



Fourth meeting of the International Nitrogen Management System (INMS-4). Full report of the High-Level Segment

29 – 30 April 2019, UN Environment HQ, Nairobi

Summary

The fourth meeting of the International Nitrogen Management System (INMS-4) was held on 29 April – 2 May 2019 at the UN Environment headquarters in Nairobi. The meeting included a high-level segment on 29 – 30 April with representatives of countries, intergovernmental conventions and programs, together with scientists, business, civil society and other stakeholders. The high-level segment allowed rapid follow up of the resolution on Sustainable Nitrogen Management adopted by the fourth UN Environment Assembly (UNEP/EA.4/Res.14).

The meeting recognized the multiple opportunities for better nitrogen management associated with water, air, climate, biodiversity, soils, stratospheric ozone, food and energy, including the need to develop improved coordination between relevant multi-lateral environmental agreements (MEAs). The meeting endorsed the proposal of the UNEA-4 nitrogen resolution to establish an Inter-convention Nitrogen Coordination Mechanism and identified the next steps.

The meeting noted that the “Towards INMS” project supported by the Global Environment Facility offers an opportunity to jumpstart implementation of the UNEA-4 resolution by provision of scientific and technical support. The engagement with UNEP Permanent Representatives and other government experts, together with relevant intergovernmental conventions and MEAs, allowed examination of the multiple connections across the nitrogen cycle, while providing guidance on priorities.

The meeting agreed that coordination is needed to address sustainable nitrogen management at three levels including the interactions between these levels:

1. Intergovernmental co-ordination, especially between countries, conventions, other MEA’s and stakeholders
2. National co-ordination within countries, between different ministries, agencies and other stakeholders
3. Provision of science and technical information in support of national and international policy processes, under the guidance of governments.

The meeting identified the need to establish a network of National Focal Points to the Inter-convention Nitrogen Coordination Mechanism. These National Focal Points would help mobilize coordination within countries and allow improved coordination at the international level.

The meeting requested that the Executive Director of UNEP invite countries to nominate National Focal Points to the Inter-convention Nitrogen Coordination Mechanism. The goal should be to establish an efficient process for governments, MEAs, science community and others to coordinate in identifying the multiple benefits of sustainable nitrogen management. As a first step, National Focal Points should be invited to submit a review of current national nitrogen policies and comment on their future plans for improved coordination, to be shared with other countries through the coordination mechanism.

The meeting requested that the Executive Director report on progress in establishing the coordination mechanism to the next annual subcommittee meeting of the Committee of Permanent Representatives in October 2019 and to the 8th International Nitrogen Initiative conference in May 2020.

Report of the High-Level Segment

29 April 2019

Opening

1. The High-Level Segment of the Fourth meeting of the International Nitrogen Management System (INMS-4) was held at the headquarters of UN Environment in Nairobi on the 29-30 April 2019. It was attended by 120 participants from 36 countries, including representatives from a range of multi-lateral environmental agreements.
2. The meeting was co-chaired by Ms Susan Gardner (Director, Ecosystems Division, UN Environment) & Professor Mark Sutton (Director of the International Nitrogen Management System - INMS) of the UK Centre for Ecology & Hydrology.
3. **The meeting was opened by Ms Gardner** who outlined the role of nitrogen as an emerging challenge for the environment. Ms Gardner highlighted how, as a global society, we struggle with air pollution, climate change and declining water quality, biodiversity and health. Inefficient nitrogen use comes with multiple impacts, which equally points to multiple benefits from sustainable nitrogen management. Gases such as ammonia (NH₃) and nitrogen dioxide (NO₂) contribute to poor air quality and can aggravate respiratory and heart conditions, leading to millions of premature deaths across the world; while nitrous oxide (N₂O) is a greenhouse gas that depletes the ozone layer. Nitrate from chemical fertilizers, manure and industry pollutes rivers and seas, posing a health risk for humans, fish, coral and plant life. Ms Gardner emphasized how sustainable nitrogen management can contribute toward solutions to all of them, offering a triple win – for economy, health and environment. Joining up across the nitrogen cycle will catalyse change for a cleaner, healthier and more climate-resilient world.

Addressing the global nitrogen challenge

4. **The UNEA-4 Resolution on Sustainable Nitrogen Management was presented by Dr Ramesh Ramachandran**, Director of the National Centre for Sustainable Coastal Management of the Government of India and Chair of the Global Partnership on Nutrient Management. The resolution as agreed (UNEP/EA.4/L.16) and subsequently edited by UN Environment services (UNEP/EA.4/Res.14) calls for a coordinated and collaborative approach to sustainable nitrogen

management. Mr Ramachandran congratulated INMS on supporting South Asia in development the resolution with the South Asia Co-operative Environment Programme (SACEP) and with the support of the International Nitrogen Initiative (INI). He highlighted how the UNEA-4 Nitrogen Resolution will help to bring nitrogen management into the delivery of Sustainable Development Goals (SDGs), including through the sharing of assessment methodologies, relevant best practices and guidance documents and emerging technologies for recovery and recycling of nitrogen and other such nutrients. He emphasized how the resolution calls for policy integration across scales and countries, to deal with the high fragmentation of policy. Such policy fragmentation is particularly an issue in Asia. Dr Ramachandran called for targets, mandates and incentives for each country to improve nitrogen management and the role of existing mandates/conventions in delivering targets.

5. **Dr Christopher Cox of UN Environment, Ecosystem Division**, summarized the strategic overview of UN Environment on nutrient management & environment, including the Global Partnership on Nutrient Management (GPNM). He emphasized how UN Environment supports INMS and congratulated the 'Towards INMS' project on the progress already made, including contributions made to agreeing the nitrogen resolution and securing funding for the South Asian Nitrogen Hub under the UK Global Challenges Research Fund (GCRF). He noted how nitrogen pollution presents significant barriers to achieving United Nations Sustainable Development Goals on: Zero Hunger, Climate Action, Good Health & Well-being, Clean Water & Sanitation, Affordable & Clean Energy, Life Below Water, Life on Land, No Poverty, Responsible Consumption & Production, and Decent Work & Economic Growth.
6. **Prof. Sutton, Director of the International Nitrogen Management System**, provided an overview of the global nitrogen challenge, reporting on work to establish INMS. He highlighted how INMS brings scientific evidence together to inform policies and the public on the multiple benefits and threats of reactive nitrogen. He noted that it provides a platform for better cooperation across science and policy domains helping to overcome the barriers. This includes providing guidance on joining up mitigation and adaptation options and strategies, linked to circular and green economy thinking. He reported progress in developing a global assessment of the threats and benefits of human alteration of the nitrogen cycle and the opportunities for improvement. Prof. Sutton explained how relevant MEAs are currently fragmented, as are national nitrogen policies in many countries, and that the UNEP Committee of Permanent Representatives has a key opportunity to address this fragmentation by developing the Inter-convention Nitrogen Coordination Mechanism.

National and Regional Perspectives

7. **On behalf of India, Mr Saurabh, Second Secretary of the Indian High Commission to Kenya**, reported the nitrogen challenges and opportunities for India and South Asia. High doses of fertilizer input of nitrogen to agriculture combined with low nitrogen-use efficiency mean that research on nitrogen pollution must be a priority for South Asia. This is emphasised by the scale of nitrogen subsidies across South Asia at around 10 billion dollars per year. Better nitrogen management will have huge economic and environmental benefits. Around 65% of the nitrogen used in India as fertilisers may be getting leaked into soil, water and other natural resources, while significantly contributing to the country's greenhouse gas burden. India uses 27 million tonnes of urea each year, the cost of which is 75% subsidised by the government. Furthermore nitrogen emissions from India's wastewaters continue to grow significantly (in part due to population growth and rapid rural to urban migration) and may become the top nitrogen source

in the next 5-10 years. This may well be true for the rest of South Asia as the region starts reigning in growth in urea consumption.

