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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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Editors
Mark A. Sutton
Centre for Ecology and Hydrology
Edinburgh Research Station
Penicuik, Midlothian
United Kingdom

Kate E. Mason
Centre for Ecology and Hydrology
Edinburgh Research Station
Penicuik, Midlothian
United Kingdom

Lucy J. Sheppard
Centre for Ecology and Hydrology
Edinburgh Research Station
Penicuik, Midlothian
United Kingdom

Harald Sverdrup
University of Lund
Department of Chemical Engineering
Lund, Sweden

Richard Haeuber
US Environmental Protection Agency
Washington DC, Washington
USA

W. Kevin Hicks
Stockholm Environment Centre (SEI)
Environment Department
University of York
Heslington, York
United Kingdom

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

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

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 (UNECE 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.

Mark A. Sutton, Kate E. Mason, Lucy J. Sheppard,
Harald Sverdrup, Richard Haeuber and W. Kevin Hicks
September 2013

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Contributors

Per Arild Aarrestad Norwegian Institute for Nature Research, Trondheim, Norway

Wenche Aas NILU, Norwegian Institute for Air Research, PB 100, Kjeller, Norway

Mark Adams Faculty of Agriculture Food and Natural Resources (FAFNR), McMillan Building, University of Sydney, Sydney, NSW, Australia

Marcellin Adon Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

Laboratoire de Physique de l'Atmosphère, Université de Cocody, Abidjan, Côte D'Ivoire

Julius I. Agboola Department of Fisheries, Lagos State University, Ikeja, Lagos, Nigeria

Julian Aherne Department of Environmental and Resource Studies, Trent University, Peterborough, ON, Canada

Luan Ahmetaj Albanian Association of Organic Horticulture-Bioplant Albania, Lagja Sanatorium, Tirana, Albania

Marcos P. M. Aidar Instituto de Botânica, São Paulo, SP, Brazil

Aristide Akpo Université Abomey Calavi, Cotonou, Bénin

Didier Alard UMR INRA 1202 Biodiversity, Genes and Communities (BIOGECO), Equipe Ecologie des Communautés, University of Bordeaux 1, Talence, France

Edith B. Allen Department of Botany and Plant Sciences and Center for Conservation Biology, University of California, Riverside, California, USA

Ana Alebic-Juretic Teaching Institute of Public Health/School of Medicine, University of Rijeka, Rijeka, Croatia

Viney P. Aneja Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, NC, USA

Richard Artz NOAA Air Resources Laboratory, Silver Spring, MD, USA

Amy Austin Faculty of Agronomy and IFEVA-CONICET, Department of Ecology, University of Buenos Aires, Buenos Aires, Argentina

Moses A. Awodun Department of Crop, Soil and Pest Management, Federal University of Technology, Akure, Ondo State, Nigeria

K. V. S. Badarinath Atmospheric Science Section, National Remote Sensing Centre, ISRO, Balanager, Hyderabad, Andhra Pradesh, India

Mei Bai School of Chemistry, University of Wollongong, Wollongong, NSW, Australia

Rajasekhar Balasubramanian Division of Environmental Science and Engineering, National University of Singapore, Singapore

Mary Barber RTI International, Washington, DC, USA

Simon Bareham Countryside Council for Wales/Joint Nature Conservation Committee, Bangor, Gwynedd, UK

Jill S. Baron US Geological Survey, Natural Resources Ecology Laboratory, Colorado State University, Fort Collins, CO, USA

Rick W. Battarbee Environmental Change Research Centre, Geography Department, University College London, Gower Street, London, UK

William J. Bealey Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Salim Belyazid Department of Chemical Engineering, Lund University, Lund, Sweden

Haldis Berge The Norwegian Meteorological Institute, Blindern, Oslo, Norway

Theresa L. Bird School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa

Albert Bleeker Department of Air Quality and Climate Change, Energy Research Centre of the Netherlands (ECN), Petten, The Netherlands

Tamara Blett National Park Service, Lakewood, CO, USA

Roland Bobbink B-WARE Research Centre, Radboud University, Nijmegen, The Netherlands

Maxim V. Bobrovsky Institute of Physico-Chemical and Biological Problems in Soil Science of Russian Academy of Sciences, Pushchino, Moscow region, Russia

