UNITED NATIONS ENVIRONMENT PROGRAMME
Programme des Nations Unies pour l'environnement Programa de las Naciones Unidas para el Medio Ambiente
Программа Организации Объединенных Наций по окружающей среде برنامج الأمم المتحدة للبيئة
联合国环境规划署

UNEP

Project Document

Section 1: Project Identification

1.1	**Project title:**	Targeted research for improving understanding of the global nitrogen cycle towards the establishment of an International Nitrogen Management System (INMS)
1.2	**Project number:**	5400 PMS:
1.3	**Project type:**	FSP
1.4	**Trust Fund:**	GEF TF
1.5	**Strategic objectives:**	GEF-5 International Waters Strategic Priority 3. (IW-3)
1.6	**UNEP Priority:**	Sub Programme 3, ecosystem management Expected Accomplishment (b) – output 3 the GPA global partnerships on nutrient management
1.7	**Geographic scope:**	Global, multi-country
1.8	**Mode of execution:**	External
1.9	**Project executing organization:**	International Nitrogen Initiative (INI), hosted by CEH
1.10	**Duration of project:**	48 months Commencing: June 2016 Completion: May 2020

1.11 Cost of project

	US$	%
Cost to the GEF Trust Fund	6,000,000	10
Cash Co-financing		
Component 1: Tools for understanding & managing the global N cycle	6,010,172	10
Component 2: Global & regional quantification of N use, flows, impacts & benefits of practices	1,954,440	3
Component 3: Demonstration and verification of full-nitrogen approach at regional/national/local levels (building on existing / planned interventions)	1,857,007	3
Component 4: Awareness raising and knowledge sharing	1,153,382	2
Sub-total	10,975,000	18
In Kind Co-financing		
Component 1: Tools for understanding & managing the global N cycle	18,248,998	29
Component 2: Global & regional quantification of N use, flows, impacts & benefits of practices	14,448,035	23
Component 3: Demonstration and verification of full-nitrogen approach at regional/national/local levels (building on existing / planned interventions)	8,397,624	13
Component 4: Awareness raising and knowledge sharing	4,506,249	7
Sub-total	45,600,907	73
Total	62,575,907	100

1.12 Project summary

The nitrogen challenge

Human perturbation of the global nitrogen cycle in the 21st century is leading both to massive benefits for food and energy production and to multiple environmental threats. Although nitrogen is abundant in the atmosphere in its unreactive form (N_2) it is unavailable for most organisms. At the same time, the supply of reactive nitrogen (N_r) compounds is limited under natural conditions. Anthropogenic inputs of N_r include fertilizer production, crop biological nitrogen fixation, and nitrogen oxides (NO_x) from combustion sources. As a result of these inputs, humans have more than doubled global terrestrial rates of N_r formation.

The benefits have been huge. It has been estimated that fertilizers N_r from the Haber-Bosch process sustain nearly 50% of the human population according to current diets, without which there would be massive problems of hunger and malnutrition in many parts of the world. The increased crop production over the last century has also allowed substantial increases in livestock population, enriching human diets and producing many other products. In addition, agricultural N_r inputs provide a foundation for bioenergy production, offering the potential to replace fossil fuels with renewable products.

Against these benefits, the environmental consequences of anthropogenic fixation of N_2 to N_r have been equally large. The overall global doubling of N_r flows has led to a web of pollution problems, often described in terms of the 'nitrogen cascade', where N_r converts between many chemical forms in different environmental compartments, resulting in multiple environmental impacts. This process is driven by the dissipation of energy contained in the N_r until it is eventually 'denitrified' back to atmospheric N_2. The consequences include water pollution of both freshwater and coastal marine systems, air pollution, greenhouse gas emissions, stratospheric ozone depletion, with threats for ecosystems, biodiversity and soil quality. The result is an array of adverse impacts on environment, health and livelihoods.

The goal of intentional N_r fixation is plant and animal growth, forming many N compounds such as amino acids, proteins, enzymes and DNA. Key losses of N_r include ammonia (NH_3), nitric oxide (NO), nitrates (NO_3) and nitrous oxide (N_2O). Even denitrification losses to form N_2 are polluting, since they represent a waste of the substantial resources (2% of world energy) used to make N_r.

To date, there has been little joined up effort to address these threats and benefits. This is the challenge addressed by 'Towards INMS'. Until now, many GEF interventions have included selected aspects of N as part water quality issues. Similarly, several international projects have addressed the issues of atmospheric NH_3 or N_2O emissions and their possible solutions. Each of these efforts, however, has been conducted in a fragmented way. At the same time, there are substantial barriers to achieve the desired goals of better water quality, cleaner air, reduced greenhouse gas emissions etc.

The INMS hypothesis

'Towards INMS' is developed with the recognition that the present lack of a coherent approach across the nitrogen cycle contributes substantially to these barriers. *'Towards INMS' therefore addresses the hypothesis that joined up management of the nitrogen cycle will offer many co-benefits that strengthen the case for action for cleaner water, cleaner air, reduced greenhouse gas emissions, better soil and biodiversity protection, while at the same time helping to meet food and energy goals.*

This approach also feeds back into each of the usual topic domains. For example, where actions needed to reduce the effects of N on transboundary waters can be shown simultaneously to deliver quantified

co-benefits for air, climate, food, energy, then this will more strongly motivate the necessary changes for water protection. The same applies for each of the other threat and benefit policy domains (food, air, climate, soil etc). By acting together through the nitrogen cycle, there is the potential to transform efforts for a cleaner and healthier environment.

Goal of Towards INMS

'Towards INMS' is prepared as a GEF 'Targeted Research Project' at the global scale. This is not research in the traditional sense of focusing on fundamental science. It is rather research in how these issues can be brought together to provide tools, approaches, information and demonstration that can support the mobilization of change at a global scale. 'Towards INMS' is therefore pitched clearly at the interface of science-policy-practice development.

With this framing, Towards INMS, has been developed with a broad partnership to address the following project objective: "*To improve the understanding of the global/region N cycle and investigate / test practices and management policies at the regional, national and local levels with a view to reduce negative impacts of reactive nitrogen on the ecosystems."*[1]

At the same time, it is recognized that 'Towards INMS' has a central role to play in catalyzing the global policy community to develop more effective global and regional strategies to manage the nitrogen cycle. This is the reason that the project is titled "*Towards*" the International Nitrogen Management System. Such an international system of science and practice support for policies in the global nitrogen cycle does not currently exist. 'Towards INMS' is therefore a key step in this process, where the system of science, evidence and options provision (representing the scope of INMS) can work hand in hand with improved coordination among policy makers. 'Towards INMS' thereby parallels ongoing developments in the international policy arena for nitrogen.

'Towards INMS' is highly relevant to support several international policy processes. These include the Global Programme of Action for the protection of the marine environment from land-based activities (GPA), the UN Convention on Biological Diversity (CBD), the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), the UN Framework Convention on Climate Change (UNFCCC), the Vienna Convention (and Montreal Protocol), as well as the regional waters and seas conventions, and the programs of UNEP, FAO, WMO, OECD, UNECE and others. This approach is highly relevant as a focused contribution to meeting many of the Sustainable Development Goals, especially as the nitrogen cycle cuts across so many of the different goals (especially SDGs 1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14, 15).

Main Anticipated Outcomes

The main outcomes of Towards INMS are as follows:

1. Stakeholders, including policy makers, scientists, industry, farmers, business and civil society, have an agreed basis for informed decision making on N cycle management.
2. Stakeholders using agreed assessment and quantification methods to evaluate N cycle status acting as a common basis for regional/global scenarios to guide management actions.

[1] Discussion with stakeholders during the first Plenary Meeting (Lisbon, 2015) has also framed a *Long-term Goal*: "To improve the understanding of the global and regional N cycle and investigate practices and policies to maximize sustainable production of food, goods and energy while reducing negative impacts of reactive nitrogen on the environment and human health."

3. Regional and Global information on N cycle fluxes and impacts, enabling strategies to be implemented to minimise negative effects of excess or insufficient reactive N, while maximising the quantified co-benefits for other sectors including the Green and Circular Economies.[2]
4. GPA, OECD, UNEA and other bodies are better informed to assist states with implementing management response strategies to address negative effects of excess or insufficient N_r, ensuring that any negative effects are minimised.
5. Local, national and regional expertise to address N_r issues increased and contributes to improved decision-making in the Policy Arena on Nitrogen at the regional / global levels.

Operational outcomes include improved access to and sharing of information in cooperation with IW:LEARN; Improved knowledge management with compiled knowledge and experiences about the project shared with other GEF projects and GEF Secretariat, accessible on IW:LEARN; Improved project execution from IW Conference participation and the use of the GEF5 IW indicator tracking system.

Structure of Towards INMS

The project is structured around four main components:

Component 1

This component will develop the necessary tools and approaches that form the basis for improving understanding and quantification of the global nitrogen cycle, and hence a foundation for developing the necessary interventions at global and regional scales. Component 1 focuses on establishing methods, models and indicators, considering especially the datasets that are required.

The perspective of the work crosses from biophysical dimensions, linking water systems (aquatic and marine) to terrestrial systems (including agricultural and other activities) to atmospheric systems, including emissions, transport, levels of nitrogen compounds and deposition. This biophysical perspective is complemented by the development of economic and social perspectives that are critical in understanding the drivers, opportunities and limitations to achieving better nitrogen management at global and regional scales.

The main elements are:

1) Action to develop better indicators of nitrogen systems, including national and farm scale nitrogen budgeting approaches, a suite of nitrogen use efficiency (NUE) approaches, and the relationship between such budget, balance and efficiency indicators to effect based indicators of societal benefits and adverse environmental effects.
2) Development of a threat assessment methodology, including identification of the key threats, stakeholder review and refinement, development of assessment methods for the different threats.
3) Development of the methodology for combined assessment of nitrogen fluxes and distribution, considering the linkages between air, land and water, and dispersion through trade, including review of methods for different N components and different environmental compartments, leading to the preparation of guidance methodology.
4) Refinement of approaches for threat benefit valuation, including review of existing studies, refinement of methodology across contrasting economies, integration of the benefits and threats for food, health, ecosystem, climate and energy, and the valuation under future nitrogen scenarios.

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[2] Circular Economy: An economy designed to not produce any waste and pollution. Circular economies are characterized by two types of material flows - biological nutrients, designed to reenter the biosphere safely, and technical nutrients, which are designed to circulate at high quality in the production system.

5) Development of flux-impact path models for assessment, scenarios and strategy evaluation, including translating storylines into model requirements, review and comparison of component models, designing model framework, testing and application of selected models in a model cluster.
6) Examination of the barriers to achieving better nitrogen management, linking the economic, social, cultural and other factors that affect adoption of measures, examination of the barriers in food systems and in relation to sustainable consumption, and exploration of the role of a full nitrogen approach and other options to overcome the barriers.

Component 2

The aim of this component is to apply tools, methods and data to synthesize knowledge on nitrogen flows, threats and benefits in the context of the global nitrogen cycle. It will apply key inputs in the form of tools and methods developed in Component 1, together with outcomes from the regional demonstration activities of Component 3, to analyse the current status of N flows, threats and benefits.

Options for improved nitrogen management in different contexts will consider the multiple benefits, linking water, air, greenhouse balance, ecosystems and soils, as well as the interactions with food and energy. These elements will inform the development of storylines and scenarios of different "nitrogen futures" and how these relate to cost-benefit analysis.

The main elements are:

1) Application of a suite of modelling tools to quantify nitrogen flows, threats and benefits at global and regional scales, including developing a shared database of inputs and model outcomes, provision of international support for regional inventory and model development, and integrated analysis to quantify present and future threats and benefits.
2) Preparation of a first global assessment of N fluxes, pathways and impacts, assimilating lessons from the regional demonstrations. The work will draw on the outcomes of Components 1 and 3, while providing material to support the actions of Component 4.
3) Integrating methods, measures and good practices to address issues of excess and insufficient reactive nitrogen, including preparation of a document on the state-of-the-art for good nitrogen management, considering different N forms and N effects.
4) Exploration of future N storylines and scenarios with management /mitigation options and cost-benefit analysis, including review of existing N policies for different countries and regions and review of existing storylines and scenarios.
5) Review of existing interventions and outcomes already achieved by GEF and others.

Component 3

This component establishes targeted research demonstrations on the nitrogen cycle at a regional scale for each of the main world regions. The approach is to demonstrate how a joined up approach to nitrogen management can catalyze stronger action for a cleaner environment (water, air, greenhouse gas, ecosystems, soils) and improved food and energy production simultaneously. The choice of regional scale reflects the need to link between local and global scales, to share regionally specific lessons and to work in partnership with regional intergovernmental and other international processes.

The main elements are:

1) Design common methodology for regional demonstration of nitrogen flows, priorities, mitigation options, co-benefits, success stories, barriers-to-change and ways of overcoming barriers.
2) Conduct the regional demonstrations to refine regional nitrogen assessments and improve understanding of regional N cycle.

3) Use a workshop to synthesize outcomes from demonstration activities focusing on reducing adverse N impacts & maximizing co-benefits.
4) Build consensus on benchmarking N indicators for different regions and systems, linking between the regions and global scale analysis.
5) Refine the regional approach to demonstrate the benefits of joined up N management, leading to concrete plans of how a perspective from the N cycle can be embedded in the future activities of GPA and other national programs and international conventions.

Five regional demonstrations are included with funding support from GEF according to three cases. In addition, at least one demonstration is planned without specific funding from GEF for a fourth case:

1) Developing regions with excess reactive nitrogen: South Asia, East Asia, Latin America
2) Developing Regions with insufficient reactive nitrogen: East Africa
3) Transition economies with excess reactive nitrogen: East Europe.
4) Developed regions with excess reactive nitrogen (West Europe). It is expected that additional input from a North American demonstration may also be developed during the course of the project.

Component 4

The purpose of this component is to support internal and external communication and knowledge exchange in the project. Key to the success of this targeted research activity is the uptake of emerging results by other partners, ongoing engagement and exchange of ideas with stakeholders to ensure that tools and products are fit for purpose and communication of all results in the most effective way.

The work will be informed by the outputs from the other components and the needs and practicalities of partners and external stakeholders.

Information and datasets within the project will be organised and made accessible through the web portal and INMS database system. This foundation will be paired with activities to engage with the N stakeholder community on a variety of levels, including developing a network of 'Nitrogen Champions'. Training will be provided to regional and national experts.

The links between INMS, GPA and other relevant intergovernmental process will be made along with considering the long-term needs for an International Nitrogen Management System. Channels for knowledge exchange with the general public will also be explored and exploited, including refinement of N Footprinting approaches and developing audience relevant communication products.

The main elements are:

1) Establishment of the INMS communications hub and its ongoing operation, including a web portal, the INMS database, internal project communication and press and public engagement functions.
2) Training in nitrogen measurement, modelling and mitigation techniques provided to regional and national experts, international engagement on linking intergovernmental processes and sharing experience on the use of N footprinting to increase public awareness
3) Development of synthesis to demonstrate INMS in support of GPA objectives, co-ordinating the inputs from INMS and into other policy processes and formulating a long-term strategy for INMS, including potential homes and financing options.
4) Harmonization and publication of guidance documents on 'N budgets efficiency and benchmarking', 'threats fluxes and distribution methods', 'N measures and good practices' including information on barriers and successes.
5) Provision of support to IW-LEARN and engagement with GEF & STAP, including connecting the INMS web portal with IW-LEARN, developing a 'Community of Practice', 'Experience Notes' and taking part in IW-LEARN Conferences.

List of Acronyms

Acronym	Full name
ABKAE	Ataturk Horticultural Central Research Institute, Turkey
ADEME	French Agency for Environment and Energy Management
Ag-HU	Research Faculty of Agriculture, Hokkaido University, Japan
AGRA	Alliance for a Green Revolution in Africa
APR	Annual Performance Review
APZIFU	Action Plan for the Zero Increase of Fertilizer Use, China
ARI	Agrophysical Research Institute, Russia
ASU	Institute of Water Resources Engineering, Lithuania
ATB	Leibniz Institute for Agricultural Engineering, Germany
AU	Aarhus University, Denmark
BASF	BASF the Chemical Company, originally: "Badische Anilin und Soda Fabrik"
BFU	Beijing Forestry University, China
BRRI	Bangladesh Rice Research Institute
BSC	Black Sea Commission: Commission on the Protection of the Black Sea Against Pollution
CAA	Clean Air Act, China
CARR	Chinese Academy of Science, Center for Agricultural Resources Research, Institute of Genetic and Developmental Biology
CAS	Chinese Academy of Sciences
CAU	China Agricultural University, Beijing
CBA	cost-benefit analysis
CBD	United Nations Convention on Biological Diversity
CCAC	Climate and Clean Air Coalition
CCST	Centro de Ciência do Sistema Terrestre, Brazil
CCST-INPE	Earth System Science Centre/National Institute For Space Research, Brazil
CDA	Chilika Development Authority, Bhubaneswar, Orissa, India.
CEH	Centre for Ecology & Hydrology, UK Natural Environment Research Council
CEO	Chief Executive Officer
CEMA	European Federation of Agricultural Engineers
CGIAR	Consultative Group on International Agricultural Research
CIC	Intergovernmental Coordinator Committee of the La Plata Basin Countries, Latin America
CIEMAT	Research Center for Energy, Environment and Technology, Madrid, Spain
CIFOR	Centre for International Forestry Research, CGIAR
CIMMYT	International Maize and Wheat Improvement Center, CGIAR
CLRTAP	UNECE Convention on Long-Range Transboundary Air Pollution
CNR	Consiglio Nazionale delle Ricerche, Italy
CNW	China Nitrogen Workgroup
COP	Conference of Parties
CoP	Community of Practice
CPRD	Convention on Co-operation for the Protection and Sustainable Use of the River Danube

Acronym	Full name
COPA-COGECA	European Farmers and Cooperatives Organization, , established from the "Comité des organisations professionnelles agricoles" and the "Comité général de la coopération agricole de l'Union européenne"
CSD	Commission on Sustainable Development
CSF	Committee on World Food Security
CSO	Civil Society Organization
DALY	Disability Adjusted Life Years
DBSB	Danube/Black Sea Basin Strategic Partnership on Nutrient Reduction
DEDJTR	Victorian Department of Economic Development, Jobs, Transport and Resources, Australia
DMG	INMS Demonstration Management Group (for each regional demonstration)
DPBMA	The Prut and Dniester River Basins, Dniester-Prut Basin Management Administration
DRP	The Danube Regional Project
EA	Executing Agency (in the case of Towards INMS, this is the INI as hosted by NERC-CEH)
EAC	East Africa Community
ECLAIRE	Effects of Climate Change on Air Pollution and Response Strategies for European Ecosystems, an EU research project
ECN	Energy Research Centre of the Netherlands
EEF	Enhanced efficiency fertilizers
EMBRAPA	Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária), Brazil
EMEP	European Monitoring and Evaluation Programme, established under the UNECE LRTAP Convention
ENA	European Nitrogen Assessment
ENEA	Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy
EOU	Evaluation and Oversight Unit of UNEP
EPMAN	Expert Panel on Mitigation of Agricultural Nitrogen of the TFRN
EPNB	Expert Panel on Nitrogen Budgets of the TFRN
EPNF	Expert Panel on Nitrogen and Food of the TFRN
EPN-EECCA	Expert Panel on Nitrogen for Eastern Europe, Caucasus and Central Asia Countries of the TFRN
EPOC	Environmental Policy Committee of the OECD
EU-NEP	European Union Nitrogen Expert Panel
EU-TACIS	European Union Technical Assistance for Commonwealth of Independent States
FAO	Food and Agriculture Organization of United Nations
FE	Fertilizers Europe - the European fertilizer industry association
FFCUL	Fundacao da Faculdade de Ciencias da Universidade de Lisboa, Portugal
FSCNB-HU	Field Science Center for Northern Biosphere, Hokkaido University, Japan
Future Earth	Future Earth - an international effort to deliver environmental and related sciences towards global sustainability
GEF	Global Environment Facility
GEFTF	GEF Trust Fund
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environment Protection, hosted by the IMO
GLOC	Global Conference on Land-Ocean Connections
GLP	Global Land Project of Future Earth
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities

Acronym	Full name
GPNM	Global Partnership on Nutrient Management
HBNF	Haber–Bosch N fixation
HELCOM	Helsinki Commission - the Baltic Marine Environment Protection Commission
HTAP	UNECE Hemispheric Task Force on Air Pollution (under the LRTAP Convention)
IA	Implementing Agency (in the case of Towards INMS, this is UNEP)
IAC	Instituto Agronomico de Campinas (Campinas Agronomic Institute), Brazil
IAEM	Institute of agroecology and environmental management of National Academy of Agrarian Sciences, Ukraine
IAI	Inter-American Institute for Global Change Research
IARI	Indian Agricultural Research Institute
ICPDR	International Commission on Protection of the Danube River
ICSU	International Council of Scientific Unions - the International Science Council
IEA	International Energy Agency
IEEP	Institute for Engineering and Environmental Problems in Agricultural Production, Russia
IFA	International Fertilizer Manufacturers Association
IFOAM	International Federation of Organic Agriculture Movements
IGBP	International Biosphere-Geosphere Programme
IGO	Inter-Governmental Organization
IGR-3	Third Intergovernmental Review of the GPA (Manila, January 2012)
IIASA	International Institute for Applied Systems Analysis
IITA	International Institute of Tropical Agriculture, CGIAR
ILRI	International Livestock Research Institute, CGIAR
IMK-IFU	Institute of Meteorology Karlsruhe, Karlsruhe Institute of Technology, Germany
IMO	International Maritime Organization
ING	Indian Nitrogen Group
INI	International Nitrogen Initiative
INMS	International Nitrogen Management System
INPE	Instituto Nacional de Pesquisas Espaciais. National Space Research Agency, Brazil
INRA	National Institute for Agronomic Research, France
IOC	Inter-governmental Oceanographic Commission of UNESCO
IPBPSS	Institute of Physicochemical and Biological Problems in Soil Science, Russia
IPNI	International Plant Nutrition Institute
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Inter-governmental Panel on Climate Change
ISA	Instituto Superior de Agronomia, University of Lisbon, Portugal
ISFM	Integrated soil fertility management
ISSCAS	Institute of Soil Science, Chinese Academy of Science, China
IW	International Waters
IW-LEARN	International Waters Learning Exchange and Resources Network
JNEG	Japan Nitrogen Expert Group
JRC	Joint Research Centre of the European Commission

Acronym	Full name
JSPS	Japan Society for the Promotion of Science
JST	Japan Science and Technology Agency
KIIT	Kalinga Institute of Information Technology, Bhubaneswar, Orissa, India.
KU	Kyoto University, Japan
LA	Latin America
LA UMR	Laboratoire d'Aérologie Observatoire Midi-Pyrénées, France
LBP	La Plata River Basin, Latin America
LOICZ	Land Ocean Interactions in the Coastal Zone, an IGBP project
LRTAP	The Convention on Long-range Transboundary Air Pollution, established under the auspices of the UNECE
LVBC	Lake Victoria Basin Commission
M&E	Monitoring and Evaluation
MakU	Makerere University, Uganda
MAP	Mediterranean Action Plan
MET Norway	Norwegian Meteorological Institute
MOA	Ministry of Agriculture, China
MoE	Ministry of the Environment, Japan
MOE	Ministry of Environment of Moldova
MOEP	Ministry of Environmental Protection, China
MOOC	Massive Online Open training Course
MOST	Ministry of Science and Technology, China
MSFD	Marine Strategy Framework Directive of the European Union
MU	University of Missouri, United States of America
NANC	North American Nitrogen Center of the INI
ND	Nitrates Directive of the European Union
NE	NGO “New Energy”’, Ukraine
NEDO	New Energy and Industrial Technology Development Organization, Japan.
NEERI	National Environmental Engineering Research Institute (CSIR), Nagpur, India.
NERC	Natural Environment Research Council, UK
NEWS India-UK	Newton-Bhabha Fund India-UK Virtual Joint Research Centre on Nitrogen Efficiency of Whole-cropping Systems for improved performance and resilience in agriculture
NGO	Non-Governmental Organisation
NIAES	National Institute of Agro-Environmental Sciences of Japan
NIES	Center for Regional Environmental Research National Institute for Environmental Studies, Japan
NinE	Nitrogen in Europe - a networking project of the European Science Foundation which prepared the ENA
N_2O	Nitrous oxide - a greenhouse gas and ozone depleting substance
NH_3	Ammonia - a constituent of biological systems and an air and water pollutant
NH_4	Ammonium - a constituent of biological systems and a water and air pollutant
NO	Nitric oxide - an air pollutant
NO_2	Nitrogen dioxide - an air pollutant

Acronym	Full name
NO_3	Nitrate - a water and air pollutant
NO_x	Nitrogen Oxides (the sum of NO and NO2 concentrations)
NPL	National Physical Laboratory (CSIR), New Delhi, India
N_r	Reactive nitrogen
NUE	Nitrogen Use Efficiency
O_3	Ozone - a reactive gas that forms a protective layer in the stratosphere and pollution in the air we breath.
OECD	Organization for Economic Cooperation and Development
ONU	Odessa National I. I. Mechnikov University, Ukraine
ONW	Our Nutrient World - a report produced for UNEP by GPNM and INI
OSCE	Organization for Security and Co-operation in Europe
OSPAR	Oslo and Paris Commission - the Convention for the Protection of the Marine Environment of the North-East Atlantic
PBI	Planetary Boundaries Initiative
PBL	Netherlands Environmental Assessment Agency
PCH	PigCHAMP Pro Europa S.L., Spain
PCU	Project Coordination Unit, in the case of Towards INMS provided by NERC-CEH
PEMSEA	Partnership in Environmental Management for the Seas of East Asia
PIK	Potsdam Institute for Climate Impact Research, Germany
PIR	Project Implementation Review
PM2.5	Particulate Matter air pollution with a particle diameter of less than 2.5 microns
PMB	Project Management Board of Towards INMS
PPA	INMS Project Partners Assembly (decision making body of INMS)
PPG	Project Preparation Grant
PROBAPS	Project: Protection of the Baltic Sea; benefits, costs and policy instruments
Ramsar convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat
RIVM	National Institute for Public Health and the Environment, The Netherlands
RRes	Rothamsted Research, UK
SACEP	South Asia Co-operative Environment Programme
SAG	Stakeholder Advisory Group of a Demonstration Region within Towards INMS
SANC	South Asian Nitrogen Centre of the INI
SCON	Society for Conservation of Nature, India
SCOPE	Scientific Committee on Problems of the Environment
SDG	Sustainable Development Goal
SDSN	Sustainable Development Solutions Network
SEI	Stockholm Environment Institute
SKWP	SKW Stickstoffwerke Piesteritz GmbH
SMART	Specific, Measurable, Achievable, Relevant and Time-bound indicators and objectives
SPAG	Stakeholder and Policy Advisory Group of Towards INMS
SRI	Scientific Research Institute for Atmospheric Air Protection, St Petersburg
STAP	Scientific and Technical Advisory Panel of the GEF

Acronym	Full name
Statistica.MD	Moldavian Statistics Service, Moldova
TEEB	The Economics of Ecosystems and Biodiversity
TFEIP	UNECE Task Force on Emissions Inventories and Projections (under the LRTAP convention)
TFRN	UNECE Task Force on Reactive Nitrogen (under the LRTAP Convention)
TNO	Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, The Netherlands
Towards INMS	GEF/UNEP project: "Targeted research for improving understanding of the global nitrogen cycle towards the establishment of an International Nitrogen Management System INMS)"
UBA	University of Buenos Aires (Universidad de Buenos Aires), Brazil
UBA	Federal Environment Agency, Germany
UBONN	University of Bonn, Germany
UEA	University of East Anglia, UK
UED	University of Edinburgh, UK
UGENT	Ghent University, Belgium
UKRstat	Ukrainian Statistics Service, Ukraine
UnB	Brasilia University (Universidade de Brasília), Brazil
UNCCD	UN Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEA	United Nations Environment Assembly
UNECE	United Nation Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United National Economic Social and Cultural Organization
UNESP	Sao Paulo State University (Universidade Estadual Paulista), Brazil
UNFCCC	UN Framework Convention on Climate Change
UPCM	University Pierre and Marie Curie, Paris
UPM	Technical University of Madrid
UPMC	University Pierre and Marie Curie, Paris
US-EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USP	University of Sao Paulo (Universidade de São Paulo), Brazil
VNIIOU	Federal State Budget Scientific Institution “All-Russian Scientific Research Institute for Organic Fertilizers and Peat”, Russia
WFD	Water Framework Directive of the European Union
WGSR	Working Group on Strategies and Review of the UNECE LRTAP Convention
WHO	World Health Organisation of the United Nations
WMO	World Meteorological Organisation of the United Nations
WPWBE	Working Party on Water Biodiversity and Ecosystems of the OECD
WRI	World Resources Institute, Washington, USA
WTO	World Trade Organisation
WUR	Wageningen University and Research Centre, The Netherlands
WWF	Worldwide Fund for Nature conservation

Acronym	Full name
ZJU	Zhejiang University, China

Contents

Section 2: Background and Situation Analysis (Baseline course of action)

2.1 Background and context

1. 'Towards INMS' addresses a critical global problem of excess reactive nitrogen in water and the wider environment that has been long recognised by the GEF. This project is designed to better understand the global cycle of reactive nitrogen and represents the first collaborative activity to deliver an International Nitrogen Management System (INMS) that will combine multiple sets of information from different sectors and integrate reactive nitrogen (N_r) across environmental compartments. The project responds to recommendations made by the STAP (*Hypoxia and Nutrient Reduction in the Coastal Zone, 2011)* and reflects the concerns raised at the June 2013 GEF Council by Prof. Rockstom in his presentations on Planetary Boundaries.

2. Recent analysis led by UNEP,[3] highlights the impacts of differing agricultural practices to the releases of N_2O from fertilisers and manures, while WMO[4] has further highlighted the contribution of reactive nitrogen on climate change. Combined with substantial regional and global analyses by UNEP, the LRTAP and others,[5,6,7,8] the findings of these studies emphasize the current interest and importance of the global nitrogen debate.

3. Through this proposed project, the GEF will be in a strong position both to develop a better understanding of the regional and global nitrogen cycles and to assist in developing a management system that would, for example through the GPA, work to combat the negative impacts of reactive nitrogen.

2.2 Global significance

4. The sustainability of our world's population depends fundamentally on nutrients, including reactive nitrogen (N_r) and phosphorus (P). Industrially produced fertilizers (containing N_r and P) are essential to global food security and have been the main driver of dramatically improved agricultural yields over the last 60 years, allowing the human population to grow to over seven billion. At the same time, nutrient loads from continents to oceans and coastal zones (including deposition of N_r from atmosphere) have more than doubled, primarily from agricultural uses (including inefficient application of manure/fertilizer and animal waste), from wastewater (including from rapidly growing cities in both developed and developing world) and from emissions of nitrogen oxides (NO_x) due to fuel combustion.

5. Reactive nitrogen has been highlighted as one of the three 'planetary boundaries'[9] that have been exceeded as a consequence of human activities. The other two exceeded threats are climate change and biodiversity loss from a

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[3] UNEP (2013) *Drawing Down N_2O to Protect Climate and the Ozone Layer.* A UNEP Synthesis Report. (Eds.: J. Alcamo, S.A. Leonard, A.R. Ravishankara and M.A. Sutton). ISBN: 978-92-807-3358-7., United Nations Environment Programme, Nairobi.

[4] WMO press release (6th November 2013). Greenhouse Gas Concentrations in Atmosphere Reach New Record http://www.wmo.int/pages/mediacentre/press_releases/pr_980_en.html

[5] Sutton, M.A. et al. (2011) *The European Nitrogen Assessment: Sources, Effects and Policy Perspectives* (Eds.) Cambridge University Press.

[6] Suddick, E.C. et al. (2012) The role of nitrogen in climate change and the impacts of nitrogen–climate interactions in the United States: foreword to thematic issue. Biogeochemistry, DOI 10.1007/ s10533-012-9795-z

[7] Sutton, M.A. et al. (2013) *Our Nutrient World: The challenge to produce more food and energy with less pollution.* Global Overview of Nutrient Management. CEH Edinburgh, on behalf of GPNM and INI. 114 pp

[8] Austin, A.A. et al. (2013) Latin America's Nitrogen Challenge. *Science* **340**, 149; Eshel, Gidon, et al. Land, irrigation water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States. *Proceedings of the National Academy of Sciences* 111.33 (2014): 11996-12001.

9 Planetary boundaries: exploring the safe operating space for humanity. Rockström, J., W. et. al.. Ecology and Society **14**(2): 32. http://www.ecologyandsociety.org/vol14/iss2/art32/ and Steffen, W. et al. (2015) Science, **347**, DOI: 10.1126/science.1259855

total of nine boundaries overall. The importance of N_r is further raised by links between the carbon and nitrogen cycles and impacts on climate change.[10] This highlights how improved management of the nitrogen cycle must become a core priority for global society in future years. By contrast, the planetary boundary for phosphorus was not initially estimated to be exceeded by Rockström et al., although concerns about global P resource depletion add another dimension to its current pollution impacts at local and regional scales.

6. Estimated global N flows are shown in Figure 1, illustrating how the main sources of new N_r production are fertilizer production (estimated at 120 million tonnes annually, Mt /year), crop biological N fixation (60 Mt / year) and combustion (releasing NO_x at 40 Mt N_r / year). In terms of environmental losses, the recycling flows are equally important. For example, atmospheric nitrogen deposition (NO_x and NH_3) on land amounts to 70 Mt N_r, while 120 Mt is lost from agricultural soils to leaching and denitrification. Around 40-66 Mt of N_r enters the ocean by rivers into the coastal zone, while there is also substantial nitrogen fixation and denitrification in the open ocean. Although in total these ocean fluxes are even larger (at 100 to 250 Mt) they occur over a very large area, with much higher localized N inputs and concentrations occurring in the coastal zone.