8. **On behalf of Sri Lanka, H.E. Mr Sunil de Silva, High Commissioner of Sri Lanka to Kenya and Permanent Representative to UNEP, outlined their perspective on sustainable nitrogen management.** Mr de Silva thanked INMS for mediating the global dialogue on nitrogen management and the scientists for their years of hard work which are now coming to fruition with the adoption of the nitrogen resolution and establishment of the GCRF South Asian Nitrogen Hub. On behalf of Sri Lanka, he thanked India for championing the resolution to UNEA-4. He emphasized how we all drink, eat and breathe from our environment, which is being polluted by nitrogen, and the issues are moving at a rapid pace. He recognized that knowledge is the powerhouse which can heal life on earth, and we have a sound science community who are working on all aspects and are connected through the UN. There is a need to link the science, data and social politics, along with the need for strong regulation and strong policies, underpinned by credible research, to allow politicians to formulate policy. Nitrogen is a simple element but it finds its way across all sectors and has a social dimension. Sri Lanka will be grateful to UN Environment to work together on bridging the gap between science and policy and looks forward to working with other countries in developing the next steps.
9. **On behalf of Germany, Dr Marcus Geupel of the Umweltbundesamt, reported on the development of a national strategic approach for nitrogen management.** He explained how Germany has a number of nitrogen-related environmental targets which require actions, these include; National Emission Ceilings (ammonia, nitrogen oxides), Critical Loads for eutrophication, N-Surplus in agriculture as a national goal/indicator, N input to Baltic Sea and into the North Sea, Quality Standards for Nitrate in Groundwater bodies and Nitrogen Dioxide (NO₂) concentration limits. He explained how a 'First Nitrogen Report to the Federal Government' would be delivered on the 31st of May 2019, which agreed on an integrated strategy approach. The report highlights the need for further mitigation measures and potentially the development of an Action Programme on integrated Nitrogen Reduction. The report is available in English (<https://www.bmu.de/en/publication/stickstoffeintrag-in-die-biosphaere-1>). Dr Geupel emphasized the need to address both:
 - a. **Science challenges** to set up a catalogue of N measures, quantifying (economic) benefits of addressing related effects of reactive nitrogen and deriving an integrated nitrogen target value that has precautionary meaning for all other related sectoral limit and target values, and
 - b. **Political challenges** to meet EU and national targets, linking policy areas, adjusting the strategy to related legislative units, fostering cooperation, while raising awareness and acceptance.
10. **On behalf of the European Union, Mr Sebastian Gil, Deputy Permanent Representative of the EU to UNEP, outlined nitrogen policy in the European Union and its possible future development.** He reflected that nitrogen is essential for crops and food, but that much of this nitrogen ends up in the environment. Working on the reduction of nitrogen pollution is important as it is suffocating waterways and threatening air quality, with major impacts on human health including in infants. He emphasized that the EU we takes these issues seriously, with the goal is to truly reduce pollution, rather than to shift pollution from one source to another. This requires a co-ordinated approach, for example the National Ceilings Emissions Directive and the Nitrates Directive, including solutions for covering manure, types of fertilisers, fertilizer timing and use of catch crops. He emphasized that there needs to be coherence between the plans of both these policies, for example if the air pollution policy is applied properly, then there should be more nitrogen available where it is needed. Fitness checks on

whether current regulations are fit for purpose are also made in the case of the Water Framework Directive, include monitoring of nutrient balance. He noted that the EU is working with the UNECE Task Force on Reactive Nitrogen (TFRN) on the joint guidance document for the management of nitrogen – for adoption in 2020. The Common Agricultural Policy gives farmers support and there is scope for green agriculture support, linking to several sources of help and funding. On behalf of the EU, he thanked INMS for bringing these issues to a higher level of awareness.

11. **On behalf of the United States, H.E. Ms Lori Dando, US Permanent Representative to UNEP outlined the benefits of integrated nitrogen management.** She explained that the US recognises the considerable size of the nitrogen challenge, both globally and within the country. The US is addressing nutrient pollution in an integrated approach. The Environment Protection Agency (EPA) is reviewing programs that deliver improved sustainable nutrient, agricultural and land and water management (at the state level); delivering outreach programs on nutrient management across scales. The EPA is also working on improving nutrient management through community projects. This includes providing financing for programs and conducting research and management (i.e. programmes on reducing N losses at municipal plants). The US government supports the work of the INMS.
12. **On behalf of Pakistan, Mr Abdul Jalil Marwat, Chief of the National Fertilizer Development Centre, Ministry of National Food Security and Research, Islamabad, provided a perspective on sustainable nitrogen.** Nitrogen (N) use is high in Pakistan (3.4. M tonnes of N yr⁻¹) compared to other plant nutrients like phosphate and potash, although nitrogen use efficiency (NUE) is <50%. This low NUE is adding to costs of production as the farmer has to use more nitrogenous fertilizers to meet the N requirement of crop. Mr. Marwat suggested that the country should focus on agro-technologies to improve NUE. Leguminous crops in rotation to improve NUE provide an example of this and the concept of adoption of Integrated Plant Nutrient Management System to promote all sources of N i.e. inorganic, organic and bio-sources.
13. **On behalf of the Latin American Centre of the International Nitrogen Initiative, its regional director, Dr Jean Ometto of the Brazilian National Space Agency, provided a regional perspective on sustainable nitrogen management.** Agricultural production in Latin America is high and vital for the economy in the region, but challenges include impacts to waterbodies from nutrient pollution. He emphasized that improving nutrient management, with better fertiliser use and better distribution of products is needed. Necessary improvements in technology include changing wastewater management and addressing nutrient emissions from fossil fuel burning. Mr Ometto endorsed the commitment of Latin America to INMS.
14. **On behalf of Bangladesh, Prof. Mizanur Rahman of the Bangabandhu Sheikh Mujibur Rahman Agricultural University provided a perspective on sustainable N management from Bangladesh.** Prof. Rahman emphasized that Bangladesh is a small country with a high population density. The country needs to use large amounts of nitrogen fertiliser to produce its main staple crop of rice. Because of continuous cropping solely depending on inorganic fertilisers, soil health is deteriorating. Furthermore, high temperature and moisture conditions of the country favour faster mineralization of fertilisers and soil organic matter, which contribute to higher loss of nutrients from cropping systems to the environment. Such losses are thought to be increasing under climate change. Prof Rahman, highlighted that that there is a national incentive to improve nitrogen use efficiency (NUE), but concerns include limited access to better technology (i.e., current farming equipment especially for urea deep placement).

Perspectives from Inter-governmental conventions and programmes

WATER

15. **A perspective from the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was provided by Mr Habib El-Habr, Programme Coordinator of the GPA.** He highlighted that a core aim of the GPA is to prevent the degradation of the marine environment from land-based activities. GPA is achieving this by bringing together governments, the private sector, NGOs, and the scientific community to develop solutions and catalyse action. The GPA plays a significant role in elevating the pollution agenda to the United Nations Environment Assembly (UNEA) through its Pollution Partnerships, which include the Global Partnership on Marine Litter (GPML), the Global Wastewater Initiative and the Global Partnership on Nutrient Management (GPNM).

AIR

16. **A perspective from the Geneva Air Convention was provided through video-link by Ms Anna Engleryd, Chair of the Executive Body of the Convention on Long-range Transboundary Air Pollution.** Ms Engleryd outlined how long-term strategies to reduce nitrogen emissions to the atmosphere will guide work until 2030. However, increased cooperation outside the UNECE area is required, given the hemispheric scale of transboundary air pollution transport. Therefore the UNEA resolutions are timely and welcome. She highlighted the priority to make use of existing policy frameworks, while recognizing that better coordination is needed between the various conventions relevant for nitrogen. This is needed to avoid duplication of policy targets and to provide a coordinated, holistic approach which fosters knowledge exchange across the nitrogen cycle. She thanked the INMS community for its work in supporting science coordination across platforms, and emphasized the need to build on this in developing the Inter-convention Nitrogen Coordination Mechanism identified by the UNEA-4 nitrogen resolution (UNEP/EA.4/Res.14). We must bring all the frameworks together to deliver the integrated approach needed to address the complex challenges of nitrogen use and pollution. Ms Engleryd highlighted that we should not delay, as action is needed urgently to address the air quality and other inter-linked nitrogen challenges.

