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Do macroinvertebrates care how we optimize hydrological models?

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Streamflow is one of the most important abiotic parameters that govern the occurrence and distribution of freshwater biota. Each species has hereby specific preferences to the aquatic environment. Due to this strong link between streamflow and species, uncertainties and inaccuracies in simulated streamflow will also affect simulated species response in ecohydrologic modelling studies. In hydrology, guidelines and thresholds for certain metrics are available that enable an assessment of when model skill is sufficient for hydrological applications. Hereby, the question remains how to define when a hydrological model has sufficient skill to simulate the specific requirements for species occurrences. This is a pertinent research question since the improvement of hydrological model skill requires significant efforts and may limit the application of species predictions to well-researched and data-rich study regions.

This study provides for the first time an assessment of the importance of hydrological model skills for simulating macroinvertebrate species in two mesoscale catchments in Germany. Therefore, species predictions are made with hydrological model simulations optimized (1) to the exact species flow preferences, (2) to multi-objective functions considering the trade-off between multiple flow preferences and (3) optimized with standard hydrological performance criteria on daily-, monthly-, and annual time steps, spanning a wide range of model skills. To evaluate the significance of these optimization steps, a comparison is made to species predictions using the observed flow conditions and models without any optimization.

Our results show, that the type of calibration clearly impacts the species response and causes significant differences in ecological assessment metrics regarding the status of the freshwater aquatic ecosystem. From these results, we can therefore provide recommendations regarding the optimization efforts and hydrological model skill required for simulating species responses.