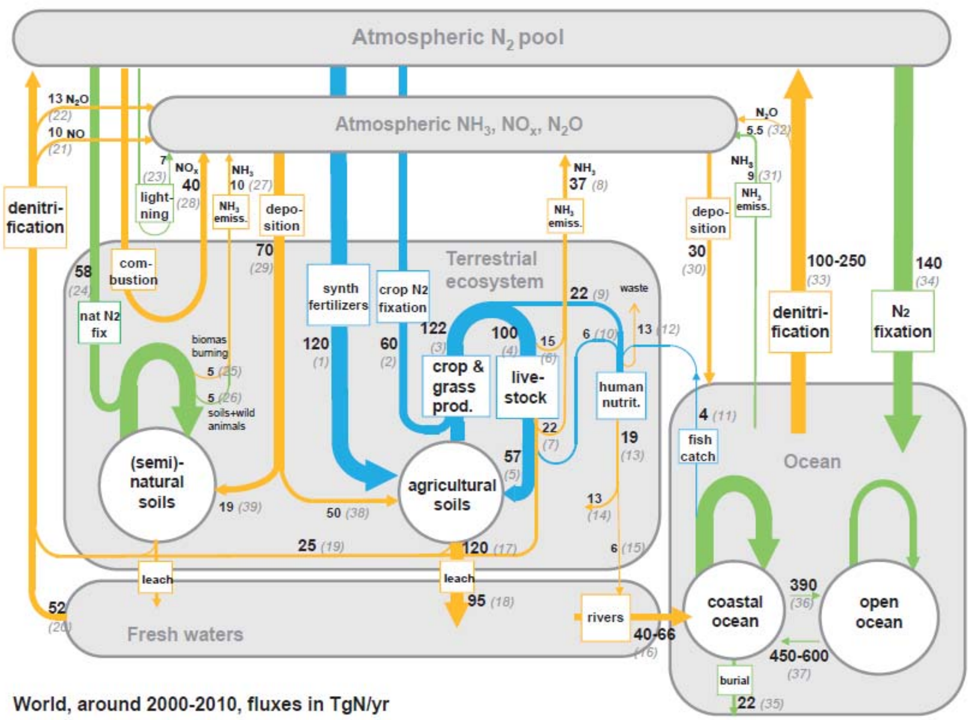

***Figure 1:** Estimated global nitrogen budget showing intentional agricultural flows (blue), natural flows (green) and untintentional anthropogenic flows (yellow). The numbers in bold indicate nitrogen flows in Tg /yr (= million tonnes or Mt per year) while the numbers in brackets give access to literature sources, as compiled by the 'Our Nutrient World' report (2013).*

7. This summary of the main global flows of nitrogen quickly illustrates how the nitrogen cycle is affecting all global compartments linking land, oceans and atmosphere. It also shows the potential magnitude of the benefits arising from better management. The total losses from agriculture amount to a fertilizer value of around 160 billion USD annually. Yet even this is small compared with the estimated societal costs of the associated nitrogen pollution, which were estimated by 'Our Nutrient World' to lie in the range 200 to 2000 billion USD annually. It is obvious that better nitrogen management, especially by emphasizing improved recovery and reuse, has the potential to contribute significantly to both the emerging Green Economy and Circular Economy.

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[10] Gruber, N and Galloway, J. (2008) An Earth-system perspective of the global nitrogen cycle. *Nature* **451**, 293.

8. This proposal leading to the development of the International Nitrogen Management System (INMS) acknowledges the importance in both the benefits and the problems of nitrogen use, and the close linkages between nutrients (specifically nitrogen and phosphorus) in their application in agricultural fertilizers, manures and human wastes, as well as the coupled complexity arising from combustion sources of NO_x emissions to the atmosphere. The prime focus on N_r allows it to address the cross-cutting impacts on pollution, health, climate change, land management, biodiversity, etc., and to identify links with other nutrient cycles for more detailed consideration in the future. These other biogeochemical links include carbon, phosphorus, sulphur, and micronutrients. In developing 'Towards INMS', recognition is given to these interactions and to concerns about both excess N_r impacts and the consequence for regions with typically insufficient N_r. These regional differences are particularly addressed through the 'Towards INMS' demonstration activities.

2.3 Source activities

9. Given the different contributions to new N_r production and the major internal flows in the global nitrogen cycle, particular attention is needed to improve N_r management associated with the following sources:

10. **Fertilizers in agriculture:** In order to feed the world's population approximately 2% of the global energy production is used in the production of N_r, mainly for inclusion in fertilizer. Since the 1960s the use of synthetic nitrogen fertilizer (through the Haber Bosch process) has increased more than nine times. The efficiency in the use of N_r is low with less than 25% incorporated into agricultural products and the remaining 75% being lost to the global environment.

11. **Manures in agriculture:** Most N_r inputs to agriculture go to feed livestock (100 Mt/yr), with only a small fraction used for direct plant food consumption by humans (22 Mt/yr). Waste from livestock is often used ineffectively, contributing to substantial losses from agriculture of N_r to both water and atmosphere. There are a wide range of technologies already available to promote better manure use and to reduce N_r emissions to air and water. One of the main issues is that there is currently a low adoption of these technologies in most developed and developing countries, while implementation of the approaches needs to be tuned to regional characteristics.

12. **Atmospheric emissions and deposition:** In practice, all of the N_r produced in combustion sources is directly emitted as NO_x and N_2O to the environment. In addition, current mitigation technologies are based on denitrification (conversion back to N_2) rather than aiming to recover and reuse the N_r produced. These emissions (40 Mt/yr) are eventually removed from the atmosphere with a fraction being deposited on agricultural land. This is expected to contribute to agricultural productivity, but the gains must be offset against crop losses due to tropospheric ozone (O_3) pollution that results from NO_x emissions, threatening food security. At the same time emissions of ammonia (NH_3) and organic N from fertilizers, manures and biomass burning (47 Mt/yr) combine with NO_x to increase rates of N_r deposition to natural ecosystems, disturbing ecosystem function, both for terrestrial and marine ecosystems.[11,12]

13. **Wastewater (point sources)**: In addition to livestock wastes, human waste contributes significantly to the N_r loads (19 Mt/yr), especially downstream of major cities. In developed (and increasingly in developing countries) wastewater is treated to reduce these sources - often in large energy-demanding centralised wastewater treatment facilities. However, much of the world's population's wastewater remains untreated or inadequately treated. At the same time, where N_r is removed from water, the focus is typically on denitrification approaches, which destroy N_r as a resource rather than recycling it.

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[11] e.g. Dise et al. (2011) in *The European Nitrogen Assessment*, Cambridge University Press.

[12] e.g Kim et al. (2014) Increasing anthropogenic nitrogen in the North Pacific Ocean. *Science* **346**, 1102-1106.

14. According to current trends in increasing population and increasing per capita consumption of animal products, the future will require further use of chemical N fertilizers in several world regions, especially those with currently limited N availability (such as in Africa and large parts of Latin America). In order to avoid increasing losses, much better plant and agronomic approaches will be needed to make better use of the available resource. In agricultural areas with livestock, the significance of the N losses from manure calls at the same time for major improvements in manure N_r recycling, both in terms of amount of manure re-use and the effectiveness of the recycling techniques and technologies.

15. The growth of middle classes is particularly associated with increasing per capita consumption and this is being exacerbated by increasing urbanization exacerbating urban N_r pollution, both to wastewaters and to air. These changes will further increase the threats of N_r pollution, and increase the likelihood of new areas with coastal hypoxia unless more effective nitrogen management practices are developed.

2.4 Threats, root causes and barriers

16. Five key threats of **excess** reactive nitrogen have been identified (see Figure 2) as follows:

- **Water quality:** Excess N_r can lead to the formation of eutrophic conditions in water resulting in hypoxic conditions and the creation of so-called 'dead zones' in coastal waters. In 2011 the GEF STAP highlighted[13] the increasing number of coastal hypoxic zones with a total of over 500 recorded. Coastal hypoxia kills or impairs marine ecosystems leading to reduced fishery production with impacts on human livelihoods and wellbeing. Excess nitrogen pollution of aquifers used as drinking water sources also pose threats to human health.
- **Air quality:** Excess N_r results in shortening of human life through exposure to air pollutants, including particulate matter formed from NO_x and NH_3 emissions, and from increased concentrations of nitrogen dioxide (NO_2) and ground-level ozone (O_3). In addition estimates of N_r inputs to Large Marine Ecosystems (LMEs) indicate that up to 30% can be derived from atmospheric deposition.
- **Greenhouse gas balance:** One of the main effects of N_r on climate is the emission of nitrous oxide (N_2O), which is a greenhouse gas with 298 times higher global warming potential than carbon dioxide. In addition there are several interactions with other N_r forms, carbon, particulate matter and atmospheric N deposition, plus tropospheric O_3 which lead to a complex mix of both warming and cooling effects.[14] Following successful action to reduce emissions of CFC and HFCs, N_2O is now also the main cause of stratospheric ozone depletion, increasing the risk of skin cancer from UV-B radiation.
- **Ecosystems and biodiversity:** In addition to effects on aquatic systems, atmospheric deposition of N_r leads affects many terrestrial ecosystems across the world, posing a significant biodiversity threat. For example it has been estimated that 40% of all biodiversity Protected Areas globally have annual deposition in excess of 10 kg N per ha posting a signficant threat.[15] In particular, many species of high conservation value are naturally maladapted to high levels of N_r, so that many conservation sites are at particular risk.
- **Soil quality:** While N_r is intentionally added to agricultural soils, natural soils are typically adapted to low nitrogen availability. The input of excess N_r into such natural soils can lead to nutrient imbalances, increasing the vulnerability of species, and in particular can result in soil acidification, especially where ammonium (NH_4) inputs are converted to nitrates (NO_3) by microbial oxidation (nitrification) in the soil.

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[13] STAP (2011) Hypoxia and Nutrient Reduction in the Coastal Zone: Advice for Prevention, Remediation and Research

[14] Butterbach Bahl et al. (2011) Chapter 19 in *The European Nitrogen Assessment*, Cambridge University Press.

[15] Bleeker A., Hicks W.K., Dentener F., Galloway J. & Erisman J.W. (2011) N deposition as a threat to the World's protected areas under the Convention on Biological Diversity. *Environmental pollution* **159**, 2280-2288.

17. In addition, key threats from **insufficient** reactive nitrogen include:

- **Food security** – Inadequate N_r in agricultural systems is a key limitation to food and feed production. This is especially the case in sub-Saharan Africa, but also in large parts of Latin America and other parts of the world. In particular, lack of N_r inputs does not only reduce yields, but it increase the risk of low yield in unfavorable years. In this way adequate N_r inputs (be it from mineral fertilizer or biological nitrogen fixation) is often considered as form of insurance by the farmer. Better nitrogen management will therefore contribution to improved availability and access to nutritious food.
- **Energy security:** With a need to reduce dependence on fossil fuels, renewable sources of energy are becoming more important. Biomass production is a key such source of renewable energy, for which adequate inputs are necessary just as with other forms of agriculture and forestry. Lack of sufficient N_r therefore limits bioenergy production, with some systems being more demanding than others. The importance of this sector is expected to increase in the future, especially if a larger fraction of agricultural land should be targeted for biomass production for biorefinery into multiple products including energy.
- **Soil quality**: Nitrogen affects soil quality both when in excess (leading to nutrient imbalances and acidification) and when in insufficient supply. In the latter case, a shortage of N_r (and other nutrient inputs) can result in mining soil N_r stocks, depleting them and leading to soil degradation. This can be exacerbated by a shortage of micronutrients and organic matter depletion, leading to loss of fertility and erosion.

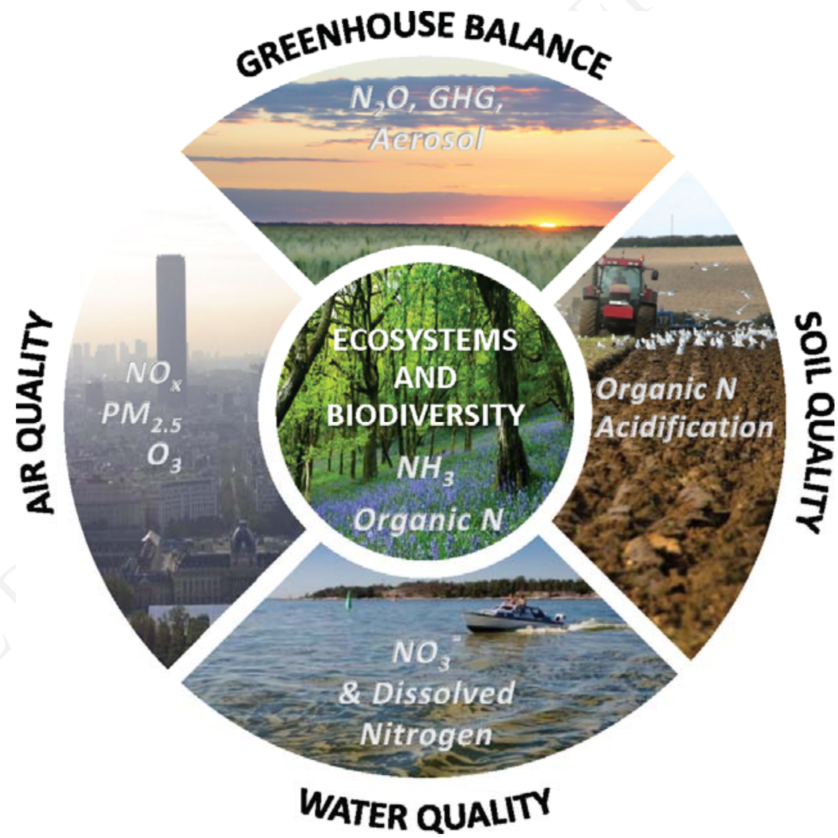

Figure 2: *Five key threats of excess nitrogen in the environment, which can be summarized under the acronym WAGES: Water, Air, Greenhouse balance, Ecosystems and Soils (from Our Nutrient World). In addition, the INMS Pump Priming Workshop (Edinburgh, May 2015) emphasized the importance of nitrogen for both Food and Energy Security.*

18. All of these threats are linked to human disturbance of the nitrogen cycle. In cases with too much N_r, **the root cause** is the search to improve human and livestock nutrition – a goal which has been more than achieved in most

parts of the world. However, the increased N_r inputs have been coupled with a massive increase in N_r losses, due to the **relative inefficiency of agricultural systems**. In addition, as N_r inputs in agriculture increase, the efficiency with which they are used tends to decrease, exacerbating losses. Although significant efficiency gains have been made in recent decades, there are still unsustainably high levels of N_r pollution, with many available technology options not yet adopted.

19. A similar story appears for N_r pollution of water bodies from waste water sources. Although tertiary treatment is available in a few countries, for many there is little basic sewage treatment, with major point sources of N_r (and P) pollution added to rivers, lakes and coastal seas. Even in situations where water is treated for its high N_r levels, the focus is typically on denitrification to remove the N_r, which is a waste of a valuable resource. This threat is being exacerbated by **rapid urbanization**, especially with **inadequate infrastructure**. A key problem is that significant capital expenditure is needed to implement improved water treatment, while existing infrastructure can make it difficult to transform to improved systems where N_r is recovered and re-used.

20. In the case of NO_x, substantial progress has been made through implementations of policies, regulations, and technological advances in reducing, emissions from combustion sources. In particular, adoption of catalytic and non-catalytic abatement technology has reduced emissions converting NO_x to N_2. However, recent technologies especially for vehicles have been showing slower progress in achieving further reductions – as the law of **diminishing returns in refining current technologies** applies. In addition, these gains in lower emission per vehicle mile have been off-set by a rapidly growing vehicle fleet, associated with **increasing transport volumes**. New dimensions are needed to address both these points, including further development of methods for NO_x capture and use (harvesting the value of the N_r produced), as well as to make progress with alternative transport and energy sources with lower NO_x emissions.

21. In considering these root causes and the barriers, to change it is worth to note first that until now each of these issues have largely been considered in isolation. Efforts to promote improved water quality for N_r have not been sufficiently linked to those to improve N_r air quality or reduced N_2O emissions.

22. In this way, increased attention to the nitrogen cycle can contribute in two ways.

a. Firstly, a joined up view promotes the **visibility of the win-win options** and seeks to minimize the adoption of measures with antagonistic effects. For example measures that promote nitrogen use efficiency would be expected to propagate with win-wins through the system, as would measures that promote N_r recovery and reuse in the circular economy. Conversely, measures that reduce N_r pollution by removing it from one place to another may have unwanted side effects. For example, where waste water treatment focuses on denitrification to remove N_r, this may increase emissions of N_2O, in addition to being a waste of the energy used to produce N_r in the first place. This perspective is at the heart of the Towards INMS hypothesis that a joined up approach to N_r management will help overcome the barriers to change.

b. Secondly, a joined up approach to nitrogen management can be expected to have substantial benefits through **improving public awareness**. One of the reasons for lack of progress in better nitrogen management among citizens is a lack of awareness of how the nitrogen cycle links so many well-known impacts. If further progress is to be made then the public need to be better informed promoting a virtuous cycle of interest to find out more and to take action, including recognition of the health and other benefits to citizens. We are already seeing progress in this perspective, as nitrogen begins to be known better to the public. In this regard the narrative connecting nitrogen and food choice has proved particularly successful in raising press interest.[16] An illustration is the option of 'demitarian' (half meat consumption), the consequences of which have been explored at a

[16] As for example, illustrated by the wide global press reception to Our Nutrient World: Smith, B.P. et al. (2013) Communicating 'Our Nutrient World' – a report for UNEP (Published 18 February 2013). March 2013. Centre for Ecology & Hydrology 12 pp. See also Sutton M.A., Howard C.M., Bleeker A. and Datta A. (2013) The global nutrient challenge: From science to public engagement. *Environmental Development* **6**, 80-85.

continental scale,[17] while the word demitarian itself (and the nitrogen narrative with it) has even entered the world of popular gastronomy.[18] These examples illustrate the substantial potential for better public awareness about the nitrogen cycle. If progress is to be made in addressing the barriers-to-change, a sea-change in public awareness will be needed.

23. The role of barriers-to-change also necessitates a global approach. These include the global scale of trade in mineral fertilizers, food crops, animal feed and livestock products, which can constrain the adoption of nutrient best practices. This issue thereby complements the global nature of nitrous oxide pollution emphasizing how action at local, regional and global scales is needed.

2.5 Baseline analysis and gaps

2.5.1 Current Scientific Understanding

24. Scientific efforts over the last decade have substantially increased our understanding on different parts of the nitrogen cycle. Process understanding has advanced significantly, as has scientific knowledge on good management practices. By contrast, there are still major uncertainties in the local, regional and global quantification of nitrogen flows. Similarly, the frequent lack of adoption of available best practices has highlighted the need for integrated scientific-economic-social analyses across the nitrogen cycle to improve understanding of the barriers to change.

25. At the regional scale, work for example in Europe,[19] the US[20] and Latin America[21] has highlighted the level of process-understanding in different biospheric compartments (terrestrial, freshwater, marine, atmosphere, as well as specifically in agricultural systems). In many cases the mechanistic basis for nitrogen transformations is well understood, and the core challenge has been to quantify the relative importance of different N_r sources and sinks. For example, while the magnitude of manufactured N_r inputs is in most cases well known, the regional rates of biological nitrogen fixation and denitrification to N_2 remain uncertain. Similarly, the magnitude of nitrogen oxides (NO_x) emissions from combustion sources to the atmosphere is relatively well known. By contrast, although the scale of ammonia (NH_3) emissions from livestock and crops is reasonably well known, the emissions from biomass burning sources are rather uncertain as are emissions of organic N. In addition, it appears that climate warming will substantially increase NH_3 emissions, but the climate relationships are not included in global models.[22] In terms of freshwater N_r flows, the uncertainty in N_r losses (either as uptake of N_r or N_2 generation) propagates uncertainty in the relationship between catchment N_r export to coastal areas and the net amount of N_r stored in soils and sediments.

26. Considering the multiple impacts of N_r, robust evidence is available on "critical loads" and "critical levels" of N_r for selected temperate ecosystems, which are the thresholds for atmospheric deposition and pollutant air concentrations, respectively, above which significant environmental degradation can be expected. However, major uncertainties remain for different parts of the world and in establishing dose-response relationships (currently being addressed by the EU ÉCLAIRE project). While such critical loads and critical levels are already being applied operationally within the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP), the key challenges

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[17] Westhoek, H. et al. (2015) *Nitrogen on the Table: The influence of food choices on nitrogen emissions and the European environment.* (European Nitrogen Assessment Special Report) Centre for Ecology and Hydrology, UK. 67 pp. See also: Webster, B. (2014) Raise taxes on meat to turn us into demitarians, says UN, *The Times* (25 April 2014), p 17. And the subsequent leader article "Eat Less Meat: A vital message buried in a new report on climate change" *The Times* (15 January 2015), p 30.

[18] Friedland, J. (2015) *Eatymology: The Dictionary of Modern Gastronomy.* Sourcebooks.

[19] Sutton, M.A. et al. (2011) *European Nitrogen Assessment.* Cambridge University Press

[20] EPA-SAB (2011) Reactive Nitrogen in the United States: An Analysis of Inputs, Flows, Consequences, and Management Options - A Report of the Science Advisory Board. (EPA-SAB-11-013).

[21] Austin, A.A. et al. (2013) Latin America's Nitrogen Challenge. *Science* **340**, 149.

[22] Fowler, D. et al. (2013) The Global Nitrogen Cycle in the 21st century. Special Issue of *Philosophical Transactions of the Royal Society*

are to extend application to other world regions and to refine the dose-response relationships in order to connect quantitatively with economic cost-benefit assessments. In the US assessment of nitrogen and climate interactions,[23] the analysis included synthesis on the relationships for both water and air N_r pollution to human health. Such regional assessments form part of the long-term goal through the International Nitrogen Initiative (INI) to stimulate the development of nitrogen assessments for each major world region. Assessments for Latin America,[24] North America, South Asia, Sub-Saharan Africa and China are being developed, with key issues already highlighted through the Global Overview on Nutrient Management: "*Our Nutrient World: The challenge to produce more food and energy with less pollution*",[25] prepared jointly by the Global Partnership on Nutrient Management (GPNM) and the INI.

27. In applying this state-of-the-art to priorities for GEF, the focus must be on research and synthesis that allows tools to be developed that can support actions to address the drivers of N_r pressures and to reduce disruption of the global nitrogen cycle. Key tasks will bring together regional and global analysis of drivers, pressures, flows and impacts in a way that allows the regional challenges to be interrelated. At the core, must be the development and application of shared indicators of threat / benefit and of performance indicators, which can be used to measure progress. For example *Our Nutrient World* provided first national estimates of "full-chain nitrogen use efficiency", which represents the percentage of input nitrogen forms that reach the ultimate intended products used by humans. This interest has since been taken up by GPNM and the EU Nitrogen Expert Panel, as well as within OECD and TFRN. Such approaches need further development to account for all sources (fertilizer, biological nitrogen fixation, combustion sources) and the full suite of final human uses (e.g. food consumed, biofuels, manufactured products).

28. Substantial progress has been made over the last two decades in developing so-called *'integrated assessment models'* as tools to support policy evaluation. An example is the GAINS model for air pollution and climate interactions, which links regional atmospheric emission, dispersion and deposition modeling with costed options for pollution mitigation, thereby allowing the development of cost-optimized abatement scenarios. By contrast, global integrated assessment of the nitrogen cycle is still in its infancy, and it must be a major priority to link models of anthropogenic activities, air, land and water with economic analysis into new tools for global integrated assessment of nitrogen. Through the development of such tools, combined with cost-benefit analysis, a suite of products will allow GEF to provide support global and regional international agreements, maximizing the benefits of N_r while reducing the many adverse effects. Examples of other existing component models that have already been discussed through the UK Funded INMS Pump Priming project (complementing the PPG) include IMAGE, TM5, EMEP, Global NEWS, MEDUSA, NEMO, MAGPIE, CLM, ORCHIDEE. Further work is needed to bring these water, air, terrestrial and economic assessment modelling communities more closely together.

29. Continuing to use and release reactive nitrogen into the environment will add to the problem of coastal hypoxic zones with wider detrimental impacts on health and quality of life stemming from excess nitrogen in both air and water. In particular, current trajectories point to a 70% increase in nitrogen consumption over the next 40 years, which will substantially exacerbate the current pollution problems for international waters and the other environmental and security threats unless action is taken.[26] In addition, regions that have insufficient nutrients leading to concerns on food security need to develop and implement appropriate policies and practices to manage N_r effectively prior to the introduction of modern fertilizers to prevent exacerbation of problems from excess N_r - akin to the 'leap-frogging' in energy supply required in much of the developing world to avoid a high C trajectory.

30. This substantial worsening of N_r loss and impacts, according to anticipated business-as-usual results from a combination of both increasing global population and per capita consumption rates (of food and energy). It is

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[23] Suddick, E.C. et al. (2013) The role of nitrogen in climate change and the impacts of nitrogen - climate interactions in the United States. Thematic issue of *Biogeochemistry* **114**, 1

[24] Austin, A.A. et al. (2013) Latin America's nitrogen challenge. *Science*, **340**, 149.

[25] Sutton, M.A., et al. 2013. Our Nutrient World: The challenge to produce more food and energy with less pollution.

[26] Sutton and Bleeker (2013) The shape of nitrogen to come. *Nature* **459**, 435.

therefore vital that a sustainable N pathway is mainstreamed into future policy making to take account of the scientific evidence, recognizing the multiple benefits of taking action.

2.5.2 Relevant baseline programmes and initiatives

31. The GEF (and others) have been supporting local, national and regional actions to develop new and identify best practices for nutrient management. The proposed project is supported by a number of key global initiatives, nutrient and nitrogen research activities and GEF projects that provide significant baseline knowledge and experience.

32. **The Global Program of Action for the Protection of the Marine Environment from Land-based activities (GPA**) works with its member states in their efforts to develop and implement national programs of action, including to identify and assess the nature and severity of problems in relation to: food security and poverty alleviation; public health; coastal and marine resources and ecosystem health, including biological diversity; and economic and social benefits and uses, etc. To date 77 countries have developed national programs of actions and are in various stages of their implementation. The Third Inter-governmental Review (IGR-3), identified nutrient management as one of the core priorities for the GPA and decided to engage themselves and step up their "efforts to develop guidance, strategies or policies on the sustainable use of nutrients so as to improve nutrient use efficiency with attendant economic benefits for all stakeholders, including farmers, and to mitigate negative environmental impacts through the development and implementation of national goals and plans over the period 2012-2016, as necessary". [27] The next intergovernmental review of GPA is planned for later in 2016 or 2017. Advance preparation with countries, supported by the technical and scientific input of INMS, offers a key opportunity to show how improved nitrogen management can strengthen GPA's approach to meet its goals over the coming five year period.

33. **The International Nitrogen Initiative (INI)** is a scientific partnership that addresses the problems of excess reactive nitrogen in some parts of the world and insufficient reactive nitrogen in others. It is a joint project of the International Geosphere-Biosphere Program (IGBP) (now in transition to 'Future Earth') and the Scientific Committee on Problems of the Environment (SCOPE). INI has established the series of International Nitrogen Conferences, raising awareness of the challenges and developing the foundations for scientific integration, as expressed in the Nanjing (2007), Delhi (2010), Edinburgh (2011) and Kampala (2013) declarations on nitrogen management. INI has provided key scientific input to several intergovernmental processes, including on climate change, regional air pollution, water quality and biodiversity. This includes leadership in the UNECE Task Force on Reactive Nitrogen (TFRN), and delivery of the nitrogen indicator under the Aichi Process for the CBD.

34. The INI operates through regional centres which have been developing regional nitrogen assessments, including the recent European Nitrogen Assessment,[28] which fed in to support the recent revision of the Gothenburg Protocol under the UNECE Convention on Long-range Transboundary Air Pollution. Similarly, the US assessment of nitrogen climate interactions,[29] has contributed to the US National Climate Assessment. The basis for regional assessments for Africa, South and East Asia are currently being developed, but currently require a stronger coordinated approach to ensure engagement between countries, which can only be addressed through the INMS objectives. At the same time, this community development over the last decade has prepared the way to mobilize the international community in support of the GEF objectives.

35. In developing the next stage towards future global nitrogen assessment (GNA) the community of the INI has recognized that a key part of the challenge must be to develop the partnerships of international authorization, while noting that there is currently no international policy framework that addresses the cross-cutting nature of the global

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[27] Manila Declaration: GPA IGR-3

[28] Sutton, M.A. et al. (2011) *The European Nitrogen Assessment*, Cambridge University Press

[29] Suddick, E.C. et al. (2013) The role of nitrogen in climate change and the impacts of nitrogen - climate interactions in the United States. Thematic issue of *Biogeochemistry* **114**, 1.

nitrogen cycle (see section 2.5.3 below). As identified in the '*Our Nutrient World*' report, the next priority must therefore be to build the basis for a more durable international scientific support process.

36. **The Global Partnership on Nutrient Management (GPNM)** is a multi-stakeholder partnership comprising of governments, private sector, scientific community, civil society organizations and UN agencies committed to promote effective nutrient management to achieve the twin goals of food security through increased productivity and conservation of natural resources and the environment. UNEP, through the coordination of the GPA, provides the Secretariat of GPNM. It is a response to the nutrient challenge – how to reduce the amount of excess nutrients in the global environment consistent with global development. The GPNM reflects a need for strategic, global advocacy to trigger governments and stakeholders in moving towards lower nitrogen and phosphorous inputs to human activities. It provides a platform for a common agenda, mainstreaming best practices and integrated assessments, so that policy making and investments are effectively 'nutrient proofed'. The GPNM also provides a space where countries and other stakeholders can forge more co-operative work across the variety of international and regional *fora* and agencies dealing with nutrients, including the importance of assessment work.

37. Although the GPA is an intergovernmental body, it should be noted that the resources available to the GPA are currently limited, while the role of the INI and GPNM are primarily partnerships/NGOs, drawing on diverse and often unconnected resources. The proposed development of the more structured *International Nitrogen Management System* INMS) will therefore allow GEF to pull together substantial diverse efforts to deliver the necessary coordinated global scientific input, which is currently missing from GPA and other international policy frameworks and further engagement of the public in the key debates (see further in Section 3).

38. **Task Force on Reactive Nitrogen (TFRN)** is a body established under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP). Although a regional body (covering Europe, North America, Caucasus and Central Asia), it is relevant to mention it here as a key part of the baseline of the Towards INMS proposal. The TFRN was established in 2007 by the Executive Body of the CLRTAP. It has the twin aims of providing necessary information to support revision of regional air pollution policies for NH_3 and NO_x (e.g. Gothenburg Protocol Revision, signed 2012) and developing the vision and scientific basis to implement an integrated approach to reactive nitrogen management, counting the multiple co-benefits of taking action. The TFRN has thus developed guidance documents on NH_3 abatement[30] and on national nitrogen budget approaches (now adopted by the LRTAP Convention),[31] as well as examining the relationship between nitrogen and climate, nitrogen and food,[32] and most recently (also in contribution to the development of the INMS proposal) the links between nitrogen in the CLRTAP and the UNECE Transboundary Water Convention (Water, Food, Energy, Ecosystems nexus).

39. A key output of TFRN and the CLRTAP relevant for the present baseline is the *European Nitrogen Assessment* (ENA), which was delivered through support from the European Commission (NitroEurope IP) and the European Science Foundation (NinE and COST 729 programs). Among its other findings, a key conclusion was that the environmental impact of N_r emissions in Europe at around 70 billion to 320 billion Euro per year, was of similar magnitude to the direct agricultural benefits of nitrogen use (not including the downstream benefits in the food chain)[33]. In addition, through the ENA, the TFRN has been critical in developing the thinking for counting the multiple

[30] UNECE (2014) Guidance document on preventing and abating ammonia emissions from agricultural sources. Executive Body for the Convention on Long-range Transboundary Air Pollution. (ECE.EB/AIR/120). See also: UNECE (2015) *United Nations Economic Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions*. United Nations Economic Commission for Europe, Geneva

[31] UNECE (2013) Guidance document on national nitrogen budgets. Executive Body for the Convention on Long-range Transboundary Air Pollution. (ECE.EB/AIR/119). http://www.unece.org/environmental-policy/conventions/envlrtapwelcome/guidance-documents-and-other-methodological-materials/gothenburg-protocol.html

[32] Westhoek, H. (2015) *Nitrogen on the Table: The influence of food choices on nitrogen emissions and the European environment.* (European Nitrogen Assessment Special Report on Nitrogen and Food.) Centre for Ecology and Hydrology, UK. 67 pp.

[33] Sutton M.A. et al. (2011) *The European Nitrogen Assessment*, Cambridge University Press.

benefits of improved N use. It should be noted how the TFRN has benefited from and fed into the mature science policy support process of the CLRTAP.[34] This adds significantly to the baseline from which the INMS can learn as it feeds in to support GPA and other policy processes. Finally, the TFRN and ENA have played a key role in raising public awareness of the nitrogen challenge, including developing links with business communities, civil society, communication tools (e.g. ENA video on YouTube) and public awareness through press interventions (e.g. working in partnership with the London-based Science-Media Centre). These actions contribute significantly to the baseline.

