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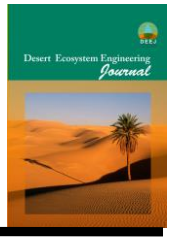

Spatial Prediction of Shallow Landslides Using Decision Tree Algorithm: A Case Study of Yozidar-Degaga Route in Kurdistan Province, Iran

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Extended Abstract

Introduction: Iran's mostly mountainous topography, tectonic activity, high seismicity, diverse geological and climatic conditions, population growth-induced pressures on natural resources, and land-use changes in recent decades have created natural conditions for a wide range of landslides. Therefore, it is necessary to take appropriate measures to reduce the damage caused by landslides, identify their prone areas, determine the factors affecting them, and prepare their susceptibility maps. Thus, this study sought to identify the most important factors involved in the occurrence of landslides, and investigate the efficiency of the alternating decision tree models for preparing landslide susceptibility maps in the southwestern part of Kurdistan province (the communication route connecting Yozider to Degaga).

Materials and methods: First, a distribution map with 175 landslides and 100 non-landslide locations was identified and classified into a ratio of 80% and 20% for training and model validation, respectively. Thirteen factors derived from topographic, land cover and rainfall data were selected for modeling using the Information Gain Ratio (IGR) technique. Then, the ADT algorithm was used to train and prepare the landslide susceptibility maps. Moreover, statistical criteria were used to evaluate the models for both training and validation datasets. Finally, the model's performance was evaluated in terms of the area under the receiver operating curve (AUC).

Results: The highest IGR index values were found to belong to the distance from road, lithology, and road

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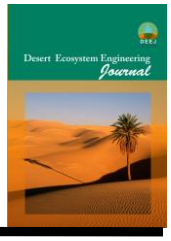

density, respectively. Furthermore, factors such as SPI, curvature, profile curvature, plan curvature, river density, distance from the river, and LS proved to have a negative effect on the modeling results, as zero value was assigned to these indices, which, in turn, led to the creation of noise. On the other hand, final modeling was performed and the 13 remaining factors were removed from the model due to their low impact on shallow landslides in the study area. Then, shallow landslide susceptibility maps were prepared based on the ADT algorithm, using quantile, natural breaks, and geometrical interval methods in the ArcGIS 10.2 environment. Finally, the best method was selected based on the landslides' frequency histogram in each susceptibility class of the maps. The results indicated that the natural breaks method was the best-known method, according to which the landslide susceptibility maps were divided into five classes, including very low susceptibility (VLS), low susceptibility (LS), moderate susceptibility (MS), high susceptibility (HS), and very high susceptibility (VHS).

Discussion and Conclusion: The results of IGR-based factor analysis revealed that distance from roads, lithology, and road density had the highest effects on the occurrence of landslides, which could be attributed to the existence of landslide-susceptible formations such as marl and shale, and inappropriate human-set policies including road construction and incorrect cutting off of heels, as road construction provides the grounds for more penetration of water into sensitive soil formations and saturation of these soils under force. Moreover, the soil saturation on slopes under the force of gravity can facilitate the occurrence of landslides in the study area, which is consistent with the results found by Pham et al. (2015, 2016, 2019) who reported that the existence of lithological units susceptible to landslides (i.e., marl and shale) in the middle parts of the slopes played an important role in the occurrence of landslides in such areas, considering the fact that marl and shales layers might act as a lubricant for overlying saturated soils, and, therefore, facilitate the occurrence of landslides. However, it could be argued that the upper floors and higher altitudes of the area are less susceptible to landslides due to the presence of crystalline and basaltic units that are resistant to any mass movement, especially landslides. As for the land vegetation, it was found that landslides mostly occurred in drylands that were formerly semi-dense and grassland forests, indicating the significant role of forest degradation and land-use change in landslide occurrence.

The designed models for both the training and validation data were evaluated using the Kappa, TP, specificity, sensitivity, accuracy, and squared statistical measures. Finally, the models' performance was examined through the AUC. Accordingly, the results of model validation showed that the ADT model had a relatively moderate performance with the sub-curve level of 0.665. Furthermore, the sub-curve level of the ADT model was found to be 0.677 for the training data. Finally, the study area was divided into five classes, including the very high, high and moderate, low, and very low sensitivity. It was also found the severity of landslides increased when moving from low-sensitivity classes to the high-sensitivity ones, indicating higher chances for the occurrence of landslides in areas with high sensitivity. Therefore, considering the high influence of the roads in the model proposed in this study, it is suggested that the priority of taking appropriate measures to prevent and/or control landslides be taken into account so that the effect of road construction in the study area could be reduced. Moreover, in cases where future road development operations are considered along the route, principles of road construction and the stability of the slope must be strictly observed.

Keywords: Decision Tree Algorithm, Shallow Landslide, Spatial Prediction, Validation, Yozidar-Degaga.