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Can smarter calibration and regionalisation of rainfall-runoff models improve prediction of low-flows in tropical catchments?

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The majority of the world's population is projected to grow in the tropics. Hence there is a need for robust methods for undertaking water resource assessments to underpin the sustainable management of water in tropical regions. A key characteristic of wet-dry tropical environments is that the high flows occur over several wet months and there is a long dry season with periods of low- or no-flow. The dry-season flows are important for water dependent ecosystems and consumptive water use.

It is a challenge to accurately estimate runoff in tropical regions because these areas typically have a relatively low density of hydrometerological data. While many studies have tested different hydrological similarity methods for modelling runoff in ungauged mediterranean and temperate catchments, few have tested such methods in tropical regions or for simulating low-flows.

In this presentation a rainfall-runoff multi-model ensemble is used to test different methods of regionalising model parameter sets in 105 wet-dry tropical catchments from northern Australia, specifically focusing on low-flow. To ensure low-flows were well modelled multiple calibration runs were undertaken using different objective functions and the 'best all-round' calibrated parameter set selected based on a weighted combination of different metrics. The best method of regionalisation was then compared to regression-based methods for predicting key hydrological metrics.

Under calibration mode, the use of multiple criteria to select an optimal parameter set resulted in an improved ability to simulate low-flows with no loss in predictive capacity for higher flows. Under prediction mode, the 'informed' transposition of optimised parameter sets from gauged to ungauged catchments was better than random assignment of intact parameter sets for medium to high-flows, but not for low-flows.

The best performing method of parameter regionalisation was assigning parameters on the basis of spatial proximity (slightly outperformed the physical similarity method), particularly with respect to model bias. This regionalisation method performed similarly to statistical regression approaches in predicting mean annual flow and high-flow metrics. The regression method demonstrated more skill in predicting low-flow metrics. However, unlike the hydrological model, the regression method does not provide a continuous simulation of daily streamflow. It is difficult to improve the prediction of low flows in data sparse ungauged catchments through smarter calibration and regionalisation because of fundamental limitations in rainfall-runoff model structure, inability of hydrological similarity methods to adequately capture the heterogeneity of those factors controlling low-flows and the difficulty in accurately measuring low-flows.