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Conditioning rainfall-runoff model parameters for ungauged catchments and land management impacts analysis

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Abstract. Data scarcity and model over-parameterisation, leading to model equifinality and large prediction uncertainty, are common barriers to effective hydrological modelling. The problem can be alleviated by constraining the prior parameter space using parameter regionalisation. A common basis for regionalisation in the UK is the HOST database which provides estimates of hydrological indices for different soil classifications. In our study, Base Flow Index is estimated from the HOST database and the power of this index for constraining the parameter space is explored. The method is applied to a highly discretised distributed model of a 12.5 km^2 upland catchment in Wales. To assess probabilistic predictions against flow observations, a probabilistic version of the Nash-Sutcliffe efficiency is derived. For six flow gauges with reliable data, this efficiency ranged between 0.70 and 0.81, and inspection of the results shows that the model explains the data well. Knowledge of how Base Flow Index and interception losses may change under future land use management interventions was then used to further condition the model. Two interventions are considered: afforestation of grazed areas, and soil degradation associated with increased grazing intensity. Afforestation leads to median reduction in modelled runoff volume of 24% over the simulated 3 month period; and a median peak flow reduction ranging from 12 to 15% over the six gauges for the largest simulated event. Uncertainty in all results is low compared to prior uncertainty and it is concluded that using Base Flow Index estimated from HOST is a simple and potentially powerful method of conditioning the parameter space under current and future land management.

◻ Final Revised Paper (PDF, 1030 KB)   ◻ Discussion Paper (HESSD)

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