Mapping and assessing risk and vulnerability of water-induced disasters in the Tinau Watershed, Western Nepal

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SYMPOSIUM NOTES

Introduction

Background

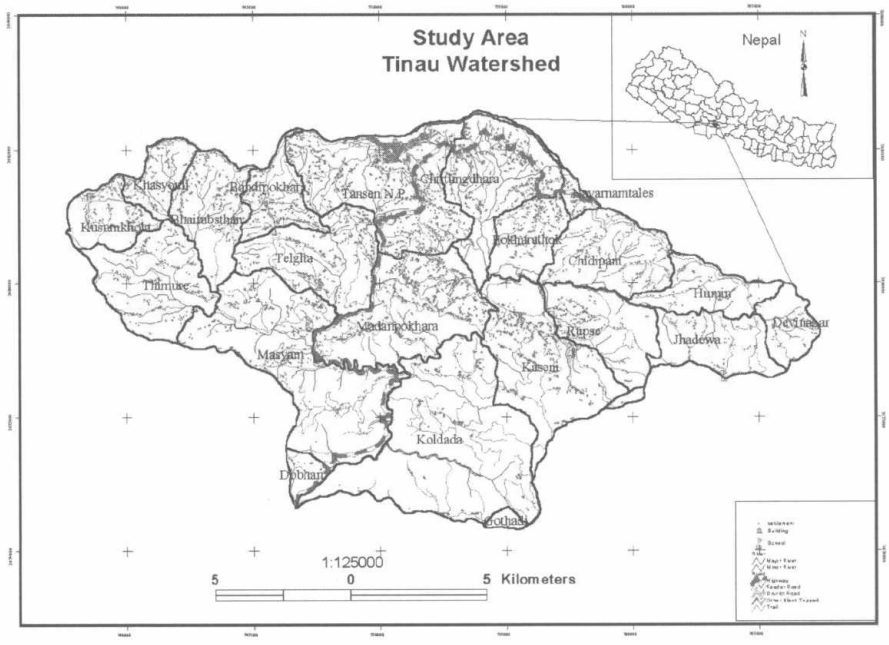
High relief, steep slopes, relatively steep river gradient, and active geology with intense monsoon rainfall make the young Himalayas as one of the most hazardous areas in the world and it frequently suffers from different kinds of water induced disasters like soil erosion, landslide, debris flow, flood, glacial lake out-burst flood, landslide dam out-burst flood etc. Against the backdrop of high population density and expansion of infrastructure resulting in changes in natural slope, river morphology and the drainage system, land use/land cover; the frequency in the occurrence of the landslide and flood hazards has been increasing in recent years. The loss of lives by flood and landslide and avalanches comprises about 29% of the total loss from all types of disasters.1 As a result of increased hazard, magnitude of lives and property at risk has also correspondingly increased. There is need to identify the areas that are susceptible to water induced disaster and comprehensive risk assessment for designing mitigation measures in order to reduce the risk and vulnerability. Such activities provide a sound basis for disaster mitigation planning and hence for allocation of financial and other resources. Risk assessment includes an evaluation of the potential occurrence of hazard events, assessment of vulnerability and potential damages, and the assessment of stakeholders' capacity simultaneously. However, there are few studies and research in landslide and flood hazard mapping with risk and vulnerability assessment in Nepal. With in this background the present research project was implemented for mapping and assessing risk and vulnerability of water induced disaster in Tinau sub watershed.

The present research project is the component of Provention Consortium research grant for disaster reduction. The project aims to identify the frequency, magnitude, and extent of water induced disasters experienced in the study area, map hazard and risk, access the socio-economic impact of water induced disaster and explore the response and recovery capacity of local people.

Project Area

Tinau watershed lies in Palpa District of Western Development Region of Nepal. It extends from 27°45'00" to 27°52'51" north latitude and 83°25'30" to 83°42'30" east longitude (Map .1). The total area of watershed is 234.2 sq. km. Elevation ranges from 330 m at the confluence of Tinau and Jhumsa Khola to 1893.4 m at Ghustung Lekh. The study area has highly rugged terrain with steep slopes and deeply incised valley of Tinau Khola, bounded in the south by the Siwalik range. The Mahabharat range occupies the central and northern part of the watershed. Being in between of Main Boundary Thrust (MBT) and Central Boundary Thrust (CBT), this watershed is tectonically very active and geomorphologically very unstable.

The sub-watershed covers complete or partial portion of 20 VDCs and one municipality. The estimated population of sub watershed based on focus group discussion is 66665. The population composition of watershed is dominance of Magar caste ethnic group. It occupies 42.6% of total population followed by Brahamin/Chhetri 31.3%, Occupational or so called "Dalit " (untouchable) caste 12.9%. Other hill ethnic caste occupies 4.6% and other caste population occupies about 2% of the total population.