GREENHOUSE GASES AND CLIMATE

17. **A perspective from the Green Climate Fund (GCF) was provided by Mr Kilaparti Ramakrishna, GCF Head of Strategic Planning.** He emphasized that the connection between SDGs is profound and highly complex. There is no mechanism to ensure that these connections are fully realised. He emphasized the urgency: we are the last generation that can make a significant impact on climate change. Mr Kilaparti explained that the GCF was established in 2010 by the sixteenth Conference of the Parties (COP16) of the UN Framework Convention on Climate Change (UNFCCC). The first board meeting was held in 2012 and the first project approved in 2015. Between 2015 and 2018, 102 projects (USD 5.0 billion) have been approved and 100+ countries reached. The GCF aims to provide an operating entity of the UNFCCC financial mechanism, focusing on being a country-driven fund. The GCF is the largest financial supporter for climate-related projects in the world, with USD 1 million per country, and 17 billion worth of projects currently in the pipeline. It is evident that nitrogen management must be part of this, which is essential to reduce nitrous oxide (N₂O) emissions and to maximize the co-benefits.

ECOSYSTEMS & BIODIVERSITY

18. **A perspective from the UN Convention on Biological Diversity (CBD) was provided through video-link by Mr David Cooper, Deputy Executive Secretary of the CBD.** Mr Cooper explained that excess of reactive nitrogen in the environment is a major cause of biodiversity loss, and also contributes to other connected drivers (i.e. invasive species). Under the CBD program, Aichi Biodiversity Target 9 states that by 2020, pollution should no longer be detrimental to biodiversity. Urgent efforts are needed as it is clear that this Target will not be met by 2020. Actions to reduce nitrogen pollution include subsidy reform, reduction in food waste/consumption, more sustainable agriculture, reduction in ecosystem degradation. Such actions will help protect species, improve ecosystems, reduce impacts on vulnerable ecosystems and reduce invasive species. Measures taken in some region have stabilised nutrient pollution, but pollution is still affecting biodiversity. In other regions, nutrient pollution is still increasing.

STRATOSPHERIC OZONE

19. **A perspective on stratospheric ozone was provided by Ms Sophia Mylona, Senior Environmental Affairs Officer, UNEP Ozone Secretariat.** She explained how ozone depletion increases UV-A and UV-B radiation, impacting human health and degrading biodiversity. She summarized key events in understanding how nitrogen oxides (NO_x) lead to stratospheric ozone depletion: starting with research by Paul Crutzen (1970) identifying NO_x as a causal agent in ozone depletion (1970), leading to the Vienna Convention (1985) and the Montreal Protocol (1987). Although N₂O is not a controlled substance under the Montreal Protocol, Ms Mylona noted that Article 3 in the parent Vienna Convention mentions nitrogen through links to Annex 1 (which mentions N₂O and NO_x). The Montreal Protocol has been adjusted 7 times, amended 5 times. The benefits and achievement of the Montreal Protocol are numerous, including 460 billion dollars saved through prevention of damage to agriculture and fisheries lost, and 2 million cases of skin cancer by 2030. Ms Mylona noted that comprehensive assessments are provided every four years under the protocol, but between these years, the Ozone Secretariat responds to requests for information from partners. As progress has been made in reducing other ozone depleting substances, it is becoming more widely acknowledged that N₂O mitigation would make a significant contribution to limiting stratospheric ozone depletion alongside the benefits through reducing greenhouse gas emissions.

REGIONAL INTEGRATION AND INTER-CONVENTION COORDINATION

20. **On behalf of the South Asian Cooperative Environment Programme (SACEP), Dr Abas Basir, Director General of SACEP provided perspective on sustainable nitrogen management for South Asia.** Dr Basir congratulated the INMS on progress made, including the nitrogen resolution agreed at UNEA-4, which will help to bring nitrogen management into the delivery of the Sustainable Development Goals. He noted that the resolution clearly calls for policy integration across scales and countries, to deal with the high fragmentation of policy (e.g. freshwater, marine, air, climate, biodiversity, stratospheric ozone, food, energy). Dr Basir called for targets, mandates and incentives for each country to improve nitrogen management and the role of existing mandates/conventions in delivering targets.
21. **On behalf of the Lake Victoria Basin Commission, Dr. Ally Said Matano, Executive Secretary to LVBC, provided an African perspective on sustainable nitrogen management.** In Africa, nitrogen issues affect water security, food security and social economic activities. Atmospheric

nitrogen deposition and terrestrial sources of nitrogen are contributing to water pollution and eutrophication of the regions lakes, affecting fisheries and other ecosystem services. Nutrient loading from urban wastewaters, due to a lack of sanitation is also a great issue. Community policies are needed, i.e. limits on effluents diverted to waterbodies. Mr Matano requested multi-stakeholders involved in the nitrogen cycle in Africa to take action to improve nitrogen use efficiency (NUE) and reduce nitrogen losses. Expectations of INMS include providing evidence to support the development of holistic and integrated policies in the region. A commitment was made to contribute to the INMS demonstration region for East Africa.

22. **Discussion on international conventions and cooperation networks for nitrogen.** It was asked of the chairs, how do we see governments using the UNEA-4 Nitrogen Resolution (UNEP/EA.4/Res.14) to make changes to N management within their regions/countries? Among the options for reducing the fragmentation across the nitrogen policy arena, it was noted that a co-ordination mechanism of existing frameworks/conventions seems to most popular. Such an approach could also serve to foster synergies between global multi-lateral agreements and regional programmes, such as LVBC and SACEP. In depth discussion on the Nitrogen Resolution was followed up on 1 May (paragraphs 38-48, below).

Summary of progress in INMS: Science & Evidence to address the Global Nitrogen Challenge

23. **On behalf of the International Nitrogen Initiative, Prof. N. Raghuram, Guru Gobind Singh Indraprastha University, New Delhi and Chair of INI, outlined the global sources and trends in nitrogen pollution.** He explained that the INI has been working with six regional centres which together provide the glue which holds together global science cooperation in nitrogen management. INI has supported the development of nitrogen assessments for Europe, India, China, Brazil and the US, which together will strengthen global nitrogen assessment under INMS. Prof. Raghuram introduced the different forms of reactive N and their common sources, highlighting that nitrogen losses are a huge waste of resources worth \$200 billion/year. He emphasized that Planetary Boundaries have been crossed for nitrogen, linked to a global loss of biodiversity. He highlighted the priority of improving quantification of adverse nitrogen impacts, whilst not forgetting that nitrogen inputs to agriculture have been crucial for food security and population growth. He noted that the 8th INI conference will be held in Berlin on the 3rd-7th May 2020 (<https://ini2020.com/>).
24. **INMS Component 1: Tools for understanding and managing the global N cycle. Dr Hans van Grinsven, of PBL in the Netherlands (Co-lead for INMS C1), described the progress to date.** He noted nitrogen share contributions with mortality by air pollution at around ~30%; Loss of ecosystem services >10%; Food crop yield increase 30-60%. These are global averages, so will vary widely by region. Dr van Grinsven highlighted that the outputs of INMS Component 1 are largely tools to understand/manage global N cycles. Tools included indicators, threat and benefit assessment, N fluxes and distribution, valuation of threats and benefits, flux-impacts models, and identification of barriers to sustainable nitrogen management. Expected outcomes will be reports on current methods to improve nitrogen management at a global scale, supported with the development of new networks to feed into this, on a volunteer basis and using existing data. He highlighted that key challenges will be to make sure that the intended audience will use these outputs, emphasizing the importance of the multi-actor discussions on the following days of INMS-4.

