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Proper estimation of hydrological parameters from flood forecasting aspects

Mamoru Miyamoto (1), Kazuhiro Matsumoto (2), Morimasa Tsuda (1), Yuzuru Yamakage (2), Yoichi Iwami (1), Hitoshi Yanami (2), Hirokazu Anai (2,3)

(1) ICHARM, Public Works Research Institute, Tsukuba-shi Ibaraki, Japan (mmiyamoto@pwri.go.jp), (2) Fujitsu Laboratories LTD., (3) Kyushu University

The hydrological parameters of a flood forecasting model are normally calibrated based on an entire hydrograph of past flood events by means of an error assessment function such as mean square error and relative error. However, the specific parts of a hydrograph, i.e. maximum discharge and rising parts, are particularly important for practical flood forecasting in the sense that underestimation may lead to a more dangerous situation due to delay in flood prevention and evacuation activities. We conducted numerical experiments to find the most proper parameter set for practical flood forecasting without underestimation in order to develop an error assessment method for calibration appropriate for flood forecasting.

A distributed hydrological model developed in Public Works Research Institute (PWRI) in Japan was applied to fifteen past floods in the Gokase River basin of 1,820km2 in Japan. The model with gridded two-layer tanks for the entire target river basin included hydrological parameters, such as hydraulic conductivity, surface roughness and runoff coefficient, which were set according to land-use and soil-type distributions. Global data sets, e.g., Global Map and Digital Soil Map of the World (DSMW), were employed as input data for elevation, land use and soil type. The values of fourteen types of parameters were evenly sampled with 10,001 patterns of parameter sets determined by the Latin Hypercube Sampling within the search range of each parameter.

Although the best reproduced case showed a high Nash-Sutcliffe Efficiency of 0.9 for all flood events, the maximum discharge was underestimated in many flood cases. Therefore, two conditions, which were non-underestimation in the maximum discharge and rising parts of a hydrograph, were added in calibration as the flood forecasting aptitudes. The cases with non-underestimation in the maximum discharge and rising parts of the hydrograph also showed a high Nash-Sutcliffe Efficiency of 0.9 except two flood cases. Furthermore, the applicability of the proper parameter set to flood forecasting aptitudes was validated by applying it to an unlearned flood event. The result with the proper parameter set could reproduce observed discharge with high accuracy, i.e. 0.90 of Nash-Sutcliffe Efficiency, without underestimation in the maximum discharge and rising parts of a hydrograph. In conclusion, the practical calibration method was proved more effective when coupled with additional conditions regarding flood forecasting aptitudes than merely conducting error assessment for an entire hydrograph.