output for disaster mitigation by preparing Water-induced Disaster Hazard Maps. So, DWIDP has clearly defined the activities to be carried out to minimize the impact of the disasters and it has initiated systematic hazard mapping throughout Nepal. The National Water Plan has set that by 2017, establishment of water induced hazard warning systems in all over the country and bringing them in functional stage. In order achieve the goal of Government on disaster management; DWIDP is working for water induced hazard risk assessment and hazard mapping of hazard prone areas. Apart from DWIDP, other international organizations like JICA, ICIMOD, UNESCO etc are also working separately on hazard mapping of different hazardous area of Nepal. Different Programmes and Projects are implemented under the DWIDP for disaster mitigation. One of them is Disaster Mitigation support Programme Project (DMSP).This project is being implemented since September 1999, under the agreement of Nepal Government and the Government of Japan to contribute in promoting capacity of Nepal Government and communities for the mitigation of water-induced disasters. Under this project, DWIDP has prepared flood hazard maps of

1. Rupandehi District
2. Bagmati River Basin
3. Kamala River Basin
4. Rapti River Basin
5. Rangun River Basin
6. Tinau River Basin
7. Aandhi Khola River Basin
8. Kankai River Basin
9. Trijuga River Basin

Flood hazard maps are generally prepared for river basin. Fig.6 shows the integrated water-induced map of Rangun river basin. It covers an area of about 495.8 sq km and occupies mainly the Dandeldhura District with a small portion of the Doti District of Far West Nepal. Prepared flood hazard maps so far are integrated water-induced maps for large area.

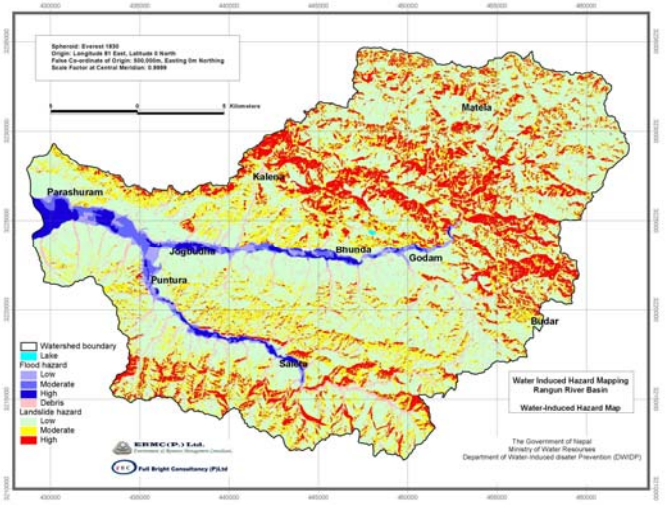

Fig.6 Integrated water-induced map of Ranugn river basin

Figure 7 shows the flood hazard map prepared for some part of Rupandehi district (lies in the Western development region of Nepal). It covers area about 1011.3 sq.km. Map shows the landslide and flood hazards. Different service centre are also mentioned in the figure.

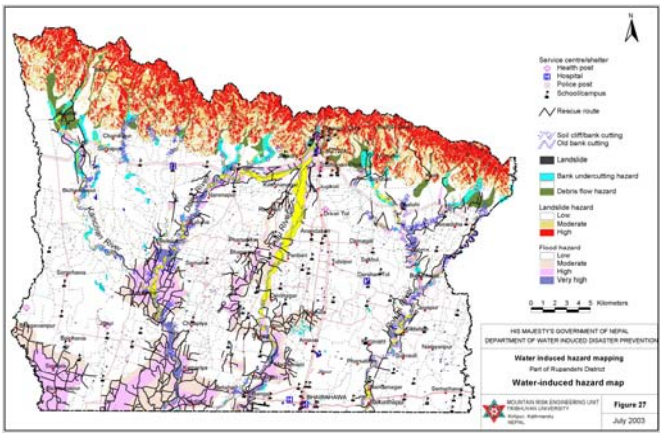

Figure 7 Flood hazard map of Rupandehi district

These maps show the flood and landslide hazard for study area and they are categorized as low, moderate and high risk area. Present practice of flood hazard mapping do to resembles with the different types of flood hazard maps as prepared by International Centre for Water Hazard and Risk Management (ICHARM). These maps do not show the depth of inundation, land use pattern, developed infrastructures, evacuation route and evacuation centre. Prepared hazard maps are for wider area so in order to issue the early warning and evacuation order we have to develop maps for smaller area containing all the information's necessary in flood hazard mapping as developed by ICHARM. Due to such situation of hazard mapping, it couldn't be disseminated at the public level. Hazard mapping should be done separately for flood and landslides so that it would be easy and transferrable even to the community people.

