

Implementation of the UNEA-4 Resolution on Sustainable Nitrogen Management (UNEP/EA.4/Res.14)

Briefing Paper for the Nitrogen Working Group (8-9 June 2020)

NWG Briefing-1 /Inf. Doc. 1

Updated Outline for the International Nitrogen Assessment

Note prepared by the INMS Project Coordination Unit

Summary

A core task is to bring together evidence from across INMS in the form of a global assessment of nitrogen, sources, flows impacts and solutions, including cost-benefit analysis, examination of barriers and opportunities and a synthesis of emerging messages from regional activities. This synthesis draws together outcomes from tools development (INMS Component 1), model application, scenarios, mitigation (Component 2), and regional demonstrations (Component 3). The outputs are expected to be important in helping raise global awareness (Component 4).

Outline negotiations with Cambridge University Press have provided the basis to publish a high impact volume, including costs to allow open access publication of the INA. It is anticipated to produce a volume of c. 600 pages with c. 25 chapters, overall structured as 5 main parts.

Initial consultation meetings, at INMS-3 in Edinburgh April 2018 and INMS-4 in Nairobi April 2019 have been held with the wider INMS community. Editorial meetings have also been held at INMS-4 and in January 2020. The process going forward has now been restructured in the light of COVID-19.

Together with the INA chapters, the product will include a Technical Summary and Summary for Policy Makers, and other possible summaries (for Business, Civil Society, Schools), which are anticipated to be important in distilling key messages and for awareness raising.

This document gives background for the first e-briefing of the Nitrogen Working Group established by the UNEP Committee of Permanent Representatives as a preparatory action for the Interconvention Nitrogen Coordination Mechanism (INCOM). The e-briefing offers Conventions and Member States the opportunity to advise further on the content and approach of the assessment.

Member States are invited to offer comments on the structure of the INA during the meeting on 8 June, as well as by email to inms@ceh.ac.uk up to 18 June.

In cooperation with



1. Rationale in Brief

The core rationale is that a high profile synthesis of knowledge and of emerging findings from INMS on the global nitrogen cycle will make a significant contribution to mobilizing change for better nitrogen management by a) facilitating evidence gathering and improved understanding, b) distilling the key findings, barriers and opportunities and by c) raising awareness at the global scale among journalists, governments and the public. The goal is to provide the first comprehensive assessment that integrates, science, practice and policy across the nitrogen cycle that will ultimately mobilize a stronger, more coherent response for sustainable nitrogen management globally and regionally.

The main part of this document is a description of the outline of the proposed INA product. Appendix A then lists technical details about the editorial and authorship approaches.

2. Results Framework & Timescales

The planned schedule as listed in the INMS Project Document (ProDoc) is summarized in Table 1. Figure 1 then provides a current update on timescales – with the grey box denoting the current time (May 2020). Concerning timing, all parts of the INA (i.e. Parts A-E) are now being prepared concurrently, while it anticipated that finalization of Part E can only be done once advanced Drafts from Parts A-D are ready.

Table 1: Results framework from the Prodoc Appendix 16, Annex1.

Outcomes & Outputs	Indicator	Baseline	Target	Sources of Verification	Assumptions
Output 2.2: Detailed overview of regional/local N flux and consolidation into a global assessment of N fluxes and pathways	Completion of regional assessments of N fluxes, including impacts & lessons from demos	Some regional assessments existing, but not available for most regions.	Agreed scope & outline of global assessment of N fluxes etc. (by end Yr 1) <ul style="list-style-type: none"> Commissioned experts delivered high quality chapters passing peer review (Yr 4) Review of chapters by SPAG, GA and other stakeholders (Yr. 4) Global assessment report published for wider public dissemination (Yr 4) 	<ul style="list-style-type: none"> Scoping document shared with partners and external review Assessment chapters delivered for peer review Modelling and scenario outcomes and delivered and reported Body of evidence on success stories and challenges shared 3 international policy processes using the results 	Timely delivery of chapter drafts and reviews

As discussed in previous INMS meetings, in order to include results of the Towards INMS project as we wish to include the results from the INMS project into the INA, as much as practicable, we have suggested that the final publication needs to be delivered to the publishers at the end of Year 4. Following this the publishers would then need 6 months to format and proof the work (including feedback with editors and authors) - with a planned launch date in 2022. Using this timeline, we need first drafts of the chapters to start arriving later this year and early 2021 – to allow time for harmonisation and cross referencing etc.

1. Chapter and other products

As the process includes a close link to outputs from other INMS activities, it is expected that in many cases INMS Activity Leaders will be invited as Coordinating Lead Authors. However, other chapters may emerge that are not currently in the INMS Work Plan. If it is agreed that other such chapters are necessary and feasible, a wider search for Coordinating Lead Authors may be made.

