

---

This is the **accepted version** of the journal article:

Wassen, M.J.; Schrader, J.; Eppinga, Maarten; [et al.]. «The EU needs a nutrient directive». *Nature Reviews Earth & Environment*, Vol 3, issue 5 (May 2022), p. 287–288. DOI 10.1038/s43017-022-00295-8

---

This version is available at <https://ddd.uab.cat/record/299911>

under the terms of the  <sup>IN</sup> COPYRIGHT license

# **Title: The EU needs a nutrient directive**

## **Authors:**

Martin J. Wassen<sup>1\*</sup>, Julian Schrader<sup>2,3</sup>, Maarten B. Eppinga<sup>4</sup>, Jordi Sardans<sup>5,6</sup>, Frank Berendse<sup>1</sup>, Raoul Beunen<sup>7</sup>, Josep Peñuelas<sup>5,6</sup> and Jerry van Dijk<sup>1</sup>

## **Affiliations:**

<sup>1</sup>Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, the Netherlands.

<sup>2</sup>Biodiversity, Macroecology & Biogeography, University of Goettingen, Goettingen, Germany.

<sup>3</sup>School of Natural Sciences, Macquarie University, Sydney, New South Wales, Australia.

<sup>4</sup>Department of Geography, University of Zurich, Zurich, Switzerland.

<sup>5</sup>CSIC, Global Ecology Unit CREAF-CSIC-UAB, Bellaterra, Barcelona 08193, Catalonia, Spain.

<sup>6</sup>CREAF, Cerdanyola del Vallès, Barcelona 08193, Catalonia, Spain.

<sup>7</sup>Faculty of Science, Open University, the Netherlands.

\*Corresponding author: Martin J. Wassen [m.j.wassen@uu.nl](mailto:m.j.wassen@uu.nl)

## **Standfirst:**

To prevent ecosystem degradation and support the Farm to Fork initiative, the EU needs an integrated nutrient directive that regulates the agricultural application of nitrogen and phosphorus. This directive must go beyond the current inadequate regulations by considering nutrient balances and accounting for regional differences.

The long-term use of fertilizers in the European Union and the resulting enrichment of nitrogen (N) and phosphorus (P) has contributed to a loss of biodiversity and the disruption of aquatic and terrestrial ecosystems, with severe implications for both ecosystem services and human well-being. N loads are still above the critical levels of deposition for many ecosystems<sup>1</sup>, and N runoff to natural areas continues, even where N loads have stabilized such as in northwestern Europe. P also accumulates in arable soils in forms not directly available to crops due to continuous fertilization. Farmers thus tend to continue fertilizing every year<sup>2</sup>, the reserves of mineable P are becoming scarcer, and the price of P fertilizer is rising<sup>3</sup>. Policies are therefore urgently needed to

promote the sustainable application, re-use and cycling of phosphorus while reducing nitrogen input. The need to make food production more sustainable is recognized in the European Green Deal and more specifically in the Farm to Fork strategy that lays out the actions and policies the EU will put forward to accelerate the transition. In recognition of the detrimental effects of N and P on biodiversity, the newly adopted Farm to Fork strategy, among other strategies, aims to reduce nutrient losses to the environment by stimulating sustainable nutrient use by developing integrated action plans to manage nutrients.

## **EU policies on N and P**

Past and present EU policies for nutrient management are inadequate, and regulations for even single nutrients are scattered over several policies. The EU Nitrates Directive (1991)—which set a threshold value of <50 mg/l nitrate in groundwater—was unsuccessful at reducing the water pollution caused or induced by nitrates from agricultural sources in many countries. Similarly, the Water Framework Directive (WFD, 2000)—which adopted an integrated, ecosystem-based approach to the protection and sustainable use of water—did not improve the ecological status of aquatic ecosystems throughout Europe to the desired level. This limited success can be attributed to poor targeting of N and P sources and to disregarding the balance between the two nutrients. Current policies often target a single nutrient even though the agricultural application of N and P are directly coupled, and the ecological impacts of nutrients arise in part from their stoichiometric balance<sup>6,7</sup>. For example, the decrease in N deposition due to EU legislation has increased the ratio of P to N in several northwestern European grasslands. Decreasing N further without simultaneously reducing P will drive more species to extinction in these grasslands than if N is not reduced at all<sup>6</sup>.

The current nitrogen crisis in the Netherlands and Flanders illustrates how the ineffective management of nutrients causes societal problems<sup>4</sup> and will cost billions of euros to reduce nitrogen deposition. Protected Natura 2000 sites are negatively affected by a substantial overload of nitrogen deposition, so plans for new activities that would further exacerbate nitrogen deposition have been annulled in court. Such action has impeded livestock farming, industry, infrastructural development, and the building sector. A profound decrease in livestock is needed, but this solution faces widespread opposition from livestock farmers. A similar crisis looms for other regions in the EU with extremely high levels of nitrogen deposition.

Regional differences, however, need to be taken into account, because N levels are not above critical levels in all European countries<sup>5</sup>. Most European regions have too much phosphate in their soils, but some regions have too little. P fertilization in the latter areas, mostly in southern Europe, will remain necessary for growing P-demanding crops such as wheat and maize<sup>3</sup>. Uncoordinated legislation on N and P fertilization and management

is counterproductive if their relative availability and balance are not considered. Policies addressing environmental quality (such as the Nitrates Directive and the WFD) and policies that focus on ecological impact (the Birds and Habitat Directives) also generally target cumulative concentrations or effects in the environment, whereas a source-oriented focus would be more effective.