Aaron Boone GAME, CNRM, Toulouse, France

William D. Bowman Department of Ecology and Evolutionary Biology and Mountain Research Station/ INSTAAR, University of Colorado, Boulder, CO, USA

Cristina Branquinho Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

William Budd Division of Governmental Studies and Services, Washington State University, Pullman, WA, USA

Krishnakant Budhavant Indian Institute of Tropical Meteorology, Pune, India

Vishwakarma Institute of Technology, Bibwewadi, Pune, India

Keith Bull Centre for Ecology and Hydrology, Lancaster Environment Centre, Lancaster, UK

Mercedes M. C. Bustamante Departamento de Ecologia, Universidade de Brasília, Brasília-DF, Brazil

Sergey S. Bykhovets Institute of Physico-Chemical and Biological Problems in Soil Science of Russian Academy of Sciences, Pushchino, Moscow region, Russia

Andrzej Bytnerowicz USDA Forest Service, Pacific Southwest Research Station, Riverside, California, USA

J. Neil Cape Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Silvina Carou Environment Canada, Toronto, Ontario, Canada

Luís Carvalho Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Pierre Castera Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

Sandra Chaves Faculdade de Ciências, Center for Biodiversity, Functional and Integrative Genomics (BioFIG), Universidade de Lisboa, Lisboa, Portugal

Deli Chen School of Land and Environment, The University of Melbourne, Melbourne, VIC, Australia

Thomas A. Clair Environment Canada, Dartmouth, NS, Canada

Christopher M. Clark Global Change Research Program/Environmental Protection Agency, Crystal City, VA, USA

Adelaide Clemente Museu Nacional de História Natural, Universidade de Lisboa, Lisboa, Portugal

Cory C. Cleveland Department of Ecosystem and Conservation Sciences, College of Forestry and Conservation, University of Montana, Missoula, MT, USA

Edward C. Cocking Centre for Crop Nitrogen Fixation, School of Biosciences, University of Nottingham, Nottingham, UK

Luciana D. Colleta CENA/Esalq, Universidade de São Paulo, Piracicaba, SP, Brazil

Ellen J. Cooter Atmospheric Modeling and Analysis Division, US Environmental Protection Agency, Research Triangle Park, NC, USA

Emmanuel Corcket UMR INRA 1202 Biodiversity, Genes and Communities, Equipe Ecologie des Communautés, University of Bordeaux 1, Talence, France

Sarah E. Cornell Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden

Otília Correia Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Patrícia Correia Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Cristina Cruz Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Chris J. Curtis Environmental Change Research Centre, Geography Department, University College London, London, UK

School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa

Eric Davidson The Woods Hole Research Center, Falmouth, MA, USA

Claire Delon Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

O. Tom Denmead CSIRO Land and Water, Canberra, ACT, Australia

School of Land and Environment, The University of Melbourne, Melbourne, VIC, Australia

Robin L. Dennis Atmospheric Modeling and Analysis Division, US Environmental Protection Agency, Research Triangle Park, NC, USA

Frank Dentener European Commission, Joint Research Centre, Institute for Environment and Sustainability, ISPRA (VA), Italy

Teresa Dias Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Martin Diekmann Institute of Ecology, FB 2, University of Bremen, Bremen, Germany

Babakar Diop Université de Bamako, Campus Universitaire de Badalabougou, Bamako, Mali

Nancy B. Dise Department of Environmental and Geographical Sciences, Manchester Metropolitan University, Manchester, UK

Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Hans van Dobben Alterra, Wageningen University and Research Centre, Wageningen, The Netherlands

Anthony J. Dore Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Christopher J. Dore Aether Ltd, Abingdon, Oxfordshire, UK

Edu Dorland Section of Landscape Ecology, Department of Geobiology, Utrecht University, Utrecht, The Netherlands

Staatsbosbeheer, Princenhof Park 1, Driebergen, The Netherlands

Ulrike Dragosits Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Enzai Du College of Urban and Environmental Sciences, Peking University, Beijing, China

Lei Duan School of Environment, Tsinghua University, Beijing, China

Laouali Dungall Université Abdou Moumouni, Faculté des Sciences, Niamey, Niger

Cecilia Duprè Institute of Ecology, University of Bremen, Bremen, Germany

Bridget Emmett Centre for Ecology and Hydrology, Environment Centre Wales, Bangor, UK

