



Spatial dependence of flooding

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Much research has focused on estimating the characteristics of flooding at a single site. However, it is the spatial characteristics of flooding that are important for certain risk assessments; for the co-ordination of flood mitigation activities; for the estimation of the required capacity of the emergency services; and for the re-insurance industry.

The statistical techniques available for estimating spatial dependence and collective risk of flooding are not as well-developed as those available for single sites. All previous methods have either involved using crude multivariate measures of dependence, or more sophisticated bivariate methods. Heffernan and Tawn (2004, *J. Roy. Statist. Soc., B*) have developed a method for multivariate extreme values that can be applied to the large number of sites that typify spatial applications. However this method assumes that the only form of dependence present in the multivariate data is between different variables.

In estimating the probability of multiple flood events it is necessary to take account of the temporal dependence of river flows. The temporally dependent nature of river flows can result in flood events caused by the same weather system to occur on different rivers at different times. We present an extension to the Heffernan and Tawn method that enables us to take this temporal dependence into account. This extension makes it possible to estimate the conditional probability that one river will have a flood event given that another river has had a flood event; the probability that more than one river will have a flood event given that another river has had a flood event; and the expected number of rivers that will have flood events given that another river has had a flood events. As we use a statistical method, the uncertainty involved in estimating these probabilities is accounted for and described. The estimated probability of multiple floods can then be used to estimate the likely extent of spatial dependence of flooding within a region. We present and compare two small case studies of this method using daily mean flow data from two different regions of Britain.