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A novel flood risk management approach based on future climate and land use change scenarios

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Abstract

Climate change and increasing urbanization are two primary factors responsible for the increased risk of serious flooding around the world. The prediction and monitoring of the effects of land use/land cover (LULC) and climate change on flood risk are critical steps in the development of appropriate strategies to reduce potential damage. This study aimed to develop a new approach by combining machine learning (namely the XGBoost, CatBoost, LightGBM, and ExtraTree models) and hydraulic modeling to predict the effects of climate change and LULC change on land that is at risk of flooding. For the years 2005, 2020, 2035, and 2050, machine learning was used to model and predict flood susceptibility under different scenarios of LULC, while hydraulic modeling was used to model and predict flood depth and flood velocity, based on the RCP 8.5 climate change scenario. The two elements were used to build a flood risk assessment, integrating socioeconomic data such as LULC, population density, poverty rate, number of women, number of schools, and cultivated area. Flood risk was then computed, using the analytical hierarchy process, by combining flood hazard, exposure, and vulnerability. The results showed that the area at high and very high flood risk increased rapidly, as did the areas of high/very high exposure, and high/very high vulnerability. They also showed how flood risk had increased rapidly from 2005 to 2020 and would continue to do so in 2035 and 2050, due to the dynamics of climate change and LULC change, population growth, the number of women, and the number of schools – particularly in the flood zone. The results

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highlight the relationships between flood risk and environmental and socio-economic changes and suggest that flood risk management strategies should also be integrated in future analyses. The map built in this study shows past and future flood risk, providing insights into the spatial distribution of urban area in flood zones and can be used to facilitate the development of priority measures, flood mitigation being most important.

Keywords: flooding risks, machine learning, hydraulic modeling, Vietnam

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