25. **INMS Component 2: Quantifying N flows, threats and benefits. Prof Wim de Vries, of Wageningen University Research in the Netherlands (Co-lead for INMS C2), described the progress to date.** Prof. de Vries highlighted the global scale of nitrogen threats to air, water, climate and biodiversity, noting that that livestock production is the major contributor to human alteration of the global nitrogen cycle. He reported progress in developing integrated quantification of the benefits of better nitrogen management in food, feed and fibre production. A suite of models, scenario, quality and impact models already exist, including the IMAGE model, (which can be used to calculate surplus N budgets over time) and the Global NEWS model (which can be used to predict future N flows, and to model what impacts/N losses are natural and anthropogenic). He noted that Component 2 of the INMS project is developing nitrogen-focused views of story-lines and scenarios, in analogy to the experience of the Inter-governmental Panel on Climate Change (IPCC) for climate, i.e. applying the Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs). This includes consideration of dietary change aspirations to assess the capability potential policies to mitigate nitrogen pollution.
26. **INMS Component 3: Regional demonstration of integrated N management. Dr Cargele Masso of the International Institute for Tropical Agriculture (Co-lead for INMS C3), described progress to date.** Dr Masso considered that food and energy production must increase to support population growth, whilst pollution must decrease to maintain healthy atmospheric conditions. He emphasized that integrated holistic solutions are needed. The key priority of most INMS demonstration regions is to support actions to reduce excess nitrogen use and impacts (East Asia, South Asia, East Europe, West Europe, North America and parts of Latin America). Conversely, in the East Africa INMS regional demonstration (and in parts of the Latin America demonstration) there is a contrasting situation, with insufficient nitrogen, with infertile soils, which cannot support plant/root structures. In all regional demonstrations however, there appears to be substantial nitrogen wasted which contributes to pollution problems, such as nitrogen loading from sanitation, which contributes to eutrophication even in regions with insufficient nitrogen. He highlighted that there is a need for benchmarking nitrogen indicators and sharing common methodologies across the regions to collect comparable data. He highlighted that work is ongoing in explore how the 'barriers to change' vary locally and between regions.
27. **INMS Component 4: Awareness raising and knowledge sharing. Dr Clare Howard, UK Centre for Ecology & Hydrology (Lead for INMS C4), described progress to date.** Dr Howard explained how Component 4 is designed to ensure outputs of all components are used and shared with stakeholders (e.g. citizens/consumers, local managers, private sector, science and academia, IGOs, and policy decision makers). Component 4 activities include the INMS website – for internal and external outputs. Examples of public-facing outputs are the INMS database on measures for improved nitrogen management, new nitrogen-footprint analyses for Latin America and Eastern Europe, and the Massive On-line Open Courses (MOOCs) “Nitrogen - a global challenge” and “Nutrients and Wastewater”. Dr Howard explained that as INMS is supported through UN Environment under the lead of the Global Environment Facility (GEF) International Waters portfolio, Component 4 has a commitment to share works with the wider international waters community. She noted that INMS has been presented at a number of high-level events this year including UNEA-4. The INMS Director also made a commitment on behalf of INI to ‘Halve Nitrogen Waste’ at the ‘Our Ocean Conference’, in Bali, in 2018.¹ This framing is now being explored in relation to nitrogen scenarios and global assessment in INMS.

¹ <https://www.ceh.ac.uk/news-and-media/news/ini-commits-support-global-goal-halve-nitrogen-waste-2030>

28. **Global Assessment: Prof Mark Sutton, UK Centre for Ecology & Hydrology and Director of INMS, described progress in developing the first International Nitrogen Assessment (INA).** Prof. Sutton explained that the first INA will need to balance in-depth details with hard-hitting concise statements. It will include a review of existing and possible goals, as included in the UNECE Gothenburg Protocol, Manilla declarations and Our Ocean Action Plan 2014, which include goals to increase NUE, reduce nutrient pollution and meat consumption. Experience from putting together the European Nitrogen Assessment is helping in developing robust product. The proposed structure for the INA consists of approximately 25 chapters across five parts: 1) Problem Definition, 2) Foundations for Assessing Nitrogen, 3) Lessons from Regional Demonstrations, 4) Integrated Assessment across Multiple Environment Impacts and, 5) Grasping the Future Challenge. In addition to scenario analysis it is planned to include a chapter on possible pathways to Halve Nitrogen Waste, quantifying the multiple benefits. Evaluation of policy instruments and options will be a key focus. The editorial team will shortly be calling for contributors as authors and reviewers. Multi-actor discussion during INMS meetings is providing feedback to tune the approach.
29. Following the presentations, discussion focused on the relevant science and evidence priorities and challenges under INMS:
- It was noted that consideration of the cross-over between policy priorities for governments is important. It is often the case that when a new government comes into power, they set new directions for policy. We need to identify these new directions and ensure that nitrogen issues are highlighted in each relevant region/country.
 - Attracting more countries to engage with nitrogen policy development is crucial. It can often be a 'new' topic, to be considered as a complement to existing issues. It was suggested that we need to make it clear how sustainable nitrogen management can simultaneously deliver on multiple environmental goals which have not yet been achieved, such as climate, water pollution, air pollution and ecosystem health.
 - The comment was made that it will be very challenging to achieve a halving of nitrogen waste by 2030 in Bangladesh against a background of climate change, where there is a risk of increasing nitrogen inputs in response to reduced harvests under climate change.
 - It was noted that the benefits of regional and global actions on nitrogen in relation to the Sustainable Development Goals will need to be highlighted if we want to communicate both INMS and the International Nitrogen Assessment at the highest level.
 - While it was noted that presenting 'nitrogen as the new carbon' has obvious merit, such an approach should be clear to emphasize the much wider range of impacts of nitrogen across multiple environmental challenges (water, air, climate, soils, biodiversity, ozone etc).
 - It was noted that the regional aspect of the International Nitrogen Assessment is unique and should therefore be highlighted.

Global perspectives on nitrogen management

30. **On behalf of the World Meteorological Organisation, Dr Lorenzo Labrador of WMO, outlined the opportunities to link models and measurements as a foundation to improve understanding of nitrogen air pollution.** Dr Labrador outlined the work of the Global Atmospheric Watch (GAW) Programme, while noting that loss of crops due to tropospheric ozone pollution (resulting from emissions of NO_x and volatile organic compounds, VOCs) is costing billions of US\$ annually. He emphasized that there is a clear need for an operational product to monitor the deposition of atmospheric pollutants. The Measurement-Model Fusion (MMF) process for Global Total Atmospheric Deposition (GTAD), being coordinated by WMO,

combines observations with model outputs, with assimilation applied retroactively. The MMF-GTAD over the next three years will assess nitrogen amongst other elements, and it is hoped that the INMS community can be involved in this effort.

