Geophysical Research Abstracts
Vol. 19, EGU2017-17342, 2017
EGU General Assembly 2017

Long Term Large Scale river nutrient changes across the UK

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During recent decades and centuries, pools and fluxes of Carbon, Nitrogen and Phosphorus (C, N and P) in UK rivers and ecosystems have been transformed by the spread and fertiliser-based intensification of agriculture (necessary to sustain human populations), by atmospheric pollution, by human waste (rising in line with population growth), and now by climate change.

The principal objective of the UK's NERC-funded Macronutrients LTLS research project has been to account for observable terrestrial and aquatic pools, concentrations and fluxes of C, N and P on the basis of past inputs, biotic and abiotic interactions, and transport processes. More specifically, over the last 200 years, what have been the temporal responses of plant and soil nutrient pools in different UK catchments to nutrient enrichment, and what have been the consequent effects on nutrient transfers from land to the atmosphere, freshwaters and estuaries?

The work described here addresses the second question by providing an integrated quantitative description of the interlinked land and water pools and annual fluxes of C, N and P for UK catchments over time. A national-scale modelling environment has been developed, combining simple physically-based gridded models that can be parameterised using recent observations before application to long timescales. The LTLS Integrated Model (LTLS-IM) uses readily-available driving data (climate, land-use, nutrient inputs, topography), and model estimates of both terrestrial and freshwater nutrient loads have been compared with measurements from sites across the UK.

Here, the focus is on the freshwater nutrient component of the LTLS-IM, but the terrestrial nutrient inputs required for this are provided by models of nutrient processes in semi-natural and agricultural systems, and from simple models of nutrients arising from human waste. In the freshwater model, lateral routing of dissolved and particulate nutrients and within-river processing such as denitrification, decomposition and chlorophyll growth are undertaken, and the effects of groundwater storage and processes in lakes connected to the river network can be included.

Following assessment against observations of terrestrial and nutrient fluxes in rivers across the UK, the LTLS-IM has been run nationally for 200 years (1800 to 2010), and the work presented here provides, for the first time, national, regional or catchment estimates of the origins and trends in riverine nutrients in the period following the industrial revolution. Ongoing work is now exploring the effects of future climate, waste water treatment and land-management scenarios on water quality, and the effects of nutrient enrichment on the development of eutrophication in rivers.