40. **Organization for Economic Cooperation and Development** (OECD) has been developing an approach for regional nitrogen balances in agricultural soils. This represents a key baseline that, through partnership with the Expert Panel on Nitrogen Budgets (EPNB) of the TFRN, offers a starting position in the construction of full nitrogen budget approaches. In parallel, the OECD has been exploring the concept of 'Economy-wide Nitrogen Use Efficiency'[35] as a high level indicator to complement the nitrogen budgets approaches. Engagement of INMS with the OECD during the 'Towards INMS' PPG phase has led to the nitrogen challenge being presented to the OECD's Environmental Policy Committee (EPOC) and its Working Party on Water Biodiversity and Ecosystems (WPWBE), building the links with member countries to support engagement in INMS, especially through developing country case studies.

41. **Convention on Biological Diversity** (CBD). As noted above, the INI has the lead responsibility within the Biodiversity Indicators Partnership for developing and implementing the nitrogen indicator under the CBD Aichi Process. The work so far provides a simple starting point for engaging with the nitrogen efficiency approaches developed by Our Nutrient World.

42. **Regional water conventions and other international activities.** It is relevant to briefly mention the wide range of other scientific and policy analyses that support the baseline of the present project. These are highly diverse and for brevity we illustrate here only the main links:

- **Regional Water Conventions.** Key partners of the present project have been central to the delivery of actions within the regional water conventions, including the Helsinki Commission (HELCOM), Oslo and Paris Commission (OSPAR), US-Canada International Boundary Waters Treaty and International Joint Commission, MedPol, Black Sea Convention, Cartagena Convention. The involvement of these groups is represented in the project partnership.
- **Intergovernmental Panel on Climate Change** (IPCC) and the **Framework Convention on Climate change** (UNFCCC). In particular, the TFRN has coordinated input relevant to nitrogen to the 5th Assessment Report, which includes several authors from the project partnership.
- **Food and Agriculture Organization** (FAO) of the United Nations, has recently established its Agenda for Action on livestock management practices and its Livestock Environmental Assessment and Performance Partnership (LEAP), which together with its long term expertise on crop and livestock systems, contribute significantly to the project baseline.
- **International Plant Nutrition Institute** (IPNI) and the **Consultative Group on International Agricultural Research** (CGIAR) are international organizations focused on improving agricultural performance. They have a wealth of data relevant to the present project, especially in relation to approaches to improving nitrogen use efficiency, and in low emission fertilizer practices.
- Through these groups a direct link is established with private sector interests, as highlighted by GEF, including the **International Fertilizer Manufacturers Association (IFA)** and its regional bodies such as **Fertilizers Europe,** with engagement through its leadership of the **EU Nitrogen Expert Panel**), as well as other industry and agricultural

[34] Reis S. et al. (2012) From Acid Rain to Climate Change. *Science* **338**, 1154

[35] Bleeker, A. et al. (2013) Economy-wide nitrogen balances and indicators: Concept and methodology. Organisation for Economic Cooperation and Development (OECD) (Working Party on Environmental Information), ENV/EPOC/WPEI(2012)4/REV1. Paris

business groups (e.g. COPA-COGECA the European Farmers Union, and the International Federation of Organic Agricultural Movements, IFOAM, who have contributed to the Towards INMS PPG phase).

- While livestock and crop agriculture together represent a key source and challenge for nutrient management, links with **Civil Society Groups**, such as through the **European Union Air Quality Stakeholder Expert Group** and the **Global Partnership on Waste Water** will allow the links with other source sectors (transport, large combustion plants, waste water treatment etc.) and public engagement to be further developed.
- The approach is highly relevant as a focused contribution to meeting many of the **Sustainable Development Goals**, especially as the nitrogen cycle cuts across so many of the different goals (especially SDGs 1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14, 15).

43. The partners of the proposed Towards INMS project have been selected bearing in mind both the leading scientific expertise and access to appropriate tools, and to ensure strong links are made in building on this broad base-line activity, including representatives of governments, private and voluntary sectors and international frameworks. Further details on partners activities contributing to the baseline is given in Appendix 12.

2.5.3 Policy baseline and gaps

44. Until now, national and international policies have been specific to different nitrogen sources (industry, transport, agriculture, waste, etc.) or specific issues (e.g. food supply, health, trade, water and air quality, climate change, biodiversity), but have not addressed the links between these issues.

45. Analysis of existing N_r policies indicates that they have been most successful in sectors consisting of few major actors / source stakeholders (e.g. electricity generation companies, car manufacturers, municipal water treatment companies), but have made less progress when engaging many diverse actors (e.g., transport and food choices by citizens, farmer practices). The challenge of diverse actors requires long-term dialogue, education and training, especially utilizing the 'cluster points' in nitrogen and other nutrient pathways, where a few key actors have the opportunity to influence other parts of the chain (e.g. car manufacturers, supermarkets, local leaders, etc).[36]

46. As a result of this diversity of policy challenges relevant for nitrogen, there are several international conventions and programmes for which nitrogen plays a key role. However, there is currently no international treaty that brings together the different benefits and threats of N_r. The lack of such a joined up approach means that the issues become fragmented, with the implication of often lower willingness to take action.[37]

47. In addition to the need for an integrated policy approach to the many threats and benefits of N_r, it also needs to be articulated why the issue is relevant for policy at the global scale. Firstly, some of the N_r threats are global and hemispheric in nature. These include the threats of N_2O on global warming and stratospheric ozone depletion. Although N_2O is included in the Kyoto Protocol, by sitting alongside CO_2 and CH_4 it often fails to get the specific attention needed to address its control. The case for N_2O and stratospheric ozone is even worse as N_2O is not currently addressed in the Montreal Protocol.[38] A core message from the recent UNEP report 'Drawing Down N_2O' was that an approach to control N_2O needs especially to address overall nitrogen cycling to improve nitrogen use efficiency, which instantly makes the link to the other threats and benefits of N_r. This means that while water pollution and air pollution typically operate at both regional transboundary and local scales, the policy response needs to operate at multiple scales, from global to regional to local. A further reason to develop a global approach is the nature of the barriers-to-change. These are often supra-national in scale, being affected by trade in fertilizers and agricultural products, which can constrain the adoption of the best practices to manage N_r especially if additional costs are involved.

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[36] Sutton, M.A. et al. (2013) Our Nutrient World: The challenge to produce more food and energy with less pollution. Chapter 8

[37] Sutton, M.A. et al. (2011) Too much of a good thing. *Nature* **472**, 159-161.

[38] UNEP (2013) *Drawing Down N_2O to Protect Climate and the Ozone Layer.* A UNEP Synthesis Report. (Eds.: J. Alcamo et al.).

48. It is not the role of 'Towards INMS' to fill this policy gap – that is for the countries and other stakeholders to agree on the most suitable ways forward for better nitrogen governance regionally and globally. By contrast, it is clearly within the role of 'Towards INMS' to better understand these limitations and to develop engagement with the policy community. In this way, 'Towards INMS' is needed to articulate and demonstrate how science evidence can support policy makers and practitioners in better meeting their shared goals linked to the nitrogen cycle.

2.6 Stakeholder mapping

49. Given the wide ranging impacts of the nitrogen cycle, addressing the interface of science, policy and practice is relevant for many different stakeholder groups. This is being addressed in several stages as part of the INMS process:

a) Incorporating well-established partnerships with stakeholders, including those who have been involved in the original conception of 'Towards INMS' (pre PIF stage).
b) Developing partnerships with stakeholders during the PPG phase, specifically to widen the scope of the project activity.
c) Forging new partnerships, including those that will continue to be developed during the life of the project. In such cases contacts so far have served to provide initial introductions, which will become stronger as groups are invited to engage in execution of the INMS Activities.

In Table 1 below, we summarize the nature of the different stakeholder groups and show how they are being included in the developing engagement of 'Towards INMS'.

***Table 1:** Summary of main stakeholder groups for Towards INMS and how they are being engaged in the project.*

Stakeholder group	Examples	Engagement in project execution
Nitrogen consumers and local managers	All citizen depend on nitrogen for food, energy and transport. The project is relevant both to members of the public and local managers (e.g., farmers, conservation managers, planners)	Local managers will be engaged through the regional demonstrations, including local case studies of Component 3, while communication activities in Component 4 will engage the wider public, building on established foundation with INI including press engagement.
Private sector	The major private sector interests are fertilizer manufacturers and nitrogen users in agriculture (e.g. farmer groups). Businesses involved in nitrogen innovation also have prospect to become more important.	Fertilizer manufacturer companies and business organizations are involved at global and regional scales, including in indicator refinement (Component 1). Farmer organizations are engaged as stakeholders through the regional demonstrations (Component 3). Links with nitrogen innovators (e.g. agricultural engineering, nutrient recovery and reuse, NO_x capture and utilization will be further developed during the project.
Science and academia	As a targeted research project on the global nitrogen cycle the project is prepared under the lead of the International Nitrogen Initiative (INI), including a wide range of academic partners globally.	Partners of the International Nitrogen Initiative (INI) are involved in all components, especially utilizing the INI Regional Centers (East Asia, South Asia, Latin America, Africa, Europe and North America), which provide the basis to implement the Regional Demonstrations of Component 3.
International Governmental Organizations	Given the wide relevance of the nitrogen cycle several key IGOs are included: UNEP, FAO, WMO, OECD, UNECE, CGIAR (including ILRI, IITA), IIASA	IGOs contribute a wide range of roles in the project, bringing underpinning expertise, information on practices, datasets needed for modelling and access to policy communities, including governments.
Policy and decision-making	GPA, CBD, UNEA, UNECE (LRTAP and Water conventions), UNFCCC, Montreal Protocol, Regional Seas Conventions.	Engaged at national, global and regional scales through development of scenarios, policy options and anticipated benefits (Components 2 and 3). Component 4 will serve to develop wider dissemination and networking beyond the project partnership.

2.7 Linkages with other GEF and non-GEF interventions

50. The GEF (together with other donors) has had a long history of supporting projects to address the problems of excess nutrients and their impacts on coastal zones (summarized in the STAP 2011 report)[39] through the implementation of transformative management changes and through practical demonstration projects, for example reducing nutrient loss from farms through Agriculture Pollution Control (APC) activities in the Danube River Basin. In addition, the GEF has invested in targeted research projects over the past ten years ago to understand nutrient and carbon cycling in coastal zones[40] that will be further built upon within 'Towards INMS'. The problems of insufficient N_r have not previously been a focus under GEF IW, but are highly relevant to avoid emerging pollution problems as human populations rapidly expand. In this context, the project will build on the baseline established by key partners, including amongst work of the CGIAR (formerly the Consultative Group on International Agricultural Research), including the International Institute for Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI), as well as other partners such as the International Plant Nutrition Institute (IPNI). In order to ensure balance, groups with interest in both conventional and organic farming methods included.

51. UNEP is currently completing the GEF project 'Global Foundations for reducing nutrient enrichment and oxygen depletion from land-based pollution in support of the global nutrient cycle' (Global Nutrient Foundations, or **GNC project**) which contributes to the work of the GPNM and is one of the building blocks contributing to the baseline for the proposed project. The core objective of the GNC project has been "to provide the foundations (including partnerships, information, tools and policy mechanisms) for governments and other stakeholders to initiate comprehensive, effective and sustained programmes addressing nutrient over-enrichment and oxygen depletion from land based pollution of coastal waters in Large Marine Ecosystems". Although the focus is therefore not exactly the same as 'Towards INMS' (with GNC focusing on coastal waters only and nutrients rather than nitrogen), it nevertheless provides outcomes that are relevant for 'Towards INMS'.

52. The present achievement of the GEF/UNEP GNC project can be summarized as:

- The development and application of quantitative modelling approaches: to estimate and map present day contributions of different watershed based nutrient sources to coastal nutrient loading and their effects; to indicate when nutrient over-enrichment problem areas are likely to occur; and to estimate the magnitude of expected effects of further nutrient loading on coastal systems under a range of scenarios.
- A systematic analysis of available scientific, technological and policy options for managing nutrient over-enrichment impacts in the coastal zone from key nutrient source sectors such as agriculture, wastewater and aquaculture, and their bringing together an overall Policy Tool Box.
- A basis that can contribute to future modelling to assess the likely impact and overall cost effectiveness of the various policy options etc. brought together in the Tool Box, so that resource managers have a means to determine which investments and decisions they can better make in addressing root causes of coastal over-enrichment through nutrient reduction strategies.
- The application of this approach in the Manila Bay (Philippines) watershed and at Lake Chilika (India) with a view to helping deliver the key tangible outcome of the project – the development of stakeholder owned, cost-effective and policy relevant nutrient reduction strategies (containing relevant stress reduction and environmental quality indicators), which can be mainstreamed into broader planning.

[39] STAP (2011) Hypoxia and Nutrient Reduction in the Coastal Zone: Advice for Prevention, Remediation and Research

[40] UNEP/GEF The Role of the Coastal Ocean in the Disturbed and Undisturbed Nutrient and Carbon Cycles, executed by LOICZ - a sister programme to the INI under the International Geosphere-Biosphere Programme (IGBP)

- A consolidated global partnership on nutrient management to provide a stimulus for the effective development, replication, up-scaling and sharing of these key outcomes.

53. 'Towards INMS' is conceived with many links to on-going programmes and initiatives with an interest in reactive nitrogen and will actively involve these in both the development of the full-sized project and throughout the project's implementation. It will exploit other GEF interests and achievements in nutrients and coastal eutrophication, including through GEF IW projects including the Transboundary Water Assessment Programme (TWAP) with an expectation of exchange of data and methods. Close links will be established between "Towards INMS" and the GEF Nexus project titled: "Integrated Solutions for Energy, Water, Energy and Land". In both projects, IIASA is involved in a central role of supplying modelling tools and providing scenarios. Thus coordination of activities can be performed by way of IIASA contributors. While the GEF Nexus project focusses on water quantities and their implication on energy (also by way of cooling water) and land use (irrigation), "Towards INMS" views into an additional aspect, water pollution and pollution from the N cycle in general. Both projects will benefit from using common underlying scenarios – in fact, addressing future developments according to the scenarios developed under IPCC (RCP- and SSP scenarios) has been proposed, scenarios which have been co-developed by IIASA and other partners in "Towards INMS" (PBL and PIK).

54. The project is closely linked and aligned to the goals of the GPA and will work with the UNEP Regional Seas Programme to co-ordinate activities and recommendations to protect the marine environment. The Executing Agency (INI) will provide significant links to their programmes, assisting with both excess and insufficient reactive nitrogen, and provide close co-operation with the broader initiatives of the IGBP and SCOPE, including with the LOICZ (Land-Ocean Interactions in the Coastal Zones) programme which GEF IW has previously supported, as well as broader linkages with the international 'Future Earth' research community.

55. 'Towards INMS' will be closely linked with the GEF IW:LEARN to share the experiences and knowledge gained and will actively participate at the International Waters Conferences to further encourage enhanced linkages between the science and policy actors to strengthen the approaches to nutrient management and food security. Similarly, the project will provide a contribution focused on nitrogen that complements the developing Water-Food-Energy-Ecosystem Nexus Assessment of the UNECE Transboundary Waters Convention, as well as activities under the Task Force on Reactive Nitrogen (TFRN) of the UNECE Convention on Long-range Transboundary Air Pollution, including its development of Guidance Documents on nitrogen mitigation, nitrogen budgets and integrated approaches.

56. Complementary international research efforts include major programmes supported by the European Union, such as the completed NitroEurope Integrated Project (64 partners, €28M) and ÉCLAIRE (38 partners, €11M), coordinated by the NERC Centre for Ecology and Hydrology through the INI and TFRN coordination team. The present GEF project will provide significant gravity to catalyze future major European Union and other international funding initiatives in support of its objectives.

57. The INI office has already prepared a future research strategy document in support of this process,[41] and is actively engaged in developing the research agenda with the European Commission (DG Research and DG Environment), including contributing to the European Commission 'Horizon Scanning' on the 'Junction of Health, Environment and Bioeconomy' (JHEB),[42] which clearly profiles the nitrogen and nutrient issues. A newly funded EU twinning project NitroPortugal[43] has just been established, while bilateral funding initiatives (e.g. Newton Bhabha fund between UK and India, UK and China, UK and Brazil) are allowing the establishment of complementary research

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[41] *Managing the European Nitrogen Problem*, Sutton et al., prepared by the Task Force on Reactive Nitrogen (Centre for Ecology and Hydrology / Partnership for European Environmental Research)

[42] Stahel, W.R. et al. (2015) *The Junction of Health, Environment and Bioeconomy: Foresight and Implications for European Research & Innovation Policies.* European Commission.

[43] NitroPortugal: https://www.openaire.eu/search/project?projectId=corda__h2020::874f27c29158672bb240554cc0631796

underpinning that will provide material to strengthen the 'Towards INMS' regional demonstrations. These examples show how Towards INMS can therefore multiply the impact of GEF substantially by stimulating such future funding activities. This reflects the strongly catalytic nature of the 'Towards INMS' approach.

2.8 Conclusions on the project baseline

58. The **baseline** for the proposed project is therefore strong. By contrast, existing efforts to-date have largely focused on the regional scale (e.g. regional water and air conventions), as well as on separate environmental compartments and individual nitrogen threats and benefits. Despite the many efforts to reduce pollution undertaken by GEF and others, there is insufficient understanding of the global N cycle and how this interacts at the regional/national levels. In particular, the understanding and the links between encouraging efficient use of N_r to support food production, while minimizing the environmental impacts of excess nitrogen needs to be strengthened, through the development of specific nitrogen cycle tools and management approaches. At the same time, it is recognized that it must be a priority to link more closely efforts to improve nitrogen management between water (freshwater and marine), air, greenhouse gases and stratospheric ozone depletion, ecosystems and soils, and between these multiple threats and the food and energy security benefits.

59. Substantial preparatory activities have already been made over the last 10 years that now bring the global science, policy and practice communities to the stage where they are ready to take the next step towards developing a more joined up approach. The foundation is therefore well set to show how an understanding of global and regional nitrogen cycles can provide the basis to develop an International Nitrogen Management System that will catalyze better informed decision making and better uptake of practices. By linking the benefits of improved N_r management for environment (water, air, climate, biodiversity etc) with food and energy security at a global scale, 'Towards INMS' offers the opportunity to catalyze change toward a more sustainable world, for example, contributing simultaneously to several of the newly agreed Sustainable Development Goals.

Section 3: Intervention Strategy (Alternative to the baseline)

3.1 Project rationale, policy and expected global environmental benefits

3.1.1 Rationale and Hypothesis

60. 'Towards INMS' is developed with the recognition that the existing approach to science and management of the nitrogen cycle is highly fragmented. There are many benefits and threat of reactive nitrogen (food, energy, water and air quality, greenhouse gases, stratospheric ozone, ecosystems and biodiversity and soils). Yet, there are few experts who have the skills to link all of these issues together. Such a fragmented approach is likely miss potential synergies and may even exacerbate trade-offs between issues. The result is that the present approach to managing the nitrogen cycle is unlikely to provide an optimal set of solutions.

61. In part, the fragmentation of science across the nitrogen cycle is the natural result of a deliberate specialization into focused research communities. While this has allowed significant advances in the details of mechanistic understanding, it has also left science communities with little understanding of each other, resulting in weak communication between related issues across the nitrogen cycle. As a consequence, coherent scientific advice to support improved policies and practices across the nitrogen cycle is often in short supply.

62. These divisions have certainly been amplified by the matching separation of policy areas. For example, differences in policy perspective between actors (e.g., separate departments for agriculture, energy, transport, waste water etc) are compounded by separation between target outcomes (water, air, climate, economy etc).

63. 'Towards INMS' is developed with the recognition that the present lack of a coherency across the nitrogen cycle contributes substantially to the **barriers-to-change** towards a more optimized global nitrogen cycle. This means that to maximize the benefits for one policy domain (such as aquatic ecosystems and the coastal zone) requires taking account of the other benefits that possible actions could contribute. Even more than that, because N_r is a valuable resource, actions that simultaneously contribute to improved business efficiency and profits are likely to provide an even stronger motivation to overcome the barriers to change. To achieve this, however, requires that a more joined-up science approach is delivered, with appropriate tools, options and much wider awareness of the issues.

64. Considering this rationale, **'Towards INMS' addresses the hypothesis that joined up management of the nitrogen cycle will offer many co-benefits that strengthen the case for action for cleaner water, cleaner air, reduced greenhouse gas emissions, better soil and biodiversity protection, while at the same time helping to meet food and energy goals.**

65. This leads to a broad approach where the challenges of one issue become linked to the challenges and opportunities of the interacting issues. For example, where actions needed to reduce the effects of N_r on transboundary waters can be shown simultaneously to deliver quantified co-benefits for air, climate, food, energy, then this will more strongly motivate the necessary changes for water protection. The same applies for each of the other threat and benefit policy domains (food, air, climate, soil etc). By acting together through the nitrogen cycle, there is the potential to transform efforts for a cleaner and healthier environment.

3.1.2 Policy challenge and opportunity

66. The different policy drivers and frameworks linked to nitrogen have already been listed under the relevant baseline and stakeholder mapping in Section 2. Each of these frameworks, such as the GPA, CBD, LRTAP, UNFCCC, Vienna Convention and the regional seas conventions and other groups such as OECD, Commission for Sustainable Development (including SDGs), UNEP, GPNM, CCAC etc, face many challenges to making progress in meeting their goals. In the case of nitrogen, it is evident that these different topic domains hardly work together at present, with many policy opportunities not being fully grasped.

67. This policy landscape provides both a key challenge and opportunity for 'Towards INMS'. The question can be asked: if the science is to be more joined up in evidence provision, how can this foster joined-up policy making and improved adoption of the best practices?

68. These issues have been addressed in Chapter 8 of the *Our Nutrient World* report, which specifically called for the development of international consensus to:

a) Establish a global assessment process for nitrogen between air, land, water, climate and biodiversity, considering the main driving forces, the interactions with food and energy security, the costs and benefits and the opportunities for the Green Economy,
b) Develop consensus on the operational indicators, with benchmarking to record progress on improving nitrogen use efficiency and reducing the adverse environmental impacts,
c) Investigate options for improvement of nitrogen use efficiency, demonstrating benefits for health, environment, and the supply of food and energy,
d) Address barriers to change, fostering education, multi-stakeholder discourse and public awareness,
e) Establish internationally agreed targets for improved N_r management at regional and planetary scales,
f) Quantify the multiple benefits of meeting the nitrogen management targets for marine, fresh-water and terrestrial ecosystems, mitigation of greenhouse gases and other climate threats, and improvement of human health,
g) Develop and implement an approach for monitoring time-bound achievement of the nitrogen management targets, and for sharing and diffusing new technologies and practices that would help to achieve the targets.[44]

69. Altogether this represents a high ambition that cannot easily be achieved in a single step. However, 'Towards INMS' outlines a major contribution to meeting this agenda as part of what must be a longer term ambition. Specifically, it is important to examine each of the components of this agenda, for what is suitable for inclusion in 'Towards INMS' and what must be left as subsequent or parallel steps.

70. In relation to this list, 'Towards INMS' is specifically designed to address points a, b, c and d. In addition, it addresses point f and parts of g, especially in relation to innovation and sharing technologies. By contrast, the setting of internationally agreed goals (e) is the task of governments and policy makers, which a process like INMS may be requested to support in future. With the exception of point e, this list can be considered as matching to the **key criteria** for an appropriate science evidence system to support international policy development.

71. In considering such calls, it is important to distinguish between science support for policy and policy processes. Similarly a distinction needs to be made with policy implementation through in better practices on the ground. These can be considered as three parallel tracks which need to work closely together mutually supporting each other's aims:

- ***Track 1: International Policy Development for Nitrogen****:* This is the role of governments in cooperation with all stakeholders. Negotiation of agreements needs to be based on sound scientific evidence, while also requiring appropriate indicators for monitoring success, which should be based on sound science.
- ***Track 2: Scientific Support for Nitrogen Policy Development***: This matches to the role of an eventual International Nitrogen Management System, for which the 'Towards INMS' project has been developed as key step. The role is necessarily under the lead of the science community and needs to be organized in such a way that all relevant stakeholder inputs are included, while developing an effective approach that is responsive to the needs of policy makers. Key elements of Track 2 include providing the evidence of the multiple threats

[44] *Our Nutrient World* also included targets for phosphorus and micronutrients, however this must be considered as a further step in the global capacity building. This question is being addressed in parallel, for example through the Phosphorus Task Team of the GPNM, bringing in additional issues associated with phosphorus and potash mining, resource depletion and a more specific focus on the water environment. While the Towards INMS approach focuses on integration across the nitrogen cycle, it recognizes interactions with other elements cycles such as C (especially in relation to climate), S (in relation to air pollution), P and Si (in relation to water).

and benefits of nitrogen management, the provision of scenarios demonstrating cost-benefit of particular policy choices, including the harmonization and benchmarking of performance indicators, the sharing and dissemination of best practices, and the synthesis of indicator monitoring.

- ***Track 3: Practices improvement for better N management***: This is the role of all stakeholders, but can be particularly motivated by governments and other stakeholders. Through INMS the science community can play a key role in identification of the most suitable options that maximize the nitrogen co-benefits, while profiling the potential of success stories for wider dissemination and adoption. Implementing wide-scale adoption of better practices is especially the role of governments and agencies.

72. It is clear that **'Towards' INMS is focused clearly on Track 2.** In addition 'Towards INMS' can at the same time support motivation for both Track 1 and Track 3. However, these are fundamentally parallel processes that need to operate under the lead of governments (Track 1) and government agencies and others including business and civil society (Track 3).

73. It is worth reflecting that during the PPG phase different stakeholders have encouraged INMS to follow their own views within this landscape of the three tracks. For example, one agency stakeholder appeared to encourage that INMS also deliver Track 1. Conversely, one business stakeholder made it clear that they did not want to see progress in 'global governance' in connection with nitrogen, implying that INMS should avoid contact with Track 1. From another angle again, a stakeholder from a particular government department emphasized that INMS should reduce its focus on Targeted Research and instead more-strongly prioritize the local implementation of improved practices (Track 3). Such differences of view are natural. They illustrate how the definition of these three tracks can help clarify stakeholder needs. They also emphasize how 'Towards INMS' is a process of building global and regional capacity that can stimulate activity under all three tracks, while developing consensus on the exact balance and relative roles.

74. It may be possible to identify a fourth track: ***Public engagement about the nitrogen threats and opportunities***. Without significant public engagement little substantive progress can be expected in the exchange between policy making, scientific support and practice development. The key actors benefiting from N_r use and contributing to N_r pollution would have insufficient information on how to improve, while governments would not be empowered to take action by their citizens. It is therefore also important that 'Towards INMS' also focuses on developing clear public messages and actively engages with industry, business, media and civil society.

3.1.3 Potential policy homes for INMS

75. Apart from the substantive contributions it provides, it is clear that the longer term aim of 'Towards INMS' is to build the capacity to establish an operational International Nitrogen Management System. With 'Towards INMS' being a project running over the next four years, the aim must be to prepare the way to support global nitrogen policy and practice improvement over the next decade and beyond. In regards of Track 1, **a coordinated approach to international nitrogen policy is currently missing. This means that the very development of 'Towards INMS' presses policy makers to reflect on what they would consider the most suitable architecture to address policies on the global nitrogen cycle.**

76. The central question could be framed most simply as: What would be the most suitable policy home to which INMS should eventually report? This is not an easy question for 'Towards INMS' itself to answer, let alone to resolve during the INMS PPG phase. The reason for this is that the question is primarily one for policymakers themselves rather than for the scientists to answer. Nevertheless, it is appropriate for the INMS science and stakeholder community to consider the issues and reflect on possible options to stimulate thinking by national and international policymakers.

77. In a **first stage** of this discussion (going back over a decade), the fragmentation of science and policy of the nitrogen cycle was first recognized. It was this recognition that led to the establishment of the INI as a focal point to bring science evidence more closely together. At the same time, scientists were often heard to suggest that an

international convention on nitrogen issues was needed. It was such calls for example (Saltsjobaden 2007 workshop), that led to the establishment of the UNECE Task Force on Reactive Nitrogen by the Executive Body of the LRTAP Convention (Decision 2007/1). Nevertheless, although the TFRN was given a mandate to address the full nitrogen cycle from a technical perspective, it still sits within a negotiating context of a specific threat (in this case air pollution). The science call for a new 'nitrogen convention' has also appealed to journal editors given its simplicity (e.g. see the strapline associated with the article in *Nature*[45] that launched the European Nitrogen Assessment).

78. If this call for a 'nitrogen convention' is taken as a starting position, it is also interesting to see the response from policy makers. Through the 'corridor discussions' of many inter-governmental meetings, the present INI chair has posed this question to numerous government officials. The response seems to be almost universally: "we already have enough intergovernmental processes; we don't need more. Do your best to work with the existing processes."

79. This comment should also be seen in the context of a multi-decadal international policy cycle. To summarize broadly: The 1980s was the decade of increasing environmental recognition; the 1990s was the decade of setting up inter-governmental processes and starting to make commitments; the 2000s was the decade of realizing how difficult it is to deliver the commitments; and finally, the 2010s is the decade of avoiding new commitments and even trying to back out of existing commitments. While there are of course exceptions, this *zeitgeist* means that the 2010s are not the ideal decade for establishing any new inter-governmental policy process.

80. These discussions have continued at length at the sidelines of numerous meetings, for example with UNEP, GPA, UNEA, CBD, UNECE (TFRN, LRTAP and the Transboundary Water Convention), OECD, European Commission and with representatives of national governments. At the same time, experience has been gained in better understanding how science can support all these processes, including providing the evidence necessary to support agreements on international protocols, declarations and decisions. A number of themes emerge:

a. The more specific and focused the agreement that policy makers see to make, the more specific and robust the science evidence needs to be to support that agreement.

b. A broad combination of evidence is needed, including information on temporal trends in agreed indicators, scenarios, methods to achieve the desired outcomes (technologies, practices etc), costs of taking action, scale of benefits and cost-benefit analysis.

c. Long-term policy processes with sustained intercessional activity provide the foundation for the most robust, specific and ambitious agreements. One of the reasons for this is that with sustained science input, it allows the parties to a proposed agreement access to a robust long-term body of science, to build confidence in the science evidence, and to be able to request tasks be undertaken by the science community to address their concerns. Together with an improved technical underpinning of the possible practices, it gives the countries confidence to know that their agreement is both achievable and that the benefits outweigh the costs.

d. The evidence needed by policy processes varies between rather simple to highly complex approaches. On the one hand a simple analysis can have great power in policy context (e.g. Planetary Boundaries), while conversely, where there objections, there may be calls for more and more detail. This reflects the interface between political negotiation and science evidence, and emphasizes how the science must go beyond technical approaches also to understand the opportunities and the barriers-to-change.

e. Global policy frameworks need to be able to use evidence of varying detail, especially so as to allow data-poor areas of the world to engage fully in the process. This calls for the science community to be able to deliver a range of approaches to satisfy all needs, from those countries and regions where only basic evidence is possible (implying the need for simple indicators etc) to those developed regions where there is the call for more-sophisticated approaches to be implemented.

[45] Sutton et al. (2011) Too much of a good thing. *Nature* (11 April 2011).

81. This list could easily be extended. It should, however, be sufficient to illustrate the challenge for 'Towards INMS' to engage with countries in developing a more effective interaction between Tracks 1, 2 and 3 to support better management of the global nitrogen cycle.

82. If the first answer to the question 'what should be the policy home for nitrogen?' was the call by scientists for a self-standing international 'nitrogen convention', then the **second stage** was therefore the recommendation by numerous government officials makers to use one of the existing policy frameworks.

83. To respond to this recommendation, it is necessary to comment on each of the main existing international policy frameworks with regard to their suitability to host an international policy approach on the nitrogen cycle. We follow here the order of the 'WAGES' acronym, starting with Water, and then considering the other options. It should be noted that while this is *not* intended as a critical review of these frameworks, it is inevitably necessary to reflect briefly on their most relevant strengths and limitations.

a. **WATER: Global Programme of Action to protect the marine environment from land-based activities.** (GPA) This is the only international programme to address the connection between land-based pollution and the marine environment. Since the Manila Declaration (2012), nutrients are considered as one of the three core challenges (together with waste water and marine litter) of relevance for the GPA. The nitrogen challenge is therefore closely matched to meeting GPA goals. The GPA process is subject to regular Intergovernmental Reviews of the programme which take place every 4 to 5 years. The GPA has a key strength of working with regional marine conventions around the world. Conversely, a weakness for nitrogen is that the focus is specifically on the marine environment. Issues of wider nitrogen management are therefore not automatically a priority, unless it can be demonstrated how joined-up nitrogen management strengthens the opportunity to meet the marine goals of the GPA. This is indeed a fair opportunity, making INMS highly relevant to GPA. The GPA also has the advantage of strong links through UNEP and GPNM communities. There is also a clear need for science evidence provision to GPA, as shown by experience at the 3rd Intergovernmental Review (IGR-3). However, as it stands, GPA lacks any solid intercessional process.[46] This means that it is currently not easy to connect science efforts between the IGR meetings (every 4-5 years) in order to support to advance planning by the countries of their desired outcomes.

b. **AIR: Convention on Long-range Transboundary Air Pollution** (LRTAP). Substantial progress has been made by the LRTAP convention in addressing the nitrogen issue and pioneering thinking connected with the wider nitrogen cycle. It established the Task Force on Reactive Nitrogen (TFRN) in 2007. This has since supported revision of the UNECE Gothenburg Protocol (e.g. options for the Protocol's Annex IX, critical levels, ENA, key guidance documents). The LRTAP convention has a very strong intercessional process, allowing the building up of both long-term science capacity and a strong mutual understanding of needs between the policy making and science communities. In particular, through the Working Group on Strategies and Review, the architecture of the Convention allows a close interaction between policy and science expertise. Apart from its substantive commitments on N_r emissions reductions to the atmosphere, the Gothenburg Protocol took a significant step in introducing voluntary reporting of national nitrogen budgets, following the methodology prepared by the TFRN. The limitations of the LRTAP convention for an integrated approach on the global nitrogen cycle are two-fold: Firstly, the convention is limited to goals related to air pollution, and secondly, it only covers the geographic scope of the UNECE region. Although the UNECE Transboundary Waters Convention has shown that it is possible to include Convention parties beyond this region, it has so far not proved possible to agree this within LRTAP. There is also the potential for much stronger cooperation between the UNECE LRTAP and Transboundary Waters conventions. However, these have different modes of operation, which provides a barrier to stronger linkage.

