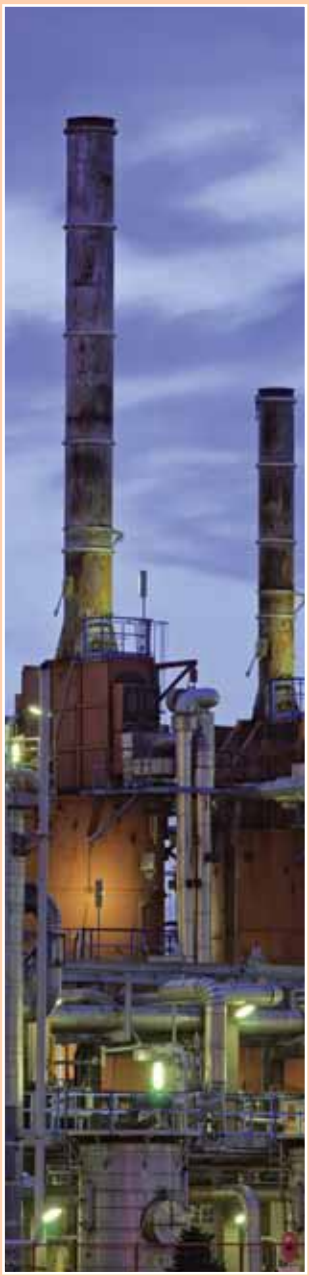
Managing the European Nitrogen Problem

A proposed strategy for integration of European Research on the multiple effects of reactive nitrogen

Executive Summary




This executive summary has been prepared by the co-chairs of the UNECE/CLRTAP Task Force on Reactive Nitrogen (TFRN) in collaboration with the chairs of the Nitrogen in Europe (NinE) programme of the European Science Foundation, the chairs of COST Action 729, the Scientific Steering and External Advisory Groups of the EU NitroEurope Integrated Project and the European Centre of the International Nitrogen Initiative (INI).

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www.clrtap-tfrn.org/european-research-strategy

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- Globally, reactive nitrogen (Nr)[1] production has more than doubled during the last century as a result of human activity. The additional Nr has been essential to increase both global food production and the fraction of animal products in human diets. Use of Nr is thus of central importance for world food security. At the same time, the acceleration of Nr production, combined with a low efficiency of Nr use, has led to a complex web of environmental impacts *(paras 5-10 in main report).*
- The natural nitrogen cycle is generally tuned to operate with Nr in short supply. Under these conditions Nr is recycled tightly within ecosystems. However, when Nr is supplied in excess, it is easily lost to the wider environment, generating a cascade of different Nr forms and effects, before eventually being denitrified to di-nitrogen (N_2).
- The web of adverse Nr impacts crosses all environmental spheres, with major consequences for the functioning of ecosystems, leading to effects on greenhouse balance, air quality and atmospheric chemistry, biodiversity, soil quality and water quality in both freshwater and marine systems *(paras. 11-14 in main report).*
- Understanding the cause - effect relationships and developing options to minimize the adverse effects represent major challenges for the European Research Area. Although progress is being made in understanding the individual Nr threats, it is becoming increasingly clear that a holistic research strategy is needed *(paras. 15-18 in main report)*. Such a **'full nitrogen approach'** is important because of the many synergies and antagonisms: fixing one form of Nr pollution often creates another.

Globally, reactive nitrogen (Nr) production has more than doubled during the last century as a result of human activity

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[1] The term reactive nitrogen (Nr) represents all biologically active, photochemically reactive, and radiatively active N compounds in the atmosphere and biosphere, including inorganic reduced N compounds (e.g., NH_3, NH_4^+), inorganic oxidized N compounds (e.g., NO_x, HNO_3, N_2O, NO_3^-), and organic N compounds (e.g., urea, amines, proteins).

