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An application of adaptive neuro-fuzzy inference system to landslide susceptibility mapping (Klang valley, Malaysia)

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Landslides are one of the recurrent natural hazard problems throughout most of Malaysia. Recently, the Klang Valley area of Selangor state has faced numerous landslide and mudflow events and much damage occurred in these areas. However, only little effort has been made to assess or predict these events which resulted in serious damages. Through scientific analyses of these landslides, one can assess and predict landslide-susceptible areas and even the events as such, and thus reduce landslide damages through proper preparation and/or mitigation. For this reason , the purpose of the present paper is to produce landslide susceptibility maps of a part of the Klang Valley areas in Malaysia by employing the results of the adaptive neuro-fuzzy inference system (ANFIS) analyses. Landslide locations in the study area were identified by interpreting aerial photographs and satellite images, supported by extensive field surveys. Landsat TM satellite imagery was used to map vegetation index. Maps of topography, lineaments and NDVI were constructed from the spatial datasets. Seven landslide conditioning factors such as altitude, slope angle, plan curvature, distance from drainage, soil type, distance from faults and NDVI were extracted from the spatial database. These factors were analyzed using an ANFIS to construct the landslide susceptibility maps. During the model development works, total 5 landslide susceptibility models were obtained by using ANFIS results. For verification, the results of the analyses were then compared with the field-verified landslide locations. Additionally, the ROC curves for all landslide susceptibility models were drawn and the area under curve values was calculated. Landslide locations were used to validate results of the landslide susceptibility map and the verification results showed 98% accuracy for the model 5 employing all parameters produced in the present study as the landslide conditioning factors. The validation results showed sufficient agreement between the obtained susceptibility map and the existing data on landslide areas. Qualitatively, the model yields reasonable results which can be used for preliminary land-use planning purposes. As a final conclusion, the results obtained from the study showed that the ANFIS modeling is a very useful and powerful tool for the regional landslide susceptibility assessments. However, the results to be obtained from the ANFIS modeling should be assessed carefully because the overlearning may cause misleading results. To prevent overlerning, the numbers of membership functions of inputs and the number of training epochs should be selected optimally and carefully.