LM0308: Catchment Management for Water Quality

Year 1 report

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Executive Summary: LM0308 Year 1 Report

The aims of the Catchment Management for Water Quality initiative are:

- to provide better access to data and modelling through the development of a web-based data and modelling platform;
- to explore approaches to enable more integrated modelling to deliver holistic solutions for multiple pollutants, services & policies;
- to support the development of a community of practitioners, policy makers and scientists to develop future questions and encourage joint working.

A key task of the project that had to be completed in Year 1 was the identification of important current and emerging questions relating to policy development and implementation in the areas of water and air pollution through consultation across the community. Data and models selected to explore these questions can then be prioritised for making available on the Catchment Management Integrated Data and Modelling Platform to be launched in 2017. Analysis of the benefits realised through coupling of models for each question will also be hosted on the platform as a series of Case Studies to provide a resource for the community.

Year 1 activities were focused primarily on the development of and engagement with the Community Forum. The overall objective was to establish a stakeholder and user forum such that the direction of the project is driven by the needs of the catchment management community. It also sets the basis for the long term engagement through the Forum which will continue beyond the life of the LM0308 project.

Individual discussions were held with 47 individuals representing 13 organisations, and following this, workshops were held with over 48 people representing more than 40 different organisations from the water environment sector, including representation from Wales, Scotland and Northern Ireland. All the information gathered through the individual consultations and workshops was used to set out a list of >280 individual questions which have been collated and combined into 120 broader questions covering a range of topics and 6 over-arching Themes.

Further analysis of the questions identified some questions as out of scope of the project as they were either fundamental research questions, too large and complex for the project or already explored in other projects. Remaining questions were then prioritised with the support of the Project funders and the project external Management Group to ensure a wide range of issues are covered including:

- Scale
- Effectiveness of measures
- Multiple pollutants
- Interpolation from catchment to national and monitored to unmonitored sites
- Performance of catchments under future climate change
- Cost –effectiveness of measures
- Apportionment
- Uncertainty and ensemble approaches

Based on the discussions in the two community forums and the subsequent analyses of the key questions, six Case Studies were designed and refined to be hosted on the Integrated Modelling Platform for the enduser community (for details see Appendix Task-1).

Case Study 1: Multiple pollutant and ecosystem services responses to land management policies and agri-environment interventions at the farm to catchment scale.

Purpose: To examine potential trade-offs and co-benefits for a suite of ecosystem services at the farm to catchment scale that may be potential 'by-products' of an agri-environment scheme designed to reduce total multi-pollutant loads entering watercourses.

Case Study 2: Effectiveness of land management policies and agri-environment interventions for reducing pollutant loads and maintaining environmental quality at the national scale.

Purpose: To determine the potential impact of an agri-environment scheme on total pollutant loads (from all sectors) entering watercourses for England, and any additional consequences of scheme implementation for national GHG emissions.

Case Study 3: Costs and benefits of mitigation measures to reduce pollutant concentrations for the protection of drinking water in river-systems upstream of intakes.

Purpose: To demonstrate benefits of reduced compliance risk and water treatment costs against different upstream pollution control measures taking into account the costs involved by both water companies and other actors.

Case Study 4: Effectiveness of pollution control measures under scenarios of future climate and land cover change at the catchment scale.

Purpose: To demonstrate the effectiveness of measures given future projections of climate and land cover change at the catchment scale.

Case Study 5: Uncertainty in ecological responses to water quality control measures at the river basin scale.

Purpose: To demonstrate the attribution of sources of errors and their effects in estimating the ecological response to mitigation methods aimed at nutrient reduction.

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.

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

A seventh Case Study may be defined later in the project (in consultation with sponsors and the enduser community) to provide a focus on the interpolation of data from catchment to national and monitored to non-monitored catchments is under-development.

While the engagement of the Community Forum and the definition of the Case Studies was the primary Activity in Year 1, other activities necessary to construct the platform, set standards for models and databases, and provide feedback to the community were getting underway. Some of these activities were delayed in starting due to the emphasis on fully engaging the Community

Forum to help the project team develop relevant Case Studies. With the case studies now in place, the second year will focus primarily on implementing Integrated Modelling Platform for the studies. Year three will return emphasis to Community Forum engagement for evaluation and refinement of the platform and its model and data tools.

Summaries of the activities to date, progress on year 1 milestones, and activities planned for years 2 and 3 are given below for each work package (task).

Task 1. The catchment management science-policy-practice forum

Lead: Atkins – JHI (CREW)   Contributors: All   Cost £119,000

1.1 Aim: To establish and run a forum of policy makers, regulators, industry, advisors and scientists who, together, will co-construct the key questions facing land, water and air management, helping to address policy objectives.

1.2 Objectives:

- To establish a stakeholder and user forum to improve communication between users and modellers so that the key questions of users and ways to answer them are co-constructed
- Identify who the stakeholders and users are and to understand their interests and requirements
- Identify the 5 key questions to be addressed in Tasks 3-5
- Developing an improved dialogue between model developers and users so the development meets the users' needs
- Delivery the tools and model outputs to the user community
- Create a forum to achieve project legacy

1.3 Activities to date

The overall objective was to establish a stakeholder and user forum such that the direction of the project is driven by the needs of the catchment management community. It also sets the basis for the long term engagement through the Forum which will continue beyond the life of the LM0308 project.

Year 1 as been a very active year for this Task, with several key tasks fulfilled on time such that the subsequent project Tasks (2-5) can progress. A summary of the Task 1 activates is given below:

1) Stakeholder and user identification process (March / April 2014)

Production of a stakeholder map covering contacts from a wide range of organisations involved in catchment management from either a policy, practice or research angle, e.g.:

- Governments of England, Wales and Scotland
- Policy makers from Defra, SEPA and DoE Northern Ireland covering aspects including water, soils, air, economics, flooding, ecosystems and biodiversity, climate change and farming, amongst others including the Forestry Commission
- The research community e.g. NERC, Universities,
- Regulators: EA, NE, SEPA, NRW, NIEA etc covering a range of catchment management technical areas e.g. modelling, flooding, land management etc.
- 3rd Sector organisations: e.g. representatives from NFU, CLA, Scottish Agricultural College, Angling Trust, Rivers Trust (and the CaBA network), WWF, RSPB, CRT etc.
- Water Industry: contacts from the major water companies in the UK, as well as UKWIR and DWI

Names, roles and contact details were sourced for this range of organisations and roles to form the basis for engaging stakeholders.

2) Communications release (April 2014)

A 2-pager introductory note was produced and sent out to the stakeholder contacts to notify them of the project, disseminate some information on what the objectives are and to let stakeholders know that that we would be making contact.

3) Proforma development (April 2014)

In recognition that catchment management is a broad topic area, covering many different disciplines, it was decided that some standardisation was needed in terms of how we conduct the pre-consultation task. We therefore developed a question "proforma" which essentially acted as a guide to all pre-consultation meetings and telephone discussions so that the technical emphasis and therefore conversation was not biased towards the experience and expertise of the person conducting the interview.

4) Proactive user engagement (April/May 2014)

Pre-consultation was carried out with a range of stakeholder contacts where we either had good relationships and / or the stakeholder contacts would have specific contributions to make that could help start the project off prior to the workshops. A day of meetings were held at Defra to see different policy experts including water, soils and biodiversity so that the basis of the questions ultimately selected were informed by policy needs. We also followed up on these meetings with subsequent telephone conversations we required. Similar discussions were held with Scottish and Welsh contacts so that the information gathered was not considered England-specific. Telephone interviews were also held with a range of representatives from the EA, NE, and some 3rd sector organisations such as the NFU, the RSPB, WWF and the Rivers Trust. Discussions were also held with some water industry contacts. Overall, pre-consultation was undertaken with approximately 47 people across 13 different organisations.

5) **Assimilation of information into Long List of Questions (May 2014)**

Throughout all the pre-consultation discussions, notes were taken and the information collated into a spreadsheet. This spreadsheet formed the basis for the "long list" of questions. This long list was categorised by "User Group" to help frame the discussions within Workshop 1.

6) Workshop 1 (July 2014)

The invitee list included all contacts and invitations were circulated at the start of June. The workshop design was then planned throughout the remainder of June, including logistics, venues, pre-work and information releases, poster presentation development etc. The workshop was conducted on 1st July with approximately 48 people attending from 40 organisations. The format of the day consisted of presentations (focused around dissemination of information relative to the purpose of the project) followed by a couple of breakout sessions which were structured around the questions gathered through the pre-consultation stage. The outputs for the day were written up and disseminated but the main output from this workshop was the identification of a wider range of questions from the stakeholder attendees, structured broadly around scale (national (mainly policy and regulators), catchment (regulators and water industry) and land-holding (mainly 3rd sector organisations and other practitioners).

7) Question consolidation and condensing and the Forum Management Group

The consortiums original tender response set out that the 7 Case Studies would be selected from this workshop, however the response from stakeholders in the consultation tasks meant that an additional step was required to further condense the questions. This additional step was focused around consolidating and condensing the long list of questions into a shorter, more manageable list for review by a smaller stakeholder group called the "Forum Management Group". This additional group was formed from a range of selected stakeholder organisations (19 people from 13 organisations) and a further workshop was held on 11th September in Birmingham, during which the consolidated list of ~120 questions was discussed and collectively the 7 Case Study titles were developed using these questions to guide the scope of the Case Studies.

8) Workshop 2 (October 2014)

The purpose of this workshop was to present the draft case studies and further develop the scope of the case studies with the stakeholders, including the ways in which the case study questions could be answered through models and data. 44 people attended from 27 organisations. The format of the day consisted brief presentation of the Case Studies followed by break out groups for individual Case Studies. The workshop participants were asked to select two Case Study "tickets" allowing them the opportunity to participate in the development of two case studies of their choosing. During the breakout sessions, participants were asked to discuss and comment on:

- If the scope of the draft case study is correct and useful, or whether it needs adjusting
- What scenarios it could cover (e.g. what control measures / scale / outputs / formats etc)
- Who the likely users would be and what outputs / outcomes they are interested in
- What policy instruments the case studies intersect with.

During these discussions it was also requested that stakeholders make notes of relevant data / models on post-it notes to help the Consortium identify appropriate and desirable data / models for inclusion in the framework.

The information gathered in this second Forum workshop has then been used to flesh out the detail of the Case studies which were released in April, 2015 (see Appendix Task-1), and to inform the first general call for proposals from the Community Fund also in April, 2015 (see Appendix Task-6).

<u>1.4 Progress on Milestones</u>

Key milestones related to Task 1 in year 1 are:

Milestone 1.1: Establish User Forum – Complete

Milestone 1.2: Establish Key Questions – Complete

Milestone 1.3: Stakeholder input to selection of models to test – Largely complete (partly covered in pre-consultation, workshops 1&2 and also as part of the call for community funding which is currently underway)

1.5 Plans for Years 2 and 3.

Two more workshops are included in the scope of works, one for this year (workshop 3 – an update workshop and workshop 4 – dissemination and training workshop). Hence there is another forum due for 2015, however in order to ensure we avoid stakeholder consultation fatigue this will need to be carefully timed for when we can demonstrate progress on the Case Study development and the Platform development. In between times, we will be liaising with the Community Fund task to disseminate information and calls for bids to the fund. We will also be coordinating the Forum Management Group to become Case Study "champions" to help guide the development of the Case Studies over 2015.

Task 2. Integrated Modelling Platform and Interface

Lead: CEH Cost: £75,000

2.1 Aim: To provide a web-based data and modelling platform to allow the discovery and download of the major modelling and data resources assembled by the project. To work with modelling user groups to address the standards and common formats required to promote integration of their use across this community.

2.2 Objectives:

The task will deliver a web-based platform and user interface that can provide researchers and users with a range of resources developed in other tasks including:

- data storage, discovery and retrieval services (Task 4),
- model database including documentation and tutorials (Task 3 & 5)
- model evaluation documentation (Task 3)
- archiving and retrieval of analysis results (Task 3)
- visualization and comparison tools (Tasks 3 & 5)
- alignment and compatibility with the NERC E4A (Environmental Assessment: Archive, Access and Analysis)

2.3 Activities to date

There are two specific areas of activity to date. A set of user stories based on the original requirements have been developed. In addition the team have developed a clickable mockup for the platform as an aid to help users visualise the user interface and comment on the functionality identified to date. Once this has been demonstrated to the stakeholders (in workshops or by webex) we will be in a better position to define the overall scope of the platform and manage the expectations of the users.

The requirements for metadata capture within the integrated modelling platform were captured as a basic form template so that information could be quickly shared across the partners and eventually the wider modelling community. These templates were developed into a series of web forms to enable the rapid evolution of these forms both the users providing the information and those searching it. This web based facility is now being defined within the project to form the basis of the final metadata descriptions for the integrated modelling platform.

2.4 Progress on Milestones

Key milestones related to Task 2 in year 1 are:

Milestone 2.1: Development web-interface and modelling platform – A prototype project website and platform has been developed. Iterative development of the platform is ongoing with project team.

Milestone 2.2: Complete model documentation and conditioning (develop standard metadata descriptions and liaison with model owners) – Web form functionality established for prototype portal to allow uploading and downloading standard metadata descriptions by model owners and endusers.

2.5 Plans for Years 2 and 3.

Now that the Community forum has agreed a set of case studies, activity toward implementation of the platform will increase. In year 2 we will complete iterative development of platform (Task 2.1) and complete the web form functionality for ingesting information into the model and data catalogue (Task 2.2). Both of these activities will be completed using resources remaining from year 1. New activities in year 2 will involve ingesting identified models to be used in the case studies into the platform and ensuring they are properly described using the agreed metadata standards (Task 2.3), and ingesting datasets identified in task 4.3 into the platform, with appropriate conditioning for compatibility (Task 2.4). Year 3 will involves completion of testing of the platform with the Community Forum (Task 2.5) and the ingestion of any additional models and data prioritised by the Community Forum (Task 2.6). Delivery of final integrated data and modelling platform (Tasks 2.7 and 2.8; joint deliverable with Task 5) is on schedule for the end of year 3.

Task 3. Selection and Evaluation of Models; Answering of User Questions

Leads: Reading and ADAS Contributors: CEH, JHI, Atkins Cost: £112,000

3.1 Aim: To collate and transfer knowledge of model pedigree and performance to the user community.

3.2 Objectives:

- to provide a methodology by which users can select the most appropriate models for a particular job, along with an understanding of the advantages and disadvantages of each model, and a knowledge of model pedigree and past performance;

- to provide supporting evidence on model pedigree and performance to underpin the model selection tool;
- to assess the confidence in model-based assessments of environmental issues through comparison of different modelling methodologies;
- to provide answers to the policy questions raised by the users as part of the forum.

3.3 Activities to date

A process of defining requirements and designing the structure of the model database has been undertaken and a document describing the Database for Model Selection and the Model Evaluation Protocol was produced and submitted to DEFRA on the 12 February 2015 (Appendix Task-3). The document describes the database structure and format of the model and application data fields, the template for capturing information on model evaluation and the method for implementing the database.