31. **On behalf of the International Fertilizer Industry Association (IFA), Mr Patrick Heffer outlined industry perspectives on global N management.** He noted that fertiliser use is increasing, but the rate of increase is decreasing. Around 25% of fertiliser consumption is in China (193 kg per hectare annually), whilst for Africa, it is less than 1.6% (around 7 kg per hectare). R&D for fertiliser industry includes fertiliser technologies, slow and controlled release, water-soluble fertiliser enriched fertiliser, biological products (bio-stimulants etc.), digital precision farming, diagnostic tools and decision-making tools. Mr Heffer noted that there is increased interest in the work of start-up companies, especially in plant nutrition to increase NUE and uptake of nutrients in soils. There has been fast growth of the Slow Controlled Release Fertiliser (SCRSF) markets. The next steps will be to develop additional plant nutrition solutions in the four areas of product, rate, time and place, to provide more options for farmers. He noted that there are also some options for producing fertilisers using renewable energy.
32. **On behalf of the Organisation for Economic Cooperation and Development, Mr Gerard Bonnis provided an overview of the recent OECD report, “Human Acceleration of the Nitrogen Cycle”.** Mr Bonnis explained how the OECD highlights a spatially targeted risk approach. For example, the approach was used to monitor smog in Paris and showed that pollution was coming especially from farmers’ fertiliser and manure use, rather than just from cars. This demonstrated the importance of the nitrogen cascade in local scenarios and spatial placement of sources and subsequent local impacts. A second approach is to deliver measures that address global risks. An example of this would be a precautionary approach to prevent future impacts on the environment (i.e. biodiversity, ecosystem health). A third approach is an integrated policy approach, which provides criteria to guide nitrogen policies which would include effectiveness, cost efficiency and feasibility (wide acceptance and support). Mr Bonnis noted that the risks of pollution swapping between different forms of nitrogen pollution (e.g. between air, water, climate), and strategies to avoid this, should also be a high consideration.
33. **A consideration of Planetary Boundaries and Social Network Analysis was presented through video link by Dr Sarah Cornell of the Stockholm Resilience Centre.** Dr Cornell highlighted how altered geochemical flows of N and P have no Holocene precedent. The quantification of nitrogen and phosphorus planetary boundary levels is ongoing and has been carried out under multiple different scenarios and assumptions. She noted that, whilst numbers can change, the overall message is that the earth system is changing significantly and unpredictably in response to changes in nitrogen and phosphorus flows. Globally, systemic change is occurring. Dr Cornell recommended that a whole new level of integrated science is needed that combines equity, social justice, geochemical flows, and transboundary issues. Cross-cutting impacts and benefits of better nutrient management can contribute to looking after multiple planetary boundaries at the same time. Dr Cornell highlighted links between laws, where citation connectivity network shows gaps, coherence issues and possible opportunities. Social Network Analysis has identified ‘legal gateways’ connecting across levels, scales and sectors.
34. **A consideration of policy synergies and trade-offs across the N cycle was presented by Prof David Kanter of New York University and Vice-chair of the International Nitrogen Initiative.** Prof Kanter highlighted that nitrogen is unique as an element in that it is both environmentally harmful, yet essential to achieving sustainable growth (i.e., it cannot be banned, such as certain harmful chemicals). Once di-nitrogen (N_2) from the atmosphere is fixed into nitrogen compounds it becomes extremely mobile, with multiple reactive nitrogen (N_r) forms contributing multiple impacts. Inefficient use comes with multiple consequences, which

conversely points to the multiple benefits of better nitrogen management relevant to 16 of the 17 SDGs. He noted a very high ratio of co-benefits of action from reduced N pollution, in comparison to electricity decarbonisation. Prof Kanter emphasized the importance of establishing the Inter-convention Nitrogen Coordination mechanism. He noted that a narrow and aggressive action towards climate change could risk a trade-off with nitrogen pollution with increased stratospheric ozone depletion. He concluded that a coherent nitrogen approach should maximise synergies and minimise trade-offs, for which he recommended a source-focused approach to reduce losses and guarantee food security.

35. **On behalf of the UN Food and Agriculture Organisation, Dr Aimable Uwizeye, Global Livestock Assessment Information, Sector Analysis and Policy Branch presented work of FAO by video-link on the role of livestock as a source of nitrogen pollution.** He noted that the livestock sector is growing, with multiple externalities (greenhouse gases, water pollution, atmospheric pollution etc.). Around 65 Tg N is lost from the livestock sector annually, equivalent to one-third of global nitrogen emissions. He estimated that around 61% of nitrogen emissions are from South Asia and East South-Eastern Asia, both of which are hotspots for NO_x and N₂O. North America, Western Europe, East and South-Eastern Asia are hotspots for NH₃. He noted that there is large variability in nitrogen use efficiency (NUE) across production systems and livestock types. However, there is an opportunity to improve NUE in all sectors. In general, broilers (poultry grown for meat) have the highest NUE, while beef and buffalo have the lowest NUE.

Continuation of Plenary Discussion

36. **A summary of the plenary discussion was provided by Ms Isabelle van der Beck of UN Environment Ecosystems Division and Task Manager of the GEF funded 'Towards INMS' project.** She noted the wide international agreement in favour of a joined-up nitrogen approach, as an urgent requirement to help overcome the barriers to change to multiple environmental threats. She emphasized that nitrogen does not represent a new problem, but rather, sustainable nitrogen management is needed to addressing many existing challenges, such as pollution of international waters, air pollution, greenhouse gas, biodiversity loss and stratospheric ozone depletion. Ms van der Beck noted that together with UN Environment, the FAO, OECD and industry and others recognize and support this approach. She noted that INMS is providing a critical resource in achieving this. She welcomed the contributions of the countries, multi-lateral environmental agreements and others as stakeholder and policy advisers to INMS. This engagement will be critical as INMS provides input to development of the discussed Inter-convention Nitrogen Coordination Mechanism, communicating the voice of the nitrogen community to the UNEP Committee of Permanent Representatives and the UN Environment Assembly. Ms van der Beck suggested that a further resolution at UNEA may be needed to build on the UNEA-4 nitrogen resolution to further mobilize delivery of nitrogen management as a cross cutting approach to sustainable development.
37. **An evening reception at UN Environment headquarters was hosted by Ms Susie Kitchens, Deputy High Commissioner of the United Kingdom to Kenya and Permanent Representative to UNEP. The reception was addressed by Ms Joyce Msuya, Acting Executive Director of UNEP.** Ms Msuya emphasized the importance of developing public communication messages, which she followed up by initiating the preparation of a nitrogen article and short video on 'Fixing Nitrogen' for World Environment Day 2019.²

² <https://www.unenvironment.org/news-and-stories/story/bittersweet-nature-nitrogen-calls-better-management-practices>

30 April 2019

High-Level Segment: Multi-Actor Discussion

38. A discussion was facilitated by INMS Director, Prof Mark Sutton, and INMS Task Manager, Ms Isabelle van der Beck of UNEP, focused on reviewing the mandate of the UNEA-4 resolution on Sustainable Nitrogen Management, UNEP/EA.4/L.16³, hereafter the ‘nitrogen resolution’. The meeting mainly addressed paragraphs (a), (b) and (c) of the nitrogen resolution, i.e., those specifically related to policy. The meeting agreed that future discussions are needed to amplify the developments needed concerning the remaining paragraphs (d) and (e) of the resolution. The meeting also recognized the need to develop national and international engagement in relation to future nitrogen financing mechanisms.

Options for improved integration of nitrogen policies

39. The discussion first focused on reviewing four options for addressing the nitrogen policy arena, as presented in the concept note accompanying submission of the nitrogen resolution to UNEA-4 (See **Appendix 1** to this report) and as summarized in the UN Environment *2018 / 2019 Frontiers Report*, chapter on “The Nitrogen Fix: From Nitrogen Cycle Pollution to Nitrogen Circular Economy”.

40. The four options identified in these documents are:

Option 1: Status quo – fragmentation of nitrogen issues between multiple MEAs. It was noted that this is not effective in addressing the many synergies and trade-offs across the nitrogen cycle.

Option 2: One existing MEA takes the lead in addressing interactions across the nitrogen cycle between water, air, climate, ecosystems and biodiversity, soils, stratospheric ozone etc. It was noted that this model faces the difficulty of limited topic-based and geographic mandates of existing MEAs.

Option 3: Establishment of a new intergovernmental convention on nitrogen. It was noted that this could provide a strong approach linked to possible goals, but could also be seen as overlapping with existing MEAs.

Option 4: Establishment of an Inter-convention Coordination Mechanism on nitrogen. It was noted that this could provide a flexible approach that would bring multiple MEAs together to address synergies, getting the best from existing activities while avoiding duplication.

41. The meeting noted the request to the Executive Director of UNEP under paragraph (a) of the nitrogen resolution: “Consider the options to facilitate better coordination of policies across the global nitrogen cycle at the national, regional and global levels, including consideration of the case to establish an intergovernmental coordination mechanism on nitrogen policies, based primarily on existing networks and platforms and consider the case for developing an integrated nitrogen policy, which could enhance the gravity of common cause between multiple policy domains” (UNEP/EA.4/L.16).

³ The unedited version of 9 March 2019 was used for this discussion. This document has since been re-edited by the services of UN Environment and re-issued as UNEP/EA.4/Res.14.