Map 1. Study area

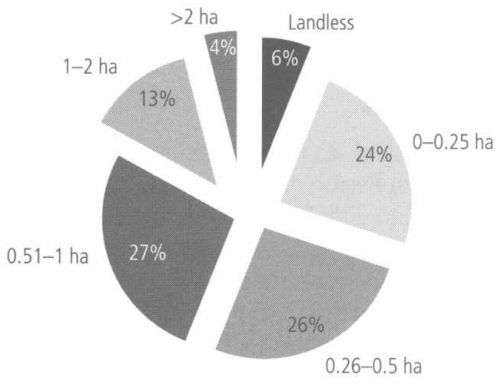


Figure1. Landholding pattern in Tinau Watershed

The main source of income of the local people is agriculture. About 92% households are engaged in agriculture as a main source of income. However the landholding pattern is not even. About 6% households are landless and 24% households are marginal having up to 0.25ha land.

Project Implementation

The main focus area of over all project implementation is landslide and flood hazard mapping and risk identification of Tinau sub watershed. During the project implementations period following activities were carried out.

Information requirement analysis

Various literatures, documents, knowledge and discussion with advisor were used as references for information requirement analysis and identification of data. Various methods for mapping and assessing community risk and vulnerability of natural disaster were reviewed and the detail work plan for this project was prepared. Checklist for observation, interview guide, schedule and focus group discussion guide were also prepared.

Preliminary field observation

A short field observation was carried out during the last week of July to obtain basic information of watershed. The verification of watershed boundary, identification of organization and institutions working in the field of flood and landslide disaster, and some secondary information collection from local level organization was done during this field trip. GPS observation of 50 sample site of landslide and flood location and major landmarks, (for RS imagery analysis) was also taken. A pilot survey of focus group discussion, household survey and RRA was conducted in MadanPokhara to check the checklist of focus group discussion and household survey. The checklist and interview guide and schedule were finalized on the basis of pilot survey.

Acquisition of secondary information

Various government and non-government organizations identified during information requirement analysis were visited. Both spatial and non-spatial data were collected from respective source as follows:

- Toposheet maps (Scale: 1: 25000) published by Topographical Survey Department, Nepal. 1958, & 1993.
- Land system, Land utilization and land capability map published by Land Resource Mapping Project, Nepal, 1986.
- Geological maps prepared by Department of Mines and Geology, Nepal, at the scale of 1: 50000.
- Digital version of IRS Satellite imagery acquired in 2001 (obtained from Forest Department).
- Aerial photos (1978, 1996) prepared by Topographical Survey Department, Nepal.
- Hydrological and climatological data of last 20 years from Department of Hydrology and Meteorology.
- The recorded information of loss of lives and properties by Disaster in Nepal (1983 – 2002) from Department of Water Induced Disaster Prevention and Ministry of Home.
- Demographic and other socioeconomic census data (2001) from Central Bureau of Statistics.
- Various socio-economic information were also obtained from District Profile of Palpa district (2000).
- The information on mitigation measure, rescue operation for landslide and flood hazard implemented by Disaster Management Committees and Nepal Red Cross Society.

Aerial photo interpretation and digital image processing

Information on channel course, landslide extent, and flood wash area were identified and preliminary distribution map of these parameters were prepared through aerial photo (1996) interpretation and digital image processing of IRS image (2001).

Field survey and group discussion

A field survey was carried out in September 2003. The field survey was carried out to map flood prone area, flood wash area, landslide extent distribution, channel course diversion; verify and update the information obtained from maps, aerial photos, and imagery interpretation. Focus group discussions at each hazard prone area with the key informants were held in order to obtain additional information on landslides and floods and also on the number of households and population. A social map on landslide and flood hazards was also prepared with the help of the local people During the group discussions the participants were asked to show and delineate the areas susceptible to landslide and flood hazards

Preparation and acquisition of digital database

The information collected and mapped on toposheet showing distribution of landslide, flood wash area, flood prone area, channel shifting was digitized and prepared spatial digital database. The map of geology, toposheet (1958), Land utilization map (1986), Land utilization/ land capability map (1986) were also digitized The digital data set of river, road, landuse, settlement and administrative unit of base map were also prepared The digital data set of contour and spot height was acquired from Survey Department.

The layers of landslide, and flood area, and channel course were prepared from aerial photo interpretation (1978, 1996) and digital image processing (IRS image 2001). The parameters layer of DEM, slope, relief, rainfall interpolated, slope aspect, distance from lineament, distance from stream, drainage density were prepared.

Preparation of hazard and risk maps

The landslide and flood hazard maps of Tinau sub-watershed was prepared using GIS based analysis. Subsequently, risk map of each hazard were also prepared (Fig. 2).

At first landslide distribution maps was prepared based on field survey and image interpretation. Eleven parameters: lithological unit, lineaments, slope gradient, slope shape, slope aspect, relative relief, drainage density, water table and drainage condition, distance from road, landuse, and vegetation density were used for landslide hazard mapping. Landslide hazard map was prepared by using the bivariate statistical method. The landslide hazard map was categorized into three categories according to the probability of occurrence of landslide as high hazard area represent high probability and low hazard area represent low probability of occurrence.

Similarly, flood hazard mapping was done using the Digital Elevation Model generated from contours and spot heights. In addition to this information obtained from land system maps, and channel morphology was also used. The flood hazard was classified in to four categories according to the probability of occurrence of flood and channel shifting.

