

Integrated Analysis of Land Use and Water Quality: Economic, Hydrological and Policy Analysis

Principal Investigator – Dr. Ian J. Bateman, University of East Anglia, United Kingdom, 2013-2017

Challenge

Land use and changes in that use play a major role in determining the quality of rivers and lakes. Indeed the effectiveness of water quality management will always be compromised without a clear understanding of land use influences. However, land use is determined by a complex array of drivers including policy (e.g. the EU's Common Agricultural Policy), market forces (e.g. changes in commodity prices, input costs, etc.), cross-sectional environmental variation (e.g. soil type, rainfall, etc.) and temporal environmental variation (e.g. the effects of climate change such as temperature variance, etc.). While controlling for these drivers the project focuses upon the role of policy making. However, land use policy suffers from systematic inadequacies in that it often focuses upon a single issue (e.g. increasing agricultural production) without considering the indirect effects of such changes (e.g. water pollution). Furthermore, many of these indirect effects occur outside the remit of market values, further impeding their incorporation within decision-making systems.

The project integrates both land use and water quality models and incorporates these within economic decision making systems such as cost benefit analysis. The intention is to refine a superior approach to cost-benefit analysis, which integrates land and water systems. This is achieved through co-development of integrated econometric and hydrological models.

Project

This project builds upon and extends prior work to generate integrated land-water models capable of predicting the impact of new scenarios defined by changes in the above drivers; e.g. policy change. The outputs of this analysis are quantified assessments for the following scenarios and variables:

- i. Land use (e.g. crop type, stocking species and intensity, etc.)
- ii. Food production and its value (e.g. £/ha)
- iii. Farm incomes (e.g. £ per farm household)
- iv. Water chemical quality (e.g. nutrient status, mg/litre)
- v. Water ecological status (e.g. WFD measures)

The research includes the following steps:

1. Understanding and modelling the determinants of land use and linking these to hydrological models of the impact of land use change upon water quality.
2. Assessing in quantitative terms the variations in ecosystem services arising from land use change. In particular, to assess variations in provisioning (food production) and regulating (water quality) services.
3. Relating changes in agricultural production to market values.

4. Relating water quality change to the value of ecosystem service related goods. Specifically focusing upon recreation values.
5. Examining the trade-offs between food production values and recreation values.

Outputs

This research project has held several key end-user oriented meetings and workshops:

- Bateman, I. (2014). Development and use of modeling techniques for improving decision making, particularly as it relates to the food, water, environment and energy nexus. Full day workshop at the Department for Environment, Fisheries and Rural Affairs (Defra).
- Report to Government. Monthly meetings held at Defra to discuss project related research needs and contributions.

Additionally, this research has been disseminated through several presentations:

- Bateman, I.J., Day, B.H., Agarwala, M., Bacon, P., Bad'ura, T., Binner, A., De-Gol, A.J., Ditchburn, B., Dugdale, S., Emmett, B., Ferrini, S., Fezzi, C., Harwood, A., Hillier, J., Hiscock, K., Hulme, M., Jackson, B., Lovett, A., Mackie, E., Matthews, R., Sen, A., Siriwardena, G., Smith, P., Snowdon, P., Sünnenberg, G., Vetter, S. and Vinjili, S. (2014) Bringing the environment into economic decision making: Optimising land use across the UK, presented at The 5th World Congress of Environmental and Resource Economists (WCERE), Istanbul, Turkey, 28th June to 2nd July 2014.
- Bateman, I. presented work at ENVECON - the premier environmental economic research conference in the UK.

This research has resulted in scholarly journal publications and end-user reports:

- Bateman et al. (In Preparation). Spatially explicit integrated modeling and economic valuation of climate change induced land use change and its indirect effects

Outcomes

Outcomes include:

- The research undertaken in this project is highly interdisciplinary, combining hydrology, ecology and economics. Developing integrated modelling techniques across these fields of expertise builds important relationships between researchers from multiple institutions. These networks are expected to form the basis of future research projects as well.
- Through regular engagement with government departments (Defra, Environment Agency, etc) the project builds and reinforces an ongoing process of stakeholder consultation and engagement. A chief benefit is that end-users communicate their research needs as projects are developed, resulting in outputs that are more likely to be utilized and can serve to improve decision making.
- By integrating analyses of climate change, land use change, water quality and ecological status, and by linking these to changes in the economic value of

ecosystem services, the project facilitates consistent comparisons of trade-offs. This is a useful tool for policy evaluation and it is anticipated that this project will result in a change in practice.

Research Team and Partners:

Research Team:

Dr. Ian J. Bateman, University of Exeter, United Kingdom

Partners:

Centre for Social and Economic Research on the Global Environment (CSERGE)
University of East Anglia
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Highly Qualified Personnel (HQP):

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