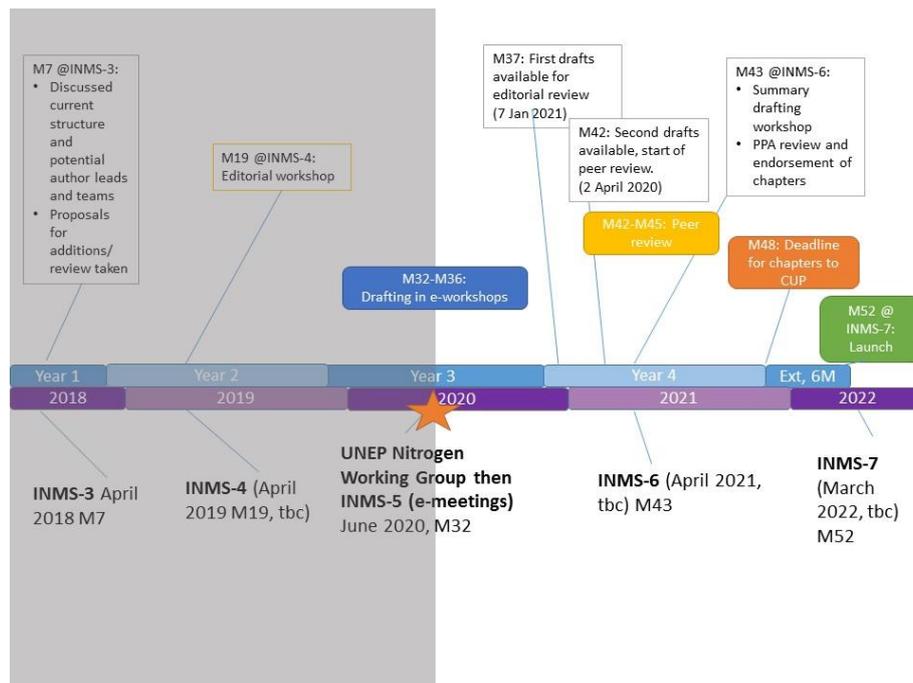


Figure 1: Schedule of actions for the International Nitrogen Assessment (INMS Activity 2.2).

Common themes for all chapters

Experience shows that chapters are most successful where they addressed a specific question, which is therefore addressed in the chapter outlines. The link to the SDGs is anticipated to be a common theme across chapters.

For each chapter, it is planned to have a highly structured chapter summary of up to 500 words covering:

- Nature of the Problem (including key questions and key links to SDGs)
- Approaches taken
- Key findings
- Major challenges
- Recommendations

Such strong and focused chapter executive summaries, will provide a resource that greatly helps the preparation of the overall Summary for Policy Makers and Technical Summary.

Chapter Length. To retain the overall product in c. 600 pages, each chapters is expected not to exceed typically 25 pages.

Additional products

Subject to resources it is intended also to make additional related products:

- INA Resource Pack for Schools
- INA Summary for Business
- INA Summary for Civil Society
- INA Launch Video
- Other INA Briefing Notes

2. Outline of the assessment book

Draft Title Options

“The International Nitrogen Assessment: From multiple challenges to joined-up solutions.”

“The International Nitrogen Assessment: Evidence and actions for sustainable development.”

Other title variants may also be considered.

Front Matter

Foreword Executive Director UN Environment to be invited

Contents

Acknowledgements

Summary for Policy Makers (c. 1 page bullet points, plus c. 15 pages inc. figures)

Technical Summary (c. 15-20 pages inc figures)

1. Introduction: From pollution problems to nitrogen opportunity

Including: short context setting: why nitrogen. Linking of pollution problems, nitrogen as a connecting theme between multiple element cycles; briefly on nitrogen and the SDGs. Setting the scene for the assessment, including INA in relation to underpinning Theory of Change. Context of INA in relation to global developments, including UNEA-4 Nitrogen Resolution, Colombo Declaration, UNEP Nitrogen Working Group and INCOM. (c. 7-10 pages).

Introducing the idea of the 4th Nitrogen Revolution, to be developed in later chapters:

1st Nitrogen Revolution: Agricultural exploitation of biological nitrogen fixation (-2000?). It helped boost food production.

2nd Nitrogen Revolution: Mining of nitrogen from geological sources (+500). It accessed nitrogen compounds to help advance medicine, technology and food production.

3rd Nitrogen Revolution: Industrial mining of nitrogen in the atmosphere (+1900). It enabled huge massive upscaling of fixed nitrogen production, increasing food, human population and pollution.

4th Nitrogen Revolution: Embracing the circular nitrogen economy (+2020...). The transition from linear to circular system for sustainable development, with more nitrogen available for food (less wasted) and massively reduced pollution across multiple issues.

