LM0308: Catchment Management for Water Quality

Case Study 6: Effects of input data quality and quantity on evaluation of land management policies and agri-environment interventions at catchment to national scales.

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Purpose: To demonstrate the sensitivity / uncertainty in outputs of models at various scales resulting from differences or uncertainties in input driving data.

This case study is a more technical aspect of the development of the Integrated Modelling Platform and as such the entries in the table below are more general than in other case studies. In particular, this case study will draw on the results of case studies 1-5, using those as base cases against which changes in model output arising from different or uncertain input datasets can be compared. It will not be possible to examine uncertainty arising from all inputs for all five case studies. Instead, as case studies 1-5 are completed, a selection of pollutants, measures, and scenarios from each will be used in this exemplar case study to examine how uncertainty can be assessed and expressed within the context of the Integrated Modelling Platform. In turn, the uncertainty results presented in this case study will inform and contribute to the other case studies.

Policy driver(s)	This case study informs a number of policy drivers: Water Framework Directive (good chemical and/or ecological status), Farm Payment Schemes, Climate Change Abatement Agreements, Conservation Targets, Flood Risk Mitigation
Enduser(s)	This case study is of interest to a number of endusers: Government Agencies, Catchment Managers, Conservation Agencies, Water Industry, NGO's
Pollutant(s)	Nitrate, Phosphorous, Sediment, Flood Potential, Carbon loss and Sequestration, Biodiversity Loss
Measures	This case study will draw on model applications in case studies 1-5 with their associated measures (land use and climate change drivers).
Scenario if appropriate	Change resolution of a number of spatial input datasets and evaluate effects on model outputs. Change quantity and quality both spatial and time series input datasets and evaluate effects on model outputs.

Outcome / output	Relative or absolute change in model outputs (area in given response class; average stream pollutant concentrations; etc) as a function of changing the input database used to drive the model. In the case of multi-pollutant and ecosystem service ensemble modelling, the effects on extent of identified trade-offs or co-benefits will be evaluated as a function of scale of input data.
Scale / Location	Catchment to National as appropriate in each of the other 5 case studies used as base cases for this exemplar analysis.
Risks	IPR issues. In particular, obtaining IPR for datasets that can be used to assess uncertainty arising from use of the "best" dataset vs the use of the "most readily available" dataset.
Risks	Availability of alternate datasets relevant to case studies 1-5 to use for assessment of effects of different spatial scales (e.g., some farm practice data may be location sensitive and different resolutions might not be available or accessible). Project timing. The uncertainty analyses undertaken in this exemplar cannot begin until the "base cases" derived from the other 5 case studies have been completed. Concise and explainable results. There exist too many possible ways of analysing uncertainty arising from the large number of models and datasets used in the other case.

Background / Narrative:

How do different input datasets affect model outputs and hence the evidence base upon which to base action? The question covers many familiar aspects of the effects of data quality and quantity on model outputs such as the resolution of spatial data, the frequency of time-series data, and the quality of observed data (lab errors, are the correct things being measured, etc.). But there are additional considerations that may contribute to the uncertainty or reliability of input data ranging from IPR issues which may affect the choice of datasets, to whether there is benefit of being able to include local data to improve on national data when the scale of model outputs is local. The questions of propagation of uncertainty as models are chained, how uncertainty affects model comparisons, and whether uncertainty can be translated into risk should be considered.

In particular, there is a need to examine the effects of input data quality/quantity on estimates of potential trade-offs and/or co-benefits among multi-pollutant responses and ecosystem services (ES). In that interventions to control multi-pollutant runoff are likely to be applied at farm and field scales, and many input data sets are much coarser (e.g., climate and land use at the km scale) the effects of scale of input data might be expected to differ in effect and importance if integrated modelling outputs are to be used at national scales (e.g., policy formulation and evaluation) or local scales (e.g., implementation of individual interventions in an agri-environment scheme).

