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The parametrisation of statistical models of change in extremes and its impact on the description of change

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The impact of climate change on environmental extremes such as high flows or rainfall, is routinely investigated by fitting non-stationary extreme value distributions to long-term observational records. These investigations often use regression models in which one or more distribution parameters is allowed to change as a function of time or some other preocess-related covariate. The changes in quantiles implied by different regression model are quantified in this study using different quantile change metrics. We expose the mathematical structure of these change metrics for various commonly used non-stationary models, showing how for most commonly used models the resulting changes in the estimated quantiles are a non-intuitive function of the distribution parameters, leading to results which are difficult to interpret and therefore of little practical use in engineering design. Further, it is posited that the most commonly used non-stationary models do not preserve fundamental scaling properties of environmental extremes.

A new (parsimonious) model is proposed which results in changes in the quantile function that are easy to interpret, and for which the scaling properties are maintained, so that when the location parameter is allowed to change so is the scale. The proposed parameterization is applicable within a range of commonly used distributions (e.g. GEV, GLO, Kappa, ...) and is better suited for investigating changes in environmental extremes as it provides more interpretable description of changes in design events under a non-stationary model. The empirical behaviour of the quantile change metrics under different modelling frameworks when applied to river flow data in the UK is investigated to showcase the usefulness of the proposed model.