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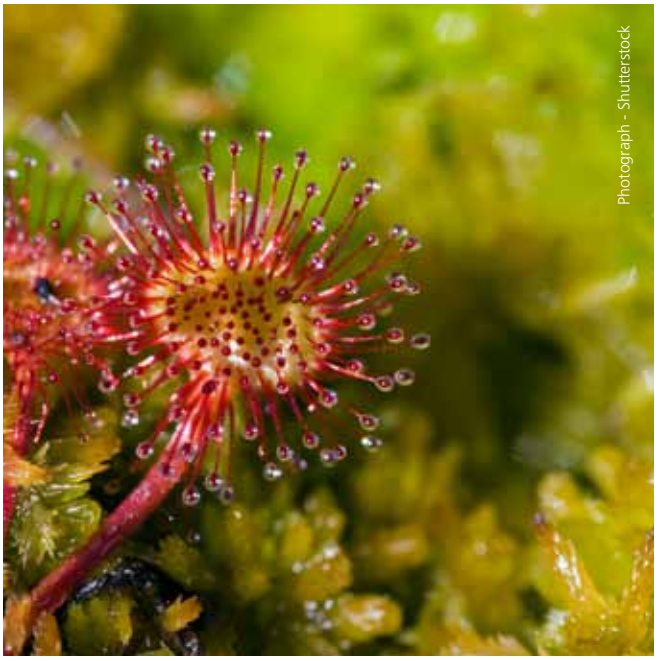
- The need for an integrated response to Nr is now beginning to be recognized internationally *(paras. 19-32 in main report)*.
  - UNEP has identified problems related to Nr as an emerging global environmental issue and recently established the Global Partnership on Nutrient Management (GPNM).
  - The UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) has recently established the Task Force on Reactive Nitrogen (TFRN) to make the links between the different airborne and other Nr threats.
  - The Nitrogen in Europe (NinE) programme of the European Science Foundation has initiated the European Nitrogen Assessment (ENA), analyzing the current status of science and policy frameworks, and prioritizing the future challenges.
- These moves are in line with the emerging request for integrated approaches in European Union Directives and the international conventions (Framework Convention on Climate Change, CLRTAP, Convention on Biological Diversity, Marine Conventions etc.).
- The fundamental importance, cross-cutting implications and complexity of the Nr problem, combined with the emerging needs of international policy development, requires a major directed research effort on the European nitrogen problem.
- The research should be targeted to underpin the needs of EU legislation and the international conventions, with an emphasis to understand the linkages. This will allow Europe to develop integrated strategies that balance the different benefits and threats of excess Nr and which may serve as a guiding model for other regions of the world.
- A European cross-programme research activity on Nr must be a priority for the EU Seventh Framework Programme (FP7). This should focus on drawing together European expertise on the different Nr threats, benefits and their management. It is proposed to implement this through a cluster of Collaborative Projects that would support the development of more integrated solutions to the nitrogen problem *(paras. 33-38 in main report)*.
- As a focus for discussion among the EU Member States and other parties to the relevant international conventions, we here outline a cluster of seven collaborative projects that link the key threats to greenhouse balance, atmospheric chemistry, biodiversity, water quality and soil quality, with the development of integrated approaches for sustainable Nr management while bearing in mind the challenges of future food and energy security.

- Each of the major nitrogen threats and mitigation options should be considered, with the cluster supported by coordination measures to maximize synergies *(paras. 39-47 in main report)*:

  - **Project Concept 1: Integrating the biospheric and atmospheric effects of nitrogen on global radiative balance.** (In support of FCCC and CLRTAP.) (Large collaborative project: €8M, 2011-2014.)
  - **Project Concept 2: Developing new approaches to quantify and minimize the impacts of atmospheric nitrogen deposition on European habitats**. (In support of CBD, CLRTAP, Habitats Directive, Water Framework Directive and EU policies on soils and eutrophication). (Medium-sized collaborative project €5M, 2011-2014.)
  - **Project Concept 3: Quantifying the multiple roles of atmospheric chemistry on European impacts of reactive nitrogen.** (In support of the CLRTAP, FCCC and CBD.) (Large collaborative project: €6M, 2012-2015.)
  - **Project Concept 4: Integrating the role of nitrogen in catchment, coastal and marine eutrophication.** (In support of Nitrates Directive, WFD, Water and Marine Conventions.) (Large collaborative project: €8M, 2012-2015.)
  - **Project Concept 5: Integrating the consequences of EU and international policies on nitrogen-related impacts in European landscapes as a basis to develop locally optimized solutions.** (In support of FCCC, CLRTAP, CBD, WFD, CAP and EU policies on soils and eutrophication.) (Large collaborative project ca. €9M, 2013-2016.)
  - **Project Concept 6: Understanding nitrogen flows and emissions in the food production and consumption chain of Europe.** (In support of FCCC, CLRTAP, CBD, WFD, CAP and EU policies on soils and eutrophication.) (Large collaborative project ca. €5M, 2012-2015.)
  - **Project Concept 7: Managing the European nitrogen cycle to increase nitrogen use efficiency by 50%.** (In support of FCCC, CLRTAP, CBD, WFD, CAP and EU policies on soils and eutrophication.) (Large collaborative project ca. €8M, 2013-2016.)

- The overall outcome of such a cross-cutting programme should be an improved understanding of how different parts of the nitrogen cycle fit together, together with the consideration of key mitigation options, thereby underpinning the development of future European and international nitrogen management strategies.
- The aim of this document is to stimulate debate among European Member States, other parties to the international conventions and the scientific community. Feedback is requested on six key questions to help tune the research strategy *(paras. 1-4 in main report).*



Nitrogen threatens the biodiversity of many European habitats, leading to losses of sensitive species such as the insectivorous plant sundew

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