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On merging rainfall data from diverse sources using a Bayesian approach

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Numerous studies have presented comparison of satellite rainfall products, such as from Tropical Rainfall Measuring Mission (TRMM), with rain gauge data and have concluded, in general, that the two sources of data are comparable at suitable space and time scales. The comparison is not a straightforward one as they employ different measurement techniques and are dependent on very different space-time scales of measurements. The number of available gauges in a catchment also influences the comparability and thus adds to the complexity. The TRMM rainfall data also has been directly used in hydrological modelling. As the space-time scale reduces so does the accuracy of these models.

It seems that combining the two sources of rainfall data, or more sources of rainfall data, can enormously benefit hydrological studies. Various rainfall data, due to the differences in their space-time structure, contains information about the spatio-temporal distribution of rainfall, which is not available to a single source of data. In order to harness this benefit we have developed a method of merging these two (or more) rainfall products under the framework of Bayesian Data Fusion (BDF) principle. By applying this principle the rainfall data from the various sources can be combined to a single time series of rainfall data. The usefulness of the approach has been explored in a case study on Lake Tana Basin of Upper Blue Nile Basin in Ethiopia. A 'leave one rain gauge out' cross validation technique was employed for evaluating the accuracy of the rainfall time series with rainfall interpolated from rain gauge data using Inverse Distance Weighting (referred to as IDW), TRMM and the fused data (BDF). The result showed that BDF prediction was better compared to the TRMM and IDW.

Further evaluation of the three rainfall estimates was done by evaluating the capability in predicting observed stream flow using a lumped conceptual rainfall-runoff model using NAM. Visual inspection of the simulated and observed flow plots and statistical indices for goodness of fit were used to evaluate the predictive capability of the three rainfall sources. The simulation with the BDF rainfall better predicted the observed stream flow showing again the capability of the proposed merging technique in estimating rainfall from diverse sources. This finding has given qualitative confirmation of the improvements that can be obtained by merging rain gauge and TRMM rainfall data using the Bayesian Data Fusion technique.

Keywords: Bayesian data fusion, rainfall, TRMM, Lake Tana, Gilgel Abay