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Establish susceptibility and risk assessment models for rainfall-induced landslide: A case in Central Taiwan

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Most of the landslide cases in Taiwan were triggered by rainfall or earthquake events. The heavy rainfall in the typhoon seasons, from June to October, causes the landslide hazard more serious. Renai Towhship is of the most large landslide cases after 2009 Typhoon Morakot (from Aug. 5 to Aug. 10, 2009) in Taiwan. Around 2,744 landslides cases with the total landslide area of 21.5 km2 (landslide ratio =1.8%), including 26 large landslide cases, induced after 2009 Typhoon Morakot in Renai Towhship. The area of each large landslides case is more than 0.1 km2, and the area of the largest case is around 0.96 km2. 58% of large landslide cases locate in the area with metamorphosed sandstone. The mean slope of 26 large landslide cases ranges from 15 degree to 56 degree, and the accumulated rainfall during 2009 Typhoon Morakot ranges from 530 mm to 937 mm.
Three methods, including frequency ratio method (abbreviated as FR), weights of evidence method (abbreviated as WOE), and logistic regression method (abbreviated as LR), are used in this study to establish the landslides susceptibility in the Renai Township, Nantou County, Taiwan. Eight landslide related-factors, including elevation, slope, aspect, geology, land use, distance to drainage, distance to fault, accumulation rainfall during 2009 Typhoon Morakot, are used to establish the landslide susceptibility models in this study. The landslide inventory after 2009 Typhoon Morakot is also used to test the model performance in this study. The mean accumulated rainfall in Renai Township during 2009 typhoon Morakot was around 735 mm with the maximum 1-hr, 3-hrs, and 6-hrs rainfall intensity of 44 mm/1-hr, 106 mm/3-hrs and 204 mm/6-hrs, respectively. The range of original susceptibility values established by three methods are 4.0 to 20.9 for FR, -33.8 to -16.1 for WOE, and -41.7 to 5.7 for LR, and the mean landslide susceptibility value are 8.0, -24.6 and 0.38, respectively. The AUC values are 0.815 for FR, 0.816 for WOE, and 0.823 for LR. The study normalized the susceptibility value range of three landslide susceptibility models to 0 to 1 to deeply compare the model performance. The normalized landslide susceptibility value > 0.5 and $\leqq$0.5 are regarded as predicted-landslide area and predicted-not-landslide area. The ratio of the area in the predicted-landslide area to the total area is 3.0% for FR, 71.4% for WOE, and 26.5% for LR. And the correct ratio is 65.5% for FR, 61.9% for WOE, 74.5% for LR.
The study adopted 14 rainfall stations with more than 20 years daily rainfall data in Renai Township to estimate the 24 hrs accumulated rainfall with different RPYs. Landslide susceptibility map under 24 hrs accumulated rainfall distribution with different RPYs is used to estimate the landslide disaster location and scale. The landslide risk under different RPYs in Renai Township is calculated as 2.62 billion for 5 RPYs, 3.06 billion for 10 RPYs, 4.69 billion for 25 RPYs, 5.97 billion for 50 RPYs, 6.98 billion for 100 RPYs, and 8.23 billion for 200 RPYs, respectively.