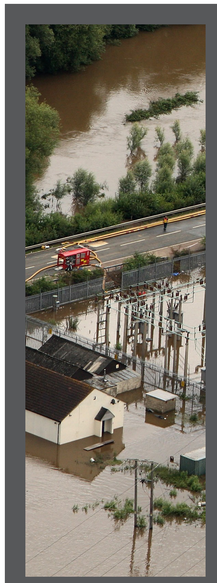

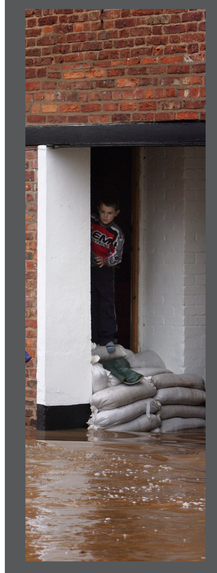

Forecaster priorities for improving probabilistic flood forecasts

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1. What do forecasters really want from their system?

Hydrological ensemble prediction systems (HEPS) have in recent years been increasingly used for the operational forecasting of floods by European hydrometeorological agencies. The most obvious advantage of HEPS is that more of the uncertainty in the modelling system can be assessed. In addition, ensemble prediction systems generally have better skill than deterministic systems both in the terms of the mean forecast performance and the potential forecasting of extreme events. Research efforts have so far mostly been devoted to the improvement of the physical and technical aspects of the model systems, such as increased resolution in time and space and better description of physical processes. Developments like these are certainly needed, however, in this paper we argue that there are other areas of HEPS that need urgent attention. This was also the result from two a group exercise and a survey conducted to operational forecasters within the European Flood Awareness System (EFAS) to identify the top priorities of improvement regarding their own system. They turned out to span a range of areas, the most popular being to include verification an assessment of past forecast performance, a multi-model approach for hydrological modelling, to increase the forecast skill on the medium range (>3 days) and more focus on education and training on the interpretation of forecasts. In light of limited resources we suggest a simple model to classify the identified priorities in terms of their cost and complexity to decide in which order to tackle them. This model is then used to create an action plan of short-, medium- and long-term research priorities with the ultimate goal of an optimal improvement of EFAS in particular and to spur on the development of operational HEPS in general.

2. Gauging forecaster priorities: a user preference exercise

This study was spawned from a group exercise at the 7th annual workshop of the European Flood Awareness System (EFAS) which was held in June 2012 at the Swedish Meteorological and Hydrological Institute (SMHI), followed by an individual survey to the 30 operational forecasters that attended the workshop.

Part 1: Pitching your chosen priority in front of a jury

The participants were given the task to individually come up with the most important areas for future developments. They were then asked in groups to:

- Prepare a 5 min presentation on the most important area of development for flood forecasting.
- Pitch this on front of a panel of "dragons" and the rest of the participants
- Allocate "funds" to the best suggestions in order to rank the priorities

The pitched priorities (in order of popularity):

1. Multi-model forecasting system
2. Build a European flood forecasting infrastructure
3. Forecast verification tool
4. Improve physical model representations
5. Improve standardization of hydrological data

Part 2: Questionnaire

A questionnaire was later sent out to the participants where they had to rank 23 suggested improvements gathered from the workshop

The top ranked priorities were (in order):

1. Forecast verification for hydrological and meteorological forecasts
2. Introduce multi-model approach for hydrological modelling
3. Increase the average skill of the medium range forecast (>3 days)
4. Education and training of how to use and interpret forecasts
5. Improve physical model representations

The bottom ranked priorities were (in order):

1. Replace/expand web forum by social networks
2. Distinguish between different flood situations
3. Increase the frequency of forecasts
4. Increase the temporal resolution of the forecast
5. Blending of national and EFAS forecasts

3. What can be improved in HEPS?

Cooperation between forecasters

There are networks and steps taken to improve cooperation between forecasters, but there is much more effort needed in this area, such as further development of a European Flood forecasting infrastructure as well as training and knowledge exchange between forecasters and researchers.

Existing decision making tools

Having sufficient decision making tools is naturally important for forecasters and areas of priorities range from improving the dissemination platform to enhancing the product generation and visualisation of forecasts.

The general performance of the forecast

Improving the general performance of the forecast is a common demand from forecasters, and from a scientific point of view it is tempting to conclude how improving the reliability and skill of forecasts would make a forecaster's life easier. However, further improvements to any forecasting system are usually expensive in terms of resources and time, and the benefit can be difficult to quantify.

Tools to evaluate and compare forecasts

Having better tools to evaluate and compare forecasts means that decision making by the forecaster can be made more straightforward and perhaps also more transparent. This is especially important as multimodel probabilistic systems become more and more complicated, meaning that forecasters must be able to interpret advanced forecast results and a multitude of sometimes contradictory information.

Data collection and processing

Data collection and processing are the bugbears of hydrological science and it is increasingly important that the hydrological data is quality checked at all levels.

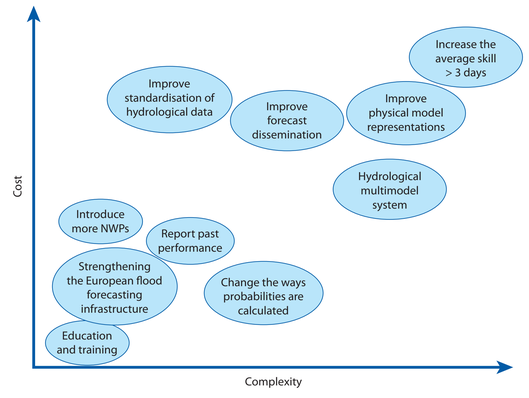

Figure 1 Schematic view of the relative cost vs estimated complexity of the top 10 priorities from the survey. The cost is the estimated effort in terms of resources, which can be both financial and human. The complexity is the estimated level of technical and/or scientific development that is required.

4. How to best improve HEPS

We propose following "road map" to improve HEPS within the limited resources at hand. The strategy is to first focus on the less costly/complex priorities, whereas the more costly and/or complex priorities should be addressed with concerted efforts. It is necessary to review the current operational framework and make sure that resources are used optimally.

1. **Secure funds for the priorities that yields most benefit to a low cost and with low complexity**
   - Training and collaboration between forecasters at national and international level
   - A "User guide" for hydrological probabilistic forecasting to improve forecast interpretation
   - E-learning tools designed to show the added benefit of using HEPS
2. **Plan and coordinate activities to deal with intermediate cost/complexity priorities**
   - Report past performance through forecast verification scores
   - Showing calibration and validation results
   - Include more NWPs
3. **Long-term strategy to coordinate research and development for costly and/or complex priorities**
   - A multimodel hydrological system
   - Standardise hydrological data collection
   - Improve forecast dissemination
4. **Collaboration with the scientific community on long-term improvements of HEPS**
   - Improve the physical representations in the used models
   - Improve the forecast on lead times > 3 days

5. References

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