Jan Willem Erisman The Netherlands and Energy Research Centre of the Netherlands (ECN), VU University Amsterdam, Petten, The Netherlands

Louis Bolk Institute, Driebergen, The Netherlands

Andreas Fangmeier Institute for Landscape and Plant Ecology, University of Hohenheim, Stuttgart, Germany

Alan Feest Water and Environmental Management Research Centre, University of Bristol, Bristol, UK

Mark E. Fenn Pacific Southwest Research Station, USDA Forest Service, Riverside, CA, USA

Cátia Fidalgo Faculdade de Ciências, Center for Biodiversity, Functional and Integrative Genomics (BioFIG), Universidade de Lisboa, Lisboa, Portugal

Maria Cristina Forti National Institute for Space Research (INPE), São José dos Campos-SP, Brazil

David Fowler Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Jenny Gaiawyn Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

James N. Galloway Department of Environmental Sciences, University of Virginia, Charlottesville, VA, USA

Corinne Galy-Lacaux Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

Eric Gardrat Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

Cassandre Gaudnik UMR INRA 1202 Biodiversity, Genes and Communities (BIOGECO), Equipe Ecologie des Communautés, University of Bordeaux 1, Talence, France

Linda H. Geiser Pacific Northwest Region Air Resource Management, USDA Forest Service, Corvallis, OR, USA

Markus Geupel Federal Environment Agency, Dessau-Rosslau, Germany

Frank S. Gilliam Department of Biological Sciences, Marshall University, Huntington, WV, USA

Benjamin S. Gimeno Ecotoxicology of Air Pollution, CIEMAT (Ed. 70), Madrid, Spain

Douglas A. Glavich Pacific Northwest Region Air Resource Management, USDA Forest Service, Corvallis, OR, USA

Carla Gonzalez Center for Environmental and Sustainability Research, Ecological Economics and Environmental Management Group, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal

Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Christine Goodale Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, NY, USA

Megan L. Gore Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, NC, USA

David J. G. Gowing Environment, Earth and Ecosystems, The Open University, Milton Keynes, UK

Tara Greaver US Environmental Protection Agency, Research Triangle Park, NC, USA

David W. T. Griffith School of Chemistry, University of Wollongong, Wollongong, NSW, Australia

Peter Groffman Cary Institute of Ecosystem Studies, Millbrook, USA

Richard Haeuber US Environmental Protection Agency, (6204J), USEPA Headquarters, Washington DC, USA

L'uboš Halada Institute of Landscape Ecology, Slovak Academy of Sciences, Nitra, SK, Slovak Republic

Jane R. Hall Centre for Ecology and Hydrology, Environment Centre Wales, Bangor, Gwynedd, UK

Stephen Hallsworth Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Jiming Hao School of Environment, Tsinghua University, Beijing, China

Harry Harmens Centre for Ecology and Hydrology, Environment Centre Wales, Bangor, Gwynedd, UK

Ian J. Harrison Conservation International, Arlington, VA, USA

Jean-Paul Hettelingh Coordination Centre for Effects (CCE), National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

W. Kevin Hicks Stockholm Environment Institute (SEI), Environment Department, University of York, York, UK

Julian Hill School of Land and Environment, The University of Melbourne, VIC Australia

Arjan van Hinsberg Netherlands Environmental Assessment Agency (PBL), Bilthoven, The Netherlands

Lars Hogbom The Forestry Research Institute of Sweden (Skogforsk), Uppsala, Sweden

Juraj Hreško Institute of Landscape Ecology, Slovak Academy of Sciences, Nitra, SK, Slovak Republic

Carmen Iacoban Forest Research and Management Institute, Forest Research Station, Campulung Moldovenesc, Romania

Carmen Infante Postgrado de Geoquímica, Facultad de Ciencias, Universidad Central de Venezuela, Caracas, Venezuela

Tamiel K. B. Jacobson Faculdade UnB Planaltina, LEdoC, Universidade de Brasília, Planaltina, Distrito Federal, Brazil

Paul Jarvis[†] School of GeoSciences, The University of Edinburgh, Edinburgh, UK

Matti Johansson United Nations Economic Commission for Europe, Geneva, Switzerland

Robert F. Johnson Department of Botany and Plant Sciences and Center for Conservation Biology, University of California, Riverside, CA, USA

