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111. Sustainable optimization of nutrient budgets and co-benefits for other pollutants to ensure clean water

Ellerkamp, C.[a*], Meers, E.[b], Sigurnjak, I.[b], Wang, M.[a], & Strokal, M.[a]

Wageningen University & Research, The Netherlands a; Ghent University, Belgium b; *Corresponding author, email: carolin.ellerkamp@wur.nl

Introduction

The European Union "GREENHOOD" project (Horizon-CL6-2024-Zeropollution-01-1) has started at the beginning of 2025. The main goal is to demonstrate how regions can operate within safe ecological and regional nutrient budgets. We will integrate the insights from four demonstration sites (Spain, Belgium, Norway, Finland and the Netherlands) into integrative modelling approaches to simulate nutrient budgets at the regional / basin scales in Europe. The demonstration sites are operated to measure the effects of investigated measures for optimizing nutrient budgets such as the use of bio-based fertilizers to replace synthetic chemical fertilizers, and nature-based solutions to improve surface water quality in agricultural areas. The measured effects from the demonstration sites will be upscaled to the basins and Europe to identify their effects on nutrient reductions in rivers and coastal waters. In this abstract, we would like to present examples of the solutions and models that will form the basis for simulating nutrient budgets in Europe.

Methodology

We will develop a multi-pollutant model to simulate co-benefits between sustainably optimizing the budgets of nutrients and other pollutants, to ensure clean water. The MARINA-Nutrients (Ural-Janssen, Kroeze et al. 2024) and MARINA-Antibiotics models (Zhang, Li et al. 2025) will be integrated for specific basins in Europe and will be used to develop basin-specific scenarios. The demonstration site in Norway for example experiences nutrient pollution associated with fish sludge and manure, whereas the demonstration site in Spain (Ebro basin) has overfertilization issues. Basin-specific baselines are lacking. We will integrate the two models by taking their strengths and updating them in terms of basin-specific data, supported by the GREENHOOD project insights, and information from the demonstration sites. The new scenarios will incorporate the effects of measured solutions (e.g., bio-based fertilizers, nature-based solutions such as ponds, and wetlands) to better understand the effectiveness of measures on pollution reductions (e.g., nitrogen, phosphorus, antibiotics), considering global change drivers. This will support policy recommendations for sustainably optimizing nutrients budgets at the basin scale in Europe with co-benefits for other pollutants such as antibiotics.

Results and discussion

The project has just started. In the poster, we will show examples of expected results using other regions for which our models simulate water pollution levels. We will show lessons that we can learn from other regions and apply to European basins in our integrated modelling. One of them is China for which we show that manure is a source of multiple pollutants in rivers including nutrients (Li, Wang et al. 2022) and antibiotics (Zhang, Li et al. 2025). Manure is also a recognized issue in several demonstration sites in the GREENHOOD project. We expect manure to play an important role in the sustainable optimization of nutrient budgets, which may be also co-beneficial to reduce other pollutants such as antibiotics. Another insight is that manure recycling on land contributed to less river pollution but more groundwater pollution in China (Zhang, Li et al. 2025). This is one of the lessons to consider when modelling the effects of solutions to reduce nutrient and antibiotic pollution in waters from manure. Another lesson is related to the fact that fluoroquinolones were the dominant contributors to antibiotic pollution in China, which may differ in Europe because of different antibiotic usage. Synergies and trade-offs in pollution control between nutrients and other pollutants are important for sustainable practices.

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