Geophysical Research Abstracts,
Vol. 11, EGU2009-5657, 2009
EGU General Assembly 2009

Exploring biological, chemical and geomorphological patterns in fluvial ecosystems with Structural Equation Modelling

S. Bizzi, B. Surridge, and D.N: Lerner

The University of Sheffield, Catchment Science Centre, Civil & Structural Engineering, Sheffield, United Kingdom (s.bizzi@sheffield.ac.uk)

River ecosystems represent complex networks of interacting biological, chemical and geomorphological processes. These processes generate spatial and temporal patterns in biological, chemical and geomorphological variables, and a growing number of these variables are now being used to characterise the status of rivers. However, integrated analyses of these biological-chemical-geomorphological networks have rarely been undertaken, and as a result our knowledge of the underlying processes and how they generate the resulting patterns remains weak. The apparent complexity of the networks involved, and the lack of coherent datasets, represent two key challenges to such analyses.

In this paper we describe the application of a novel technique, Structural Equation Modelling (SEM), to the investigation of biological, chemical and geomorphological data collected from rivers across England and Wales. The SEM approach is a multivariate statistical technique enabling simultaneous examination of direct and indirect relationships across a network of variables. Further, SEM allows a-priori conceptual or theoretical models to be tested against available data. This is a significant departure from the solely exploratory analyses which characterise other multivariate techniques.

We took biological, chemical and river habitat survey data collected by the Environment Agency for 400 sites in rivers spread across England and Wales, and created a single, coherent dataset suitable for SEM analyses. Biological data cover benthic macroinvertebrates, chemical data relate to a range of standard parameters (e.g. BOD, dissolved oxygen and phosphate concentration), and geomorphological data cover factors such as river typology, substrate material and degree of physical modification. We developed a number of a-priori conceptual models, reflecting current research questions or existing knowledge, and tested the ability of these conceptual models to explain the variance and covariance within the dataset.

The conceptual models we developed were able to explain correctly the variance and covariance shown by the datasets, proving to be a relevant representation of the processes involved. The models explained 65% of the variance in indices describing benthic macroinvertebrate communities. Dissolved oxygen was of primary importance, but geomorphological factors, including river habitat type and degree of habitat degradation, also had significant explanatory power. The addition of spatial variables, such as latitude or longitude, did not provide additional explanatory power. This suggests that the variables already included in the models effectively represented the eco-regions across which our data were distributed. The models produced new insights into the relative importance of chemical and geomorphological factors for river macroinvertebrate communities. The SEM technique proved a powerful tool for exploring complex biological-chemical-geomorphological networks, for example able to deal with the co-correlations that are common in rivers due to multiple feedback mechanisms.