



Land Slide Monitoring and Hazard Mapping in Uttarakhand Using Reinforcement Learning and Neural Network

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Abstract— Landslides are among the most hazardous of natural disasters. Government and research institutions worldwide have attempted for years to assess landslide hazard and risk and to show its spatial distribution. To achieve a scientific assessment of an area susceptible to land sliding, a reinforcement learning method in artificial neural network may be applied, and the objective of this study was to apply and verify models of landslide-susceptibility zonation in the several areas of Uttarakhand using this Neural Network approach. Land cover was identified from the topographic database. Terrain map units were interpreted from aerial photographs. These factors were used with an artificial neural network to analyze landslide susceptibility. Each factor weight was determined by a back propagation exercise.

Keywords — Neural Network, Reinforcement Learning, Tasks, Weighted Graph, Cost Function, Supervised Learning, and Error Correction.

I. INTRODUCTION

Numerous landslides, land erosion and subsidence occurred at different places of Bageswar, Uttarakhand in the month of September 2010 initiated by heavy rain-falls and cloud burst resulting in 19 deaths, widespread damage to human settlements, cultivated lands, irrigation canal, bridge, village foot tracks and major communication routes. More than 50 major landslides classified as rock slide/fall, debris slide, rock-cum-debris slide, and slope wash debris flow and bank erosion of different nalas/streams have been recorded. The slides have resulted in huge debris flows that flooded and deposited sediments over human settlement, communication routes and cultivated lands. The data reveal that steep slopes, high relief, thick slope wash material/overburden, complex fold, numerous faults and proximity to thrusts have rendered the slopes highly vulnerable to mass movements.

II. OBJECTIVE

Studies carried out by various governmental and non-governmental organizations in Uttarakhand Himalaya provide a reasonable insight into the environmental fragility of the slopes, particularly in areas traversed by major and minor tectonic structures (weak zones). Way back in the mid nineties a major project pertaining to landslide mapping in Uttarakhand was launched by Indian Space Research Organization. This project was aimed at providing the geodynamic status of the slopes along major pilgrim roads so that any future work, particularly that involving widening of the existing roads must take into account the finding of these studies so that appropriate engineering measures can be employed.

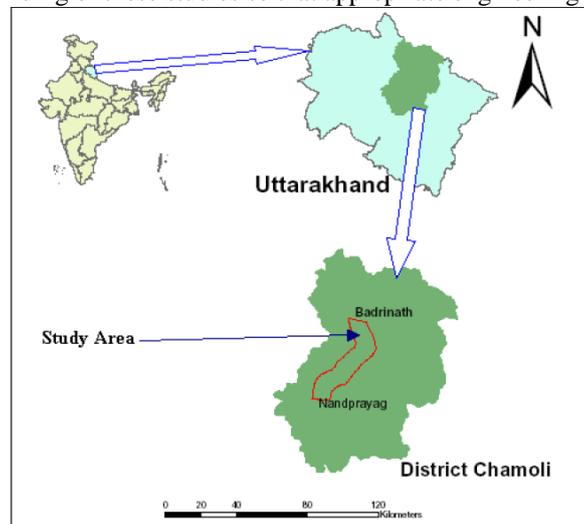


Fig.1. Study Area of this Paper

Appreciating the chronic problem of landslides, the Department of Science and Technology, Government of India, generously supported and is still supporting projects related to landslide studies in the Himalaya. In addition, geologists and environmental scientists are persistently pleading for a detailed geomorphologic, structural and lithological mapping of the slopes along the proposed roads so that our engineers know exactly what kind of treatment strategies need to be employed. Considering the ever-increasing incidences of landslide induced tragedies in the Himalaya, time has come to put the findings of these studies not only in the public domain, but devise a methodology so that the same can be implemented on the ground level, particularly in road construction projects.

III. TECHNOLOGY

The paper stresses the need for developing a module which should have the provision for ascertaining the terrain stability/instability using the standard geological and ecological criteria. Further, similar to earthquake zonation, valley slopes should be categorized based on the degree of stability. With the advent of satellite remote sensing technology, it is now possible to gather information both in spatial and temporal domain. Such data provide an opportunity to ascertain the nature and magnitude of change witnessed by a particular valley slope, so that an appropriate slope treatment strategy can be evolved.



Fig.2. Real Scenario of Land Slides In District Chamoli



Fig.3. Still From The Vally of Hill While Landslides



Fig.4. Hazards and Loss Due to Natural Disaster

The paper concludes with the need for working towards generating a scientific database on spatial and temporal changes in the terrain characteristics and for devising methodologies by the concerned departments in order to minimize the severity of landslides in future.

