UTILIZATION OF RFE AND STATION DATA TO DRIVE DROUGHT AND FLOOD MODELS

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Estimating rainfall in areas with a sparse station network and rugged terrain presents a number of issues, some of which may lead to systematic errors. Satellites offer effective and economical means for estimating areal rainfall estimates in sparsely gauged regions. Due to the indirect relationship between remotely sensed variables and actual rainfall such data has large uncertainty associated with it. Furthermore these errors may be further propagated to flood or drought models that rely on the rainfall estimates as inputs. An integration of station data in the rainfall estimates may dramatically improve the value of rainfall estimates, and thus the ensuing drought and flood model results. This research will focus on two related projects, one which deals with a methodology to improve satellite-based rainfall estimates (RFE) and another study on the utility of the RFE for flood forecasting in the Mekong environment.

There is some research to show that RFE data could be effective in large area agroclimatic and hydrologic models. The work presented here uses spatially and temporally oversampled monthly RFE. Monthly RFE was used to estimate Gaussian distribution parameters for each pixel for a spatial domain that covers most of South-East Asia. These distribution parameters are then used in the development of a Standardized Precipitation Index (SPI) which measures the significance of an event by determining the probability of exceedence. The SPI is calculated independently at each 0.1-degree gridcell over the entire region. Meanwhile, long-term station data which may not be available in real-time but which has a deep history, can be used to estimate distribution parameters based on rainfall measurements at point locations. The station distribution parameters and DEM information can then be put into a localized regression to develop fields of distribution parameters. Combining these station-based distribution fields with the RFE-based SPI it is possible to back out an improved estimate of rainfall.

Included in this work is a technique for improving rainfall estimates through the integration of available station information. A two-step approach utilizing (1) the ratio of rainfall observation to rainfall estimate, and (2) the difference between the observation and estimate, combined with an inverse distance weighting scheme preserves values at station locations, but also exploits the spatial information present in the underlying rainfall field. The result is a reduction in the mean absolute error for cross-validated points.

The second part of this research focuses on how improved rainfall estimates can lead to improved hydrologic modelling. The aim of the activity was to provide valuable insight on the potential value for flood forecasting of the Geospatial Stream Flow Model (GeoSFM, a distributed hydrologic model developed by the USGS) in the Southeast Asia environment. The Nam Ou and Se Done River basins in Laos PDR were selected as the test basins. These two basins were selected because they contribute large flows to the Mekong and, therefore, have a significant impact on the Mekong River main stem forecasts; they contain an adequate number of rain and stream gauges for runoff-rainfall modelling purposes; and both basins are flood prone and positioned upstream of US Agency for International Development (USAID)/MRC village flood-referencing project activities. The GeoSFM is a physically based catchment-scale (semi-distributed) hydrologic model that consists of a GIS-based preprocessing module and a rainfall-runoff component. The GeoSFM is a model with few parameter and variable input data requirements

Based on the analysis we have conducted, we can conclude that (1) the calibrated GeoSFM had a good predictive skill for the streamflow of the two sub-basins within the Mekong basin (see Figure

1) with a Nash-Sutcliffe efficiency coefficients that were in 0.80's when the model was forced with rain-gauge measured rainfall, (2) uncalibrated model runs gave fair results if forced with rainfall data from a dense network of gauges, (3) the model has good predictive skills when calibrated with rain gauge data and run with RFE data, and (4) for the Nam Ou, a relatively large basin (19,000km^2) with few rain gauges, the RFE model forcing was comparable to rain gauge forcing (see Figure 2). On the other hand, in the smaller Se Done basin (6000km^2), with relatively denser rain gauge observations, the RFE model forcing agrees less with observed flows than rain gauge forcing.

