Oxford to Cambridge
Integrated Water Management Framework

Rethinking Water Planning

Approach 1

Systems approach to Integrated Water Management (SIWM)

Overview

At the heart of this approach is the ambition for a portfolio of interventions/measures to be selected for investment and delivery based on their value to the whole water system, not just to individual disciplines needs.

It does this using a high-level mass-balance integrated model. We elected to use Imperial College's 'Water Systems Integration Modelling Framework' (WSIMOD) model, you can find further information in our Integrated Modelling section. This modelling approach has previously been used in the Sub-regional integrated water management strategy for East London.

Sub-regional integrated water management strategy for East London PDF

The model is designed to test the in-combination effects of the current interventions put forward through each of the statutory planning processes. Then through iterative refreshes, and the inclusion of alternative options, the portfolio of interventions is refined to maximise benefits across the water system while meeting statutory needs.

Note:

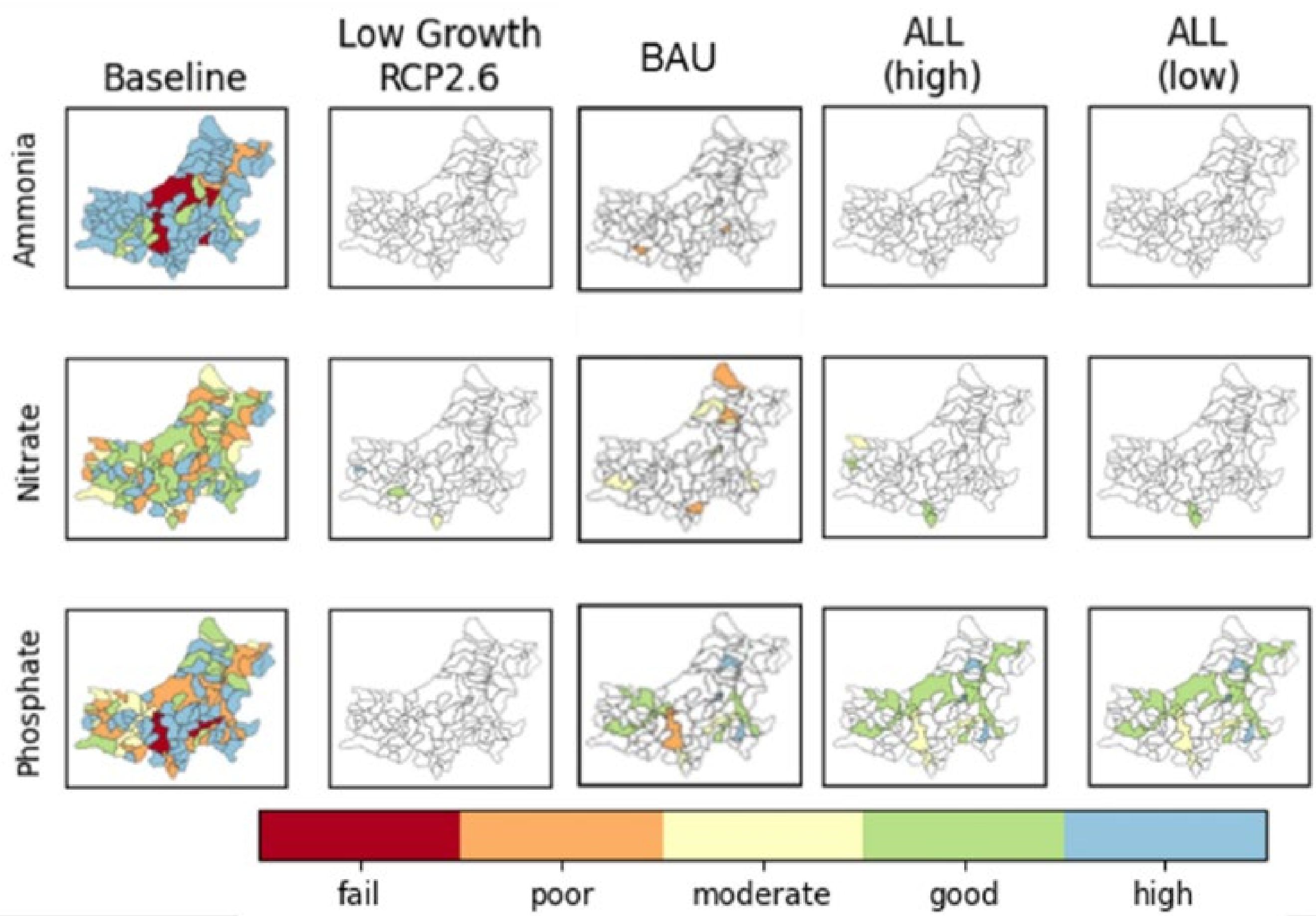
The integrated modelling is not expected or intended to replace the in-depth topic specific modelling that is undertaken to support and inform statutory water planning processes. The modelling is designed to supplement existing processes to allow the in-combination and secondary order effects (both positive and negative) to be highlighted. For example: A flood risk project uses natural flood management to hold water in a catchment. A positive second order effect of this may be that there is an increase in groundwater recharge which has a positive water resources benefit. A negative second order effect may be that the increased groundwater recharge may lead to an increase in ground water flood risk.

