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A framework for flood depth using hydrodynamic modeling and machine learning in the coastal province of Vietnam

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ABSTRACT

Flood models based on traditional hydrodynamic modeling encounter significant difficulties with real-time predictions, require enormous computational resources, and perform poorly in data-limited regions. The difficulties are compounded as flooding worldwide worsens due to the increasing frequency of short-term torrential rain events, making it more challenging to predict floods over the long term. This study aims to address these challenges by developing a rapid flood forecasting model combining machine learning algorithms (support vector regression, XGBoost regression, CatBoost regression, and decision tree regression) with hydrodynamic modeling in Quang Tri province in Vietnam. 560 flood depth locations were obtained by hydrodynamic modeling, and several locations measured in the field were used as input data for the machine learning models to build a flood depth map for the study area. The statistical indices used to evaluate the performance of the four proposed models were the receiver operating characteristic (ROC) curve, area under the ROC curve, root mean square error, mean absolute error, and coefficient of determination (R^2). The results showed that all four models successfully constructed a flood depth map for the study area. Among the four proposed models, CatBoost regression performed best, with an R^2 value of 0.86. This was followed by XGBoost regression (R^2=0.84), decision tree regression (R^2=0.72), and then support vector regression (R^2=0.7). This integration of hydrodynamic modeling and machine learning complements the framework in much of the existing literature. It can provide decision-makers and local authorities with an advanced flood warning tool and contribute to improving sustainable development strategies in this and similar regions.

Keywords: Flood depth, machine learning, hydrodynamics, Quang Tri, Vietnam.

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