Governance and groundwater modeling: Addressing governance gaps on nitrate pollution

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Introduction

Nitrate reduction in groundwater is one of the most challenging and long-term environmental issues faced by the EU. Groundwater governance in the Lombardy Plain (N Italy) includes a tangled network of stakeholders dealing with conflicting socio-economic issues, in addition to environmental requirements. Governance, as a proper process for water management, lays on multiple factors, sometimes impeding a fruitful debate within appropriate timeframes.

Overview of oecd principles on water governance (Source: OECD, 2015a).


Goal

This paper addresses how to support the mentioned governance principles and how to fill the information and capacity gaps, related to the achievement of adequate nitrate concentrations in aquifers by using groundwater flow and transport numerical models.

The main point is that such models permit including all factors that will be potentially affected by climate change.
The numerical model
Main model terms: Natural vs Human
The nitrogen mass balance

N mass balance. Input, export and surplus on crop soils (t y⁻¹)

- Input:
  - Livestock manure 56.9%
  - Synthetic fertilizers 35.0%
  - Biological fixation 5.8%
  - Atmospheric deposition 2.3%

- Export:
  - Crop uptake 73.2%
  - Volatilization NH₄ 13.8%
  - Denitrification in soil 12.9%

- Surplus:
  - Recharge 67.5%
  - Fontanili 43.2%
  - Denitrification 19.6%
  - Wells 2.8%

- Outflow (south) 0.2%

Rivers 34.3%

(a) Nitrate concentration
(b) Nitrate conc. differences

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Hoes et al. (2019). A Dutch approach towards sustainable food systems. Wageningen Univ & Res.
Final remarks

1. The research points out the versatility and reliability of numerical flow and solute transport modeling, used as a backcasting exercise, as an accurate support tool to deal with the complexity of groundwater governance.

2. Groundwater resilience under changing climatic conditions could be properly addressed, overcoming the information and capacity gaps inherent to governance processes.

3. Modelling results provide decisive information in the path to achieve sustainability; for instance, in the application of the EU Nitrate Directive.
THANK YOU !!!

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