Following two community forums and one steering committee meeting, the case studies have been agreed. This has been described under Task 1 as the Community Forum had such a major role to play in this (Appendix Task-1) and work is in progress to deliver an initial summary report for each user question. Further details for each user question including the title, purpose, policy drivers, users, risks, background, approach, models and data to be used, work-plan and links to the end user questions are given in the appendices.

Progress delivering the Case Studies is as follows:

Case studies 1 and 2 involve the use of the Farmscoper model to assess the impact of mitigation measures – land management policies or agri-environmental interventions. The next step in these case studies before the running of the Farmscoper model is to work with the steering group to finalise the list of measures to be modelled for each case study. Work involving INCA-P (Case Studies 4 and 5) slowed whilst the model was modified to provide better simulations of particulate phosphorus. This has been done and the work to apply INCA-P to the Tarland (Case Study 4) and the Thames (Case Study 5) will resume. INCA-N has been calibrated for the Tarland catchment and simulations to assess the effectiveness of measures under future scenarios are set to start. Work on Case Study 3 is waiting on outcome from the Community Fund call to see if a model for metaldehyde is put forward which will impact on other models used in the case. Case Study 6 uses the LUCI model which has already been tested at both catchment and national scales. This Case Study is dependent on the Community Fund to see which data-rich catchments and other ecosystem service models are put forward from the community to use for this exemplar. Finally, at the request of the Funders we have been asked to include the SEPARATE as part of Case Study 2. Identifying the data needs for this model and how to integrate it with other models is underway. Case Study 7 remains outstanding as an activity requiring attention to formulate and progress.

3.4 Progress on Milestones

Key milestones related to Task 3 in year 1 are:

Milestone 3.1: Database for model selection – Largely complete.

Milestone 3.2: Protocol for model evaluation – Largely Complete

A report describing the database for model selection and the model evaluation protocol (Appendix Task-3) was produced and submitted to DEFRA on the 12 February 2015. Task 2 has developed web forms for ingesting the relevant model information onto the Project's prototype platform. Will be complete as case studies populate the platform using the web forms.

3.5 Plans for Years 2 and 3.

The Database for Model Selection and the Model Evaluation Protocol will be implemented for the case studies in year 2 (completing Tasks 3.1 and 3.2). The database will be initially populated using the consortium's models and the Model Evaluation Protocol will be followed once the initial model runs are done as part of the case studies in Task 3.3 (with an initial summary report for each). It is anticipated that time in year 2 will be needed to catch-up on the over-run with the initial model applications for the case studies. In year 3, once the initial case study outputs have been produced, an assessment of model performance will be conducted (Task 3.4) and revised summary reports will be produced for each case study (Task 3.5).

Task 4. Compilation and Integration of Data

Lead: CEH/ADAS/JHI Contributors: All Cost: £75,000

4.1 Aim: To develop a database of key national datasets to underpin national integrated water quality modelling.

4.2 Objectives:

- gain a full understanding of the data requirements of an integrated water quality modelling framework, based on the requirements of the models selected and of the expert panel;
- source and collate the required datasets;
- assess the datasets available for suitability within the framework in order to produce a viable long-term solution.

4.3 Activities to date

A simple format for model dataset information has been devised, focussing on identifying not just the data used as direct input to models, but the source datasets on which these are based and the processing / interpolation / aggregation required to produce the model inputs. This will enable us to understand where model data requirements can be met by a single "national database for water quality modelling", what the model requirements are in terms of bespoke enhancements to these source national datasets, and where to focus attention in identifying and addressing licensing issues.

This information on model datasets has been compiled for Farmscoper, SAGIS, Questor, INCA-N and INCA–P, and LUCI. A response from the SEPARATE team has yet to be provided. Definitions of model outputs were also provided to assist with identification of common standards and formats for comparability to be completed in task 5 (deliverables) 5.2 and 5.3. Appendix Task-4 lists the datasets identified, identifies where each is used by the model applications being considered within the project, and lists additional known datasets that could improve modelling across the following key areas:

- Underpinning spatial datasets (rivers, catchments, DTM)
- Meteorological
- Land cover and land use
- Soils
- Diffuse inputs
- Point inputs
- Agricultural practices

Additional datasets not currently used by these models have also been identified, from the stakeholder workshops and from discussions with modellers around areas where data availability could improve modelling. These datasets fall within themes including riparian tree shading, weirs, higher resolution land cover (e.g. IACS). See Appendix Task-4 for details.

4.4 Progress on Milestones

Key milestones related to Task 4 in year 1 are:

Milestone 4.1: Draft list of required datasets – Complete (see Appendix Task-4)

Milestone 4.2: Final list of required and relevant datasets – Complete (see Appendix Task-4)

Note: Inevitably further datasets will be identified through the project, added to the list, and considered for inclusion within the national database. The list in Appendix Task-4 looks more specifically at datasets used by models within the consortium or being applied within the project. Additional datasets in other areas including ecosystem services have been considered, including datasets being looked at within the Sustainable Intensification Platform and Catchment Matcher projects.

Milestone 4.3: National database for water quality modelling (due in August 2015) - approximately 10% complete. There has been a delay in starting the work in gathering datasets while the model selection is finalised and the data formats from task 5 are defined.

Gridded meteorological driving data, including the UKCP09 baseline data and CEH-GEAR and CHESS datasets (including rainfall, temperature, PE, radiation, soil moisture) have been standardised into the proposed netCDF-CF storage format, and will be made available over the web through the platform as a range of standard web-services for visualisation, download and via a programming API for direct access by model code. CEH's Land Water Information System is developing tools for web-based visualisation of time series from these datasets, which it is hoped will be incorporated into the platform. ISO and UK government compliant metadata have been produced for these datasets.

4.5 Plans for Years 2 and 3

We expect rapid progress on the collation of the source datasets. Where these are available over the web the platform will reference these using ISO (and data.gov.uk) standard metadata records to fully describe the information resource and provide a pointer to it. In some cases there may be a benefit in reformatting the data to meet the data standards defined within the project in order to enable integration with other data sources or for direct download / consumption by a model. In other cases the source data may require processing in order to make it fit for purpose for the models defined, in which case the processed dataset will be stored and made available via the platform (though the resources for this processing are limited).

We are on track to produce a national database (Task 4.3) for the principal datasets identified in each of the areas in Appendix Task-4. The database will not initially contain the more complex datasets requiring processing or those needing extensive discussion about licensing. Formats for some of the datasets may change later in the project where needed to meet interoperability requirements, as these are finalised.

ADAS will be reviewing additional sources of farm practice information and, in discussion with other modelling groups using this type of data, will be assessing potential for providing national coverage of these datasets, though in some cases synthesised datasets, based on these data sources using expert judgment, may be more appropriate in many cases.

JHI will be assisting with the collation of data, focussing particularly (but not solely) on data for Scotland and soils data required by some models, access to which is seen as a particular issue for some modelling communities.

Task 5. Modelling framework / integration / coupling

Lead: Reading / CEH Contributors: All Cost: £100,000

5.1 Aim: To develop flexible and robust solutions to link models data and other information such that complex questions or uncertainties can be resolved

5.2 Objectives:

1. To synthesise and review the opportunities and barriers to linking models and data for catchment systems to answer multiple pressures
2. Document codes (languages, data storage, state visibility, and discretisation) and implementation of standards for data exchange and model modularity of models prioritised by users and tested in task 3
3. Options to be determined by users
    a. Extend current meta-models / modelling frameworks (SAGIS, Farmscoper, LUCI) to embed other specialised models and explore uncertainty
    b. Enhancements of specialist models to increase their interface for users and/or coupling to other specialist models
    c. Source and assess value of existing tools to aid in model comparison, uncertainty and evaluation.
    d. Web-enable prioritised models to enable user access and implementation in the cloud environment thus benefitting from transparency and repeatability of model applications workflow tracking, greater security, ease of user access etc.
4. Implementation in the web platform

5.3 Activities to date

The production of the report outlining opportunities and barriers to integrated modelling has been started and is 40% complete.

The work in Task 5 will begin in earnest in year 2. The main work of Task 5 is the integration and coupling of models and data, and the development of a modelling framework to allow users open access to the models and data on the platform. Both require that the initial core models and datasets have been ingested into the platform. This, in turn, could not be accomplished until the community forum had completed its initial work and defined the relevant questions (embodied in Case Studies) for the first applications of the Integrated Modelling Platform. The Case Studies have now been defined (Appendix Task-1), the core models and datasets have been identified and are being ingested into the prtoal. Year 2 will see the majority of task 5 work accomplished.

5.4 Progress on Milestones

Key milestones related to Task 5 in year 1 are:

Milestone 5.1: Paper / report outlining opportunities and barriers to integrated modelling including: Why, when and how would integrated modelling be necessary and /or beneficial; trade-offs and benefits; technical options and standards for inter-operability - Progress on the report outlining opportunities and barriers to integrated modelling has been slower than anticipated because of the need to tailor the document to UK water quality modelling. Existing reviews of Integrated Environmental Modelling have been analysed but given the document also has a design aspect, then it is taking longer than expected to draft the technical standards and inter-operability sections. We have assigned additional team members within the project to help out with these sections.

Milestone 5.2: Documentation of core model input requirements, develop improved standards for all models on the platform - The documentation of core model input requirements and standards is proceeding, but activity on this milestone was delayed because the adoption of case studies was only completed in the last two months of year 1, and consideration of core model input requirements requires knowledge of what models will actually be used for the case studies.

Milestone 5.3: Development of core model output standards to enable improved integration and thus enhance likely usability of model output library – As for milestone 5.2, the development of core model output standards is proceeding, but activity on this milestone was also delayed because the adoption of case studies was only completed in the last two months of year 1, and consideration of core model output standards requires knowledge of what models will actually be used for the case studies.

Now that the case studies are defined and in place, it is expected that Milestones 5.2 and 5.3 will be completed in the first half of year 2.

5.5 Plans for Years 2 and 3

Completion of task 5.1 is estimated as 31 May 2015. Development of core model input and output requirements and standards to enable improved integration and thus enhance likely usability of model output library (Tasks 5.2 and 5.3) will be completed by approximately month 18 as the case studies are implemented. Year 2 activities will also begin to identify and assess options to improve the platform integration (Task 5.4), e.g.: sourcing of additional tools (visualisation, analytical, uncertainty, ensemble, library); adding models to enhance or link; developing modelling frameworks or meta-models to enhance functionality. These activities will build on additional resources brought in through the Community Fund (see next section), and will feed into the Year 3 activities focussed on: ingestion of selected tools and /or enhanced models or modelling framework/ meta-models (Task 5.5); final testing / iteration/refinements of the platform (Task 5.6); and delivery of the final integrated data and modelling platforms (Task 5.6).

Task 6. Community Forum Fund

Lead: CEH Contributors: All Cost: £150,000

6.1 Aim: Provide funding for critical resources to be brought into the project to ensure maximum user impact and uptake.

6.2 Objectives:

1. Establish an assessment panel to consider requests for funding to being on board a range of assets and resources from the community external to the consortium
2. Award funding on an objective and competitive basis ensuring licensing and IPR arrangements are in compliance with Defra requirements

6.3 Activities to date

The Community Fund was established for the Project with an initial balance of £140,000. A Community Fund Panel (CFP) has been established to assess priorities and practicalities of suggested resources to be funded. This Panel consists of representatives of each consortium member and a representative from each of the funders. Administration of the fund will be administered by CEH with purchase orders / subcontracts issued ensuring appropriate IPR / licensing arrangements consistent with Defra requirements.

The CFP set the following guidelines for administration of the Community Fund. To be successful applications need to satisfy the following requirements:

- Be essential to the case studies or for future legacy of the platform.
- Typical award amount £10-35k (an exceptional case could be £50k).
- Be practical and aligned to technical requirements of the platform.
- Be deliverable in a time frame to ensure the Platform can benefit. Last award will be agreed 1st March 2016 with delivery required 6 months before project end on 29th Feb 2017.

- Any tool must be provided under the licensing and IPR arrangement required by the funders i.e. freely available and downloadable from the platform.
- No model development per se will be funded (e.g., no new code).

Examples of activities eligible for funding could include:

- involvement in / data provision for case studies
- provision and conditioning of critical national data
- provision of a critical model, potentially with enhancement to make more user friendly / suitable for user needs, all with documentation;
- model conditioning for integration with other models
- visualisation / ensemble tools

First Community Fund Call

The first call for proposals to the Community Fund was issued 19 March, 2015 (see Appendix Task-6). Three specific project area needs were addressed:

Area 1) – Faecal Indicator Organisms (FIOs) mobilisation and transport - Case Study 1 will be using the Farmscoper and LUCI models) to explore effectiveness of land management interventions at the catchment scale. A FIO mobilisation and transport model is sought to complement this work to demonstrate the benefits of considering multiple pollutants.

Area 2) – Metaldehyde pollution - Case Study 3 will be exploring the benefits of pollution control measures and water treatment costs. Expertise and tools which would expand this work to include metaldehyde is sought.

Area 3) - Data-rich catchment exemplars - Case study 6 is exploring the effects of data quality and quantity on evaluation of land management interventions at a catchment/local scale. Exemplar sites which are rich in data are sought to provide a test-bed for the Case Study together with an ecosystem service mapping/modelling tool to compare to outputs from a selection of models applied in Case Studies 1-5.

Three proposals were received in response to the call (one proposal in each area). The proposals are currently under consideration by the CFP. Details of the proposals will be released when final decisions on funding are made.

The Community Fund will also provide funds to bring the SEPARATE team and application at national scale from Project WQ0223 into Case Study 2 plus any other relevant resources to be hosted on the Platform. Costs to be negotiated.

6.4 Progress on Milestones

Key milestones related to Task 6 in year 1 are:

Milestone 6.1: Establish the Community Fund – Completed.

Milestone 6.2: Establish Community Fund Panel (CFP) and Chair – Completed.

Milestone 6.3: First meeting of CFP to develop criteria and timetable for funding – Completed

Milestone 6.4: First Awards – First Call issued 19 March, 2015, with awards anticipated early in year 2 based on the three proposals received.

6.5 Plans for Years 2 and 3.

The CFP will continue to meet quarterly (or as needed; Task 6.5) to prepare the next call for proposals required to advance the Project goals.

Additional calls are anticipated in year 2, and perhaps year 3 if they can contribute effectively before the end of the project.

Appendices

Appendix Task-1 – Case studies selected to address the community Forum Questions, March, 2015.

Appendix Task-3 - Database for model selection and the model evaluation protocol: Report submitted to Defra, Feb, 2015.

Appendix Task-4 – Datasets used by consortium model applications, mapped against list of provisional datasets.

Appendix Task-6 – First Community Funding Call, March 2015.

