Long-Term Large-Scale Project

River Biology

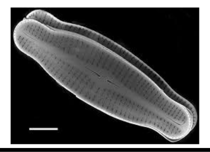
Don Monteith[1], Peter Henrys[1], Vicky Bell[1], Martyn Kelly[2], Ed Tipping[1] & Jo Pitt[3] 1) NERC Centre for Ecology & Hydrology and 2) Bowburn Associates 3) Environment Agency

Linking IM output to ecological quality

- The ecological status of surface waters is tightly linked to macronutrients concentrations.
- So is ecological quality, as determined by Water Framework Directive (WFD) tools, related to N and P concentrations for waters predicted by the IM?
- If so, can we use IM forecasts of future nutrient concentrations to predict ecological status?

The species composition of diatoms, a diverse group of siliceous algae that grow attached to submerged stones and plants, provide one of the key indicators of ecological status of running waters under the EU WFD. Deviation in composition from that expected for unimpacted waters is expressed as an Ecological Quality Ratio and subsequent classification of sites into High, Good, Moderate, Poor and Bad classes.

Achnanthidium minutissimum, a key indicator species, is often abundant in waters with soluble reactive phosphorus (SRP) concentration below 100 µg L^{-1}.



Approach: EA diatom WFD ecological quality classification of 1800 flowing waters in England and Wales (using the DARLEQ2 tool) were related to the mean annual Total Dissolved Phosphorus (TDP) and nitrate concentration predicted by the LTLS integrated model for the corresponding 5 km grid square and nine surrounding grid squares.

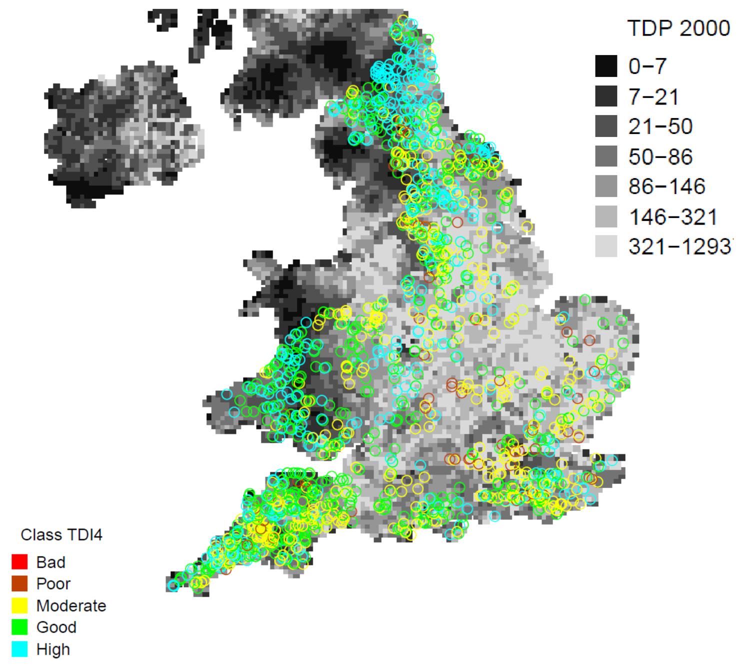


Figure 1: Contemporary WFD Phytobenthos- (diatom-) inferred ecological status (colour coded) superimposed on 5 km gridded mean annual TDP concentration (grey shading) predicted by the Integrated model.

Findings:

- Discrimination of mean TDP by diatom-inferred ecological status class was highly significant.
- There was no signification relationship with mean nitrate concentration.
- Subsequent probabilistic modelling provides the potential to predict spatial changes in the phytobenthos metric from IM-inferred changes in TDP at regional to national levels.

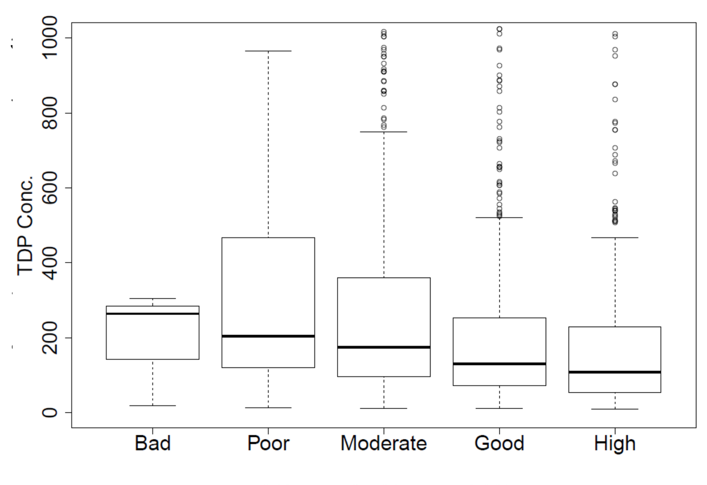


Figure 2: IM-inferred mean annual TDP concentration ranges classified by diatom-inferred ecological status for sites within the associated grid square.

