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Science for Environment Policy

Nitrogen pollution models reviewed

Computer models can be powerful tools when developing policies to address nitrogen pollution from agriculture. In a new study, researchers have made recommendations regarding the best design and use of these models to aid the effective implementation of European legislation on nitrogen.

Water bodies polluted with excess nutrients, such as nitrogen, may experience eutrophication, which reduces levels of oxygen in the water and damages aquatic wildlife. In the EU, nitrogen pollution is mainly regulated through the Nitrates Directive, the Water Framework Directive (WFD), the Groundwater Directive and the Marine Strategy Framework Directive.

Despite some success in improving water quality, nitrogen pollution is still a major concern. This is partly because some EU Member States have not yet fully implemented the relevant regulations, but also because the ecological benefits of pollution mitigation measures may not be apparent for many years.

Models provide a valuable way of identifying strategies to reduce nitrogen losses from agricultural land which can help Member States achieve good ecological and chemical status of waters by 2015, as stipulated by the WFD. Modelling can also indicate how long it will take for water quality to improve in response to measures, and can help predict and compare the impacts and costs of nitrogen policies.

In this study, the researchers reviewed a number of models used in Europe to assess nitrogen mitigation strategies. From this, they identified a number of ways in which models can be of use and made recommendations for the effective design of these powerful tools:

1. There are uncertainties associated with modelling the complex processes in nitrogen pollution, but these can be reduced through evaluation and validation. For example, modelled results can be compared against extra measurements taken in catchments and the validity of results can also be assessed by stakeholders, based on their local knowledge.
2. Models are useful to investigate the time lag between implementing mitigation measures and observing environmental responses in a river basin.
3. Models can improve the cost-effectiveness of reducing nitrogen pollution by identifying areas where mitigation measures will have the most success and the optimal time to implement the measures.
4. Models must account for the range of scales involved in tackling nitrogen pollution. For example, mitigation measures occur at the farm scale, but their impact must also be considered at the river basin and continental scales.
5. Avoid pollution swapping and ecosystem service swapping. For example, model assumptions should not allow one ecosystem service to be compromised for the sake of another.
6. Bio-economic models, which combine physical and biological processes of nitrogen cycling and economic decision behaviour, can be used to achieve a balance between economic costs, agricultural management and environmental protection.
7. The modelling process can be improved by taking into account stakeholder knowledge and concerns from the earliest stage of model development.

This study highlights the value of models in exploring mitigation options that reduce nitrogen in water from agricultural sources and to support the implementation of measures in Member States.