LM0308: Catchment Management for Water Quality

Year 1 report

March 2015

Appendix Task-1

Case Studies, March 2015

LM0308: Catchment Management for Water Quality

Case Studies
March 2015

Introduction

The aims of the Catchment Management for Water Quality initiative are:

- to provide better access to data and modelling through the development of a web-based data and modelling platform;
- to explore approaches to enable more integrated modelling to deliver holistic solutions for multiple pollutants, services & policies;
- to support the development of a community of practitioners, policy makers and scientists to develop future questions and encourage joint working.

One task of the project is the identification of 7 key current and emerging questions relating to policy development and implementation in the areas of water and air pollution through consultation across the community. Data and models selected to explore these questions would be prioritised for making available on the Catchment Management Integrated Data and Modelling Platform to be launched in 2017. Analysis of the benefits realised through coupling of models for each questions will also be hosted on the platform as a series of Case Studies to provide a resource for the community.

Development of questions

Individual discussions were held with 47 individuals representing 13 organisations, and following this, workshops were held with over 48 people representing more than 40 different organisations from the water environment sector, including representation from Wales, Scotland and Northern Ireland. All the information gathered through the individual consultations and workshops was used to set out a list of >280 individual questions which have been collated and combined into 120 broader questions covering a range of topics and 6 over-arching Themes (Figure 1).

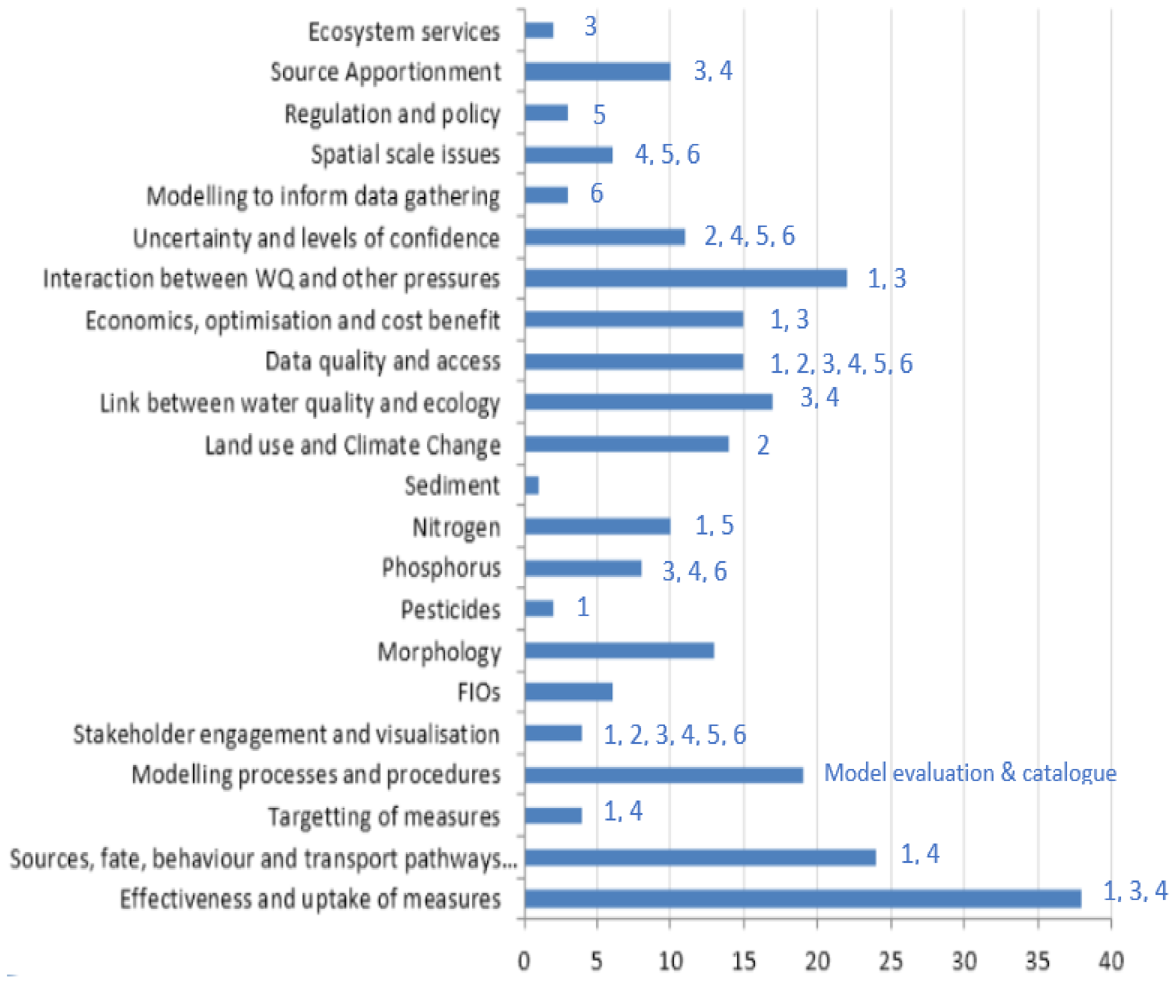

Figure 1 Results of analysis of community questions relating to topic and 6 over-arching Themes. The bars indicate the number of stakeholder questions involving each topic; the numbers after the bar indicate the over-arching theme into which the questions were collected.

Further analysis of the questions identified some questions as out of scope of the project as they were either fundamental research questions, too large and complex for the project or already explored in other projects. Remaining questions were then prioritised with the support of the Project funders and the project external Management Group to ensure a wide range of issues are covered including:

- Scale
- Effectiveness of measures
- Multiple pollutants
- Interpolation from catchment to national and monitored to unmonitored sites
- Performance of catchments under future climate change
- Cost –effectiveness of measures
- Apportionment
- Uncertainty and ensemble approaches

The following Case Studies have been developed out of these questions:

Case Study 1: Multiple pollutant and ecosystem services responses to land management policies and agri-environment interventions at the farm to catchment scale.

Lead: Jack Cosby (CEH); Richard Gooday (ADAS)

Purpose: To examine potential trade-offs and co-benefits for a suite of ecosystem services at the farm to catchment scale that may be potential 'by-products' of an agri-environment scheme designed to reduce total multi-pollutant loads entering watercourses.

Case Study 2: Effectiveness of land management policies and agri-environment interventions for reducing pollutant loads and maintaining environmental quality at the national scale.

Lead: Richard Gooday (ADAS); Peter Daldorph (Atkins)

Purpose: To determine the potential impact of an agri-environment scheme on total pollutant loads (from all sectors) entering watercourses for England, and any additional consequences of scheme implementation for national GHG emissions.

Case Study 3: Costs and benefits of mitigation measures to reduce pollutant concentrations for the protection of drinking water in river-systems upstream of intakes.

Lead: P Daldorph (Atkins); Andy Wade (University of Reading)

Purpose: To demonstrate benefits of reduced compliance risk and water treatment costs against different upstream pollution control measures taking into account the costs involved by both water companies and other actors.

Case Study 4: Effectiveness of pollution control measures under scenarios of future climate and land cover change at the catchment scale.

Lead: Andrew Wade (University of Reading); Leah Jackson-Blake (James Hutton Institute)

Purpose: To demonstrate the effectiveness of measures given future projections of climate and land cover change at the catchment scale.

Case Study 5: Uncertainty in ecological responses to water quality control measures at the river basin scale.

Lead: Richard Williams (CEH); Andy Wade (University of Reading)

Purpose: To demonstrate the attribution of sources of errors and their effects in estimating the ecological response to mitigation methods aimed at nutrient reduction.

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.

Lead: Jack Cosby (CEH); Andy Wade (Reading)

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

A 7th Case Study focussed on the interpolation of data from catchment to national and monitored to non-monitored catchments is under-development.

The Case Studies can be matched to the issues as follows:

Table 1 Summary of issues covered by the 7 Case Studies

	Case Study Number						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Effectiveness of measures							
Performance of catchments under future climate change (and land management)							
Cost –effectiveness of measures							
Apportionment							
Uncertainty / data quantity and quality							
Interpolation from catchment to national and monitored to unmonitored sites							
Multiple Pollutants	Sediment; N; P; FIO; (biodiversity; carbon; flood mitigation)	N; P; FIO; agri-GHG	N; P; Met-aldehyde	Sediment; N; P	N; P	Based on Case Studies 1-5	To be agreed
Multiple scales	Catchment	National	River System	Catchment	River Basin	Catchment - National	Catchment – National

The Following pages include full descriptions of the Initial 6 Case Studies describing the purpose, data and models to be used, workplan, risks and endusers.

LM0308: Catchment Management for Water Quality

Case Study 1: Multiple pollutant and ecosystem services responses to land management policies and agri-environment interventions at the farm to catchment scale.

Lead: Jack Cosby (CEH); Richard Gooday (ADAS)

Purpose: To examine potential trade-offs and co-benefits for a suite of ecosystem services at the farm to catchment scale that may be potential 'by-products' of an agri-environment scheme designed to reduce total multi-pollutant loads entering watercourses.

Policy driver(s)	Water Framework Directive (Good Chemical Status), Farm Payment Schemes (Countryside Stewardship, Glastir, SRDP), Climate Change Abatement Agreements, Conservation Targets, Flood Risk Mitigation
Enduser(s)	Government Agencies (DEFRA, EA, NRW), Catchment Managers, Conservation Agencies, Local Authorities, River Trusts
Pollutant(s)	Nitrate, Phosphorous, Sediment, Fecal Indicator Organisms (FIO), Flood Potential, Carbon loss (and Sequestration), Biodiversity Loss
Measures	Case study based in Wales (as exemplar) so measures are derived from Glastir and Glastir Advanced agri-environment schemes in Wales. For farm to catchment scale applications in England or Scotland, measures derived from Countryside Stewardship or SRDP would be used.
Scenario if appropriate	Long term impact of the implementation of mitigation methods representing major / common options within Glastir and Glastir Advanced. These include reduction of fertilizer application, change in stocking density, woodland edge expansion, streamside corridor tree planting, and bracken control. Economic assessment of these options where possible.
Outcome / output	Percentage change in total pollutant load to the catchment watercourses resulting from applied agri-environment interventions (including FIO delivery to the estuary). Evaluation of co-occurring effects on selected ecosystem services expressed as percentage of areas within the catchment: 1) losing or gaining C; 2) prone to sediment losses; 3) providing flood mitigation; 4) with suitable habitat connectivity (including assessment of areas within the catchment where effects are antagonistic or complementary). Cost-benefit analysis if data and methodology are available.

Scale / Location	Catchment Scale; Conwy catchment in Wales 520 km^2; sea level to 1000 m elevation; climate gradient; all major Welsh soils and landuse; peats, forests, unimproved and improved grasslands; dairy, cattle, sheep, mixed livestock; shellfish industry in estuary.
Risks Risks	Availability of datasets for inclusion in the platform as inputs to the models and for access by endusers. Of particular concern is a robust soils database for LUCI that can be used on the platform without IPR restrictions on use as input data or IPR restrictions on use of platform outputs derived from models using the soil database. Other required databases (above) should be available. Availbility of a suitable FIO model that can be included on the platform without IPR restrictions (and that can be sourced through the community funding pot and be made available in a suitable timeframe for the case study) Difficulty in translating Glastir, Countryside Stewardship or SRDP agri-intervention options into suitable inputs for the models. This includes the possibility that some policy options may involve interventions in processes or land use changes that cannot be addressed by the models because the bio-physical basis of the intervention is not included in either LUCI or Farmscoper.

Background / Narrative:

The New Environmental Land Management Scheme (Countryside Stewardship), the successor to Environmental Stewardship (ES), will be a key package in delivering the Government's sustainable agriculture and rural policies and is likely to form a substantial part of the Rural Development Programme for England (RDP) 2014 -2020. Countryside Stewardship will contribute to Defra strategic priorities for sustainable development, natural resource protection, supporting sustainable farming and food, and sustainable rural communities. While covering cover soil and water issues, Countryside Stewardship also focuses on other ecosystem services such as biodiversity, the historic environment, genetic conservation and educational access, plus measures to address climate change such as reducing greenhouse gas emissions and carbon storage. Agri-environment schemes in Wales (Glastir) and Scotland (SRDP) are similarly focused on sustainable land management and the simultaneous delivery of environmental goods and services.

In these multi-targeted schemes, there is a need to examine potential tradeoffs and/or co-benefits in terms of reductions and or enhancements of ecosystem services (ES) provided in the catchment as a result of the targeted actions to reduce water pollution to the streams. In that interventions to control multi-pollutant runoff are likely to be applied at farm and field scales, the evaluation of potential changes in ES should be evaluated at similar scales.

It is likely that the effects of interventions and their knock-on effects on ES will vary spatially within a single catchment. A key aspect of this case study will be to identify areas within the catchment where: 1) trade-offs occur, i.e. areas where some ES are either enhanced or unaffected while others are seriously degraded; and 2) where co-benefits are derived, i.e. all ES are either unaffected or enhanced. Knowledge of this spatial pattern in response to interventions will allow more efficient and cost-effective implementation of agr-environment policy.

Basic approach:

The intention of this case study is to link the agri-environment interventions used to produce changes in agricultural pollutant loads as predicted by the Farmscoper model for a given scenario with the LUCI ecosystem services tool to evaluate the effects of those interventions on other ecosystem services in a catchment. The most recent version of Farmscoper incorporates a catchment-based calculation that operates at Water Management Catchment (WMC) scale. The LUCI tool can also be applied at a catchment scale, but has a 5m spatial resolution allowing evaluation of the effects of agri-interventions implemented at the farm to field scale on ecosystem service provision. The use of the two models will allow analysis of the spatial patterns of trade-offs and/or co-benefits for ES that accompany the changes in agricultural pollutant loads.

The case study will focus on the Conwy catchment in Wales which consists of areas involving a number of different agricultural activities (dairy, improved and semi-improved grazing, etc.) and areas of environmental concern (peatlands, wetlands, forests, etc.). The Conwy River drains to an estuary that is home to a commercially important shellfish industry, a concern for both pollutant loading to the river as a result of upstream activities as well as potential loss of ES in the near-marine environment of the catchment.

The agri-environment interventions implemented in this case study will be derived from the Galstir and Glastir Advanced schemes in Wales, using a number of intervention options appropriate to the Conwy catchment in Wales. The case study is an exemplar to demonstrate the improved decision making capability and added value that result from the use of a multiple model, multi-pollutant, combined water quality and ecosystem services approach to assessing the effectiveness of land-use policy. The modelling approach and procedures demonstrated by this exemplar are readily transferable to other catchments in Wales (where different Glastir options may be appropriate) or to catchments in England or Scotland (using appropriate measures from Countryside Stewardship or SRDP).

Case studies 1 and 2 are similar in that the consequences of land management policies and agri-environment intervention schemes to reduce multi-pollutant runoff are being examined. Both studies consider catchment scale responses as a starting point and evaluate co-occurring effects on ES. However, the case studies differ in their approaches for incorporating integrated modelling to address broader aspects of the topic.