Sarah E. Jovan Forest Inventory and Analysis Program, USDA Forest Service, Portland Forestry Sciences Lab, Portland, OR, USA

[†]Paul Jarvis (deceased 2013)

Larisa G. Khanina Institute of Mathematical Problems in Biology of Russian Academy of Sciences, Pushchino, Moscow region, Russia

Sanna K. Kivimaki Centre for Ecology and Hydrology, Penicuik, Midlothian, UK

Alexander S. Komarov Institute of Physico-Chemical and Biological Problems in Soil Science of Russian Academy of Sciences, Pushchino, Moscow region, Russia

Ina Koseva Department of Environmental and Resource Studies, Trent University, Peterborough, ON, Canada

Manitoba Centre for Health Policy, University of Manitoba, Winnipeg, Manitoba, Canada

Alessandra R. Kozovits Department of Biodiversity, Evolution and Environment, Federal University of Ouro Preto, Ouro Preto, MG, Brazil

Maciej Kryza Department of Climatology and Atmosphere Protection, Wrocław University, Wrocław, Poland

Eero Kubin Finnish Forest Research Institute, Muhos, Finland

Monika J. Kulshrestha Radio and Atmospheric Sciences Division, National Physical Laboratory, New Delhi, DL, India

Umesh C. Kulshrestha School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, DL, India

Brian Lamb Washington State University, Lab for Atmospheric Research, Pullman, WA, USA

Sabrina R. Latansio-Aidar Departamento de Biologia Vegetal, Universidade Estadual de Campinas, Campinas, SP, Brazil

Allison Leach University of Virginia, Charlottesville, VA, USA

Ian D. Leith Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Catherine Liousse Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

Xuejun Liu College of Resources and Environmental Sciences, China Agricultural University (CAU), Beijing, China

Zoe Loh School of Land and Environment, The University of Melbourne, VIC Australia

CSIRO Marine and Atmospheric Research, Aspendale, VIC, Australia

Danilo López-Hernández Laboratorio de Estudios Ambientales, Instituto de Zoología y Ecología Tropical, Facultad de Ciencias, Universidad Central de Venezuela, Caracas, Venezuela

Xiankai Lu Dinghushan Forest Ecosystem Research Station, South China Botanical Garden, Chinese Academy of Sciences, Zhaoqing, China

Stephen Maberly Centre for Ecology and Hydrology, Lancaster Environment Centre, Lancaster, UK

Cristina Máguas Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Esteban Manrique Instituto de Recursos Naturales, Centro de Ciencias Medioambientales, Consejo Superior de Investigaciones Científicas, Madrid, Spain

Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Madrid, Spain

Maria-Amélia Martins-Loução Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Kate E. Mason Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Scot Mathieson Scottish Environment Protection Agency, Stirling, UK

Colin McClean Environment Department, University of York, York, UK

Sean McGinn Agriculture and Agrifood Canada, Lethbridge, Alberta, Canada

Thomas Meixner Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona, USA

Thiago R. B. de Mello Departamento de Botânica, Universidade de Brasília, Brasília-DF, Brazil

Viviane T. Miranda Department of Biodiversity, Evolution and Environment, Federal University of Ouro Preto, Ouro Preto, Brazil

Departamento de Ecologia, Universidade de Brasília, Brasília-DF, Brazil

Eric Mougin Géosciences Environnement Toulouse, Université de Toulouse, Toulouse, France

J. Owen Mountford Centre for Ecology and Hydrology, Crowmarsh Gifford, Wallingford, Oxfordshire, UK

Jonas Mphepya North-West University, Potchefstroom Campus, Potchefstroom, South Africa

Stephanie Muir School of Land and Environment, The University of Melbourne, VIC, Australia

Serge Muller Laboratoire des Interactions Ecotoxicologie, Biodiversité et Ecosystèmes (LIEBE), UMR CNRS 7146, U.F.R. Sci. F.A., Campus Bridoux, Université Paul Verlaine, Metz, France

Cássia B. R. Munhoz Departamento de Botânica, Universidade de Brasília, Brasília-DF, Brazil

John Murgel Department of Ecology and Evolutionary Biology and Mountain Research Station/ INSTAAR, University of Colorado, Boulder, CO, USA

Hans-Dieter Nagel OEKO-DATA, National Critical Load Focal Center, Strausberg, Germany

