The European Nitrogen Assessment

Sources, Effects and Policy Perspectives

A century ago, when the world depended on fossil nitrogen and manure recycling, there was insufficient reactive nitrogen to feed the growing human population. With the invention of the Haber–Bosch process, humans found a way to make cheap reactive nitrogen from the almost inexhaustable supply of atmospheric di-nitrogen. What humans did not anticipate was that the massive increase in reactive nitrogen supply, exacerbated by fossil fuel burning, would lead to a web of new environmental problems cutting across all global-change challenges.

The European Nitrogen Assessment presents the first full, continental-scale assessment of reactive nitrogen in the environment and sets the problem in context by providing a multidisciplinary introduction to the key processes in the nitrogen cycle. Issues of up-scaling from field, farm and city to national and continental scales are addressed in detail with emphasis on opportunities for better management at local to global levels. A comprehensive series of maps showing nitrogen pools and fluxes across Europe also highlight the location of the major threats and allow a comparison of national budgets for the first time. Five key societal threats posed by reactive nitrogen are assessed, providing a framework for a set of policies that can be used for joined-up management of the nitrogen cycle in Europe. This includes the first cost–benefit analysis for different reactive nitrogen forms and consideration of future scenarios.

Incorporating a handy technical synopsis and summary for policy makers, this land-mark volume is an essential reference for academic researchers across a wide range of disciplines, as well as for stakeholders and policy makers in Europe and beyond. It is also a valuable tool in helping communicate the key environmental issues and future challenges to the wider public.

Mark Sutton is an environmental physicist investigating human alteration of the nitrogen cycle, with specific attention to ammonia. He is coordinator of the major integrated project 'NitroEurope', a 5-year effort, bringing together 64 research institutes to ask how nitrogen is affecting the European greenhouse gas balance. Dr Sutton is vice-chair of the 'Nitrogen in Europe' (NinE) programme of the European Science Foundation, the Director of the European Centre of the International Nitrogen Initiative (INI) and co-chair of the Task Force on Reactive Nitrogen of the UN-ECE Convention on Long-range Transboundary Air Pollution.

Clare Howard is currently engaged in a postdoctoral fellowship in knowledge transfer, with an emphasis on research networks which focus on nitrogen. Dr Howard is project coordinator for the European Nitrogen Assessment and for the Task Force on Reactive Nitrogen, which sits beneath the Working Group on Strategies and Review of the Convention on Long Range Transboundary Air Pollution. Her research interests involve the modelling of biogeochemical cycles of nitrogen and carbon and assessing uncertainty in model systems.

Jan Willem Erisman heads the Biomass, Coal and Environmental Research Unit of the Energy Research Centre of the Netherlands (ECN) and is a professor in Integrated Nitrogen studies at Vrije Universiteit, Amsterdam. His research focuses on atmosphere–biosphere exchange of gases and aerosols related to acidification and eutrophication and climate change. He was instrumental in establishing the International Nitrogen Initiative, the Nanjing Declaration on Nitrogen Management, the EU 6th Framework research program NitroEurope and for chairing the European Science Foundation project NinE and the EU COST Action 729.

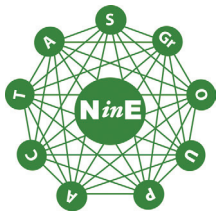
Gilles Billen is research director of the Centre National de la Recherche Scientifique (CNRS) at the University Pierre and Marie Curie (Paris) where his research covers many aspects of biogeochemistry, with an emphasis on the nitrogen, phosphorus and silica cycles. His main expertise is on the assessment and modelling of the ecological functioning of hydrosystems, including marine, estuarine and freshwater environments. From 1997 to 2007, he was the Director of the PIREN-Seine programme, a large interdisciplinary research programme on the Seine river watershed.

Albert Bleeker works as a senior scientist at the Energy Research Centre of the Netherlands, in the department of Air Quality and Climate Change. He has almost 20 years of experience in the field of nitrogen, where his main expertise is on the atmospheric emission, transport and deposition of nitrogen at various spatial scales, as well as studies on the effect of nitrogen in the natural environment. Currently, he is the Nitrogen in Europe (NinE) Programme Co-ordinator and a member of the COST 729 Management Committee.