Basic approach:

The question of uncertainty in model outputs is obviously an open-ended one, and depends in part on the model used, the questions asked, the intended use of the answers, etc. In this suite of case studies (1-5) we are compounding this complexity by using a number of models driven by different types, quality and quantity of data, providing both spatial and temporal outputs, and addressing a broad range of questions. These case studies are intended to demonstrate the appropriateness of an Integrated Modelling (IM) approach and the utility of an IM platform.

Indeed, the application of IM to policy and decision-making raises a whole new class of uncertainty considerations that are moot in single model, single pollutant modelling activities. This case study (6) will demonstrate several approaches to evaluating uncertainty in an IM environment using a selection of the same models and data sets as in the first 5 case studies. The outputs of this case study are in no way definitive or exhaustive, rather they are indicative of the types of uncertainty analyses that can be performed in an IM environment. It is intended that this case study demonstrate an important function of the IM platform, that it is never too late to go back to previously achieved results (the outcomes of studies 1-5) and ask relevant questions about the reliability or uncertainty of the results and the confidence that can be placed in them.

Models to be used:

Dependent on Case Study but could include:

- Farmscoper
- LUCI
- INCA (N,P, Sediment)
- Other models potentially needed: (e.g., model of fate and transport of FIO's).

Data to be used:

Dependent on Case Study but could include:

- Inputs
    - Agricultural census by Water Management Catchments (WMC)
    - Robust Farm Type counts by WMC
    - DEM data
    - Soils data
    - Landuse cover
    - Climate data
- Outputs
    - Agricultural pollutant reductions at WMC scale
    - Cost of scheme implementation at WMC scale
    - Net and Gross primary productivity
    - Soil carbon stocks and change
    - N and P in streams
    - Flood mitigation potential
    - Sediment and erosion potential
    - Green House gas emissions
- Validation
    - Harmonized Monitoring Scheme data

Other requirements:

- Test site (catchment scale, but not in consortium) with other models and rich data sets that can be used as an ‘independent’ source for comparison with models used in the case studies. This will be an opportunity for the community funding pot to bring in additional participants. The call should be announced once the details of this uncertainty case study exemplar (based on the other 5 case studies) have been finalized.

Workplan:

For efficiency in the project and as added value to the other case studies, the uncertainty analyses undertaken here will be based on the models and data sets used in case studies 1-5. The workplan for case study 6 will therefore have to be developed in conjunction with the other 5 case studies.

Milestones:

This case study is based on case studies 1-5. In general those case studies will have sourced their models and defined their input data sets by Feb-Mar 2015, and have completed their simulations by May 2015. The milestones below are based on those estimated timelines.

- Scope out Case Study (Feb 2015)
- Identify models and datasets used in studies 1-5 that can have one or more of their input data drivers replaced with an alternate data source that is also available to the consortium and will address the objectives above (Apr 2015)
- Identify and source data-rich catchments and alternative ecosystem service modelling tool (April 2015)
- Derive descriptive measures and/or visual presentations of the sensitivity / uncertainty in outputs of models at various scales resulting from differences or uncertainties in input driving data. (Nov 2015)
- Completion of first model application outputs and testing with Community Forum (Jun 2016)
- Start conditioning and ingestion of external data and models into Platform (Nov 2016)
- Iteration to identify benefits of model coupling (Nov 2016)
- Final report (Mar 2017)

Link to Enduser Questions:

Uncertainty, confidence and communication

- How does using different input datasets affect the model outputs and hence the evidence base upon which to base action?
- What is the uncertainty associated with modelling the different effectiveness of measures?

Effectiveness of measures / mechanisms

- Capture uncertainty in effectiveness of measures – understanding timescales of response and implications for economics.

Evidence of outcome

- Link models to monitoring
- Can models help to target measures and provide an estimate of the level of confidence that they will work – no point in investing customers money if uncertainty high.