Use of Remote Sensing and GIS Technology for Landslide Hazard mapping using ANN

S.Prabu¹, S.S.Ramakrishnan², R.Vidhya³,

¹ Research Scholar / IRS, CEG, Anna University, Chennai-25, Email: sevu_prabu@yahoo.co.in
² Professor / IRS, CEG, Anna University, Chennai-25, Email: ssramki@annauniv.edu
³ Assistant Professor / IRS, CEG, Anna University, Chennai-25, Email: vidhya@annauniv.edu

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Abstract: Use of socio economic data, remote sensing and GIS for developing a technique for landslide susceptibility mapping using artificial neural networks is the main objective of the present study. The technique is applied in the selected study areas in Nilgiris district of Tamil Nadu The Second objective of the study is to analyze the socio economic impact of the landslide. Landslide locations are identified by interpreting the satellite images along with the field survey data, and spatial database on the topography, soil, forest, and land use. The landslide-related factors are extracted from the spatial database. These are then used with an artificial neural network to analyze landslide susceptibility. Each factor’s weight is determined by the back-propagation training method. Different training sets are identified and applied to analyze and verify the effect of training. The landslide susceptibility index is calculated by back propagation method. The susceptibility map is created using GIS. The results of the landslide susceptibility analysis are verified using landslide location data. The artificial neural network has been found to be an effective tool for analyzing landslide susceptibility compared to the conventional method of landslide mapping.

Keywords: Landslide susceptibility mapping, Geographical Information System, Socio Economic Impact, Artificial Neural Networks.

1. Introduction

Landslide risk is defined as the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular landslide hazard for a given area and reference period (Varnes, 1984). When dealing with physical losses, (specific) risk can be quantified as the product of vulnerability, cost or amount of the elements at risk and the probability of occurrence of the event. When we look at the total risk, the hazard is multiplied with the expected losses for all different types of elements at risk (= vulnerability * amount), and this is done for all hazard types. Schematically, this can be represented by the following formula:

\[ \text{Risk} = \sum (H \times \sum (V \times A)) \]

Where:

\( H \) = Hazard expressed as probability of occurrence within a reference period (e.g., year)

\( V \) = Physical vulnerability of a particular type of element at risk (from 0 to 1)

\( A \) = Amount or cost of the particular elements at risk (e.g., number of buildings, cost of buildings, number of people, etc.). Theoretically, the formula would result in a so-called risk curve, containing the relation between all events with different probabilities, and the corresponding losses.

Out of the factors mentioned in the formula for risk assessment, the hazard component is by far the most difficult to assess, due to the absence of a clear magnitude-frequency relation at a particular location, although such relations can be made over larger areas.

Furthermore, the estimation of both magnitude and probability of landsliding requires a large amount of information on the following aspects:

1. Surface topography
2. Subsurface stratigraphy
3. Subsurface water levels, and their variation in time
4. Shear strength of materials through which the failure surface may pass Unit weight of the materials overlying potential failure planes
5. The intensity and probability of triggering factors, such as rainfall and earthquakes.

All of these factors, required to calculate the stability of individual slopes, have a large spatial variation, and are only partly known, at best. If all these factors would be known in detail it would be possible to determine which slopes would generate landslides of specific volumes and with specific run out zones for a given period of time.

Risk analysis, assessment and management require a large amount of information. Relatively large volumes of multi-disciplinary and technical information have to be collected, processed, analyzed, and eventually communicated to a broad range of users under quite different conditions, ranging from planning and regulatory activities to emergency management (Fedra, 1998). Modern information technology provides some of the tools to support these activities, leading...