Peringe Grennfelt has a background in atmospheric chemistry. His research includes regional air pollution problems in Europe, in particular acidification, nitrogen deposition and tropospheric ozone. He has coordinated several national and international research programmes including the EU project Network for the support of European Policies on Air Pollution (NEPAP). He is presently leading the Mistra Climate Policy Research Programme (Clipore) and the Swedish Clean Air Research Programme (SCARP).

Hans van Grinsven works at the Netherlands Environmental Assessment Agency where he conducts research and coordinates projects related to agriculture and environment, focusing on nitrogen and phosphorus, and sustainable food production. Dr van Grinsven was responsible for evaluations of national implementation of the EU Nitrates Directive and was also closely involved in the evaluations of the implementation of the EU Water framework Directive and EU NEC directive.

Bruna Grizzetti is a researcher in the field of large scale modelling of nutrient and water transfer. She works on modelling nutrient pressures on water at European scale in support to the implementation of environmental European policies, such as the Water Framework Directive, Nitrates Directive and the Marine Strategy. Since 2007, Dr Grizzetti has been a member of the Coordination Team of the European Nitrogen Assessment process, supported through the European Science Foundation.



Ministry of Infrastructure and the Environment

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Foreword

Addressing the grand challenges of society depends fundamentally on firm scientific evidence. Today, Europe faces several of these challenges, as outlined in the Europe 2020 strategy adopted by the Commission on 3 March 2010, including climate change, energy and food security, health and an ageing population. Research and innovation are crucial to address these challenges effectively. For that reason, the Commission launched the 'Innovation Union' flagship initiative, with the aim to re-focus research and development as well as innovation policy on these grand societal challenges.

In this framework we very much welcome the European Nitrogen Assessment. It is fair to say that nitrogen will be a new story for many people. Yet we can here clearly identify a case of science at its best: innovative thinking that enables the development of connections from evidence-based policies to evidence-tested decisions.

The Assessment highlights how human production of reactive nitrogen has literally changed the world. Since the invention of the Haber-Bosch process a century ago, humans have been able to double the world's circulation of nitrogen compounds, resulting in nitrogen fertilizers sustaining around 3 billion people, almost half of the world population. It is therefore obvious that nitrogen is essential, not only to meeting the challenge for food security, but, with the increasing importance of biofuels, also for energy security.

Yet with this achievement, originating from European innovation a century ago, has also come an inheritance of environmental effects that cuts across all global ecosystems. As the Assessment reveals, excess reactive nitrogen contributes to climate change; it adversely affects water, air and soil quality, and is putting unsustainable pressure on ecosystems and biodiversity in Europe. Moreover, the surplus of nitrogen compounds leaking into air and water may lead to a substantial health risk for vulnerable human populations.

The Assessment highlights how nitrogen is related to each of the great challenges that European society faces, and the need to develop joined up approaches to address them. In this respect the European Nitrogen Assessment is an important step, building scientific and institutional bridges and sharing different perspectives. It is rewarding to see different environmental disciplines being brought together, and scientists proactively seeking to engage European industry, policy makers and the public.

These significant commitments also emphasize the importance of critical mass in the European Research Area. The Assessment is a key output from a large amount of ongoing research in Europe and elsewhere, but in particular from the NitroEurope Integrated Project supported by the European Commission's 6th Framework Programme and the Nitrogen in Europe (NinE) Research Networking Programme of the European Science Foundation. With the involvement of Action 729 of the COST Programme, the necessary expertise has been gathered to drive the Assessment.

The message of 200 leading European experts from different disciplines and perspectives is surely that we need to take steps forward. Only by joining forces to face the societal challenges will European research provide the scientific basis and the evidence needed for solutions. If European innovation has handed us down a nitrogen inheritance, threatening the environment as a price for a solution to nourish the growing world population, it is only right that European science should lead the way in responding to the challenge.

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