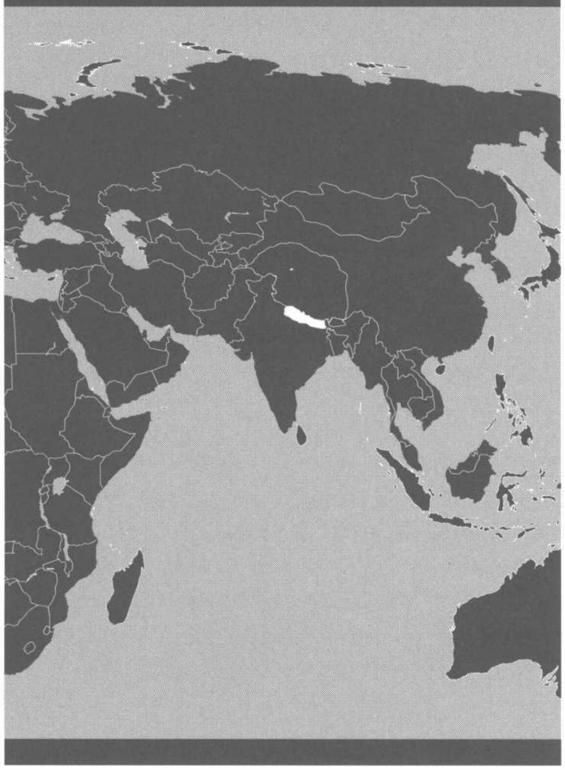
Nepal



GIS and remote sensing for flood disaster identification: a case study of the Koshi River basin in Nepal

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SYMPOSIUM NOTES

This research is conducted for flood hazard assessment and risk identification around the Koshi river area. This research is a Provention Consortium funded project for the applied research grants for disaster risk reduction program.

Floods and landslides are the most destructive types of water-induced disaster in Nepal. In July 1993, Nepal experienced a devastating flood in the Terai region, which took the lives of 1,336 people and left 487,534 people homeless. In 1999, floods and landslides killed 113 while 47 people were reported missing and 91 seriously injured. A total of 8,844 families were affected, 3,507 houses and cattle sheds were destroyed and 177,32 hectares of land and agricultural crops were ruined in the year's floods and landslides (HMG/N, 2000). The disaster caused a total loss of NRs. 3.6 million. In July and August 2002, Nepal experienced numerous landslides and floods in the Eastern and Central regions, which took the lives of 451 people and affected nearly 55,000 families. The estimated loss of property from natural disaster is about NRs. 10,000 million annually, which is about 20% of GDP (DPTC 1995).

Study area

The Koshi River, one of the largest rivers of the world, is also a major tributary of the River Ganges. Reoccurring flood events in the Koshi River causes heavy loss of human lives and physical properties in Nepal and Bihar of India every year (Pradhan, 2000). During the monsoon season, the problem of flooding and water logging occurs throughout the area.

The present study area is located in the southeastern part of Nepal. The study area extends from Chatara to Bhantabari, and it covers three districts, namely Saptari, Sunsari, and the southern tip of Udaypur (Fig. 1). The villages that fall within the project area are Chatara, Byarban, Rajabas, Prakashpur, Chakraghatti, Jhumka, Madhuban, etc. all of which border the bank of the Koshi river.

Figure 1: Location of the study area

Objectives of the study

The main objective of the project was focused on the flood hazard assessment and risk identification using tools such as GIS and Remote Sensing with detailed field survey. An important component in this study was the socio-economic data analysis which assessed local people's perception and indigenous knowledge for risk identification from floods. These objectives can be listed as:

- To identify the perception and consequence of flood disaster in local people.
- To evaluate the socio-economic impact of flood.
- To prepare detail flood hazard map and to identify the frequency, magnitude, and extent of flood disasters experienced.
- To make recommendation regarding the decision for investment and design for sustainable projects that will withstand the impacts of potential hazard events.

Regional geology and climate

The Terai plain lies in the northern part of the Indo-gangetic plain. Tectonically, the area is situated south of the Siwalik zone, separated by the Main Frontal Thrust (MFT) and extends up to the banks of the Ganges River, over which the Terai plain is assumed to be thrusted.

The study area represents most of the Terai plain of the Sunsari district. Quaternary geological study of the area revealed us five lithostratigraphic units. Sediments of the area are in general fining towards south. The upper surface is made up of boulder and pebble beds whereas the lower surface is predominantly fine clay and silt. The surficial sediments of the area can be divided into the five lithostratigraphic units (Pradhan, 2000), described in Table 1.

