



Statistical software to identify spatiotemporal patterns and coherence over river networks



Data and Models

UK river water quality monitoring programmes currently provide rich spatiotemporal datasets to explore water quality changes. The Environmental Statistics group at The University of Glasgow have developed statistical methods to describe, and better understand possible causes of, spatiotemporal trends, and seasonal patterns in river water quality. Such approaches explore non-linear patterns, reduce dimensionality in order to identify coherent spatiotemporal patterns, and account appropriately for the river network structure. In this collaborative work with the Scottish Environment Protection Agency and the Environment Agency, the first tool developed enables identification of common spatiotemporal patterns through adjusting for spatial and/or temporal correlation to reveal 'hidden' features in the data. The second tool evaluates reducing the size of the monitoring network through investigating how predictions/uncertainty of predictions change with network size.

Main messages

The statistical tools and associated documentation developed enable users to identify dominant spatial and temporal patterns in nutrient data collected on river networks. Specifically, the results will help users to identify areas of the networks where water quality has remained stable over time and/or to identify groups of monitoring locations that exhibit the same temporal pattern. Such information can be used to inform modifications and re-design of the monitoring network with the aim of providing efficiency savings in the monitoring budget.

Future work includes developing the tools to help agencies quantitatively evaluate the ability of a smaller monitoring network to provide relevant indicators of water status and change over time. This will provide critical information, to evaluate and refine policies for water protection.

Synopsis

Novel statistical software tools, aimed at the Environmental Science (ES) communities, were developed to enable identification of spatiotemporal and coherent patterns over river networks. Implementation of the software and benefits of the methods were demonstrated to the ES community through dedicated workshops.

Background. Why

UK environment agencies invest a wealth of resource in monitoring river networks in order to protect ecological quality and for reporting to Europe. Cutting-edge statistical tools that account for the river network structure appropriately are required to provide a comprehensive picture of water quality changes over space and time.

Scientific questions/ project description

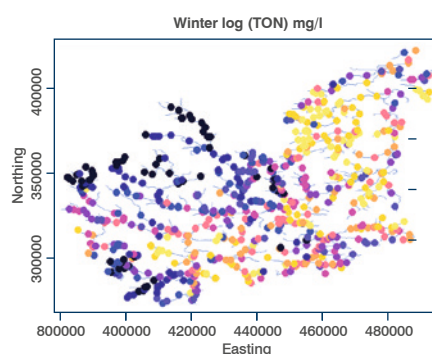
Advanced statistical models, which appropriately account for the flow direction and connectedness of monitoring locations, can provide predictions for water quality across the river network and identification of clusters of locations displaying common spatiotemporal patterns. In this work, statistical software tools were developed for such models, in order to provide the ES community with new insights and impact for water quality assessment, and to inform the design of future water quality monitoring programmes.

Outputs and Interpretation

Statistical software tools were developed in the R programming language to produce an R package, 'stpca', which contains demonstration river network data along with full tutorial documentation and help files. The R package is available at: <http://dx.doi.org/10.5525/gla.researchdata.277> (open access).

Additionally, the methods were integrated into the software TIBCO Spotfire, through the TIBCO Enterprise Runtime for R engine, to allow users within the Scottish Environment Protection Agency (SEPA) to explore the utility of the methods within their standard modelling framework. This was possible through an academic secondment to SEPA and a user help guide accompanies the methods.

A full description of the statistical methods and associated application are provided in the publication: *Flow-directed PCA for monitoring networks*, *Environmetrics* (2017), 28(2), and approaches were illustrated to colleagues within the Environment Agency and SEPA at dedicated project workshops.



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For further information visit:

glasgow.ac.uk/research/az/SECURE