Case study 2 starts at the catchment scale using Farmscoper, but then combines Farmscoper with SAGIS to extrapolate to larger scales providing assessments for thousands of catchments from regional to a national scale using Countryside Stewardship scenarios for England. As the scale increases, information about the linkages among interventions and ES (both occurring at field or farm scale) is potentially obscured, but a broader more-policy relevant perspective is obtained (effectiveness at national scale).

This case study (1) also starts at the catchment scale using Farmscoper but combines Glastir interventions in Wales with the LUCI modelling tool to disaggregate to smaller scales, evaluating the effects on ES at the scale of implementation (field or farm). Because of the greater spatial detail, this case study is implemented here in a single catchment, the Conwy River in Wales, as an exemplar. At this smaller scale of resolution, the broader effectiveness of the policy at the national scale is potentially lost, but it becomes possible to evaluate effects on a range of ES and to identify trade-offs and co-benefits operating at the scale of uptake and implementation of the interventions.

This can provide feedback to development of the next policy initiative and/or help to target specific local instances of implementation that enhance co-benefits and minimize trade-offs.

Case studies 1 and 2 are thus complementary in the added information they provide through an integrated modelling framework. Case study 1 highlights the increased spatial information that can be derived from ensemble models which can be used for more efficient targeting and evaluation of agr-environment interventions. Case study 2 demonstrates the ability to extrapolate from ensemble models to regional and national scales to provide policy relevant evidence and information.

Models to be used:

- Farmscoper
- LUCI
- Model of FIO mobilization and transport – to be identified (see other requirements)
- Economic analysis by Defra

Data to be used:

- Inputs
    - Agricultural census by WMC
    - Robust Farm Type counts by WMC
    - DEM data (5m resolution)
    - Landuse cover
    - Climate data
- Outputs
    - Agricultural pollutant reductions at WMC scale
    - Cost of scheme implementation at WMC scale
    - Soil carbon stocks and change
    - N, P and FIO’s in streams
    - Flood mitigation potential
    - Sediment and erosion potential
    - Green House gas emissions
- Validation
    - Harmonized Monitoring Scheme data

Other requirements:

- Model of fate and transport of FIO’s that can be run on catchment scale and includes delivery to estuarine shellfish beds. This can be a stand-alone model that can run in ensemble mode with Farmscoper and LUCI or a module that can be inserted in LUCI. This may have to be sourced from the community funding pot.
- Contact Chris Burgess to identify possible synergies
- Economic requirements to be identified in consultation with Defra

Workplan:

- Scenario simulation with Farmscoper to determine reduction in the agricultural load at WMC scale, applied to Conwy catchment.
- Convert Farmscoper scenario to equivalent changes in land use or land management for input to LUCI.
- Scenario simulation with LUCI using translated interventions, applied to Conwy catchment.
- Mapping of individual ES and their changes in the Conwy catchment and identification of areas of trade-off and co-benefit.
- Document the linkage between Farmscoper and LUCI and develop as tool for Integrated Modelling Platform
- Document ES analysis procedure for trade-offs and co-benefits and develop as tool for Integrated Modelling Platform
- Develop protocol and documentation to assist platform end-users in repeating the modelling and procedures demonstrated by this exemplar in other UK catchments.

Milestones:

- Scope out Case Study (Feb 2015)
- Develop model documentation for the Platform (March 2015)
- Identify and source FIO model/module (April 2015)
- Start conditioning and ingestion of data and models with documentation into Platform including model input and outputs (June 2015)
- Completion of first model application outputs and testing with Community Forum (Nov 2015)
- Start conditioning and ingestion of external data and models into Platform (June 2016)
- Iteration to identify benefits of model coupling (Nov 2016)
- Final report (Mar 2017)

Link to Enduser Questions:

Effectiveness of measures / mechanisms

- Capture uncertainty in effectiveness of measures – understanding timescales of response and implications for economics.
- What is the combined impact of multiple pressures, biological response, and the effectiveness of measures

Evidence of outcome

- 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

Integration / focus / scaling

- Integration of models across receptors / objectives to identify co-benefits and trade-offs; to help justify / prioritise action depending on local objectives, priorities and characteristics

Uncertainty, confidence and communication

- What is the uncertainty associated with modelling the different effectiveness of measures?

LM0308: Catchment Management for Water Quality

Case Study 2: Effectiveness of land management policies and agri-environment interventions for reducing pollutant loads and maintaining environmental quality at the national scale.

Lead: Richard Gooday (ADAS); Peter Daldorph (Atkins)

Purpose: To determine the potential impact of an agri-environment scheme on total pollutant loads (from all sectors) entering watercourses for England, and any additional consequences of scheme implementation for national GHG emissions.

Policy driver(s)	Water Framework Directive (achieving Good Chemical Status)
Enduser(s)	Government Agencies
Pollutant(s)	Nitrate, phosphorus (for all sectors) Sediment, ammonia, nitrous oxide, methane and carbon dioxide (agricultural sector only)
Measures	Countryside Stewardship (previously Countryside Stewardship)
Scenario if appropriate	Long term impact of the implementation of approximately 30 mitigation methods representing major / common options within Countryside Stewardship
Outcome / output	Percentage change in total pollutant load for each catchment. Percentage change in national GHG emissions from agriculture. Cost of scheme implementation.
Scale / Location	England (3,800 WFD catchments)
Risks	IPR issues over data used in WQ0223 to develop SEPARATE is a critical issue to resolve that requires Defra/EA assistance.

Background / Narrative:

The new environmental land management scheme, Countryside Stewardship, is proposed to be more targeted with more focused agreements for the benefit of the environment. There is a need to assess the potential impacts of this scheme in terms of pollutant reductions and other environmental outcomes, to help assess the cost-effectiveness of the scheme.

The results of this case study will show how stakeholders can determine where best to focus resources to encourage implementation of Countryside Stewardship which will achieve the greatest or most useful reductions in pollutant loads, taking account of some of the uncertainty in the reductions achieved through Countryside Stewardship and the potential cost to the industry (outside of any recompense associated with scheme enrolment).

Basic approach:

The intention of this case study is to link the changes in agricultural pollutant loads predicted by Farmscoper for a given scenario with a source apportionment tool which determines the contribution to the pollutant load from agriculture and other sectors. In previous applications of this type, Farmscoper has been paired with the SAGIS tool (Source Apportionment Geographical Information System). However, the Farmscoper/SAGIS linkage has only been carried out on a few well-studied catchments. There has been no national scale application of this type because existing source apportionment models (such as SAGIS) were developed primarily for catchment scale applications.

A recent Defra project (WQ0223) developed a new national scale multiple pollutant (nutrients and sediment) source apportionment screening framework for England and Wales. SEPARATE (SEctor Pollutant AppoRtionment for the AquaTic Environment) includes export to aquatic systems from both diffuse and point sources and summarizes the source apportionment on the basis of WFD cycle 2 waterbodies. This case study will link Farmscoper outputs describing changes in pollutant loads for different scenarios to the SEPARATE tool to evaluate effectiveness of scenario measures in improving water quality in WFD cycle 2 waterbodies.

The most recent version of Farmscoper incorporates a catchment-based calculation that operates at Water Management Catchment Scale (92 catchments representing England), whereas source apportionment input data is typically at waterbody scale (approx. 3,800 catchments representing England), so there is the potential for enhancement of the linkage between the two models.

A number of different scenarios will be applied within Farmscoper / SEPARATE to assess the uncertainty in the reductions in the agricultural load associated with the policy being modelled. The exact suite of the mitigation methods currently available within Farmscoper that will be used to represent the potential impact of Countryside Stewardship will be agreed with Defra. This can be a refinement of a previous assessment of the appropriate methods done under Defra Project WQ0223 (before Countryside Stewardship was finalised).

Case studies 1 and 2 are similar in that the consequences of land management policies and agri-environment intervention schemes to reduce multi-pollutant runoff are being examined. Both studies consider catchment scale responses as a starting point and evaluate co-occurring effects on ES. However, the case studies differ in their approaches for incorporating integrated modelling to address broader aspects of the topic.

Case study 1 starts at the catchment scale using Farmscoper but combines Glastir interventions in Wales with the LUCI modelling tool to disaggregate to smaller scales, evaluating the effects on ES at the scale of implementation (field or farm). Because of the greater spatial detail, case study 1 is implemented in a single catchment, the Conwy River in Wales, as an exemplar. At this smaller scale of resolution, the broader effectiveness of the policy at the national scale is potentially lost, but it becomes possible to evaluate effects on a range of ES and to identify trade-offs and co-benefits operating at the scale of uptake and implementation of the interventions. This can provide feedback to development of the next policy initiative and/or help to target specific local instances of implementation that enhance co-benefits and minimize trade-offs.

This case study (2) also starts at the catchment scale using Farmscoper, but then combines Farmscoper / SEPARATE to extrapolate to larger scales providing assessments for thousands of catchments from regional to a national scale using Countryside Stewardship scenarios for England. As the scale increases, information about the linkages among interventions and ES (occurring both at field or farm scale) is potentially obscured, but a broader more-policy relevant perspective is obtained (effectiveness at national scale).

Case studies 1 and 2 are thus complementary in the added information they provide through an integrated modelling framework. Case study 1 highlights the increased spatial information that can be derived from ensemble models which can be used for more efficient targeting and evaluation of agr-environment interventions. Case study 2 demonstrates the ability to extrapolate from ensemble models to regional and national scales to provide policy relevant evidence and information.

Models to be used:

- Farmscoper
- SEPARATE

Data to be used:

- Inputs
  - Agricultural census by WMC
  - Robust Farm Type counts by WMC
  - Point and diffuse loads for WFD waterbodies
- Outputs
  - Agricultural pollutant reductions at WMC scale
  - Cost of scheme implementation at WMC scale
  - Pollutants loads at approx. 1km lengths along 1:50k river line
  - Reduction in total pollutant load at waterbody scale
- Validation
  - Harmonised Monitoring Scheme data
  - Existing national source apportionment and scheme impact assessments

Other requirements:

- Contact Chris Burgess to identify any synergies
- Inclusion of Adie Collins and Pam Naden PIs of the Defra-funded project WQ0223: Developing a field tool kit for ecological targeting of agricultural diffuse pollution mitigation measures.
- Economic work would be beyond scope due to scale of Case Study but to be discussed with Defra for priorities across Case Studies

Workplan:

- Extraction of existing SEPARATE data to determine the total loads and agricultural contribution at waterbody scale
- Scenario simulation with Farmscoper to determine reduction in the agricultural load at WMC scale and an assessment of the uncertainty in this reduction
- Development of a routine to link Farmscoper outputs with SEPARATE outputs

Milestones:

- Scope out Case Study (Feb 2015)
- Develop model documentation for the Platform (March 2015)
- Start conditioning and ingestion of data and models with documentation into Platform including model input and outputs (June 2015)
- Completion of first model application outputs and testing with Community Forum (Nov 2015)
- Start conditioning and ingestion of external data and models into Platform (June 2016)
- Iteration to identify benefits of model coupling (Nov 2016)
- Final report (Mar 2017)

Link to Enduser Questions:

Effectiveness of measures / mechanisms

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

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?

Integration / focus / scaling

- Integration of models across receptors / objectives to identify co-benefits and trade-offs; to help justify / prioritise action depending on local objectives, priorities and characteristics

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Case Study 3: Costs and benefits of mitigation measures to reduce pollutant concentrations for the protection of drinking water in river-systems upstream of intakes.

Lead: P Daldorph (Atkins); Andy Wade (University of Reading)

Purpose: To demonstrate benefits of reduced compliance risk and water treatment costs against different upstream pollution control measures taking into account the costs involved by both water companies and other actors.

Policy driver(s)	Drinking Water Directive (Drinking Water Inspectorate) Economic regulation (OFWAT) Water Framework Directive (Environment Agency)
Enduser(s)	Government Agencies (OFWAT, Drinking Water Directive; Environment Agency), Water companies
Pollutant(s)	Nitrate, phosphorus, metaldehyde
Measures	Water company selected measures (catchment and water treatment)
Scenario if appropriate	Application of range of diffuse pollution control measures
Outcome / output	Percentage reduction in peak concentrations, frequency and duration of exceedance of drinking water standards. Predicted impacts on eutrophication/phytoplankton growth (phosphorus). Economic cost-benefit.
Scale / Location	Selected catchment upstream of a drinking water supply intake, following discussion with water company (catchment scale). Location likely to be in South East England although to be confirmed
Risks	Uncertainties related to the degree to which water companies will wish to become involved in the case study Availability of metaldehyde model and the outcome of the community fund call with regard to bringing in expertise on metaldehyde Availability of metaldehyde data IPR issue surrounding SAGIS flows data if SAGIS is used

Background / Narrative:

Water companies need to provide drinking water that meets strict water quality standards. Some of these standards relate to pollutants that arise from land management systems (including agricultural production) operating within water supply catchments. Obvious examples are nitrate and pesticide pollution upstream of surface water river and reservoir intakes. Phosphorus can also cause problems in surface storage reservoirs as a result of eutrophication.

Water companies incur costs in treating sub-standard raw water at their intakes or being required to blend water between sources. They also incur a risk of non compliance that can result in regulatory fines. Upstream mitigation measures could reduce the levels of losses of pollutants from agriculture and hence reduce costs and compliance risk to the water industry. However, such mitigation methods themselves also incur costs to farmers and other land owners. This case study will try to demonstrate approaches to examine the costs and benefits of these two approaches to pollution control to provide an optimum solution for surface waters at the catchment scale. It will also test the benefits of this modelling approach with water industry representatives.

Basic approach:

The intention of this case study is to use selected models to test impacts of measures. Because of the drinking water standards are in the form of maximum permissible concentrations, time series models will be selected; possibly SWAT and INCA to test the impact of a range of agricultural measures as agreed with the water company for a selected catchment. For metaldehyde, the possibility of using expertise SWAT) outside the consortium via the community fund or a modified version of one of the INCA suite of models will be considered.

Farmscoper, along with more specific information on metaldehyde, may be used to estimate the impact and costs of the selected measures which will then be linked to the models. Costs associated with water treatment and management of risk by the operator at an appropriate level of detail will provided by the water company.