Part A: The global nitrogen challenge: problem definition

2. Nitrogen, environment and sustainable development

Including: Demonstrating the multi-dimensional nature of the nitrogen challenge based on existing information, highlighting the links between different threats, examination of synergies between nitrogen and other element cycles according to environmental media. Relationship to other problems, inc reference to limits theories, e.g. limits to growth, green growth, planetary boundaries, sustainable development. Demonstrating the multiple relevance of nitrogen as a catalysing agent to meet multiple Sustainable Development Goals. (c. 20 pages)

3. Nitrogen and food security

Including: Historical reflection on how nitrogen has been critical to feed the world, and relevance of the four nitrogen revolutions. Illustrations of how much nitrogen is helping food production compared with other elements, and the relationship to comprehensive plant, livestock and human food nutrition. Juxtaposition of regions with too little food and regions with excess consumption. Consideration of nitrogen use efficiency across the food chain in different regions. Consideration of the drivers for why food production and consumption wastes so much nitrogen, with the main pollution losses. Short reflection on challenges for the future (with these themes to be developed in later chapters). (c. 25 pages)

4. Nitrogen in current national and international policies

Including: Focus on the current status of policies that a) are relevant to nitrogen, b) specifically address elements of the nitrogen challenge, and c) specifically develop synergies across different parts of the nitrogen challenge. Consider the status of national policies and examination of the potential for lessons between different regions and countries. Examination of what has been successful, and what has apparently been less successful. Consideration the key barriers and opportunities. Consideration of international nitrogen policy frameworks and policies. To what extent does nitrogen fit so far, and which have been the most successful drivers to date, in relation to different nitrogen challenges and the identification of synergies. Consideration how the regional challenges relate to global context. Link to provision of linked INMS dataset on nitrogen policies as supplementary material. (c. 20 pages).

5. Towards a holistic response to the global nitrogen challenge

Including: developing the framing of how to work together, across policies and regions. Taking existing policy and science processes as the starting point, explain the options and the rationale for moving forward. Highlight key themes as agreed in the UNEP resolution on sustainable nitrogen management, and in the Colombo Declaration. Identify the developing role of the INCOM and how this assessment provides a contribution to informing interconvention coordination. Outline the rationale of the tools being developed by INMS (Part B) and the global assessment approach of flows and impacts (Part C). Outline the forward look in two ways: a) the development of scenarios based on Shared Socioeconomic pathways, which were then applied in the framing of policy arena, moving forward internationally / globally, link to INCOM; perspective toward circular systems - philosophical) - include here the **intro to scenario approach** (as used in Part C) / forward reference to other parts too inc. 1/2NW. (c. 15 pages; links directly to INMS Activities 4.3-4.4). (These themes are then developed in later chapters)

Part B: Foundations for Assessing the Nitrogen Cycle

6. Approaches and challenges to assess nitrogen impacts

Including: i) Introduction (inc. History, Definitions, concepts and conventions); ii) Linkage to Cascade and DPSIR (Driver, Pressure, State, Impact, Response); iii) Characteristics of impacts; The Matrix; iv) Pressure Impact relations; v) Regional differentiation (c. 25 pages; links directly to INMS Activity 1.2).

7. Performance indicators for the global nitrogen cycle

Including: i) Introduction to N-Budgets and Nitrogen Use Efficiency from different perspectives (inc. History, Definitions, concepts and conventions); ii) scales and system boundaries of nitrogen budgets; iii) Work from the Expert Panel on Nitrogen Budgets and CHANS; example cases; iv) Relationships between flow, budget and effects based nitrogen indicators; v) Regional differentiation. (c. 20-25 pages; links directly to INMS Activity 1.1).

8. Approaches and challenges to assess nitrogen pressures and distribution

Including: i) Quantifying pressures and states (inc. History, Definitions, concepts and conventions); ii) Key fluxes to, in and from (a) air, (b) terrestrial systems, (c) aquatic systems, (d) products and trade; iii) Measuring and monitoring; iv) Inventories of nitrogen pressures and flows; v) Relationship to global models. (c. 20-25 pages; links directly to INMS Activity 1.3).

9. Approaches and challenges to value nitrogen benefits and threats

Including: i) Introduction valuation and N-share (inc. History, Definitions, concepts and conventions), including comparison of approaches; ii) Valuation functions for human life and health; iii) Valuation functions for crop, food and wood production; iv) Valuation functions for biodiversity and ecosystem services; v) Interpretation and limitation of valuation results. (c. 20 pages; links directly to INMS Activity 1.4). [Results of the valuation approach are presented in Part C]. [Hans has requested two costs chapters, but they must be shorter therefore]

Part C: Global integrated assessment across the nitrogen cycle

These chapters present outcomes of INMS modelling and available comparison with measurements with a focus on the global scale. They include the drivers, states and assessment of the main key impacts. The main focus is on present conditions, but some modelling approaches also need to include assessment of past conditions in order to understand the present (e.g. hydrological system). Having provided the status of present condition, each chapter will consider future projections based on a short list of the nitrogen scenarios based on Kanter et al. (Global Environmental Change) as summarized in Chapter 5. Agreement still needs to be made on the short list of scenarios to be shown in the main text. It may be possible assessment of other future projections to be included in Supplementary Material. In part E, chapter 27 will provide a shorter synthesis of future projections to bring together across the range of issues across the nitrogen cycle Water, Air, Greenhouse, Ecosystems, Soils etc according to the 'WAGES' mnemonic, with a focus on the forward look through future projections. Substantial use of on-line Supplementary Material is expected.

