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SPATIAL PORTABILITY OF GRADIENT BOOSTING IN FORECASTING EXTREME HYDROLOGICAL EVENTS ON SMALL RIVERS OF ARMENIA

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This article examines the spatial transferability of a gradient boosting model (CatBoost) for forecasting extreme hydrological events on small rivers with a lead time of 1–7 days. Climate data, precipitation aggregates, running discharge statistics, snowmelt indices, and seasonal variables were used as predictors. To assess inter basin generalization, a leave-one-river-out spatial cross-validation scheme was used, in which the model was trained on a set of basins and tested on an independent river. Classification quality was assessed using precision, recall, and the F1 score. To interpret the factors determining model transferability, SHAP analysis was used, revealing differences in the contributions of precipitation and temperature regimes for basins with different conditions for the formation of extreme water discharges. It was found that the quality of inter basin transfer depends on the hydrological similarity of the rivers, the type of recharge, and seasonal characteristics (January–March, November–December). SHAP analysis demonstrated the key role of aggregated water discharge values and revealed differences in the contributions of these factors between the basins. The practical significance of the study lies in the applicability of the developed model to basins with limited or no long-term observational data, provided standard climate data are available. The use of an inter-basin cross-validation scheme (Leave-One-River-Out) allows for an early assessment of the model's generalizability before its implementation in new areas, while SHAP analysis ensures forecast transparency and helps identify key risk factors for each basin. Thus, the obtained results can be used to develop effective and adaptive early warning systems under various hydrological conditions. This study confirms the potential of using machine learning methods to develop portable early warning systems for extreme hydrological events on small rivers, especially in conditions of limited observations. The proposed approach can serve as a basis for developing forecasting systems in regions with insufficient hydrometeorological knowledge.

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Keywords: mountain rivers, extreme events, gradient boosting, spatial transferability, SHAP analysis.

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