Models to be used:

- Farmscoper
- INCA and/or SAGIS models for N & P
- Metaldehyde model (SWAT; yet to be specified)

Data to be used:

- Inputs
    - Agricultural census data
    - Robust Farm Type counts
    - Point and diffuse loads
    - Catchment data required to set up INCA (update existing model) – e.g. River Wensum

- Outputs
    - Agricultural pollutant reductions at intake for specified chemicals
    - Cost of scheme measures
    - Benefit value in terms of compliance risk and treatment requirements (qualitative and quantitative)
    - Commentary from the water company on benefits
- Validation
    - Water company river monitoring data

Other requirements:

- Economic input from water company
- Metaldehyde model via community fund
- Metaldyhyde data from water company

Workplan:

- Engagement with water company in the selection of a suitable catchment (e.g. Anglian Water, Thames Water, Essex and Suffolk Water). Discussions have already taken place with Anglian Water.
- Decision on modelling approach based in part on outcome of community fund
- Scenario simulation with Farmscoper to determine reduction in the agricultural load for the selected pollutants
- Collation of cost information
- Method to input measures impacts into river models
- Run models

Milestones:

- Scope out Case Study (Feb 2015)
- Establish arrangement with water company and select catchment (this will also depend on the availability of models (Feb 2015)
- Develop model documentation for the Platform (March 2015)
- Establish modelling approach to metaldehyde (April 2015)
- Start conditioning and ingestion of data and models with documentation into Platform including model input and outputs (June 2015)
- Completion of first model application outputs and testing with Community Forum (Nov 2015)
- Start conditioning and ingestion of external data and models into Platform (June 2016)
- Iteration to identify benefits of model coupling (Nov 2016)
- Final report (Mar 2017)

Link to Enduser Questions:

Effectiveness of measures / mechanisms

- Assess the effectiveness of measures in relation to peak concentrations and compliance risk – understanding economic implications for the water company and polluter

Uncertainty, confidence and communication

- How much certainty is associated with the measures and model outputs and how useful are they to the water company for decision making
- How much information water companies will wish to share in relation to commercial sensitivities
- Availability of a metaldehyde model and outcome of community funding call

Integration / focus / scaling

- Catchment scale, upstream of an intake. Need to consider relevance for other types of sources

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Case Study 4: Effectiveness of pollution control measures under scenarios of future climate and land cover change at the catchment scale.

Lead: Andrew Wade (University of Reading); Leah Jackson-Blake (James Hutton Institute)

Purpose: To demonstrate the effectiveness of measures given future projections of climate and land cover change at the catchment scale.

Policy driver(s)	Water Framework Directive, New Environmental Land Measures Scheme, Scotland Rural Development Plan, Land Use Strategy for Scotland, Water Environment Fund
Enduser(s)	River Basin Management Planners, Catchment Based Hosts (CaBa)
Pollutant(s)	Suspended sediment, Total Phosphorus, Total Dissolved Phosphorus, Nitrate
Measures	Large scale catchment measures: targeted interventions including reduction in fertiliser and manure application to arable and improved pasture, reduction in Sewage Treatment Works final effluent concentration, and re-afforestation.
Scenario if appropriate	Climate: 3 GCM/RCM combinations from EU FP6 Ensembles (baseline: 1981-2010; future: 2031-2060). The Ensembles data is available free of charge for research, education and commercial work. The data policy is available at http://www.ensembles-eu.org/ and notes that appropriate acknowledgement must be given to the data source. The climate model runs have been biased corrected by the James Hutton Institute. Existing land use scenarios for the 2050s: these are consistent with the Land Use Strategy for Scotland (2011) targets, all scenarios incorporated an increase in woodland cover and two included an increase in arable land area. Four scenarios have been developed, broadly corresponding to the quadrants of the IPCC SRES scenarios representing “World Market” (A1), “National Enterprise” (A2), “Global Sustainability” (B1) and “Local Stewardship” (B2).

Outcome / output	Projections of streamwater suspended sediment, total phosphorus, total dissolved phosphorus and nitrate concentrations for: baseline, baseline + measures, future climate and land cover, future climate and land cover + effective measures.
Scale / Location	The Tarland tributary (74 km^2) drains the most westerly area of intensive agriculture in the River Dee catchment. In 2008, the Tarland Burn was classified as being at 'Moderate' ecological status, primarily due to morphological alterations, namely channel straightening and resultant loss or degradation of habitat. Water quality is also of concern, primarily due to diffuse inputs of nutrients and sediments from agriculture which comprises a mosaic of grassland and arable including beef cattle, sheep, barley and small areas of other crops.
Scale / Location	The village of Tarland has a wastewater treatment works (600 person input). The Tarland sub-catchment has been the focus of the Tarland Catchment Initiative since 2000, which aims to provide a scientific assessment of the efficacy of measures used to improve the aquatic and riparian habitats, in addition to building relationships with land owners and the local community.
Risks	For future applications to all UK catchments, the following datasets must be available as a minimum: mean daily flows, EA, SEPA, NEIA water chemistry data, land cover map, final effluent concentration data, daily precipitation and air temperature. For this specific case study then, for repeatability, the ENSEMBLES data and the JHI mapped projections of 2031-2060 need to be made available or accessible. The model used to generate the estimate of the hydrologically available rainfall and soil moisture deficit needs to be available.

Background / Narrative:

Compliance with the Water Framework Directive is required by 2015 and during the second (2021) and third management cycles (2027) and beyond (Directive 2000/60/EC, Articles 4 and 13). Future population growth, climate change, changes in nutrient supply, agricultural intensification and other land use changes may cause deterioration of water quality in some areas; other areas may see an improvement. Models can be used to quantify how future trends may affect water quality, taking into account uncertainty in future conditions. Models may also be used to assess whether measures put in place to achieve compliance with environmental objectives today are likely to remain effective in the future, thereby helping River Basin Management Planners 'future proof' measures.

Basic approach:

The novelty in this case study is to demonstrate if measures selected to improve the chemical status under the Water Framework Directive are 'future proof', namely if measures implemented to lower streamwater suspended sediment, total phosphorus, total dissolved phosphorus and nitrate concentrations today will still improve the water quality in the 2050s, based on integrated climate projections and land use change scenarios.

The dynamic (daily) response of three pollutants (suspended sediment, phosphorus as total phosphorus and total dissolved phosphorus, and nitrate) will be assessed for a baseline (1981-2010) period and compared to model-based projections for: the effects of measures (fertiliser application reduction, reduced final effluent concentrations); climate and land cover change; climate and land cover change plus those measures identified as effective for the baseline period runs. The assessment of multiple pollutants will be done by using INCA-P and INCA-N.

The baseline + measures case, when run with a phased in measure, can be used to look at the time lag between the introduction of a measure and catchment response, and whether compliance is achieved within a certain (e.g. 20 year) period.

Models to be used:

- Hydrological model to generate soil moisture deficit and hydrologically effective rainfall for input to INCA models
- INCA-P
- INCA-N

Data to be used:

Model	Input	Output and model testing
SMD and HER generator	Daily temperature and precipitation timeseries (source: Met Office for baseline, three RCM/GCM model combinations from the EU FP6 ENSEMBLES project for future scenarios; format: csv)	Timeseries of soil moisture deficit and hydrologically effective rainfall (format: csvs)
INCA-P and INCA-N	Timeseries of soil moisture deficit and hydrologically effective rainfall (source: SMD and HER generator; format: text file) Parameter values (source: various; format: text file) Nutrient budget: annual fertiliser and manure nutrient loads for different crops, timing of application (British Survey of Fertiliser Practice; Agricultural Census data); annual plant uptake rates and growing season dates	As below
INCA-P and INCA-N	Annual N and P atmospheric deposition fluxes DEM-derived data (50m): sub-catchment area, sub-catchment and reach slope, reach length. Also for defining sub-catchments (in combination with stream network data) Land use: Derived from the Land Cover Map of Scotland (2008) for the baseline; future scenarios: (2007)four storylines, linked to the four quadrats of the IPCC SRES scenarios, all consistent with the Land Use Strategy for Scotland (2011) targets (source: James Hutton Institute; format: part of parameter text file).	As below
INCA-N	Sewage effluent inputs (mean annual flow, nitrate, ammonium concentration), abstraction data Data to constrain model parameters (ideal but not essential): groundwater nitrate and ammoninum concentrations, baseflow index, soil nitrogen process fluxes. Data for model calibration and evaluation: mean gauged daily flow, in-stream NO_3^- concentration and fluxes (text file)	Daily timeseries of discharge and in-stream nitrate concentration and fluxes (text file)

Model	Input	Output and model testing
INCA-P	Sewage effluent inputs (mean annual flow, TDP, PP and SS concentration), abstraction data Data to constrain model parameters (ideal but not essential): groundwater phosphorus concentrations, soil properties (texture, nutrient content), phosphorus sorption characteristics (terrestrial and in-stream), average reach width, relationship between stream discharge and velocity, parameterisation of Freundlich P sorption isotherm (terrestrial and in-stream), in-stream sediment texture, baseflow index. Data for model calibration and evaluation: Mean gauged daily flow, observed in-stream concentrations (e.g. TP, TDP, PP, SRP, SS) (text file)	Daily timeseries of discharge and in-stream concentrations and fluxes of TDP, SRP, SS, PP and TP at the outflow from each sub-catchment (text file)

Abbreviations: P (phosphorus), TDP (total dissolved phosphorus), PP (particulate phosphorus), TP (total phosphorus), SS (suspended sediment), RCM/GCM (Regional Climate Model/Global Climate Model)

Other requirements:

None

Workplan:

Description of Model Run	Run Exists?
INCA-P calibration and testing	Y
INCA-P baseline run for 1981-2010	Y
INCA-P run to assess effectiveness of measures on stream water phosphorus concentrations.	N
INCA-P run to assess effects of climate and land cover change on stream water phosphorus concentrations.	Y
INCA-P run to assess effectiveness of measures on stream water phosphorus concentrations under scenarios of climate and land cover change.	N
INCA-N calibration and testing	N
INCA-N baseline run for 1981-2010	N
INCA-N run to assess effectiveness of measures on stream water nitrate concentrations.	N
INCA-N run to assess effects of climate and land cover change on stream water nitrate concentrations.	N
INCA-N run to assess effectiveness of measures on stream water nitrate concentrations under scenarios of climate and land cover change.	N

Milestones:

- Scope out Case Study (Feb 2015)
- Develop model documentation for the Platform (March 2015)
- Start conditioning and ingestion of data and models with documentation into Platform including model input and outputs (June 2015)
- Completion of first model application outputs and testing with Community Forum (Nov 2015)
- Start conditioning and ingestion of external data and models into Platform (June 2016)
- Iteration to identify benefits of model coupling (Nov 2016)
- Final report (Mar 2017)

Link to Enduser Questions:

Future pressures and extrapolation of impacts

- Potential effects of future trends such as population growth, climate change; land-use change, food security and nutrient supply need to be better quantified.
- What are the implications of climate change and agricultural intensification for water quality?
- Future proofing – climate change and other impacts
- How will future land use and climate change affect pressures e.g. N, P, Sediment in water

Evidence of outcome

- 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

Uncertainty, confidence and communication

- What is the uncertainty associated with modelling the different effectiveness of measures?

LM0308: Catchment Management for Water Quality

Case Study 5: Uncertainty in ecological responses to water quality control measures at the river basin scale.

Lead: Richard Williams (CEH); Andy Wade (University of Reading)

Purpose: To demonstrate the attribution of sources of errors and their effects in estimating the ecological response to mitigation methods aimed at nutrient reduction.

Policy driver(s)	Water Framework Directive (ecological quality), Farm Payment Schemes, New Environmental Land Measures Scheme
Enduser(s)	Catchment Managers e.g. those developing River Basin Management Plans and Catchment Based Approach Hosts
Pollutant(s)	Phosphorous and Nitrogen
Measures	Catchment scale measures that can represented in SAGIS and/or INCA-P - Land use change, on-farm measures (from Farmscoper), shading from trees, flow augmentation (at low flows) and final effluent improvements
Scenario if appropriate	River Thames under current climate conditions, baseline and mitigation options (including low-flow mitigation) will be run with a number of model combinations.
Outcome / output	An assessment of the effects of different sources of uncertainty on our estimation of biological effects (algal growth) in a river system. How does this uncertainty compare with the magnitude of the impact of mitigation measures on nutrient concentrations and biological response? How does uncertainty in impact mitigation translate into costs and/or benefits?
Scale / Location	Catchment/ River Thames above Runnymede, SE England Area: 10,000 km^2, 7% Urban, 68% Agricultural Issues: P concentrations, algal blooms, point and non-point pollution sources
Risks	For future applications to all UK catchments, the following datasets must be available as a minimum: mean daily flows, EA, SEPA, NEIA water chemistry data, land cover map, final effluent concentration data, daily precipitation and air temperature.

Risks	The model used to generate the estimate of the hydrologically available rainfall and soil moisture deficit needs to be available. A reliable calibration of the branched version of INCA-P is achieved. For wider and un-restricted use of SAGIS the underlying flow data from Wallingford HydroSolutions needs to be made freely available[1].

Background / Narrative:

There are many sources of uncertainty in trying to predict the results of a particular intervention action in the catchment on the quality of water in a receiving water body. These include uncertainties in the measured data (used for generating loads and assessing model performance), in models used to in-fill measured data (temporally and spatially), in the effectiveness of a particular mitigation measure and in the river models that deliver the final result. This case study will try to estimate where these uncertainties lie for the case of assessing the effectiveness mitigation methods that reduce P (and N) loads to rivers in reducing their concentration and potentially modifying the ecological response e.g. algal growth. How do the uncertainties in the modelling process compare with the actual changes predicted? How can we reduce uncertainty?

Basic approach:

A multi-model approach will be used in this case study in which the models will be run separately and in sequence. The aim is to estimate the uncertainty in the biological response of the river system that results from (1) possible errors in estimates of input loads (2) uncertainty caused by using different models to provide the input instream loads and (3) uncertainty in the effectiveness of mitigation methods. The model chains will allow us to drive one model, QUESTOR, with the input loads from the other models (SAGIS and INCA-P) and compare these with the loads generated from measurement of flows and water chemistry. This will be done for baseline cases representing current conditions. Following this, a range of mitigation options for reducing chemical contaminations and augmententing flows will be explored.. Only gross mitigation options can be readily included. With INCA-P we can look at changes in land use and fertiliser additions on N and P loads reaching rivers reaches. With SAGIS we can look at annual and seasonal reductions in N and P loads across the catchment or from parts of the catchment. It is possible to use FARMSCOPER to specify the percentage changes expected due to a more specific range of farm-scale interventions as is being done in other case studies. All models can consider improvements in sewage works' final effluents.

The study will focus on Phosphorus (but will include also include N) as the driver of biological change. We will develop metrics to define biological change, but it will likely include changes in predicted P and N concentration and algal growth and associated dissolved oxygen (DO) and Biochemical oxygen demand (BOD) change. In a previous study for Defra, the metric we used was days in excess of "unacceptable" threshold concentrations of BOD, DO and chlorophyll-a . Comparing changes in this metrics between the modelled baseline and the modelled scenarios shows the direction and magnitude of change.

[1] There would be no restrictions to those who already hold a licence for LowFlows Enterprise. This would include the Environment Agencies and many Water Companies.

Models to be used:

- SAGIS
- INCA-P
- QUESTOR

Data to be used:

This project will focus on the Thames catchment and this defines the spatial extent of all the data. The data will be for (where possible) existing, calibrated model runs set up for recent periods.

