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Economic assessment of flood forecasts for a risk-averse decision-maker

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A large effort has been made over the past 10 years to promote the operational use of probabilistic or ensemble streamflow forecasts. It has also been suggested in past studies that ensemble forecasts might possess a greater economic value than deterministic forecasts. However, the vast majority of recent hydro-economic literature is based on the cost-loss ratio framework, which might be appealing for its simplicity and intuitiveness. One important drawback of the cost-loss ratio is that it implicitly assumes a risk-neutral decision maker. By definition, a risk-neutral individual is indifferent to forecasts' sharpness: as long as forecasts agree with observations on average, the risk-neutral individual is satisfied. A risk-averse individual, however, is sensitive to the level of precision (sharpness) of forecasts. This person is willing to pay to increase his or her certainty about future events. In fact, this is how insurance companies operate: the probability of seeing one's house burn down is relatively low, so the expected cost related to such event is also low. However, people are willing to buy insurance to avoid the risk, however small, of loosing everything. Similarly, in a context where people's safety and property is at stake, the typical decision maker is more risk-averse than risk-neutral. Consequently, the cost-loss ratio is not the most appropriate tool to assess the economic value of flood forecasts. This presentation describes a more realistic framework for assessing the economic value of such forecasts for flood mitigation purposes. Borrowing from economics, the Constant Absolute Risk Aversion utility function (CARA) is the central tool of this new framework. Utility functions allow explicitly accounting for the level of risk aversion of the decision maker and fully exploiting the information related to ensemble forecasts' uncertainty. Three concurrent ensemble streamflow forecasting systems are compared in terms of quality (comparison with observed values) and in terms of their economic value. This assessment is performed for lead times of one to five days. The three systems are: (1) simple statistically dressed deterministic forecasts, (2) forecasts based on meteorological ensembles and (3) a variant of the latter that also includes an estimation of state variables uncertainty. The comparison takes place on the Montmorency River, a small flood-prone watershed in south central Quebec, Canada. The results show that forecasts quality as assessed by well-known tools such as the Continuous Ranked Probability Score or the reliability diagram do not necessarily translate directly into economic value, especially if the decision maker is not risk-neutral. In addition, results show that the economic value of forecasts for a risk-averse decision maker is very much influenced by the most extreme members of ensemble forecasts (upper tail of the predictive distributions). This study provides a new basis for further improvement of our comprehension of the complex interactions between forecasts uncertainty, risk-aversion and decision-making.