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Development of a censored modelling approach for stochastic estimation of rainfall extremes at fine temporal scales

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With the COP21 drawing to a close in December 2015, storms Desmond, Eva and Frank which swept across the UK and Ireland causing widespread flooding and devastation have acted as a timely reminder of the need for reliable estimation of rainfall extremes in a changing climate. The frequency and intensity of rainfall extremes are predicted to increase in the UK under anthropogenic climate change, and it is notable that the UK's 24 hour rainfall record of 316mm set in Seathwaite, Cumbria in 2009 was broken on the 5 December 2015 with 341mm by storm Desmond at Honister Pass also in Cumbria. Immediate analysis of the latter by the Centre for Ecology and Hydrology (UK) on the 8 December 2015 estimated that this is approximately equivalent to a 1300 year return period event (Centre for Ecology & Hydrology, 2015).

Rainfall extremes are typically estimated using extreme value analysis and intensity duration frequency curves. This study investigates the potential for using stochastic rainfall simulation with mechanistic rectangular pulse models for estimation of extreme rainfall. These models have been used since the late 1980s to generate synthetic rainfall time-series at point locations for scenario analysis in hydrological studies and climate impact assessment at the catchment scale. Routinely they are calibrated to the full historical hyetograph and used for continuous simulation. However, their extremal performance is variable with a tendency to underestimate short duration (hourly and sub-hourly) rainfall extremes which are often associated with heavy convective rainfall in temporal climates such as the UK.

Focussing on hourly and sub-hourly rainfall, a censored modelling approach is proposed in which rainfall below a low threshold is set to zero prior to model calibration. It is hypothesised that synthetic rainfall time-series are poor at estimating extremes because the majority of the training data are not representative of the climatic conditions which give rise to heavy rainfall. Tipping bucket raingauge data aggregated to a minimum temporal resolution of 15 minutes have been identified throughout the UK, and the longest records (minimum 30 years duration) have been selected for analysis. Rainfall extremes are estimated for a range of annual exceedance probabilities to a minimum 1e-4 (10,000 year return period) by simulating up to 100,000 years of rainfall and sampling annual maxima and peaks over high threshold. A range of low thresholds are tested for the censored modelling, as well as seasonally varying thresholds, and the results compared with comparable estimates from extreme value analysis.

References:

Centre for Ecology & Hydrology. (2015) Anonymous's blog. *North West floods – Hydrological update.* Weblog [Posted 08/12/2015 - 14:18]. Available from: http://www.ceh.ac.uk/news-and-media/blogs/north-west-floods-hydrological-update [Accessed 04/01/2016].