An outline of the full and proposed short list of future scenarios to be examined be presented to the Nitrogen Working Group in order to gather feedback on what Member States consider of most importance.

10. Assessment of global and continental scale total nitrogen budgets

Including: i) Aim and description of models used to do the assessments of Chapters 10-16: EDGAR, IMAGE, GLOBIOM, MAgPIE. ii) Total N budgets at global scale plus for each of the continents; iii) results shown for present and future projections according to common scenarios; iv) assessment of the main uncertainties (c. 20 pages; links directly to INMS Activities 1.5 and 2.1). The key anticipated elements of budgets include:

- NO_x and NH₃ emissions from all relevant sectors than agriculture (EDGAR, GAINS).
- Land N budgets: divide in cropland, pasture, forests/nature (IMAGE, GLOBIOM, MAgPIE): inputs +losses to air and water.
- N waste streams + river export (IMAGE-GNM, MARINA, DLEM).

11. WATER: Flows on impacts of nitrogen on freshwater, coastal and marine systems

Including: i) Aim and description of models used to do the assessments: Global NEWS, GNM, DLEM, ERSEM-NEMO; ii) Global scale river export of N to coastal systems (intercomparison of results by Global NEWS, GNM, DLEM); iii) Link to NANI and critical N input exceedances. Implications for impacts of nitrogen pollution on freshwater and coastal ecosystems; iv) ERSEM-NEMO results and implications of nitrogen pollution threats for marine ecosystems; v) assessment of the main uncertainties. For each of sections ii) to iv) the results will focus on present and *future projections* according to common scenarios, considering the context of past change. [Open question: what can be said about nitrogen and ground-waters?] (c. 30 pages; links directly to INMS Activities 1.5 and 2.1).

- 12. AIR: Emissions and air quality impacts of nitrogen on human health and crops**
Including: i) Aim and description of models used to do the assessments (TM5-FASST, EMEP4Earth, any others?); ii) Global scale emissions of NO_x and NH₃, including spatial visualization of major source sectors (e.g. illustrating roles of fossil fuel, biomass burning, agricultural sources etc); iii) Global simulation of atmospheric concentrations of NO_x, NH₃, O₃, PM and total N deposition for key receptor types; iv) *Future projections* according to the agreed common scenarios for Part C; iv) Attribution of nitrogen to impacts on human health (PM, O₃ and NO₂ linked) and crop yield (O₃ linked); v) 'Perturbation' work (??) with TM5-FASST (results can be used for the CBA) [to be further explained], vi) Consideration of major uncertainties (e.g. in climate dependence of emissions, and attribution of PM effects). (c. 30 pages; links directly to INMS Activities 1.5 and 2.1).
- 13. GREENHOUSE: Impacts of anthropogenic nitrogen use on global warming potential and radiative balance, and role of nitrogen for stratospheric ozone depletion**
Given the work done in INMS, the main focus is on the effects of nitrogen on global warming potential. As a supplementary element of this chapter, the role of N₂O in climate is also compared with a summary of the latest evidence of N₂O and stratospheric O₃ depletion. (More detailed assessment of N₂O and stratospheric O₃ has been considered elsewhere).

The chapter includes: i) Global scale impacts of anthropogenic nitrogen use on global warming potential, ii) Consideration of direct and indirect emissions of nitrous oxide; iii) Consideration of the effect of nitrogen on carbon sequestration (inc. effects of N fertilizer input in agricultural land and atmospheric N deposition to non-agricultural land resulting from NH₃ and NO_x emission), iii) Consideration of the effect of NO_x emissions in reducing carbon sequestration through formation of tropospheric O₃; iv) Consideration of the effect of NO_x and NH₃ emissions on particulate matter (PM) and its potential direct and indirect effects on radiative balance; v) Assessment of the overall effect of nitrogen on global radiative balance; vi) Consideration and implications of the common *future projections* of Part C; vii) Significance of nitrous oxide as a contributor to stratospheric ozone depletion, including possible *future projections*; viii) Consideration of major uncertainties. (c. 30 pages; direct link to INMS Activities 1.5 and 2.1).
- 14. ECOSYSTEMS: Inputs of nitrogen to terrestrial and aquatic ecosystems and the impacts on biodiversity.**
Including: i) Aim and description of models used to do the assessments: Critical Loads and Critical Levels assessments, GLOBIO and GLOBIO aquatic [the scope implies potential for including other models, inc link to atmospheric models...]; ii) Global scale N inputs to terrestrial and aquatic ecosystems and exceedance of critical nitrogen loads and levels; iii) Impacts of N inputs on eutrophication/biodiversity indicators (using results of GLOBIO aquatic model); iv) Consideration of gaps and major uncertainties. (c. 20 pages; direct link to INMS Activities 1.5 and 2.1).
- 15. SOILS: Inputs, outputs and impacts of nitrogen for agricultural land and relationships with non-agricultural land.**
Including: i) Aim and description of models that are used to do the assessments: IMAGE, GLOBIOM, MAGPIE, plus any other impact-related tools; ii) Global scale distribution of N fluxes and N performance indicators for agricultural land (IMAGE, GLOBIOM, MAGPIE, DLEM), iii) estimation of N inputs, N uptake, N surplus, iv) estimation of benefits for food and threats to agricultural soils, v) Consideration of the major losses from agricultural land, including N losses by emissions to air (NH₃, NO_x, N₂O) and water (NO₃ leaching to ground water, N runoff to