Travis Naylor The Centre for Atmospheric Chemistry, Department of Chemistry, University of Wollongong, Wollongong, NSW, Australia

Bengt Nihlgård Plant Ecology and Systematics, Department of Biology, Lund University, Lund, Sweden

Raúl Ochoa-Hueso Instituto de Recursos Naturales, Centro de Ciencias Medioambientales, Consejo Superior de Investigaciones Científicas, Madrid, Spain

Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Madrid, Spain

Jean P. H. B. Ometto Instituto Nacional de Pesquisas Espaciais (CCST/INPE), São José dos Campos, SP, Brazil

Cristina Paradela Instituto de Recursos Naturales, Centro de Ciencias Medioambientales, Consejo Superior de Investigaciones Científicas, Madrid, Spain

Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Madrid, Spain

Linda Pardo USDA Forest Service, S. Burlington, VT, USA

Bill Paton Department of Biology, Brandon University, Brandon, MB, Canada

D. D. Patra Agronomy and Soil Science Division, Central Institute of Medicinal and Aromatic Plants, Lucknow, India

Richard Payne Department of Environmental and Geographical Sciences, Manchester Metropolitan University, Manchester, UK

Tibisay Perez Venezuelan Institute for Scientific Research (IVIC), Lab. Quimica Atmosferica, Caracas, Venezuela

M. Esther Pérez-Corona Department of Ecology, Faculty of Biology, Universidad Complutense de Madrid, Madrid, Spain

Frances Phillips The Centre for Atmospheric Chemistry, Department of Chemistry, University of Wollongong, Wollongong, NSW, Australia

Jacobus J. Pienaar North-West University, Potchefstroom Campus, Potchefstroom South Africa

Pedro Pinho Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Universidade de Lisboa, Lisboa, Portugal

Jon E. Pleim Atmospheric Modeling and Analysis Division, US Environmental Protection Agency, Research Triangle Park, NC, USA

Jan Plesnik Agency for Nature Conservation and Landscape Protection of the Czech Republic, Praha 4, Czech Republic

Maximilian Posch Coordination Centre for Effects (CCE), National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

Richard V. Pouyat US Forest Service, Arlington, VA, USA

Leela E. Rao Center for Conservation Biology, University of California, Riverside, CA, USA

Nalini Rao Conservation International, VA, Arlington, USA

P. S. P. Rao Indian Institute of Tropical Meteorology, Pune, India

Loka Arun K. Reddy Air Quality Division, Environmental Diagnostics Research Department, National Institute of Environmental Research (NIER), Incheon, Korea

Gert Jan Reinds Alterra, Wageningen University and Research Centre, Wageningen, The Netherlands

Doug Rowell School of Land and Environment, The University of Melbourne, Melbourne, VIC, Australia

Zoe Russell Natural England, Ashford, Kent, UK

P. D. Safai Indian Institute of Tropical Meteorology, Pune, India

Jetta Satyanarayana Analytical and Environmental Chemistry Division, Indian Institute of Chemical Technology, Hyderabad, India

Thomas Scheuschner OEKO-DATA, National Critical Load Focal Center, Strausberg, Germany

Angela Schlutow OEKO-DATA, National Critical Load Focal Center, Strausberg, Germany

Susanne Schmidt School of Biological Sciences, The University of Queensland, Brisbane, Australia

Diego Sequera Facultad de Ciencias, Laboratorio de Estudios Ambientales, Instituto de Zoología y Ecología Tropical, Universidad Central de Venezuela, Caracas, Venezuela

Dominique Serça Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

Vladimir N. Shanin Institute of Physico-Chemical and Biological Problems in Soil Science of Russian Academy of Sciences, Pushchino, Moscow region, Russia

Yogendra B. Sharma Oxford University Centre for the Environment (OUCE), University of Oxford, Oxford, UK

Jianlin Shen College of Resources and Environmental Sciences, China Agricultural University, Beijing, China

Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha, Hunan province, China

Lucy J. Sheppard Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Luc Sigha Université de Yaoundé, Yaoundé, Cameroon

Gavin L. Simpson Environmental Change Research Centre, Geography Department, University College London, London, UK

Y. V. Singh Indian Agricultural Research Institute, CCUBGA, IARI, New Delhi, India

Jaap Slootweg Coordination Centre for Effects (CCE), National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