IV. HARDWARE AND SOFTWARE

The basic hardware needed is

1. **500 MB RAM**
2. **100 GB Hard Disk**
3. **2.5 GHz Speed for PC**

The basic software required

1. OS such as Windows XP/ Vista/ 7 or Linux
2. Simulator such as **JustNN Version 4.0a developed by Neural Planner Software Limited** freely available on Internet [open source].

Some snapshots of this software are shown below, which is very user friendly for maintaining the weighted graph of Neural Network as well as plotting the Network.

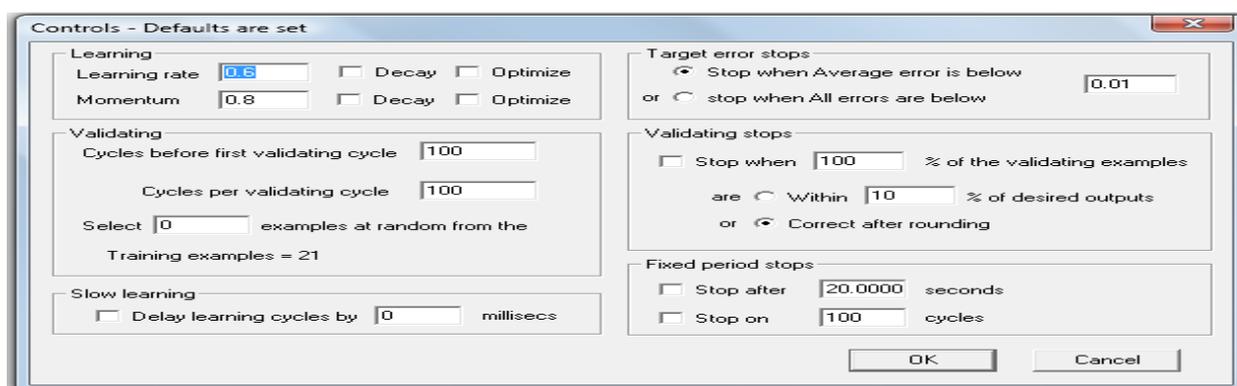


Fig. 5. SNAPSHOT OF JustNN SIMULATOR

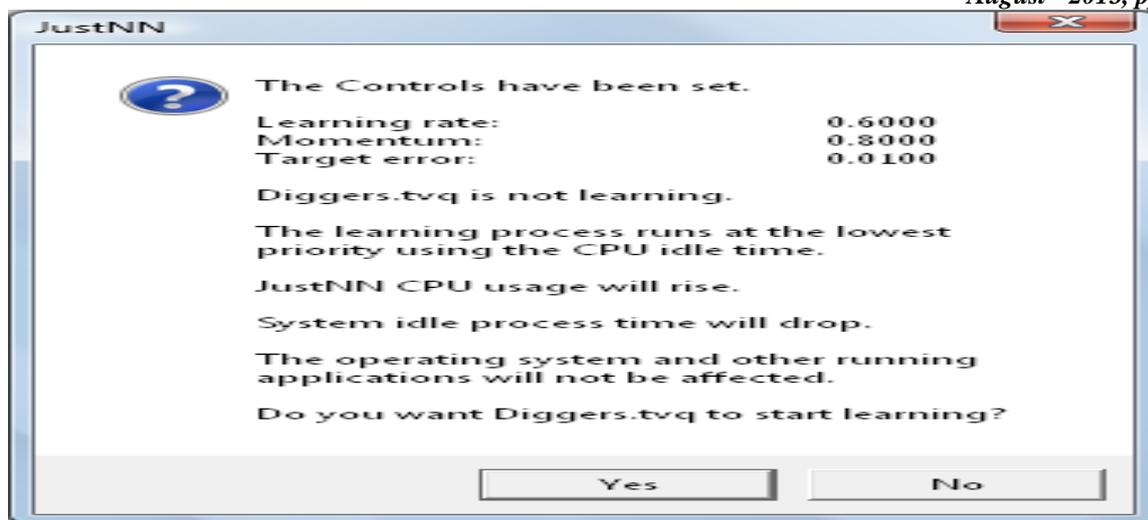


Fig.6. ADSUTING THE LEARNING RATE

V. DATA AND METHODOLOGY

Classification		GIS Data Type		Scale or Resolution	
Spatial Database	Factor	Spatial Database	Factor	Spatial Database	Factor
Landslide	Landslide	ARC/INFO Polygon coverage		1:25,000	
Topographic Map	Slope	ARC/INFO Line and Point Coverage	ARC/INFO GRID	1:25,000	10m×10m
	Aspect				
	Curvature				
Drainage Map	Distance from drainage	ARC/INFO Line Coverage			
Soil Map	Types	ARC/INFO Polygon coverage		1:100,000	
Geology Map	Litho types	ARC/INFO Polygon, Line coverage		1:63,300	
	Distance from lineaments				
Land Cover	Land Cover	ARC/INFO GRID		30 m × 30 m	
NDVI	NDVI	ARC/INFO GRID		10 m x 10 m	
Precipitation	Precipitation	GRID		10 m x 10 m	