Conclusions

Spatial variation in ecological status, inferred by the WFD phytobenthos metric, corresponds well with IM total dissolved P predictions

Contact: Don Monteith (donm@ceh.ac.uk)

Scenarios

Rachel Helliwell[1], Ed Tipping[2], Jess Davies[3], Pam Naden[2], Vicky Bell[2], Ulli Dragosits[2], Tony Dore[2], Shibu Muhammed[4]
1) The James Hutton Institute, 2) Centre for Ecology and Hydrology, 3) Lancaster University, 4) Rothamsted Research

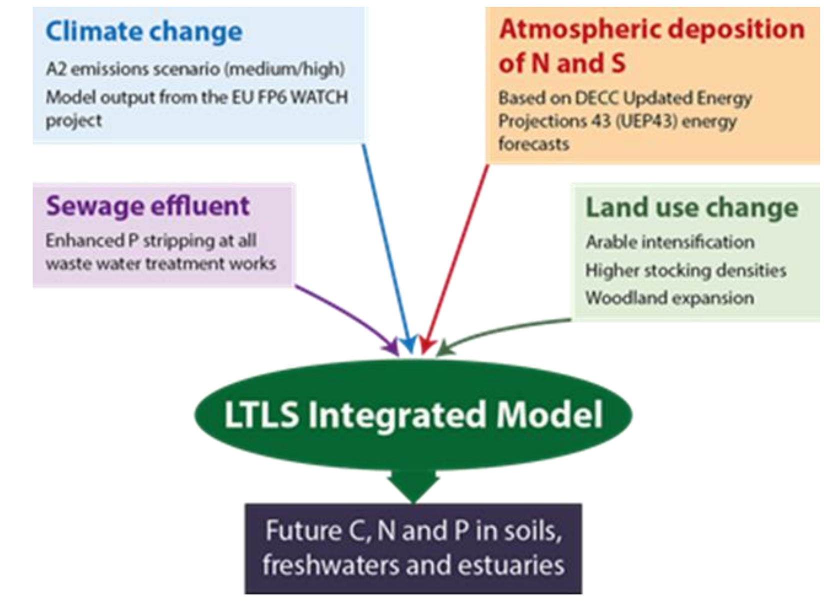
Drivers of change

LTLS models were developed to provide useful information to policy makers and environmental regulators on how multiple pollutants interact and alter in form in response to future changes in:

- Climate
- Land use
- Atmospheric pollution
- Sewage effluent

To help plan, manage and protect the environment, stakeholders were engaged in the process of constructing scenarios so model outputs were relevant and fit for purpose.

Drivers were modelled separately and in combination, allowing stakeholders to target the most effective action.



