Unveiling the mysteries of flood risk: A machine learning approach to understanding flood-influencing factors for accurate mapping

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Abstract

This study investigates the importance of flood-influencing factors on the accuracy of flood risk mapping using the integration of remote sensing-based and machine learning techniques. Here, the Extreme Gradient Boosting (XGBoost) and Random Forest (RF) algorithms integrated with GIS-based techniques were considered to develop and generate flood risk maps. For the study area of NAPA County in the United States, rainfall data from the 12 stations, Sentinel-1 SAR, and Sentinel-2 optical images were applied to extract 13 flood-influencing factors including altitude, aspect, slope, topographic wetness index, normalized difference vegetation index, stream power index, sediment transport index, land use/land cover, terrain roughness index, distance from the river, soil, rainfall, and geology. These 13 raster maps were used as input data for the XGBoost and RF algorithms for modeling flood-prone areas using ArcGIS, Python, and R. As results, it indicates that XGBoost showed better performance than RF in modeling flood-prone areas with an ROC of 97.45%, Kappa of 93.65%, and accuracy score of 96.83% compared to RF's 82.21%, 70.54%, and 88%, respectively. In conclusion, XGBoost is more efficient than RF for flood risk mapping and can be potentially utilized for flood mitigation strategies. It should be noted that all flood influencing factors had a positive effect, but altitude, slope, and rainfall were the most influential features in modeling flood risk maps using XGBoost.

Keywords: Flood-influencing factors, Flood risk mapping, Machine learning, Extreme gradient boosting, Random Forest

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