Climate Change, Nonpoint Pollution and Land Use: Modelling Interactions

Participants:

- Economics Department, Stirling Uni.
- Economics, Durham Uni.
- Statistics, Glasgow Uni.
- Geography, Dundee Uni.
- Rothmanstead Research Institute

- This is a one-year scoping study (began October 2004).

Main objectives

1. To investigate the capacity to jointly model the control of nonpoint pollution and water flows in catchments *in the context of climate change*

2. To use biophysical economic modelling to simulate the effects of economic incentives and other regulatory options to control diffuse pollution and maintain minimum water flows in order to achieve "Good Ecological Status" under the WFD.

3. To investigate the spatial, temporal and contextual compatibility between economic, environmental and agronomic modelling

4. To draw conclusions about the biggest gaps in current modelling capacity in terms of linking climate change, non-point pollution and water flows for policy analysis.

5. To investigate the best means of incorporating *uncertainty* into such a modelling framework

Issues

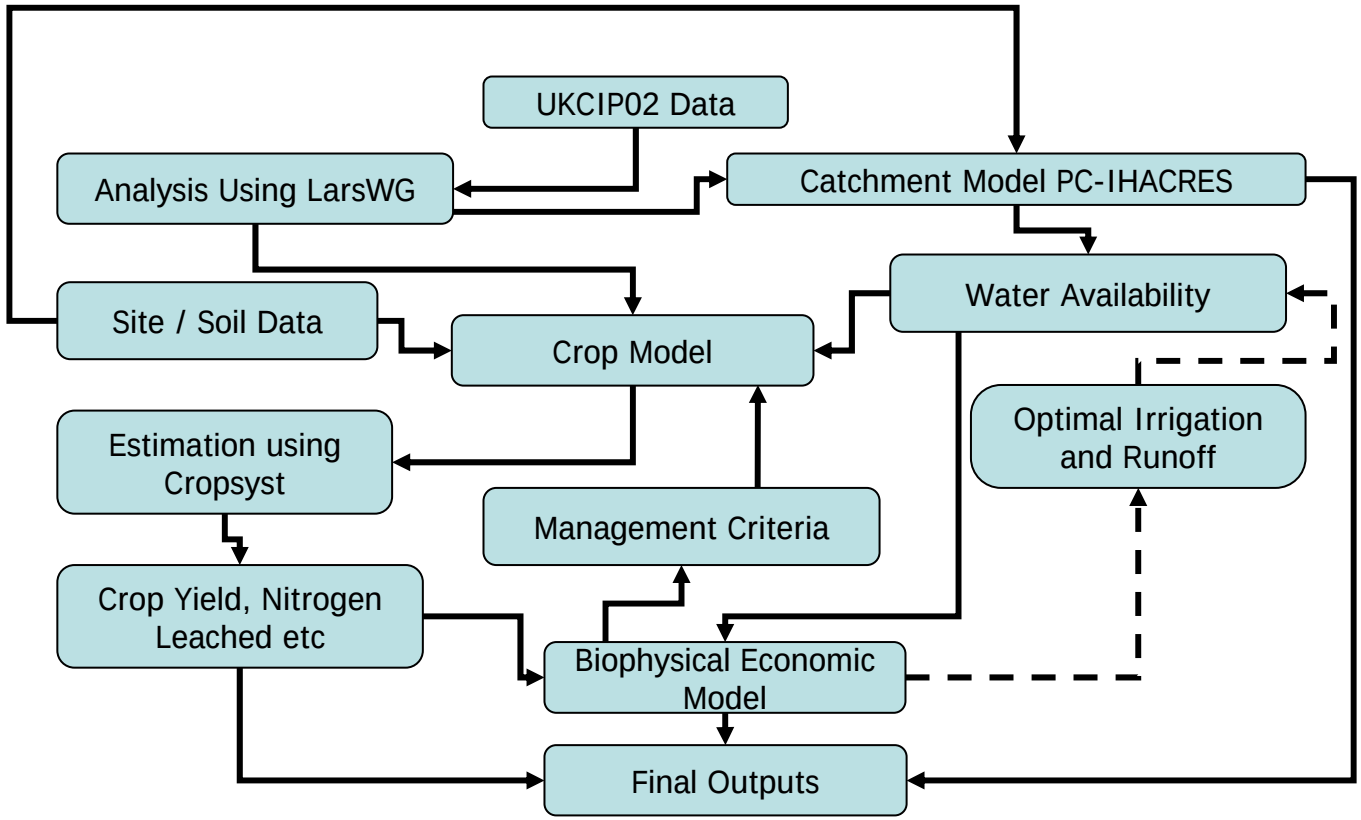
1. Water quality ➔ Nonpoint pollution (nitrates, soil erosion)
2. Water quantity ➔ Low river flow rates (abstraction)

- Both of these impact on the achievement of “Good Ecological Status” under the WFD
- Both will be affected by climate change!
- WFD advocates cost-effective management ➔ use of economic incentives
- We want to investigate this given the current predictions for climate change in Scotland up to 2080
- *Aim is NOT to produce definitive empirical results, but rather to identify/investigate problems in implementing the methodology*

Methodology

- Focus on 2 case study catchments in Eastern Scotland
- Climate change scenarios: combine UKCIP02 with the LARS-WG weather generator to produce high resolution (?) data on climate over time
- Crop response: use CROPSYST – crop yield estimator, nitrogen leaching, water flow, crop management interactions, erosion. Possibly investigate EPIC.
- Economic land use model: economically optimal management choices, crop land allocation, nitrogen inputs, optimal water quality management policies
- Combined with hydrological modelling using IH_ACRES, use CROPSYST - Economic Land Use Model interactions to predict changes in non-point pollution from (i) business as usual (ii) use of economic instruments/management standards