[46] In principle, this might be provided through the Global conference on Land Ocean Connections (GLOC), as first held simultaneously with IGR-3 at Manila in 2012, with GLOC-2 held in Jamaica in 2014. However, the connection as an intercessional preparation for anticipated governmental agreements (e.g. with IGR-4, in 2016 or 2017) has not yet been made.

c. **GREENHOUSE GAS: Intergovernmental Panel on Climate Change** (IPCC) and the **UN Framework Convention on Climate Change** (UNFCCC). At present the UNFCCC must be one of the largest and most ambitious international agreements linked to the environment, having grown substantially since its establishment in the 1990s. The IPCC is also one of the world's leading science assessment processes. These are key strengths of UNFCCC as a potential policy home for nitrogen, which could for example emphasize the links between nitrogen and climate change, as discussed in both the European and North American nitrogen assessment processes. Against this opportunity is the complexity of dealing with an extremely large organization that is already over-busy with its own challenges. As it stands, nitrous oxide gets limited attention within the wider basket of Kyoto gases, while the chances, in practice, of embedding a 'full nitrogen approach' at the present time within UNFCCC appear to be negligible . The UNFCCC appears already to face more than enough challenges, as illustrated by the respectful decline of its secretariat to take part in the 'Towards INMS' First Plenary Meeting (Lisbon, 2015). It can also be questioned whether the UNFCCC - IPCC model offers the most suitable approach for a nitrogen policy home given the very strong separation between the science evidence (IPCC) and the negotiation process (UNFCCC). As shown by the contrasting close linkage between policy makers and scientists in the LRTAP - TFRN approach, there are substantial benefits to be found from developing a close interface between these groups.

d. **ECOSYSTEMS AND BIODIVERSITY:** UN Convention on Biological Diversity (CBD). The INI already works closely with the CBD acting as the delivery partner for its nitrogen deposition indicator under the Aichi Targets process . This has led to INI contributing to several CBD meetings, building understanding of the CBD process. At the same time, the CBD secretariat has been similarly active in supporting the development of 'Towards INMS'. CBD represents a highly diverse set of biodiversity interests and in this sense could be well placed to develop as an international policy home for nitrogen. On the other hand, this very same diversity and complexity can be equally considered as a barrier, as it become hard in the busy 'CBD market-place' to profile an issue like nitrogen, which is under strong internal competition for attention with many other topics. As the challenge of nitrogen is fundamentally biogeochemical, while N_r is multi-source, multi-impact (matching to CBD), it nevertheless has a closer commonalty with other conventions dealing specifically with material flows (like GPA, LRTAP, UNFCCC).

e. **SOILS**: While the WAGES model considers soil quality as the fifth main threat of too much or too little nitrogen, there is not currently any specific intergovernmental process focusing on this threat. The closest connections could be seen with the objectives of the UN Food and Agriculture Organization (FAO) and with the developing process under the high level Sustainable Development Goals. While in many cases relevant for nitrogen, it is currently hard to see that these processes could be the primary policy home for nitrogen, as they either mainly focus on only one part of the story (FAO, improved food supply) or take a very generic high-level approach (SDGs) for which delivery partner organizations will anyway be necessary to make substantive progress.

f. **STRATOSPHERIC OZONE**: Vienna Convention and Montreal Protocol. In addition to the original five threats of the WAGES model, it is recognized that N_2O now represents the main source of stratospheric ozone depletion. Given this point, it has been discussed whether N_2O control should become part of the group of pollutants that are addressed under the Montreal Protocol (as it is currently not included).[47] Advocates of its inclusion emphasize the success of the Montreal Protocol in decreasing CFC and HFC emission substantially over the last 20 years. Conversely, critics have emphasized that the success of the Montreal Protocol was connected with the availability of finance to support transition, while being focused on a few large well-organized companies producing CFCs and HFCs. Although some N_2O arises from large industrial operations, over 70% arises from agricultural sources, implying the need for the Montreal Protocol to deal with a much wider and more diverse set of stakeholders than it has in the past. Irrespective of this debate, it remains an open question whether the Montreal Protocol would be ready to make a double leap to next address all the main polluting and beneficial effects of reactive nitrogen.

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[47] UNEP (2013) Drawing down N_2O report.

84. In addition to these issue-based international approaches, it is also worth mentioning the importance of other frameworks:

a. **Organisation for Economic Cooperation and Development** (OECD). This represents most of the developed countries in the world providing support and analysis for international policy and economic development. It also has experience of nitrogen and as a partner of 'Towards INMS' is engaged in mobilizing better understanding of the nitrogen cycle for policy application. In this regard, OECD acts as a global think-tank, disseminating innovative ideas, analysis and indicators to support the economies of its member countries. OECD also provides standards and benchmarks, for example in the field of chemicals and the environment. OECD does not, however, represent any policy process with specific policy goals. In that sense, while the cooperation between 'Towards INMS' and OECD offers substantial opportunities in refining ideas and mobilizing interest across governments, a different kind of organization/framework is needed as the prime policy home for an international approach on nitrogen.

b. **Global Partnership on Nutrient Management** (GPNM) The relevance and close connection of GPNM with INMS has already been outlined, for example, with INI leading the delivery of the Global Overview on Nutrient Management 'Our Nutrient World' in cooperation with UNEP and GPNM. The GPNM itself consists of a multi-stakeholder partnership between interested countries, industry, agronomy, environmental management and academia. The GPNM was important in bringing together support to the 3rd Intergovernmental Review (IGR-3) of the GPA in Manila. While GPNM can fulfil a catalytic function as a professional network building connections between the partners, it is clear that this is a different goal to that of an international nitrogen policy home.

c. **Climate and Clean Air Coalition** (CCAC). This is a voluntary group where countries and other stakeholders commit to take part with the common aim to reduce short lived climate polluters, especially methane and black carbon. Having identified a set of measures for reducing emissions, the CCAC promotes funding for actions to reduce these emissions as a contribution to meeting both climate and air pollution goals. As part of its agriculture programme, there is an important connection with nitrogen through manure management. Cooperation between CCAC and Towards INMS is therefore important and is facilitated especially within 'Towards INMS' by the Stockholm Environment Institute (University of York). Nevertheless, it is clear from the focus of CCAC that it is not designed to act as the main policy home for a multi-impact approach to manage the global nitrogen cycle.

85. Several of these frameworks are therefore highly relevant for nitrogen. Nevertheless, the message of this short review is that none of the existing bodies (as they stand at present) is optimized to act as a single main policy homes for nitrogen. This, is of course, not surprising. If the solution were easy, it would have already presented itself at an earlier stage.

86. The comparison of these different frameworks does, however, prepare the way for a **third stage** in the developing narrative. This originated during discussions in the margin of the United Nations Environment Assembly (UNEA-1, 2014) and subsequent discussions at the Environmental Policy Committee (EPOC) of the OECD (February 2015). Here the approach is intermediate between the first model (a 'nitrogen convention') and the second model ('work with existing conventions'). Under this approach, the importance is recognized of the '**policy arena for nitrogen**', which links each of the main environmental and other international frameworks. Such a policy arena is not primarily conceived as a convention in its own right, but rather a framework that makes the links to ensure better informed policy coordination between the existing international conventions and programmes.

87. As can be seen from the diagram below (Figure 3), the nitrogen policy arena is seen as being served with scientific support from the International Nitrogen Management System, while providing the connections with each of the other international frameworks. In this way, establishing a focused nitrogen policy arena can be seen as a much more achievable goal. It both 'works with existing' and addresses the present lack of policy coordination.

88. As regards a possible home for such a nitrogen policy arena, this must be a question for further discussion by countries. Both UNEA and OECD can serve as important forums in the first instance to further refine the concept and build support with countries for the approach. At a regional scale, frameworks such as UNECE, the South Asian

Cooperative Environment Programme (SACEP), Partnership in Environmental Management for the Seas of East Asia (PEMSEA) and other regional bodies could serve to support and further develop the approach in cooperation with the global nitrogen policy area. The exact form and design of the Policy Arena for Nitrogen must be a matter of further development. Although this concept has developed during the PPG phase of 'Towards INMS', it is a discussion that must continue with countries during the life of the project.

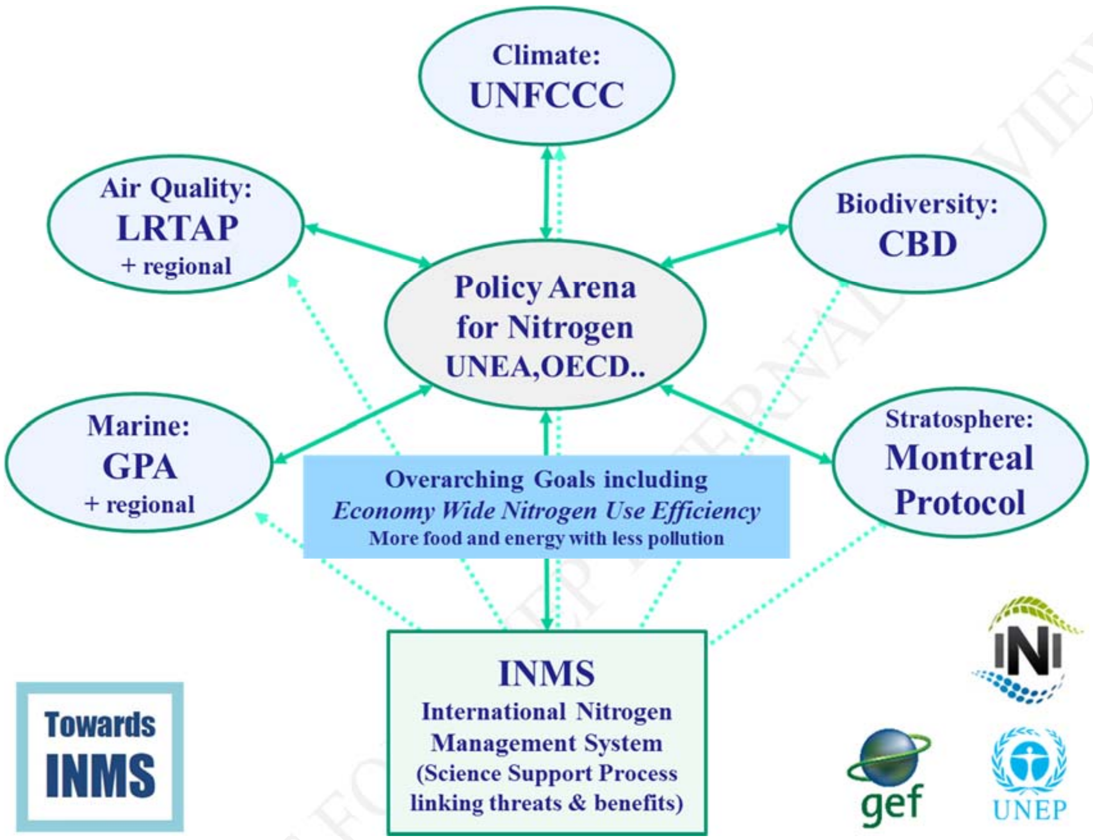

Figure 3: *Initial concept of the Policy Arena for Nitrogen showing how it may connect science support from INMS with the major effect based international agreements. Currently, these international agreements largely operate in isolation from each other failing to exploit the many synergies that operate across the global nitrogen cycle. In this approach, the policy arena provides a mechanism where governments can link their policies and strategies promoting a more optimized approach, while drawing on the scientific and technical support from INMS. Arrows also operate directly between INMS and the specific policy frameworks focusing especially on promoting improved understanding of the relevant needs as well as continuing to provide direct technical support where necessary.*

89. In summary, at present, it is envisaged that 'Towards INMS' would engage with policy frameworks at three complementary scales:

a) Continuing and strengthening science support to individual multilateral agreements, according to their specific topic focus (e.g. GPA, CBD, UNECE/LRTAP, UNFCCC, Vienna Convention, FAO, WHO etc),
b) Continuing to work with relevant global and regional multi-stakeholder partnerships to build deeper understanding of the cross-cutting issues (e.g. GPNM, CCAC),
c) Initiating new developments to work with countries towards Policy Arena for Nitrogen, continuing to engage in this process with overarching frameworks that could take an eventual lead (e.g. UNEA, OECD).

90. With the concept of the Policy Arena for Nitrogen having been developed at UNEA-1 (June 2014) and in interaction with OECD EPOC (February 2015), it was subsequently presented for discussion to the First 'Towards INMS' Plenary Meeting (Lisbon, April 2015). This allowed an open discussion of the concept chaired by UNEP garnering wide stakeholder feedback. Overall, there was support for the concept, with no objections to the general description of relationships, while agreeing on the need for both INMS and the Nitrogen Policy Arena at the heart of the diagram. The overall message of the stakeholders was one of high ambition to strengthen and extend the concept by increasing the number of linkages and goals. If the outcome of this consultation (see Figure 4) seems rather daunting, it clearly highlights the common message of the importance of nitrogen to all these domains.

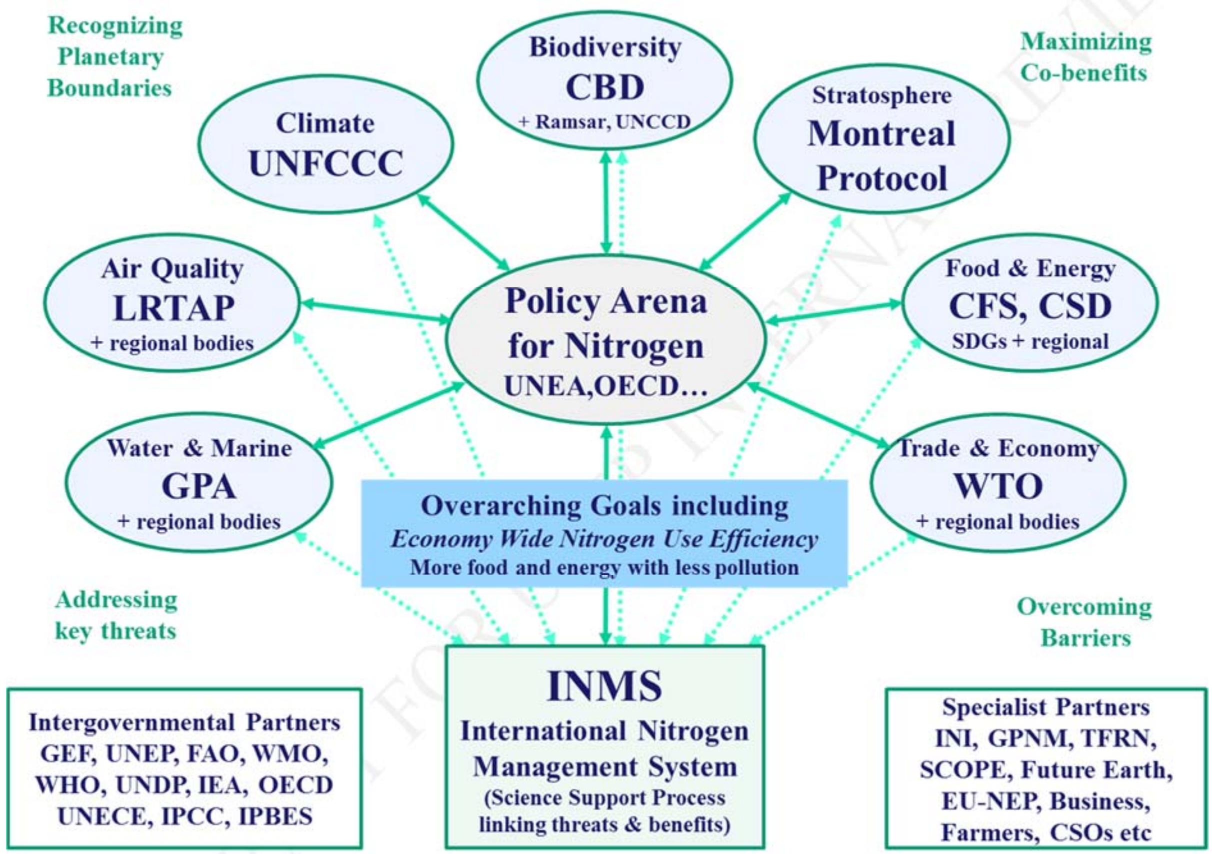

Figure 4: *Revised and extended concept of the Policy Arena for Nitrogen (Figure 3) following feedback from stakeholders during the First 'Towards INMS' plenary meeting (Lisbon, April 2015). The stakeholders indicated a high ambition to increase the number of connections, recognizing the multiple ways in which nitrogen has both benefits and threats, the needs to address barriers-to-change and the rich landscape of relevant intergovernmental and specialist partners. It remains an open question which version is most effective for public communication.*

Additional acronyms: *UNCCD is the United Nations Convention to Combat Desertification; CFS is the Committee on World Food Security; CSD is the Commission on Sustainable Development, under which Sustainable Development Goals (SDGs) are being developed; WTO is the world trade organization. WMO is the World Meteorolgical Organisation; WHO is the World Health Organisation; IPBES is the Intergovernmental Platform on Biodiversity and Ecosystem Services; IEA is the International Energy Agency, EU-NEP is the EU Nitrogen Expert Panel; SCOPE is the Scientific Committee on Problems of the Environment; CSOs is civil society organizations.*

91. The high ambition of Figure 4 may even go beyond what is realistically feasible to achieve in 'Towards INMS' in the next four years. However, it clearly indicates a strong mandate from stakeholders to continue with the process,

building the connections towards a joined-up nitrogen approach between countries, business, civil society and the global scientific community.

3.2 Objective and long-term goals of 'Towards INMS'

92. 'Towards INMS' is prepared as a GEF 'Targeted Research Project' at the global scale. This is not research in the traditional sense of focusing on fundamental science. It is rather research in how these issues can be brought together to provide tools, approaches, information and demonstration that can support the mobilization of change at a global scale. 'Towards INMS' is therefore pitched clearly at the interface of science-policy-practice development.

93. **PROJECT OBJECTIVE** With this framing, 'Towards INMS' has been developed with a broad partnership to address the following objective:

94. "To improve the understanding of the global/region N cycle and investigate / test practices and management policies at the regional, national and local levels with a view to reduce negative impacts of reactive nitrogen on the ecosystems."

95. The project objective remains unchanged from the PIF. At the same time, extensive discussion with a wide range of stakeholders during the First Plenary Meeting of 'Towards INMS' (Lisbon, April 2015), has allowed this to be complemented by the definition of a **First Long-term Goal:** ***"To improve the understanding of the global and regional N cycle and investigate practices and policies to maximize sustainable production of food, goods and energy while reducing negative impacts of reactive nitrogen on the environment and human health."*** In comparing these statements, it is clear that the stakeholder agreement on long-term goal extends the Project Objective to consider also the relevance of nitrogen impacts for human health, as well as to consider the benefits of improved nitrogen use for food, goods and energy. Although the long-term goal does not explicitly mention the different scales (global/regional/local) these points were taken by the stakeholders as being implicit, while they remain explicitly addressed within the 'Towards INMS' objective and work plan.

96. It is recognized that 'Towards INMS' has a central role to play in catalyzing the global policy community to develop more effective global and regional strategies to manage the nitrogen cycle. This is the reason that the project is titled "*Towards*" the International Nitrogen Management System. Such an international system of science and practice support for policies in the global nitrogen cycle does not currently exist. 'Towards INMS' is therefore a key step in this process, where the system of science, evidence and options provision (representing the scope of INMS) can work hand in hand with improved coordination among policy makers. 'Towards INMS' thereby parallels ongoing developments in the international policy arena for nitrogen.

97. Recognizing this parallel challenge, a **Second Long-Term Goal** of 'Towards INMS' can be distilled as:

"To develop the global community of experts in the benefits and impacts of nitrogen, in cooperation with a broad partnership of key stakeholder interests, into an effective system of evidence provision that can support improved strategy and policy development at global, regional and local scales."

The focus of this goal is therefore on building the capacity and organizational system as a foundation to deliver the substantive outcomes and outputs of the process.

3.3 Outcomes, Outputs and Key Aims

98. In following the GEF approach, 'Towards INMS' is structured with several planned overarching **Outcomes** and **Outputs**. These cover the full breadth of the project including process-related results. In addition, we summarize below seven 'Key Aims' which draw attention to some of the most important elements.

3.3.1 Project Outcomes

99. The planned Outcomes of 'Towards INMS' are as follows, numbered according to the their link to Components 1 to 4, as already agreed in the Project Initiation Form (PIF):

1.1. Stakeholders, including policy makers, scientists, industry, farmers, business and civil society, have an agreed basis for informed decision making on N cycle management.
1.2. Stakeholders using agreed assessment and quantification methods to evaluate N cycle status acting as a common basis for regional / global scenarios to guide management actions.
2. Regional and Global information on N cycle fluxes and impacts, enabling strategies to be implemented to minimise negative effects of excess or insufficient reactive N, while maximising the quantified co-benefits for other sectors including the Green Economy.
3. GPA, OECD, UNEA and other bodies are better informed to assist states with implementing management response strategies to address negative effects of excess or insufficient N_r, ensuring that any negative effects are minimised.
4.1 Local, national and regional expertise to address N_r issues increased and contributes to improved decision-making in the Policy Arena on Nitrogen at the regional / global levels.
4.2 Improved access to and sharing of information in cooperation with IW:LEARN.
4.3 Improved knowledge management with compiled knowledge and experiences about the project shared with other GEF projects and GEF Sec. and accessible on IW:LEARN.
4.4 Improved project execution from IW Conference participation and the use of the GEF5 IW indicator tracking system.

100. Although these Outcomes are each linked primarily to one of the four project Components, it is clear that there is substantial synergy between the Components in delivering them.

101. The design of the INMS project has been supported and informed by the analysis of the problems resulting from too much and too little nitrogen. A simple assessment based on the theory of change has supported the overall design of the projects' outputs and activities (to meet the expected outcomes). A basic 'problem tree' and theory of change relationship is presented in Appendix 19. The problem tree will be used throughout the project to guide actions and will be modified if required. It is expected that the theory of change will be reassessed, and if required reformulated, by the mid-term and terminal evaluations.

3.3.2 Project Outputs

102. The main Outputs of 'Towards INMS' are as follows, as already agreed in the Project Initiation Form (PIF):

Component 1:

1.1. Development of Indicators for assessing full N budgets, use, levels and impacts, including N use efficiency and benchmarking. Indicators would be developed of relevance for specific stakeholders (e.g. private sector - fertilizer producers).
1.2. Methodology for threat assessment.
1.3. Development of tools for valuation of the threats and benefits of N that are of use to multiple stakeholders groups (including the private sector).
1.4. Methods for determining N fluxes and distribution of N (water, air, land, agriculture, industry, etc.).
1.5. Approach to using existing N flux/pathway models for regional assessments and visualisation for potential scenarios to assist with development and reduction strategies.
1.6. Understanding the barriers to change at all levels of society (government, private sector and civil society) including technical, financial and socio-political limitations.

Component 2:

2.1. Quantification and assessment of the regional threats from excess N and insufficient N.
2.2. Detailed overview of regional/local N flux and consolidation into a global assessment of N fluxes and pathways
2.3. Consolidation of methods and good practices to address issues of excess and insufficient N_r.
2.4. Definition of programmes and policy options for improved N_r management at local/regional/global levels, supported by cost-benefit analysis to underpin options for the Green Economy.
2.5. Compendium summarizing the state of knowledge, experience and measures adopted by GEF (and others) gained from addressing the issues of excess and insufficient N_r.

Component 3:

3.1. 3/4 regional/national/local demonstration activities (that build on existing or planned nitrogen management actions providing catalytic results) deliver conclusions refining approaches to national / regional assessments and improving understanding of regional N cycle by addressing:

Case 1: Challenges and opportunities for developing areas with excess reactive nitrogen;

Case 2: Challenges and opportunities for developing areas with insufficient reactive nitrogen;

Case 3: Reactive nitrogen challenges and opportunities for regions with transition economies;

Case 4: Challenges and opportunities for developed areas with excess reactive nitrogen (using co-financed resources only).

3.2. Assessment and quantification of impacts from piloting activities to reducing negative impacts from poor N_r management, while demonstrating the co-benefits for other issues.
3.3. Refined benchmarking of indicators for different regions and nutrient flow systems.
3.4. Plans for inclusion of agreed approach to N cycle assessments agreed in support of the emerging Policy Arena on Nitrogen in engagement with GPA, OECD, UNEA and other bodies.

Component 4:

4.1 Information sharing and networking portal (with links to GPA) to assist the GPA, OECD, UNEA, UNECE and other bodies with uptake of understanding of N_r cycle and means to mitigate negative impacts.
4.2 Training for regional/national experts to sustain and enhance understanding of global N cycle implementation of national indicators, diffusion of new technologies, and links across the nitrogen policy arena relevant for inter-governmental processes.
4.3 Overall demonstration of the International Nitrogen Management System (INMS) in support of understanding the Global Nitrogen Cycle to further strengthen the objectives of GPA, UNEA, OECD, UNECE ad other bodies across the emerging Policy Arena on Nitrogen. .
4.4 2/3 guidance documents specific to selected private sector stakeholders advising on assessing and presenting nitrogen management and use efficiency issues.
4.5 Presentation of INMS development to UN Environment Assembly in Yr 2, 3 & 4.
4.6 With 1% of the project resources in support of IW:LEARN: Dedicated project website connected with IW:LEARN and other GEF knowledge management systems (within 6 months).
4.7 Documented cooperation and knowledge exchange with (i) IW:LEARN including at least one functioning CoP as well as (ii) with STAP.
4.8 Participation at the International Waters conferences; at least 3 experiences notes and tracked project progress reported using the GEF5 IW tracking tool.

3.3.3 Activities, Tasks and Seven Key Aims

103. In order to achieve the broad **Outcomes** and **Outputs** identified according to the GEF project methodology, these are translated into **Activities**, which constitute the main work-packages of the Components. Each Activity leads

to one of the Outputs listed above. Within each Activity, a number of **Tasks** are identified, each of which leads to a **Task Output**, as a contribution to achieving the overall Output of the Activity.

104. In the following sections of this document the work is described mainly in terms of the Components, Activities and Outputs. The Component appendices provide further detail in the Tasks and Task Outputs (Appendices 15 to 18).

Seven Key Aims

105. Within this comprehensive structure, it is also helpful to summarize briefly **Seven Key Aims** of the project. The purpose of listing these is to show at a glance some of the most important anticipated results of the project:

1. To **develop tools and indicators, assessment methodologies and models** that can be applied at global and regional scales to assess progress in better management of the nitrogen cycle and to identify options to optimize strategies and help overcome the barriers-to-change (Component 1).
2. To apply the models to **examine flows and impacts of the global nitrogen cycle, with future scenarios** to demonstrate the multiple benefits of improved nitrogen management (Component 2).
3. To **review experience on interventions** related to the nitrogen cycle and to **identify technologies and management options** that show the best promise for net benefits across the nitrogen cycle, delivered in the form of a state-of-the-art international guidance document (Component 2).
4. To support the global analysis by **specific studies at the regional scale**, incorporating national and local experiences to **demonstrate the joined-up approach** across the nitrogen cycle showing how it can lead to multiple benefits and help overcome barriers-to-change (Component 3).
5. To combine the outcomes as a basis in the form of a **first consolidated global assessment of nitrogen** flows, pathways, impacts, mitigation and management opportunities, cost-benefit analysis and improved understanding of policy barriers and opportunities, to be published as a high level international state-of-the art (Component 2).
6. To utilize the critical mass of the Towards INMS community, combined with the tools, models, management, regional demonstrations and consolidated global synthesis to **promote a clearer public understanding and awareness** of the nitrogen cycle as a foundation for the development of more optimal policies and strategies (Component 4)
7. To work with countries and policy makers in the **refinement of the policy arena for nitrogen**, or other possible models, in order to deliver more-coherent scientific and technical support to nitrogen policy and practice development in the future (All components).

3.4 Project Components and Expected Results

3.4.1 Summary of Project Components

106. The project will build on previous GEF interventions related to understanding nutrients (e.g. Global Nutrient Foundations project) and will further strengthen the science-to-policy linkages that will aid the development of global, regional and national nitrogen management strategies. The project provides the natural next step beyond previous initiatives, which have mainly focused on component parts of the nitrogen problem. In this way the proposed project works towards the establishment of a comprehensive International Nitrogen Management System (INMS) to support future decision-making, taking account of the multiple benefits of improved nitrogen management.

107. The project will develop the system of evidence to show how actions to protect the marine environment from land-based sources of nitrogen pollution have simultaneous co-benefits for freshwater, air pollution, climate, biodiversity and soils, as well as for food and energy security. By building this gravity to protect the global commons, a much stronger transformational change in the global nitrogen cycle can be expected. At the same time, the understanding gained will provide improved insights in understanding the barriers-to-change.

108. These issues are addressed through a project structure consisting of four main components as summarized in Figure 5. This illustrates the necessary inputs as well as the high level of interaction between the four main

components, with support for project and financial management by the project coordination unit (PCU). The overall project visualization is given in more detail in Figure 6, which shows how each of the main Components is delivered through four to nine Activities. While the day-to-day management is provided by the PCU, the Project Management Board (PMB) steers the overall project. The process is supported with strategic guidance from the Stakeholder and Policy Advisory Group (SPAG), with collective group of funding organisations constituting the Project Partners Assembly (PPA). The focus of the following sections is on the Activities and Outputs of the Components. A summary of the project governance structure is given at Section 4, with full details in Appendix 10.

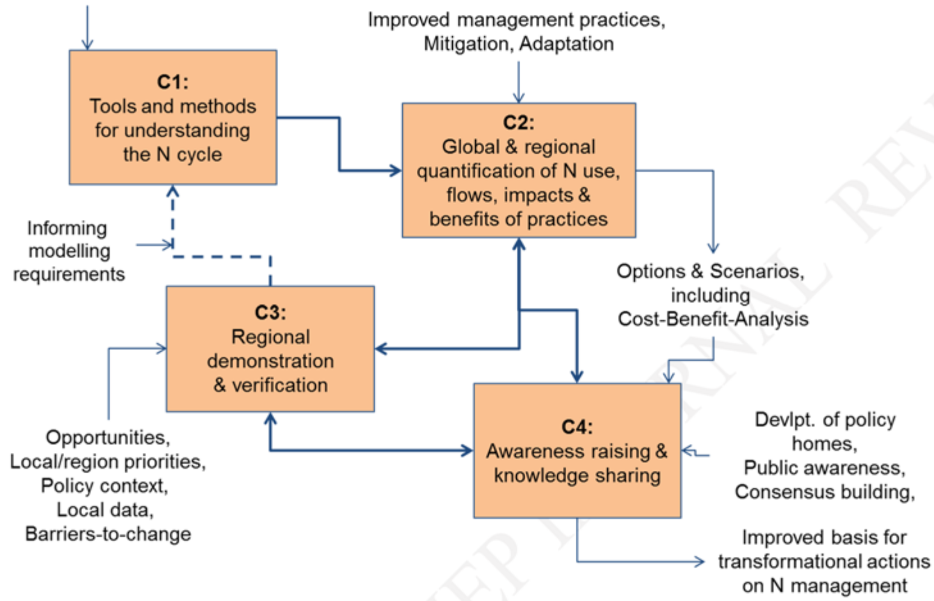

Figure 5. *Summary of the main components of the 'Towards INMS' project, inputs, interactions and outputs.*

3.4.2 Component 1

109. The purpose of Component 1 is to develop the necessary tools and approaches that form the basis for improving understanding and quantification of the global nitrogen cycle, and hence a foundation for developing the necessary interventions at global and regional scales. Component 1 focuses on establishing necessary methods, models and indicators, considering especially the datasets that are required. Its perspective crosses from biophysical dimensions, linking water systems (aquatic and marine) to terrestrial systems (including agricultural and other activities) to atmospheric systems, including emissions, transport, levels of nitrogen compounds and deposition. This biophysical perspective is complemented by the development of economic and social perspectives that are critical in understanding the drivers, opportunities and limitations to achieving better nitrogen management at global and regional scales.

110. The main elements are as follows:

1) Action to develop better indicators of nitrogen systems, including national and farm scale nitrogen budgeting approaches, a suite of nitrogen use efficiency (NUE) approaches, and the relationship between such budget, balance and efficiency indicators to effect based indicators of societal benefits and adverse environmental effects (Delivered through **Activity 1.1**).

2) Development of a threat assessment methodology, including identification of the key threats, stakeholder review and refinement, development of assessment methodology for the different threats and drafting guidance (Delivered through **Activity 1.2**).

3) Development of the methodology for combined assessment of nitrogen fluxes and distribution, considering the linkages between air, land and water, and dispersion through trade, including review of methods for different N components and different environmental compartments, leading to the preparation of guidance methodology (Delivered through **Activity 1.3**).

