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Nitrogen Deposition, Critical Loads and Biodiversity

 Springer

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Nitrogen Deposition, Critical Loads and Biodiversity

Proceedings of the International Nitrogen
Initiative Workshop, linking experts of the
Convention on Long-range Transboundary Air
Pollution and the Convention on Biological
Diversity

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ISBN 978-94-007-7938-9 ISBN 978-94-007-7939-6 (eBook)
DOI 10.1007/978-94-007-7939-6
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2014931651

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Printed on acid-free paper

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Preface

This volume describes the fruits of the International Expert Workshop on Nitrogen Deposition, Critical Loads and Biodiversity that was held on 16-18th November 2009, in Edinburgh, UK. The need for the workshop emerged as a result of discussion within the International Nitrogen Initiative (INI)—a joint project of the International Geosphere Biosphere Programme (IGBP) and the Scientific Committee on Problems of the Environment (SCOPE). The INI highlighted that, while there was a wealth of evidence on the magnitude, components and effects of atmospheric nitrogen deposition on floral biodiversity in Europe and North America, there was an obvious lack of information on impacts on above- and below-ground fauna and all impacts in other parts of the world, with no clear overview of how the different strands of evidence fitted together.

Building on underpinning funds from the Packard Foundation, INI therefore joined forces with several other initiatives—the COST 729 and Nitrogen in Europe (NinE) programmes of the European Science Foundation (ESF) and the European Union Integrated Project NitroEurope, together with the US Environmental Protection Agency, the Ministry of Infrastructure and the Environment (Minienm; formerly VROM), the Netherlands, the Stockholm Environment Institute (SEI), and the Centre for Ecology and Hydrology (CEH). The result was the basis to invite the world's leading experts on nitrogen deposition and its effects to Edinburgh to share experience and debate the future challenges.

It is important to recognize, however, that this could not be a purely academic endeavour. As has been shown by the Expert Workshop, atmospheric nitrogen deposition represents a major threat to the biodiversity of many of the world's most precious ecosystems. With this in mind, it was essential to place the workshop in the context of international actions to manage air pollution and biodiversity. The leading agreements of the United Nations in this regard are the Long-Range Transboundary Air Pollution (LRTAP) Convention, under the United Nations Economic Commission for Europe (UNECE), and the Convention on Biological Diversity (CBD), which has a global coverage. Although each Convention is highly relevant, they have very different ways of working, and, until the Edinburgh meeting, there had been insufficient working contacts between them. The Workshop therefore included a specific objective to bring together leading experts from both Conventions as a ba-

sis for improving cooperation and mutual understanding. At the same time, the policy drive of the Conventions would feed back to inform the future scientific agenda.

The outcome was a joint workshop between experts from both the LRTAP Convention and the CBD, together with many other leading experts globally. In total, 140 experts from 30 countries participated, representing most continents and regions of the world. The proceedings and conclusions of the Expert Workshop are reported in this volume, while selected papers (see Appendix) are further developed in a Special Section of the journal *Environmental Pollution* (Goodale et al. 2011). In parallel the outcomes have been reported to the LRTAP and CBD processes (UN-ECE 2009).

We take this opportunity to thank the members of the Organizing Committee: Albert Bleeker, Roland Bobbink, Mercedes Bustamante, Tom Clair, Frank Dentener, Nancy Dise, Jan Willem Erisman, Jean Paul Hettelingh, Duan Lei, Annika Nordin, Till Spranger, Wim de Vries, Zifa Wang and, last but not least, Jim Galloway who originally proposed the workshop. The Organizing Committee was co-chaired by Kevin Hicks and Richard Haeuber, while Mark Sutton acted as workshop host. We thank the Centre of Ecology & Hydrology (Edinburgh), and SCOPE, which together provided the secretariat prior, during and following the workshop, held at the George Hotel in Edinburgh. In this regard, we extend our special thanks to the key individuals who provided the organizational foundation for the success of the workshop: Clare Howard, Agnieszka Becher (CEH), Susan Greenwood Etienne (SCOPE) and Allison Leach (University of Virginia, USA). We would also like to thank Bill Bealey (CEH) for master-minding the electronic registration process, Richard Clay (SEI) for his work on the flyer and other materials for the workshop and Steve Johnson at the University of Virginia for his assistance with the workshop website. Special thanks are also due to Henk Strietman at Minienm in the Netherlands, Sjamsudin Chandrasa at COST 729 and Ellen Degott-Rekowski at ESF for their advice and support. The European Union kindly provided supporting funds allowing completion of this publication under the frame of the ÉCLAIRE project (FP7) and we gratefully acknowledge the encouragement of José M. Giménez Mingo of the European Commission. Finally, we would like to thank Tamara Welschot and Judith Terpos at Springer for their patience and advice.

