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An enhanced Topmodel for a headwater catchment in Hong Kong

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Topmodel was developed in the late 1970s by using a simple and effective manner, topographic index, to simulate the topographic influence on runoff generation, and the model is regarded as a semi-distributed hydrological model. The model has been successfully used to simulate the runoff generation for numerous watersheds worldwide. The original Topmodel there are a number of problems with its three fundamental but unrealistic assumptions. In the original Topmodel structure, total runoff only consists of overland flow and baseflow. However, field experiments reveal that near surface lateral flow in the unsaturated soil layer, namely interflow, is a critical hydrological process for runoff generation; unfortunately, the Topmodel hasn't include the simulation of the interflow process. This would result in over-estimation of the component of baseflow. In addition, in the original Topmodel, soil properties are assumed to be homogenous, and related parameter T0 is considered as a constant. As we know, soil properties can affect the various hydrological processes, such as interception, infiltration and evaporation, and thereby further influence runoff generation. In fact, field experiments show soil properties do vary significantly in space. To model interflow and heterogeneity of soil properties, this study develops an enhanced Topmodel. Then, we apply the original and enhanced models to a headwater catchment in Hong Kong. At the catchment, since May 2007, we have installed a digital data logger to record the water level and several rain gauges to record rainfall at the one minute time step. Observed precipitation, evaporation and water level series in the period from 2007 to 2009 are used for model parameter calibration and the data from 2010 to2012 are used to validate. Using a global optimization method, namely the SCE-UA (shuffled complex evolution), and Nash-Sutcliffe efficiency (E) as the objective function, several model parameters of the models for the catchment are calibrated. Then, the performances of the original and enhanced models are compared. The study results will be valuable for improving our capability of modeling physically-based hydrological processes over headwater catchments worldwide.