Modelling Linkages



Key Model Interactions

1. UKCIP 02 data to crop model
   - temperature, precipitation, solar radiation ✓
   - peak rainfall events ✗
2. Crop model to economic model
   - nitrogen to yield relationship ✓
   - nitrogen applied to nitrogen leached relationship ✓
   - Soil erosion functions ✓
3. Hydrological model to crop model
   - irrigation availability ✗
4. Overall integration for scenario analysis
   - Stochastic Biophysical Economic Modelling: developing theoretical framework with probabilistic constraints

Initial Results

The modelling should provide the following relationships for numerous crop/soil combinations and 2 river flow regimes under 4 climate change scenarios (Present, 2020, 2050, 2080)

- Nitrogen yield functions
- Nitrogen leaching functions.
- Soil erosion functions

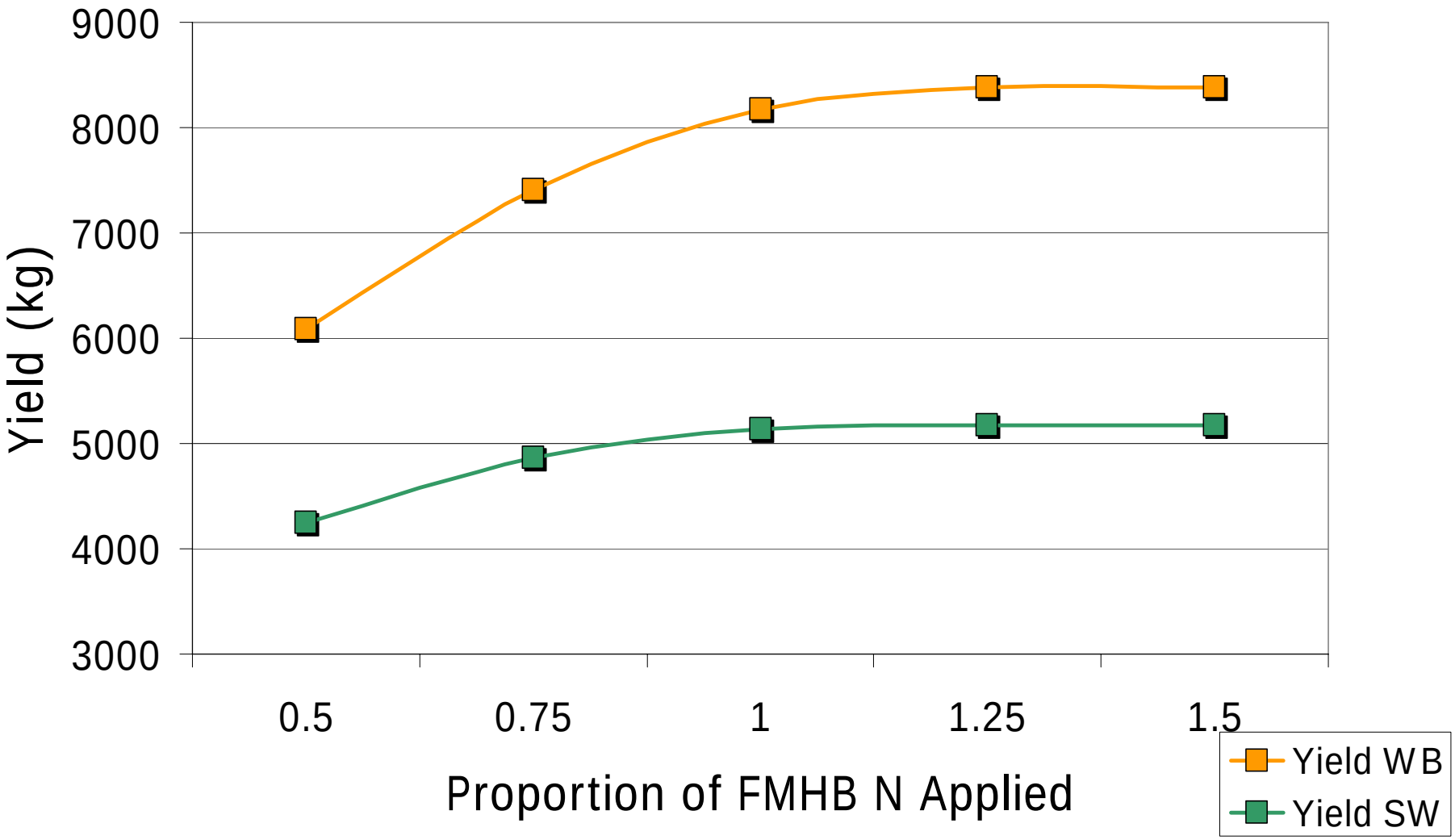
However,

- Solutions tend to centre around increased data handling effort – man power.
- Involve generating and analysing substantial amount of data
- Biggest problem faced so far has been linking the hydrological model and the crop model. This requires a daily inputting for the entire study period. No solution found as yet !

Model Compatability

- Temporal Scale: Investigated various and found the '*daily resolution' to be the most feasible and relatively accurate.*
- Spatial Scale: The crop model scales up from the plant level to per hectare values, biophysical economic model allows optimal behaviour based on these values to be calculated for the catchment. However, simplifications are required, e.g. 3 representative soils used per site.

Nitrogen Yield Function



Winter Barley: Nitrogen Leaching Function