- Inputs
    - QUESTOR dataset 1:
        - Time series of flow and water quality at the boundaries of the existing QUESTOR model simulation and for any STP discharges directly to the river system. These are taken from the National River Flow Archive (NRFA), and the Environment Agency GQA data supplemented by the CEH Thames initiative data.
        - Solar Radiation data time series at one location in the catchment.
        - Observed river quality and flow data (same source as above) for model performance evaluation.
        - Set of model parameters from the model calibration.
    - QUESTOR dataset 2: Contaminant chemical loads to each river stretch or collection of river stretches from the SAGIS Model.
    - QUESTOR dataset 3: Contaminant chemical loads and to each river stretch or collection of river stretches from the INCA Model.
    - SAGIS dataset 1: Driving data base set: Sewage treatment works discharge quality and flows, naturalised river flows, EA WIMS water quality data, diffuse inputs (PSYCHIC/NEAP-N) – **data already included in SAGIS model databases**.
    - SAGIS dataset 2: A number of different datasets (a-e) one for each set of driving data that corresponds with the mitigation measures scenario modelled (see below). Change in the driving data based on predicted changes due to selected mitigation options (N and P).
    - INCA-P dataset 1: Driving data base line:
        - Daily time series of precipitation, air temperature, mean daily flow, and streamwater nitrate and phosphorus concentrations, land cover, fertiliser inputs, sewage work flows and N and P concentrations. These data will be consistent with SAGIS model set-up.
        - Set of model parameters from the model calibration.
    - INCA-P dataset 2: A number of data set (a-d) as INCA Dataset 1, but modified to account for P mitigation options

- Outputs
    - QUESTOR all data sets resulting from the different driving data will be comprised of predicted concentrations of chemicals related to oxygen levels and nutrient species. Temperature, pH and biological variables (phytoplankton, macrophytes and benthic algae). Output at daily time steps. Many plotting options: river profiles, time series or distributions)

- SAGIS
  - All data sets resulting from the different driving data will be comprised of (i) Predicted concentrations for 28 chemicals at a selectable spatial scale (e.g. 1km interval). (ii) Chemical inputs source tracking – 'within sector' contribution from specific upstream sources. (iii) Input load and concentration source apportionment summarised by water body. (iv) Data visualisation – chainage plots showing concentration profile by source along the length of a river.
  - Additional data outputs will be created to act as inputs to INCA and QUESTOR to generate the input files described above.
- INCA-P
  - all data sets resulting from the different driving data will be comprised of Simulated daily mean flows and streamwater TP, TDP, PP, SRP and suspended sediment concentrations. Phosphorus process flux estimates for catchment processes such as, P weathering and estimates of P transport via different flow pathways.
  - Additional data outputs will be created to act as inputs to QUESTOR to generate the input files described above.

- Validation
  - QUESTOR and SAGIS have been already calibrated for the base line driving data set. It is not intended to re-calibrate the models for the other driving data sets, but to see the response of those calibrated models to other sources of driving data.
  - INCA will require water flows and water chemistry data at selected points in the river to perform a calibration of the branched version. These data will come from the NRFA and from the Environment Agency GQA data.
  - Validation data are in all cases based on measured stream water daily mean flows and spot samples of streamwater chemical concentrations. Usually these come from the NRFA and the Environment Agency GQA dataset.

Other requirements:

- Work with Paul Whitehead to adapt new version of INCA (in stream phytoplankton) parameterized to include diatoms, cyanobacteria, green algae, etc.
- Contact Chris Burgess to identify any synergies
- Make contact with Adie Collins and Pam Naden to identify any possible synergies re: Defra-funded project WQ0223: Developing a field tool kit for ecological targeting of agricultural diffuse pollution mitigation measures
- Economic work would be beyond scope due to scale of Case Study but to be discussed with Defra for priorities across Case Studies

Workplan:

<u>Baseline scenarios</u>

These are from (where possible) pre-existing model runs for the River Thames from Hannington Weir (SU5040013800) to Runneymede (TQ1703971391). The base line period is 2010 to 2012. Models for the baseline exist for SAGIS and for QUESTOR. The branched version of the INCA-P model will be setup by April 2015.

All three models will be run for the baseline: INCA-P and will deliver estimates for P species. SAGIS will provide estimates for N and P species. QUESTOR will provide estimates for N and P species plus chlorophyll-a (algae). The differences between the model results s will tell us about uncertainties created by the structure of the model selected for the simulation.

Uncertainty model runs with the baseline

The QUESTOR river model will be run with driving data from the SAGIS and INCA-P models. The QUESTOR outputs for N, P and algae from these runs will be compared with the baseline runs to assess the difference made by using different driving data.

INCA-P and SAGIS will provide flow and concentration data to replace the observed data used by QUESTOR. INCA-P data will be daily data (flow and P), SAGIS will provide monthly average data (flow, N and P). The current observed data is available weekly.

Comparison of N, P and algae concentrations generated by the baseline, and two scenarios will be compared.

Mitigation Methods for reducing algal growth.

There will be at least 4 approached tested

1. Increased river shading provided by growing tree on the river bank (shade scenario): QUESTOR only
2. Flow augmentation to reduce residence times in summer low flows (flow scenario): QUESTOR and INCA-P.
3. Land use change at a gross level in parts of the catchment. The details of the nature of the change and the extent and locations are yet to be decided. This will be done using INCA-P and the data will driver QUESTOR (land use Scenario, there could be more than one of these).
4. Changes in farm practice. A national case study is looking at baskets of farm practices to reduce N and P loss from catchments. The percentage change in loss rates is calculated by Farmscoper. The values for the Thames basin will be extracted and applied to the SAGIS loads. The resulting SAGIS outputs will be used to drive the QUESTOR model (farm practice scenario).
5. The effect of imposing stricter discharge consents for SRP on sewage works that are less than 10,000PE in size. A suitable consent level will be agreed (P point scenario).
6. The effect of imposing stricter discharge consents for NO_3 on all sewage works. A suitable consent level will be agreed (N point scenario).

The effects of the mitigation options will be assessed in terms of the changes in distributions of N,P and algae at at least three locations along the River Thames: Upstream, Middle (below Oxford) and that Runneymede. Foe algae we will also compare days above a threshold that would be deemed unacceptable. We will compare the changes in these metrics for the mitigation measures with the differences in the baseline runs and the differences caused by the different driving data.

The possibility of putting tools on the data/model platform server to allow this comparison (or any combinations of comparisons will be investigated.

Actions required:

- Andy Wade will implement the branched version of INCA-P for the agreed temporal and spatial scale end of March 2015).
- Richard Williams will provide the current QUESTOR reach structure so that this can tie in with the INCA-P branch structure (30th January 2015).
- Richard Williams will provide the list of locations where QUESTOR requires input of water quality. These are in general the upstream model point and at all tributaries entering down to Runnymede (30th January 2015).
- Peter Daldorph to provide appropriate SRP and NO_3 consent levels for the point source scenarios (mid February 2015).
- Andy Wade to suggest gross land use change that might be appropriate for the land use scenario based on outputs from the EU FP7 REFRESH project (March 2015).
- Peter Daldorph to get N and P percent reductions for the Thames catchment from suitable mitigation options using Farmscoper runs in Case Study 2 (March 2015).

Milestones:

- Scope out Case Study (Feb 2015)
- Develop model documentation for the Platform (March 2015)
- Establish the common spatial and temporal extent for the parallel applications of QUESTOR, INA and SAGIS. Also how to transfer output data from SAGIS to INCA and QUESTOR and from INCA to QUESTOR Agree on mitigation options and how they will be enacted in SAGIS and INCA. Agree on metrics to assess results of mitigation measures. Agree time frame, catchment extent, input data and mitigation measures to be included as scenarios. (Apr 2015)
- Start conditioning and ingestion of data and models with documentation into Platform including model input and outputs (June 2015)
- Completion of first model application outputs and testing with Community Forum (Nov 2015)
- Start conditioning and ingestion of external data and models into Platform (June 2016)
- Iteration to identify benefits of model coupling (Nov 2016)
- Final report (Mar 2017)

Link to Enduser Questions:

Future pressures and extrapolation of impacts

- Potential effects of future trends such population growth, climate change; land use change, food security and nutrient supply need to be better quantified.

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

- What is the combined impact of multiple pressures, biological response, and the effectiveness of measures?

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.

Lead: Jack Cosby (CEH); Andy Wade (Reading)

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.

LM0308: Catchment Management for Water Quality

Year 1 report

March 2015

Appendix Task-3

Database for model selection and the model evaluation protocol: Report submitted to Defra, Feb, 2015.

LM0308: Catchment Management for Water Quality

Database for Model Selection

12th February 2015

By

Richard Gooday, ADAS

Andrew Wade, Reading

John Watkins, CEH

Model Database

Introduction

As part of this project, a model selection tool will be developed to provide easily accessible, clear information by which users can select the most appropriate models for a particular job. The tool will incorporate a database that summarises knowledge on model pedigree and performance, and by transferring this knowledge to the user community they will gain an understanding of the advantages and disadvantages of each model and a knowledge of model past performance.

The intention of the model database is to allow users to view descriptions of the available models and assess their suitability for a given task. Critically it will also show where and for what purpose those models have been previously applied, along with an evaluation of each of these applications. The application aspect of the model database allows users to see if someone has already attempted a task comparable to what they wish to do (and direct them to reports for that study, or, if the model output is included within the portal created as part of this project, the output datasets of that study) or simply to show the types of work that a model is capable of and has been used for. The database will also show where multiple models have been applied together to answer more complex problems. The database will be populated with policy questions that have been asked and the models used to answer them, rather than constructed purely as a database of models, which is an approach felt more relevant to the users of this database.

The database is structured around records for two components – models and applications. There will be one record for every model, and a record for every application. An application can involve the use of more than one model, and models can be linked to more than one application (Figure 1).

The amount of data required by the database has been designed such that it is not too onerous to enter the details for a new record, whilst still retaining sufficient information as to be useful. Once data describing a model has been entered into the database along with its first application, other applications can then refer to that model record, thus enhancing the efficiency of subsequent data entry for similar applications.

The database is initially to be populated with the models used for the case studies within this project, with the case studies recorded as model applications. Continued use of this database will help to ensure the legacy of the overall project, and the database will become more useful and informative as further models and model applications are added to it.

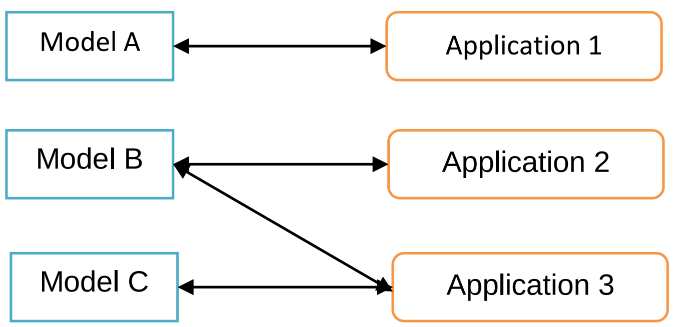


Figure 1 Example relationships between models and applications in the model database.

The will be a number of data items for each model and application (see sections below). In order to allow users to easily search the databases and compare the results returned by a search, the data items will be classified into two tiers. By default, the items in tier 1 (annotated with a * in the sections below) will be the data items that are initially searchable and for which the data for all models/applications that match the search criteria will be shown. The user will then be able to look at the items in tier 2 for any of the selected results. An advanced setting should allow for the user to also do the initial search using a number of the tier 2 items.

Where possible, data entry options will be constrained by option lists to speed up the processes of both data entry and searching the database. This is most relevant to 'structural information', where a user might be wanting to search for a "catchment scale" "nitrate leaching" model, or 'application data' where a user might wish to search for models used to assess the "effectiveness of measures" or "climate change sensitivity". Such items are likely to be tier 1 data items, as they will rapidly constrain the choice of appropriate models / previous model applications.

The initial population of the database with the models used for the case studies will be the first step in the testing of the database. The development of the database will be enhanced through interaction with the forum and project management board. Interaction with the project management board will be particularly useful, as this should ensure they are able to query the database in a way that they find intuitive and that returns useful results in an informative way.

Model Data

Model data consists of background information on the model (termed general information) and details on input and output data and process representation within the model (termed structural information). The structural information includes four items that are based on the assessment and pedigree concept from the 'NUSAP' convention (Funtowicz and Ravetz, 1990), which help specify the confidence in a model that can be ascribed based on whether it has been published and widely tested, the level of process-detail and the quality of the data used in a typical application.

General Information

- *Model name
- Version
- Release date
- Model family (e.g. the various INCA models could be linked by this)
- Model description
- Screenshot (a simple way to show model complexity and ease of use)
- Model owner & contact details
- License requirements (all models currently in the database should have no restrictive license restrictions, but this allow for the inclusion of other models with more restrictive use)
- Operating requirements
- Application type (whether the model is provided as uncompiled code, an executable, is web-based etc)
- Target user (an indicator of how simple the model is to use, e.g. modeller; consultant; non-scientist)

- Documentation (background documentation, either embedded as a file or included as a link to a website)
- Key references (the main sources of information on model description, as opposed to model application)

Structural information

- *Smallest and largest application (to show the range of scales at which the model can be applied, typically ranging from plot – field – farm – catchment – country)
- Smallest output unit (e.g. a model applied at catchment scale could produce output at 1 km^2 resolution)
- Geographic restrictions (e.g. is the model only appropriate for certain areas or land uses)
- *Temporal resolution (scale at which the model operates e.g. hourly – daily – monthly – annual)
- Input data (a description of main input data sets, and potentially where these are available on the portal developed as part of this project)
- *Key outputs (what the primary purpose of the model is, e.g. predicting nitrate losses)
- Output data (a longer description of various model outputs)
- Calibration required
- Model structure (e.g. from complex process representation to a statistical model)
- Data input (e.g. are the majority of the key parameters expert based or derived from observed data)
- Input process validation (the extent to which the internal workings of the model have been validated)
- Output data validation (the extent to which the ultimate outputs of the model have been validated)

Application Data

The database will also serve as a knowledge base of past model applications, which can be searched to help a user determine if a model is potentially useful. This knowledge base will be enhanced by recording user assessments of model performance which can then be searched by others. Part of the evaluation will be based on a scoring system, which will only be based on the views of end users and not the model developers.

General Information

- Project title
- Record ID (allocated when web form submitted)
- Associated records (needed if more than one model in chain or ensemble - each record relates to one model.)
- Date
- *Study site (the name, location and short description of the study site or area)
- *Study scale (the spatial extent of the study e.g. catchment, national)
- *Project objective (a short description of the aim and objectives of the project, which could be constructed from a list of items based on the key questions identified within this project)

- Modelled outputs (key outputs produced by the model for the application. This list could be constrained by the static model data - use web-based forms that are dynamic to update selection list)
- Project description (a short summary of the project methodology and purpose – a short description of the modelling task).
- Model (the model used which could be chosen from a drop down list linked to models in Static Model Database)
- Version (the version of the model used)
- Other models used (any other models used in a model chain or ensemble)
- Version (the version number of the additional models)
- Linkage (a description of how mulitple models were used: independently, chained, ensemble)
- Funder Details (the name of the project sponsor)
- Modeller Details (the person who ran the model and their contact details)
- Input Data (a short description of the data used as input. This field will have to be free text given the number of different datasets that could be used).
- Links to input and output datasets held on the platform

Evaluation

For every model application, the following will be noted to help evaluation model performance and the robustness of the application and outcomes.

