RES-224-25-0002, Prof N Hanley, University of Glasgow
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Climate Change, Non-Point Pollution and Land Use: Modelling Interactions

This project was an exploration of the possibilities and problems of developing a modelling framework to consider the interlinked environmental phenomena of climate change, low river flows, and non-point pollution from agriculture. The team undertook the research in a manner which would enable practical management advice to be generated, particularly in the context of integrated catchment management and the search for cost-effective management solutions under the Water Framework Directive. This included a consideration of the effects of using a combined package of economic instruments and managerial measures on non-point pollution levels.

The research work involved the use of a number of interlinked models. Climate change scenarios from UKCIP were run through a "weather generator", known as LARS-WG, to produce location specific dynamic data on a number of climate variables. These were then input into a crop growth model known as CROPSYST, which was used to produce predictions of changes in both potential crop yields and pollution run-off from different crops under different fertilizer regimes on different soil types in two case study catchments in SE Scotland. A hydrological model IHACRES was used to simulate how many days a year farmers would need to be restricted in terms of irrigation water abstraction to conform with minimum river flow levels. These restrictions were also run through CROPSYST. Finally, a bioeconomic model was constructed based on input data from CROPSYST to simulate farmer's optimal land use allocation decisions, under a variety of policy scenarios. This model assumes farmers choose what to grow and how to manage these crops on the basis of maximising profits. The policy scenarios to be considered are a pure regulatory regime, a pure economic incentive regime, and a mixed instrument package which combines elements of both.

This quantitative modelling approach to study the best way of controlling diffuse pollution from farming takes into account both the effects of climate change and the need to maintain minimum river flows for ecological quality reasons. The research team found that, for their two case study catchments in Scotland, climate change to 2080 was predicted to result in increases in both minimum and maximum temperatures, and an increasing variability in rainfall. Crop yields for certain key agricultural crops were predicted to fall over the next 80 years, by a greater amount for winter sown crops than for spring sown crops. The research also found that, for most scenarios, the amount of pollution (nitrate) leaching from farmland would rise over the next 80 years due to climate change, although how farmers adapt to a changing climate in terms of what crops they choose to grow and how they manage them will also have a big effect.

Work is on-going to produce results on the cost-effectiveness of different management strategies for controlling non-point pollution and minimum river flows, and on the treatment of uncertainty over dose-response relationships.

This project has shown both the potential and the problems in applying interdisciplinary quantitative modelling to the issues of climate change and catchment management. At a more case-specific level, it also illustrates the gains from using economic instruments, and packages of measures, to achieve water quality improvements in catchments where diffuse source pollution is a major reason for failure to meet Water Framework Directive targets.