Why did we choose to build an approach around integrated modelling?

When defining the scope of this project the inclusion of modelling was not a requirement. The requirement was to design approaches that would bring the planning of different water disciplines together. However, having explored integrated modelling in a previous project phase we were pleased to see it as a suggested approach and to build on prior experience.

Integrated modelling was chosen as a test approach because:

- It uses and provides numerical values to provide context;
- It can consider the in-combination effects of multiple options;
- It can highlight potential benefits and disbenefits that may not otherwise be considered; and
- The results can be presented via tables and/or visually through maps.



Maps showing a summary of modelling results

Metrics

To assess the benefits of the portfolios of interventions we used a selection of metrics these can be split into two categories:

Quantitative:

- Phosphate, ammonia and nitrate concentrations
- Changes to Water Framework Directive status
- % of phosphate load reduction target met
- Richards–Baker Flashiness index
- Q5 flow (flow that is equalled or exceeded for 5% of the time – high flows)
- Q90 flow (flow that is equalled or exceeded for 90% of the time – low flows)
- Phosphate load
- Cost
- Number of days below Hands off Flow

Qualitative:

- Invertebrates
- Social amenity
- Biodiversity net gain
- Soil health
- Suspended sediments
- Carbon benefits

The stepped approach

Step 1
Collect data

Step 2
System concept & mapping

Step 3
Baseline modelling / model set up

Step 4
Set up the future scenarios in the model

Step 5
Model group of interventions

Step 6
Assess proposed portfolio of interventions

Feedback and review of modelling results

Results & inclusion in statutory (investment) plans

Step 1: Data collection

Compile data required for analysis and modelling.

- Model set up and validation: historic river flows; historic water quality measurements; abstraction licence quantities; estimated rainfall.
- Intervention options: gather from published plans, draft plans, and additional options that haven't made it into existing plans. When including interventions that are not in existing plans, work would be undertaken to create and scope these alternative interventions.
- To be considered for inclusion in the approach these intervention options need to meet certain data standards. For example, by having a scale and location applied to them.

Step 2: System concept and mapping

Taking a systems based approach and mapping the system begins with stakeholder engagement. Engagement can be facilitated through Participatory Systems Mapping (PSM). PSM has a variety of uses and content can vary based on the needs of the geographical area but should be based on the following:

- Identification of system metrics and priority metrics
- Definition of the study area boundaries
- Definition of the scenarios (climate scenarios/growth scenarios) to be tested.

Approach 1 (Systems approach to integrated water management) was applied in case study 1 and case study 2. Case study 1 successfully used PSM to identify key project metrics. These were metrics that could be represented in the integrated model and used as proxies for the metrics used within individual discipline planning. Of the metrics identified through this process, four were selected as our portfolio development's primary 'target'. These were used to choose which interventions went into our 'alternative' portfolios, in other words, these were the metrics that we were focused on improving.

Step 3: Baseline modelling/model set up

An integrated baseline model is created. In our test/trial applications of this approach, we applied an amended version of the Water Systems Integrated Modeling framework (WSIMOD) approach (see technical note for further details).

The baseline model needs to be validated by comparing it against historical data to assess if the model performance is representative of the water system.

The validation assessments that were undertaken as part of our proof-of-concept case studies showed a mixed level of confidence. It is the Environment Agency project team's conclusion that if this method was to be deployed to influence investment decisions, then a higher level of confidence would be required in the model performance.

Step 4: Scenario modelling

When modelling interventions scenarios need to be forecast to assess the selected portfolios against a range of possible futures.

The time horizon that the process is being applied over should also be considered, again aligning with existing processes is advised. Our time horizon was 2050.

In the trial we considered two future scenarios:

Benign:

- Low climate change (Representative Concentration Pathway (RCP) 2.6.)
- Low growth (Office for National Statistics (ONS) low growth)

Adverse

- High climate change (RCP 8.5.)
- High growth (ONS high growth)

Step 5: Set up of interventions ready for modelling

Each of the interventions for consideration by the model need to be defined. These interventions are from published/draft plans (Water resource management plan (WRMP), Drainage and waste water management plan (DWMP), River basin management plan (RBMP), Flood Risk management plan (FRMP) etc.), and additional interventions identified by partners and stakeholders. There are minimum data standards for the inclusion of intervention options. Some of the definition requirements are:

- General location of intervention (which water bodies they are deployed within)
- The scale/size of the intervention
- Whether they are big enough to have an impact at the waterbody level.

Step 6: Modelling different option combinations

The targets that are required for each of the key metrics must first be set and then an iterative process of modelling various portfolios (groups of interventions) needs to be undertaken to identify the best portfolio. This best portfolio will be the one that meets the various disciplines plan's targets/ambitions and hopefully improves the environment.

For each of our demonstrations of the approach, through the two case studies, we ran two iterations as proof-of-concept: (i) Low Ambition and (ii) High Ambition. This is not the approach that we would advocate in a real setting, however it allowed us to provide proof-of-concept of using the modelling to compare multiple portfolios. When applied in a real-world setting, more time would be spent sourcing detailed data of interventions, and a greater number of iterations of the model run as needed.

