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Hydrology and Earth System Sciences Discussions

Interactive comment on "Estimating the benefits of single value and probability forecasting for flood warning" *by* J. S. Verkade and M. G. F. Werner

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General Comments:

The paper describes a way to evaluate the benefits of both deterministic and probabilistic forecasts and in particular issuing flood warning using probabilistic forecast with respect to a system where there would be a warning based on a perfect forecast, a warning based on a deterministic forecast, or no warning at all. The contribution is on evaluating both probabilistic and deterministic forecasts on a similar scale, while taking into consideration the information in the probabilities; i.e not only using the ensemble

mean forecast when evaluating it with respect to a deterministic forecast. The authors make a first assumption on the benefit of an effective warning in terms of costs. Actual damages costs and losses are explicitly taken into account. The hydro-economic model allows deriving the cost/loss ratio. The benefit is quantified through the Relative Economic Value. The results suggest that once the probabilistic threshold for a certain flood level is optimized, based on the probabilistic forecast system performance for this flood level, the probabilistic forecasts can benefit the society for cost/loss ratio that usually are below 0.85. The lower the lost cost ratio, the larger the improvement of probabilistic forecast with respect a deterministic forecast. For increasing lead time, here up to h=5, the benefit improvement from probabilistic forecasts increases.

The paper is well written and organized. I suggest some minor edits in order to improve clarity in the text, figures and tables. I would recommend accepting the paper with major revisions as explained below.

Specific Comments:

My main comments justifying my recommendation are;

- an analysis made on longer lead times: the authors differentiate the mitigation time and the lead time, with the mitigation time being the period when actions can be made once the decision is made. In the analysis, the authors assume that the mitigation time is linked to the forecast lead time, and then base the analysis on the lead time instead. A lead time of one hour however will not lead to a one hour mitigation time, and the benefit La should then decrease. The value La was not made a function of time but I would think that if the mitigation time is less than 1 hour, La is 0. La does not need to be a function of time for simplicity here. People can be warned in the middle of the night, else during the day. I would think that people need a 5-8 hour mitigation time, which is outside of the range analyzed in this paper. I refer to the authors to explain how the current forecasts are made, and how current warnings are issued in order to argument an analysis made on lead time 1 to 6 hours. Else I would suggest using 1-12 hours.

- adding a discussion on the relative value based on the time of concentration in the text and conclusion. This would be resolved when the analysis is based on longer lead times: The reliability of the probabilistic forecasts varies significantly for lead time shorter than the time of concentration and those longer than the time of concentration. Below the time of concentration, with a well calibrated hydrology model, and as seen on the results, probabilistic forecasts are not improving that much upon a deterministic or even perfect forecast. Past the time of concentration, the ensemble range usually expands and can give more reliable probabilities, provided that it has been calibrated and on the calibration approach (pre processor, post processor). As you remind the readers, looking at the sensitivity of those benefits with different ensemble forecast calibrations is out of the scope of this analysis ÂŰ so this is what happens in general. I think that this is an important message for operational decisions. Probabilistic forecasting is interesting for issuing warning for lead times longer than the time of concentration. But a deterministic forecast is still required in order to gain on computation time and issue reliable warnings for short lead times, in particular when the model is forced with observed precipitation.

-How to make sure that the deterministic threshold, which is used for both deterministic and probabilistic forecasts, is optimized with the probabilistic thresholds? As end users will determine new rules with probabilistic forecasting, they might use a lower/higher deterministic threshold with an optimized associated probabilistic threshold with it. This is probably out of the scope of the analysis, but I think that this is worth discussing, even briefly, this assumption in the paper. In particular, calibration of the ensemble forecasts can sometimes improve on the accuracy more than on the reliability of the forecasts (and could then be applied on both deterministic and probabilistic forecasts), or vice versa (apply only on probability forecast for example). Please discuss.

Technical revisions:

Line 5: change ÂŞSurprisesÂŤ? According to your table, you mean missed flood. Here and throughout the paper, it would be clearer if you used ÂŞmissed eventÂŤ in general.

P6642 ÂŰ line1: define EAD

Pp6642 line13 ; situationS

Pp6643: in detailS

Pp6644: increase in mitigation time decrease potential losses but also increase the cost of an alarm ÂŰ people not working, staff on hold, business closed, etc. Optimized, but not maximized.

P6645: La = 0.5 Lp ÂŰ arbitrary . How sensitive are the results to this assumption?

P6647, pp6648: ÂŞsurprisesÂŤ, please use other term.

- why use climatology and not persistence? Climatology is used for seasonal forecast. Persistence for short term flow forecasts.?

Pp6648: the paper would benefit of including in table 1 the different cost associated with each frequency.

P6651: Please clarify which flood level was chosen for the analysis, i.e. to which quantile the flood level correspond; what is the reference quantile corresponding to 1.5 m; is this the quantile threshold or which one do you use exactly?

Pp6651 ÂŰ line 19-20; The quantiles were derived over the period used in the analysis? Is this a dependent verification then? Please clarify how it affects your results ÂŰ i.e. both deterministic and probabilistic the same way?

Pp6656, line 3 ÂŰ unfinished sentence (rule of zero ÂĚ)

Pp6657: clarify that the envelop is giving the best improvement from probabilistic forecast, but it also means that a different probabilistic threshold needs to be optimized for different cost-loss ratio.

P6658, line 25-28: as mentioned above, for different lead time and different cost ratio, a different probabilistic forecast thresholds needs to be optimized in order to claim the benefits upon a deterministic forecasts.

Conclusions: I would suggest keeping it to the main points only.

P6664: line 17-19: I would say that the improvement is noted throughout different lead times and cost lost ratio, instead of saying that it is independent. Also, this is given that the probabilistic threshold is optimized. This is important to clarify so that future users understand the steps to ensure a benefit from using probabilistic forecasting.

Table 1: add to cost associated with each frequency

Table 2: add relative improvement. Specify that lead time is not mitigation time.

Figure 2: please add arrows specifying in which direction all variables increase.

Figure 6: add the line V=0 in the figure. Specify the range in cost lost ratio for which warning benefit is negative.

Figure 8: specify each probabilistic threshold for the different lines, or at least p=0, p=1. Add line V=0.

Figure 9: specify p=0 and p=1 lines.

Figure 10: please add longer lead timesÂĚ

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 6639, 2011.