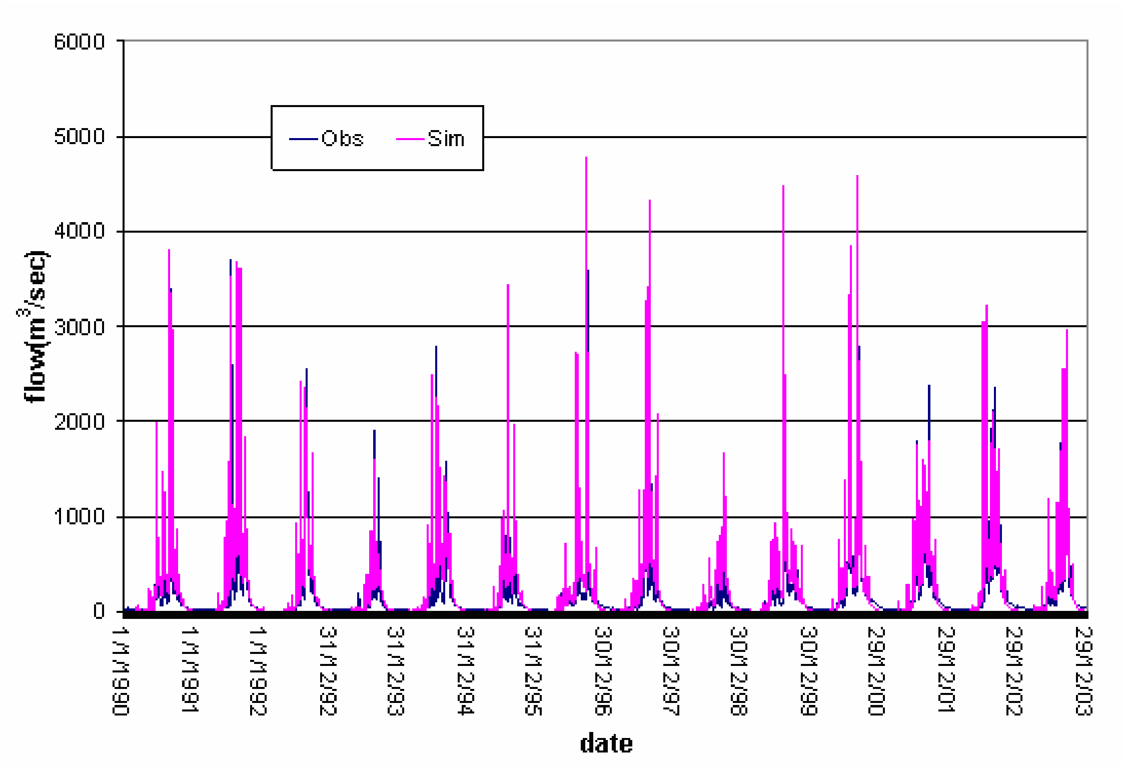

Figure 1. Observed and simulated hydrographs from calibrated GeoSFM for the Se Done River at Souvanna Khili station.

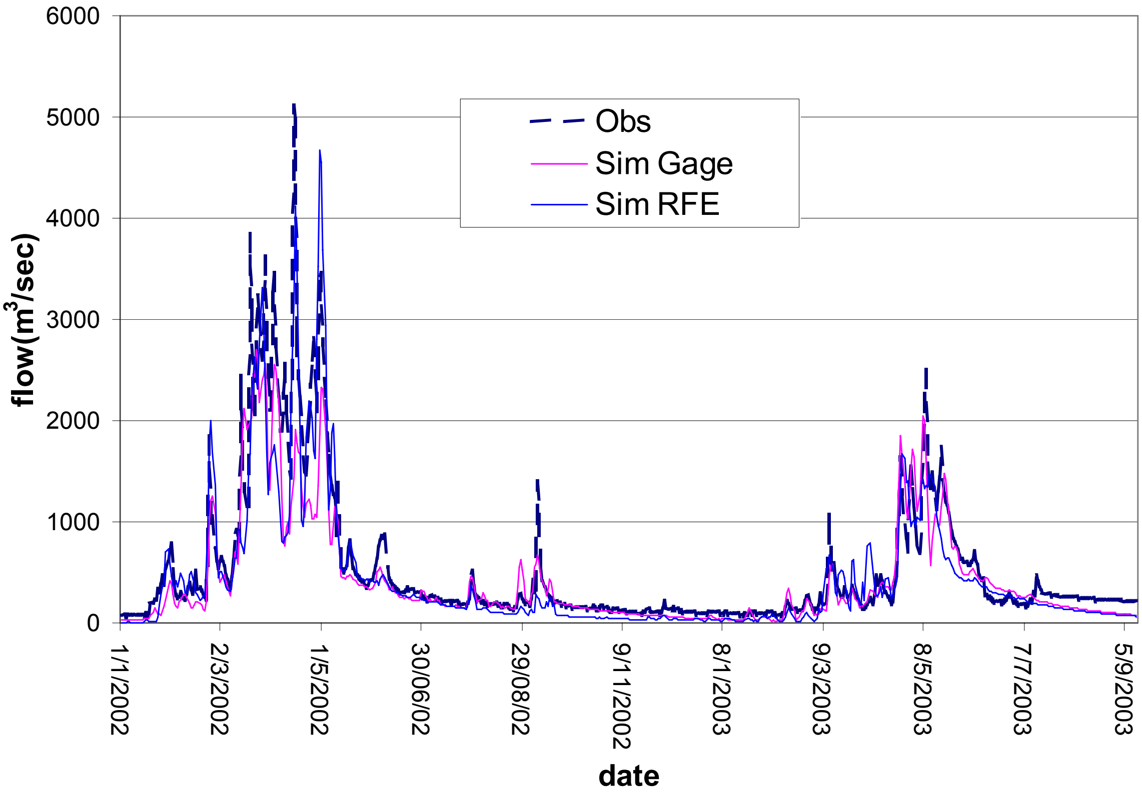

Figure 2. Observed and simulated hydrographs from calibrated GeoSFM for the Nam Ou River at Muong Ngoy station model forced with both rain gage measured and RFE data.