Fig.7. DATA TAKEN AS AN INPUT TO THE NEUARNL NETWORK SHOWN IN Fig.9

VI. ARTIFICIAL NEURAL NETWORK

An artificial neural network is a “computational mechanism able to acquire, represent, and compute a mapping from one multivariate space of information to another, given a set of data representing that mapping” (Garrett, 1994). The backpropagation training algorithm is the most frequently used neural network method and is the method used in this study. There are two stages involved in using neural network for multi-source classification: the training stage, in which the internal weights are adjusted; and the classifying stage. Typically, the back-propagation algorithm trains the network until some targeted minimal error is achieved between the desired and actual output values of the network. Once the training is complete, the network is used as a feed-forward structure to produce a classification for the entire data.

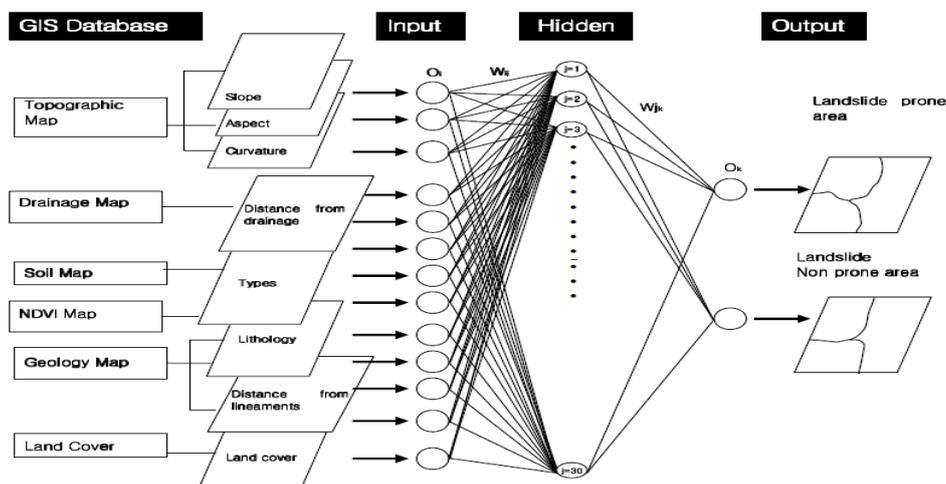


Fig.8. NEURAL NETWORK BASIC ARCHITECTURE

VII. RESULTS AND ANALYSIS

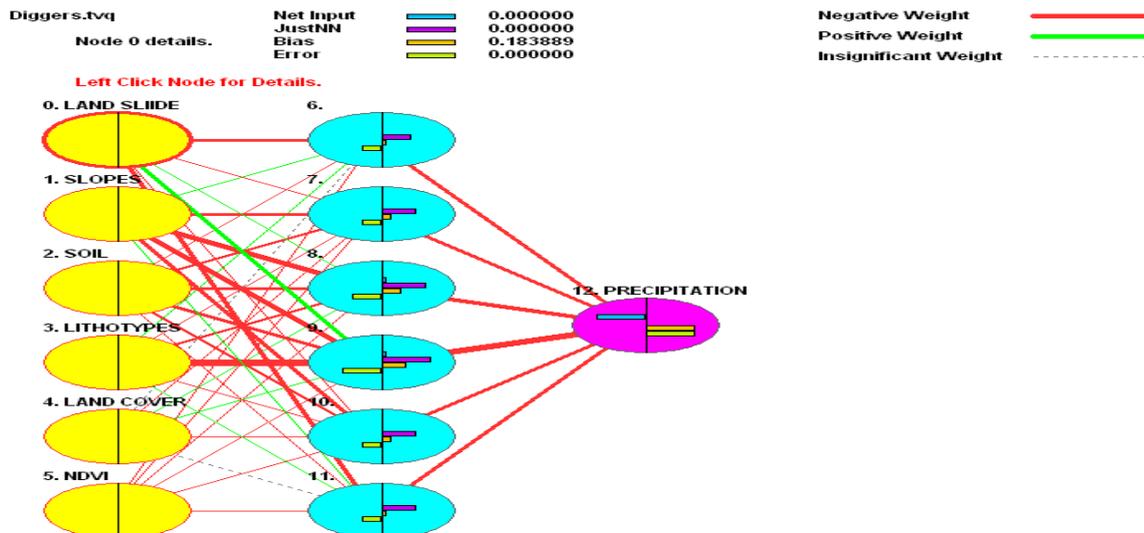


Fig.9. NEURAL NETWORK FOR THE INPUT DATA IN Fig. 7.

