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Spatio-temporal representation of the change and uncertainty in compound hydro-hazard extremes across the UK

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There is an increasing need to understand the impact of climate change on compound hydrological extremes. There are limitations in the applicability of current methodologies, particularly with respect to inadequate representation of the uncertainties in the hydrometeorological modelling chain. This study applied a novel impact and uncertainty methodological framework for the assessment of projected changes in hydro-hazards (compound hazards of flood and drought) in a spatially coherent manner. Change is assessed for three metrics, per hazard: frequency, magnitude and duration. Taking advantage of the length of continuous time-series available (1971-2099), we use a QE-ANOVA framework to both identify and quantify the sources of uncertainty in the modelling chain.

The framework is applied across 239 UK catchments using 15 hydrometeorological modelling chains from the EDgE project (End-to-end Demonstrator for improved decision-making in the water sector in Europe) over 128 years (1971-2099); two emissions scenarios were considered (RCP 2.6 and RCP 8.5), covering the lowest and highest representative concentration pathways.

The final outputs are spatial, and consist of both projections of change (three metrics, per hazard) and the magnitude and sources of uncertainty. For the change metrics, we consider a range of probabilities consistent with AR5 IPCC reporting. To facilitate the dissemination of these results, it was necessary to develop a novel method of evaluation and presentation. Following consultation with stakeholders, two types of interactive map are produced: (1) the probabilistic change in hydrological hazards; and (2) the percentage of total variance (uncertainty) of each source of uncertainty. The presentation of the outputs in this form allows decision-relevant data may be easily extracted for a variety of objectives. For example, the change metrics may serve to inform future adaptation strategies in water management.

Critically, clear spatial variability in the sources of hydrometeorological modelling uncertainty are observed; highlighting both the need to apply a spatially consistent methodology with mapped outputs. An interesting outcome of this work was the identification of hydrological models as the largest source of variability, in some instances exceeding 80% of the total variance. In terms of water management planning, such findings allow for more focussed studies with a view to improving the projections which inform the adaptation process.