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A Local to National Scale Catchment Model Simulation Framework for Hydrological Predictions and Impact Assessments Under Uncertainty

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There is a huge challenge in developing hydrological model structures that can be used for hypothesis testing, prediction, impact assessment and risk analyses over a wide range of spatial scales. There are many reasons why this is the case, from computational demands, to how we define and characterize different features and pathway connectivities in the landscape, that differ depending on the objectives of the study. However there is certainly a need more than ever to explore the trade-offs between the complexity of modelling applied (i.e. spatial discretization, levels of process representation, complexity of landscape representation) compared to the benefits realized in terms of predictive capability and robustness of these predictions during hydrological extremes and during change. Furthermore, there is a further balance, particularly associated with prediction uncertainties, in that it is not desirable to have modelling systems that are too complex compared to the observed data that would ever be available to apply them. This is particularly the case when models are applied to quantify national impact assessments, especially if these are based on validation assessments from smaller more detailed case studies. Therefore the hydrological community needs modelling tools and approaches that enable these trade-offs to be explored and to understand the level of representation needed in models to be 'fit-for-purpose' for a given application.

This paper presents a catchment scale national modelling framework based on Dynamic-TOPMODEL specifically setup to fulfil these aims. A key component of the modelling framework is it's structural flexibility, as is the ability to assess model outputs using Monte Carlo simulation techniques. The model build has been automated to work at any spatial scale to the national scale, and within that to control the level of spatial discretisation and connectivity of locally accounted landscape elements in the form of hydrological response units (HRU's). This allows for the explicit consideration of spatial rainfall fields, landscape, soils and geological attributes and the spatial connectivity of hydrological flow pathways to explore what level of modelling complexity we need for different prediction problems. We shall present this framework and show how it can be used in flood and drought risk analyses as well as include attributes and features within the landscape to explore societal and climate impacts effectively within an uncertainty analyses framework.