42. Reflecting on the options and the resolution text, the balance of discussion showed that most country and convention representatives recommended moving forward with Option 4. The meeting also noted that there is potential to engage further with the countries and MEA's if there is future willingness to progress further with Option 3 (i.e., intergovernmental nitrogen convention or "for developing an integrated nitrogen policy"). It was noted that there is an opportunity to develop innovative ways of working with the Committee of Permanent Representatives in fostering flexible integration across multiple policy domains.

Role of the International Nitrogen Management System within the Coordination Mechanism

43. The meeting recognized the need to clarify the functions of both a) *improved policy co-ordination across the nitrogen cycle* and b) *consolidated scientific support to inform the development of nitrogen policies*. It was noted that INMS is being established as a science support process that needs to work in close co-operation with the proposed Inter-convention Nitrogen Co-ordination Mechanism.⁴
44. It was recognized that further work is needed to develop a possible architecture and modes of operation of the Inter-convention Nitrogen Coordination Mechanism, including its relationship with INMS. It was proposed that embedding INMS as an integral part of the coordination mechanism is likely to be more resilient and enable more effective guidance from countries than establishing two separate bodies. It was agreed that the co-ordination mechanism consists primarily of and for the countries and MEAs, enabling them to identify and manage the synergies between issues, with appropriate support and engagement from the wider scientific, business and civil society communities.

Role and character of the Inter-convention Nitrogen Coordination Mechanism

45. The meeting agreed that the co-ordination mechanism should provide a platform that delivers support at three levels:
- It should **stimulate international coordination between countries and between multi-lateral agreements relevant for nitrogen**. It should have a strong focus on identifying synergies between intergovernmental nitrogen policies and on developing strategies to minimize any trade-offs.
 - It should **stimulate national coordination within countries** towards developing a more coherent approach for sustainable nitrogen management, especially in making links between relevant ministries, departments and agencies through the establishment of **National Focal Points**.
 - It should **stimulate the coordination of scientific and technical support** for national and international policy processes, under the guidance of governments. This science function is currently being developed under INMS, while the coordination mechanism serves to guide and inform the agenda for scientific and technical support.
46. The meeting agreed that the coordination mechanism should:

⁴ A distinction was also noted between INMS as a developing process and "Towards INMS" as a project funded by the Global Environment Facility and project partners as a catalyst to jump-start the INMS process

- a) Aim for an efficient approach to work with governments and others to mobilize sustainable nitrogen management as an approach to achieve **multiple environmental benefits and Sustainable Development Goals**.
 - b) **Establish National Focal Points** to the nitrogen co-ordination mechanism as a foundation to mobilize action. The National Focal Points should primarily be policy experts in a relevant ministry, who may be supported by technical experts as necessary.
 - c) **Support a coordinated approach to foster nitrogen communication strategies**. The meeting recognized that nitrogen has multiple facets and huge relevance across the global economy for environment and health, linking many issues. The complexity can make nitrogen hard to communicate, but also provides an opportunity for a much richer engagement with the public and stakeholders than has so far been achieved.
 - d) Include a **procedure for monitoring and reporting** of progress in relation to national and international nitrogen policies, their implementation and potential for synergies
 - e) **Consider how to raise the nitrogen discussion to a higher level**, i.e. at the level of heads of state, deputy heads of state and ministers. It was agreed that there is a need to further finesse clear messages as to the benefits of taking action on nitrogen in order to progress multiple environmental and Sustainable Development Goals while also being a contribution to improving resource efficiency and developing circular economy
 - f) Provide a space for **exploration of future actions for high-level engagement**. Examples included discussion on the possible hosting of a future **Nitrogen Summit** and the possible establishment of a **'UN Nitrogen Forum'** to explore the opportunity for **aspirational goals**, which could be reported back to develop next steps in the UN Environment Assembly.
 - g) **Work in partnership between UN Environment, the countries and conventions, with input from other UN programmes and other organizations**. These may include, for example, the Organisation for Economic Cooperation and Development (OECD), the UN Food and Agriculture Organisation (FAO), the World Meteorological Organisation (WMO), the World Health Organisation (WHO), the Global Partnership on Nutrient Management (GPNM), the Global Waste Water Initiative (GWWI) and regional programs such as the South Asia Cooperative Environment Programme (SACEP), the Lake Victoria Basin Commission (LVBC) and the Partnership in Environmental Management for the Seas of East Asia (PEMSEA). The list is illustrative rather than exhaustive.
47. The country delegates and organizations present expressed their willingness to support and work with UN Environment. The meeting welcomed the new establishment of the International Nitrogen Management System under the joint leadership of UN Environment and the International Nitrogen Initiative.

Recommendations

48. The meeting identified the following **requests to the UNEP Executive Director and others**:
- a) For the UNEP Executive Director to contact countries formally under the mandate of the nitrogen resolution, **requesting that countries establish and identify National Focal Points** to the Inter-convention Nitrogen Coordination Mechanism. The National Focal Points should be requested by the Executive Director to provide a **review of existing environmental and other policies in their country relevant to nitrogen and to provide a reflection on the plans of the country to develop more co-ordinated nitrogen policies and**

opportunities in future.⁵ The meeting agreed that, whilst such a request is necessarily on a voluntary basis, the seriousness of the task should be reflected by setting clear deadlines for submission.

- b) For the UNEP Executive Director to reach out formally to the **relevant conventions, MEA's and others to invite these processes to provide a summary of their existing activities in relation to nitrogen.** The bodies approached should also be invited to **identify the opportunities for working towards improved co-ordination** in addressing the opportunities and threats associated with human disturbance of the nitrogen cycle.
- c) For the UNEP Executive Director to work with countries and partners to develop **communication pathways** at multiple levels to reach a wide range of audiences, for example members of the public, business, farmers, local government, education, science community etc.
- d) For the UNEP Executive Director to consider further the effective options for developing the **long-term institutional arrangements** of the proposed inter-convention nitrogen co-ordination mechanism, including the establishment of a **secretariat** to the co-ordination mechanism.
- e) For the UNEP Executive Director to work with countries and key engagement partners, in preparation for the next annual subcommittee meeting of the Committee of Permanent Representatives, to develop an **outline of a proposed architecture for the Inter-convention Nitrogen Coordination Mechanism**, including the possible roles of the Committee of Permanent Representatives, Bureau of the Coordination Mechanism, National Focal Points, INMS, representatives of nitrogen-relevant conventions, MEAs and other inter-governmental bodies, other experts and stakeholders, including the International Nitrogen Initiative.
- f) For the UNEP Executive Director, Permanent Representatives and others to engage with their governments to **explore further options for high-level engagement**, for example towards hosting of a possible future Nitrogen Summit, as well as possible establishment of a 'UN Nitrogen Forum' to explore the opportunity for aspirational goals. The UNEP Executive Director is invited to report progress to the 8th International Nitrogen Initiative conference in May 2020.

1 – 2 May 2019 – Technical Sections of the INMS-4 meeting

49. Other parts of the INMS-4 meeting focused on the technical delivery of the Towards INMS project Work Plan, including on the development of tools and methods, on quantification of global nitrogen flows impacts and scenarios, on regional scale demonstration for country clusters and on awareness raising and knowledge sharing. While the focus of these sessions was on delivery by the scientific community, the presence of government representatives, MEAs, business, civil society and others provided valuable guidance in the process. Component Reports of the technical work of INMS-4 will be mounted on the INMS web portal as they are ready (www.inms.international).

⁵ The global nitrogen policy database of INMS and joint survey with OECD are available as resources for this work.

Appendix 1: Concept Note: Rationale and context for a proposed Nitrogen Resolution at UNEA-4.⁶

I. Overall Rationale

Human activities are massively altering the global nitrogen cycle, causing multiple threats to water quality, air quality, greenhouse gas balance, ecosystems and biodiversity, soil quality and stratospheric ozone. Part of this alteration is intentional: increased production of nitrogen fertilizers and biological nitrogen fixation has enabled much larger food and feed production, sustaining the human population. In addition, burning of fossil fuels, biofuels and wildfires further releases nitrogen pollution to the environment. As a result, multiple sectors of human activity are having multiple effects through alteration of the global nitrogen cycle. Altogether, it makes for an intractable challenge: we need nitrogen compounds to live, but our use of them is contributing to a web of local, regional and global environmental problems.