Risk map was prepared by combining the vulnerability and the hazard maps. For the analysis of vulnerability only four sets of parameters were chosen. These included: a) population, b) land use, c) infrastructure and d) irrigation canal Population density at the VDC level, distance from roads and trails and distance from cannel, and the land cover (based on use type) were taken in order to evaluate the degree of potential loss from the landslides.

Household survey

Based on two criteria distance from river bed and the hazard zone (the high, medium and low) five settlements were selected for intensive household survey. The household survey was conducted to differentiate the severity, risk, and vulnerability of households and the response and recovery capacity of household level with varies hazard zonation. Census of all the households was conducted in those settlements where the total number of households is less than 30. In settlements where the numbers of households are more than 30, at least 30 or 10 percent of the total households were selected for interview.

Vulnerability and Response Recovery capacity Analysis

The socio-economic and physical impact and vulnerability to landslide and flood has been analyzed in terms of the degree of losses and the socioeconomic and physical capability of the people and infrastructure to respond to and recover from the potential losses from landslides, debris flow, floods, and riverbank cutting in the watershed based on information collected from both group discussions and household surveys.

Seminars and Public Awareness Programme

One day seminar was held in Tansen with the representative of key stakeholders and organization

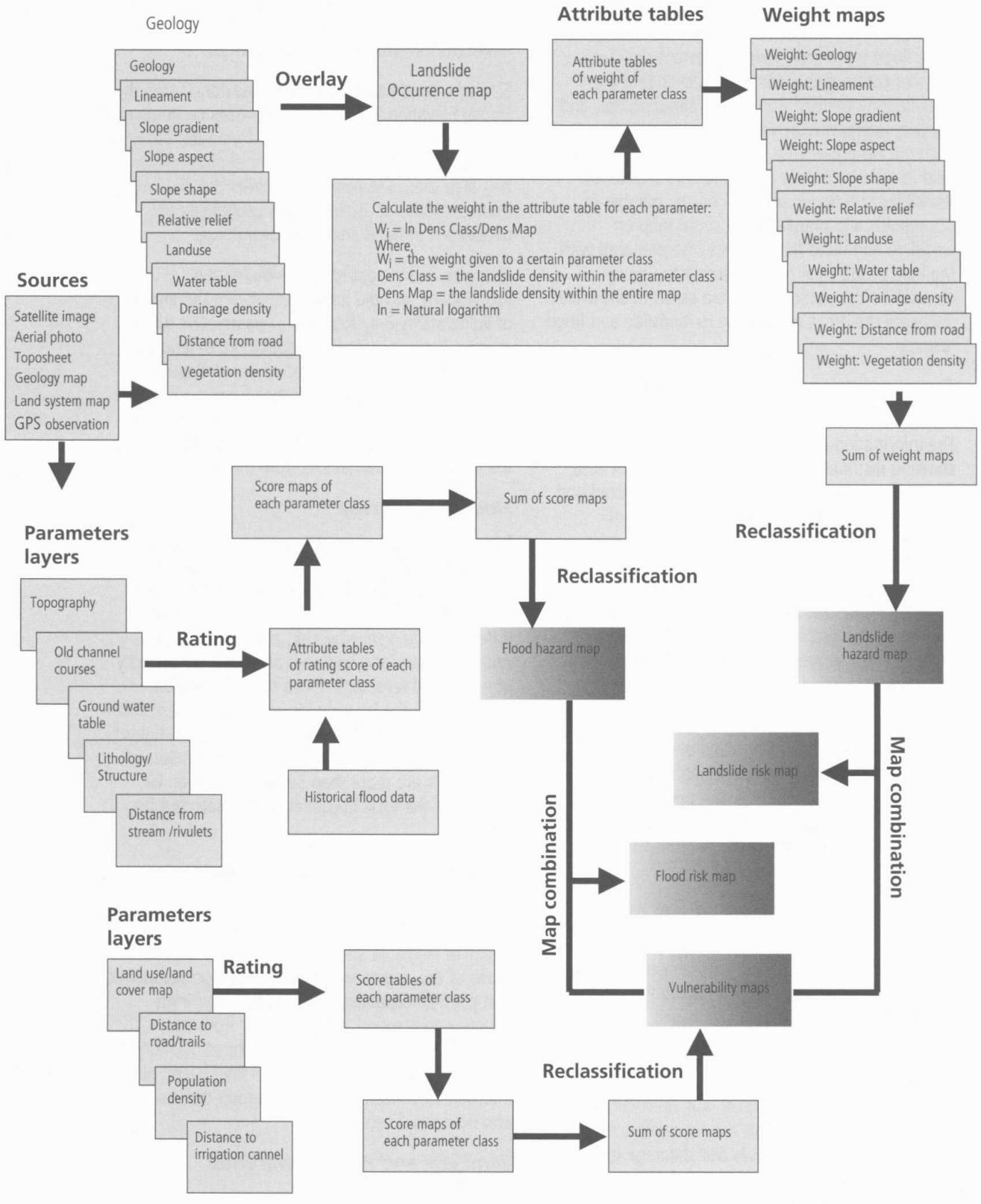


Figure 2. Flow chart for landslide and flood risk mapping