

Statistical and GIS analysis of river water quality data across the Humber catchment, UK

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The spatial distribution of river water quality in the Humber catchment (UK) was analyzed using GIS and the extensive Environmental Agency and LOIS (Land-Ocean Interaction Study) datasets. The water quality data consist of major ions (calcium, chloride, magnesium, sulphate), nutrients (ammonia, nitrogen), trace elements (aluminum, boron, cadmium, chromium, copper, iron, lead, nickel, zinc) and other major determinands such as suspended solids (SS) and chemical oxygen demand (COD) for 1432 monitoring sites for a 10 year period.

This study focused on the shape of the statistical distribution of water quality concentration values. The shape parameter *alpha* of the Gamma distribution was calculated for each water quality chemical determinand at each monitoring site. The *alpha* values were mapped using GIS. If *alpha* is smaller than 1, the distribution is strongly skewed to the right, and the distribution approaches a normal distribution as *alpha* becomes larger (e.g. *alpha* is bigger than 100). The resultant maps for many of the determinands (such as iron and suspended solids) indicate that *alpha* values are small, with low variability, because most of these determinands have low concentrations during base flow and occasionally high concentrations during high flow events. However, the maps for some major ions including calcium, chloride, nitrogen and sulphate show large and highly variable *alpha* values.

For example, the map of statistical distributions of chloride concentrations shows that large *alpha* values occur especially along the Rivers Trent and Derwent, indicating near-normal distributions, with highest concentrations under baseflow and progressive dilution under higher river flows. These distributions may be linked to sewage and industrial effluents. For nitrogen, large *alpha* values are found in the relatively urbanized southern part of the Humber catchment and along the River Hull. In the southern part of the catchment, sewage effluent from urban areas may result in relatively high baseflow nitrogen concentrations. However, in the more rural Hull catchment, high nitrogen concentrations under low flows may be linked to the high nitrate concentrations in the Chalk ground water, resulting in near-normal nitrogen concentration distributions. Statistical distributions of water quality determinand concentrations for complex pollutant sources in the upper river reaches and interrelation between determinands are also discussed.