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Novel method to estimate predictive uncertainty of flow forecasting

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Accurate and timely flow forecasting of the river is major issue for the modeler/hydrologist due to uncertainties inherent in the forecasting process. The uncertainty in flow forecasting stems mainly from the four sources: (a) uncertainties in input data (e.g., precipitation and temperature); (b) uncertainties in data used for calibration i.e. output data (e.g. streamflow); (c) uncertainties in model parameters; and (d) uncertainties due to imperfect model structure. More and more sophisticated flow forecasting models are being built. While these advances improve the accuracy of the flow forecasting, they also increased the uncertainty due to the increased complexity of the models and data sources.

Uncertainty in the flow forecasting is reflected in the model errors which are the mismatch between the observed and the forecasted flow, and often it is difficult to understand the origins of these errors. The disaggregation of the error into its source components is difficult, particularly in cases common to hydrology where the model is nonlinear and complex and different sources of error may interact to produce the measured deviation. Nevertheless, evaluating the contribution of different sources of uncertainty to the overall uncertainties in model prediction is important to understand where the greatest sources of uncertainties reside and therefore to direct efforts towards these sources. In general, relatively little or no studies have been conducted to investigate the interaction between different sources of uncertainty and its contribution to the total model uncertainty. For the decision making process, it is more important to know the total model uncertainty that accounts for all sources of uncertainty. Recently Shrestha and Solomatine (2006; 2008) developed and applied a novel

method to estimate the total model uncertainty that takes into account all sources of uncertainty without attempting to disaggregate the contribution given by the individual sources. The method is referred to as **UN**certainty **E**stimation based on Local **E**rrors and **C**lustering (UNEEC).

In the UNEEC method, the model errors are seen as the major indicator of the model uncertainty. Since the direct analytical estimation of the probability distribution of the model errors is often difficult in the forecasting model, it is estimated separately for different hydrological situations using data driven models. The parameters characterizing these distributions are aggregated and used as output target values for building the training sets for the data driven models. This model, being trained, encapsulates the information about the model error localized for different hydrological conditions in the past, and is used to estimate the probability distribution of the model error for the new hydrological model runs. Average mutual information and correlation analysis are used to determine the relevant parameters characterizing hydrological situations and the input variables for the learning models. The results are also compared with other uncertainty estimation approaches – GLUE and meta-Gaussian approach. The method is tested to estimate uncertainty of a conceptual rainfall-runoff model of Bagmati catchment in Nepal.