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Statistical Flood Forecasting for the Mekong River

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An ongoing study for improving flood forecasting for the Mekong River by statistical methods has yielded first results, which reduce forecasting errors of previous forecasting models. A forecast always is subject to uncertainty, both due to model uncertainty and natural variability. In principle, model uncertainty could be reduced by improved models and better calibration, whereas natural variability has to be endured. In flood forecasting, hydro-meteorological uncertainties, physiographic unknowns together with measurement errors and model errors are decisive factors determining the width of future uncertainty bands. The degree of certitude of forecasts varies from event to event depending on the ensemble of realizations of the flood hydrograph (Krzysztofowicz, 2001). Without any information on previous discharges and rainfall the range of forecasts can be between zero and infinity. When time series of discharges are available then the uncertainty band is the probability distribution of the stages. At any particular point in time the uncertainty band can be further narrowed by usage of real time discharges of the past, and conditional maximum and minimum discharges for the future can be estimated, due to the existence of physical continuity in space and time. As a consequence, for one day ahead forecasts the coefficient of variation of the forecast for small basins is large, whereas it is small for large river basins, as for the Mekong River (Plate, 2005). The consequences of this continuity for the Mekong are explored in this study.

The basin of the Mekong River has an area of 795,000 km^2 and a length of about 4000 km. Flooding is a major problem, and flood forecasting is the most important non-technical solution. The existing forecasting method is based on a physical hydrological model, which yields forecasts of limited accuracy, partly due to limited quality of runoff data and insufficient rainfall information in this data sparse basin. To overcome shortcomings of the physical model, we develop models based on a mix of statistical analysis and physical modeling.

As a first approach probability distributions of lateral inflows per day for the reach between Vientiane in Laos and Stung Treng in Cambodia are estimated for hydrographs which exceed a critical level. By means of past flood records upper and lower uncertainty bounds for the day ahead water stages were determined for 4 stations along the middle reach of the Mekong River. The flow time between adjacent stations is one day. Therefore, the discharge for a one day forecast is estimated as the discharge of the upstream station one day ahead. To this the inflow into the reach between the two stations is added, which is estimated from the (conditional) probability distributions of the lateral inflows. First results of this approach show that that the Nash - Sutcliffe criterion for the forecast is better than 90%. A more appropriate efficiency criterion defined by Plate (Plate & Lindenmaier, 2008) ranges from 0.2 to 0.5, which implies that the variance of the forecast error based on this approach is only 20 to 50% of the variance of forecast errors that is obtained if the assumption is used that the forecast value of tomorrow is the same as the value of today.

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