Nutrient emissions from agriculture to air and water: an integrated modelling approach for the European basins

Aslıhan Ural, Ana Robles Aguilar, Carolien Kroeze, Jan Peter Lesschen, Erik Meers, Peter J.T.M. van Puijenbroek, Maryna Strokal

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

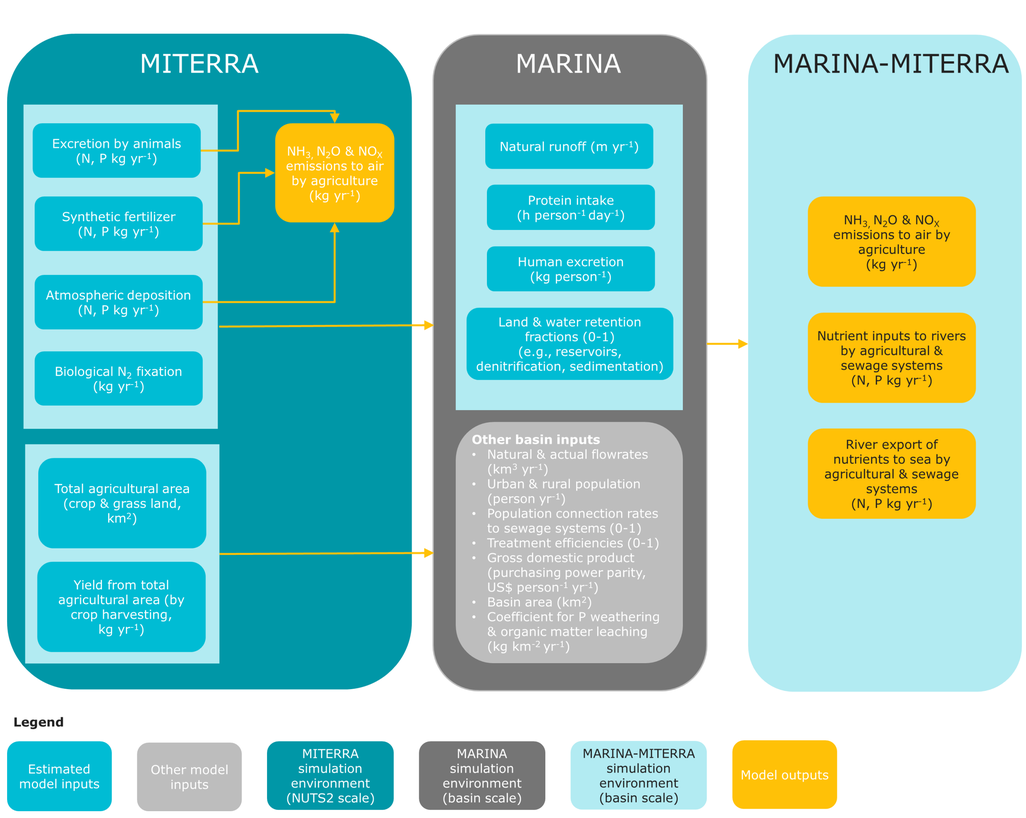
Background

Intensive agriculture and high population density are the main contributors of nutrient pollution in air and surface waters of Europe [1]. Modelling studies generally focus on either particular pollution source and/or receiving body (e.g., surface/ground waters, air).

Objective

- To develop an integrated model to quantify the contribution of agricultural activities to air and water pollution simultaneously at basin scale in the EU28 (including the UK)
- To calculate current annual nitrogen (N) emissions to air, inputs of N and phosphorus (P) to rivers, and river export of N and P to sea by European basins

Methodology



***MITERRA-Europe**: "integrated model to assess the implementation of agricultural measures on emissions to air and waters in Europe" [2]*
***MARINA:** "Model to Assess River Inputs of Nutrients to seAs"[3]*

***Figure 1.** Framework of the new MARINA-MITERRA model system. NUTS2: Nomenclature of Territorial Units for Statistics level 2, basic regions for the application of regional policies. Nitrogen emissions to air are ammonia (NH_3) and nitrous oxides (N_2O and NO_x). N and P inputs to rivers and river exports are in dissolved organic and inorganic forms.*

Preliminary results

N pollution in European basins

N losses to air and rivers by European basins in 2020 are indicated below. **Agriculture contributes more than half of N inputs to rivers (51%) mainly by manure application and grazing. N emissions to air are mainly caused by animal housing and storage systems (38%).**

