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Statistical modelling of rainfall for drought risk assessment in southeast England

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Drought risk associated with climate variability and change is a major planning concern in most parts of the world. In water-stressed regions such as London and the southeast of England, if extreme historical droughts are repeated under current demands for water, potentially disastrous water shortages would occur. In addition, both drought frequency and severity are expected to increase due to climate change. A possible way of investigating drought risk is to use statistical downscaling methods to simulate extremes and to predict rainfall under a changing climate. However, these methods are empirical and their reliability for extrapolation to new extremes has not been well tested. Generally, the aim of this research is to examine the reliability of statistical downscaling methods for drought risk assessment in southeast England.

The research presented here is using the regression downscaling method to simulate monthly rainfall in southeast England by using large-scale climate variables and indices, such as mean sea level pressure, temperature, North Atlantic Oscillation index, East Atlantic pattern and blocking index. The modelling approach starts with simple univariate regression for a single site to help understand the basic relationships between rainfall and each climate variable. The more sophisticated multiple regression method is then introduced to identify the correlations between rainfall and two or more climate variables. Each of the 12 months is modeled independently so that there are no seasonal effects in any one model. As opposed to general practice, which is fitting rainfall models to a period of a few decades (30 years is common), this study uses records going back to 1855.

As the original general aim is prediction of drought under extremes and climate change conditions, the models are subjected to a range of validation tests which go beyond the usual tests applied to statistical rainfall models. This includes conditions in which the climate appeared to deviate from the norm. Split sample tests are used, including validation periods of extreme drought conditions, such as 1976, 1920 and the sustained drought period of 1890-1910.

Conclusions are made about the uncertainty associated with using only a few decades for fitting stochastic downscaling models, the ability of this model type to generate previously unobserved extremes, and recommendations for model improvement.