- Sensitivity (was a sensitivity analysis done – Y/N? if so a description of the method is required and a short description of the outcomes)
- Uncertainty (was an uncertainty analysis done – Y/N? if so a description of the method is required and a short description of the outcomes)
- Validation (was the model output validated – Y/N? if so a description of the method is required and a short description of the outcomes)
- Link to report (this field is for a hyperlink to the project report)

There will then be short section where the person who applied the model can summarise their experience of using a particular model or models, via a series of option boxes. A scoring system could be used to rate model performance.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The model was able to address the user question(s)	o	o	o	o	o
The model was easy to use	o	o	o	o	o
The user manual was useful	o	o	o	o	o
The data to run the model were obtainable	o	o	o	o	o
The model was understandable in how it worked	o	o	o	o	o
The model was of an appropriate complexity to address the project objectives	o	o	o	o	o

The model outcomes were reliable	○	○	○	○	○

* The model creators will not be allowed to answer those questions in bold

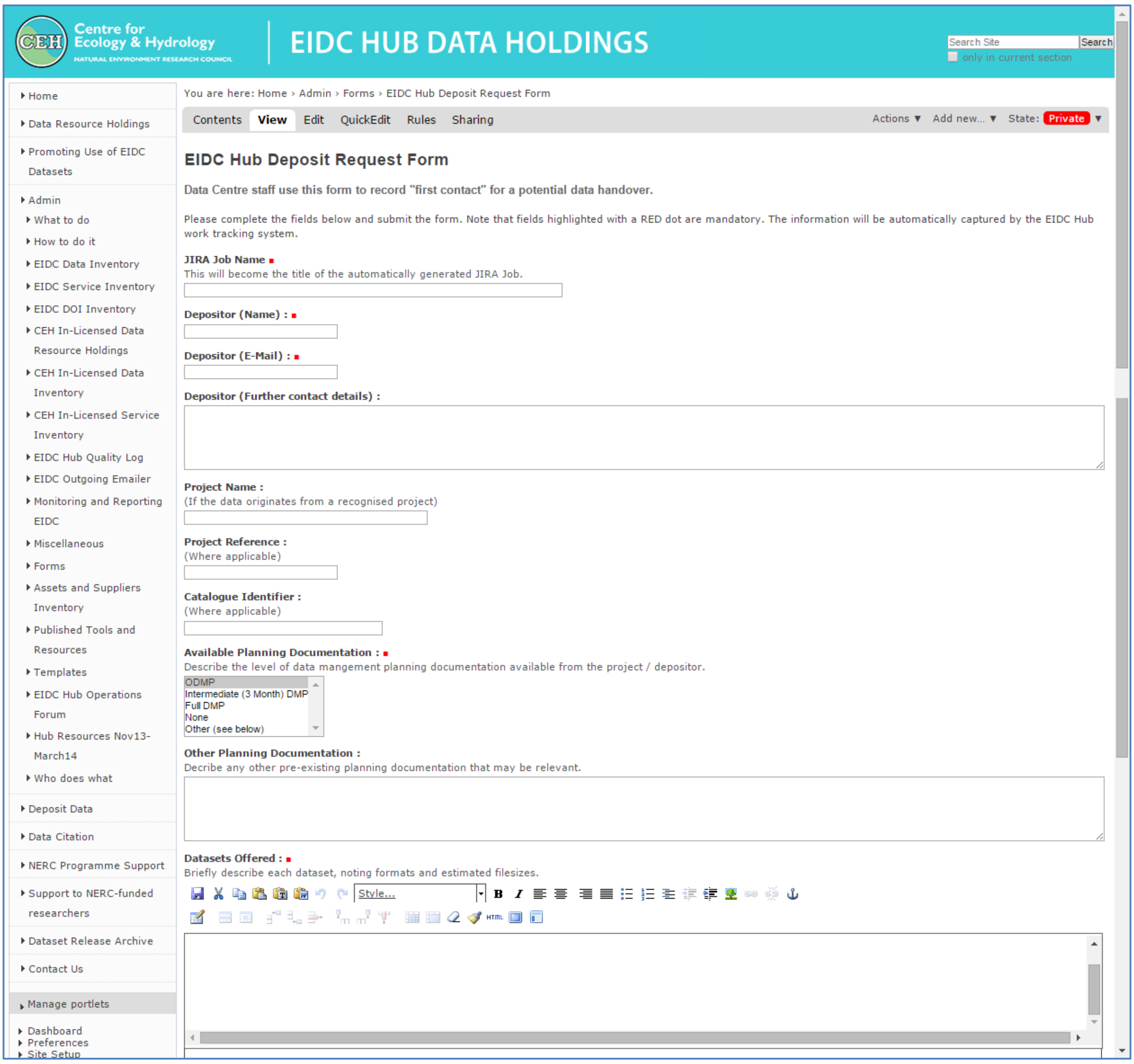
The final section in the model application section is a free text box for an overall evaluation of the model performance.

Implementation

We propose to progress the implementation of the modelling database, its information content, functionality and user interface, by presenting functional web pages as soon as possible that can then be refined and developed with the users over a number of iterations. We intent to use the Plone web content management system (CMS) for this development, which is a widely used and supported open source product (https://plone.org/).

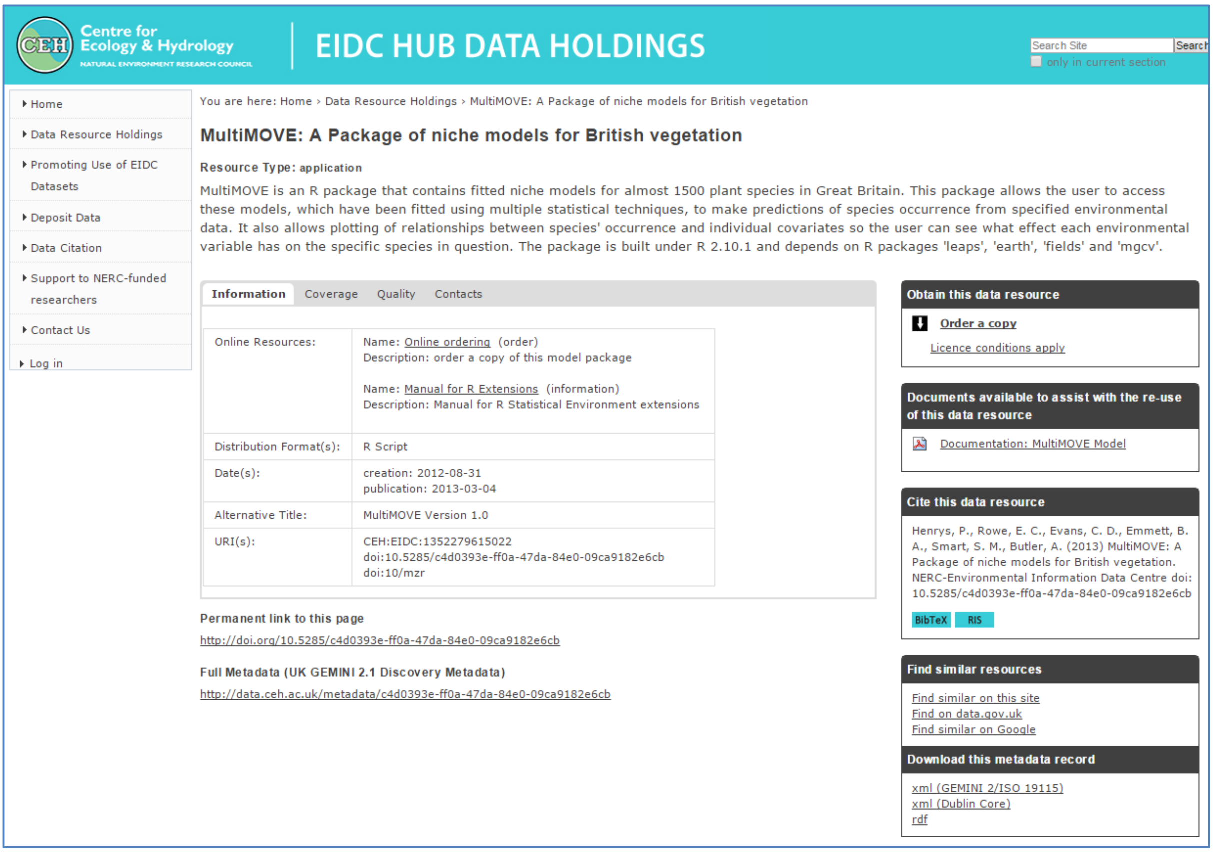
The Plone CMS approach will allow forms to be rapidly created that can capture and display the information elements required. Restructuring these forms to present or capture different information is then minimal effort compared to restructuring a traditional database application.

The forms presented can be fully functional with user prompts and document editing tools for more detailed content allowing a full range of information types to be captured. The figure below shows the type of web forms that can be produced and easily adapted. Forms to capture the data elements listed above will be produced and presented to users as the first stage system development.



The information captured by the CMS forms can be easily searched through the CMS search facilities available through a standard free-text search box in the web interface. The content can also be made available to search engines, such as Google, to allow discovery through general web searches.

The information content can be presented is a wide range of formats to suite the requirements of different users. The figure below shows a Plone web page presenting information for a model held within the CEH EIDC data centre with particular information types and links to supplementary information in side panels. This is tailored to the requirements for delivery of information to the EC INSPIRE / UKLP regulations and includes a DOI reference.



Presentation of captured information for the model database can be similarly tailored to particular requirements including references to other sources of information and the delivery services to download the models and relevant data. As this is a web application it can easily be linked to other existing web services to access models such as the CEH EIDC pages shown.

We feel that this user-centric, web information management approach to implementation will be the most efficient to produce a database for model discovery and access that can meet evolving requirements and link to of the existing web-based facilities provide by model owners.

References:

Funtowicz SO, Ravetz JR. 1990. Uncertainty and quality in science for policy. Kluwer Academic Publishers, The Netherlands.

LM0308: Catchment Management for Water Quality

Year 1 report

March 2015

Appendix Task-4

Datasets used by consortium model applications, mapped against list of provisional datasets.

Land cover and land use

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
LCM grid	CEH Land Cover Map 2007 (1990, 2000) 1km grid			Y			
LCM vector	CEH Land Cover Map 2007 vector polygons					Y	
EDINA agcensus	June Ag Census data on 1km grid, redistributed from parish boundary level totals						
Detailed June agricultural census data	Farm scale data on all agricultural and livestock, for selection of farms across the UK		Y, for livestock numbers, farm numbers, etc.				
Full IACS data	Sub-field scale agricultural data for all areas of land receiving subsidies.						

Farm practice and related data*

*Within Task 2, ADAS are collating datasets used within Farmscoper and identifying and describing new datasets of farm practice information. This work will involve discussion with consortium modellers regarding their preferred farm practice data for use within modellers, e.g. whether a wide range of raw survey information, summarised survey information, or synthesised parameter values based on expert analysis of survey information are preferred.

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
Fertiliser application rates	British Survey of Fertiliser Practice		Y	Y (Fertilizer additions of N & P)			
Defra and other surveys – numerous, including Farm Business Survey, Farm Practices Survey, Cattle Tracing Scheme			Y	Y			

Diffuse source loads / inputs

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
Farmscoper catchment losses	Farmscoper catchment scale average loads for multiple pollutants for ~100 water management units (EA)						
PSYCHIC P and SS outputs	PSYCHIC model 1km gridded estimates of phosphorous and sediment load (based on 2012 Ag census)	Y, phosphorous aggregated to waterbody scale, SS used with FOREGS data to estimate metals from sediments					
NEAP-N model outputs	NEAP-N model 1km gridded estimates of nitrogen load	Y, aggregated to waterbody scale					
FOREGS geochemical atlas	Measurements of chemicals, including metals, including from top soil, sub-soil, stream sediments	Y, metals, including other data on summarised to waterbody scale and used with PSYCIC SS data and other literature on soil organics					
Atmospheric pollution datasets	Defra / CEH atmospheric pollution datasets, annual for past decade, various pollutants						

Point source loads / inputs

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
EA WIMS database	Data for effluent discharge points	Y, for effluent load			Y, for effluent loads		
SAGIS outputs	Catchment scale summary of pollutant sources from a range of sources						
MCERTS data	Environment Agency statutory monitoring of emissions	Y					
EA SEPTIC tank	Currently unspecified EA dataset on septic tank locations and potential loads	Y - alongside additional informatio n					
Highway runoff pollutant loads	WRc produced 1km grid of pollutant inputs from highways	Y					
Urban runoff pollutant loads	SAGIS data on pollutants from urban areas, based on rainfall, CORINNE urban areas and literature	Y					
SAGIS minewater pollutant loads	Based on WIMS data and EA spreadsheets	Y					
SAGIS storm tank and CSO pollutant loads	Based on EA location information and monitoring data	Y					

Water quality measurement data

		SAGIS	Farms coper	INCA	QUESTOR	LUCI	SEPARATE
EA WIMS samples	Samples for various purposes	Y, for calibra tion					
CEH Thames monitoring data	Detailed 2-weekly monitoring of various chemicals / pollutants				Y		
DTC monitoring data	High resolution monitoring in DTC catchments						
JHI Tarland monitoring				Y			
EA high resolution monitoring	Currently no further information						
Water company datasets for specific regulatory purposes, e.g. metaldehydes							
BGS Baseline geochemical survey				Y (GW P and N)			

Volumetric influences on rivers

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
EA NALD abstraction database	Raw database of licensed abstractions, including actual use information on monthly and daily basis for larger abstractions						
EA CAMS ledgers	Pre-processed influence information for abstractions and discharges within each CAMS water body						
LowFlows influence data	Pre-processed set of artificial influence data, at points across flow duration curve, for WFD water bodies				Y		

Weirs, etc.

