From field to factory: shifting regulatory focus to reduce nitrogen pollution

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Abstract

Nitrogen pollution is one of the most important environmental issues of the 21st century, contributing to air and water pollution, biodiversity loss, climate change and stratospheric ozone depletion. While the planetary boundary for nitrogen is one of two that humanity has exceeded, it has yet to garner the attention from the policy community that it deserves. Moreover, emerging calls for a coordinated international response to nitrogen pollution need to be reconciled with the reality that solutions, particularly in the agricultural sector, are often locally specific. This is the goal of the new "Pathways to Nitrogen's Planetary Boundary" project (PNPB): disaggregating nitrogen's planetary boundary into several regional boundaries, and developing pathways to reach these boundaries using regionally-tailored nitrogen use efficiency strategies. This new form of regional integrated assessment aims to provide a roadmap for policy-makers to better address nitrogen pollution. It also adopts a form of scenario development seldom used in environmental modeling: "backcasting" technical pathways to achieve a future goal (nitrogen's planetary boundary), instead of forecasting multiple futures from a common present. The regional teams (East Asia, South Asia, East Africa, Eastern Europe, Latin America and North America) have already been formed as part of the International Nitrogen Management System initiative. Their focus on improving understanding of regional nitrogen flows is a crucial first step for developing the regional boundaries and pathways. PNPB would provide a forum for sharing methods, tools, data, and results among the teams, and ultimately aggregate the pathways to determine the extent to which they meet nitrogen's planetary boundary.

Introduction

This paper describes a proposed collaboration between the Sustainable Development Solutions Network (SDSN) and the International Nitrogen Management System (INMS) on a project to develop regional pathways for returning to nitrogen's planetary boundary. Nitrogen pollution is one of the most important environmental issues of the 21st century, contributing to air and water pollution, biodiversity loss, climate change and stratospheric ozone depletion. While the planetary boundary for nitrogen is one of two that humanity has exceeded (Steffen et al. 2015), it has yet to garner the attention from the international policy community that it deserves. This project – "Pathways to Nitrogen's Planetary Boundary" (PNPB) – would provide a roadmap for policy-makers on how to improve nitrogen use efficiency at a regional scale, and ultimately reduce nitrogen pollution to levels safe for the environment and human wellbeing.

Both INMS and SDSN would bring important value to the project. INMS, an initiative under UNEP and the International Nitrogen Initiative, is a science-policy network of scientists, NGOs, industry representatives and policy-makers, focused on improving understanding of the global nitrogen cycle and supporting international policy processes relevant to nitrogen. It is in the Project Preparation Phase for a $6 million grant from the Global Environment Facility, with substantial partner co-financing and contributions in kind. It is already developing a suite of regional-scale

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projects to better quantify nitrogen flows and identify regionally specific policy options for improving nitrogen management.

The SDSN, a United Nations initiative, mobilizes scientific and technical expertise from academia, civil society, and the private sector in support of sustainable development problem solving at local, national, and global scales. It led the Deep Decarbonization Pathways Project (DDPP), an effort to develop a set of country-specific? technical pathways for reducing greenhouse gas emissions in line with the 2^{o}C target, an approach the PNPB seeks to emulate (DDPP, 2015. In particular, PNPB adopts the "backcasting" approach pioneered by the Deep Decarbonization Pathways Project, which develops technical pathways to achieve a target based on expert judgment, best available technologies and other factors.

Methods

PNPB would build on the INMS regional projects already in development:

- East Africa: Burundi, Kenya, Rwanda, Tanzania, and Uganda (Lake Victoria Basin)
- East Asia: China, Japan, South Korea, Philippines
- South Asia: India, Bangladesh, Sri Lanka and Nepal
- Eastern Europe: Ukraine, Russia, Belarus, Moldova and Romania (Black Sea Basin)
- Latin America: Bolivia, Brazil, Paraguay and Uruguay (La Plata Basin).

There is also interest in developing a North American and Western Europe project. Each project has been selected based on a number of criteria, including that it should cover more than one country (in order to address transboundary issues), build on existing activities, be representative of the key nitrogen challenges faced by different regions across the globe, and have a strong partnership with at least one regional intergovernmental environment program.

In line with the Deep Decarbonization Pathways Project, PNPB would be a collaborative initiative where each regional team develops its own unique technical pathway for increasing nitrogen use efficiency, based on strategies suited to that region and using nitrogen's planetary boundary as a benchmark. Recent updates of nitrogen's planetary boundary have generated more nuanced and geographically disaggregated estimates of the amount of nitrogen that can be safely fixed and applied from an environmental standpoint, while still growing enough food to feed the world (de Vries et al. 2013). As a result, efforts to improve nitrogen use efficiency (and thereby increase food production and reduce nitrogen pollution) are effectively synonymous with efforts to return to nitrogen's planetary boundary. Nevertheless, there is still considerable uncertainty around what constitutes a reasonable (and politically acceptable) planetary boundary for nitrogen, and so PNPB would use recent estimates as a benchmark, rather than as a concrete global target.

PNPB would provide a forum for sharing methods, tools, data, and results among the regional teams, and ultimately aggregate the pathways to determine the extent to which they improve global nitrogen use efficiency and match up against recent estimates of nitrogen's planetary boundary. In this way PNPB would build on previous work that has assessed the environmental and economic impacts of improving global nitrogen use efficiency, by disaggregating a global goal into regionally specific targets and pathways using nitrogen use efficiency strategies particularly suited to that region (Sutton et al. 2013; Bodirsky et al. 2014). PNPB would also provide a global policy context, evaluating the existing international institutions and policies currently in place to manage nitrogen pollution. The ultimate goal of the project is to produce a final report to be presented and disseminated to relevant stakeholders detailing each regional pathway, as well as the creation of an online database with the details of each pathway freely accessible to the public. We believe this

project could provide important momentum for concerted global efforts to reduce nitrogen pollution – a credible, multidisciplinary, policy-relevant roadmap for international and regional policy-makers to address this problem.

Key individuals

The table below lists the key individuals across INMS, SDSN and New York University that would be most involved in the project.

INMS		SDSN		NYU	
Name	**Role**	**Name**	**Role**	**Name**	**Role**
Mark Sutton	Chair	Jeffrey Sachs	Director	David Kanter	Project lead
Clare Howard	Project manager	Achim Dobermann	Co-Chair, Thematic Network 7	Danielle Spiegel-Feld	Executive Director, Guarini Center
Cargele Masso	East Africa project lead	Rebecca Nelson	Co-chair, Thematic Network 7	TBD	Project manager
Xiaoyang Yan	East Asia project lead	Lauren Barredo	Manager, Thematic Network 7		
N. Raghuram	South Asia project lead				
Lidiya Moklyachuck	Eastern Europe project lead				
Jean Ometto	Latin American project				

Conclusions

Improving the management of nitrogen as a resource and as a pollutant is one of the most important challenges of the 21st century. At the heart of this challenge lies a critical tension: how to reconcile calls for an international response to nitrogen pollution with the reality that solutions are often locally specific. The PNPB project aims to take a first step towards resolving this tension by disaggregating nitrogen's planetary boundary into several regional boundaries, and developing pathways to reach these boundaries using regionally-tailored nitrogen use efficiency strategies. In doing so, this project hopes to provide a roadmap to decision-makers that could help them develop policies to return humanity within nitrogen's planetary boundary.

References

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