5. Essential FHM data situation

Accuracy of flood hazard mapping depends upon the quality of input data required for analysis. Present data situation in Nepal are as follows.

***Hydro meteorological data*:** Department of Hydrology and Meteorology (DHM), Nepal has established many measuring stations throughout the country. Hydro meteorological data are available for many river basins. However, due to lack of resources, advance techniques, equipments and accountability on data collection they are not reliable and consistent.

Satellite images, Land-use and topographic maps: Survey Department, Nepal is an authentic office to preserve and revised the satellite images, land-use and topographic maps of Nepal. High quality satellite images, precise land- use and topographic maps are not available even at Survey Department. Topographic maps are prepared in 1995 and we are still using those toposheets. It's already more than a decade and at present there are many changes in land use pattern which are not taken into account.

Digital elevation model (DEM): Generally GIS based DEM of the study area are freely downloaded from internet. Survey department is also providing DEM but these data are not precise as available in the market. Actually, we do not have trend to invest for precise data. So, availability of precise DEM is another problem to develop accurate flood hazard map of the study area.

6. Present problems of Flood Hazard Mapping

- Concept of flood hazard mapping and non structural countermeasure works are somewhat new for us.
- So far, we don't have complete flood hazard map. No practice of early warning and evacuation. Departments and public are not completely aware about the benefit of flood hazard mapping.
- Investment of Nepal Government on pre-disaster activity is not sufficient. Flood Hazard Mapping is not taken as development activity and sufficient budget is not allocated for it.

- No trend and culture to invest on hydro-meteorological observation, data collection and research activity which are essential for inundation analysis, flood hazard mapping and development of early warning system.
- Flood Hazard Maps developed by Departments are not complete for dissemination.
- Lack of availability of precise data and softwares for inundation analysis and flood hazard mapping.

7. Types of FHM necessary for Nepal (As described by ICHARM)

Department of Hydrology & Meteorology of Nepal is collecting data of different river basins regularly. Even though there are problems on collected data, some of the data sets are reliable. Further improving the data collecting system, we would be able to manage more precise hydrological data and rely on it. With such data sets we can perform rainfall runoff modeling. If we will be able to manage other GIS based data and inundation analysis software, we can perform inundation analysis and produce flood hazard map precisely. So, we are in a stage of producing maps based on inundation analysis (i.e. maps type E, F &, G as proposed by ICHARM).

8. Other information's about FHM

Government of Nepal has taken privatization policy in communication system. These days we have many private television and FM radio stations. Telecommunication and internet system are established in many districts. Newspapers are published even at regional and local level. So we can say that we have good communication system for information dissemination at the time of disaster. Department of Hydrology and Meteorology provides information and forecast about weather and rainfall. Generally Ministry of Home and chief district officer issues evacuation order at the time of harsh and abnormal rainfall and weather condition. Apart from government many other social and nongovernmental organizations such as Nepal Red Cross Society, UNOCHA, JICA, UNICEF, Rotary, Save the Children etc are assisting in awareness raising, rescue operation, relief activity and evacuation at the time of water induced disasters.

9. Koshi flood disaster of Nepal

The Koshi Basin is the largest river basin of Nepal. It originates from the Tibetan Plateau of China and in high Himalayas of Nepal. The Koshi enters Bihar (Northern most State of India) and finally ends at the confluence of Ganges, travelling from Nepal. It may be the only river in the world which has horizontally changed its course as much as 120 km in the last 250 years. Floods from the Koshi river in the past have created havoc in the downstream area of Nepal and India leading to loss of lives and property and causing widespread human suffering.

