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Effectiveness assessment of Keras based deep learning with different robust optimization algorithms for shallow landslide susceptibility mapping at tropical area

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ABSTRACT

This research aims at investigating the capability of Keras's deep learning models with three robust optimization algorithms (stochastic gradient descent, root mean square propagation, and adaptive moment optimization) and two-loss functions for spatial modeling of landslide hazard at a regional scale. Shallow landslides at the Ha Long area (Vietnam) were selected as a case study. For this regard, set of ten influencing factors (slope, aspect, curvature, topographic wetness index, landuse, distance to road, distance to river, soil type, distance to fault, and lithology) and 193 landslide polygons were prepared to construct a Geographic Information System (GIS) database for the study area. Using the collected database, the DNN with its potential of realizing complex functional mapping hidden in the data is used to generalize a decision boundary that separates the learning space into two distinct categories: landslide (a positive class) and non-landslide (a negative class). Experimental results point out that the utilized the Keras's deep learning model with the Adam optimization and the mean squared error lost function is the best with the prediction performance of 84.0%. The performance is better than those of the employed benchmark approaches of random forest, J48 decision tree, classification tree, and logistic model tree. We conclude that the Keras's deep learning model is a new tool for shallow susceptibility mapping at landslide-prone areas.

1. Introduction

The northern mountainous region of Vietnam is currently receiving the substantial impact of landslides. Based on the report of the Vietnamese Institute of Geosciences and Mineral Resources, around 10,200 locations in this mountainous region are classified as having a high risk of landslide occurrences. From 2000 to 2015, 779 people were killed and such natural hazards injured 426 others. The economic losses caused by landslides reached billions of US dollars. Thus, local authorities in this region are continually seeking measures to bring down the economic and human losses in landslide-prone areas.

Based on previous studies, landslide susceptibility mapping can be a useful method for landslide event prediction (Chawla et al., 2018; Elmoulat and Ait Brahim, 2018; Shahabi and Hashim, 2015). Such mapping can help local authorities in policy-making, landuse planning, and establishing effective mitigation/prevention strategies. Among various existing methods for landslide susceptibility mapping, statistically-based methods can be considered as the most popular ones. These methods are established based on a general assumption that factors triggering past landslides will continue to bring about landslides in the future. Therefore, information regarding terrain and climatic conditions of local areas affected by landslides can be collected and analyzed to

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