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Hydrological Modelling of Droughts and Stormwater Events to Develop Climate Resilient Water Management Strategies

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The research project KliMaWerk has been launched in 2022 in the context of the “WaX” funding measure and is a part of the federal research program on water “Wasser: N”, which contributes to the strategy “Research for Sustainability (FONA)” of the BMBF (Federal Ministry of Education and Research, Germany).

The overall aim of the project is to develop strategies to increase the hydrological and ecological resilience of rivers against droughts and floods, two extremes, being elementary problems of climate change. The project follows a fully comprehensive and interdisciplinary approach by investigating the entire river basin (system), i.e. surface and subsurface water distribution in time, physico-chemical and ecological status, and competing water uses. Based on available data and additional field campaigns (biological and morphological mapping, groundwater and soil measurements), stakeholder involvement and the analyses of coupled surface/groundwater models on different scales, the project aims at the development of a toolbox as a modular planning instrument for the selection of management strategies and measures for both urban and rural areas. In addition, recommendations for dealing with droughts and low flow periods are being developed.

The present contribution will focus on the hydrological and hydrogeological modelling. First results are presented for selected case study regions located in the Lippe River Basin, North Rhine-Westphalia. The regions differ in terms of rural and urban catchment areas. Software packages being used are the groundwater simulation software SPRING (König 2022) and the hydrological models NASIM (Hydrotec 2022) and SWAT+ (Bieger et al. 2017). Whereas the SWAT+ model is used for computations of the entire region and upscaling, SPRING and NASIM will be deployed for detailed analysis of sub-basins. NASIM is strong in describing surface runoff processes and only roughly estimates flows to and from the groundwater. Vice versa, SPRING describes all processes relevant for subsurface flow in detail while surface runoff is simplified. Coupling between the different models will yield comprehensive hydrological models, which will significantly improve knowledge about the water balance development during the last decade, a prerequisite for scenario analysis.

A first project goal is the setup of the models based on hydrologic and geologic features. Calibration is carried out for the period 2011-2021 based on available groundwater level, streamflow measurements as well as water quality data (chemistry, temperature). In a next step, coupling of the models is done via parameters describing the interaction between surface and groundwater flow, like groundwater recharge and leakage rates. In the further course of the project, the developed models will be used to determine the effects of various measures and land management strategies for increasing resilience to climate-related extremes. The modelling results of the two focus sub-catchments are used to assess the potential for upscale to the whole Lippe catchment.

Literature

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