DAAD GSSP - Stipendienausschreibung

Advisor(s):
Prof. Dr.-Ing. Wolfgang Nowak
Dr. rer. nat. Jochen Seidel,
apl. Prof. Sergey Oladyshkin

Research group / department:
Chair of Stochastic Simulation and Safety Research for Hydrosystems (LS^3)
Institute for Modelling Hydraulic and Environmental Systems (IWS)
and Stuttgart Centre for Simulation Technology (SC SimTech)

Opportunistic Rainfall Data for Hydrological Modelling

Keywords:

Introduction / Background:

Errors in hydrological modelling can stem from model uncertainties and errors (epistemic uncertainties) as well as input data. This holds particularly true for precipitation, which is highly variable in space and time, especially when dealing with intense local events. Therefore, it is very important to accurately estimate precipitation, both for understanding and modelling of hydrological processes and when designing and planning for extreme rainfall events. Weather radars provide high resolution spatial and temporal rainfall estimates. Yet, their measurements can suffer from several types of errors, such as the measurement height above ground or attenuation due to intense rainfall. Interpolated rainfall fields using common rain gauge data often miss extreme events due to an insufficient density of rain gauges. Both approaches often lead to a systematic underestimation of flood peaks in hydrological modelling. A fairly new approach that can improve rainfall quantification uses so-called opportunistic sensors (OS). OS are sensors that were not originally designed to provide high-quality rainfall data or any rainfall data at all. However, they typically have a much larger density than official rain gauges. Examples include commercial microwave links (CML) or personal weather stations (PWS). The potential of OS for improving rainfall estimates has be shown by Bárdossy et al. (2021) and Graf et al. (2021), but a systematic investigation of this data source using hydrological models is still to be carried out.

Research goals:

One research goal will be to investigate how rainfall interpolations using information from opportunistic sensors can improve hydrological modelling. The underlying research question was posed by Bárdossy and Anwar (2023), namely "[w]hy do our rainfall–runoff models keep underestimating the peak flows?". They conclude that the rain gauge density used for interpolating rainfall fields has a significant impact on this question. Given their much larger density, using data from opportunistic rainfall sensors should have two benefits: They should yield better estimates of catchment precipitation and also capture more extreme precipitation events. Hence, it is a promising research goal to improve and evaluate the performance of OS data with sub-hourly temporal resolution. For this, techniques to merge OS data with rain gauge data or weather radars have to be developed or improved, implemented, tested and compared.

Research Environment:
This research will be embedded into the Chair of Stochastic Simulation and Safety Research for Hydrosystems (LS^3) at the IWS, Faculty of Civil and Environmental Engineering. Depending on qualification of the candidate, a formal association of the project to the SC SimTech and the Cluster of Excellence in Data-Integrated Simulation Science is possible and advisable.

References:

Bárdossy, A., Seidel, J., & El Hachem, A. (2021). The use of personal weather station observations to improve precipitation estimation and interpolation. Hydrology and Earth System Sciences, 25(2), 583–601.

Graf, M., El Hachem, A., Eisele, M., Seidel, J., Chwala, C., Kunstmann, H., & Bárdossy, A. (2021). Rainfall estimates from opportunistic sensors in Germany across spatio-temporal scales. Journal of Hydrology: Regional Studies, 37, 100883.

Bárdossy, A. Anwar, F. (2023). Why do our rainfall–runoff models keep underestimating the peak flows?, Hydrol. Earth Syst. Sci., 27, 1987–2000.

Prerequisites:

- MSc in hydrology, environmental sciences, hydrogeology, water management (or similar) or in data sciences, statistics, applied mathematics.
- Skills in programming (e.g. python, matlab, julia)
- Skills at scientific writing and presentation
- Ability to work independently and in a team
- Willingness to learn new concepts and methods
- Experience (e.g., coursework, thesis work) in hydrological modelling
- Willingness to contribute to the goals and culture of the research group