surface water); vi) Estimation of potential adverse impacts, including soil acidification and relationship to Net Agricultural Nitrogen Inputs (NANI) and other performance indicators (inc. N surplus and Nitrogen Use Efficiency; vii) Consideration of major implications, land management considerations and uncertainties. For each of parts ii) to vi) the assessment will include both present conditions and *future projections* based on the common scenarios for Part C. Outputs include tables at world, continent and country scale, plus maps. (c. 25 pages; direct link to INMS Activities 1.5 and 2.1).

16. Costs and benefits of nitrogen at global and regional scales.

Including: i) Brief outline of the approaches used to do the CBA, as informed by the methods description already given in Chapter 9; ii) relationship of drivers (food, energy, goods and services demands), pressures (flows to water, air, farmland, natural land, food, ocean) and impacts (health, climate, ecosystem/biodiversity, food, recreation etc); iii) integration of the cost benefit approach and results for the base year and future projections according to the common scenarios outlined in Chapter 5. (c. 15 pages; direct link to INMS Activities 1.4, 1.5 and 2.1).

Part D: Nitrogen challenges and opportunities for key world regions

As far as possible a common approach is used for the regional chapters of the INA, together with a chapter on the approach, synthesis and lessons. The following principles have been agreed on the overarching approach of the regional chapters:

Principle 1: Each chapter must be multi sector and deal (as far as data allow) with all source sectors and all nitrogen forms.

Principle 2: Each chapter should demonstrate the INMS Regional Methodology, showing how sources link to impacts, priorities, solutions, barriers and success stories, and how the Integrated Nitrogen approach may help catalyse change.

Principle 3: We want a broadly common approach of the chapters, though the exact mapping out will vary in content as e.g. different issue priorities and scales are identified. Common sections and order is expected, but overall space allocation may vary between chapters according to regional priorities.

Principle 4: The scale of each INA chapter may not necessarily be exactly the same as the INMS demo area. One demo region primarily addressing the continental scale, may focus on large scale with short case studies; while another demo primarily addressing small scale may give more attention to setting this in the regional context.

Principle 5: It has been agreed that estimating the regional nitrogen budget is a useful means of bringing evidence together and informing on opportunities for abatement, mitigation improving system efficiency. Such estimates will be made for the regions as far as the data allow.

Principle 6: The chapters may make use of Electronic Supplementary Material to allow more detailed presentation of results where needed. (This principle applies to all chapters in the INA).

Principle 7: Each INMS demonstration, from which the INA regional chapters are being developed is based around cooperation between more than one country. Therefore every regional chapter has should identify throughout it (from Intro to discussion) the lessons being learned from the multi-

country approach (e.g. transboundary pollution, success stories between different national approaches to solution, lessons shared by working together)

Considering these principles the following parts of the regional chapters planned (page allocations are approximate and may vary between chapters according to need):

i. Introduction & Context of the Region: Character of the region, including the countries involved and potential topics of importance being examined between the involved countries (**1 page**)

ii. Analysis of Nitrogen Sources: The chapter should cover all N source sectors, while using Supplementary Material to give further evidence if needed (**7 pages**)

iii. Analysis of Nitrogen Budget: Pulling together the emissions and flows to make a nitrogen budget for the demo region, with the purpose of identifying the major opportunities to improve system-wide nitrogen use efficiency, circularity and to reduce nitrogen pollution (**3 pages**).

iv. Analysis of Key Nitrogen Threats: As informed by stakeholder engagement in the Demo Region, if particular issues important within the wider WAGES perspective, drawing on Part C Characterising the nature and priority issues for this demo region (**4 pages**).

v. Description of region in relation to agreed performance indicators: Suggest to harmonize this with a global/regional chapter specifically bringing together indicators. With this in mind, then suggest short section in each regional chapter (**1 page** text in addition to figures already shown).

