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Master Thesis Abstract

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Flash flood modelling using low-cost and open-access devices

The settlements distributed along the Echaz River catchment, located in the middle of the state of Baden-Württemberg, have been suffering with flash floods over the past years. These events are characterized by their considerable destructive potential and low predictability. The objective of this thesis is the development of a simple model to predict flash flood events, providing valuable time for the local authorities to take preventive actions. As the traditional public monitoring networks do not provide the required resolution for the development of flood warning models, the local municipality of Reutlingen implemented a low-cost water level gauge network over the whole catchment. This study presents an assessment of the water level measurements as a response to the precipitation events along the wet season of 2020. Personal weather stations (Netatmo) are used as an alternative source of precipitation data. Data acquisition scripts are developed with Python programming language. The reliability of both networks is confirmed by the comparison with the public networks. As the recent events of 2020 do not provide enough information about less likely floods, past data from 2016 to 2019 is also considered. The correlation between different accumulation periods of rainfall from 5 minutes to 60 minutes and the water level peaks are analyzed. Simple linear regression results show that it can be used for an initial estimation. The machine learning methods of decision trees and logistic regression allow the identification of rainfall depth-duration thresholds. With that, a model considering the average rainfall values for the whole catchment and the water level sensor at its mouth provides multiple triggers for the early identification of flash floods. The results show that the flash floods that occurred over the past 5 years (2016-2020) would have been identified with the proposed model. The longer the return period for the flood, i.e. the more severe, the earlier and with more reliability the model triggers the alarm. The analysis of precipitation events leads to the verification of high spatial variability within the catchment. However, the amount of data constitutes a constraint for better predictions for specific points upstream, that are more affected by the floods. The uneven spatial distribution of the precipitation monitoring network increases the uncertainty for these purposes. Nevertheless, rough estimation for initial thresholds are made with the available data. Although the small data available increases the risk of model overfitting and lower performance for the first upcoming seasons, the model quality grows with the incorporation of new data. The developed model is simple, low-cost, easy to interpret and implement. Therefore, has also good potential for other small catchments dealing with flash floods.