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On the Effective Use of Probabilistic Forecasts in Flood Forecasting, Warning and Response Systems

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The primary reason for forecasting is to realise value - a user's benefit, either economic or other - by reduction of uncertainty about the future. Benefits may vary from application to application. In flood forecasting, decision and response systems (FFDRS, sometimes referred to as flood early warning systems), the aim is generally to reduce the adverse effects of flooding. Either the flood hazard itself is mitigated or timely warning is given to a community at risk, thus allowing for implementation of measures aimed at reduction of damage, casualties or both.

While forecasting can indeed reduce uncertainties about future values of hydrologic variates, these uncertainties cannot be fully eliminated. Increasingly often, the remaining uncertainty is explicitly estimated probabilistically and communicated to forecast users. These probabilistic forecasts thus constitute estimates of the distribution of future values of hydrologic variates.

Prescriptive studies of forecast value suggest that forecasts that are enhanced by estimates of predictive uncertainty have higher value than those that are not. The reason for this is that the estimate of predictive uncertainty can be taken into account in the decision-making processes. To wit, a probabilistic forecast allows for weighing possible scenarios with the probability of occurrence thereof, thus enabling risk analyses.

Descriptive studies, however, suggest that the maximum potentially value of forecasts is often not obtained. Reasons for that include (i) misunderstanding or misinterpretation of the forecast and (ii) non-use or non-optimal use of forecasts. Thus, the forecasts are not used as effectively as they potentially could have been.

We hypothesize that the very nature of probabilistic forecasts introduces challenges that, in current operational practice, hamper fully effective use thereof. These challenges arise in various online (i.e. real-time) and offline (i.e. not real-time) system components or protocols, including forecast visualisation, communication, decision-making, training and verification.

In the present work, it is identified which challenges are relevant, whether best or bad practices pertaining to these challenges exist, and what constitutes a promising development path for flood early warning systems that make use of probabilistic forecasts.

The approach taken in this study is as follows. First, a simple model of a forecast, decision and response model is outlined; this model aids the subsequent analysis. Second, an inventory of potential issues, or challenges, is made by means of a literature review as well as expert solicitation. Subsequently, a conceptual model of FFDRS development - the Staged Development Model - is created, to which case study systems are subjected. From the analysis, best practices are identified. Finally, the results are discussed.