The consequence is that improving nitrogen management is critical to meet many of the Sustainable Development Goals (SDGs) – See Box 1. Yet current policy approaches to nitrogen are highly fragmented between nitrogen form and issue. The world lacks a coherent policy framework across the nitrogen cycle, which would be necessary to identify synergies and minimize trade-offs. Such a framework would be of benefit to help overcome barriers by demonstrating the multiple benefits of taking action. For example, a possible goal to halve nitrogen waste would make a major contribution to developing the Circular Economy, representing a saving of around \$100 billion (as fertilizer value), in addition to even larger benefits for ecosystems, health, climate and livelihoods.

Box 1: Example interactions of nitrogen with the Sustainable Development Goals.

Goal 2: Hunger – Fertilizer and biological nitrogen supply is vital to increase food production.

Goal 3: Good Health & Wellbeing – Nitrogen pollution in water and air threatens human health.

Goal 6: Clean Water & Sanitation – Wasted nitrogen threatens water quality with excess nitrate.

Goal 9: Industry & Innovation – Huge untapped potential to develop a circular nitrogen economy.

Goal 11: Sustainable Cities & Communities – Hotspots of unsustainable nitrogen consumption.

Goal 12: Responsible consumption & production – Opportunities to optimize nitrogen intake in food.

Goal 13: Climate Action – Nitrogen is the main source of nitrous oxide, contributing to net warming.

Goal 14: Life Below Water – Nitrogen waste contributes to coastal dead zones and coral bleaching.

Goal 15: Life On Land – Nitrogen deposition threatens biodiversity, affecting ecosystem services.

Goal 17: Partnerships for the Goals – Broad partnership is vital to address the nitrogen challenge.

Addressing the global nitrogen challenge is extremely timely under the theme of UNEA-4 on “*Innovative solutions for environmental challenges and sustainable consumption and production*”. Taking a holistic policy approach to nitrogen and the environment is both innovative and explicitly links consumption and production. Until now, most efforts to reduce nitrogen pollution (through air, land, water, climate) have focused on the production side, considering the role of technical measures including in industry, transport and agriculture. However, several recent reports have

⁶ This annex was originally submitted to the UNEP Resolutions Portal by the Government of India in January 2019, to support its proposal for the UNEA-4 resolution on Sustainable Nitrogen Management. It is included here to provide background and highlight the analysis of four options to address the international nitrogen policy arena.

demonstrated the need to couple production and consumption, especially in considering the interactions with food security and dietary choice (e.g. *Our Nutrient World*, *Drawing Down N₂O*, *Nitrogen on the Table*, *Indian Nitrogen Assessment*). Such a holistic approach also offers increased flexibility in exploring solutions that link environment, food and energy.

The proposed Nitrogen Resolution adds significant value by recognizing the fragmentation of current programmes and policies relevant to the nitrogen cycle. The resolution proposes to address this by developing a more coordinated approach that will support progress toward multiple SDGs.

It is up to Member States as to how far they wish to go. The proposed resolution focuses on mandating UNEP to bring together Member States in developing improved policy coordination across the nitrogen cycle. In order to facilitate consensus, the draft resolution does not focus on specific time-bound goals. However, Member States may wish to take note of currently emerging national and international goals related to nitrogen.

II. Overview of policy options

A distinction needs to be made between a) the options for developing overarching coordination across the nitrogen cycle, the b) specific policies which may be developed. The draft Nitrogen Resolution focuses on the first of these. This can then provide a framework for better informed sharing of experiences of specific policies.

a) Options for Overarching Nitrogen Policy Coordination

The proposed nitrogen resolution does not specify the exact form that future coordination should take. Rather it seeks to bring Member States together to address the issue and agree a way forward. To inform this discussion, four options are summarized here as a starting point:

Option 1: Nitrogen fragmentation across policy frameworks.

This represents the status quo, where different nitrogen-related impacts are considered in different policy processes. For example, Air Pollution from ammonia (NH₃) and nitrogen oxides (NO_x) is addressed under the Geneva Air Convention (UNECE Convention on Long-range Transboundary Air Pollution), while nitrous oxide impacts on climate (N₂O) are addressed under the Framework Convention on Climate Change (UNFCCC). The effects of N₂O on stratospheric ozone are relevant under the Vienna Convention (though are not currently part of the Montreal Protocol), while the impacts of excess nitrogen deposition are considered under the UN Convention on Biological Diversity (CBD). The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) addresses both the issues of nutrient management and waste water, including the leaching and run off of nitrates (NO₃⁻) and other nitrogen compounds. Conversely, the food benefits of nitrogen are relevant for the UN Food and Agriculture Organisation (FAO). The sum total of environmental impact associated with nitrogen is relevant for UNEP, but is not currently addressed as such. This status quo is far from satisfactory, as many synergies and opportunities are missed across the nitrogen cycle and between the existing policy processes.

Option 2: Nitrogen leadership under one existing policy framework

Under this option, one policy framework would take the lead to coordinate nitrogen issues and mitigation options on behalf of other policy frameworks. Experience shows that this is difficult to achieve, as each framework is limited by the extent of its mandate. For example, it may be considered out of scope for the UNFCCC to address air and water pollution effects of nitrogen. Future leadership by an individual policy process would require a change in mandate. For example, it

has been discussed whether the Vienna Convention on Stratospheric Ozone, which already in-principle includes N₂O as an ozone depleting substance, could provide a policy home to address all nitrogen impacts.

Option 3: A new international convention to address the nitrogen challenge.

This option could deliver a strong coordinated approach to the global nitrogen challenge, with an appropriate mandate to cover all nitrogen-relevant issues. However, current feedback suggests that there is little appetite for such an approach, which would require substantial resources and could lead to tensions with existing topic-focused policy areas.

Option 4: A nitrogen coordination mechanism, e.g., under the mandate of UNEA.

Under this option, the focus is on facilitating improved coordination between the existing policy processes that address parts of the nitrogen cycle. This option would require regular sharing of experiences between conventions, which could also consider scenarios for mutual benefit, for example, which help meet multiple goals for air, climate, land, water, biodiversity, food, energy etc. One option would be to establish such a coordination mechanism under auspices of UNEA, for example, as a specific working group of the Committee on Permanent Representatives (CPR), although other options may be considered.

As a starting point for discussion, it is here suggested that Option 4 is most likely to be successful. However, it is emphasized that this is for Member States to decide. The current draft of the Nitrogen Resolution does not specify any one of the options, but simply resolves that UNEP should establish a process to agree and then implement, based on the results of discussion between Member States.

