Nitrogen Opportunities for Agriculture, Food & Environment

UNECE Guidance Document on Integrated Sustainable Nitrogen Management

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UNECE Convention on Long-range Transboundary Air Pollution,
with support from GEF/UNEP International Nitrogen Management System.

Foreword

With the establishment of the Task Force on Reactive Nitrogen in 2007, the UNECE Convention on Long-range Transboundary Air Pollution (informally the Air Convention) took an important step in embracing the challenge that control of air pollution is linked to many other transboundary and global challenges. This interconnected reality is no more apparent than with human disturbance of the nitrogen cycle, which links food and energy production with pollution of air, soil and water, human health, climate change and biodiversity loss.

The mandate given by the Executive Body of the Convention (ECE/EB.AIR/91/Add.1, decision 2007/1) clearly recognized this perspective, establishing the Task Force *"with the long-term goal of developing technical and scientific information, and options which can be used for strategy development across the UNECE to encourage coordination of air pollution policies on nitrogen in the context of the nitrogen cycle and which may be used by other bodies outside the Convention in consideration of other control measures"*. In this way, the Convention fully appreciated that sustainable nitrogen management not only benefits air, but also helps many other aspects of sustainable development.

The present document has been prepared by the Task Force on Reactive Nitrogen with exactly this philosophy in mind. With a focus on agriculture and food in the wider environment, the document identifies principles and measures for integrated sustainable nitrogen management, with a view toward harvesting multiple simultaneous benefits. The document builds on the existing *UNECE Guidance Document on preventing and abating ammonia emissions from agricultural sources* (Ammonia Guidance Document, ECE/EB.AIR/120) and the *UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions* (Ammonia Framework Code, ECE/EB.AIR/129). These documents still stand: the first as the definitive reference on ammonia abatement and the second as a practical guide to help Parties establish their own National Ammonia Codes, as required under Annex IX of the Gothenburg Protocol.

What was missing was a document to guide Parties and other stakeholders in how to reduce multiple forms of nitrogen loss simultaneously. Apart from ammonia (NH_3), this has meant considering emissions of nitrogen oxides (NO_x) and nitrous oxide (N_2O) to air, alongside nitrate (NO_3^-) and other reactive nitrogen (N_r) losses to water. In addition, it is now recognized that, while denitrification of N_r to atmospheric di-nitrogen (N_2) does not cause pollution directly, it represents a waste of valuable N_r resources, reducing nitrogen use efficiency across the economy. This in turn requires more new N_r inputs (such as from fertilizer and biological nitrogen fixation), ultimately increasing nitrogen pollution. Just as the Colombo Declaration has identified the ambition to "halve nitrogen waste" from all sources, it means that there is a need for guidance on principles and measures to help reduce all nitrogen losses.

The engagement through the Air Convention is already forcing us to change our thinking. In the past, we mainly focused on individual nitrogen pollutants, with a fragmented approach across nitrogen issues. At the same time, society has encountered major barriers-to-change to reducing nitrogen emissions. Under the emerging 'joined-up' approach to nitrogen, we realise that the synergies are critical, since they provide win-wins that can help mobilize action. By reducing all nitrogen losses, there is the opportunity not just for cleaner air and water, and for reducing climate change and stratospheric ozone depletion, but simultaneous co-benefits for health, ecosystems and circular economy. With around $200 billion worth of N_r resources wasted annually to air, land and water, it highlights a $100 billion per year opportunity from halving all nitrogen waste, gaseous, aqueous and solid (i.e., the sum of all N losses including denitrification to N_2).

We hope that the present document can be useful to inform the present review of the UNECE Gothenburg Protocol and the eventual revision of air pollution policies beyond 2030. At the same time, this guidance can support the goals of multiple UN conventions, including on climate, biodiversity, water, stratospheric ozone etc. In this regard, the UNECE experience is already providing useful lessons as GEF/UNEP develop the International Nitrogen Management System (INMS) and an intergovernmental mechanism for coordination of nitrogen policies, with the UNECE Air Convention playing a key role in leading the way.