vi. Options for Better Nitrogen Management: Bearing in mind the flows and the priority threats identified, what are the options for solutions and better nitrogen management across the different sources, and considering regional context. These can be measures already implemented or for *future* implementation, considering the different source sectors and N flows (**3 pages**).

vii. Progress in implementing Sustainable Nitrogen Management: This includes Success Stories, Barriers-to-Change and demonstration of a joined-up N approach. What has been done; use text box or two for 1 or 2 success stories; show how the nitrogen approach is helping to overcome barriers, mobilize or inform change. Highlight the emerging policy lessons (**3 pages**).

viii. "Regional Future look". This may draw on the global scenarios chapters to consider specific regional circumstances about possible futures, especially in relation to regional priorities. Where are things going according to current business as usual, if policies are or are not adopted? Information on current rates of change can be of interest, and a basic business-as-usual projection (**1 page**).

ix. References Assume **2 pages** for references in double column format.

Using this model, the following chapters are proposed for Part D:

17. Approach, Synthesis and Lessons and from the Regional Nitrogen Assessments

Including: comparisons between regions including on key indicators, such as nitrogen use efficiency, N related outputs, N surplus/deficit and threat-based indicators. The focus is on present conditions (c. 20 pages)

18. Assessment of nitrogen flows, impacts and solutions in East Asia (with special focus on East China Sea as common area of interest to INMS demonstration activity). (c. 25 pages)

19. Assessment of nitrogen flows, impacts and solutions in South Asia (whole sub-continent as covered by INMS demonstration activity). (c. 25 pages)

20. **Assessment of nitrogen flows, impacts and solutions in Africa** (with focus on Lake Victoria catchment INMS demonstration activity). (c. 25 pages)
21. **Assessment of nitrogen flows, impacts and solutions in Latin America (with focus on La Plata River Basin INMS demonstration activity)**. (c. 25 pages)
22. **Assessment of nitrogen flows, impacts and solutions in West Europe** (with focus on coastal seaboard INMS demonstration activity within EU context). (c. 25 pages)
23. **Assessment of nitrogen flows, impacts and solutions in East Europe** (with focus on East Europe INMS demonstration activity and key characteristics of EECCA context). (c. 25 pages)
24. **Assessment of nitrogen flows, impacts and solutions in North America** (with focus on Nooksack INMS regional demonstration activity within North American transboundary context). (c. 25 pages)

Part E: Grasping the future challenge

These chapters bring together the forward look for the assessment. They draw on the evidence from the methods, upscaling, scenarios and regions to consider what is needed to deliver change where Sustainable Nitrogen Management becomes a key part of achieving impact for the Sustainable Development Goals.

25. **Key actions for better nitrogen management**
Including: i) Consideration of the most promising measures according to sector, region, climate; ii) Highlight multiple synergies from measures, including how to design ‘packages of measures’ to maximize co-benefits / minimize trade-offs; iii) Contrast case studies to visualize how measures fit together; iv) Introduce the INMS Measures Database (link to Supplementary on-line Material); v) Describe the methodology for identifying the Nitrogen Top 10 – defining criteria for the most effective measures, leading to: vi) listing of the Nitrogen Top 10 measures (regional Top 10s may also be proposed). (Link to INMS Activity 2.3, c. 25 pages).
26. **Addressing the barriers to better nitrogen management**
Including: i) What makes addressing nitrogen pollution so challenging, particularly in the agricultural sector? Highlight economic, social, cultural and other factors, plus insights from rural sociology, geography, anthropology etc.; ii) How do these barriers differ across different actors? (Government vs. private sector vs. civil society vs. consumers); iii) How the emerging insights inform approaches to overcome barriers, contrasting different regions/sectors/ political systems? iv) What are the easiest vs. most difficult barriers to overcome? The chapter is expected to be informed by the results of a specific survey related to implementation of measures and policies conducted as part of INMS (link to INMS Activity 1.6, c. 20 pages).
27. **Synthesis of possible futures for the global nitrogen cycle**
This chapter brings together possible nitrogen futures drawing on storylines and Shared Socio-Economic Pathways (SSPs) for nitrogen (from Chapter 5) and the outcomes of mapping and modelling (Chapters 10-16). Includes: i) Summary of previous scenario efforts for nitrogen, emphasizing lack of integrated approach; ii) Illustrating how the different nitrogen storylines are brought together with quantitative evidence from across the threat-based chapters (Chapters 10–16) (core part of chapter); iii) synthesis of the scenarios, showing different ways

of looking at the outcomes; iv) reflection of the outcomes, based on stakeholder engagement of the draft results: commenting on how different stakeholders see the dominant nitrogen threats and opportunities; iv) distillation of the key messages for the future according to the scenarios viewpoint, e.g. what may happen if no action is taken? What are the alternatives? v) Nitrogen interactions: nitrogen and climate from directions (Climate change worsening nitrogen threats; Nitrogen worsening Climate threats; Opportunities for win-wins with Climate-smart nitrogen management; (c. 30 pages; Direct link to INMS Activities 2.1 and 2.4).