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
EA river obstructions datasets	Locations of weirs and other assets within rivers, sometimes containing the vertical height of barriers				Y		

River flows

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
WHS Low Flows influenced flow duration curves	Modelled monthly flow duration curves adjusted for abstractions, discharges and impoundments, based on best estimate of artificial influences at points across UK (consistent with CAMS but currently available data is out of date)	Y			Y		
Grid to grid natural modelled flow time series	Modelled natural flows (i.e. not incorporating artificial influences) for all 1km grid cells across the UK						
National River Flow Archive daily flow time series					Y		
Environment Agency river flow data	Largely available via the NRFA	Y					
Future flows	Modelled river flows under different climate scenarios for 100+ gauging stations across GB						

Meteorology and climate

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
UK CIP daily baseline	5 km gridded daily temperature, rainfall, PE, etc.			Y			
CEH-GEAR	1km gridded daily rainfall dataset, updated annually						
SAAR	1km grid of Standard Average Annual Rainfall (from Met Office)					Y	
MORECS	40km grid of various meteorological parameters, including temperature, actual and potential evaporation, soil moisture (Met Office Rainfall and Evaporation Calculation System)					Y	
BADC	Rainfall, and other meteorological point data, archived for the Met Office for research use				Y (radiation data, modified for tree shading)		
CHESS driving data	1km gridded daily temperature, radiation, humidity, PE, etc.						
Future flows climate	Gridded rainfall and PE projections for 11 ensemble members under SRES A1B emission scenario, bias corrected fir hydrological application from UKCP09						
EU ENSEMBLES project climate scenarios	Climate scenarios from EU ENSEMBLES project (ensembles-eu.metoffice.com/docs/ENSEMBLESDatasets.pdf)			Y			

Tree shading

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
EA tree shading dataset	Relative reduction in summer radiation provided by tree cover (not all GB)						
EA tree dataset	Trees above 2.5m (some issues, not all GB)						
Bluesky Tree database	Full UK coverage tree dataset						
CEH woody areas dataset	Woody area dataset (trees above 2m based on NDVI data), currently Wales only though more limited dataset exists for all UK						

Catchments

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
Water Management Areas	EA large-scale water bodies		Y				
WFD water bodies	River catchments / sections above water body monitoring points (rivers, lakes, tidal waters)	Y					
EA CAMS areas	EA Catchment Management Strategy catchments						
CEH Integrated Hydrological Units	Catchments for sections of all GB rivers						

Digital Terrain Models

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
CEH IHDTM	Hydrologically corrected DTM at 50m resolution						
NextMap DTM	5 or 10m resolution DTM					Y (this dataset is appropriate to fine scale application)	
OS Terrain5	5m DTM						

River networks

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
OS Open Rivers	Rivers dataset at ~1:100k						
EA WFD rivers	WFD Rivers based on EA Detailed River Network	Y (processed for use within SAGIS) - shapefile					
CEH river network	1:50k networked river dataset				Y (via LowFlows 2000)		
EA DRN	Environment Agency Detailed River Network					Y (this is the dataset appropriate to fine scale application)	
OS Water Layer	Up to 1:2.5K networked river dataset (previously EA Detailed River Network)						

Soils

		SAGIS	Farmscoper	INCA	QUESTOR	LUCI	SEPARATE
Harmonised World Soils Database	FAO / IIASA global soils database on 30’ grid						
CEH HOST	Soil classifications, at 1:50k scale, based on hydrological properties			Y (for Baseflow index)			
NatMap vector	Vector soils dataset at 1:250K scale from Cranfield					Y (this dataset is appropriate to fine scale application)	
1:25K soil map of Scotland	JHI derived soil map			Y			
1:250K soil map of Scotland	JHI derived soil map			Y			
Scottish Soils Information and Knowledge Base	JHI data including phosphorus content, depth of topsoil, bulk density, grain size distribution			Y			

LM0308: Catchment Management for Water Quality

Year 1 report

March 2015

Appendix Task-6

First Community Funding Call, March 2015

LM0308: Catchment Management for Water Quality

1st Funding Call

March 2015

Introduction

The aims of the Catchment Management for Water Quality initiative are:

- to provide better access to data and modelling through the development of a web-based data and modelling platform;
- to explore approaches to enable more integrated modelling to deliver holistic solutions for multiple pollutants, services & policies;
- to support the development of a community of practitioners, policy makers and scientists to develop future questions and encourage joint working.

One task of the project is the identification of 7 key current and emerging questions relating to policy development and implementation in the areas of water and air pollution through consultation across the community. Data and models selected to explore these questions would be prioritised for making available on the Catchment Management Integrated Data and Modelling Platform to be launched in 2017. Analysis of the benefits realised through coupling of models for each questions will also be hosted on the platform as a series of Case Studies to provide a resource for the community.

Development of questions

Individual discussions were held with 47 individuals representing 13 organisations, and following this, workshops were held with over 48 people representing more than 40 different organisations from the water environment sector, including representation from Wales, Scotland and Northern Ireland. All the information gathered through the individual consultations and workshops was used to set out a list of >280 individual questions which have been collated and combined into 120 broader questions covering a range of topics and 6 over-arching Themes (Figure 1).

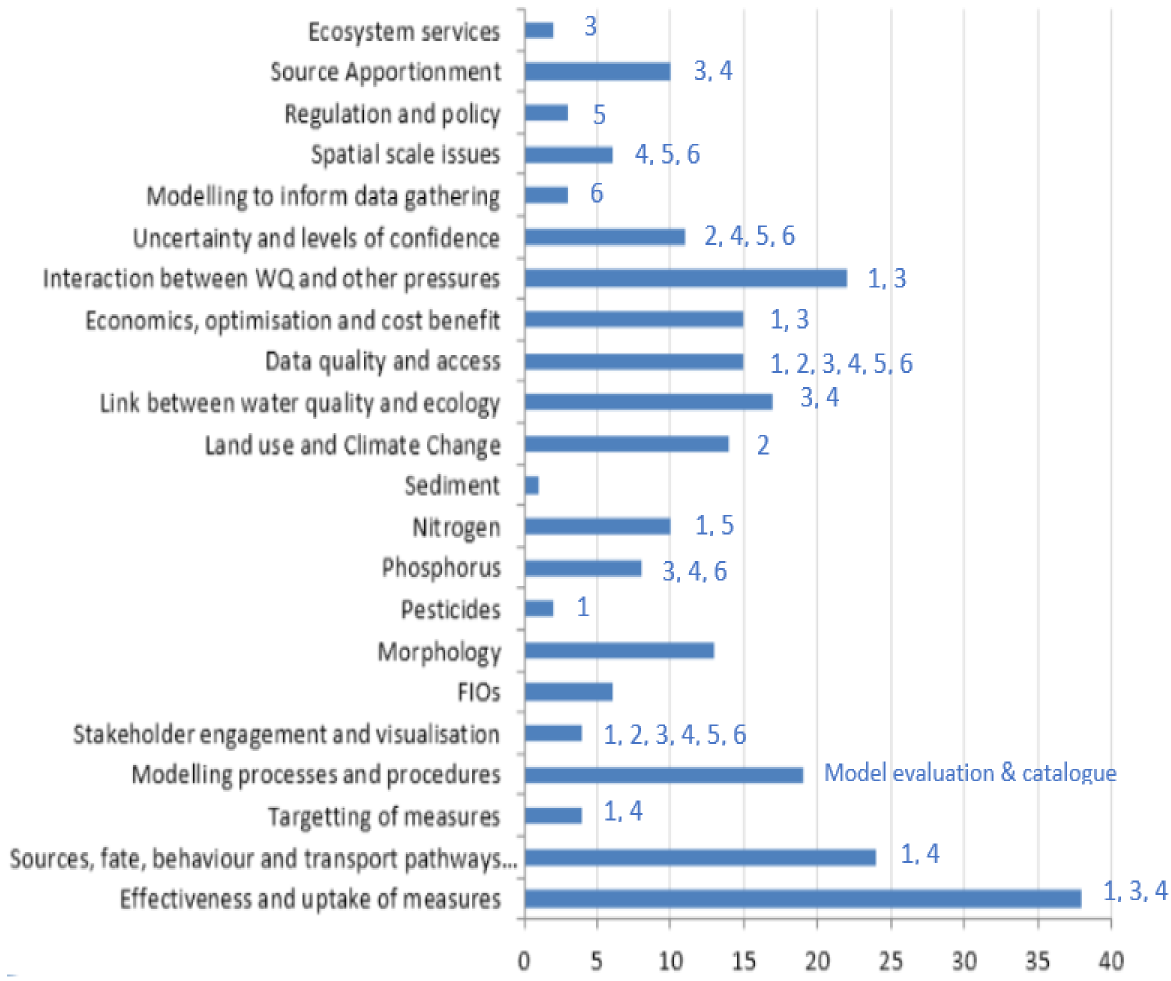


Figure 1 Results of analysis of community questions relating to topic and 6 over-arching Themes. The bars indicate the number of stakeholder questions involving each topic; the numbers after the bar indicate the over-arching theme into which the questions were collected.

Further analysis of the questions identified some questions as out of scope of the project as they were either fundamental research questions, too large and complex for the project or already explored in other projects. Remaining questions were then prioritised with the support of the Project funders and the project external Management Group to ensure a wide range of issues are covered including:

- Scale
- Effectiveness of measures
- Multiple pollutants
- Interpolation from catchment to national and monitored to unmonitored sites
- Performance of catchments under future climate change
- Cost –effectiveness of measures
- Apportionment
- Uncertainty and ensemble approaches

The following Case Studies have been developed out of these questions:

Case Study 1: Multiple pollutant and ecosystem services responses to land management policies and agri-environment interventions at the farm to catchment scale.

Lead: Jack Cosby (CEH); Richard Gooday (ADAS)

Purpose: To examine potential trade-offs and co-benefits for a suite of ecosystem services at the farm to catchment scale that may be potential 'by-products' of an agri-environment scheme designed to reduce total multi-pollutant loads entering watercourses.

Case Study 2: Effectiveness of land management policies and agri-environment interventions for reducing pollutant loads and maintaining environmental quality at the national scale.

Lead: Richard Gooday (ADAS); Peter Daldorph (Atkins)

Purpose: To determine the potential impact of an agri-environment scheme on total pollutant loads (from all sectors) entering watercourses for England, and any additional consequences of scheme implementation for national GHG emissions.

Case Study 3: Costs and benefits of mitigation measures to reduce pollutant concentrations for the protection of drinking water in river-systems upstream of intakes.

Lead: P Daldorph (Atkins); Andy Wade (University of Reading)

Purpose: To demonstrate benefits of reduced compliance risk and water treatment costs against different upstream pollution control measures taking into account the costs involved by both water companies and other actors.

Case Study 4: Effectiveness of pollution control measures under scenarios of future climate and land cover change at the catchment scale.

Lead: Andrew Wade (University of Reading); Leah Jackson-Blake (James Hutton Institute)

Purpose: To demonstrate the effectiveness of measures given future projections of climate and land cover change at the catchment scale.

Case Study 5: Uncertainty in ecological responses to water quality control measures at the river basin scale.

Lead: Richard Williams (CEH); Andy Wade (University of Reading)

Purpose: To demonstrate the attribution of sources of errors and their effects in estimating the ecological response to mitigation methods aimed at nutrient reduction.

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.

Lead: Jack Cosby (CEH); Andy Wade (Reading)

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

A 7th Case Study focussed on the interpolation of data from catchment to national and monitored to non-monitored catchments is under-development.

The Case Studies can be matched to the issues as follows:

Table 1 Summary of issues covered by the 7 Case Studies

	Case Study Number						
	1	2	3	4	5	6	7
Effectiveness of measures							
Performance of catchments under future climate change (and land management)							
Cost –effectiveness of measures							
Apportionment							
Uncertainty and data quantity and quality							
Interpolation from catchment to national and monitored to unmonitored sites							
Multiple Pollutants	Sediment; N; P; FIO; (biodiversity; carbon; flood mitigation)	N; P; FIO; agri-GHG	N; P; Met-aldehyde	Sediment; N; P	N; P	Based on Case Studies 1-5	To be agreed
Multiple scales	Catchment	National	River System	Catchment	River Basin	Catchment - National	Catchment – National

Funding Call

Purpose

The project team has brought into the project a range of resources which are available for the Case Studies and which will be made freely available on the platform. A Community Fund is available to provide support for additional resources to be brought into the project to ensure maximum user impact and uptake. Examples of activities eligible for funding could include:

- involvement in / data provision for case studies
- provision and conditioning of critical national data
- provision of a critical model, potentially with enhancement to make more user friendly / suitable for user needs, all with documentation;
- model conditioning for integration with other models
- visualisation / ensemble tools

Critically, any resource funded must be made freely available for use by the community on the platform.

Funding topics

In this first call funding is available in 3 areas to provide early input into the development of the Case Studies.

Area 1) – Faecal Indicator Organisms (FIOs) mobilisation and transport

Case Study 1 will be using the Farmscoper and LUCI models) to explore effectiveness of land management interventions at the catchment scale. A FIO mobilisation and transport model is sought to complement this work to demonstrate the benefits of considering multiple pollutants.

Models to be used include:

Farmscoper - http://www.adas.uk/Services/Service/farmscoper-397

LUCI - http://www.victoria.ac.nz/sgees/research/research-groups/enviro-modelling/ecosystem-service-modelling

LUCI - http://www.lucitools.og/

LUCI - http://neat.ecosystemsknowledge.net/pdfs/polyscape_tool_review.pdf

Contact: Jack Cosby (jaccos@ceh.ac.uk) or Richard Gooday (richard.gooday@adas.co.uk) for more information.

Area 2) – Metaldehyde pollution

Case Study 3 will be exploring the benefits of pollution control measures and water treatment costs. Expertise and tools which would expand this work to include metaldehyde is sought.

Models to be used include:

INCA - http://www.reading.ac.uk/geographyandenvironmentalscience/research/INCA/

SAGIS - https://connect.innovateuk.org/documents/2779724/7364681/Jenny+Grubb+paper.pdf/

SWAT - http://swat.tamu.edu/

Contact: Peter Daldorph (peter.daldorph@atkinsglobal.com) or Andy Wade (a.wade@reading.ac.uk) for more information.

Area 3) - Data-rich catchment exemplars

Case study 6 is exploring the effects of data quality and quantity on evaluation of land management interventions at a catchment/local scale. Exemplar sites which are rich in data are sought to provide a test-bed for the Case Study together with an ecosystem service mapping/modelling tool to compare to outputs from a selection of models applied in Case Studies 1-5.

Models to be used include (see above for web links to these models):

LUCI, INCA, Farmscoper, SAGIS

Contact: Jack Cosby (jaccos@ceh.ac.uk) or Andy Wade (a.wade@reading.ac.uk) for more information.

Selection criteria

- Contribute to the case studies
- Typical award amount £10-35k (an exceptional case could be £50k)
- Be practical and aligned to technical requirements of the platform
- Be deliverable in a time frame to ensure the Platform can benefit. Last award will be agreed 1st March 2016 with delivery required 6 months before the end of the project on 29th Feb 2017.
- Any tool must be provided under the licensing and IPR arrangement required by the funders i.e. freely available and downloadable from the platform
- No fundamental model development will be supported; only conditioning or coupling of existing models for use on the platform

The Project Team will advise on practicality of proposals and pass to the Funding Panel. If short-listed , there will be iterations with the project team and panel to ensure good fit to case studies and platform. Administration of the fund will be administered by CEH with purchase orders / subcontracts issued ensuring appropriate IPR / licensing arrangements consistent with Defra requirements.

Application forms should be emailed to Bridget Emmett (bae@ceh.ac.uk) by 5pm March 31st 2015. All submitted proposal emails **MUST** have the subject title "Catchment Management Community Proposal"