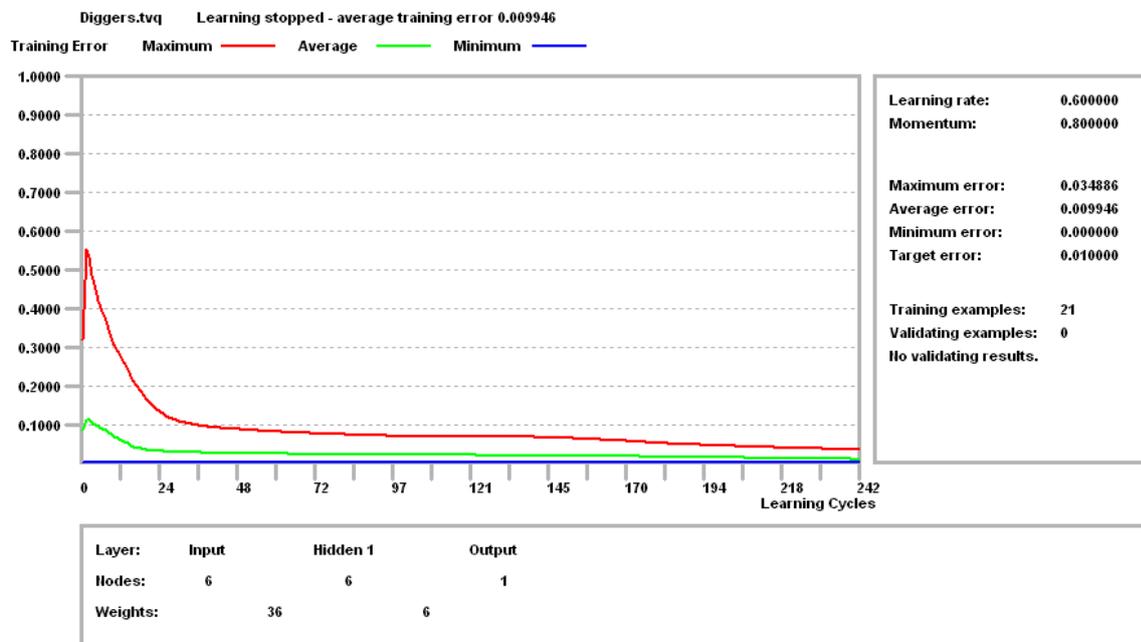


Fig.10. GRAPH REPRESENTING THE LEARNING RATE AND TRAINING EXAMPLES

Diggers.tvq 138 cycles. Target error 0.0100 Average training error 0.009950

The first 6 of 6 Inputs in descending order.

Column	Input Name	Importance	Relative Importance
1	SLOPES	9.6985	
3	LITHOTYPES	8.8090	
0	LAND SLIDE	7.3620	
2	SOIL	6.7925	
5	NDVI	3.6394	
4	LAND COVER	2.5742	

Fig.11. AVERAGE TRAINING ERROR FOR THE NEURAL NETWORK

VIII. FUTURE WORK

This paper focuses on the reinforcement supervise learning of neural network which is used to predict the natural disaster like landslide in an area of Uttarakhand, India. But this method can be modified Computer Vision techniques. This paper also emphasizes on the small area of Uttarakhand where the qualitative data of population and pollution are

very low. We cannot ignore these two factors as they affect the landslide areas; hence one must deploy this method on the hill areas of urban cities areas like Dehradun, Uttarakhand also.

IX. CONCLUSION

Landslides are one of the most hazardous natural disasters, not only in Uttarakhand but also in worldwide. Government and research institutions worldwide have attempted for years to assess landslide hazards and risks and to show their spatial distribution. An artificial neural network approach to estimating the areas susceptible to landslides using a spatial database (SDB) is presented. For the landslide susceptibility analysis, a landslide location SDB and a landslide-related database was constructed. Prepared landslide prediction map could be the basis for decisions making. The information provided by this map could help citizens, planners and engineers to reduce losses caused by existing and future landslides by means of prevention, mitigation and avoidance. If the factors relevant to the tectonic activity, vulnerability of buildings and other property were available, a hazard and risk analysis could also be done.

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