28. Goals and Pathways: How to Halve Nitrogen Waste by 2030?

Including: i) Developing the narrative of halving nitrogen waste as a high-level ambition and communication tool; ii) Discussion on dates and urgency: what are the implications of aiming for 2030 or 2050? iii) Explain the ‘backcasting’ approach, what broad actions would be needed to halve nitrogen waste? (drawing on Chapters 10–16, 25, 27); iv) and what are options for different pathways, also bearing in mind the possible timescales? v) Contrasting global and regional differences to possible pathways: what is common/different between regions? v) Summarizing the benefits that would be gained by halving nitrogen waste. Refining the key statistics and narrative for (circular) economy, innovation, environment, health, ecosystems etc (c. 20 pages; lined to INMS Activities 2.4 and 4.3).

29. Evaluation of policy options and instruments for better nitrogen management

Including: i) Briefly recap relevant conclusions from Chapter 5 (nitrogen in current policies); ii) present an evaluation framework for what constitutes an “effective” policy option/instrument; iii) Across each sector, consider what appear to be the most promising/historically effective policy options for improving N management? (transport, industry, wastewater, agriculture, integration...); iv) consider case studies across different countries (may here draw on lessons from example GEF engagement); v) Consider Full-chain NUE policy dimension: What would a more integrated set of policy instruments look like? How to minimize trade-offs/maximize synergies? vi) Exploration of possible innovative policy approaches for nitrogen (e.g., design standards in fertilizer industry, nitrogen labelling etc., policies linking and mobilizing different actors from producers to consumers). (c. 20 pages; Link to INMS Activities 2.5, 4.3).

30. Nitrogen and public communication

Including: i) Analysis of the different goals and audiences of public communication, consideration of the different stakeholders/actors and how they impact on production/ consumption/ and nitrogen pollution. What needs to be communicated better and why? ii) What can be learned from the successes/failures of public communication around other major environmental issues? iii) Role of different public communication channels and how they might be used to raise public awareness to catalyze change (e.g., Social media vs. assessment reports vs. policy briefings, SDGs etc.); iv) Examples of nitrogen communication plans for different audiences: for the public, for schools, for business, for governments. Illustrate possible narratives and possible key messages; v) distillation of possible high-level core messages for public communication (c. 20 pages; Links to INMS Activities 4.1, 4.2, 4.3).

Appendix A: Authorship, Editing and Publishing Arrangements

1. Authorship Approach

In the Indian Nitrogen Assessment (2017) each chapter has simply a list of authors, the first author of which is taken as the lead author. In the European Nitrogen Assessment (2011) a more formal approach was adopted where typically one or two authors are identified at the front of a chapter as “Lead Authors”, with other Authors Listed as “Contributing Authors”. This approach allows that two people may share the effort of being lead author (exceptionally three). This approach may also match to the co-chair approach adopted widely across INMS.

In the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC) a three-tier approach is adopted, consisting of “Coordinating Lead Authors”, “Lead Authors”, “Contributing Authors”. This approach allows for a higher level of sophistication in chapter structure, although conversely can be considered as more complex and unwieldy. Conversely, it can lead to the impression that to be a “contributing author” is less appealing than being listed as a “lead author”, especially as “recommended citations” may exclude contributing authors. This experience from the climate world can also influence expectations in other subjects.

Considering these examples, the resources available under INMS, the anticipated scale of effort, and author expectations, it has been agreed to use a two-tier approach, with a third tier available but only used in exceptional circumstances:

Coordinating Lead Authors: Typically one or two people only. Provide the overall vision for the chapter, liaise with editors and take the lead responding to reviewer comments. They coordinate the overall chapter.

Lead Authors: In general this is the preferred name for chapter authors who contribute to part of the chapter, as guided by the coordinating lead authors. All lead authors sign up to ownership of the chapter and confirm its sign off. This will be the usual level of co-authorship.

(Contributing Authors): For most cases it is planned NOT to list these separately from Lead Authors, giving two levels of authorship. However, if a chapter turns out to be especially complex, at the request of the Coordinating Lead Authors, a proposal may be made to the editors to explain why a three-level hierarchy would be desirable. Based on the strength of the case made and the particular circumstances, the editors may exceptionally agree to allow this label. It is anticipated that contributing authors would make a limited contribution to just one part of the chapter.

Coordinating lead authors are currently being invited, drawing especially on the parts of INMS that have contributed to the work.

2. Editorial Approach

The editors comprise of a mix of component leads, regional representation, and members of the International Nitrogen Initiative (INI). In some cases the INMS regional demonstration lead is also an editor, while others have opted to act as lead author of the relevant demonstration chapter.

