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Evaluating flood sensitivity to changes in high and low frequency precipitation using a discrete wavelet transform

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Climate change has a significant role in increasing extreme precipitation, including the intensity, frequency, and magnitude of events due to increases in atmospheric moisture and climate variability. This means that future increases in floods due to climate change must be considered in the construction of flood defenses, as well as the planning of new infrastructure and hydraulic structures. Previous approaches for stress testing the design of flood defenses have relied on the scenario neutral approach and the use of harmonic functions to represent changes in the seasonality and mean of precipitation. Such approaches may inadequately account for changes in extreme precipitation, especially in runoff dominated catchments. Here, we adapt the scenario neutral approach by integrating a discrete wavelet transform (DWT) to develop the flood response surface. Such an approach allows evaluation of flood sensitivity to high and low frequency components of precipitation. Using 39 catchments in Ireland, we examine the sensitivity of flooding (QT20) to changes in low and high frequency precipitation and air temperature. A sensitivity domain of 525 extreme precipitation scenarios is applied by combining 21 low frequency and 25 high frequency sets of precipitation and air temperature changes, with short duration frequency incorporated in each harmonic wavelet function. Clustering and discriminant analysis are used to create a typology of catchment sensitivity based on generated response surfaces, the mean of annual maximum precipitation, and the mean of annual maximum flows. Results allow characterization of catchment sensitivity in gauged and ungauged locations and the integration of a wider spectrum of precipitation changes when assessing sensitivity allowances for climate change.