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A Comparative Assessment of Information Value, Fuzzy Expert System Models for Landslide Susceptibility Mapping of Dharamshala and Surrounding, Himachal Pradesh, India

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Abstract : Landslide is a geomorphic process that plays an essential role in the evolution of the hill-slope and long-term landscape evolution. But its abrupt nature and the associated catastrophic forces of the process can have undesirable socio-economic impacts, like substantial economic losses, fatalities, ecosystem, geomorphologic and infrastructure disturbances. The estimated fatality rate is approximately 1person /100 sq. Km and the average economic loss is more than 550 crores/year in the Himalayan belt due to landslides. This study presents a comparative performance of a statistical bivariate method and a machine learning technique for landslide susceptibility mapping in and around Dharamshala, Himachal Pradesh. The final produced landslide susceptibility maps (LSMs) with better accuracy could be used for land-use planning to prevent future losses. Dharamshala, a part of North-western Himalaya, is one of the fastest-growing tourism hubs with a total population of 30,764 according to the 2011 census and is amongst one of the hundred Indian cities to be developed as a smart city under PM's Smart Cities Mission. A total of 209 landslide locations were identified in using high-resolution linear imaging self-scanning (LISS IV) data. The thematic maps of parameters influencing landslide occurrence were generated using remote sensing and other ancillary data in the GIS environment. The landslide causative parameters used in the study are slope angle, slope aspect, elevation, curvature, topographic wetness index, relative relief, distance from lineaments, land use land cover, and geology. LSMs were prepared using information value (Info Val), and Fuzzy Expert System (FES) models. Info Val is a statistical bivariate method, in which information values were calculated as the ratio of the landslide pixels per factor class (Si/Ni) to the total landslide pixel per parameter (S/N). Using this information values all parameters were reclassified and then summed in GIS to obtain the landslide susceptibility index (LSI) map. The FES method is a machine learning technique based on 'mean and neighbour' strategy for the construction of fuzzifier (input) and defuzzifier (output) membership function (MF) structure, and the FR method is used for formulating if-then rules. Two types of membership structures were utilized for membership function Bell-Gaussian (BG) and Trapezoidal-Triangular (TT). LSI for BG and TT were obtained applying membership function and if-then rules in MATLAB. The final LSMs were spatially and statistically validated. The validation results showed that in terms of accuracy, Info Val (83.4%) is better than BG (83.0%) and TT (82.6%), whereas, in terms of spatial distribution, BG is best. Hence, considering both statistical and spatial accuracy, BG is the most accurate one.

Keywords : bivariate statistical techniques, BG and TT membership structure, fuzzy expert system, information value method, machine learning technique
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