The following editors are included:

- Mark Sutton (Lead Editor, INMS Director),
- Clare Howard (Managing Editor, INMS Coordinator),
- Nicole Read (Assistant Managing Editor, INMS team),
- Vincent Aduramigba (INI Africa Director),
- Jill Baron (INI North America Director and C1 co-lead),
- Hans van Grinsven (INMS C1 co-lead),
- Kentaro Hayashi (INMS C3 East Asia Demo Co-lead),
- David Kanter (INI Vice Chair and co-lead INMS scenarios),
- Jean P. Ometto (INI Latin America Director, INMS C2 co-lead),
- N Raghuram (INI Chair),
- Wim de Vries (INMS C2 co-lead).

The INA book is structured into five main parts, with editors taking particular oversight for different parts of the book:

- Part A (Problem definition): Mark Sutton & Clare Howard
- Part B (Foundations for assessing nitrogen): Hans van Grinsven & Jill Baron
- Part C (Global assessment of nitrogen impacts): Wim de Vries & Jean Ometto
- Part D (Regional demonstration and solutions): N. Raghuram & Vincent Aduramigba
- Part E (Grasping the future challenge): David Kanter & Kentaro Hayashi

The **tasks of the editorial team** are as follows:

- To develop the overall structure of the Assessment, under the guidance of the PMB and informed by advice from the Nitrogen Working Group / INCOM.
- To agree the approach to identifying and inviting Coordinating Lead Authors (CLAs) and to recommend inclusion to CLAs the involvement of Lead Authors.
- To contribute to the organisation of Chapter Development and Review Workshops, taking a lead on particular parts as appropriate to expertise.
- To monitor progress of a group of chapters for which they will take particular responsibility.
- To identify peer reviewers for chapters and to evaluate the reviewers comments, providing a steer to the CLAs for revision of chapters.
- To support the review process, assessing comments from external reviewers, across INMS, external processes and country contributions, providing a steer to CLAs.
- To contribute to the drafting of the Technical Summary and Summary for Policy Makers as Lead Authors, together with others where necessary.
- To ensure that revised chapters meet appropriate standards for peer review and that all findings are justified and substantiated.
- To provide ad hoc advice as needed and to engage in the launch of the assessment volume.

The tasks of the **Lead editor** also include:

- To invite coordinating lead authors to lead chapters giving them appropriate guidance as agreed by the Editorial team and with the support of the Managing Editor
- To foster engagement with the PMB and the Nitrogen Working Group / INCOM in advising on development of the assessment.

- To lead on engagement with external bodies and other policy processes, fostering feedback and advice on emerging needs, to be reported back to the Editorial Group and PMB to tune the process according to need.
- To monitor progress the development of chapter drafts, and to organise chapter development meetings, with support of the Managing Editor and Assistant Managing Editor.
- To guide overall approach with other editors, and to monitor progress, with the support of the Managing Editor and Assistant Managing Editor.
- To lead on the preparation of Technical and Executive Summaries with the support of the other editors.

The tasks of the **Managing Editor** and **Assistant Managing Editor** additionally include:

- Provide the central contact point for editors and Coordinating Lead Authors
- Provide the main contact point with Cambridge University Press, especially in relation to timescales, finances, submitting agreed chapters, exchanging proofs.
- Prepare progress reports to the Editorial Team and the PMB especially in relation to timescales and the requirement for time at publishers.
- Work with and provide guidance to editorial assistants at CEH in the implementation of the editorial management tasks.

3. Peer Review and Publishing Arrangements

Peer review Process

The main focus of peer review will be through the appointment of two or three invited chapter reviewers identified by the editorial team. In addition, it has been requested by stakeholders to include an Open Review Process where anyone can comment on chapters.

In order to handle the Open Review Process in an efficient way, given the resources available, it is proposed to make the submitted chapters available in password protected part of the INMS website. Reviewers will need to register as INMS Reviewers users to be able to access this part of the system. This is necessary to avoid open pre-publishing of draft chapters. Announcements will be made to invite chapter reviews, which will be conducted using a web-form approach the structure of which will be agreed by the editorial team.

Following peer review, Coordinating Lead Authors will need to address comments from peer and open review to the satisfaction of the respective editor assigned to each chapter. The Lead and Managing editors will provide oversight of this process to ensure a common standard is reached.

Publishing Process

Outline negotiations with Cambridge University Press have provided the basis to publish a high impact volume, of c. 600 pages, consisting of around 25 chapters. Not all chapters need to be the same length, while Supplementary On-line Material can also be included. The publishing costs are significant, and together with open-access charges for the entire volume are available.

It is possible that unexpected key results of high importance may not emerge until after the deadline for the Assessment. In this case, the PMB may consider the case for publishing a “Special Report of the International Nitrogen Assessment” at a later date.