Step 7: Implementation

At this point, in a real-world scenario, the final portfolio of interventions is fed into the statutory water planning process. How exactly this is achieved will need further consideration before being undertaken as part of a real planning cycle. It is anticipated that each of the stakeholders would consider the 'preferred portfolio' and build the appropriate recommended options into their respective plans. There remains a question around the funding of these options, especially where an alternative intervention/portfolio costs more than an existing intervention/portfolio. Time may be required for the industry, regulators, and funders etc. to adjust/buy-in to less traditional intervention outputs as a result of this process.

Lessons and recommendations

Cross-disciplinary engagement

- The process brings together various stakeholders, enhancing relationships and creating a shared/more holistic understanding of the catchment/system and the respective statutory plans across the various water disciplines.
- A systems map provides a useful focal point for stakeholder engagement and ensures there is a shared understanding of the interdependencies and influences beyond an individual organisation's sphere of responsibility.

Resources

- In the trials we were unable to undertake an iterative approach to portfolio selection, due to resource constraints. This challenge might continue if the approach is deployed, unless carefully programmed into the future plan making processes. It is important to make the time for this because iteration is key to the benefit of the approach.
- This approach would require an additional investment of time from all the key stakeholders, along with agreeing responsibility for hosting and facilitating the process. We think that the benefits of a more coordinated plan, both in terms of the environment and perhaps efficiencies from working together would outweigh this.

Integrated modelling

- The modelling provides an in-context indication of the impacts of interventions within catchments.
- However, the mass balance integrated modelling was unable to represent smaller interventions, meaning that the process will need to accommodate these interventions through a parallel consideration.
- This type of integrated model is unable to represent the details of discipline specific modelling e.g. water and wastewater network modelling. This needs to be clearly understood by all with a feedback loop built into the process that allows for the outcomes of discipline specific modelling to be fed in.
- To represent the business as usual portfolio's performance, all options from the plans need to be represented in the model. For example, in our trial some emerging Water Industry National Environment Programme (WINEP) options were not yet available for use/application in the project in time.
- There was mixed confidence in the validation of models in both case studies. In general, there was a high level of confidence in the lower catchments and a lower level in the upper catchments. We are unsure of the full reasons behind this, we have a few possible theories, for example it may be because the upper catchments are at the start of the mass balance model, whereas the lower catchments had information from the upper catchments feeding in or it may be because larger rivers are easier to model.
- *Case study 2 included an extra module within the modelling to better represent groundwater. The results of this were variable, but in general increased the scores when validating the modelled flow.

Process

- The identification of options/interventions through iterative modelling focuses the selection on what can be quantified and represented. Therefore the wider qualitative metrics have not been used to drive option selection. This is likely to align with how options are selected within current processes but may not be representative of where we would like selection to go in the future.

- The approach has highlighted the benefits of assessing water interventions in a river basin/catchment setting, particularly where that planning process sits at a different spatial and temporal scale.

- The two case studies have both identified significant in-combination risks of business-as-usual portfolios on key environmental objectives for the catchments. However caution needs to be applied to this conclusion because not all business-as-usual options were modelled in this proof of concept.

- When applied in a real-world scenario more work will be needed to align the metrics available within the model and the statutory targets within the plans. For example, understanding if the new portfolios allow water companies to meet the water resources supply/demand targets.

- During the case studies the systems mapping exercise did not significantly influence the subsequent modelling work, above or beyond what a baseline systems map could have achieved with a small amount of local guidance.

- There remain a few outstanding questions which require further exploration to determine the effectiveness of this approach in a real-world setting:

    - The funding of options identified for multiple benefits
    - How this process would work within/as part of the staggered delivery of statutory planning cycles
    - Who would lead on the integrated modelling and drawing together of plans

Data

- If taken forward the requirements of this methodology could be used to encourage industry wide improvements and standardisation of option definitions in plans.

- The data standard of interventions/options in the current plans need to be improved for them to be able to be represented in the integrated modelling.

- In some cases, due to timing of the project, data on intervention measures i.e. through WINEP wasn't available. In reality, the methodology would be run at the most optimal time for data inclusion.

- Cost information on planned measures was difficult to obtain from existing plans which made it impossible to carry out a realistic cost comparison or a cost-benefit analysis of the portfolios.

Conclusions

The complexity of the system, minimum data requirements, and time/resource required to run enough iterations to validate results were prohibitive for a project of this size. However, as a proof of concept trial, we have illustrated that given sufficient time, resource, and adequate stakeholder support a systems modelling led approach to intervention selection is possible leading to beneficial systems-wide outcomes.

The project

Project background and purpose

Project background, purpose, approach and conclusions PDF

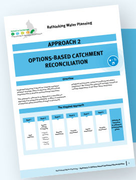
Techniques applied in the trials

Integrated Modelling summary PDF

Participatory Systems Mapping PDF

Trialling ways to achieve the ambition

Approach 1: Systems Approach to Integrated Water Management (SIWM) PDF



Approach 2: Options-Based Catchment Reconciliation PDF