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Assessing the characteristics and likelihood of compound flooding events around the UK

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Floods are amongst the most dangerous and costly of natural disasters. Coastal flooding is rated as the second highest risk for causing civil emergency in the UK, after pandemic influenza. The 1953 coastal flooding event was one of the greatest environmental disasters the country has ever faced, with 326 lives lost and an estimated cost of £0-50 million (approximately £.2 billion today), in addition more than 2,000 lives were lost in the Netherlands and Belgium. More recently the winter season of 2013-14 lead to the worst coastal flooding around the UK in 60 years.

In coastal areas, extreme water levels can be generated from a variety of sources including: (1) storm-tides (storm surges plus high astronomical tides); and (2) waves; but also through terrestrial precipitation, either directly as (3) surface runoff (pluvial); or through increased (4) river discharge (fluvial). When two or more these sources combine, compound flooding can occur and the consequences of the event can potentially be significantly multiplied compared to a single source occurring on its own. Frequently these sources are thought of as independent of one another. However, in reality there can be complex dependence between the sources. Failure to recognize these interplays can result in an underestimation of flooding return periods in coastal areas, particularly as the contributing factors might not necessarily be extreme values on their own. For example, a moderate river flow and a moderate storm surge occurring concurrently may be enough to cause an extreme water level, when considered separately their own the water levels would not be extreme.

In this study, the joint occurrence of extreme storm surge and river flow events is examined at both a national UK and regional scale. We find a distinct regional spatial pattern, with East coast sites having far less incidences of joint occurrence when compared to West coast sites. The meteorological conditions that lead to joint occurrences are then compared to the individual flooding components to identify areas where multiple flooding mechanisms are associated with similar weather patterns and storm tracks. The spatial variability seen on a more localised/regional scale cannot be explained by the meteorological conditions alone. Instead additional factors such as relief of coastal area, catchment size and slope, geological setting and river flashiness are correlated to the number of joint occurrences. We also investigated the lag time between storm surge and high river flow events.