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ORIGINAL ARTICLE

Landslide susceptibility mapping using statistical bivariate models and their hybrid with normalized spatial-correlated scale index and weighted calibrated landslide potential model

Zhuo Chen[1,2] · Danqing Song[3] · Mukhiddin Juliev[4,5] · Hamid Reza Pourghasemi[6]

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Abstract

Considering the slope units as our reference mapping units, three statistical models [frequency ratio (FR), index of entropy (IOE), and evidential belief function (EBF)] are used in combination by two methods [normalized spatial-correlated scale index (NSCI) and weighted calibrated landslide potential model (WCLPM)]. For this aim, ten conditioning factors correlated with landslide namely, altitude, slope angle, slope aspect, relief amplitude, cutting depth, gully density, surface roughness, distance to roads, rainfall, and lithology are considered. The performance of the models is tested using the area under the receiver operating characteristic (ROC) curve (AUC) and several statistical evaluation measures. The weighted calibrated landslide potential index (WCLPI)-based FR model has the highest predictive capability, followed by the calibrated landslide potential index (CLPI)-based FR, the WCLPI-EBF, the CLPI-EBF, the WCLPI-IOE, the CLPI-IOE, the FR, the EBF, and the IOE models, respectively. Results indicated that hybrid models have improved significantly the performance of single models. This highlights that NSCI and WCLPM hybrid techniques are promising methods for landslide susceptibility assessment.

Keywords Landslide susceptibility · Evidential belief function · Frequency ratio · Index of entropy · Normalized spatial-correlated scale index · Weighted calibrated landslide potential model

Introduction

Landslide is one of the most damaging global geological hazards and represents a major risk to people and property (Pineda et al. 2016; Chen et al. 2020b; Chen and Song 2021). Mapping the landslide susceptible areas is valuable to understand and predict future landslides for local authorities (Aditian et al. 2018). Landslide susceptibility mapping (LSM), which predicts the spatial probability of landslide occurrence in a specific area, is a helpful tool towards estimation of landslide hazard and risk (Guzzetti et al. 2006a; Nicu and Asăndulesei 2018; Ozioko and Igwe 2020).

Different approaches for assigning landslide susceptibility can be roughly classified as: heuristic methods, such as analytic hierarchy process (Zhang et al. 2016; Abedini and Tulabi 2018) and weighted linear combination (Akgun et al. 2008; Hung et al. 2016), depended largely on the prior knowledge of the investigator; deterministic methods, mainly incorporated the physical modeling of landslides by considering the simple limit equilibrium models (Trigila et al. 2015; Pradhan and Kim 2016); statistical methods (data-driven methods), such as weights of evidence (Ilia and

✉ Danqing Song
songdq2019@mail.tsinghua.edu.cn

1 Faculty of Geosciences and Environmental Engineering, Southwest Jiaotong University, Chengdu 611756, China

2 State Key Laboratory of Hydraulic and Mountain River Engineering, Department of Geotechnical Engineering, Sichuan University, Chengdu 610065, China

3 State Key Laboratory of Hydroscience and Engineering, Department of Hydraulic Engineering, Tsinghua University, Beijing 100084, China

4 Department of Ecology and Water Resources Management, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan

5 Turin Polytechnic University in Tashkent, 100000 Tashkent, Uzbekistan

6 Department of Natural Resources and Environmental Engineering, College of Agriculture, Shiraz University, Shiraz, Iran

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