Some features of Koshi river

- Total length 729 km.
- Catchment area 60,400 Sq.Km.
- Average annual flow 1590 m^3/sec.
- River width: Up to 11km in Nepal and up to 18 km in India.
- Average annual sediment volume: 118 million cubic meter.
- Past maximum flood : 913,000 cusec (25849 m^3/sec ;5^{th} Oct.1968)
- Recent Flood: 168,500 cusec (4770 m^3/sec; 18^{th} August, 2008)

In 1954, with an objective of flood control, irrigation and hydropower generation, Koshi project agreement was signed between India and Nepal. Before the construction of Barrage, Koshi River was known as the "sorrow of Bihar" due to flooding in the monsoon and drought in winter. It became the "pride of India" (Bihar) when the Barrage was completed. It was constructed between 1955 and 1963 on the Nepal side of the Indo-Nepal border. The Koshi Barrage has a discharge capacity of 950,000 cusecs (26896 m^3/sec) in a peak flood.

Koshi project

- Agreement in April, 1954.
- 1150 m long barrage with 56 gates.
- Two head regulator for canals (Eastern: 612,500ha & Western 356,610 ha).
- Power generation of 20 MW (11 km d/s of Barrage at eastern canal).

- Earthen Left embankment 144 km (32 km with 57 numbers of spurs in Nepal).
- Earthen Right embankment 125 km (25 km with 51 numbers of spurs in Nepal).
- Length of spur; 150 – 300 m.
- Nepal territory leased for 199 years.

Some clauses of Koshi Project treaty:

- The Government of India (GoI) shall be authorized to conduct necessary investigation for storage or detention for dams on the Koshi or its tributaries - soil conservation, check dams, forestation, etc. for prevention of future problems (Art. 2.2).
- Nepal shall provide necessary lands to execute the said project (Art. 3.1) and compensation of land to be provided by India to Nepal (Art. 3.2). India shall execute all necessary repair work and maintenance, and if incident occurs, compensation for every damage case shall be provided to Nepal (Art. 3.3).
- India shall be the owner of all lands acquired from Nepal. The sovereignty rights and territorial jurisdiction of the Government in respect of such lands shall continue unimpaired by such transfer (Art.5).
- Nepal shall be responsible for ensuring security in the project areas (Art. 14).

Koshi Flood Disaster of 18th August 2008

The breach on the embankment of the Koshi River (12.6 km upstream of barrage) occurred on 18th August, 2008 at 12.45 pm. At the time of breaching, about 168 thousand cusec of water diverted into Kusaha, Laukahi, Ghuski, Sreepur, Haripur, Narshimha, Madhuban and Basantapur VDC of Sunsari district. It caused the displacement of more than 107,200 people in Nepal. Progression of embankment breaching took

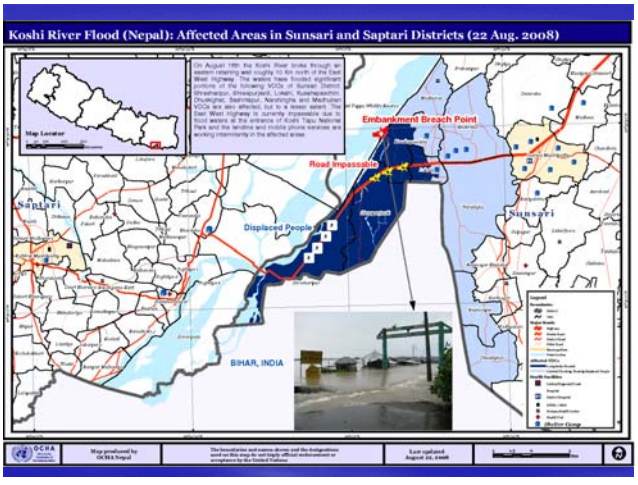

Figure 8 Koshi flood of 2008 (Photo: OCHA)

place at the rate of about 500 m. in every five hours. It is the country's worst flooding in five decades. Rains during monsoon season and lack of repair caused the embankment to collapse. When the Koshi River changed its course towards the east, breaching 1.70 km of its left embankment and it deposited silt on the flood affected area and adjoining villages covering 5475 hectors of agricultural land. About 80% of flow passed through the breached section. The death toll would have been very high if the flood had occurred at night. At the time of disaster about 15 kilometers of the East West highway was obstructed and 3 kilometers was destroyed. The floods have drastically impacted habitats of wildlife, aquatic, flora and fauna of the Koshi Tappu Wildlife Reserve (KTWR) in Sunasari district. About two thirds of houses were severely damaged as most of them were huts made of mud, bamboo and thatch. These houses were generally one story high. The floor and walls were mud plastered. It caused extensive damage to the optical fiber cable network laid along the highway. In addition telephone exchange, power plant,

Figure 9 Koshi Flood Disasters of August,2008

Main Distribution Frame (MDF) Transmission system were submerged in the floods and caused disturbances to the communication network in the eastern region of Nepal.