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September 2013

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Acronyms and Abbreviations

ANC	Acid Neutralizing Capacity
BC	Base Cation
BNF	Biological Nitrogen Fixation.
CAD	Composition of Asian Deposition Network
CAFÉ	Clean Air for Europe
CAP	Common Agricultural Policy of the European Union
CBA	Cost Benefit Analysis—an economic tool to weigh the total expected costs against the total expected benefits of one or more actions.
CAPMoN	Canadian Air and Precipitation Monitoring Network
CASTNET	United States Clean Air Status and Trends Network
CBD	UN Convention on Biological Diversity
CLE	Critical level
CL	Critical load
DEBITS	Deposition of Biogeochemically Important Trace Species
DIN	Dissolved Inorganic Nitrogen
DON	Dissolved Organic Nitrogen
EANET	Acid Deposition Monitoring Network in East Asia
EMEP	European Monitoring and Evaluation Programme of the LRTAP Convention
GAW	Global Atmospheric Watch
GHG	Greenhouse Gas—includes carbon dioxide (CO ₂), nitrous oxide (N ₂ O), methane (CH ₄), ozone (O ₃), water vapour and various other gases.
GWP	Global Warming Potential
GPNM	Global Partnership on Nutrient Management—established under the lead of UNEP
HNO ₃	Nitric acid—a reactive gas air pollutant
HONO	Nitrous acid—a reactive gas air pollutant
ICP	International Cooperative Programme of the LRTAP Convention
IDAF	DEBITS in Africa
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme

INI	International Nitrogen Initiative
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LRTAP	UNECE Long-range Transboundary Air Pollution Convention
NADP	United States National Atmospheric Deposition Program
N ₂	Di-nitrogen—unreactive nitrogen gas making up 78% of the atmosphere
N ₂ O	Nitrous oxide—a greenhouse gas
NEC(D)	National Emissions Ceilings (Directive) of the European Union
NH ₃	Ammonia—a reactive gas air pollutant
NH ₄ ⁺	Ammonium—ion present in aerosols and precipitation
NH _x	Collective term for NH ₃ and NH ₄ ⁺ , inorganic reduced nitrogen
NO	Nitric oxide—a reactive gas air pollutant
NO ₂	Nitrogen dioxide—a reactive gas air pollutant
NO ₂ ⁻	Nitrite—ion present in water samples
NO ₃ ⁻	Nitrate—ion present in aerosols, precipitation and water samples
NO _x	Nitrogen oxides (the sum of NO and NO ₂)
NO _y	Collective term for inorganic oxidized nitrogen, including NO _x , NO ₃ ⁻ , HONO, HNO ₃ etc.
N _r	Reactive nitrogen—collective term for all nitrogen forms except for unreactive di-nitrogen (N ₂). Includes, NH _x
O ₃	Ozone—tropospheric ozone (ozone in the lowest 10–20 km of the atmosphere) unless specified in text
PAN	Peroxyacetyl nitrate (C ₂ H ₃ O ₅ N) is one constituent of photochemical smog
PM _{2.5} /PM ₁₀	Particulate Matter. Aerosol mass contained in particles with an aerodynamic diameter below 2.5 (or 10 for PM ₁₀) micrometre, measured with a reference technique
SAC	Special Area(s) of Conservation designated under the Habitats Directive of the European Union
TFRN	Task Force on Reactive Nitrogen of the LRTAP Convention
UKEAP	United Kingdom Eutrophying and Acidifying Pollutants network
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
VOCs	Volatile Organic Compounds
WGE	Working Group on Effects of the LRTAP Convention
WGSR	Working Group on Strategies and Review of the LRTAP Convention
WMO	World Meteorological Organization

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Chapter 1

Nitrogen Deposition, Critical Loads and Biodiversity: Introduction

W. Kevin Hicks, Richard Haeuber and Mark A. Sutton

Abstract Human activities, related primarily to agricultural practices and the combustion of fossil fuels for energy and transport, have caused steep increases in global emissions of reactive nitrogen (N_r) over the last 50 years (e.g., Gallo-way et al. *Biogeochemistry*, 70(2), 153–226, 2004, *Science*, 320, 889–892, 2008). Atmospheric nitrogen (N) deposition derived from these sources represents a major threat to natural ecosystems around the world, leading to changes in structure, function and the associated biodiversity (e.g. Phoenix et al. *Global Change Biology*, 12, 470–476, 2006; Bobbink et al. *Ecological Applications*, 20, 30–59, 2010). Although substantial progress has been made in past decades, especially in Europe and North America, major uncertainties remain regarding the global perspective. In the last 30 years, Europe and North America have made great progress in assessing the problem, although the knowledge base is greater for impacts on flora than fauna; in many other parts of the world, however, the required datasets and assessments in many cases do not yet exist. This chapter summarizes the approach taken in the Workshop on Nitrogen Deposition, Critical Loads and Biodiversity and outlines the contents and structure of the book.

Keywords Nitrogen deposition • Biodiversity • Critical loads • Ecosystem services • Monitoring and modelling

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