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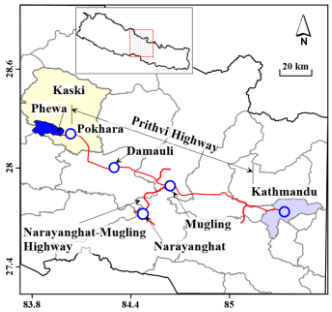
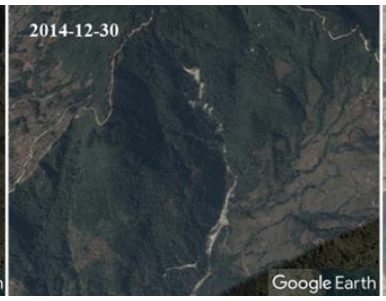
Shallow Landslide Susceptibility Mapping and Runout Zonation in Phewa Lake Catchment

Background and Objectives

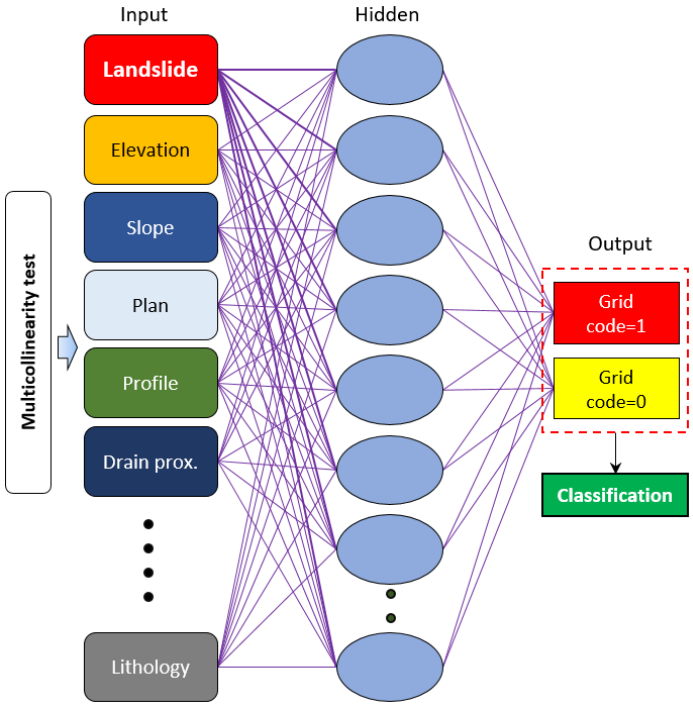
Phewa Lake, one of the lakes having national significance covers an area of about 4.4 Km^2 and has been one of the prominent tourist attractions of Pokhara. It is assumed that the high amount of sediment intake during past landslide events is one of the causes of lake area reduction. The main objective of this research is to prepare landslide susceptibility and runout zonation. First, an artificial neural network (ANN) was applied to delineate a probable landslide source zone using information from a landslide inventory. Second, a probable landslide runout zone was identified to delineate the potentially affected area.