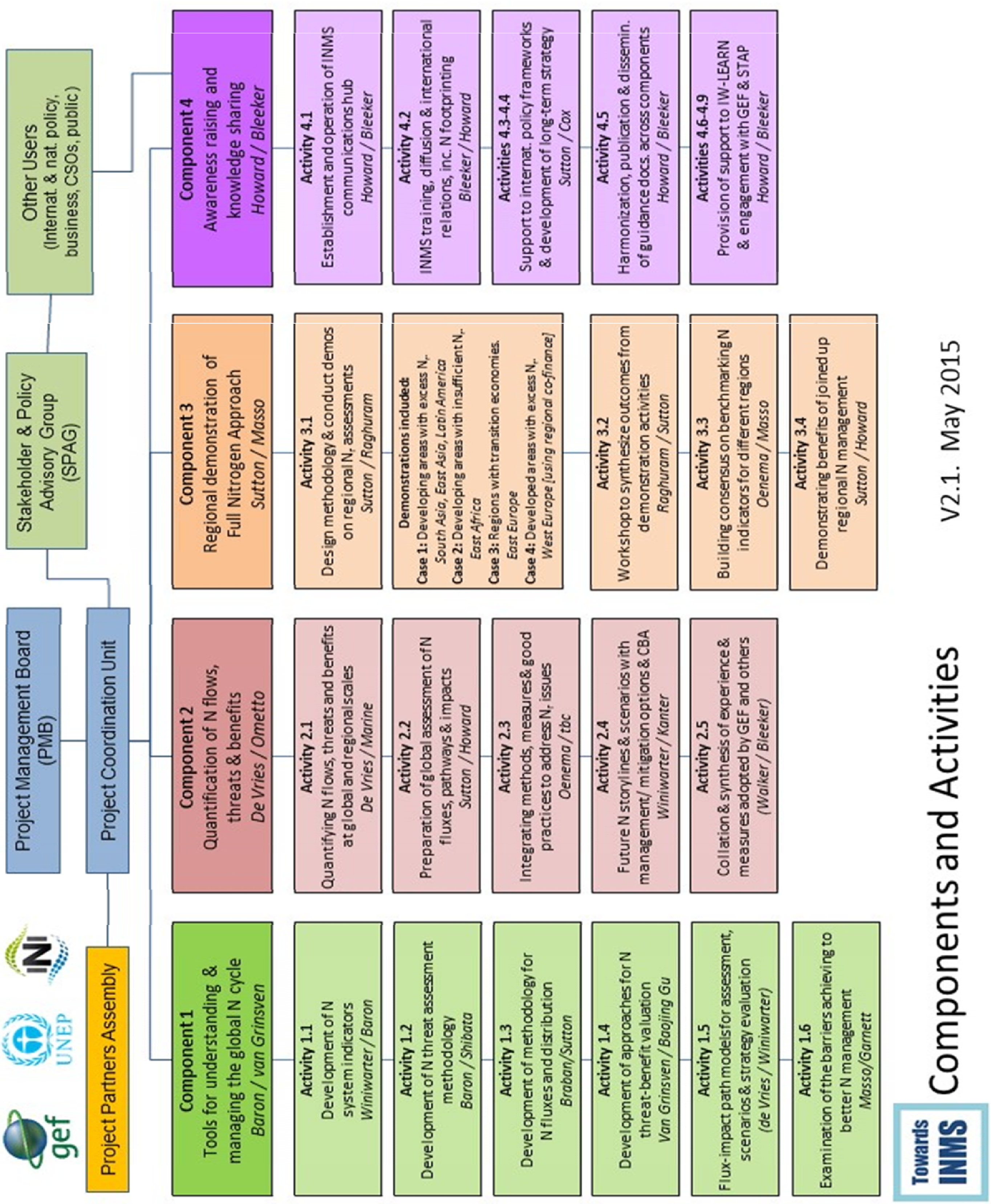

Figure 6: *Summary of the Components and Activities of 'Towards INMS'. The Activities represent groups of people working together and are directly linked to each of the project Outputs.*

4) Refinement of approaches for threat benefit valuation, including review of existing studies, refinement of methodology across contrasting economies, integration of the benefits and threats for food, health, ecosystem, climate and energy, and the valuation under future nitrogen scenarios (delivered through **Activity 1.4**).

5) Development of flux-impact path models for assessment, scenarios and strategy evaluation, including translating storylines into model requirements, review and comparison of component models, designing model framework, application of selected models in a model cluster, and demonstration of the model cluster at global and regional scales (delivered through **Activity 1.5**).

6) Examination of the barriers to achieving better nitrogen management, linking the economic, social, cultural and other factors that affect adoption of measures, examination of the barriers in food systems and in relation to sustainable consumption, and exploration of the role of a full nitrogen approach and other options to overcome the barriers (delivered through **Activity 1.6**).

111. The following table summarizes the Activities in relation to the Outputs, along-side information on Specific products (summarizing task outputs):

Table 2: *Summary of Activities, Outputs and Specific Products for Component 1.*

Activity	**Output**	**Specific Products (summary of Task Outputs)**
Activity 1.1 : Nitrogen System indicators	Output 1.1: Indicators developed for assessing full N budgets, use, levels and impacts, including N use efficiency and benchmarking. Indicators to be developed of relevance for specific stakeholders.	Guidance Documents on Nitrogen Budgeting and Nitrogen Use Efficiency approaches, and on relating level and effect indicators to budget indicators.
Activity 1.2 : Development of Threat Assessment Methodology	Output 1.2: Methodology for Nitrogen Threat Assessment.	Consultation document on key N threats. Workshop report on threat assessment methodology. Guidance Document
Activity 1.3 : Development of methodology for N fluxes and distribution	Output 1.3: Methods for determining N fluxes and distribution (water, air, land, agriculture, industry etc)	Scoping report and background document on N flux and distribution methods. Workshop report and Guidance Document
Activity 1.4 : Development of approaches for threat-benefit valuation	Output 1.4: Approaches to estimate the value of N threats and benefits	Status report identifying gaps and challenges, identification of principles for global and regional comparison. Methodology. Document on valuing threats and benefits for future scenarios
Activity 1.5: Flux-impact path models for assessment, scenarios & strategy evaluation	Output 1.5: Approach to using existing N flux/pathway models for global/regional assessments and visualisation for potential scenarios	Proposal of approach to implement scenarios and storylines for stakeholder feedback. Document and database on models and data needs. Document on criteria for N modelling cluster, modelling outputs linking N flows and effects. Report on N modelling for scenario needs
Activity 1.6 : Examination of the barriers achieving to better nitrogen management	Output 1.6: Understanding the barriers to change at all levels of society (government, private sector and civil society) including technical, financial and socio-political limitations.	Report on economic and cultural factors. Report on barriers in food systems. Report on barriers to consumption-production & behavioural change. Report summarizing options for overcoming barriers at global and regional levels.

3.4.3 Component 2

112. The purpose of Component 2 is to apply tools, methods and data to synthesize knowledge on nitrogen flows, threats and benefits in the context of the global nitrogen cycle. It will apply key inputs in the form of tools and methods developed in Component 1, together with outcomes from the regional demonstration activities of Component 3, to analyze the current status of N flows, threats and benefits. While the first target is the global scale, it will necessarily use the regional activities to illustrate regional variation in context as well as the possible solutions. Options for improved nitrogen management in different contexts will consider the multiple benefits, linking water, air, greenhouse balance, ecosystems and soils, as well as the interactions with food and energy. These elements will inform the development of storylines and scenarios of different "nitrogen futures" and how these relate to cost-benefit analysis. The work will provide key high-level outputs that will support awareness raising and knowledge sharing of Component 4. The targeted research of Component 2 therefore will help develop global policy framing for nitrogen, providing an improved basis for transformational actions on nitrogen management, globally and regionally.

113. The main elements are as follows:

1) Application of a suite of modelling tools to quantify nitrogen flows, threats and benefits at global and regional scales, including developing a shared database of inputs and model outcomes, provision of international support for regional inventory and model development, and integrated analysis to quantify present and future threats and benefits (delivered through **Activity 2.1**).

2) Preparation of a first global assessment of N fluxes, pathways and impacts, assimilating lessons from the regional demonstrations, including: scoping the structure of the consolidated global assessment, commissioning author teams, drafting and peer review, preparation of summary documents and review, publishing and distribution of the consolidated assessment. The work will draw on the outcomes of Components 1 and 3, while providing material to support the actions of Component 4 (delivered through **Activity 2.2**).

3) Integrating methods, measures and good practices to address issues of excess and insufficient reactive nitrogen, including preparation of a document on the state-of-the-art for good nitrogen management, considering different N forms and N effects. It will include workshops to develop methods that link good practices for N effects (linked to food, energy, water, air, climate, biodiversity etc) and lead to preparation of international guidance on approaches for improved management of the nitrogen cycle (delivered through **Activity 2.3**).

4) Exploration of future N storylines and scenarios with management /mitigation options and cost-benefit analysis, including review of existing N policies for different countries and regions and review of existing storylines and scenarios. It will lead to a published strategy on scenarios and storylines, together with a report on N policy options and their possible contribution to development of the Green Economy / Circular Economy (delivered through **Activity 2.4**).

5) Collation and synthesis of the experience of measures for improved nitrogen management as adopted by GEF and others, including UNEP, OECD, FAO etc in sharing and disseminating success stories including lessons learned through case studies at national and local levels. These case studies will complement and further enhance the Regional Demonstrations of Component 3 (delivered through **Activity 2.5**).

114. The following table summarizes the Activities in relation to the Outputs, along-side information on Specific products (summarizing task outputs):

Table 3: *Summary of Activities, Outputs and Specific Products for Component 2.*

Activity	Output	Specific Products (summary of Task Outputs)
Activity 2.1: Quantifying N flows, threats and benefits at global and regional scales	Output 2.1: Quantification and assessment of the global and regional threats from excess and insufficient reactive nitrogen	Database and access to sources. Inventory expertise and models provided to support C3 demonstrations. Report on global and regional N flows, threats and benefits. Report comparing present situation with future scenarios.
Activity 2.2: Preparation of global assessment of N fluxes, pathways and impacts assimilating lessons from the regional demonstrations	Output 2.2: Detailed overview of regional/local N flux and consolidation into a global assessment of N fluxes, pathways, effects and benefits of improved N management	Scope and structure of global assessment agreed. Author teams appointed and produce draft chapters. Peer reviews provided to authors and documents revised. Documents reviewed by PPA, SPAG and other stakeholders. Report published with wide public dissemination.
Activity 2.3: Integrating methods, measures & good practices to address issues of excess & insufficient reactive nitrogen	Output 2.3: Consolidation of methods and good practices to address issues of excess and insufficient reactive nitrogen	Background documents produced for workshop on best N management practices. Basis for developing guidance linking N forms & issues, high-lighting most promising options. Workshop Report with document for review. Document finalized and published. Practice database updated.
Activity 2.4: Exploration of future N storylines & scenarios with management/ mitigation options & cost-benefit analysis	Output 2.4: Definition of programmes & policy options for improved reactive nitrogen management at local/regional/global levels, supported by cost-benefit analysis to underpin options for the Green Economy	Report with database as input to workshop on N policies, storylines & scenarios. Published strategy on storylines and scenarios. Report on Policy options and contribution to Green Economy.
Activity 2.5: Collation & synthesis of knowledge, experience & measures adopted by GEF and others on excess & insufficient reactive nitrogen	Output 2.5: Compendium summarizing the state of knowledge, experience and measures adopted by GEF (and others) gained from addressing the issues of excess and insufficient reactive nitrogen	Database and summary of GEF N related actions and those adopted by others. Synthesis and database on N measures as contribution to global assessment.

3.4.4 Component 3

115. This purpose of Component 3 is to establish targeted research demonstrations on the nitrogen cycle at a regional scale for each of the main world regions. The approach is to demonstrate how a joined up approach to nitrogen management can catalyse stronger action for a cleaner environment (water, air, greenhouse gas, ecosystems, soils) and improved food and energy production simultaneously. In essence the hypothesis is that a joined up approach across the nitrogen cycle can deliver multiple co-benefits that will strengthen the case for transformational change. The choice of regional scale reflects the need to link between local and global scales, to share regionally specific lessons and to work in partnership with regional intergovernmental and other international processes.

116. The main elements are as follows:

1) Design common methodology to conduct regional demonstrations of nitrogen flows, priorities, mitigation options, co-benefits, success stories, barriers-to-change and ways of overcoming barriers to change (delivered through **Activity 3.1**).

2) Conduct the regional demonstrations to refine regional nitrogen assessments and improve understanding of regional N cycle (delivered through **Activity 3.1**). (This is the main activity – replicated for several different demonstration conditions across the world.)

3) Use a workshop to synthesize outcomes from demonstration activities focusing on reducing adverse N impacts & maximizing co-benefits (delivered through **Activity 3.2**).

4) Build consensus on benchmarking N indicators for different regions and systems, linking between the regions and global scale analysis (delivered through **Activity 3.3**).

5) Refine the regional approach to demonstrate the benefits of joined up N management, leading to concrete plans of how a perspective from the N cycle can be embedded in the future activities of GPA and other national programs and international conventions (delivered through **Activity 3.4**).

117. The following table summarizes the Activities in relation to the Outputs, along-side information on Specific products (summarizing task outputs):

Table 4: *Summary of Activities, Outputs and Specific Products for Component 3.*

Activity	Output	Specific Products (summary of Task Outputs)
Activity 3.1: Design common methodology & conduct regional demos to refine regional N_r assessments and improve understanding of regional N cycle	Output 3.1: Four demonstration cases deliver conclusions refining approaches to regional assessments and improving understanding of regional N cycle. (Four cases as described in the main text below)	Main N flows quantified by source sector & pathway; better data access & understanding with estimated uncertainties. Key N benefits/threats quantified & regional priorities identified. Basis to compare regions in relation to agreed indicators. Document on N mitigation/ management options identifying win-wins & regional priorities. Synthesis of current local/regional efforts including success stories, full N approach, and approaches to overcome barriers. Global N scenarios informed by regional evidence.
Activity 3.2: Workshop to synthesize outcomes from demonstration activities focusing on reducing adverse N impacts & maximizing co-benefits	Output 3.2: Assessment and quantification of impacts from piloting activities to reducing negative impacts from poor N_r management, while demonstrating the co-benefits for other issues	Advance background documents according to common template. Basis for synthesis publication agreed. Publication on synthesis from the regional demonstrations.
Activity 3.3: Building consensus on benchmarking N indicators for different regions and systems	Output 3.3: Refined benchmarking of indicators for different regions and nutrient flow systems	Scoping paper on benchmarking N indicators from regional perspectives. Joint report (under A2.3) informed with regional perspectives on benchmarking.
Activity 3.4: Refinement of regional approach to demonstrate benefits of joined up nitrogen management	Output 3.4: Plans for inclusion of agreed approach to N cycle assessments accepted by GPA and others	Briefing document for testing with stakeholders. Revised document on common approach, while recognizing regional priorities. Recognition of N cycle approach with GPA and other international frameworks.

118. The regional demonstrations make the link to the global scale while incorporating examples and lessons by integrating with existing and planned activities at the local level. Four cases are considered in order to be representative of the wide range of situations globally:

Case 1: Developing regions with excess reactive nitrogen (South Asia, East Asia, Latin America)

Case 2: Developing Regions with insufficient reactive nitrogen (East Africa),

Case 3: Transition economies with excess reactive nitrogen (East Europe).

Case 4: Developed regions with excess reactive nitrogen (West Europe). It is expected that additional input from a North American Demonstration may also be developed during the course of Towards INMS.

119. Cases 1 to 3 will be addressed with financing support from GEF, while Case 4 will be addressed based on financing from other sources to the extent that this becomes available. Review during the PPG phase has shown that the distinction between these cases is not necessarily a simple one. For example Latin America includes areas with both excess and insufficient N_r, while even East Africa includes areas with local excess N_r leading to environmental problems. Nevertheless, by covering all four cases it is ensure that the full diversity of regional issues is considered while building the critical mass necessary to establish a robust global approach.

120. The criteria for selecting the locations to implement Cases 1, 2 and 3 are described and evaluated in Appendix 17. This led to the proposal to further develop the East Asia, South Asia, Latin America, East Africa and East Europe demonstration studies, which was agreed by the full partnership at the First INMS Plenary Meeting (Lisbon, April 2015). It was concluded (see Appendix 17) that it was not possible currently to further develop proposed demonstration regions in the East Baltic and in Central Asia. Further capacity building would be needed (especially in Central Asia), for possible consideration of demonstrations in future INMS related activities. The involvement of selected experts from these regions in 'Towards INMS' meetings could serve to prepare the ground for such demonstrations in the future. The following locations were selected (Appendix 17):

Case 1: Regions with excess reactive nitrogen loss.

East Asia (China, Japan, including engagement with Philippines and South Korea);

South Asia (India, Bangladesh, Sri Lanka, Nepal, potentially including Pakistan and Myanmar if additional resources can be made available from other sources);

Latin America – La Plata catchment (Brazil, Paraguay, Uruguay, Argentina, Bolivia)

Case 2: Regions with insufficient reactive nitrogen.

East Africa - Lake Victoria catchment (Kenya, Uganda, Tanzania, Burundi, Rwanda);
(**Latin America** is also relevant for this case.)

Case 3: Regions with transition economies.

East Europe –Dniester/Prut/Lower Danube. (Ukraine, Moldova, Romania). This area also provides the opportunity to engage with and develop improved scientific and environmental cooperation with Russia and Belarus.

[Central Asia: While there is not yet sufficient foundation to conduct a Central Asia demonstration, it is proposed to develop the links under the outreach of Component 4 in order to prepare the way to allow a demonstration here in a future project.]

Case 4: Developed countries with excess reactive nitrogen loss.

West Europe – Atlantic Coast (Spain, Portugal, France, UK, Belgium). This may be included to the extent that external funding sources are available.

The inclusion of other areas, e.g. in **North America** must be dependent on other funding opportunities and will be reviewed during the project inception phase.

121. The outcomes of the Component will feed specifically to support progress in improved nitrogen management for environment, health and food, deliver documentation to support the global consolidated synthesis, and contribute to the goals of regional agreements as outlined in Section 2.

3.4.5 Component 4

122. The purpose of this component is to support all internal and external communication and knowledge exchange in the project. Key to the success of this targeted research activity is the uptake of emerging results by other partners, ongoing engagement and exchange of ideas with stakeholders to ensure that tools and products are fit for purpose and communication of all results in the most effective way. As such, Component 4 will be informed by the key high-level outputs from the other three components and the needs and practicalities of partners and external stakeholders. A solid foundation will be built for internal communication within the project, e.g. newsletters, annual meetings and a dedicated members area of the web portal. Information and datasets within the project will be organized and made accessible through the web portal and INMS database system. This foundation will be paired with activities to engage with the N stakeholder community on a variety of levels, using a variety of approaches, including initiating a network of 'Nitrogen Champions'. Training will be provided to regional and national experts. The links between INMS, GPA and other relevant intergovernmental process will be made along with considering the long-term needs and implications of an INMS. Integrated guidance emerging from the project will be harmonized and communicated. Channels for knowledge exchange with the general public will also be explored and exploited, including further investigating N footprinting and developing audience relevant communication products for dissemination through the website.

123. The main elements are as follows:

1) Establishment of the INMS communications hub and its ongoing operation, including a web portal, the INMS database, internal project communication and press and public engagement functions (delivered through **Activity 4.1**).

2) Training in nitrogen measurement, modelling and mitigation techniques provided to regional and national experts, development of international engagement on linking intergovernmental processes, and sharing of experience on the use of N footprinting to increase public awareness (delivered through **Activity 4.2**).

3) Development of synthesis to demonstrate INMS in support of GPA objectives, co-ordination of the inputs from INMS into other policy processes, and development of a long-term strategy for INMS, including potential policy homes and financing options (delivered through **Activities 4.3 and 4.4**).

4) Harmonization and publication of guidance documents on 'N budgets efficiency and benchmarking', 'threats fluxes and distribution methods', 'N measures and good practices' including information on barriers and successes (delivered through **Activity 4.5**).

5) Provision of support to IW-LEARN and engagement with GEF and STAP, including: giving financial support to IW:LEARN, connecting INMS website with IW-LEARN, cooperating with IW-LEARN and STAP in development of Community of Practice (CoP), participate in International Waters conferences and prepare INMS Experience Notes (delivered through Activities 4.6 to 4.9).

124. The table on the next page summarizes the Activities in relation to the Outputs, along-side information on Specific products (summarizing task outputs):

Table 5: *Summary of Activities, Outputs and Specific Products for Component 4.*

Activity	Output	Specific Products (summary of Task Outputs)
Activity 4.1: Establishment and operation of INMS communications hub	Output 4.1: Local, national and regional expertise to address N_r issues increased and contributes to improved GPA and other decision making at the regional / global levels	INMS web portal operational and active. Information on N flows, outcomes, indicators shared. Information exchange across the project, including newsletter & other products. Key messages for press, plus public engagement tools.
Activity 4.2: INMS training, diffusion and international relations, including nitrogen footprinting	Output 4.2: Training for regional/national experts to sustain and enhance understanding of global N cycle implementation of national indicators, diffusion of new technologies, with links between GPA and other inter-governmental processes	Training provided to regional & national experts including diffusion of new technologies. Increased engagement by countries on links between GPA & other intergovernmental processes. Workshop interventions, information on INMS portal and popular publications.
Activities: 4.3-4.4 Demonstration of INMS to provide support to international policy frameworks, & development of long-term strategy	Output 4.3: Overall demonstration of the International Nutrient Management System (INMS) in support of understanding the Global Nitrogen Cycle to further strengthen the GPA objectives and international nitrogen policies. Output 4.4: Presentation of INMS development to UN Environment Assembly in Yrs 1 & 3	Science support to GPA & regional processes showing the benefits of N cycle approach. Contributions of INMS to global/international policy processes including UNEA. Proposal developed for how INMS can contribute to the policy arena for nitrogen.
Activity 4.5: Harmonization, publication & dissemination of guidance documents across components.	Output 4.5: Guidance documents specific to selected stakeholders advising on assessing and presenting nitrogen management and use efficiency issues	Guidance documents published on: a) N budgets, NUE & benchmarking, b) N threats, fluxes & distribution, c) N measures & good practices including barriers/successes.
Activities 4.6-4.9: Provision of support to IW-LEARN & engagement with GEF & STAP.	Output 4.6: With 1% of the project resources in support of IW:LEARN Output 4.7: Dedicated project website connected with IW:LEARN and other GEF knowledge management systems (within 6 months). Output 4.8: Documented cooperation and knowledge exchange with (i) IW:LEARN including at least one functioning CoP as well as (ii) with STAP. Output 4.9: Participation at the International Waters conferences; at least 3 experiences notes and tracked project progress reported using the GEF5 IW tracking tool.	Required contribution to support IW:LEARN provided. INMS website connected with IW:LEARN. Documented knowledge exchange with IW:LEARN & STAP, including Community Of Practice. Experience notes produced. Project tracked using tracking tool.

3.5 Intervention logic and key assumptions

125. The ‘Towards INMS’ project is developed under the logic that a global approach to managing the nitrogen cycle will mobilize a stronger ‘gravity of common cause’ that can help overcome barriers-to-change. This can be aided especially by linking the threats of nitrogen pollution in freshwater and coastal environments with other environmental challenges, including air quality, greenhouse gas emissions, stratospheric ozone depletion and effects on biodiversity, as well as with the benefits of improved nitrogen use. As explained in the baseline analysis, too little attention to the science of the nitrogen cycle has been compounded by a fragmented approach to policy development and implementation.

126. With this rationale, the logic of the Towards INMS intervention can be summarized as follows, including key assumptions in bold font:

a. That **targeted research on the nitrogen cycle is needed** to provide the foundation to understand the interlinkages between reducing the problems of nitrogen in waters and coastal zones, and how future management approaches could deliver simultaneous quantified co-benefits (C1).

b. That **consensus development is needed on the most appropriate tools and metrics** to describe the nitrogen cycle, especially in relation to assessing global, regional and local performance linked to the different nitrogen threats and benefits (C1).

c. That **efforts need to be placed toward both improving the basis for cost-benefit analysis** for nitrogen **and the quantitative modelling tools** as a basis to support identification and prioritization of threats and benefits and how these vary regionally, as well as to demonstrate where co-benefits may occur by virtue of linkages through the nitrogen cycle (C1, C3).

d. That an **improved understanding is necessary to the barriers-to-change**, that considers both the generic challenges and can informed by regional demonstration engagement (C1, C3).

e. That the **application of tools to show the main flows and impacts of the nitrogen cycle at global and regional scales is necessary** for delivering a global assessment of the current state of impacts and the opportunities for mitigation (C2, C4).

f. That **there are many available management and mitigation methods**, practices and technologies to improve management of the nitrogen cycle, and that specific **attention to the interactions across the nitrogen cycle will help provide clear guidance** on the most effective methods that offer multiple-benefits (C2, C3, C4).

g. That the **establishment of future scenarios provides key information to support policy makers** in developing shared views of the possible actions that may be taken, and that this is essential information for an international nitrogen management system (C2, C3, C4).

h. That **there is information available from previous GEF interventions and others** (e.g. national case studies) that can be combined with information from specific regional demonstrations to support the global assessment and sharing of best practices (C2, C3).

i. That **a major global assessment** that brings together the leading scientific understanding with robust information on the nature and extent of threats and the benefits of taking action **can provide a high visibility product to attract the attention of the world’s press and governments** as they consider how to respond (C2, C3, C4).

j. That the **global assessment needs to recognize the balance between the identification of possible shared goals at the global level and the importance of identifying local and regional priorities**, as informed by evidence at the regional and local scales (C3, C4).

k. That sufficient **resources need to be reserved to allow effective communication** across a diverse network of partners, to ensure high quality delivery of products and to enagege externally with diverse stakeholders, including governments, press, international frameworks etc. (C4).

l. That the current policy response to nitrogen is highly fragmented and sub-optimal, so that **a more coherent joined up view will help strengthen the delivery of several policy processes** connected to nitrogen (C4).

m. That the science engagement of **Towards INMS will stimulate policy makers to think about the most optimal way of addressing the nitrogen cycle**, and that the developing narrative of the 'nitrogen policy arena' provides a useful starting point to stimulate thinking by policymakers as well as the development of a long term policy home INMS (C4).

3.6 Risk analysis and risk management measures

127. The following main risks are identified for the 'Towards INMS' project, for each of which a risk mitigation strategy is identified:

Table 6: *Risks and mitigation strategies. L=Low risk; M=Medium risk; H=High risk.*

Risk	Rating	Mitigation Strategy
Failure to agree on common global approaches for indicators and models (C1)	L	Development and utilization of inclusive networks of scientists and policy makers to ensure that demand for relevant information is met by the supply of appropriate indicators
Limited country buy-in (C1-C4)	L	Working with the GPA and other international frameworks (e.g. CLRTAP, UNECE Water Convention, HELCOM, OECD etc.) plus Industry (e.g. International Fertilizer Manufacturers Association, Companies, Farmer Organizations) and NGOs (e.g. WWF etc.) to facilitate the global dialogue on nitrogen. Ensure regular contributions on nitrogen appear in the Popular Press, TV and Radio.
Limited GPA buy-in (C1-C4)	L	Working with the GPA to facilitate the global dialogue on nitrogen. Active demonstration at the GLOC and GPA Bureau meetings of how the INMS can support GPA objectives.
Limited willingness by countries / stakeholders to develop strategies for problems of too much or too little N_r (C2-C4)	M	Close co-operation with countries and fertilizer industry will assist with mitigating impacts of insufficient or too much reactive nitrogen.
Impact from climate change and variability on conclusions	M	Specific attention to include effects of regional climate variation and global climate change will be examined by models.
Inadequate communication between science assessment and policy development processes	M	Improved awareness and dialogue between researchers and policy makers through the development of INMS, which is specifically targeted to build the process of science-policy support.
Slow development of the global policy 'home' for N_r (Track 1) to take up the results of the project (Tracks 2 and 3).	H	The project will work with existing mechanisms, in the first instance with GPA, which has already indicated its priority concern for nutrients, complemented by engagement with the UN Environment Assembly, CBD, LRTAP, regional water conventions, OECD, business groups, civil society etc. This will develop the network of key 'nitrogen champions' to ensure that the outcomes of the project are used.
Interactions with other stressors	M	The development of N cycle tools will include assessing linkages with other global stressors interacting with N_r.

3.7 Consistency with national priorities or plans

128. The development of the International Nitrogen Management System through this project will assist with improving the knowledge-base available and in an easily accessible manner to support coordinated action at various levels.

129. It is fully consistent with the goals of the GPA, which especially address nutrient-related issues at global, regional and national levels, as well as with other intergovernmental processes. This is consistent with the Manila Declaration of the GPA IGR-3 (January 2012) through which 64 governments and the European Commission agreed "to step up efforts to develop guidance, strategies or policies ….. so as to improve nutrient use efficiency …, and to mitigate negative environmental impacts through the development and implementation of national goals and plans…".

130. The INMS Project will assist the strengthening of national and local capacities to implement appropriate nitrogen management approaches. At the same time it will support national governments and regional authorities to assess and report reactive nitrogen loads and impacts to the GPA, while delivering a more coordinated approach in cooperation with other bodies, including especially the CBD, LRTAP, OECD, as well as developing links with the Vienna Convention (Montreal Protocol), UNFCCC, IPCC, IPBES and others. The approach has cross-cutting relevance to the Sustainable Development Goal (SDG) process and will also contribute to activities on that demonstrate The Economics of Ecosystems and Biodiversity (TEEB).

131. The outputs of this project will also assist regional water conventions (e.g. Danube/Black Sea Conventions, Cartagena Convention and protocol on Land-Based Sources of Marine Pollution, US-Canada International Boundary Waters Treaty and International Joint Commission, US-Canada Air Quality Agreement, MAP, HELCOM, UNECE Transboundary Water Convention etc.) to develop regionally specific management plans for reactive nitrogen. Similarly, the approaches to be developed and harmonised on an international basis (e.g. nitrogen budgets, nitrogen use efficiency indicators including components and NUE of the full chain, including refinement of system benchmarks) is fully consistent with the agreement of the UNECE Gothenburg Protocol under the LRTAP Convention for countries to establish and monitor national nitrogen budgets.

132. As the project progresses over the proposed 4 years, there will be substantial potential to refine the links with other policy domains, showing how nitrogen management practices can support other needs. These include demonstrating the links between improved NUE, reduced marine pollution and reduced nitrous oxide (N_2O) emission (relevant for the UN Framework Convention on Climate Change and the Montreal Protocol) and the links between improved NUE, reduced marine pollution and reduced ammonia (NH_3) emissions, relevant for the LRTAP Convention. Similarly, improved nitrogen management will contribute significantly to meeting food goals identified by FAO.

133. Demonstrating how key actions to protect the marine environment will simultaneously benefit these other policy domains and will help build the momentum that is essential for a more-effective protection from pollution of the global marine environment.

134. This Targeted Research Project addresses IW objective 3 'to support foundational capacity building, portfolio learning, and targeted research needs for ecosystem-based, joint management of transboundary waters' that will lead to outcomes enabling countries to develop and implement science-based nitrogen management strategies. The Project is also consistent with, and supportive of, IW objective 1 'Catalyse multi-state co-operation…'

135. The INMS Project responds to STAP recommendations in 'Hypoxia and Nutrient Reduction in the Coastal Zone' for UNEP to take the lead in developing research activities to further understand and assist with developing policies to mitigate problems of coastal hypoxia.

136. By addressing the problems caused by excess reactive nitrogen on coastal waters and fish stocks in particular, and by supporting good management practices when other regions increase their use of fertilizers, the project will

help ensure food security and environmental sustainability, implementation of the Sustainable Development Goals. Furthermore, such actions will also contribute in achieving CBD Aichi Target 8 which calls for action to reduce pollution, including from excess nutrients, to levels that are not detrimental to ecosystem function and biodiversity. In regard of sustainable development goals, the Rio+20 outcome document "Future We Want" noted "with concern that the health of oceans and marine biodiversity are negatively affected by marine pollution, including marine debris ...... and **nitrogen-based compounds**...." (para 163).

137. This project will further assist other GEF focal areas, specifically Land Degradation (LD) and Biodiversity (BD), by demonstrating how improved nitrogen management practices can simultaneously provide quantified co-benefits for these other focal areas. This will be supported by cost-benefit analysis, thereby building additional support to implement the necessary nutrient management actions. In the same way, there is also the scope to extend the analysis of co-benefits for climate change and air quality benefits for human health (especially for links to mitigation of N_2O and NO_x emissions).

138. The Towards INMS PPG phase is already developing partnership with OECD as a forum to bring together country-case studies, and build consensus on the development of national nitrogen strategies and plans. A joint workshop between the UNECE Task Force on Reactive Nitrogen (TFRN), which forms a regional contribution to INMS, with OECD will take place in May 2016 to further refine this development, including a progress update on INMS development.

3.8 Incremental Cost Reasoning

139. Through targeted research to improve the understanding of the global nitrogen cycle, this project is expected to deliver improved socio-economic benefits to a range of stakeholders, including:

- For farmers through better management policies and practices contributing to food security ;
- For coastal communities, by supporting improved (long-term) fisheries, where currently impacted by hypoxic waters;
- For citizens across the world, by improving overall environmental quality through improved water quality, air quality and reduced greenhouse gas emissions, as a result of better N management;
- For communities economically dependent on biodiversity, by improved revenue from tourism as a result of management policies and practices to reduce nitrogen deposition and coastal hypoxia.

140. A key innovative part of the project will be to include cost/benefit estimates of multiple externalities related to nitrogen, which will, for the first time, demonstrate the multi-focal benefits of a joined up approach (including links between water quality, biodiversity, greenhouse gases, air quality etc.).

141. The GEF and other donors have supported considerable research and supported measures to mitigate the impacts of nutrients over the last 20 – 30 years. This project represents the first collaborative activity to deliver an International Nitrogen Management System (INMS) that will combine multiple sets of information from different sectors and integrate reactive nitrogen across the environmental compartments. By making these connections between the protection of International Waters and other benefits and threats, the project will establish a major leap forward, providing the basis for transformational change in global and regional management of the nitrogen cycle.