Stratigraphic unit	Composition	Distribution
Bayarban	Pebble with sand and few clay	Around Bayarban village
Madhuban	Fine sand, silt and clay	Around Madhuban village
Rajabas	Fine to coarse sand	Around Rajabas, Prakashpur villages
Chakraghatti	Coarse to medium sand with clay veneers	Around Chakraghatti village
Chatara	Boulder with coarse sand, silt and clay	Exposed around Chatara village in Chatara Dharan road

Table 1: Lithostratigraphy of the study area

Climate

The study area has a subtropical climate. The estimate of the Koshi alluvial fan can be described as a transistion between the dry and moderately extreme climate of the lower hilly area and the Terai flood plain. The average rainfall in winter (December to Febuary) is approximately 32 mm, whereas in the monsoon it can be as high as 550-725 mm. The mosoon contributes 70 to 80 percent of the total annual rainfall in the area. The rainy days are maximum in July and August.

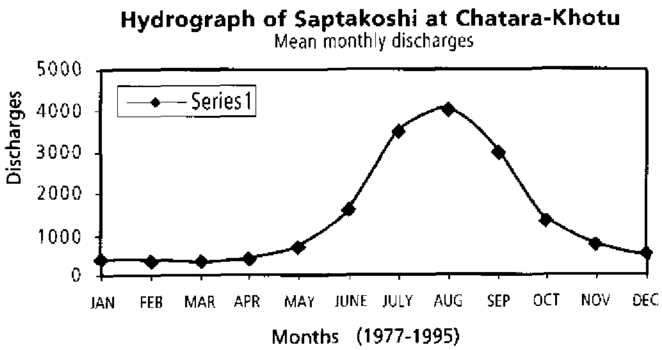

Figure 2: Mean monthly discharges hydrograph of Sapta-Koshi at Shatara-Khotu (Mean monthly discharges).

Flood analysis

Estimation of flood volume/rate is an important task for planning and design of flood regulation work and measures to be used for river protection. In order to design the flood control, irrigation and hydropower projects, the knowledge of Probable Maximum flood volume and its corresponding stage are essential.

The Probable Maximum Rainfall and the Probable Maximum Flood were computed by using Hazen's method, California's method and Weibul's method. Among these three methods the Hazen's method gives the least value and the California's method gives the highest value. The Probable Maximum Rainfall for the recurrences interval of 10, 100, 1000, 10,000 years by using California's method are 2650 mm, 3500 mm, 4350 mm, 52000 mm respectively. Again, the Probable Maximum Flood by California's method for the recurrence interval of 10, 100, 1000, 10,000 years are 10, 100 cumec, 15,900 cumec, 21,100 cumec, 26,300 cumec respectively.

Flood hazard assessment

The flood hazard mapping and assessment started with the study of aerial photograph and Landsat Thematic Map (7 bands) of Koshi River Basin. The use of satellite remote sensing method is useful in preliminary assessments during the early stages of a development planning study because of the small-to-intermediate scale of the information produced and the ability to meet cost and time constraints. Remote sensing imagery was used to assess the current status of floodplain and flood-prone areas. The delineation and characterization of the flooded areas was based on relationships between physical parameters such as reflectance and emittance from features located on the surface. Reflectance and emittance decreases as the water content or the soil moisture on the ground increases. Accordingly, the flood plain and water bodies were delineated. The important bands of the Landsat TM imagery that were used in the analysis are given below:

Band 1 – useful in determining concentration of water bodies

Band 4 – useful in delineation of water bodies

Band 6 – This band is especially useful in studying floodplain and soil moisture anomalies

The floodplain and the flood-prone areas that were delineated from Remote Sensing imagery and the aerial photographs were geo-referenced and digitized. This information was used in the production of the final maps as well as for the GIS analysis. The initial information, as obtained from Remote Sensing and Aerial photograph were later verified during the field visits to those sites. Any new and missing information was later added and amended. The new update of data from the field was later on added to the initial database to produce that final hazard map. Also, the method of participatory GIS was used, incorporating local people's knowledge of historical flood events and their impact. Accordingly, the final flood hazard map was prepared and relationships between the floodplain and the spatial features most vulnerable to flooding were analyzed which is shown in Figure 3.

As seen from the filed survey and in the flood hazard map, the flood casualties are mostly confined along the riverbanks of the Koshi River, starting from Chatara (Where the river starts to Fan outward) and near up to the Koshi barrage. The impact of the flood is more severe along the east bank that is more densely populated with high agricultural practices.