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Limitations of a distributed hydrological model structure for flood predictions in basins with different characteristic

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In this study, we investigate the limitations of a distributed hydrological model structure for flood prediction in different basins by applying the OHDIS-kwmss model to four basins with different physio-climatic characteristics. In the original OHDIS-kwmss model, the overland flow, saturated flow and unsaturated flow processes were modeled by using derived storage-discharge equations for each process based on kinematic wave theory. In the derivation stage of the storage-discharge equation for the unsaturated zone the lateral soil moisture suction head was neglected by assuming the steep slope and therefore the applicability range of the OHDIS-kwmss model was limited to steep slope basins. To expand the range of the model applicability for mild slope and dry basins, a new storage-discharge equation for unsaturated zone considering the lateral soil moisture suction was developed and coupled with the original OHDIS-kwmss model. The new equation is based on Darcys equation and the soil moisture suction head term was replaced using Campbells simplified model representing the soil moisture and hydraulic conductivity characteristics.
The modified OHDIS-kwmss model was applied to four basins (the Illinois basin US, the Mae Chaem basin Thailand, the Upper Kotmale basin Sri Lanka and the Maruyama basin Japan) with different physical and climactic characteristics. Considering the climatic factors, the Illinois basin and the Mae Chaem basin are dry basins whereas the Upper Kotmale basin and Maruyama basin are wet basins. According to the basins slope variation, the considered basins can be classified into three categories. The Maruyama basin is categorized as steep slope basins. The Mae Chaem basin and the Upper Kotmale basin can be considered as moderate slope basins whereas the Illinois basin can be considered as a mild slope basin.
The results of the applied model to Maruyama basin confirmed that the modified OHDIS-kwmss model is capable of predicting wider range of flood events with high prediction accuracy for wet and steep slope basins without changing the parameter values. Furthermore, the model gives very good prediction accuracy for the wet and moderate slope Upper Kotmale basin in both calibration and verification stages. It is good evidence to say that the modified OHDIS-kwmss model structure is sufficient to capture the hydrology in wet and moderate slope basins. In contrast, for dry and moderate slope basin and dry and mild slope basins the model gives poor prediction. Optimized set of model parameters using the basin outlet flow data for one event cannot be used to make reliable predictions for any other event. In other words, it is not possible to obtain a stable set of model parameters for dry and mild slope or dry and moderate slope basins to make accurate flood prediction for wider range of flood events. It is concluded that the transferability of the modified OHDIS-kwmss model is limited to steep and moderate slope basins with wet climate condition but for mild or moderate slope dry basins the present hydrologic model structure is insufficient and we need to develop a model with different hydrologic structure.

Keywords: distributed hydrological model, transferability hydrological model, flood predictions, OHDIS-kwmss