

1. The Nitrogen Challenge in Africa

Nitrogen is one of the essential nutrients for plant growth and food production, but an excess of nitrogen, resulting largely from intensive agriculture and combustion processes, is leading to widespread pollution in soil, water and air throughout the world. Nitrogen pollution has already resulted in serious ecosystem damage and significant adverse effects on public health.

Nitrogen is relevant to almost every one of the 17 UN sustainable development goals (SDGs), yet it is almost entirely invisible in the SDG process and indicators¹. Sutton et al. (2013)² identify 5 key areas under threat from too much nitrogen: Water quality, Air quality, Greenhouse gas balance, Ecosystems and biodiversity, and Soils (WAGES, Figure 1). This highlights how pervasive the problem of nitrogen mismanagement is.

Furthermore, an imbalance appears between regions with “too much” nitrogen and those with “too little”. In Africa, polluted cities coexist with large rural areas struggling with low nitrogen supplies to crops and insufficient yields to feed growing populations. As it stands, the supply of nitrogen in sub-Saharan Africa is insufficient to combat food security, however, increasing nitrogen supply without increasing emissions of pollutants remains an important societal challenge.

The challenge: *Increase nitrogen supply to nitrogen poor regions, while decreasing nitrogen waste and environmental impact.*

2. Requirements for Meeting the Challenge

Fill Knowledge Gaps

There currently exist critical knowledge gaps in the nitrogen cycle. For example, we lack reliable information on the quantity of fertilizer currently applied. Further, data on how much reactive nitrogen (NO_x , NH_3 , N_2O , NO_3^- , NH_4^+) is deposited by rain or emitted from agricultural activities is currently lacking, creating roadblocks to the development and application of best practice guidelines. Continued monitoring is also critical for evaluating long term trends of nitrogen loads in ecosystems and evaluating the response of ecosystems to management actions.

Improve Nitrogen Use Efficiency

Improving nitrogen use efficiency is paramount for both increasing the amount of active nitrogen available for plants, and minimising the amount of nitrogen pollutants released into the environment. To achieve this, a multi-faceted approach is required. Examples include: improving the performance of nitrogen fertilizers using precision agriculture and targeted placement and timing; improving the management of biological nitrogen fixation; improving the performance of livestock production; and improving the methods by which organic nitrogen is used.

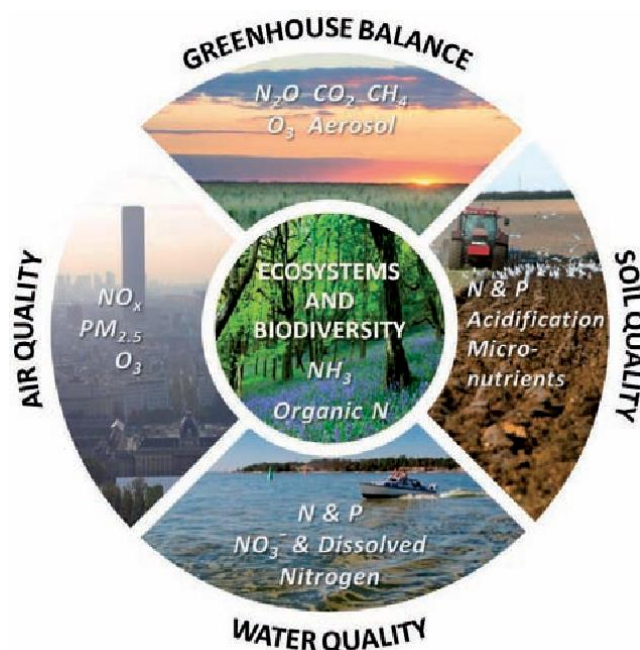


Figure 1: WAGES - The 5 key threats from too much nitrogen identified by Sutton et al. (2013)

Knowledge Sharing and Communication

In addition to obtaining critical data, communication and cooperation between researchers and practitioners is essential for both the development and adoption of methods for improving nitrogen use efficiency. Communication with citizens, schoolchildren and university students is also essential for educating the community on how to minimize the impact of nitrogen pollution on the environment.

3. The Integrated Nitrogen Studies in Africa (INSA) Project.

To respond to these requirements, the INSA project will construct a multi- and interdisciplinary research network focused on the study of nitrogen, with the aim to:

1. **Provide access to the most recent studies on the nitrogen cycle and nitrogen assessments in Africa.**
2. **Create synergies and adopt new approaches for studying nitrogen and environmental impacts of nitrogen.** Evaluate the impact of nitrogen on: the chemical composition of the atmosphere, greenhouse and reactive gases emissions, atmospheric deposition, ecosystems, eutrophication, biodiversity, food security, nitrogen use efficiency and sustainable agriculture.
3. **Facilitate knowledge transfer between African and European institutions.**
4. **Share knowledge across the broader community.** Disseminate results and share knowledge through a consortium of participants, including decision makers, politicians, and stakeholders. Help children, citizens and future decision-makers, to understand the role of nitrogen in the environment, to enable them to contribute to the sustainable management and improvement of nitrogen use in Africa.

The INSA project aims to:

- Evaluate ecosystem threats and benefits from nitrogen
- Encourage a multi- and interdisciplinary approach
- Facilitate a transfer of knowledge between scientists, stakeholders and land managers
- Educate children, citizens and future decision-makers about the role of nitrogen in the environment
- Propose concrete solutions for improving nitrogen management and use efficiency

1. Sutton M.A., Howard C.M., Adhya T.K., Baker E., Baron J., Basir A., Brownlie W., Cordovil C., de Vries W., Eory V., Green R., Harmens H., Hicks K.W., Jeffery R., Kanter D., Lassaletta L., Leip A., Masso C., Misselbrook T.H., Nemitz E., Nissanka S.P., Oenema O., Patra S., Pradhan M., Ometto J., Purvaja R., Raghuram N., Ramesh R., Read N., Reay D.S., Rowe E., Sanz-Cobena A., Sharma S., Sharp K.R. Skiba U., Smith J.U., van der Beck I., Vieno M., and van Grinsven H.J.M. (2019) Nitrogen - Grasping the Challenge. A Manifesto for Science-in-Action through the International Nitrogen Management System. Summary Report. Centre for Ecology & Hydrology, Edinburgh, UK.
2. Sutton M.A., Bleeker A., Howard C.M., Bekunda M., Grizzetti B., de Vries W., van Grinsven H.J.M., Abrol Y.P., Adhya T.K., Billen G., Davidson E.A, Datta A., Diaz R., Erisman J.W., Liu X.J., Oenema O., Palm C., Raghuram N., Reis S., Scholz R.W., Sims T., Westhoek H. & Zhang F.S., with contributions from Ayyappan S., Bouwman A.F., Bustamante M., Fowler D., Galloway J.N., Gavito M.E., Garnier J., Greenwood S., Hellums D.T., Holland M., Hoysall C., Jaramillo V.J., Klimont Z., Ometto J.P., Pathak H., Plocq Fichelet V., Powlson D., Ramakrishna K., Roy A., Sanders K., Sharma C., Singh B., Singh U., Yan X.Y. & Zhang Y. (2013) Our Nutrient World: The challenge to produce more food and energy with less pollution. Global Overview of Nutrient Management. Centre for Ecology and Hydrology, Edinburgh on behalf of the Global Partnership on Nutrient Management and the International Nitrogen Initiative.

