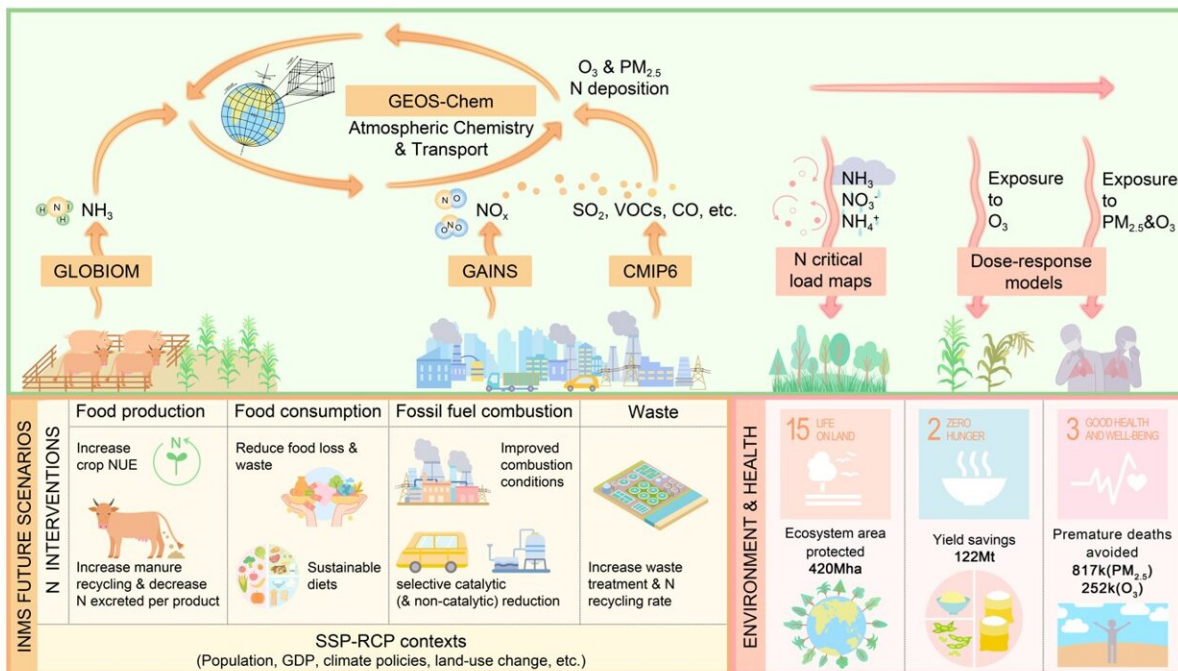


High-ambition nitrogen interventions could cut NO_x emissions by up to 52% by 2050

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An integrated modeling framework evaluates how ambitious nitrogen interventions can reduce ammonia and nitrogen emissions, consequently improve air quality by lowering fine particulate matter and ozone levels, and decrease nitrogen deposition, ultimately benefiting the environment and public health. Credit: Guo Y., Zhao H., Winiwarter W., Chang J., Wang X., Zhou M., Havlik P., Leclere D., Pan D., Kanter D., Zhang L. (2024) Aspirational Nitrogen Interventions Accelerate Air Pollution Abatement and Ecosystem Protection, *Science Advances*, doi.org/10.1126/sciadv.ado0112.

The Earth's nitrogen cycle is among the most heavily exceeded planetary boundaries. Agricultural production and fossil fuel burning release nitrogen pollutants like ammonia (NH_3), nitrogen oxides (NO_x), and nitrous oxide (N_2O), which contribute to air pollution and damage ecosystems.

These pollutants harm [human health](#), crops, and ecosystems. Given the growing global energy and food demand, this damage is expected to increase even further.

The potential of nitrogen pollution mitigation technologies and policies—so-called "nitrogen interventions"—for improving [air quality](#) and reducing impacts on ecosystems, has been underexplored.

A gap exists between traditional nitrogen budget research, which tracks nitrogen flows across air, water, and soil, but lacks detail on biogeochemical transformations, and Earth science research, which models these transformations but usually focuses on a single environmental medium.

To address this knowledge gap, an international research team combined multidisciplinary methods to evaluate how nitrogen interventions could improve air quality and reduce nitrogen deposition.

Their study, [published](#) in *Science Advances*, found that interventions, such as improving fuel combustion conditions, increasing agricultural nitrogen use efficiency, and reducing food loss and waste, could significantly lower premature deaths attributed to [air pollution](#), crop losses, and ecosystem risks.

While typically considered for individual goals like air or [water quality](#), recognizing the broad co-benefits of nitrogen management is critical for future policy design and effective pollution control.

"We established an integrated assessment framework combining future nitrogen policy scenarios with integrated assessment models, air quality models and dose-response relationships to assess how ambitious measures can reduce air pollution and ecosystem damage at detailed geographic levels," explains lead author Yixin Guo, a postdoctoral researcher jointly appointed by Peking University and IIASA.

The study shows that by 2050, high-ambition nitrogen interventions could cut global ammonia and nitrogen oxides emissions by 40% and 52%, respectively, compared to 2015 levels. This would reduce air pollution, prevent 817,000 premature deaths, lower ground-level ozone concentrations, and cut crop yield losses.

Without these interventions, environmental damage will worsen by 2050, with Africa and Asia being affected the most. On the other hand, should those measures be implemented, Africa and Asia would benefit from them the most.

"We found that nitrogen interventions offer increasing benefits over time, with greater effects by 2050 than by 2030. The biggest reductions in ammonia and [nitrogen oxides](#) are expected in East and South Asia, mainly through improved crop practices and technology adoption in industrial sectors. These reductions will help lower air pollution levels, making it easier for many regions to achieve the World Health Organization interim targets. Additionally, as populations grow, the health benefits of these interventions will increase, especially in developing areas," adds Yixin.

"Our results highlight that nitrogen interventions can significantly help achieve multiple SDGs, including Good Health and Well-being (SDG3), Zero Hunger (SDG2), Responsible Consumption and Production (SDG12), and Life on Land (SDG15)," says Lin Zhang, a study co-author and tenured associated professor at Department of Atmospheric

and Oceanic Sciences at Peking University.

"This [collaborative research](#) shows how IIASA research can be rolled out globally. Solutions for environmental impacts will vary by region, enabling customized [policy recommendations](#), even for complex issues like nitrogen pollution," concludes Wilfried Winiwarter, a study co-author and senior researcher in the Pollution Management Research Group of the IIASA Energy, Climate, and Environment Program.

More information: Yixin Guo et al, Aspirational Nitrogen Interventions Accelerate Air Pollution Abatement and Ecosystem Protection, *Science Advances* (2024). [DOI: 10.1126/sciadv.ado0112](https://doi.org/10.1126/sciadv.ado0112). www.science.org/doi/10.1126/sciadv.ado0112

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