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Acronyms

AE	Abatement Efficiency
AN	Ammonium Nitrate
BAT	Best Available Technique
BMP	Best Management Practices
BSP	Best System Practices
C	Carbon
C/N	Carbon-to-Nitrogen ratio
CAN	Calcium Ammonium Nitrate
CBA	Cost-Benefit Analysis
CDU	Crotonylidene diurea
CH_4	Methane
CLRTAP	UNECE Convention on Long-range Transboundary Air Pollution (informally the "Air Convention")
CO_2	Carbon dioxide
CP	Crude Protein
DCD	Dicyandiamide - a nitrification inhibitor
DM	Dry Matter
DMPP	3,4-dimethylpyrazole phosphate – a nitrification inhibitor
DOC	Dissolved Organic Carbon
DON	Dissolved Organic Nitrogen
DPSIR	Driver-Pressure-State-Impact-Response
ECE	United Nations Economic Commission for Europe
ENA	European Nitrogen Assessment
EU	European Union
EU28	The former group of 28 countries of the European Union, now EU27
FAO	Food and Agriculture Organization of the United Nations
FYM	Farmyard Manure
GEF	Global Environment Facility
GHG	Greenhouse Gas
GPS	Global Positioning System
H_2O	Water
HELCOM	Helsinki Commission for Baltic Marine Environment Protection
HNO_3	Nitric acid
IBDU	Isobutylidene diurea
INCOM	Inter-convention Nitrogen Coordination Mechanism
INMS	International Nitrogen Management System – implemented through the GEF/United Nations Environment Programme Towards INMS project
IPCC	Intergovernmental Panel on Climate Change
K	Potassium
LRTAP	UNECE Convention on Long-range Transboundary Air Pollution (informally the "Air Convention")
N	Nitrogen
N footprint	Nitrogen footprint
N_2	Dinitrogen – a colourless and odourless gas, forming about 78 per cent of the Earth's atmosphere
N_2O	Nitrous oxide – a powerful greenhouse gas
NAC	National Ammonia Code
NBPT	N-(n-butyl) thiophosphoric triamide – a urease inhibitor
NGO	Non-governmental organization
NH_3	Ammonia – an air and water pollutant and the primary nitrogen form in biological systems

NH_4^+	Ammonium – present in biological systems and soils, while forming a pollutant in atmospheric PM and aquatic systems
NH_x	Total ammoniacal nitrogen – sometimes referred to as TAN
NI	Nitrification Inhibitor
NO	Nitric oxide – a tropospheric air pollutant
NO_2	Nitrogen dioxide – a tropospheric air pollutant
NO_2^-	Nitrite
NO_3^-	Nitrate – present as a secondary pollutant in atmospheric PM and a eutrophying pollutant of aquatic systems
NO_x	Nitrogen oxides – a combination of NO and NO_2
N_{org}	Organic nitrogen
NPK	Nitrogen, Phosphorus and Potassium in combination
N_r	Reactive Nitrogen – a term used for a variety of nitrogen compounds that support growth directly or indirectly, as opposed to N_2 which is inert
NUE	Nitrogen Use Efficiency – typically defined as the ratio of N in outputs divided by the N in inputs. May be expressed for different systems such as crops, livestock, food chain and the whole economy
O_3	Ozone
OECD	Organization for Economic Cooperation and Development
P	Phosphorus
PM	Particulate Matter – includes NH_4^+ and NO_3^- as major components. PM_{10} and $PM_{2.5}$ refer to atmospheric particulate matter (PM) that has a diameter of less than 10 and 2.5 micrometres respectively
R-NH_2	Organic nitrogen compounds
S	Sulphur
SEA	Strategic Environmental Assessment
Si	Silicon
SO_2	Sulphur dioxide
TAN	Total Ammoniacal Nitrogen
TFIAM	Task Force on Integrated Assessment Modelling of the UNECE Air Convention
TFRN	Task Force on Reactive Nitrogen of the UNECE Air Convention
TN	Total Nitrogen
UAN	Urea Ammonium Nitrate
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds
WGSR	Working Group on Strategies and Review of the UNECE Air Convention
WHO	World Health Organization
Zn	Zinc