Business as Usual

142. Currently the intentional and unintentional release of nitrogen to the environment has dramatically altered the global nitrogen cycle. In addition to emissions to the atmosphere and inputs to soils, surface and groundwater, there has been a large increase in nitrogen flows in rivers and submarine groundwater discharge to coastal waters

through much of the world.[48] Approximately 20% of nitrogen release comes from fossil fuel use, with the remainder from agriculture. But the efficiency of nitrogen use in food production is low: on average more than 80% of the nitrogen applied to fields is lost to the environment.[49] This inefficiency is compounded by an increasing demand for meat and dairy products commensurate with growing economic security in many countries. Crops are increasingly fed to livestock, especially monogastrics, to satisfy this increasing demand. About 30% of the global arable land is currently used to produce animal feed, with a comparable amount of nitrogen fertilizer application. The crop-livestock production system is the single largest cause of human alteration of the global nitrogen cycle.[50]

143. A Business as Usual (BAU) scenario assumes a world in 2050 with increasing human population, increased economic growth, increasing per-capita consumption of meat and dairy. This scenario causes increased releases of nitrogen to the environment and increased adverse impacts.[51] There are important regional differences, however. Industrialized countries are expected to become more efficient in their use and recovery of nitrogen while developing countries will increase agricultural productivity, but at the cost of reduced nutrient use efficiency and increased losses to the environment.

144. Under the BAU scenario damage to surface, ground and coastal waters will worsen, leading to increased occurrences of harmful algal blooms, hypoxia or dead zones, loss of fisheries and increased human health impacts. 'Towards INMS' will quantify the cost-benefit effects of alternative food and energy scenarios on regional and global nitrogen cycles with the intention of informing future nitrogen policy development. Both concepts and empirical data for current cost-benefit assessments can and will be improved through 'Towards INMS'.

The Cost Increment of INMS for GEF

145. The integrated nitrogen assessment approach in 'Towards INMS', combined with nitrogen cost-benefit assessment, provides consistent information about current impacts of food and energy production and consumption on the aquatic and wider environment. By also expressing impacts in the universal language of loss or gain of ecosystem services and loss or gain of welfare (in economic or human health units), information will help to improve the debate and cooperation between states or between economic sectors for collective management of large water systems while providing benefits for environment, food production, economic development, community health, and regional stability (source GEF-5 IW strategy, 2011). It may stimulate identification of transboundary solutions, interventions and investments, particularly for related to improved nitrogen management in agriculture and treatment and recycling of nitrogen in wastewater.

146. Comparison of cost and benefits of current nitrogen use and emissions, for BAU projections and for various abatement scenario's (like the recently developed Shared Socio-economic Pathways, SSPs), will further support identification of transboundary and trans-sector solutions for improved water quality while maintaining food security, a viable agricultural sector with improved nitrogen resource efficiency. 'Towards INMS' thus will help GEF to remove current barriers between the agricultural sector and the public water sector to find comprehensive and socio-economically inclusive solutions that prevent a further degradation of water and agricultural systems around the globe and instead direct human activities and institutions toward sustaining multiple uses of the soil and water resource. This will be one of the building blocks for the GEF goal to implement a range of policy, legal, and institutional reforms and investments contributing to sustainable use and maintenance of ecosystem services.

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[48] Beusen, A.H.W. et al. (2013) Global land–ocean linkage: direct inputs of nitrogen to coastal waters via submarine groundwater discharge. *Environmental research letters* **8**(3), p.034035.

[49] Our Nutrient World (2013).

[50] Bouwman, L. et al. (2013) Exploring global changes in nitrogen and phosphorus cycles in agriculture induced by livestock production over the 1900–2050 period. *Proceedings of the National Academy of Sciences* **110**(52), pp.20882-20887

[51] Bouwman, L. et al. (2013).

147. The increment of the GEF contribution will lead to the planned integrated INMS, and through the planned use of expert networks and research will benefit the global / regional understanding of reactive nitrogen. At the same time it will assist with strengthening research and management capacity in key developing regions facing major nitrogen challenges.

148. Further details on the incremental cost analysis can be found in Appendix 3.

3.9 Sustainability

149. 'Towards INMS' is putting in place for the first time the basis to establish an international support system for global nitrogen policy and practice improvement – the International Nitrogen Management System (INMS). The sustainability of this concept will depend fundamentally on the success of the 'Towards INMS' process and the extent to which stakeholders (governments, international frameworks, science community, business, practitioners, CSOs) find that the process meets its objectives in delivering appropriate scientific support for future decision making.

150. To ensure this sustainability, INMS will need to:

a. **Continually innovate** to develop a strong vision, supported by an effective public communications strategy

b. **Listen** to the needs of governments and other stakeholders

c. **Emphasize delivery of the key high-level outputs** that are needed to deliver the main elements of support for the INMS process

d. **Deliver the work to a high international standard**, demonstrating INMS as the leading source of authority for science support management of the global nitrogen cycle.

e. **Be nimble in decision making** in order to grasp opportunities and to respond to rapidly changing needs within the policy environment.

f. **Continue to bring the nitrogen challenge to a higher level** of decision making a combination of well-focused contributions to international policy processes and by effective communication with journalists through press, Radio, TV and other media.

g. **Demonstrate clear solutions and the benefits of those solutions**, providing convincing evidence of how a joined up approach to the nitrogen cycle can deliver multiple quantified benefits and help overcome the barriers-to-change.

151. The innovation of 'Towards INMS' is primarily through developing connections between the marine environment and the coupling with other food and energy security and environmental benefits of improved nitrogen management. By linking experts from different disciplines and regions, and taking experience from best practices in support of international frameworks, the International Nitrogen Management System (INMS) will provide a key resource for policy makers and management practitioners. The project will enable new multi-focus future scenarios to be evaluated providing management guidance, technical and management capacities which will be strengthened in developing regions to address the issues of reactive nitrogen.

152. Significant business opportunities in the private sector can be anticipated through improved nitrogen management. Currently around 120 million tonnes of N_r fertilizer are manufactured, worth around US$ 120 billion annually. This can be combined with another $60 billion worth of N_r acquired through biological nitrogen fixation and $40 billion worth of N_r produced in combustion processes. The substantial value of the nitrogen resource points clearly to the business benefits of improving efficiency while reducing wasteful N_r polluting losses. The proposal therefore includes specific attention to the development of innovative approaches, including the active involvement of the OECD and business groups.

153. The combination of global analysis, regional case studies and examination of both technological and consumption based options will provide a key resource to build critical mass on addressing the global nitrogen challenge. The work will provide key inputs to global organisations, conventions and initiatives, such as the GPA, CBD, LRTAP, FAO, WMO etc., allowing the synergies between their different interests to be developed. The benefits of having strengthened capacity in developing regions will be an important legacy to future global and regional nitrogen management strategies, enabling assessments and management responses to both excess and insufficient reactive nitrogen.

154. Finally, the GEF contribution will be an important catalyst for further understanding and managing all nutrients, in cooperation with the GPNM. Through the effective establishment of the INMS, lessons will be learnt that can be applied to other nutrients (notably phosphorus), potentially leading in due course to an overall nutrient management system. Reports from the project combined with the working INMS system and feedback from the policy and practice communities will provide a solid foundation to inform the development of future GEF activities, especially in the transition to GEF 6 and the emerging emphasis on a multi-focal or trans-focal area approach. In this sense the present INMS proposal can be seen as preparing the way for the aspirations of GEF 6.

3.10 Replication

155. Replication is relevant in several aspects of ‘Towards INMS’ as the project crosses between multiple scales:

156. **Experimental Replication**: Although experimental studies are not the prime focus of the GEF grant for ‘Towards INMS’ a substantial resource is made available by partner co-financing that includes experimental studies. Such experimental studies provide valuable information to support the evidence synthesis of the project, ranging from studies on the adverse impacts of N_r in the environment to those which address how improved management practices can deliver multiple quantified co-benefits for food, energy and environment. Attention to replication issues will be given to support the development of research standards, especially in the Threat Assessment Methodology the Methodology of N fluxes (Component 1) and in evaluation of practices that optimize nitrogen management (Components 2 and 3).

157. **Regional Replication**: Component 3 is deliberately designed to refine and implement a replicated approach to regional demonstration of improved nitrogen management across the nitrogen cycle. While allowing for specific regional aspects to be emphasized, the PPG phase has provided for a degree of standardization in the regional demonstrations, allowing greater power in the planned results through replication. For example, by ensuring that common information is collected and common terms calculated, a much clearer comparison of the regions can be made. This will mean that the messages that emphasize regional differences will be much more strongly justified from the evidence collected.

158. **Policy Process Replication**: This is not strict replication, but it is worth taking seriously that different policy processes have different character associated with their purpose, origin, historical evolution etc. This means that it is of great benefit for scientist in INMS to continue to work with a wide variety of different policy processes. In this way, a much stronger feel can be developed of what make for successful policy making, and what hinders it. These points are highly relevant as the discussion on the ‘nitrogen policy arena’ continues into the project Inception Phase. The multiple impacts of nitrogen put nitrogen scientists focused on providing international policy support into the rare position of being able to see across several policy processes and use the lessons from this in engaging with policy makers to develop the optimal character of the nitrogen policy arena.

3.11 Public awareness, communications and mainstreaming strategy

159. As outlined under Sustainability (3.11) above, developing public awareness in relation to the nitrogen cycle is a key objective of 'Towards INMS'. The foundation must be a strong set of key outcomes emerging from Components 1-3, while significant resource is allocated in Component 4 to mobilize these outcomes to develop public awareness.

160. One of the first tasks in the project will be the development of project communication strategy. This will be developed by the PCU for agreement and presentation to the PMB, SPAG and PPA. Feedback will be used to refine the strategy. Where such feedback results in a proposal to amend the priorities for resource allocation, this will be presented by the EA to the IA for approval, subject to reaching agreement on which tasks will be replaced by others.

161. INI has been highly successful in mobilizing public and policy awareness of nitrogen over the last five years. This has come about as a result of a combination of a) developing and delivering key science products that are suitable to engage policy and the public, b) engaging policy audiences in the development and dissemination of these products and c) engaging the press in these outcomes at a high level. The report 'Our Nutrient World' prepared under the lead of INI for GPNM and UNEP is an example of a clear focused product, as is the recent report 'Nitrogen on the Table', with both receiving wide press and policy coverage. Similarly, the Barsac Declaration (on nitrogen and the demitarian diet), developed by the NinE and COST 729 programmes, now features in a new dictionary of gastronomy: '*Eatymology*' (where 'Demitarian' appears between 'Crop Swap' and 'Drunkorexia'). These examples illustrate how different narratives can be used to mainstream nitrogen science for different audiences.

162. The Component 3 regional demonstrations provide another important route for mainstreaming improved understanding of the nitrogen cycle. Here a different strategy is expected to be applied for different regions, meeting the needs of key stakeholders. For example, in agricultural contexts, the message that reducing nitrogen pollution can save farmers money in fertilizer inputs is an extremely powerful message. For another audience again the buzz word is the Circular Economy. There are many different ways to 'sell' the importance of nitrogen.

3.12 Environmental and social safeguards

163. The proposed project includes: a) scientific development of measurements and models, b) science synthesis and application, c) research demonstration activities including engagement with local stakeholders and d) awareness raising and knowledge sharing. As such there are no specific safeguards needed that relevant to the project, beyond good office and travel practices (reducing water, energy, paper use, making full use of telephone and video conferencing facilities, appropriate catering for meetings, using ground-transportation rather than air-transportation where possible etc).

164. The 'Towards INMS' project engages with local stakeholders through both analysis of barriers-to-change (Component 1) and examination of the options for better field use and management of nitrogen (Component 3). By working with reputable organizations in existing and planned interventions 'Towards INMS' will ensure that appropriate social safeguards are in place at the partner organisations, who will assume their own legal responsibilities for the work undertaken.

165. Where these points are relevant in 'Towards INMS', this will be handled by consulting partners receiving funds through a project contract for specific tasks, where they will sign an appropriate declaration to confirm that that they meet the social and environmental requirements of their own country and organisation.

Section 4: Institutional Framework and Implementation Arrangements

4.1 Project Level Decision Making and Planning

166. The overall project governance and internal communication flows within the 'Towards INMS' project are summarized in Figure 7. General oversight of project activities will be undertaken by the **Project Management Board (PMB)**, which will allow project-level communication between the **Component Leaders**, the **Project Co-ordination Unit (PCU)**, the **Executing Agency (EA)** (i.e. NERC-CEH on behalf of INI) and the **Implementing Agency (IA)** (i.e. UNEP). The PCU will undertake the day-to-day functions of the project, including maintaining communication between all parties in the project. Each of these groups is outlined below and further details can be found in Appendix 10.

167. The work of the project will be reviewed and informed by the **Project Partners Assembly (PPA)**, which consists of representatives of all main partners (i.e. funding partners). It represents the overarching decision-making body. In addition, the project includes a **Stakeholder and Policy Advisory Group (SPAG)** to provide advice to the project and support wider dissemination. Members of the SPAG may also be Main Partners of the project, in which case they will also be members of the PPA. Members of the SPAG otherwise have **observer** status at the PPA. External communication from the project is further supported by Component 4, which includes focus on public engagement and awareness raising. In addition to the partnership itself, the PCU and Partners may also utilize **Consultants** to conduct specific aspects of the work. Such consultants have observer status at the PPA, being represented in decisions of the PPA by their relevant hosting Main Partner.

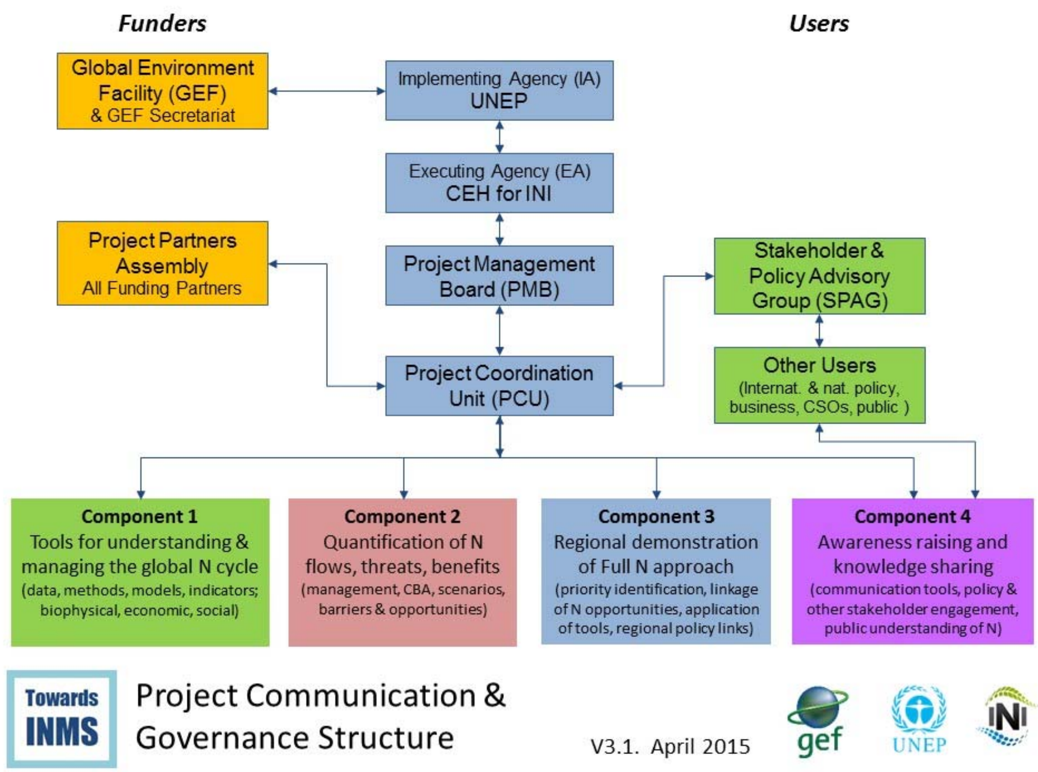

Figure 7: *Summary of the Towards INMS project communication and governance structure. Catalytic funding is provided by the Global Environment Facility, while all funding partners are represented in the Project Partners Assembly. UNEP is the Implementing Agency (IA), while the International Nitrogen Initiative (INI) is the Executing Agency (EA), as hosted by CEH. The Project Coordination Unit (PCU) is the team that actually manages the project coordination (based at the EA), who work closely with the Project Management Board (Component Leaders, IA and EA). The project is supported by the Stakeholder and Policy Advisory Group (SPAG), which consists of key users, which may also be project partners. Membership of the SPAG will be proposed during project Inception Phase by the EA and IA, for agreement by the Project Partners Assembly.*

4.1.1 Project Management Board

168. The PMB will be established to oversee the activities of the project and to approve material (reports, outputs, etc.) for submission to the PPA, IA and to the GEF. The PMB will provide overall guidance to the project and will consist of IA, PCU (on behalf of the EA) and the Component Leaders. The PMB will meet as required for the execution of the project, making full use of electronic conferencing facilities. The PMB will receive direction (consistent with the Pro-Doc/CEO) from the PPA, supported by advice from the SPAG acting as the executive of the Towards INMS Project.

169. Note that the PMB will not be expected to deal with day-to-day administration of the project, which will be handled by the Project Co-ordinator, Project Director and PCU, under guidance from the IA. This will ensure conformity with UNEP's and GEF's requirements.

4.1.2 Project Co-ordination Unit (PCU)

170. The Project Co-ordination Unit (PCU) will be responsible for day-to-day project management and execution and will work closely with the project partners to ensure the objectives of this project are achieved. They will be responsible for providing the PPA, PMB, IA and the GEF with all management information and the required outputs from this project. The PCU will be responsible for the organization of the Inception Meeting and subsequent meetings of the Project Partners Assembly, and provide secretariat facilities for PMB, PPA and SPAG.

171. The PCU will consist of a Project Director (25% Full Time Equivalent, FTE), Project Co-ordinator (100% FTE), Technical support specialist (50% FTE), Project Management and Communications support will also be provided (up to 100% FTE, depending on staffing needs and availability) and financial support staff (25%). Terms of reference for these roles can be found in Appendix 11.

4.1.3 Project Partners

172. Two partner types are defined for the 'Towards INMS' project, as follows:

Main Partners: Organizations who have provided co-financing through cash and in-kind contributions to the project. Main Partners may also take on 'Co-ordinating' and/or 'Lead' roles. Co-ordinating Partners are those within the Project Management Board (such as Component Leaders) and Lead Partners are responsible for the delivery of either an Activity or Task. As a contributor to project co-financing, each Main Partner is a full member of the PPA.

Associate Partners: Organisations who have not provided co-financing, but who have otherwise committed to contribute to or otherwise support the project.

173. The Partners are the organizations contributing to 'Towards INMS'. Each organization will support the work through one or more of its staff, one of whom will be appointed by the Partner to be their Lead Representative for 'Towards INMS' at the PPA (Lead Representatives of Main Partners would therefore be voting members of the PPA).

174. Following the inception meeting the IA and EA may agree to propose additional Main Partners or Associate Partners to the project, which will require approval of the PPA before acceptance of a new partner is confirmed.

4.1.4 Project Partners Assembly

175. 'Towards INMS' has around 80 Main Partners contributing funding resources to the project. Their involvement is critical and essential to the overall delivery of the project. Each Main Partner will be directly represented as part of the Project Partners Assembly (PPA), which will meet annually. As the aggregate of all funding partners, the PPA is the overarching decision making body of 'Towards INMS'. Associate Partners (i.e. non-funding partners) contribute to the PPA as non-voting members. The PPA will support the execution of the project through the PMB and the PCU, who will report to the PPA annually. Members of the SPAG who are not Partners of INMS and other groups or individuals with an interest in INMS join the PPA as observers. As far as possible the PPA will take decisions by consensus.

4.1.5 Stakeholder and Policy Advisory Group (SPAG)

176. A Stakeholder and Policy Advisory Group (SPAG) will be established during the INMS Inception Phase and will meet on an ad hoc basis. A proposal for membership will be made by the PMB for adoption or amendment by the PPA. The group will advise the PMB on scientific, policy and other stakeholder issues as needed to support development of options for an International Nitrogen Management System. The SPAG will be composed of differing expertise as the needs of the project evolve and may include Partners as well as other bodies and individual experts.

4.2 Component Level & Regional Demonstrations, Decision Making and Planning

4.2.1 Decision Making & Planning in Components 1, 2 & 4

177. As described above, project level communication and governance of the work of the Components will be directed by the PMB. Within each Component are a number of Activities (each delivering on one 'Output') and within these, several Tasks (each delivering on a 'Task Output').

178. To ensure effective delivery of the 'Outputs' and 'Outcomes' of the project, each Component, Activity and Task is guided by a 'Leader' (in most cases two, allowing for flexibility and greater global representation). 'Terms of Reference' for each of these roles is included in Appendix 11. Component Leaders will be responsible for reporting back to the PCU and PMB on their progress and any issues which need to be addressed, including budget or Work Plan adjustments. Each of the Component Leaders will work with the Activity Leaders and Task Leaders.

179. Proposals individuals to act as Component Leaders, Activity Leaders and Task Leaders have been made by the EA as shown in Appendices 8 and 15-18. The proposals have been made considering i) relevant expertise, ii) institutional context, including Execution of the project through INI, iii) global and regional representativeness, iv) gender representativeness[52], v) contribution to preparing the 'Towards INMS' PPG phase and documentation. The EA will confirm nomination of Component Leaders, Activity Leaders and Task Leaders for approval or amendment by the PPA during the Project Inception Phase.

4.2.2 Decision Making & Planning in Component 3 & the Regional Demonstrations

180. To effectively execute the work planned in Component 3, it is necessary that communication flows between each of the regional demonstrations in Activity 3.1 and the remaining activities (A3.2-3.4). Therefore, it is planned to have a **'Component 3 Management Group' (C3MG)** which consists of the Component 3 Leaders, Activity leaders and representation from each of the regional demonstrations. Each of the Demonstrations will also form a '**Demonstration Management Group' (DMG)**, consisting for example of the Regional Co-ordinator(s), Project Officer(s), Task Leaders and additional experts as required.

[52] Gender is also addressed at Section B2 of the request for GEF CEO endorsement.

Section 5: Stakeholder participation

181. The following table summarizes the project partnership and current extent of stakeholder involvement. In some cases partners have found it procedurally difficult to assign a quantitative financial value to their contribution. In these cases, the organizations are listed with an unspecified value to their contribution. Where the organization has provided a specific letter of support, they are listed as Associate Partners (AP) rather than Main Partners (MP).

Table 7: *Summary of Stakeholder Engagement in 'Towards INMS'.*

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
			Partners primarily with global project focus	
C1	GEF Agency	Policy Support	United Nations Environment Programme (UNEP)	**Implementing Agency** for the project, ensuring coordination with GPA and liaison with other international frameworks. Input through secretariat for the GPNM.
C2	Non-ministry government body	Science & Policy Support	Natural Environment Research Council (NERC), Centre for Ecology & Hydrology (CEH), UK, as host of the International Nitrogen Initiative (INI)	**Executing Agency** for the project, providing Project Coordination Unit, project direction and coordination including financial management. Chair of the International Nitrogen Initiative. Co-chair and Secretariat of the Task Force on Reactive Nitrogen. Co-financing supplied through a wide range of UK and EU funded sources, including National Capability.
C3	Other	Science & Policy Support	University of Edinburgh (UED), UK, (with support to INI secretariat)	Studying many experimental and theoretical aspects of land-surface processes related to N cycling and management. Involved in numerous national and international N research collaborations, including GANE, NitroEurope, ECLAIRE, GREENHOUSE, TFRN and, most recently, the INMS pump-priming project. The lead contributing scientist directs Edinburgh's Global Environment & Society Academy, tasked with developing interdisciplinary solutions to the global challenges of food, water, energy and climate security, with projects concerning the interactions of N with greenhouse gas fluxes and nitrogen pollution swapping. Contributed to the European Nitrogen Assessment, the IPCC's Fifth Assessment Report (WGI). Science advice on nitrogen provided to Westminster and Holyrood Parliaments, and public engagement ('Nitrogen and Climate Change', 2015, Palgrave Macmillan).
D1	Other Multilateral Agency (ies)	Policy Support	Secretariat to the Convention on Biological Diversity (CBD), Canada	Secretariat Liaison with the Convention on Biological Diversity, especially in relation to mainstreaming the nitrogen challenge within CBD, as part of the Aichi indicator process (considering the N indicator in partnership with INI).
D2	Other Multilateral Agency (ies)	Policy Support	United Nations Economic Commission for Europe (UNECE)	Link to activities under the UNECE Conventions on Long-range Transboundary Air Pollution (Air Convention) and the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention). Contribution to INMS through ongoing and future activities on transboundary water cooperation in Eastern Europe (including Dniester river basin) under the Water Convention and through the Task Force on Reactive Nitrogen under the Air Convention. The platform of the Working Group on Strategies and Review under the Air Convention can be used in disseminating the results of INMS and involving governmental officials in target countries.

[53] Project Partners are here distinguished as: Coordinating Partners (C1..C3), Delivery and Research Partners (D1..D42), Business Sector Partners (B1..B9), Civil Society Partners (S1..S3), Regional Case Study Partners (R1R34).

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D3	Other Multilateral Agency (ies)	Policy Support	Organisation for Economic Co-operation and Development (OECD), Paris	Policy analysis on the nitrogen cycle in relation to country programmes and national case studies. Development of environmental indicators and investigation of nitrogen indicator as broad measure of environmental performance (linking air, land, water, climate, biodiversity etc). Integration of existing agricultural nitrogen balances indicator into full regional nitrogen budgeting approaches. The platforms provided by the Environmental Policy Committee (EPOC) and the Working Party on Water Biodiversity and Ecosystems (WPWBE) can be used in disseminating INMS results and involving government officials in target countries.
D4	Other Multilateral Agency (ies)	Science & Practices	Food and Agriculture Organization of United Nations (Livestock Information, Sector Analysis and Policy Branch (AGAL) , Animal Production and Health Division, (FAO-AGAL), Rome	Provides livestock sector analysis with a particular focus on resource use, environment and poverty reduction. It also provides policy support and guidance to countries and stakeholders in the livestock sector, and facilitates policy dialogue among stakeholders. AGAL will contribute to INMS through: a) Knowledge transmission on global database on agricultural commodities and inputs (GLEAM); b) Assessments of nitrogen use efficiency for livestock supply chains by region, commodity and farming systems at different scales; c) Development of mitigation strategies to reduce the environmental impact from livestock sector; d) Benchmark and monitoring of improvement options in livestock sector; d) Facilitation of policy dialogue and harmonization of metrics through international multi-stakeholders initiatives: Global Agenda for Sustainable Livestock and Livestock Environmental Assessment and Performance (LEAP) Partnership.
D5	Other Multilateral Agency (ies)	Science & Policy Support	World Meteorological Organization (WMO), Global Atmospheric Watch, Geneva	Secretariat Liaison with the Global Atmospheric Watch efforts on quantifying atmospheric concentrations and deposition of reactive nitrogen compounds, for verification of models, including key gap analysis in developing regions.
D6	Other Multilateral Agency (ies)	Science & Policy Support	International Institute for Applied Systems Analysis (IIASA)	Research contribution in the development of nitrogen integrated assessment modeling linking air pollution, human health, ecosystems, greenhouse gases and water pollution, building on IIASA's GAINS model, which elucidates important aspects of the nitrogen cycle in to with mitigation and mitigation costs. Development of regional nitrogen budget approaches and efficiency indicators. Contribution to European scale coordination (Director INI European Centre) and Chair of TFRN Expert Panel on Nitrogen Budgets (EPNB).
D7	Other Multilateral Agency (ies)	Science & Policy Support	European Commission Joint Research Centre (EC-JRC), Italy	Contribution to the development of regional and global nitrogen flow modeling, including development of indicators, regional synthesis, and options including integration of technical measures and structural change (societal choice and consumption related). The mission JRC is to provide EU policies with independent scientific support throughout the whole policy cycle. In particular, the Institute for Environment and Sustainability (IES) supports to EU policies for the protection of the environment, and the more efficient and sustainable management of natural resources.
D8	Other Multilateral Agency (ies)	Science & Practices	International Maize and Wheat Improvement Center (CIMMYT) (part of CGIAR)	Leads research on sustainable intensification in wheat and maize-based systems in South Asia, Sub-Saharan Africa and Latin America and has considerable expertise in N management. Access to facilities to measure N balance in crops and provide field facilities for demonstration, evaluation of management practices on N use efficiencies of crops. Through work on climate smart villages, CIMMYT is evaluating a range of technologies and practice portfolios, with strong community-led involvement, local organizations and strong public sector buy in. The CIMMYT impact pathway is to generate evidence on the costs and benefits of emerging practices and technologies in terms of productivity and climate change adaptation and mitigation. Outputs from 'Towards INMS' could be scaled up through CSV models in South Asia and through CIMMYT innovation hubs of MasAgro Take it to the Farmer (TTF) project in Mexico and the Cereal Systems Initiative for South Asia (CSISA).