Disaster scenario of Koshi flood 2008 in Nepal (Source: Ministry of Home Affairs, Nepal)

- About **107,200 people** of **8 VDC (**4 completely, 4 partially**)** in **Sunsari districts** were affected.
- **1 human death** was reported at the time of disaster. The total human death toll is **8.**
- The national highway was damaged at several places by the flood.
- Displaced people were kept in **28** different temporary shelter camps.
- **56751** displaced people of **7995 families** (NRC, 2/9/2008) were taken to the temporary shelters.
- Domestic animals of **55000** effected, **20000** displaced.
- **14571 Domestic animals** were killed [Small size 3270 (Chicken, Duck), large size 11301(Cow, Buffalo, Goat, Pig)]
- **5500 people** were rescued within three days of disaster.
- **3** Helicopters, **10** rafting boats, **3** ordinary boats, **4** elephants mobilized for rescue and distribution of relief materials.
- Many people suffered from different type of disease like cholera, diarrhea, pneumonia, eye conjunctivitis, fever etc.

Disaster scenario of Koshi flood 2008 in India (Source: Ministry of Home Affairs, India)

- About **30,65,000 people** from **1704 villages** in **16 districts** have been affected.
- **7 human deaths** have been reported by the State from 29.08.2008 to 30.08.2008. The total human death toll of the State is **54**.
- **2,83,797 houses** are reported to have been damaged due to flood.
- **3,78,826 persons** have been evacuated from the affected areas so far.
- **2036 boats** have been pressed into service for rescue and relief operations.
- In **182 relief camps** about **1,14,278** people have been accommodated.
- **6 mobile health teams** have also been mobilized in the affected areas of **district Supaul**.
- In **96 cattle camps** about **6764 animals** have been treated.
- **158 Health Centre** have also been opened in the flood affected areas.

Reasons of Koshi flood disaster

- Unequal Koshi project treaty
- Rise of bed level (0.05m/year) due to excess sediment load.
- Concentration of flow towards eastern embankment and striking since last 8 years
- Lack of regular monitoring mechanism and maintenance activity.
- Over confidence about the strength of structures
- Problem of security at the site.
- Lack of good coordination between Nepal & India. Trend of blaming each other
- No proper emergency response activity
- Lack of nonstructural countermeasure works like rising of awareness, development of early warning system and flood hazard mapping.
- No experience about the extent of flood damage.

Conclusion

In Nepal, disaster mitigation is considered as a humanitarian activity and more focus is given on post disaster activity. Normally we allocate budget for structural countermeasure works and post disaster activity. In order to minimize the risk from flood hazard, both structural and nonstructural mitigation measures works are equally important. Rather than relying completely on large structural measures, which may not be sustainable due to present economic condition of the country, policies and guidelines need to be developed and implemented for non-structural countermeasures against flood hazards at the community level together with structural countermeasure works. Present practice of nonstructural countermeasure works such as flood hazard mapping is not reliable. Hence it is essential to develop methodology to improve present flood management system with nonstructural countermeasures. Such non structural countermeasure of flood risk reduction is possible with rainfall runoff modeling, inundation analysis and flood hazard mapping. We can't control the hazards but its effects can be tremendously minimized with an application of hazard mapping and early warning system. So we should improve our policy to develop hazard maps and early warning system considering it as a development activity with active people's

participation. Some of the water induced disaster problems in Nepal are due to transboundary conflict and lack of co-ordination with neighbor country, India. Present Koshi flood disaster is one of the example of such disaster. So, government has to set up policy to develop bilateral coordination and co-operation with India to solve such boundary water induced disasters problem.

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