Ron I. Smith Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Fabien Solmon Laboratoire d'Aérologie, CNRS/Université de Toulouse, Toulouse, France

V. K. Soni India Meteorological Department, Pune, India

Environment Monitoring and Research Center (EMRC), Mausam Bhawan, New Delhi, India

Till Spranger Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin, Germany

Carly J. Stevens Department of Life Science, The Open University, Milton Keynes, UK

Lancaster Environment Centre, Lancaster University, Lancaster, UK

Philip J. Stone Centre for Crop Nitrogen Fixation, School of Biosciences, University of Nottingham, Nottingham, UK

Ian Strachan Scottish Natural Heritage, Inverness, UK

Sidney Luiz Stürmer Departamento de Ciências Naturais, Universidade Regional de Blumenau, Blumenau, SC, Brazil

Mark A. Sutton Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Harald Sverdrup Department of Chemical Engineering, Lund University, Lund, Sweden

Y. Sim Tang Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

Rogério Tenreiro Faculdade de Ciências, Center for Biodiversity, Functional and Integrative Genomics (BioFIG), Universidade de Lisboa, Lisboa, Portugal

Mark R. Theobald Technical University of Madrid, ETSI/Centre for Ecology and Hydrology, UPM, Madrid, Spain

Naoko Tokuchi Faculty/Graduate School of Agriculture, Kyoto University (Yoshida North Campus), Kyoto, Japan

Gail Tonnesen Center for Environmental Engineering and Technology, University of California, Riverside, CA, USA

Krishna P. Vadrevu Department of Geographical Sciences, University of Maryland (UMCP), MD, USA

Oswaldo Vallejo Universidad Nacional Experimental de Los Llanos Ezequiel Zamora, Guanare, Venezuela

Vigdis Vandvik Department of Biology, University of Bergen, Bergen, Norway

Robert Vet Environment Canada, Downsview, Toronto, Ontario, Canada

Massimo Vieno Centre for Ecology and Hydrology, Edinburgh Research Station, Penicuik, Midlothian, UK

School of GeoSciences, The University of Edinburgh, Edinburgh, UK

Wim de Vries Alterra, Wageningen University and Research Centre, Wageningen, The Netherlands

Environmental Systems Analysis Group, Wageningen University, Wageningen, The Netherlands

Shaun A. Watmough Department of Environmental and Resource Studies, Trent University, Peterborough, ON, Canada

Małgorzata Werner Department of Climatology and Atmosphere Protection, Wrocław University, Wrocław, Poland

Clare P. Whitfield Joint Nature Conservation Committee, Peterborough, UK

James M. Williams Joint Nature Conservation Committee, Peterborough, UK

Sarah Woodin IBES, University of Aberdeen, Aberdeen, UK

Jia Xing School of Environment, Tsinghua University, Beijing, China

Atmospheric Modeling and Analysis Division, National Exposure Research Laboratory, US Environmental Protection Agency, NC, USA

Véronique Yoboué Laboratoire de Physique de l'Atmosphère, Université de Cocody-Abidjan, Abidjan 22, Côte D'Ivoire

Fengming Yuan Institute of Arctic Biology, University of Alaska, Fairbanks, AK, USA

Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA

Fusuo Zhang College of Resources and Environmental Sciences, China Agricultural University, Beijing, China

Yu Zhao School of Environment, Tsinghua University, Beijing, China

School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA

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_2O), 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_2O	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	Peroxyacytyl nitrate ($C_2H_3O_5N$) 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

Contents

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., Galloway 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

W. K. Hicks (✉)
Stockholm Environment Institute (SEI), Grimston House (2nd Floor),
Environment Department, University of York, Heslington, York, YO10 5DD, UK
e-mail: kevin.hicks@york.ac.uk

R. Haeuber
US Environmental Protection Agency, (6204J), USEPA Headquarters,
Ariel Rios Building, 1200 Pennsylvania Avenue,
NW, Washington DC 20460, USA
e-mail: Haeuber.Richard@epamail.epa.gov

M. A. Sutton
Centre for Ecology and Hydrology, Bush Estate, Penicuik,
Midlothian, EH26 OQB, UK
e-mail: ms@ceh.ac.uk

M. A. Sutton et al. (eds.), *Nitrogen Deposition, Critical Loads and Biodiversity,*
DOI 10.1007/978-94-007-7939-6_1,