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D9	Non-ministry government body	Science & Policy Support	PBL Netherlands Environmental Assessment Agency, The Netherlands	Experience in global and regional assessments and scenario studies of production of consumption of energy and food on environmental emissions to air and water and impacts and air and water quality, the GHG balance and biodiversity. Assessments and scenario studies include aspects of governance and consumers choice. For this purpose PBL has developed the IMAGE and GLOBIO models and cooperated with various research groups around the globe on international IPCC, OECD and UNEP environmental assessments. Will provide analysis of nitrogen management options in relation to food choice and technical measures coupling water, air, climate, biodiversity issues in relation to quantitative assessment and building of green economy links. Builds leadership of N cost-benefit analysis and lead of the Expert Panel on Nitrogen and Food.
D10	Non-ministry government body	Science & Policy Support	National Institute for Public Health and the Environment (RIVM), The Netherlands	Monitoring and modelling N-flows in the environment. Recently, the policy program Integrated Approach to Nitrogen in which all N-sources to air are considered has been adopted and RIVM is in the lead to monitor this program for the Netherlands. RIVM is extending the scope of its work to other N-flows and other environmental and public health impacts. Contribute to INMS with experience in measuring and modelling N-flows and by making these flows quantitative and manageable for use in policy support (esp. Activities 1.3, 1.5 and 2.1)
D11	Non-ministry government body	Science & Policy Support	Italian National Agency for New Technologies, Energy and sustainable economic development (ENEA), Italy	ENEA conducts research and innovation activities, especially including energy efficiency and renewable energy sources, technological innovation, agro-food, health, and the environment. Examination of regional nitrogen flows in relation to societal choice options with specific attention to regional food access and food choice options, building on the work of the Expert Panel on Nitrogen and Food (EPNF).
D12	Non-ministry government body	Science & Practices	Institut Nationale Recherche Agronomique (INRA), France	INRA is the biggest Institute for agronomic research in Europe. Reactive nitrogen is an issue which is mostly related to agriculture by the way of crop fertilisation and livestock farming (esp. manure management). INRA could provide INMS with (i) databases on N use, on N, C and water fluxes, (ii) crop models including C and N cycling, economic models, actor models (iii) decision support tools for N fertilization and estimating N losses and (iv) long term observation sites. INRA has strong partnerships with many agriculture stakeholders and French decision makers. The involvement will seek to distill and synthesis key experiences from French agriculture allowing technology sharing with regional studies and analysis of barriers to change.
D13	Ministerial governmental body	Science & Policy Support, Regulation	United States Environmental Protection Agency (US EPA), United States	US EPA is the national agency responsible for many of the regulatory management of air and water quality, and in turn the nitrogen cycle in the US. EPA has a program office side, whose staff are responsible for policy decisions and implementation and have played key roles in the development of global environmental policies and funding mechanisms such as the GEF. EPA also has a research side that informs policies and policy-makers. Many EPA researchers measure and model the amount of nitrogen moving through air, land and water. EPA researchers also study the impacts of excess nitrogen on the human health, the environment and the economy. Much of EPA's nitrogen research is US in scope even though EPA is on the Governing Committee of various intergovernmental programs, including UNEP and the OECD programs on nutrient pollution. In making progress toward sustainable decisions, it would be best for EPA and the INMS partners to learn from and exchange research and inform policy-makers toward global sustainability.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D14	Non-ministry government body	Science & Policy Support	Federal Environment Agency of Germany (UBA), Germany	UBA is a policy advising institution gathering data concerning the state of the environment, investigating the relevant interrelationships, making projections and providing federal bodies such as the Ministry of the Environment with policy advice. UBA also provides the general public with information on the environment. One important field of interest is the reactive nitrogen (N_r) issue as Germany is obliged to commit to various N_r associated environmental quality standards. Several projects are set up to quantify N_r fluxes, calculate N_r budgets and balances and support the German integrated N_r policy initiative and several actions on international cooperation.
D15	Non-ministry government body	Science & Policy Support	Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME), France	ADEME provides expertise and advisory services to businesses, local authorities and communities, government bodies and the public at large, to enable them to establish and consolidate their environmental action. As part of this work, the agency finances projects, from research to implementation, in its areas of action. ADEME is then greatly interested in the development of a science-policy support process, to enable the more effective management of nitrogen whilst minimizing the environmental impact.
D16	Non-ministry government body	Science	Consiglio Nazionale delle Ricerche - Istituto per la Protezione Sostenibile delle Piante (CNR-IPSP)	Experience in the studies of plant responses to abiotic stress factors, with an aim of translating response mechanisms and adaptation processes into risk assessment and protection methodologies. CNR-IPSP coordinated and participated in many international projects (including ECLAIRE), and is experienced in communication and contacts with stakeholders. Contribution to INMS includes provision of data for 1. The parameterization of plant responses to N deposition, water stress and ozone exposure, for plant species representative of the major plant functional types in under-investigated areas of the globe (South-America and Asia) 2. nitrogen-ozone-VOC interactions in a demonstration forest area in Mediterranean climate.
D17	Non-ministry government body	Science	Norwegian Meteorological Institute, Oslo, Norway (MET Norway)	The Norwegian Meteorological Institute hosts the western air pollution modelling centre of the European Monitoring and Evaluation Programme (EMEP MSC-W). The EMEP MSC-W model has been developed over more than 30 years for the calculation of sulphur and nitrogen deposition, as well as for tropospheric ozone and particulate matter (PM). Although traditionally used at the European scale with resolutions of ca. 50km, the current model has been applied both globally (0.5 degrees resolution) and for near-urban scale (1-2 km) within the EMEP4UK project. MET Norway has a long history in authoritative modelling of the long-range transport of pollution, especially for the UNECE LRTAP Convention. Met.no will engage to develop N-modelling capabilities, including atmosphere-biosphere simulations of future N-scenarios in different economic and climate change scenarios.
D18	Non-ministry government body	Science & Practices	Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR), Australia	Victoria is Australia's largest food and fibre exporting state and DEDJTR is Australia’s leading agriculture research and development organization. Better managing N to meet production and environmental goals is a high priority. DEDJTR highly values international collaboration and recognizes the benefits of international harmonization of methods, practices and tools targeting N use efficiency. To that end, DEDJTR is proposing to work in close collaboration with a number of international research groups from New Zealand, USA and Europe on improvement of farm scale management of the nitrogen cycle,, with an emphasis on using an farm level N budgeting approaches. This will support the development of on-farm and catchment indicators and methods to quantify nitrogen utilization, identify sources of nitrogen losses, quantify various pathway losses and develop strategies to minimize environmental impacts.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D19	Others	Science, Practice & Policy Support	Alterra Wageningen University and Research Centre (ALTERRA)	INMS interests relate to: (i) nutrient cycling and management in the food production – consumption chain and (ii) impacts of nutrient use on soil and water quality, climate and biodiversity at a range of spatial and temporal scales. Active engagement with Towards INMS under the Components 1 and 2, especially in relation to: development of regional biogeochemical models in agriculture and natural systems, on the refinement of indicators and on the benchmarking of indicators in agriculture (efficiencies and surpluses). Examination of best management practices and the social and economic factors that determine success.
D20	Others	Science & Practice	Wageningen University and Research Centre, Livestock Research (WUR-LR)	Research in reducing NH_3 and other N-compounds from livestock husbandry, with focus on technical mitigation methods and management tools and optimization of nutrient management. WUR were involved in writing the UNECE Guidance document on mitigating ammonia, the UNECE Framework Code for good agricultural practices, the Agricultural Annex of the Guidance document on National Nitrogen Budgets and in the review of the BAT Reference document for intensive pig and poultry. WUR developed Feed Print, which calculates the carbon footprint of feed ingredients. We have mapped manure management over the world to understand how different regions handle manure, to be able to provide the best tool at the right place to mitigate environmental impact. We are involved in projects to enhance knowledge hubs on manure management and resource use efficiency.
D21	Others	Science & Policy Support	Energy research Centre of the Netherlands (ECN), The Netherlands	Involvement in different ongoing global activities related to the INMS objectives, as well as recent activities on a European level that directly link to the INMS activities (e.g. TFRN/EPNB, ESF-NinE/ENA). Development of simpler regional indicators of nitrogen efficiency performance and comparison with more detailed approaches, extending the analysis to improve estimates of full-chain nitrogen use efficiency.
D22	Others	Science	Vrije university and Louis Bolk Institute (VU), The Netherlands	A focus on Integrated Nitrogen Studies in the world, which is in the heart of the INMS proposal. The VU has a range of experiences in coordinating N-related projects, courses on nutrients and biogeochemical cycles, atmosphere-biosphere research and satellite observations and validation. Furthermore, through several contributions policies and solutions for N-pollution have been developed and successfully implemented. Particular interest in on nitrogen foot printing (N-PRINT), and environmental farming approaches.
D23	Others	Science & Practices	Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek (TNO), The Netherlands	Currently estimating and predicting NH_3 concentrations and reactive nitrogen is severely hampered by a lack of good emission timing in the chemistry-transport models (CTMs). The emission of NH_3 varies locally and inter-annually as a result of local climate (temperature) and local agricultural management. Our research in the coming years will include deriving and testing parameterization of ammonia emissions for use in our chemistry-transport model LOTOS-EUROS. A more realistic representation of the emissions will change the deposition patterns and hence may influence the most effective policies to protect nature reserves and reduce emissions. As part of this development TNO will also focus on further increasing the spatial resolution of its model to more accurately represent local emission and local depositions that can be of direct benefit to Component 1 of the 'Towards INMS' project.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D24	Others	Science & Policy Support	Potsdam Institute for Climate Impact Research (PIK), Germany	Studying causes and effects of land-use change, including externalities such as N_r pollution. It develops and maintains two complementary global simulation models, a bio-physical dynamic global vegetation, hydrology and crop growth model LPJmL and a spatially explicit economic agricultural sector model MAgPIE. Both models can be applied jointly and separately and have a long-standing reputation in global change research. The models have been applied (MAgPIE) and are currently being further developed towards explicit treatment of N dynamics to address the full terrestrial N cycle in natural and managed ecosystems as well as the economic assessment of environmental regulation and market mechanisms. The group is involved in model intercomparison studies (AgMIP, ISI-MIP) and can connect N-specific research questions of INMS with these activities. High spatial detail in simulations and analyses allows for connecting regional studies and mechanisms with global-scale responses in a consistent analysis.
D25	Others	Science	University of Bonn (UBO), Germany	Working in plant/atmosphere exchange, identifying and investigating fundamentals of aerosol impacts on plants. Our activities, e.g. within the ECLAIRE project, have taken this forward to a point where we could show that aerosols formed from NH_3 can reduce the drought tolerance of plants, indicating a so far unknown, serious threat of NH_3 to ecosystems. Our present funding largely comes from fundamentally oriented organizations (DFG), and we are interested to make the results suitable and useful in the interdisciplinary INMS environment, e.g. for the implementation in dynamic global models.
D26	Others	Science & Practices	Leibniz Institute for Agricultural Engineering (ATB), Potsdam-Bornim, Germany	A European center of agricultural engineering research at the nexus between biological and technical systems. Research targets a knowledge-based bioeconomy. ATB is developing highly innovative and efficient technologies for the use of natural resources in agricultural production systems - from basic research to application. ATB thus contributes to the nutrition of humans and animals, to a sustainable use of biomass, and to protecting of climate and environment. Co-chair of the UNECE-TFRN Expert Panel on Mitigation of Agriculural Nitgrogen (EPMAN) and UNECE Task Force on Emissions Inventories (TFEIP) Agriculture and Nature Panel.
D27	Others	Science & Practices	Aarhus University – Bioscience (AU-Bios), Denmark	Has the main responsibility to guide the Ministry of Environment in Denmark and has as such being responsible for the nitrogen monitoring in surface waters and agricultural catchments for more than 25 years. Have several Danish and International projects that include Nitrogen assessments and modelling that can support the INMS project including our nearly 30 years of N data collected that are stored in databases
D28	Others	Science & Practices	Aarhus University - Agro (AU-Agro), Denmark	Has for many years been conducting research and providing policy support on nitrogen flows in agricultural systems. This work has included the development and use of methods to quantify nitrogen flows at field, farm and regional scales. Furthermore, we have conducted extensive experimentation at the level of the animal, manure management system and field to identify practical measures that can be taken to reduce losses of nitrogen to the environment. Recently, sustainable intensification of cropping systems to support green biorefinery and protein production has been developed. Provides policy support to the Ministry for Food, Agriculture and Fisheries for Denmark. As such, AU-Agro is familiar with dealing with the technical, regulatory and economic aspects of nitrogen management policy.

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D29	Others	Science & Practices	Aarhus University – Department of Enviromental Science (AU-Envs), Denmark	Operates the Danish air quality monitoring program, and in relation to this work Danish nitrogen budgets are established each year by comparing Danish emissions to nitrogen deposition to Danish marine and terrestrial ecosystems. Includes scenario studies of the contribution from Danish and foreign sources as well as projections on future development in nitrogen depositions. ENVS AU produce the Danish national emission inventories incl. those for atmospheric releases of nitrogen, with experience of high temporal and spatial resolution emission inventories. Experience and economic valuation of the environmental pressures from various sectors.
D30	Others	Science & Practices	Institute of Water Resources Engineering (ASU), Lithuania	Many years of experience in conducting research on nitrogen losses from agricultural areas to surface waters at different spatial scales (field and catchment). Long-term nitrogen budget calculations and the effect of various land management practices have been investigated. The offered contribution to 'Towards INMS' is skills, experiences and review. Recent research suggests that a limited response of freshwater eutrophication to decline in agriculture is related to land management practices as well as to significant inertia of the terrestrial ecosystems that control the loss of N from land to rivers. The research emphasis is therefore on improving understanding of the N cycle to reduce the negative impacts through improved N management practices and policies.
D31	Others	Science Support	Agrophysical Research Institute (ARI), Russia	Has an extensive experience in research cooperation in the subject of nitrous oxide emission from arable soils. We have partners inside the country who we are prepared to work together with in the 'Towards INMS' project. Together we will also apply for grants inside Russia to support our activities in the 'Towards INMS' project.
D32	Others	Science Support	Institute of Physicochemical and Biological Problems in Soil Science (IPBPSS), Russia	Researches of N biogeochemical cycle in natural and semi-natural ecosystems in Russia. Recent and current activities and projects of IPBPSS are relevant for INMS. Skills in modelling N cycle dynamics and assessment of N fluxes in forested lands. System of models EFIMOD, which were created in IPBPSS, has been used in many regional researches on modeling the impacts of N deposition and climate change on forest dynamics and biodiversity. IPBPSS was a partner in the ECLARE project participating in the work on developing dynamic soil vegetation models. Also involved in the activities of the LRTAP Convention and responsible for calculating and mapping critical loads of N for the European Russia area.
D33	Others	Science & Practices	Instituto Superior de Agronomia (School of Agronomy) of the University of Lisbon (ISA), Portugal	Interest in improving agronomic practices that reduce nitrogen losses to water and air and in the synthesis and translation of evidence to support practice improvement and the policy development. Will contribute to the development of optimized approaches for N management (Activity 2.3) and support the European regional demonstrations. Co-chair of the UNECE Task Force on Reactive Nitrogen.
D34	Others	Science & Practices	Ataturk Horticultural Central Research Institute (ABKAE), Turkey	A public research institute working under the Ministry of Food, Agriculture and Livestock. ABKAE took part as a "Central Research Organization" in the priorities, policies, program and budget within the framework of research activities in the country on the basis of horticulture. Projects prepared under the nation-wide programs are carried out by individual scientists or teams from ABKAE or collaboration with other institutes and/or related faculties of the Universities. Within the framework of its duties, ABKAE prepares and joins research projects on evaluation-selection and breeding of high yielding, well adapted, disease resistant horticultural cultivars; agrotechnology (fertilization, irrigation, protection, physiology etc.), storage, processing and marketing. ABKAE organizes courses, seminars, conferences, training programs and workshops regularly for farmers, agricultural engineers, agricultural technicians, economists and home growers.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D35	Others	Science & Practices	Fundacao da Faculdade de Ciencias da Universidade de Lisboa, FP (FFCUL), Portugal	Contribution to INMS will be provided mainly from an international project (NitroPortugal), and will be focused on the organization of outgoing short and medium term staff exchanges and of incoming expert visits, collection of data from databases and grey literature, and on the organization of training and outreach activities. It generally aims at improving the knowledge of N-related issue on water, air and soil quality, greenhouse gas balance and impacts on ecosystem and biodiversity, to build the basis for a Portuguese Nitrogen Assessment.
D36	Others	Policy Support & Practices	Stockholm Environment Institute at York / York University (SEI/UoY), UK (link partner to the Climate and Clean Air Coalition, CCAC)	The 'Nitrogen Cascade' links closely with SEI's interest in air pollution and climate change and the water-land-energy nexus and developing integrated approaches examining trade-offs and synergies to inform decision making. Expertise relevant to INMS covers: coordinating and participating in regional and global integrated assessments for UNEP on Short-Lived Climate Pollutants (SLCPs); the Global Atmospheric Pollution Forum (GAP Forum) platform for global co-operation on air pollution issues; capacity building projects with the Climate and Clean Air Coalition (CCAC), the Consultative Group for International Agricultural Research (CGIAR) and World Bank assessing air quality, water and fertilizer issues in local/national agriculture; development of global trade and supply chain methodologies assessing links between consumption of commodities and impacts due to low NUE; impact assessment and modelling of how pollutants and other stresses combine.
D37	Others	Science & Practices	University of East Anglia (UEA), UK (link partner to the IOC UNESCO GESAMP Working Group 38)	The GESAMP working group has been studying the impact of air-sea exchange for many years and has recently focused particularly on the impact of atmospheric nitrogen deposition.
D38	Others	Science, Practice & Policy Support	North American Nitrogen Centre of INI (Including: US Environmental Protection Agency, US Department of Agriculture, US Geological Survey, Agriculture and Agri-Food Canada, University of Virginia,) (NANC)	NANC fosters collaboration of governmental and non-governmental organizations, universities and private individuals who are collectively trying to develop successful voluntary or regulatory ways of reducing N_r losses from agriculture and the built environment. Environmental endpoints, or critical loads, for terrestrial and aquatic ecosystems are actively researched. Workshops and synthesis activities drawing together continental-wide evaluations of both the state of knowledge and the socio-economic impediments to increasing crop NUE are supported and results are presented to stakeholders and peers at professional society venues.
D39	Others	Science & Policy Support	New York University (NYU), USA	The Department of Environmental Studies and the Guarini Center for Energy, Environmental and Land Use Law address interdisciplinary and policy-relevant environmental research. The Guarini Center has developed a 'building blocks' approach to global climate governance – using smaller, more decentralized forms of cooperation for climate protection – which is a valuable framework for investigating the various legal pathways available to manage global N pollution. The array of environmental and health impacts that can be traced back to N pollution creates several opportunities for generating climate co-benefits by engaging organizations with non-climate missions such as global health and agricultural development. NYU will play an active role in INMS Activities 4.3-4.4, particularly Task 4.4.2 (policy homes and financing models). The interdisciplinary array of faculty members doing environmental research – from lawyers and economists, to biologists and anthropologists – as well as its location in the heart of New York City make it a perfect base for exploring the global governance challenges related to N pollution.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
D40	Others	Science & Practices	World Resources Institute, Water Quality Team (WRI), USA	Has been working on eliminating eutrophication for more than a decade, including the extent of eutrophication worldwide, the drivers and sources, and policy mechanisms for addressing eutrophication. WRI has an interactive global map of over 700 eutrophic and hypoxic coastal zones. WRI is an expert on flexible, market-based solutions to cost-effectively achieve water quality goals, such as trading and targeting. Policy analysis, program evaluation, and analyses on barriers to change. Developed a global database of nutrient-reducing practices and nutrient-reducing programs and policies for the GEF GNC project. With offices in India, China, Brazil, Belgium, and Indonesia, WRI has an international presence and many local partners in developing countries.
D41	Others	Science & Practices	University of Missouri (MU), USA	Better managing nitrogen to meet production and environmental goals is a high priority for University of Missouri. University of Missouri highly values international collaboration and recognizes the benefits of international harmonization of methods, practices and tools targeting N use efficiency. The contribution will focus on the development of on-farm and catchment indicators and methods to quantify nitrogen utilization, identify sources of nitrogen losses, quantify various pathway losses and develop strategies to minimize associated environmental impacts.
D42	Others	Science & Practices	AgResearch Ltd (AgResearch), New Zealand	AgResearch is New Zealand's leading pastoral agriculture research and development organization. Better managing nitrogen to meet production and environmental goals is a high priority for AgResearch. AgResearch highly values international collaboration and recognizes the benefits of international harmonization of methods, practices and tools targeting N use efficiency. AgResarch will contribute to the development of on-farm and catchment indicators and methods to quantify N utilization, identify sources of N losses, quantify losses and develop strategies to minimize the resulting environmental impacts.
B1	Private Sector / Business	Policy & Practices	Fertilizers Europe (Fertilizers Europe), Belgium	In 2014 Fertilizers Europe established the EU Nitrogen Expert Panel. This panel is an independent group of leading scientists, industry representatives, practitioners, and governmental policy officers (total of 15-20 persons). The general objective of the Expert Panel is to contribute to improving NUE in food systems in Europe, through (i) communicating a vision and strategies on how to improve NUE in food systems in Europe; (ii) generating new ideas, and recommending effective proposals and solutions; and by (iii) acting as referee in controversial issues, and by communicating as authority. The first mandate of the EU N Expert Panel is to prepare a well-elaborated proposal for 'nitrogen use efficiency' in food systems in Europe, to be used as indicator by policy and practice. More mandates contributing to better and more sustainable use of nitrogen will be defined with time to come.
B2	Private Sector / Business	Science & Practices	Yara International ASA, Research Centre Hanninghof (Yara), Germany.	Yara converts energy, natural minerals and nitrogen from the air into essential products for farmers and industrial customers. The main application is fertilizers, while industrial uses and environmental solutions are also important growth segments. The backbone of the company's operations is large-scale ammonia and fertilizer production in many regions of the world. We ensure reliable supplies of mineral fertilizer and related industrial products to customers worldwide. Yara is one of the world's largest producers of ammonia, nitrate and complex fertilizer. At its centre for plant nutrition, Yara conducts research to develop improved plant nutrition management strategies for important agricultural crops.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
B3	Private Sector / Business	Science & practices	BASF SE, Division of Plant Protection, Germany	Developing novel solutions to reduce reactive nitrogen losses (mainly ammonia, nitrous oxide and nitrate) and working on establishing optimal conditions to get the best efficiency out of the N fertilizer applied to the field in agricultural systems. BASF runs global field trials on all five continents of which it can provide results and data. In addition BASF is willing to share compounds for testing in other locations (subject to local restrictions). Particular interest in developing novel nitrogen enzyme inhibitors to improve nitrogen use efficiency and decreases overall losses from reactive nitrogen pools.
B4	Private Sector / Business	Science & Practices	SKW Stickstoffwerke Piesteritz GmbH (SKWP), Germany	A producer breaking new grounds of N fertiliser use by developing new innovative products including recommendations on best usage and practices with an emphasis on improving N use efficiency. We have an own research department with scientists in the area of chemistry, analytics and agriculture as well as an agricultural experimental station. During the last years we have generated fundamental results concerning NH_3 and N_2O emissions after application of N fertilisers under practical related conditions in typical German agricultural areas. We are the sole institution holding NH_3 emission results over a three year typical crop rotation in Germany. In this study we identified and quantified options to reduce gaseous N losses significantly. In addition, we have experiences in efficient and loss reduced use of organic fertilisers like slurry or biogas digestate. We are open to integrate concertedly developed methods and measure in our existing research program and demonstrate best available practice in N fertiliser use.
B5	Private Sector / Business	Science, Policy & Practices	PigCHAMP Pro Europa (PCH), Spain	PigCHAMP Pro Europa S.L. is company located in Segovia, Spain. Its activity is aimed at consulting livestock, mainly pigs. Since 2000, technical advisor of Tragsatec, the means of the Ministry of Agriculture, Livestock and Environment to implement the Industrial Emissions Directive and in the preparation of the Technical Document on Best Available Techniques. Members of the Technical Working Group of the European IPPC-Bureau for IRPP-BREF. Over 10 years in the development of trials for the evaluation of techniques and products to reduce emissions of pollutants, in farm and field. A member of TFRN and contributor to the UNECE ammonia guidance document.
B6	Private Sector / Business	Policy Interest & Practices	International Fertilizer Manufacturers Association (IFA), Paris, France	IFA is the only association representing the global fertilizer industry. IFA has the best available global database on N fertilizer capacity, production, trade and consumption for the main fertilizer products and raw materials. IFA encourages adoption of best available technologies in fertilizer production in order to improve energy use efficiency and reduce GHG emissions. It also supports development and adoption of fertilizer best management practices in order to enhance the use efficiency and effectiveness of fertilizers, and promotes smallholders' access to fertilizers in Africa and other areas with underuse. IFA has more than 500 members throughout the world. As such it can help reaching out to the global fertilizer industry to stimulate their engagement in INMS activities where needed (e.g. in regional demonstrations), and to disseminate the main outcomes of INMS.
B7	Private Sector / Business	Science & policy interest	International Plant Nutrition Institute (IPNI), United States.	Global research partner of the fertilizer industry. Sharing of expertise in “4R Nutrient Stewardship” (right source at the tight rate, right time, and right place) that leads to enhanced crop production and crop quality, soil fertility improvement and sustainability, and attractive economic returns for farmers and allied industries, while also being socially acceptable and environmentally responsible.
B8	Private Sector / Business	Policy & Practices	CEMA aisbl – European Agricultural Machinery	Interest in the development of low emission practices, especially in regard of manure spreading methods, including liaison with other regional agricultural machinery organizations.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
S1	Civil Society Organisation	Policy and Dissemination	Non-Governmental Organisation ' New Energy' (New Energy), Ukraine	During last two years NGO "New Energy" has implemented the following projects: Social communication - new opportunities for active youth (2014 - funded by the German Foundation Nadegda); Elaboration and dissemination of recommendations on basin management of surface water resources used for drinking water supply in Kharkiv Oblast (2015 - under the Program "Ukrainian Unconventional Gas Institute" and administrated by the British Council in Ukraine). New Energy is currently engaged with the following projects: Integrated Hotspots Management and Saving the Living Black Sea Ecosystem (Black Sea Crossborder Cooperation programme); Stormwater quality: Implications for reduced impact on receiving waters and climate change adaptation. They recently contributed to Network for Environmental Assessment and Remediation in Aquatic Systems. Wastes and Wastewaters (2010-2012 – SCOPES programme) and EnviroGRIDS Project "Building Capacity for a Black Sea Catchment Observation and Assessment System supporting Sustainable Development" (EU programme).
S2	Civil Society Organisation	Policy & Dissemination	World Wide Fund for Nature conservation (WWF)	Stakeholder interested in dissemination of information on the nitrogen challenge, the benefits of nitrogen to modern society in relation to the regional and global challenges for nature.
S3	Civil Society Organisation	Policy & Dissemination	Planetary Boundary Initiative (PBI)	The PBI is a small NGO committed to governance that safeguards humanity against transgressing Earth's biophysical limits. Activities involve legal research, policy analysis, advocacy and the convening of multi-disciplinary experts and NGOs, to reach consensus on new governance options and this includes nitrogen as a key priority area. Research would review options for global, regional and local scales in response to planetary boundary science. We would develop research and explore findings with multi-sector NGOs, supported by our advisory group members.
			Partners primarily with regional demonstration focus in the project	
			CASE 1: Developing regions with excess reactive nitrogen	
R1	Others	Science and Practices	Institute of Soil Science, Chinese Academy of Sciences, Nanjing, China (ISSCAS), China	Pioneer in agricultural nitrogen research in China, focusing on the agronomic effect and environmental impact of nitrogen fertilizer. Has a number of researchers involved in nitrogen research, ranging from field study to regional evaluation. ISSCAS has led several national wide nitrogen related projects, and has hosted the 3rd International Nitrogen Conference. It is now leading a Nitrogen Working Group under China Soil Science Society. The group is made up of experts of different science background, inducing soils soil science, atmospheric science, aquatic science, etc.
R2		Science & Practices	National Institute for Agro-Environmental Sciences (NIAES), Japan	NIAES is a research institute focusing on environmental issues related to agriculture including nitrogen challenges such as cropland emissions of nitrous oxide, nitrate leaching to groundwater, and local-to-regional evaluations of nitrogen cycle. NIAES will thereby facilitate the involvement of Japanese scientists into the East Asian Regional Demonstration in close collaboration with the International Nitrogen Initiative–East Asia. Furthermore, NIAES is pursuing the Monsoon Asia Agro-Environmental Research Consortium (MARCO), which aims to provide international symposia and help to train the people who will carry on activities under the consortium. It is expected that MARCO also contributes to the case study.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
R3	Others	Science, Practice & Policies Support	China Agricultural University, Beijing - Crop and Environment (CAU - Crop)	Systematic research work on nutrient cycling and nutrient resource management in major Chinese intensively managed cropping systems. Meanwhile, CAU has also done much work on how to transfer nutrient management techniques to local farmers in order to improve their crop production and nutrient use efficiency while decreasing its nutrient losses to the environment. As a partner to INMS, CAU – Crop & Environment will provide experiences in producing more grain with moderate nutrient input and lower environmental costs.
R4	Others	Science & Practice	China Agricultural University, Beijing - Soil Science (CAU - Soil), China	A strong background working on N cycling and environmental impacts, which also covered by several ongoing projects. CAU-Soil is greatly interested in the development of the 'Towards INMS' partnership, and will contribute to several activities in components of quantification of N flows ,threats & benefits, and regional demonstration of the full N approach etc, to enable the more effective management of N whilst minimizing the environmental impact
R5	Others	Science Support	Beijing Forestry University (BFU), China	Focus on natural ecosystem (forests and wetlands) protection and management in China. It was firstly founded by both Ministry of Education and Bureau of Forestry of the national government. The group is addressing in developing nutrient measurements and models for watershed/ catchment level managements, which are not only referred to the nutrient enriched agricultural systems, but also natural ecosystems as nutrient sinks. Proposes to contribute to INMS Activities 1.1 and 2.1 and share results from its ongoing programme of work.
R6	Others	Science & Practices	Zhejiang University (ZJU), China	Currently, research in ZJU mainly focuses on the N biogeochemical cycle in coupled human and natural systems (CHANS). We have built the nitrogen cycling model in the CHANS to include both natural and anthropogenic factors that drive the global and regional nitrogen cycles. Based on the CHANS model, we have analyzed the entire nitrogen cycling in China for 14 subsystems, and closed the N budget and their future trends in China. ZJU will contribute to INMS on the industrial N cycling on regional and global scales, source appointment of atmospheric and hydrospheric nitrogen pollutions, nitrogen footprint by CHANS mass balance approach and cost-benefit analysis.
R7	Others	Science & Practices	Center for Agricultural Resources Research, Institute of Genetic and Developmental Biology, Chinese Academy of Science (CARR), China	The Chinese Academy of Sciences, Centre for Agricultural Resources Research (CARR), Institute of Genetic and Developmental Biology will provide underpinning support for the science of Towards INMS to maximize the benefit of nitrogen for agriculture while minimizing the environmental threats. Specifically, CARR will contribute to Components 1 and 2 in developing nitrogen system indicators (Activity 1.1) and in the development of future nitrogen storylines and scenarios (Activity 2.4).
R8	Others	Science & Practices	Field Science Center for Northern Biosphere, Hokkaido University (FSCNB-HU), Japan	Conducts comprehensive research primarily on the northern biosphere on the conservation processes and mechanisms that impact biodiversity and ecosystem processes, the sustainable use of natural resources and ecosystem, long-term monitoring of various ecosystems and environments. The research topics include ecology, biology, biogeochemistry, environmental science, agriculture, forestry, fishery and others. The ecosystem functions section covers biogeochemical studies including nitrogen which is highly relevant for the 'Towards INMS' project. FSCNB-HU has various international partnerships with oversea universities and research institutes for collaborative program for research and education, including leading the nitrogen action of the International Long-Term Ecosystem Research (ILTER) network. The research facility, project outcomes, database and other research resources are available for the 'Towards INMS' project.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
R9	Others	Science & Practices	Research Faculty of Agriculture, Hokkaido University (Ag-HU), Japan	Conducts research primarily on the northern biosphere on the sustainable use of natural resources and ecosystem, long-term monitoring of various ecosystems and environments, in relation to agricultural activity. The research topics include agricultural science, ecology, biology, biogeochemistry, environmental science, forestry, fishery and others. One of the research laboratories, the environmental biogeochemistry lab covers agricultural studies including nitrogen which is highly relevant for the INMS project. Ag-HU has various international partnerships with oversea universities and research institutes for collaborative program for research and education. The research facility, project outcomes, database and other research resources are available for the INMS project.
R10	Others	Science & Practices	National Institute for Environmental Studies (NIES), Japan	NIES is funded by the Ministry of Environment, Japan, covering a wide range of environmental researches such as climate change, pollution, biodiversity, material cycling, human health, and sustainability. It comprises eight research centers and one regional branch, some of which are working on regional and global nitrogen issues. The Center for Global Environmental Research is measuring atmospheric composition including several nitrogenous gases and developing a global biogeochemical cycling model. The Center for Regional Environmental Research is observing watershed-scale nitrogen cycling from atmospheric deposition to underground leaching. NIES has internal activities for these center's missions and several funded projects for integrated assessment on climatic change.
R11	Others	Science & Practices	Kyoto University (KU), Japan	Interested in the effective utilization of an indicator, Total Material Requirement, TMR. The TMR provides a measure of the physical inputs in mass required to produce a material from a given resource using a given process, including upstream inputs, in terms of primary materials including so-called hidden flow such as tailings, gangue, and waste rock, etc. Recently KU redefined two types of TMR. The first type is the TMR to obtain a material from a natural ore (natural ore TMR; NO-TMR), which is in keeping with the original definition of TMR. The other type is the TMR to recycle the material from an urban ore defined as end-of-life products or waste (urban ore TMR; UO-TMR). Recently KU has estimated TMRs for more than 400 products like not only metallic materials but also non-metals, acid/base, other chemical compounds, fertilizer, and foods etc. N-based materials and products such as fertilizer, nitric acid and ammonia are included. KU consider that further estimation and analysis must contribute to the problem solving for N-related issues.
R12	Multilateral Agency	Policy Support	Partnerships in Environmental Management for the Seas of East Asia	Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) is an international organization that works to improve management and practices of particular relevance for the global nitrogen cycle. PEMSEA recognizes that over-enrichment of water bodies is a key challenge for sustainable coastal development in the East Asian region. PEMSEA will in particular support coordination amongst partners in the East Asian demonstration region of INMS and contribute to raising awareness and dissemination of results.
R13	Others	Science & Practices	Rothamsted Research, UK (RRES)	Rothamsted Research has a long history of leading research concerning N cycling in agricultural systems, with an emphasis on grassland-based ruminant systems at the North Wyke site. There is considerable expertise regarding ammonia, nitrous oxide and nitrate leaching emissions to the environment, farm-scale modelling and development and compilation of national scale atmospheric emission inventories. RRes has been an active participant in TFRN and EPMAN activities, particularly regarding mitigation practices over the past decade. RRes has a history of close engagement with China regarding excessive N use in Chinese agriculture, continuing now in the UK-China Newton Fund ‘CINAG’ project.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
R14	Others	Science & Dissemination	Society of Nature Conservation of India. (SCON) incorporating Indian Nitrogen Group working in partnership with: • IPU University, New Delhi • Chilika Development Authority and School of Biotechnology, KIIT Univ. • Indian Agricultural Research Institute, New Delhi, India • Center for Sustainable Technologies, Indian Institute of Science, Bangalore • Punjab Agricultural University/Indian Nitrogen Group • South Asian Co-operative Environment Program (SACEP)	Widespread use of synthetic fertilizers to boost crop production has resulted bin excessive damage to air and water quality. The South Asian Demonstration led by N. Raghuram and YP Abrol from the Society for Conservation of Nature (SCON), a registered NGO competent to receive grants and submit accounts, and the umbrella organization that runs the Indian Nitrogen Group and the South Asian N Centre. SCON has earlier received grants from UNEP for South Asian N workshop and N2010. The contribution will a) coordinate the South Asian Case study (INI Centre Director), comparing the challenges for nitrogen management faced by adjacent states, b) develop a N-FOOTPRINT tool for India so as to create awareness in the public, researchers and policymakers to improve NUE, food chain efficiency and consider changes in diet patterns.
R15	Others	Science & Practices	Bangladesh Rice Research Institute (BRRI), Bangladesh	Rice is the main food in Bangladesh and Bangladesh Rice Research Institute is the mandatory organization to do research on every aspect of rice for production of more rice in Bangladesh and to feed the nation. This institute is equipped with highly trained manpower and lab facilities. BRRI will contribute Towards INMS for efficient N management in rice and to reduce its abuse. At present BRRI is also working with IFDC on NO_x emission from rice field and on its mitigation.
R16	Others	Science & Practices	CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), India	CSIR-NEERI has extensive experience in executing mega projects in solid waste management, analysis, land-fill engineering and emission inventory. CSIR-NEERI is the apex Government organization in India on environmental matters. The principal investigator contributing to Towards INMS is a leading expert on waste management and its interactions with the nitrogen cycle.
R17	Multilateral Agency	Policy Support	South Asia Co-operative Environment Programme	The South Asian Cooperative Environmental Programme (SACEP) is the main intergovernmental body promoting environmental cooperation in South Asia. As such they provide a key stakeholder receiver of the INMS South Asian demonstration activity. SACEP will contribute as an advisor to Component 3, providing support for wider dissemination and awareness raising of the work.
R18	Others	Science, Practices & Policy support	Earth System Science Centre/National Institute For Space Research (CCST-IPNE), Brazil working in partnership with: • the Brazilian Ministry of Science, Technology and Innovation (MCTI), • the University of Sao Paulo, • the University of Brasilia, • the University of Buenos Aires, • the InterAmerican Institute for Global Change Research, • Centro de Solos e Recursos Ambientais - Instituto Agronômico • Agro-Pastoril Paschoal Campanelli S/A	The mission is to generate interdisciplinary knowledge for national development with equity, and to reduce environmental impacts on the Earth. Its objectives are to conduct studies to evaluate the impacts of global and regional environmental change on the socio-economic and environmental systems, especially those associated with national development and wellbeing. In Towards INMS the focus is on deepening the understanding of how anthropogenic changes in the environment alter the distribution and functionality of the life on tropical biomes, consequently changing the biogeochemical nitrogen cycle, in relation to the capability to provide environmental services. (Director INI Center for Latin America). Leading the development of the Latin American INMS Regional Demonstration.
			CASE 2: Developing regions with insufficient reactive nitrogen	
R19	Multilateral Agency	Science & Practice	International Institute for Tropical Agriculture (IITA) (part of CGIAR), Kenya	IITA has several ongoing activities in the Lake Victoria catchment that fit in the context of Towards INMS. In addition, one of the IITA scientists is coordinating the activities of the Africa Regional Centre of the International Nitrogen Initiative; his work also fits well into Towards INMS. IITA has also established a strong partnership with many development partners interest in N management for improve food and energy production without pollution. The contribution of IITA will mainly focus on scaling up technologies intended to improve N agronomic efficiency in the context of too little N to minimize land degradation and environmental pollution.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
R20	Multilateral Agency	Science support	International Livestock Research Institute (ILRI) (part of CGIAR), Kenya In cooperation with the Institute of Meteorology and Climate Research (IMK-IFU), Karlsruhe Institute of Technology.	ILRI works since decades on livestock production systems in Africa, with a particular focus on East Africa, including the Lake Victoria region. In the last years ILRI established a new research direction focusing on nutrient balances, use of manure for feed food production, and quantifying environmental footprints of livestock production systems including effects of land use change. In this context ILRI also worked on nitrogen balances for the Lake Victoria watershed and entire Africa. In close cooperation with the Institute of Meteorology and Climate Research (IMK-IFU), ILRI has the capacity to run biogeochemical models at regional scale for quantifying and assessing N flows.
R21	Multilateral Agency	Practice & Policy Support	Lake Victoria Basin Commission (LVBC), Kenya	The institution of East African Community mandated to coordinate different actors for sustainable development of people and resources within Lake Victoria Basin. Some of the Mandates are on water resources, environment and Natural resources. LVBC has acquired experiences on Nitrogen deposition through different projects implemented under LVBC coordination. These projects include LVEMP I and LVEMP II world Bank funded projects; USAID funded projects and National initiatives. Through these projects LVBC has data and other information related to nitrogen management in the Lake Victoria that can be shared. LVBC has experts that can be used to collect data, analyze and provide information. Ongoing LVBC projects will build synergy to the 'Towards INMS' project; and therefore provide more information on atmospheric deposition in the Lake Victoria which is thought to contribute 80% of the total N in Lake Victoria.
R22	Others	Science & Practices	Karlsruhe Institute of Technology, IMK-IFU, Germany	The Institute of Meteorology Karlsruhe (IMK-IFU) is based at Garmisch-Partenkirchen, Germany, providing world leading expertise on biosphere-atmosphere-hydrosphere interactions in the nitrogen cycle. They combine measurement and modelling expertise and will contribute to the synthesis activities of INMS, especially A2.3 (preparation of consolidated global assessment) and the East African demonstration under Component 3. IMK-IFU works closely in conjunction with the International Livestock Research Institute (ILRI), Nairobi.
R23	Others	Science & Practices	Ghent University (UGENT)	Research on process understanding of N-cycle, N-excess (N-deposition, NO_3 leaching, N_2O emission) and fertilizer N use efficiency, with substantial international experience with use of state of the art isotope based tools. The current focus is especially towards Africa including N deposition and N process work (incl. N_2O) in tropical mountain forests, nitrate source apportionment (Lake Victoria and Nyungwe forest) and biological N_2 fixation for sustainable agricultural intensification for smallholder farmers. The focus of the UGENT contribution to INMS will be the use of nitrate and boron isotopes to apportion source of nitrate in Kenyan rivers draining to Lake Victoria. This would contribute to constraining the N budget of lake Victoria. UGENT has experience in the analyses of isotopes in nitrate and the use of Bayesian isotopic mixing models to quantify nitrate sources. Currently UGENT is working with on rivers in Kenya already via an IAEA funded project and training program.
R24	Others	Science & Practices	Laboratoire d'Aérologie Observatoire Midi-Pyrénées (LA UMR)	Contribution to case studies for developed countries with insufficient N_r: West and Central Africa and Lake Victoria (LV) case studies. Key issues: air quality, greenhouse gas balance, atmospheric emission and deposition of N_r. Experience and partnership: coordination of the long term monitoring deposition network IDAF (IGAC-DEBITS-Africa), label WMO, partner of EADN (Equatorial Atmospheric Deposition Network), GEF UNEP Project. A French national proposal has been submitted for a pilot study in the LV catchment (partners: ILRI, University of Nairobi). Scientific objectives: N_r emission, wet and dry deposition measurements above soil and water, Atmospheric N_r budget and GES balance.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
			CASE 3: Nitrogen challenges for transition economies	
R25	Others	Science & Practices	Odessa National I. I. Mechnikov University (ONU), Ukraine	ONU has large experience the Eastern Europe regional demonstration: 1) the Low Dniester basin (INTAS Project “Development of New Methods to Process Information about the Quality of Water in River Basins”; EU-TACIS Project «Technical Assistance for the Lower Dniester Basin Management Planning»; EU-FP6 NitroEurope, EU-FP7 ECLAIRE and 2) the Low Danube basin (EU-TACIS Project «Lower Danube Lakes: Sustainable Restoration and Protection of Habitats and Ecosystems»). Responsible for integrated monitoring in North-Western part of the Black Sea basin, most recently the FP7 PERSEUS Project “Policy-oriented marine Environmental Research for the Southern European Seas” and UNDP-EU EMBLAS Project «Improving Environmental Monitoring in the Black Sea” and UNDP-EU EMBLAS-II Project «Improving Environmental Monitoring in the Black Sea» (2014-present). Activities include a permanent state-of-the-art research station "Petrodolinskoe" and three sites for atmospheric deposition collection and river water sampling in the Low Dniester basin, as well as the integrated monitoring station "Zmiinyi Island" located in the North-Western part of the Black Sea.
R26	Others	Science & Practices	Institute of agroecology and environmental management of National Academy of Agrarian Sciences (IAEM), Ukraine	Research at IAEM is aimed to increase the role of the environmental component of agriculture in Ukraine. As a result of the use of mineral nitrogen fertilizers, industry production and the number of farm animals, the problem of eutrophication of water sources is particularly acute. This indicates the loss of nitrogen throughout the all nitrogen cycle. The contribution focuses on the East Europe regional demonstration (Dniester, Prut and Lower Danube). The activity aims to demonstrate how a cross cutting approach that joins up different parts of the nitrogen cycle, including the benefits and threats, can deliver a stronger gravity for better management of these issues. Approaches for evaluating of nitrogen flows will be developed at the level of regional demonstration.
R27	Non-ministry public body	Science & Practices	Federal State Budget Scientific Institution “Institute for Engineering and Environmental Problems in Agricultural Production” (IEEP), Russia	Focus on nitrogen flux control as a part of environmental management on a farm level, including methods of environmental assessment of agricultural enterprises based on NUE (nitrogen budgets) and the guidelines for improved manure management on large-scale livestock farms in compliance with relevant national and international legislation, with the outputs being tested on several pilot farms. (Co-chair of the UNECE Expert Panel on Nitrogen in EECCA countries, EPN-EECCA).
R28	Non-ministry public body	Science & Practices	Federal State Budget Scientific Institution “All-Russian Scientific Research Institute for Organic Fertilizers and Peat” (VNIIOU), Russia	Research and Development with estimation of N balance and cycle for different organic and mineral fertilization schemes in long-term field experiments (LTE) and development of measures which decrease atmospheric loss and leaching in groundwater of mineral N applied with organic fertilizers and prevent losses under storage of organic fertilizers. R&D to construct the model of N dynamics in conventional, organic and intensive farming. Estimation of N balance in Russian agriculture (Co-chair of the EPN-EECCCA). Highly relevant is the ongoing joint project with IEEP and UBA-Germany ‘EECCA BAT IRPP’ on Best Available Techniques for intensive rearing of pig, poultry and cattle in EECCA countries.