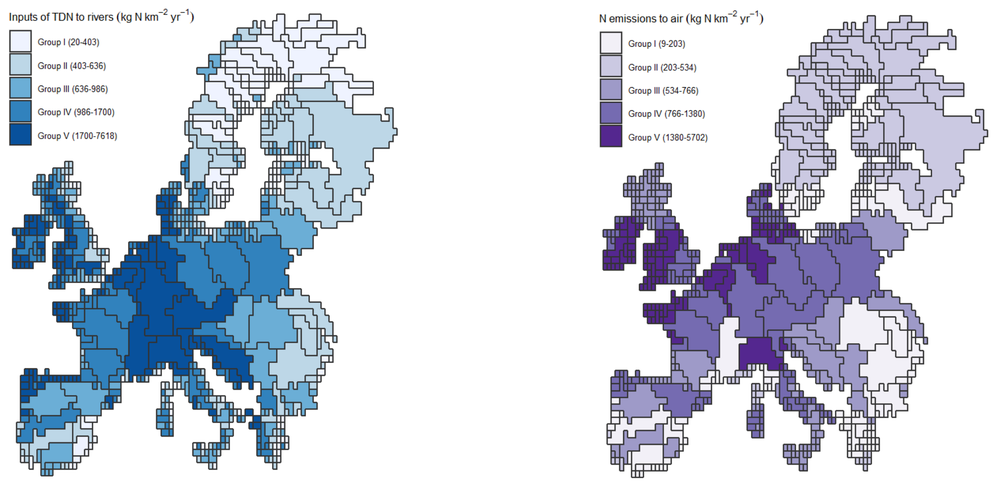


***Figure 2**. Left: Total dissolved N (TDN) inputs to rivers from diffuse and point sources by European basins in 2020 (kg N km^{-2} yr^{-1}). Right: Total N emissions (NH_3+N_2O+NO_X) to air from agriculture by European basins in 2020. Group I (0-20%), Group II (20-40%), Group III (40-60%), Group IV (60-80%), Group V (80-100%). Diffuse sources are namely fertilizer applied, animal manure applied, manure produced in grazing, biological N_2 fixation, atmospheric deposition and organic matter leaching. Point sources are sewage systems.*

N export to sea by European rivers

River export of total dissolved nitrogen (TDN) by European rivers in 2020 is indicated below. **Agriculture is the main source by 54%.**

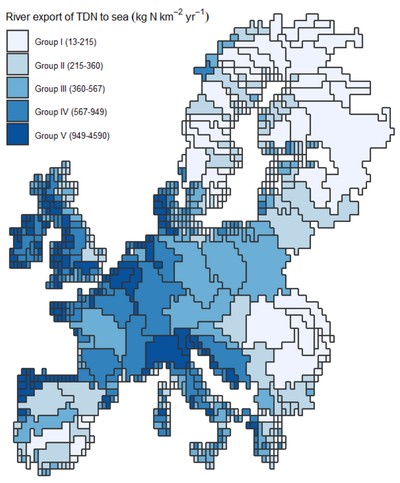


***Figure 3**. River export of TDN to seas from diffuse and point sources by European basins in 2020 (kg N km^{-2} yr^{-1}). Group I (0-20%), Group II (20-40%), Group III (40-60%), Group IV (60-80%), Group V (80-100%). Diffuse sources are namely fertilizer applied, animal manure applied, manure produced in grazing, biological N_2 fixation, atmospheric deposition and organic matter leaching. Point sources are sewage systems.*

Conclusions

- Large spatial variation in N pollution both in air and rivers in Europe caused by agricultural activities
  - ✓ N pollution in **rivers ➔** mainly by **animal manure (applied and grazing)**
  - ✓ N pollution in **air ➔** mainly by **animal housing and storage systems**
- MARINA-MITERRA model helps us to analyze air-water pollution interaction in terms of nutrient emissions at basin scale
- Our model could also contribute to assess the effects of mitigation strategies to avoid pollution swapping

Acknowledgements

This study has been developed within the scope of the *FertiCycle* project which is an Innovative Training Network (ITN) and has received funding from the European Union's Horizon 2020 Marie Sklodowska-Curie Action under Grant Agreement No 860127.

References

[1] Sutton, M., Howard, C., Erisman, J.W., Billen, G., Bleeker, A., Greenfelt, P., van Grinsven, H., Grizzetti B. (2011). The European Nitrogen Assessment. Cambridge University Press, Cambridge.

[2] Velthof, G.L., Oudendag, D., Witzke, H. P., Asman, W. A., Klimont, Z., Oenema O. (2009). Integrated assessment of nitrogen losses from agriculture in EU-27 using MITERRA-EUROPE. Journal of Environmental Quality, 38, 2, 402-417.

[3] Strokal, M., Kroeze, C., Wang, M., Bai, Z., Ma L. (2016). The MARINA model (Model to Assess River Inputs of Nutrients to seAs): Model description and results for China. Science of Total Environment, 562, 869-888.

Wageningen University & Research
Water Systems and Global Change Group
Droevendaalsesteeg 3a, 6708 PB, Wageningen
Contact: aslihan.ural@wur.nl
M: +31 (0)6 57 93 28 25
https://www.wur.nl/en/Persons/Aslihan-A-Aslihan-Ural-MSc.htm