Flash flood susceptibility assessment in Jeddah city (Kingdom of Saudi Arabia) using bivariate and multivariate statistical models

ABSTRACT

The city of Jeddah (Saudi Arabia) has experienced two catastrophic flash flood events in 2009 and 2011. These flood events had catastrophic effect on human lives and livelihoods around the wadi Muraikh, wadi Qus, wadi Methweb, and wadi Ghulail in which 113 people were dead and with 10,000 houses and 17,000 vehicles were damaged. Thus, a comprehensive flood management is required. The flood management requires information on different aspects such as the hydrological, geotechnical, environmental, social, and economic aspects of flooding. Flood susceptibility mapping for any area helps the decision makers to understand the flood trends and can aid in appropriate planning and flood prevention. In this study, two models were used for the generation of flood susceptibility maps for the Jeddah region. The first model includes bivariate probability analysis (frequency ratio), and the second model uses the multivariate analysis. For the multivariate model, the acquired weights of the FR model were entered into the logistic regression model to evaluate the correlation between flood occurrence and each related factor. This integration will overcome some of the weakness of the logistic regression, and the performance the LR will be enhanced. A flood inventory map was prepared with a total of 127 flood locations. These flood locations were extracted from different sources including field investigation and high-resolution satellite image (IKONOS 1 m). These flood locations were randomly split into two groups, one dataset representing 70 % was used for training the models, and the remaining 30 % was used for models validation. Various independent flood-related factors such as slope, elevation, curvature, geology, landuse, soil drain, and distance from streams were included. The impact of each independent flood-related factors on flooding was evaluated by analyzing each independent factor with the historical flood inventory data. The training and validation datasets were used to evaluate the flood susceptibility maps using the success and the prediction rate methods. The results of the accuracy assessment showed a success rate of 90.4 and 91.6 % and a prediction rate of 89.6 and 91.3 % for FR and ensemble FR and LR models, respectively. In addition, a comparison has been made between real flood events in 2009 and the resultant susceptibility maps. Hence, it is concluded that the FR and ensemble Fr and LR models can provide an acceptable accuracy in the prediction of flood susceptibility in the Saudi Arabia. Our findings indicated that these flood susceptibility maps can assist planners, decision makers, and other agencies to deal with the flood management and planning in the area.

Keyword: Flash floods; Remote sensing; GIS; FR; Ensemble; Susceptibility; Jeddah; Saudi Arabia