#[53]	Sources of Co-financing	Type	Name of Partner	Nature of Contribution
R29	Others	Science Support	Scientific Research Institute for Atmospheric Air Protection (SRI), Russia	Interest in developing an understanding of the processes of the global nitrogen cycle. Main activities: Accounting of national emissions; Modelling of air pollutant transport and deposition using EMEP model and CMAQ, meteorological models MM5 and WRF. Recent projects include: Russian-Swedish project "Development of the Co-operation within the Convention on Long Range Transboundary Air Pollution" implementation of the GAINS model in the Russian Federation; EECCA project "Facilitating the implementation and ratification of the protocols of the Convention on Long-Range Transboundary Air Pollution in Eastern Europe, Caucasus and Central Asia"; "Support in creating national emission inventory system needed for joining CLRTAP protocols and meeting corresponding reporting commitments"; "Review of existing and required capacities for addressing adverse environmental impact of transboundary air pollution in North-East Asia" under the UNESCAP North-East Asian Sub-regional Programme for Environ. Cooperation.
R30	Multilateral Agency	Policy & Practices Support	Commission on the Protection of the Black Sea Against Pollution (BSC PS), Turkey	Is a key user of the outcomes of 'Towards INMS' and at the same time will share datasets and facilitate knowledge exchange to support the East Europe INMS demonstration, which focuses on the Dniester, Prut and Lower Danube which flow in to the Black Sea.
			CASE 4: Nitrogen challenges for developed regions with excess reactive nitrogen [without GEF resources]	
R31	Others	Science & Practices	University Pierre and Marie Curie (UPMC), France	The METIS lab, in association with the Center of National Research (CNRS), is focusing its activity on hydrogeophysical and biogeochemical modelling including ecological modelling experimentally-based approach (Riverstrahler), taking explicitly the processes of microorganisms involved in the C, N, P, Si and oxygen cycles. The model links the water quality of river continuums from land-to-sea with human activities in the basin (water pollution by domestic effluents, agriculture contaminations). The nitrogen cascade and the nitrogen cycle in the water-agri-food have received major attention in the last 5 years, from local to global scales. The interest of the group includes analysis of the performance of organic agriculture in terms of N losses in the environment. Leads the West Europe regional demonstration activity.
R32	Others	Science & Practices	Technical University of Madrid / Universidad Politécnica de Madrid (UPM), Spain	UPM has developed different research programs related to the development of sustainable management practices for agriculture. Primary areas of experience include carbon and nitrogen dynamics in agroecosystems, nitrogen loss in the form of NO_3^- leaching and emissions of N_2O, NO_x and NH_3, greenhouse gas exchanges (CO_2, CH_4 and N_2O) and carbon sequestration in agroecosystems, soil resource sustainability as influenced by land management (e.g. conservation agriculture practices). UPM research will bring to 'Towards INMS' valuable technical experience base on its expertise areas and results from ongoing field experiments.
R33	Others	Science, Practicies & Policy Support	Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Spain	The is focused on quantifying the interactive effects of ozone and nitrogenous compounds on Mediterranean vegetation and defining air pollutant threshold values (critical loads and levels) for the protection of ecosystems. Our group has experience on atmospheric nitrogen deposition, particularly dry deposition. We are investigating the interactive effects of ozone and nitrogen enrichment on yield and quality of crops. We are interested in the influence of climate change and air pollution on carbon and nitrogen cycles and soil-plant-atmosphere interactions in Mediterranean forests ecosystems and crops. This group has hold different agreements since 2001 with the Spanish Ministry of Environment with the objective to apply and adapt the methodologies developed under the LRTAP Convention.

Section 6: Monitoring and Evaluation Plan

182. The project will follow UNEP standard monitoring, reporting and evaluation processes and procedures. Substantive and financial project reporting requirements are summarized in Appendix 7 of the Project Document. Reporting requirements and templates are an integral part of the UNEP legal instruments to be signed by the executing agency (CEH on behalf of INI) and UNEP. For the purposes of M&E activities (and the reading of this document), the Project Co-ordinator will function under the direct supervision and control of the Project Director to fulfil the M&E needs.

183. The project M&E plan is consistent with the GEF Monitoring and Evaluation policy. The Project Results Framework presented in Appendix 4 includes Specific, Measurable, Achievable, Relevant and Time-bound (SMART) indicators and targets for each expected outcome. These indicators along with the key deliverables and benchmarks included in Appendix 6 will be the main tools for assessing project implementation progress and whether project results are being achieved. The means of verification and the costs associated with obtaining the information to track the indicators are summarized in the tables at the end of this appendix (sections 4 and 5 of this appendix). M&E related costs are presented and are fully integrated in the overall project budget.

184. The M&E plan will be presented to the first meeting of the Project Management Board (PMB) to ensure project stakeholders understand their roles and responsibilities vis-à-vis project monitoring and evaluation. The PMB will be responsible for proposing to UNEP management any necessary amendments to the M&E plan during project implementation. Indicators and their means of verification may also be fine-tuned by the PMB. Day-to-day project monitoring is the responsibility of the PCU but other project partners will have responsibilities to collect specific information to track the indicators. It is the responsibility of the Project Co-ordinator to inform UNEP of any delays or difficulties faced during implementation so that the appropriate support or corrective measures can be adopted in a timely fashion.

185. The PMB will receive periodic reports on progress and will make recommendations to UNEP concerning the need to revise any aspects of the Results Framework or the M&E plan. Project oversight to ensure that the project meets UNEP and GEF policies and procedures is the responsibility of the UNEP Task Manager. The Task Manager will also review the quality of draft project outputs, provide feedback to the project partners, and establish peer review procedures to ensure adequate quality of scientific and technical outputs and publications.

186. The UNEP Task Manager will develop a project supervision plan at the inception of the project, which will be communicated to the project partners during the first meeting of the PMB. The Project Co-ordinator will also be responsible for initial screening of the financial and administrative reports from the core partners prior to their submission to the Finance and Management Divisions of the United Nations Office at Nairobi. Progress vis-à-vis the delivery of agreed project outputs will be assessed by the PMB and endorsed by the PPA at least annually. Project risks and assumptions will be regularly reviewed both by project partners and the PCU on behalf of UNEP. Risk assessment and rating is an integral part of the annual Project Implementation Review (PIR), preparation of which will be the responsibility of the Project Manager. The quality of project monitoring and evaluation will be reviewed and rated as part of the PIR, which will be approved by the PMB. Key financial parameters will be monitored quarterly to ensure cost-effective use of financial resources.

187. A Mid-term Review (MTR) or Mid-term Evaluation (MTE) will be organised by the UNEP Evaluation Office or the Task Manager in consultation with the Project Co-ordinator and the outcomes reported to the Project Management Board. The review/evaluation will include all parameters recommended by the GEF Evaluation Office for terminal evaluations and will verify information gathered through the GEF tracking tools, as relevant. The purpose of the Mid-Term Review (MTR) or Mid-Term Evaluation (MTE) is to provide an independent assessment of project performance at mid-term, to analyze whether the project is on track, what problems and challenges the project is encountering, and which corrective actions are required so that the project can achieve its intended outcomes by

project completion in the most efficient and sustainable way. In addition, it will verify information gathered through the GEF tracking tools. The review will be carried out using a participatory approach whereby parties that may benefit or be affected by the project will be consulted. Such parties were identified during the stakeholder analysis (see section 2.6 of the project document). The Project Management Board will participate in the mid-term review/evaluation and develop a management response to the evaluation recommendations along with an implementation plan. It is the responsibility of the UNEP Task Manager to monitor whether the agreed recommendations are being implemented.

188. An independent terminal evaluation will take place at the end of project implementation. The Evaluation Office (EO) of UNEP will manage the terminal evaluation (TE) process. A review of the quality of the evaluation report will be done by EO and submitted along with the report to the GEF Evaluation Office not later than 6 months after the completion of the evaluation. The TE will provide an independent assessment of project performance (in terms of relevance, effectiveness and efficiency), and determine the likelihood of impact and sustainability. It will have two primary purposes:

- to provide evidence of results to meet accountability requirements, and
- to promote learning, feedback, and knowledge sharing through results and lessons learned among UNEP and executing partners.

189. While a TE should review use of project funds against budget, it would be the role of a financial audit to assess probity (i.e. correctness, integrity etc.) of expenditure and transactions.

190. Indicative terms of reference for the terminal evaluation are included in Appendix 11. These will be adjusted to the special needs of the project.

191. The TE report will be sent to project stakeholders for comments. Formal comments on the report will be shared by the EO in an open and transparent manner. The project performance will be assessed against standard evaluation criteria using a six point rating scheme. The final determination of project ratings will be made by the EO when the report is finalised. The evaluation report will be publically disclosed and will be followed by a recommendation compliance process.

192. The GEF tracking tools are attached as Appendix 14. These will be updated at mid-term and at the end of the project and will be made available to the GEF Secretariat along with the project PIR report. As mentioned above the mid-term and terminal evaluation will verify the information of the tracking tool.

193. Indicative M&E activities and responsibilities are shown below. Further details can be found in Appendix 7.

Table 8: *Indicative M&E activities and responsibilities*

Type of M&E activity	Responsible Parties	GEF Budget US$	Time frame
Project Management Board & Project Partners Assembly Inception Workshops	Project Coordinator PCU PMB UNEP Task Manager Project Partners Assembly provides endorsement	38,000	1st PMG and PPA Meetings will serve as Inception workshop and will be held within first four months of project start up.
Inception Report	Project Coordinator PCU PMB UNEP Task Manager Project Partners Assembly provides endorsement	None	Immediately following inception workshop
Measurement of indicators set in the Project Results Framework (Project Progress	UNEP Task Manager Project Coordinator in collaboration with PCU	None	Annually prior to APR/PIR and to the definition of annual work plans

and Performance to be measured on an annual basis)			
APR and PIR	Project Coordinator & PCU UNEP Task Manager PMB	None	Annually
Periodic status reports	PCU	None	To be determined by PCU, UNEP and EAs
Technical reports/Project publications	For previously agreed reports: Component, Activity and Task Leaders as appropriate For new reports: PMB, Component, Activity & Task Leaders, Hired consultants as needed	95,950	To be determined by Project Team, UNEP and PCU, EA
Mid-Term Review	Project Coordinator & PCU UNEP Task Manager Project Partners Assembly provides endorsement External consultant	20,000	Halfway through project cycle
Terminal External Evaluation	Evaluation Team PCU UNEP Task Manager Project Partners Assembly provides endorsement External Consultants	30,000	At the end of project implementation
Terminal Report	PCU PMB UNEP Task Manager Project Partners Assembly provides endorsement External Consultant*	38,000	At least one month before the end of the project
Lessons learned	PCU UNEP Task Manager Partner executing agencies*	None	Yearly as part of the APR
Audit	UNEP Task Manager PCU EA accredited Auditor	4,000	Yearly
TOTAL indicative COST		224,500	

Section 7: Project Financing and Budget

Overall project budget

194. The following table provides a summary by component of the project budget, full details of which are provided in Appendix 1 of Annex 1 of this document.

Budget per Component - Summary Table - INMS				
	Project Components/Activities/Tasks	**GEF Funding**	**Co-Financing**	**Total Project Cost**
Component 1	Tools and Methods for the N cycle	1,400,000	24,259,170	25,659,170
Activity 1.1	Development of N System indicators	230,000	14,383,693	14,613,693
Activity 1.2	Development of threat assessment methodology	185,000	1,887,941	2,072,941
Activity 1.3	Development of methodology for N fluxes and distribution	185,000	3,377,033	3,562,033
Activity 1.4	Tools & Methods for the N cycle	120,000	996,522	1,116,522
Activity 1.5	Flux-impact path models for assessment, scenarios & strategy evaluation	455,000	2,513,226	2,968,226
Activity 1.6	Examination of the barriers achieving to better nitrogen management	110,000	1,100,754	1,210,754
Activity 1.0	Component level coordination	115,000	0	115,000
Component 2	Quantification of N flows, threats and benefits	1,680,000	16,402,475	18,082,475
Activity 2.1	Quantifying N flows, threats and benefits at global and regional scales	480,000	9,371,918	9,851,918
Activity 2.2	Preparation of global assessment of N fluxes, pathways and impacts assimilating lessons from the regional demonstrations	500,000	2,606,138	3,106,138
Activity 2.3	Integrating methods, measures & good practices to address issues of excess & insufficient Nr	260,000	1,988,217	2,248,217
Activity 2.4	Exploration of future N storylines & scenarios with management/ mitigation options & cost-benefit analysis	180,000	1,807,044	1,987,044
Activity 2.5	Collation & synthesis of knowledge, experience & measures adopted by GEF and others on excess & insufficient Nr.	140,000	629,159	769,159
Activity 2.0	Component level coordination	120,000	0	120,000
Component 3	Regional Demonstrations	1,650,000	10,254,630	11,904,630
Activity 3.1	Design common methodology & conduct regional demos to refine regional Nr assessments and improve understanding of regional N cycle.	1,350,000	8,903,363	10,253,363
Activity 3.2	Workshop to synthesize outcomes from demo. activities focusing on reducing adverse N impacts & maximizing co-benefits	130,000	578,832	708,832
Activity 3.3	Building consensus on benchmarking N indicators for different regions and systems	70,000	303,724	373,724
Activity 3.4	Refinement of regional approach to demonstrating benefits of joined up nitrogen management.	50,000	468,712	518,712
Activity 3.0	Component level coordination	50,000	0	50,000
Component 4	Awareness raising and knowledge sharing	980,000	5,659,631	6,639,631
Activity 4.1	Establishment and operation of INMS communications hub (inc. portal, database, comms, public engagement	250,000	847,894	1,097,894
Activity 4.2	INMS training, diffusion and international relations, inc. nitrogen footprinting	165,000	2,525,060	2,690,060
Activity 4.3-4.4	Demonstration of INMS to provide support to international policy frameworks, & developmnt of long-term strategy	175,000	1,240,736	1,415,736
Activity 4.5	Harmonization, publication & dissemination of guidance documents across components	60,000	567,016	627,016
Activity 4.6-4.9	Provision of support to IW-LEARN & engagement with GEF & STAP	250,000	478,924	728,924
Activity 4.0	Component level coordination	80,000	0	80,000
	Project Management			
	Overall Day to Day Project Management through the PCU	290,000		290,000
	TOTAL PROJECT COST ($)	**6,000,000**	**56,575,907**	**62,575,907**

Project co-financing by co-financier

Partner involvement	Sources of co-financing	Type	Partner name/Name of co-financier	CASH CO-FINANCING	IN-KIND CO-FINANCING	TOTAL CO-FINANCING
			Partners primarily with global focus in the project			
C1	GEF Agency	Policy support	United Nations Environment Programme	-	1,708,000.00	1,708,000.00
C2	Non-ministry government body	Science and Policy Support	Natural Environment Research Council	1,134,378	3,820,322	**4,954,700**
C3	Others	Science and Policy Support	University of Edinburgh	-	3,500,000	**3,500,000**
D1	Other Multilateral Agency (ies)	Science	Secretariat to the Convention on Biological Diversity			
D2	Other Multilateral Agency (ies)	Policy support	UNECE Conventions on Transboundary Water and Transboundary Air Pollution	-	100,000	**100,000**
D3	Other Multilateral Agency (ies)	Policy support	Organisation for Economic Co-operation and develpment	-	387,000	**387,000**
D4	Other Multilateral Agency (ies)	Science and Policy Support	Food and Agriculture Organization of United Nation	-	1,844,247	**1,844,247**
D5	Other Multilateral Agency (ies)	Science	World Meteorological Organisation	-	-	**-**
D6	Other Multilateral Agency (ies)	Science and Policy Support	International Institute for Applied Systems Analysis	-	2,000,000	**2,000,000**
D7	Other Multilateral Agency (ies)	Science and Policy Support	European Commissions, Joint Research Centre	-	1,200,000	**1,200,000**
D8	Other Multilateral Agency (ies)	Science and Practices	The Interna tional Maize and Wheat Improvement Center	-	800,000	**800,000**
D9	Non-ministry government body	Science and Policy Support	PBL Netherlands Environmental Assessment Agency	-	1,250,000	**1,250,000**
D10	Non-ministry government body	Science and Policy Support	National Institute for Public Health and the Environment The Netherlands	-	580,000	**580,000**
D11	Non-ministry government body	Science and Policy Support	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	160,000	535,000	**695,000**
D12	Non-ministry government body	Science and Practices	National Institute for Agronomic Research	-	794,000	**794,000**
D13	Ministry government body	Science and Policy Support	United States Environmental Protection Agency	-	1,270,000	**1,270,000**
D14	Non-ministry government body	Science and Policy Support	Federal Environment Agency	-	1,352,152	**1,352,152**
D15	Non-ministry government body	Science and Policy Support	French Agency for Environment and Energy Management	10,000	9,000	**19,000**
D16	Non-ministry government body	Science	Consiglio Nazionale delle Ricerche	-	200,000	**200,000**
D17	Non-ministry government body	Science	Norwegian Meteorological Institute	40,000	200,000	**240,000**
D18	Non-ministry government body	Science and Practices	Victorian Department of Economic Development, Jobs, Transport and Resources - Agriculture Division	200,000	300,000	**500,000**

D19	Others	Science and Policy Support	Alterra Wageningen University and Research Centre	3,137,000	1,866,000	**5,003,000**
D20	Others	Science and Policy Support	Wageningen University and Research Centre, Livestock Research	3,286,250	426,250	**3,712,500**
D21	Others	Science and Policy Support	Energy research Centre of the Netherlands	-	1,006,250	**1,006,250**
D22	Others	Science and Policy Support	Vrije Universiteit	-	300,000	**300,000**
D23	Others	Science and Practices	Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek	-	600,000	**600,000**
D24	Others	Science and Policy Support	Potsdam Institute for Climate Impact Research	-	1,470,137	**1,470,137**
D25	Others	Science	University of Bonn	-	330,000	**330,000**
D26	Others	Science and Practices	Leibniz Institute for Agricultural Engineering	-	20,000	**20,000**
D27	Others	Science and Practices	Aarhus University, Department of Bioscience	-	475,000	**475,000**
D28	Others	Science and Practices	Aarhus University, Department of Agroecology	450,000	950,000	**1,400,000**
D29	Others	Science and Practices	Aarhus University, Department of Environmental Science	-	773,600	**773,600**
D30	Others	Science and Practices	Institute of Water Resources Engineering	-	5,500	**5,500**
D31	Others	Science and Practices	Agrophysical Research Institute	-	75,000	**75,000**
D32	Others	Science Support	Institute of Physicochemical and Biological Problems in Soil Science	15,000	35,000	**50,000**
D33	Others	Science and Practices	Instituto Superior de Agronomia (School of Agronomy) of the University of Lisbon	-	258,000	**258,000**
D34	Others	Science and Practices	Ataturk Horticultural Central Research Institute	65,000	40,000	**105,000**
D35	Others	Science and Practices	Fundacao da Faculdade de Ciencias da Universidade de Lisboa, FP	480,000	50,000	**530,000**
D36	Others	Policy support and Practices	Stockholm Environment Institute at York / York University	5,072	2,571,149	**2,576,221**
D37	Others	Science and Practices	University of East Anglia	-	98,000	**98,000**
D38	Others	Science, Practice and Policy Support	North American Nitrogen Center	-	2,100,000	**2,100,000**
D39	Others	Science and Policy Support	New York University	10,000	30,000	**40,000**
D40	Others	Science and Practices	World Resources Institute	-	497,000	**497,000**
D41	Others	Science and Practices	University of Missouri	133,000	295,000	**428,000**
D42	Others	Science and Practices	AgReseach Limited	100,000	450,000	**550,000**

B1	Private Sector/Business	Policy Interest and Practices	Fertilizers Europe	110,300	36,500	**146,800**
B2	Private Sector/Business	Science and Practices	Centre for Plant Nutrition Hanninghof, Yara GmbH & Co.KG, Germany	-	85,000	**85,000**
B3	Private Sector/Business	Science and Practices	BASF SE	-	100,000	**100,000**
B4	Private Sector/Business	Science and Practices	SKW Stickstoffwerke Piesteritz GmbH	-	171,000	**171,000**
B5	Private Sector/Business	Science, Policy and Practices	PigCHAMP Pro Europa S.L.	140,000	260,000	**400,000**
B6	Private Sector/Business	Policy Interest and Practices	International Fertilizer Industry Association	-	100,000	**100,000**
B7	Private Sector/Business	Science and Policy Interest	International Plant Nutrition Institute			
B8	Private Sector/Business	Practices Development	European Agricultural Machinery			
S1	Civil Society Organisation	Policy and Dissemination	Non-governmental organization New Energy	-	15,000	**15,000**
S2	Civil Society Organisation	Policy and Dissemination	World Wide Fund for Nature conservation			
S3	Civil Society Organisation	Policy and Dissemination	Planetary Boundary Initiative			
			Partners primarily with regional demonstration focus in the project			
			CASE 1: Developing regions with excess reactive nitrogen			
R1	Others	Science and Practices	Institute of Soil Science, Chinese Academy of Sciences	100,000	420,000	**520,000**
R2	Others	Science and Practices	National Institute for Agro-Environmental Sciences	30,000	170,000	**200,000**
R3	Others	Science, Practice and Policy Support	China Agricultural University	400,000	100,000	**500,000**
R4	Others	Science and Practices	China Agricultural University	20,000	50,000	**70,000**
R5	Others	Science and Support	Beijing Forestry University	-	300,000	**300,000**
R6	Others	Science and Practices	Zhejiang University	-	500,000	**500,000**
R7	Others	Science and Practices	Chinese Academy of Science, Center for Agricultural Resources Research, Institute of Genetic and Developmental	80,000	320,000	**400,000**
R8	Others	Science and Practices	Field Science Center for Northern Biosphere, Hokkaido University	-	45,000	**45,000**
R9	Others	Science and Practices	Research Faculty of Agriculture, Hokkaido University	-	10,000	**10,000**
R10	Others	Science and Practices	National Institute for Environmental Studies	10,000	10,000	**20,000**
R11	Others	Science and Practices	Kyoto University	3,000	2,000	**5,000**
R12	Multilateral Agency	Policy Support	Partnerships in Environmental Management for the Seas of East Asia			
R13	Others	Science and Practices	Rothamsted Research	300,000	450,000	**750,000**

R14	Others	Science and Dissemination	Society for Conservation of Nature	-	1,150,000	**1,150,000**
R15	Others	Science and Practices	BBRI Bangladesh	-	205,000	**205,000**
R16	Others	Science and Practices	CSIR-National Environmental Engineering Research Institute	-	60,000	**60,000**
R17	Multilateral Agency	Policy Support	South Asia Co-operative Environment Programme			
R18	Others	Science Practices and Policy Support	Earth System Science Centre/National Institute For Space Research	-	1,050,000	**1,050,000**
			CASE 2: Developing regions with insufficient reactive nitrogen			
R19	Multiulateral Agency	Science and Practices	International Institute of Tropical Agriculture	-	1,000,000	**1,000,000**
R20	Multiulateral Agency	Sciense Support	Livestock Systems and Environment International Livestock Research Institute	-	350,000	**350,000**
R21	Multilateral Agency	Practice and Policy Support	Lake Victoria Commission Secretariat	123,000	200,000	**323,000**
R22	Others	Science and Practices	Karlsruhe Institute of Technology			
R23	Others	Science and Practices	Ghent University	375,000	275,000	**650,000**
R24	Others	Science and Practices	Laboratoire d'Aérologie Observatoire Midi-Pyrénées	58,000	443,000	**501,000**
			CASE 3: Nitrogen challenges for transition economies			
R25	Others	Science and Practices	Odessa National I. I. Mechnikov University	-	70,000	**70,000**
R26	Others	Science and Practices	Institute of agroecology and environmental management of National Academy of Agrarian Sciences	-	270,000	**270,000**
R27	Non-ministry public body	Science and Practices	Federal State Budget Scientific Institution "Institute for Engineering and Environmental Problems in Agricultural	-	115,000	**115,000**
R28	Non-ministry public body	Science and Practices	Federal State Budget Scientific Institution "All-Russian Scientific Research Institute for Organic	-	150,000	**150,000**
R29	Others	Science Support	Scientific Research Institute for Atmospheric Air Protection	-	150,000	**150,000**
R30	Multilateral Agency	Policy and Practices Support	Commission on the Protection of the Black Sea Against Pollution	-	-	**-**
			CASE 4: Nitrogen challenges for developed regions with excess reactive nitrogen [without GEF resources]			
R31	Others	Science and Practices	University Pierre and Marie Curie	-	200,000	**200,000**
R32	Others	Science and Practices	Technical University of Madrid	-	90,000	**90,000**
R33	Others	Science Practices and Policy Support	Centro de Investigaciones Energéticas Medioambientales y Tecnológicas	-	106,800	**106,800**
				10,975,000	**45,600,907**	**56,575,907**

Project cost-effectiveness

195. The project represents exceptional cost-effectiveness in several ways. Firstly, it links USD 6 million GEF contribution with c USD 56 million co-financing from a global network of partners, multiplying the GEF contribution by a factor of ten. Secondly, by bringing together and establishing a global network to work toward INMS, the approach provides the critical mass to catalyze substantial change for a joined up approach to managing the global nitrogen cycle. As explained in the project Incremental Cost Analysis (Appendix 3), the global impact of human activities through alternation of the nitrogen cycle is many times the value of the project. For example, an improvement of global nitrogen use efficiency by 20% has been estimated in *Our Nutrient World* to be worth USD 170 billion per year in net economic and social benefits, including the cost savings for farmers and the environmental and health benefits.

APPENDICES