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Estimating the benefits of probabilistic flood warning systems in terms of flood risk

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The objective of flood forecasting and warning is to give floodplain residents and responsible authorities time to respond to a flood threat before it materialises. During the time between the flood warning being issued and the arrival of the flood waters, referred to as the mitigation time, residents can respond by moving themselves and/or their property out of harm's way, thus reducing flood damage.

The benefits of a flood warning system may be expressed in terms of reduction of the expected annual flood damage, or flood risk. This flood risk can be estimated by means of a hydro-economic expected annual damage model that links flood frequency, hydraulic flood characteristics, and flood damage. In the present paper this model is applied to estimate the potential risk reduction of a flood warning service through calculating the effect of flood warning response on the stage-damage curve. This results in a change to the expected annual damage, which can be considered the benefit of the flood warning service, expressed in flood risk. The potential of reducing flood damage is expressed as a function of lead time, as warnings issued with longer lead time increase the opportunity of a more effective response.

The method is illustrated using a flood warning scheme in the White Cart River in Scotland as a case study. Estimates of flood risk are made for four scenarios; (i) no flood warning service, (ii) a flood warning service providing a warning based on a perfect forecast, (iii) a flood warning service based on (uncertain) deterministic flood forecasts, and (iv) a flood warning service where the warning is issued based on estimates of predictive hydrological uncertainty. Estimates of the effect on flood risks include the reduction of damage due to the response to warnings issued including the cost of flood warning response as well as the dis-benefit of false alarms and missed floods. This is achieved by combining the hydro-economic expected annual damage model with the theory of relative economic value.

Results show that whilst the perfect flood warning services results in a benefit even at very short lead times, whilst for the deterministic forecast (with uncertainty) the additional cost of false alarms and missed floods results in a benefit only being attained if warnings can be issued with lead times of three hours or more. The probabilistic forecasting service compares favourably to the services where uncertainty is not explicitly taken into account for decision-making.