Statistical considerations on reducing measurement network size for estimating pollution in rainfall in the UK

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Abstract

Measurements of the pollutant ion concentrations in rainfall have been made across the UK for the last 28 years. The network originally had more sites (59 sites in 1987) but for the last decade has operated with 38 sites. This study was part of work to quantify the effect of likely budget cuts which would potentially reduce numbers of sites in the UK monitoring networks. The network measurements, taken weekly or fortnightly, are used to construct an annual concentration map for the UK from which is calculated the wet deposition, i.e. the amount of atmospheric pollutant that enters the ecosystem through rain. The study looked at sulphate, nitrate and ammonium in rainfall, as they are drivers of change through acidification and eutrophication, and how the changes in site numbers affected the concentration maps and their associated uncertainty. Concentration maps were routinely produced by conventional kriging. A simulation study, examining the effect of network size, removed sites at random with 100 simulations each of network reductions by 1 up to 25 sites. The results for the 3 ions were different reflecting differences in underlying physical processes. The automated process for the simulations gave an increasing number of failures to produce a concentration map with reduced site numbers, mainly due to difficulty in fitting variograms. Uncertainty increased as expected but there was also a shift, using the median predicted concentration for each set of site reductions, to increase concentrations in the west and decreases in the east. The second phase removed 11 sites by informed choice rather than random selection and also resulted in a fall in mapped mean concentration for all ions by a small amount with a 'tilting' of the map (non-homogeneous change to the mean). Bayesian kriging was implemented to provide a better variogram fit and reasonable estimates of uncertainty, with an increase of around 10% in the coefficient of variation with the reduced numbers of sites. Further work is required to explore the effects of these changes on production of national map estimates of concentrations and deposition.

Keywords: geostatistics; uncertainty; bias.