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Staged decision making based on probabilistic forecasting

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Flood forecasting systems reduce, but cannot eliminate uncertainty about the future. Probabilistic forecasts explicitly show that uncertainty remains. However, as - compared to deterministic forecasts - a dimension is added ('probability' or 'likelihood'), with this added dimension decision making is made slightly more complicated.

A technique of decision support is the cost-loss approach, which defines whether or not to issue a warning or implement mitigation measures (risk-based method). With the cost-loss method a warning will be issued when the ratio of the response costs to the damage reduction is less than or equal to the probability of the possible flood event. This cost-loss method is not widely used, because it motivates based on only economic values and is a technique that is relatively static (no reasoning, yes/no decision). Nevertheless it has high potential to improve risk-based decision making based on probabilistic flood forecasting because there are no other methods known that deal with probabilities in decision making. The main aim of this research was to explore the ways of making decision making based on probabilities with the cost-loss method better applicable in practice.

The exploration began by identifying other situations in which decisions were taken based on uncertain forecasts or predictions. These cases spanned a range of degrees of uncertainty: from known uncertainty to deep uncertainty. Based on the types of uncertainties, concepts of dealing with situations and responses were analysed and possible applicable concepts where chosen. Out of this analysis the concepts of flexibility and robustness appeared to be fitting to the existing method. Instead of taking big decisions with bigger consequences at once, the idea is that actions and decisions are cut-up into smaller pieces and finally the decision to implement is made based on economic costs of decisions and measures and the reduced effect of flooding. The more lead-time there is in flood event management, the more damage can be reduced. And with decisions based on probabilistic forecasts, partial decisions can be made earlier in time (with a lower probability) and can be scaled up or down later in time when there is more certainty; whether the event takes place or not. Partial decisions are often more cheap, or shorten the final mitigation-time at the moment when there is more certainty.

The proposed method is tested on Stonehaven, on the Carron River in Scotland. Decisions to implement demountable defences in the town are currently made based on a very short lead-time due to the absence of certainty. Application showed that staged decision making is possible and gives the decision maker more time to respond to a situation. The decision maker is able to take a lower regret decision with higher uncertainty and less related negative consequences. Although it is not possible to quantify intangible effects, it is part of the analysis to reduce these effects. Above all, the proposed approach has shown to be a possible improvement in economic terms and opens up possibilities of more flexible and robust decision making.