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Catchment-scale spatial importance for better understanding the discharge generation processes

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Identification of discharge generation hotspots is important for undertaking actions aimed at flood protection or drought reduction. Such hotspots may be identified by integrated hydrological models (especially in natural areas), sewer system hydrodynamic models (especially in urban areas) or using a spatial sensitivity analysis method. Each of the mentioned methods requires a trained and validated hydrological in order to obtain meaningful results. This is often costly in terms of required data, labor and computation time.

In this study we propose a simple method for identification of discharge generation hotspots at a catchment scale using a machine learning approach and a big dataset. Our approach uses a functionality of the Random Forests algorithm that allows to quantify predictors importance in a model. The predictors, however, are not lumped (e.g. catchment average rainfall), but spatially distributed (e.g. rainfall field in an appropriate spatial resolution). Hence, a spatial pattern of the predictors importance for the model output (e.g. discharge at a catchment outlet) is obtained. Depending on the combination of the variables used as predictors and predicted variable the importance pattern can be interpreted in a different way. However, if predictors represent rainfall intensity in a different locations of the catchment and the predicted variable is the discharge at the catchment outlet, then the importance pattern can be interpreted as spots with most and least importance for discharge generation.

We test this methodology in an urbanized catchment located in NE Poland – Biala River. In order to achieve high spatial resolution of the importance pattern we use 1x1 km rainfall fields from meteorological radar. The rainfall data is in 10 min and the discharge is logged in 1 h temporal resolution what assures that the model captures quick, flash flood events that frequently occurs in the study area. The modelling period is VI 2015 –VI 2016. We analyze the results using of the sewer system network, terrain morphology and impervious surface abundance. The results show that the proposed method is valuable for identifying the discharge generation hotspots.