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A new simple method to incorporate climate variability in probabilistic climate change scenarios, applied to assessing future river flooding in the UK.

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Understanding the impacts of climate change is crucial for adaptation and mitigation policy decisions. This is particularly true for the water sector and flood risk as they have a direct link with climate, and climate change might result in a potentially changed risk to society.

Increasingly water managers request probabilistic projections of climate change impacts so they can incorporate uncertainty in their strategic planning. Climate change impact studies often rely on scenarios from global climate models (GCMs) or regional climate models (RCMs), but until recently, very few probabilistic climate change scenarios were available, thus making it difficult to generate probabilistic impact assessments. In addition, climate variability, which is known to play a significant role in the generation of floods and in the management of flood risk, is not always explicitly accounted for in climate change impact studies. In particular natural variability is often considered as stationary in future impact assessments.

A new simple methodology is presented here that develops probabilistic climate change scenarios incorporating baseline and future variability of GCM outputs. The method is based on the change factor method, where the changing climate is defined as monthly differences between a future climate and a baseline climate. This change factor method has been widely used as a simple method to remove bias in GCMs, particular important for precipitation. Usually, for a GCM, both future and baseline climate are taken as the average of a 30-year GCM output time series, typically 2071-2100 for the 2080s future climate, and 1961-1990 as baseline climate. Instead, for each future and baseline, we randomly sample (with replacement) any monthly average from the relevant 30-year period to build multiple synthetic 30-year time series. Each multiple time series can then be used to calculate change factors, exactly as it is done for a single GCM realisation. By repeating the process, probabilistic estimates of the monthly change factors can be made, which account for the climate variability for both the baseline and the future.

Once probabilistic monthly change factors are created, they can be used to construct an ensemble of synthetic daily time series representative of the future using the well known- perturbation method. In our case, we applied the method to precipitation, and used the ensemble precipitation time series as input to a rainfall runoff model, the probability distributed moisture hydrological model (PDM). These multiple hydrological model runs create an ensemble of ‘future’ daily river flow series, resulting in a probability distribution of future river flood indices to be constructed for a catchment. The results show that using a simple resampling technique and the change factor method, it is possible to identify a range of flood indices changes all representative of possible future scenarios. The flood indices probability distribution allows for different percentiles of future change to be considered.

This new simple method provides a simple but powerful tool in developing probabilistic climate change scenarios when no multiple ensemble GCM output or probabilistic scenarios are available. The methodology has the potential to incorporate the probability distributions from multiple different GCMs to form a single distribution of flood indices which incorporates multiple GCMs and natural variability.