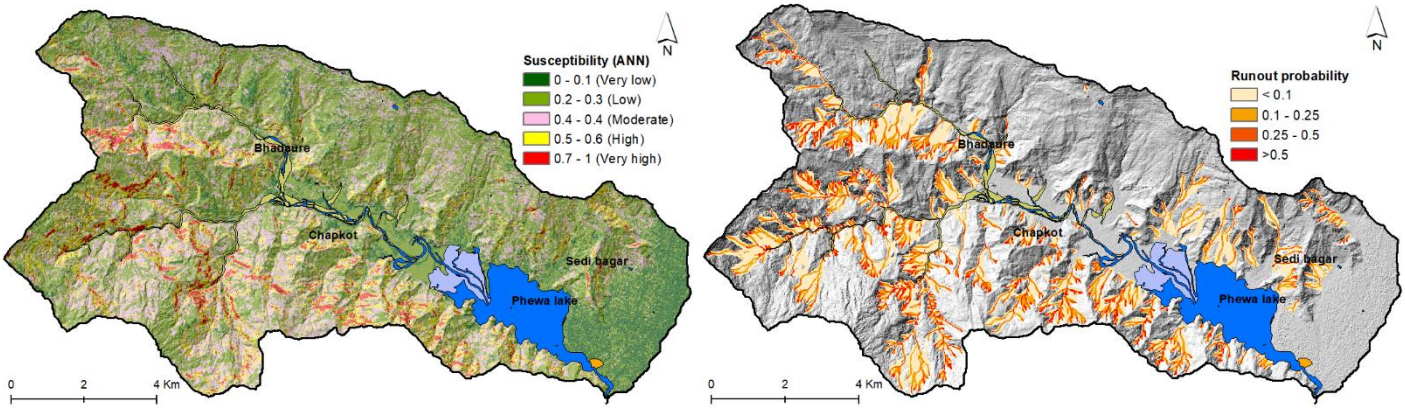
Materials and Methods

A preliminary landslide location was delineated in a remote Google EarthTM-aided recognition survey. The landslides were identified by comparing the imagery with that captured in Google earth's historical archives and verified in the field. Total 675 landslides were located and transformed into pixel assigning a label "1" for landslide and "0" for non-landslide. Generally, the occurrence of landslides in an area is governed by various causative factors (CFs). In this study, 11 CFs were used based on relevance and availability, as follows 1) aspect, 2) elevation, 3) slope, 4) plan curvature, 5) profile curvature, 6) drainage proximity, 7) topographic wetness index, 8) stream power index, 9) sediment transport index, 10) normalized difference vegetation index and 11) geology. For the susceptibility analysis, the independent datasets were processed through a multi-collinearity test. The runout susceptibility map was prepared using the open source software Flow-R, which has been developed at the University of Lausanne (Harton et al., 2008). Flow-R provides a variety of algorithms to analyze runout propagation.

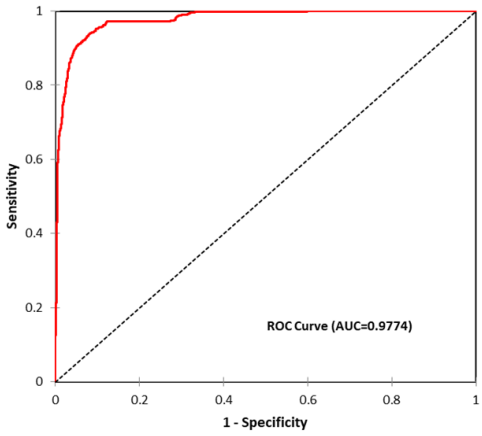


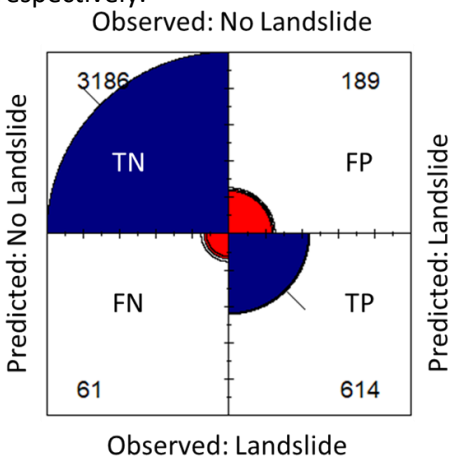
Results

Identification of probable debris flow source area is a difficult task because of the complex nature of topographic terrain, soil characteristics, viscosity and yield stress of the soil. In this research, we tried to integrate the result of ANN model and concave curvature to identify the source area without considering heterogenetic nature of soil. In this study an angle of reach has chosen as 11° as suggested by Rickenmann and Zimmermann (1993).



The receiver operating characteristic curve (ROC) curve is created by plotting the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings. The area under ROC curve showed that the accuracy of the result is 97.74%. In addition to improve the reliability of the landslide susceptibility maps, the landslide susceptibility model was evaluated in a 2×2 contingency table. The number of correctly predicted landslides and non-landslides are indicated by TP (True positives) and TN (True negatives), and the number of incorrectly predicted landslides and non-landslides are FN (False negatives) and FP (False positives), respectively.





Remarks

The landslides are affected not only by a single factor but a list of factors such as rainfall, landuse, geology, slope condition, aspect, seismic activity etc. The historical landslides in the study area has not been considered during development works. From the study of construction practices within the catchment, it was realized that the construction practices should be evaluated and improved. This can be seen at some extent even at famous structures such as the World Peace Pagoda in the southern part of the Phewa Lake.

Reference

Horton, P., Jaboyedoff, M. and Bardou, E. (2008), "Debris flow susceptibility mapping at a regional scale." 4th Canadian Conference on Geohazards: From Causes to Management, 399–406.

Rickenmann, D. and Zimmermann, M. (1993), The 1987 debris flows in Switzerland: documentation and analysis. Geomorphology, 8(2-3), 175-189.

FOR FURTHER INFORMATION:

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