### **An integrated EU nutrient directive**

We propose the creation of an integrated EU nutrient directive to regulate the agricultural use of N and P to address the limitations of current EU policies. This directive must acknowledge regional differences in N and P loads and the balance between elements. The directive should thus include a set of policy instruments that account for the differential behavior of nutrients in the environment, enable regional diversification in nutrient application that takes soil type, soil legacies, and agricultural contexts into account, and supports innovative agricultural practices that prevent nutrient losses to the environment. Accounting for the differential behavior of nutrients implies that the higher mobility of N compared to P and hydrology are taken into account when defining the width of buffer zones with limited agricultural fertilization around natural areas. Examples of innovative agricultural practices that prevent nutrient losses to the environment are based on need, are site- and crop-specific as practiced in precision farming, promote soil organic matter and microbial activity via organic fertilization, increase crop diversification (e.g. by intercropping) to stimulate facilitative processes that lead to better and more complete use of soil P stocks, and substitute P fertilizers containing rock phosphate with organic fertilizers and recycled products<sup>8</sup>. The nutrient directive could build on the approach put forward in the Nitrates Directive that sets limits for nitrate application based on soil-dependent nitrate leaching. Threshold values for P, however, should also be set and include obligations to identify risks of unsustainable nutrient use, establish action programs to limit and balance nutrient use, and reduce the nutrient sources of emissions from agriculture.

A new nutrient directive complies with the EU principle of subsidiarity, which demands action at the EU level that is justified and more effective than action taken at the national, regional, or local level. The directive also satisfies the principle of proportionality, which stresses that action taken by the EU should not go beyond what is necessary to achieve the aims of the Treaties. The international dimension of the problem makes the EU the logical and most competent authority to implement an integrated nutrient directive that provides a long-term perspective of the sustainable use of nutrient resources. N emissions diffuse over Europe via the atmosphere, and N and P are transported via transnational rivers. An EU approach is also necessary to avoid simply translocating N emissions from one EU country to another, as seen currently with the move of Dutch livestock industries to, for example, Belgium, France, Spain, and Poland.

An integrated nutrient directive that regulates the application of N and P can be central to supporting the EU Farm to Fork strategy, which focuses on developing a circular, regional, less import-driven European food system and aims to reduce nutrient losses by at least 50% and the use of fertilizers by at least 20% by 2030. Such a directive would contribute to reaching the environmental goals set by the Birds and Habitats Directives and the Water Framework Directive by shifting focus to the sources of pollution and stimulating member states to work towards sustainable agricultural practices, in line with the suggestion of the Farm to Fork strategy to develop Integrated Nutrient Management Action Plans (INMAP)<sup>9</sup> together with member states to reach these aims.

## References

1. Sutton, M. A. *et al.* *The European nitrogen assessment: sources, effects and policy perspectives*. (Cambridge University Press, 2011).
2. Withers, P. J. A. & Haygarth, P. M. Agriculture, phosphorus and eutrophication: A European perspective. *Soil Use Manag.* **23**, 1–4 (2007).
3. Heffer, P. Assessment of fertilizer use by crop at the global level. in *IFA publication* (2008).
4. Stokstad, E. Nitrogen crisis threatens Dutch environment—and economy. *Science* **366**, 1180–1181 (2019).
5. Dentener, F. *et al.* Nitrogen and sulfur deposition on regional and global scales: A multimodel evaluation. *Global Biogeochem. Cycles* **20**, 1–21 (2006).
6. Wassen, M. J., Schrader, J., van Dijk, J. & Eppinga, M. B. Phosphorus fertilization is eradicating the niche of northern Eurasia's threatened plant species. *Nat. Ecol. Evol.* **5**, 67–73 (2021).
7. Penuelas, J., Janssens, I. A., Ciais, P., Obersteiner, M. & Sardans, J. Anthropogenic global shifts in biospheric N and P concentrations and ratios and their impacts on biodiversity, ecosystem productivity, food security, and human health. *Glob. Chang. Biol.* **26**, 1962–1985 (2020).
8. Garske, B., Stubenrauch, J. & Ekardt, F. Sustainable phosphorus management in European agricultural and environmental law. *Review of European, Comparative and International Environmental Law* **29**, 107–117 (2020).
9. European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. European Commission

**Acknowledgements:** We thank Johan and Frans Vollenbroek for their valuable comments on the first draft and Fulco Teunissen for language editing.

**Author contributions:** MJW wrote the drafts, all other authors commented on and edited drafts of the manuscript.

**Competing interests:** Authors declare that they have no competing interests

## Figure 1

Current EU policy on nutrient emissions is scattered over multiple directives that target the exceedance of threshold concentrations in the environment (Nitrates Directive, Water Framework Directive) or ecological impacts only (Birds and Habitats Directive). The Nitrates Directive only focuses on N, while ignoring P. Together, these Directives have been ineffective in reducing N and P emissions to the environment and ignore regional differences in stoichiometric imbalances from historical legacies of N and P use. An integrated EU Nutrient Directive focusing on the sustainable use of N and P within regional threshold values based on history of use, multiple sources, and ecological impacts could repair the shortcomings of current policies and support the impact-oriented directives by targeting the most important sources of those impacts.