Drivers of change

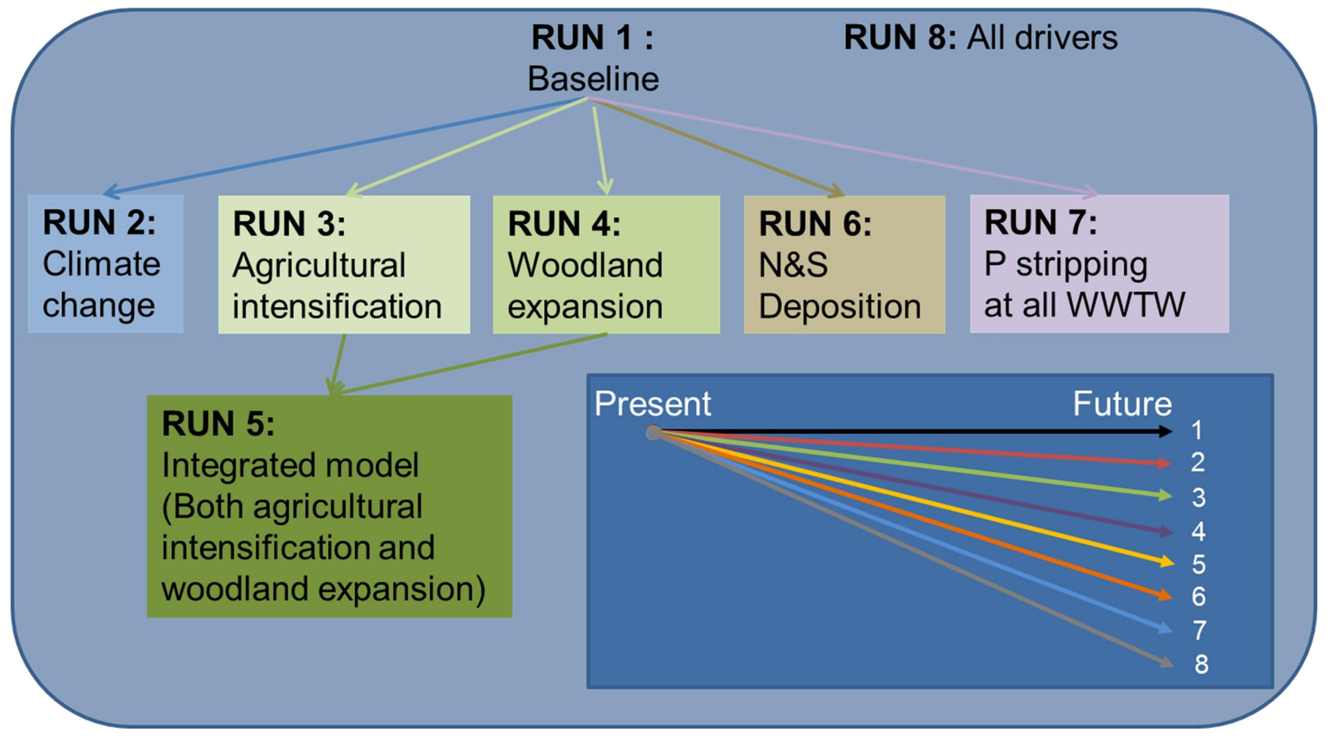
Models can help determine:

- If policy measures in place are having an effect
- The timescales required to meet policy targets
- If policies can be joined up to deliver multiple benefits (win-wins) across a policy areas
- How to spatially target policies to achieve greatest benefit and cost effectiveness.

Baseline projections: The baseline model run for the future is based on 1800-2010 for all drivers except climate. For climate, the enhanced WATCH data for the period 1800-2001 was used, then the control climate scenario from 2001-2100.

Future projections: The outputs from related projects or desk studies on land use, deposition and water treatment were used to drive the LTLS suite of models and the Integrated model into the future.

The LTLS modelling team sequentially ran their models to demonstrate the model capability and sensitivity to each driver.



Scenario Framework (*WWTW- Waste Water Treatment Works, S- Sulphur, N- Nitrogen*)

What issues can the models address?

Whilst acknowledging a) the limitations of national scale model assessments, data quality and availability,
b) the preliminary nature of the model output produced as part of the LTLS project,
we suggest that the LTLS modelling allows these topics to be addressed:

- For strategic purposes, an integrated analysis of air, land and water macronutrient pools and annual fluxes of C, N and P for different landscape units (large river basins, regions and UK wide assessments)
- How long-term changes in N deposition impact other ecosystem services e.g. greenhouse gas regulation (both storage and losses)
- Whether sustainable agricultural intensification can increase productivity and achieve soil and water quality targets
- The effect of woodland expansion on soil carbon stocks and dissolved organic carbon in rivers draining semi-natural habitats
- The impact of population growth and new waste water treatment technology (P stripping) on future river P loads
- Timescales of change; e.g. non-agricultural soils respond slowly to atmospheric deposition; whereas rivers respond quickly to reductions in sewage effluent or a reduction in the use of inorganic fertilisers.

Conclusions

- To enhance impact, and maximise the uptake of results, stakeholder engagement in co-constructing scenarios is important.
- Models are useful tools for strategic planning, if the limitations are recognised and understood.
- Models cannot replicate the complexity of the real world. Results tend to represent averages conditions and the bigger picture.

Contact: Rachel Helliwell, rachel.helliwell@hutton.ac.uk