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Appropriate hydrological scales to achieve output uncertainty goals

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Abstract

The optimum complexity of a hydrological model depends on the objectives and area of study and may result in a so-called 'appropriate model'. Appropriate spatial scales of dominant variables are important components of such an appropriate model. Dominant refers to the relative importance of variables with respect to flooding in a rainfed river basin. Appropriate spatial scales have been determined using an existing methodology based on a balance in uncertainties from inputs and parameters extended with a criterion based on a maximum output uncertainty. The original methodology uses different relationships between scales and variable statistics. It is extended with two different uncertainty propagation methods, the mean-value first-order second-moment (MFOSM) method and Monte Carlo analysis, and backward uncertainty propagation to obtain appropriate scales based on two uncertainty criteria. The methodology is applied to three flood estimation methods: the SCS curve number method combined with (a) the SCS dimensionless unit hydrograph and (b) a dimensionless unit hydrograph derived in the United Kingdom (UH method) and a modified version of the hydrological model HBV. The application revealed that the methodology can be used for the considered flood estimation methods under similar climatological and geographical conditions and assuming independence of all inputs and parameters. The results showed for a specific maximum output uncertainty (25%) different relative input and parameter uncertainties for the different flood estimation methods (3-6%) and different appropriate spatial scales for the dominant variables for a certain input and parameter uncertainty. For example, the appropriate spatial scales for precipitation, elevation, soil, and land use are respectively about 13 km, 65 m, 3.4 km, and 2.1 km for HBV. The input and parameter uncertainty targets probably are not achievable in practical, real world modelling. Thus, if these models are to be used, higher uncertainty must be accepted. Otherwise, one should evaluate more complex models that "might" yield higher accuracy, and evaluate these models using the methodology proposed in this study.