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Ministry of Energy, Water Resources and Irrigation
Water Resources Research and Development Centre
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Landslide Susceptibility Zonation of Koshi Province, Nepal

Background

With the onset of the rainy season each year, the probability of experiencing additional landslides rises. Steep and vulnerable basins face an increased risk of collapse when heavy rain and runoff combine with the destabilized slopes caused by earthquakes and subsequent tremors. Moreover, as the demand for new construction sites and materials to rebuild damaged homes grows, the natural resources present in the hillsides, such as deforestation and soil extraction, may be exploited, further compromising slope stability. Travel routes often face the danger of becoming impassable due to landslides, disrupting and prohibiting transportation. These highway slides not only pose risks to safety but also result in significant financial burdens as they impede business activities. Despite the hazards, residents in Nepal choose to reside in lowland areas or atop slopes, commuting along these routes. Human settlements and highways now find themselves bordered by extensive active landslides or recently destabilized hillsides.

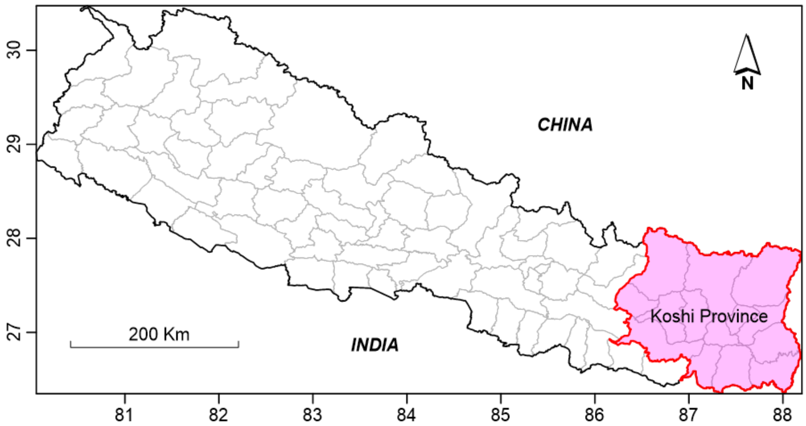

Figure1: Location map of study area

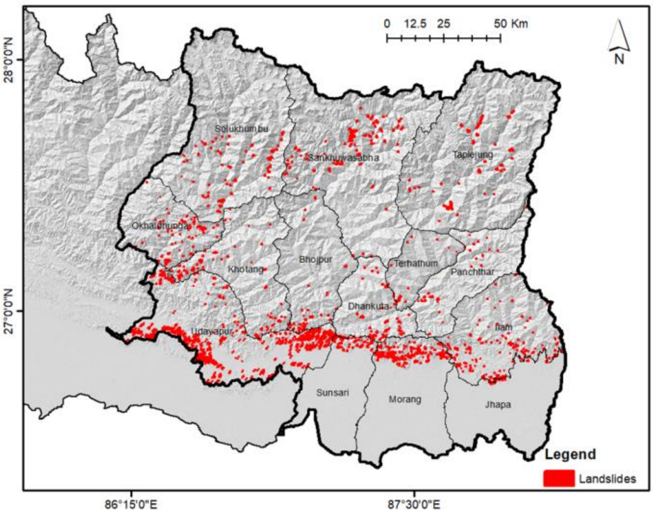

Figure2: Observed landslides

Objective

The focus of this study is the analysis of landslides and the subsequent development and implementation of localized probable landslides in the mountains of Nepal. Shallow landslides triggered by rainfall pose a significant risk to both lives and property, as they occur suddenly and can travel long distances as high-speed debris flows. Predicting landslides on natural hillslopes fulfills a societal need for hazard assessments.

Methodology

The digital elevation model (DEM) to be utilized was provided by the Department of Survey, Government of Nepal at a resolution of 20m × 20m. Nine geomorphological conditioning factors (CF) were created using the DEM: elevation, slope, plan curvature, profile curvature, topographic wetness index (TWI), sediment transport index (STI), stream power index (SPI), drainage proximity and vertical distance from channel network (VDCN). Similarly, landuse map was collected from Department of Survey and geological map was collected from Department of Mines and Geology, Government of Nepal.

This study was performed in three steps: 1) collection of landslide inventory data and the CF database; 2) random selection of a landslide inventory as training and validation data, and subjecting the inventory to the machine-learning models to delineate landslide-susceptible areas; and 3) validation of the landslide susceptibility model using the validation landslide dataset.

AdaBoost, Random Forest and MARS model was used for the prediction and The results of different model was combined with generalized linear model (GLM) for better prediction.

Results

One of the popular methods for assessing model accuracy is using a receiver operating characteristic curve (ROC) in the landslide susceptibility assessment. The area under ROC curve shows the result of ensemble model is better than any other result of utilized three models. The accuracy is 96.9%.

