REVIEW OF ARTIFICIAL INTELLIGENCE APPLICATION IN LANDSLIDE MAPPING

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1. INTRODUCTION

A landslide is a downward movement of slope materials that could be triggered by rainfall and earthquake. Having a landslide potential map of an area could be very useful information for geotechnical engineers to provide a risk evaluation of the area. The main types of landslide maps include landslide inventory map, landslide susceptibility map, and landslide hazard map. The landslide hazard map considering triggering factors must be conducted for the risk assessment.

The conventional landslide hazard mapping approach uses geotechnical engineering data to assess hazard areas. However, engineering properties of materials must be obtained to predict the landslide hazard area, which is costly and time-consuming. Recent studies indicate that improvements in analysis methods, especially Artificial Intelligence (AI) and Machine Learning (ML), can be applied to increase the reliability of landslide predictions. This paper discusses the review of the application of AI in landslide mapping.

2. APPLICATION OF AI IN LANDSLIDE MAPPING

Landslide mapping using AI could include the following applications: (1) using AI applications for predicting landslide inventory, (2) using AI to assess landslide susceptibility area, and (3) using AI to conduct the landslide hazard map.

Wang et al. (2021) used ML to identify landslide inventory. Five ML algorithms, including logistic regression (LR), support vector machine (SVM), random forest (RF), boosting methods, and convolutional neural network (CNN), were evaluated on each database. From the case study results, the CNN achieves the highest identification accuracy of 92.5%. The boosting methods come second in accuracy, followed by RF, LR, and SVM.

Zhu et al. (2020) predicted the landslide susceptibility map using a deep-learning-based model using the long short-term memory (LSTM), recurrent neural network (RNN), and conditional random field (CRF). The input variables for this study include elevation, slope, aspect, plan curvature, profile curvature, relief amplitude, NDBI, total surface radiation, NDVI, population density index, distances to rivers, MNDWI, TWI, and lithology. This study concludes that the LSTM-CRF had a higher landslide prediction rate (75.67% of the total predictive rate). Novellino et al. (2021) studied landslide risk assessment using ML and InSAR techniques. The ANN, GBM, and MaxEnt machine learning techniques were used with spatial environmental variables and InSAR. The median of the three chosen models presents 96% of the area under curve of the receiver operating characteristic (AUROC) and 82% of the true skill statatics (TSS).

A review of ML techniques in geotechnical engineering analysis was conducted by Baghbani et al. (2022). The results of their analysis are shown in Figure 1. Figure 1 indicates that most of the ML technique using in landslide susceptibility mapping is ANN, followed by SVM, LSTM, ResNet, ANFIS, FIS, CNN, and GAN.

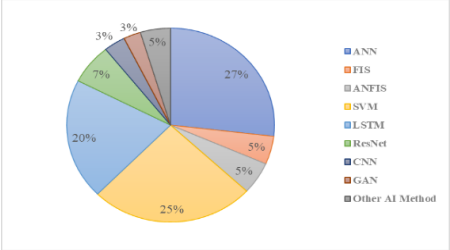

Figure 1. Percentage of ML used in landslide mapping

3. CONCLUSIONS

Research studies show that the most used AI technique in landslide mapping is ANN. Nowadays, using developed ML such as LSTM, MaxEnt, and GBM shows a high success rate. However, the prediction of landslide-prone areas currently depends on spatial environmental variables such as geology, topography, land use, land cover, etc., which are not the geotechnical engineering parameters. The future development of AI and ML in landslide-prone area mapping will focus on how to link between the geotechnical behaviors of geological materials and the spatial environmental parameters, which can help improve the accuracy of the landslide hazard mapping.

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