The ensemble landslide susceptibility maps were classified using natural break algorithm in GIS platform. In case of Province-1, total of 69.72 % of the area was categorized as having a very low susceptibility, 16.01 % as low susceptible, 6.84% as moderate, 4.07% as high and the remaining 3.36 % was considered have very high susceptibility. Analysis of the landslide distribution with respect to the susceptibility classes was an important part of this study. Figure 4 depicts the percentage of landslides under different susceptibility classes/conditions. About 81.51 % of landslide data were located in the very-high-susceptibility class, demonstrating the reliability of the map.

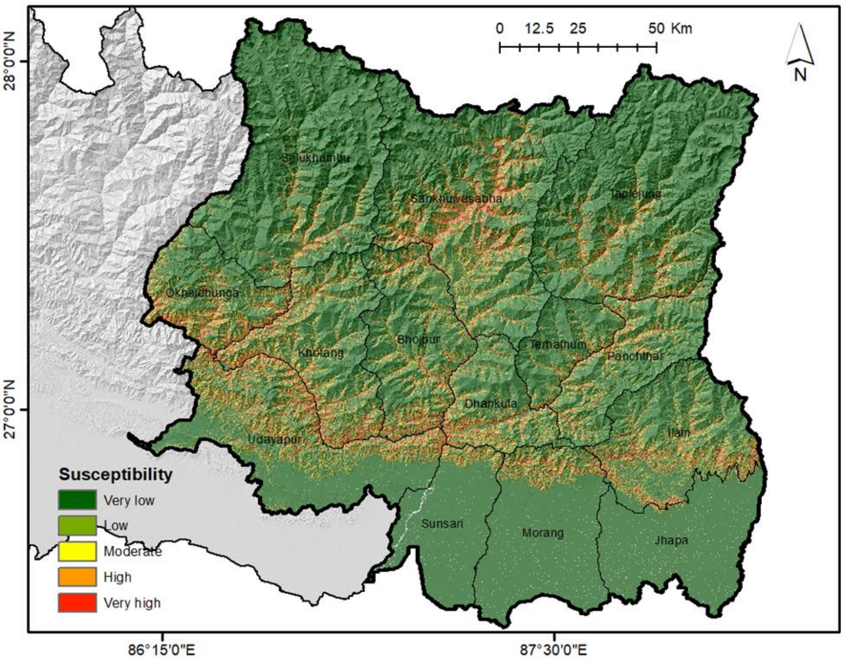

Figure 3: Landslide susceptibility zone of Koshi Province

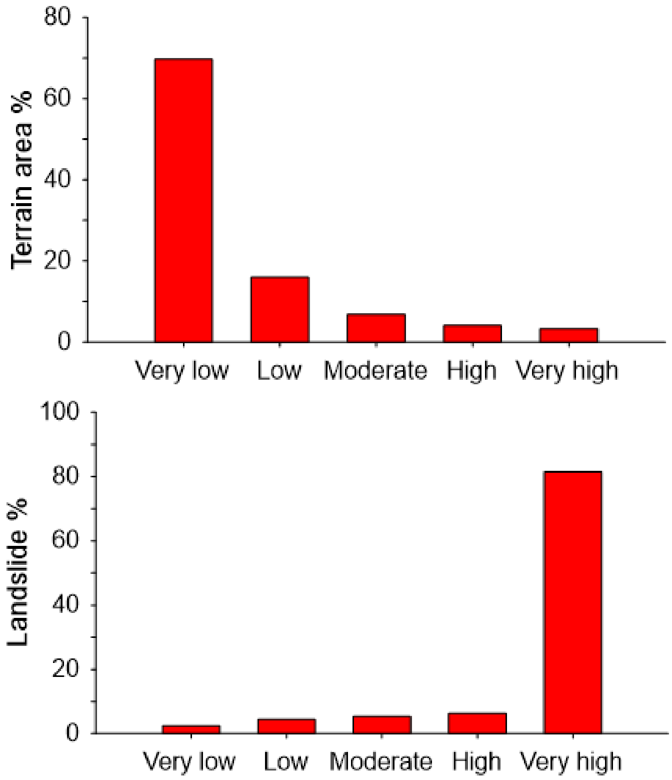

Figure 4: Terrain percentage and distribution of landslide

Conclusions

The possible problems that may come due to these natural processes like heavy rainfall shouldn't be ignored. The presented modelling results should be considered as good approximations however many relevant assumptions had to be made during the calculation.

It is recommended to carry out community-level hazard mitigation and control in at least one of the most vulnerable villages, which are suffering from large-scale landslide problems.

FOR FURTHER INFORMATION:
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