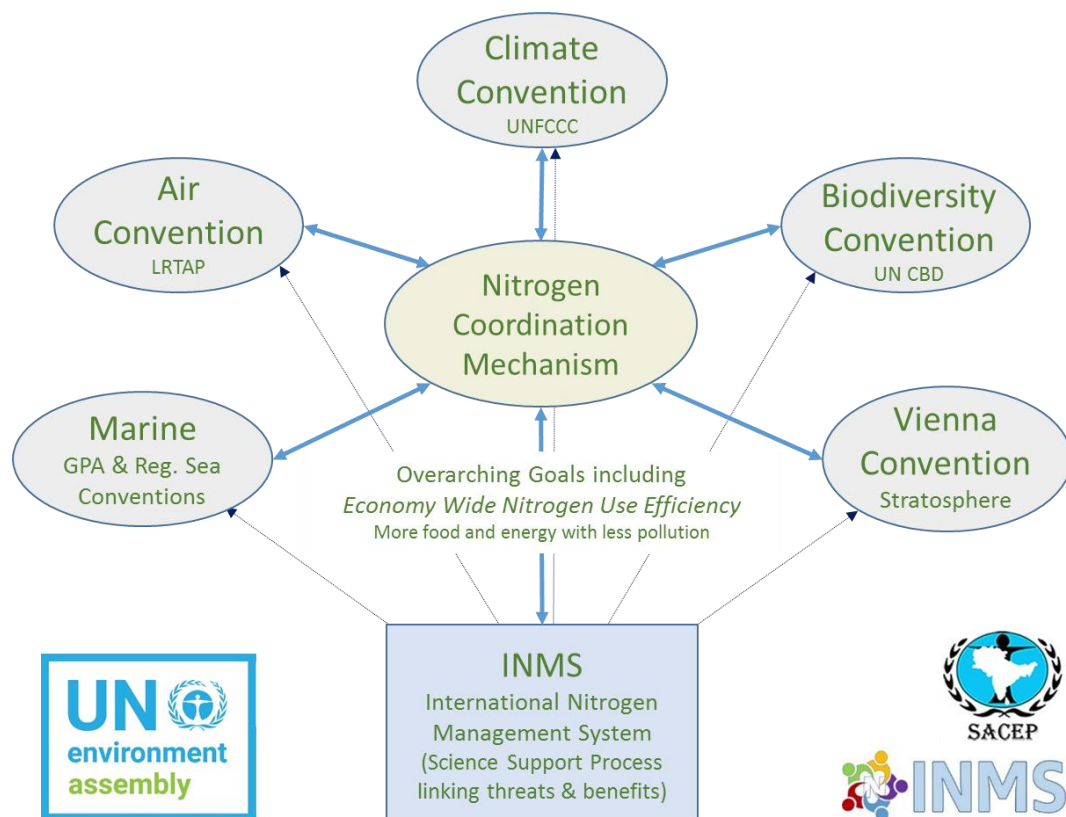


Figure 1: Illustration of how multiple policy areas across the nitrogen cycle could be brought together through a Nitrogen Coordination Mechanism (Option 4), under the auspices of UNEA, for example as a Working Group of the Committee of Permanent Representatives.

The above diagram illustrates the potential for linkages associated with Option 4. Other contributing groups may also be envisaged in such a framework, but this simple version should be sufficient to illustrate the connections. The figure also shows the contribution of the International Nitrogen Management System (INMS), recently established by UNEP with support through the Global Environment Facility (GEF). It is important to make the distinction between INMS as a science support process for nitrogen policy (including multiple actor involvement), while the Nitrogen Coordination Mechanism primarily represents partnership of Member States coming together promote coherency and progress on nitrogen policies. Such a Nitrogen Coordination Mechanism (e.g. 'UN Nitrogen') should also be seen in the context of improving wider coordination across Pollution and Circular Economy (PACE) challenges.

b) Options for Specific Nitrogen Policies

While it is not the purpose of the draft Nitrogen Resolution to specify specific policies for nitrogen, it is useful to illustrate the broad relevance of the Resolution. This is shown below by summarizing the 10 Key Actions identified by the *Our Nutrient World* report (UNEP/CEH), each of which would contribute to a more circular and cleaner nitrogen economy (Box 2). The summary demonstrates the systemic nature of the Nitrogen Challenge, which calls for a multi-sectoral, multi-impact approach.

Box 2: 10 Key Actions identified by *Our Nutrient World* (UNEP/CEH) as a foundation to reducing to producing more food and energy with less nitrogen pollution.

Agriculture

1. Improving nutrient use efficiency in crop production,
2. Improving nutrient use efficiency in animal production,
3. Increasing the fertilizer equivalence value of animal manure,

Transport and Industry

4. Low-emission combustion and energy-efficient systems, including renewable sources,
5. Development of NO_x capture and utilization technology,

Waste and Recycling

6. Improving nutrient efficiency in fertilizer and food supply and reducing food waste,
7. Recycling nitrogen and phosphorus from waste water systems, in cities, agriculture and industry,

Societal consumption patterns

8. Energy and transport saving,
9. Lowering personal consumption of animal protein among populations consuming high rates (avoiding excess and voluntary reduction),

Integration and optimization

10. Spatial and temporal optimization of nutrient flows.

III. Relationship with other UNEA resolutions, Programme of Work & other UN initiatives

The draft Nitrogen Resolution has been developed through a partnership of South Asian countries facilitated through the South Asia Cooperative Environment Programme (SACEP) with the support of the International Nitrogen Management System (INMS) of UNEP, and with funding from GEF.

The activity of INMS is also linked to the Global Partnership on Nutrient Management (GPNM) which has its secretariat under the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), hosted by UN Environment in Nairobi. The GPNM is a multi-actor forum (which produced the *Our Nutrient World* report) and which complements the

Global Waste Water Initiative (GPI) and Global Partnership on Marine Litter (GPML) under the GPA. It should be noted that the future of the GPA is currently under review by the UNEP Committee of Permanent Representatives.

Under the UNECE Geneva Air Convention, the Task Force on Reactive Nitrogen (TFRN) has been established in 2007 with *“the long-term goal of developing technical and scientific information, and options which can be used for strategy development across the UNECE to encourage coordination of air pollution policies on nitrogen in the context of the nitrogen cycle and which may be used by other bodies outside the Convention in consideration of other control measures”* (Executive Body Decision, 2007/1). The technical work of the TFRN has underpinned development of the multi-pollutant, multi-effect UNECE Gothenburg Protocol on air pollution, including its supporting documentation, and supported development of the revised EU National Emissions Ceilings Directive (EU 2016/2284).

Several resolutions agreed at UNEA-3 point to the importance of nitrogen:

UNEP/EA.3/Res.4. Environment and Health. *“13. Invites member States to increase awareness of the risks posed to human, animal and environmental health from the **improper use of fertilizers and pesticides** and to promote measures to address them;” ... “16. Requests the Executive Director to present a report on the environmental and **health impacts of pesticides and fertilizers** and ways of minimizing them, given the lack of data in that regard, in collaboration with the World Health Organization, the Food and Agriculture Organization of the United Nations and other relevant organizations by the fifth session of the United Nations Environment Assembly;”*

UNEP/EA.3/Res.6. Managing soil pollution to achieve Sustainable Development, is relevant but does not mention nitrogen or nutrients explicitly.

UNEP/EA.3/Res.8. Preventing and reducing air pollution to improve air quality globally. *“4. Further encourages governments to pursue synergies and co-benefits between national clean air policies and policies in key areas such as transport, including vehicle emissions and fuel standards, urbanization, climate change, energy access and agriculture **and to take advantage of synergistic effects of efficient nitrogen management on reducing air, marine and water pollution.**”*

UNEP/EA.3/Res.10. Addressing water pollution to protect and restore water-related ecosystems. *“Recognizing the contributions of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities and recalling its three partnerships, namely the Global Wastewater Initiative, the **Global Partnership on Nutrient Management** and the Global Partnership on Marine Litter,”... “7. Invites member States, in collaboration with relevant stakeholders, the private sector, industry, academia, civil society and the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, including by encouraging platforms for wastewater and **management of nutrients**, to help in preventing and mitigating water pollution and to protect and restore water-related ecosystems in order to minimize adverse impacts on human health and the environment;”*

It should be evident that the division of these resolutions reflects the current fragmentation of nitrogen policies. Critically, the Air Resolution (EA.3/Res.8) explicitly recognizes the need to go further in taking advantage of the synergies to be found from efficient nitrogen management.

IV. Financial requirements and implications

The scale of financial requirements will depend on the direction taken by Member States. For example, if Option 4 is favoured, the major costs would be regular (e.g. annual meetings) which

could be held back-to-back with key Open Ended meetings of the UNEP Committee of Permanent Representatives. Support for appropriate secretariat at UN Environment would be necessary.

Investment is already in place in providing the technical and scientific support through the International Nitrogen Management System (INMS), which is funded with 6M USD from for 2016-2021 from GEF, plus 54M USD contribution-in-kind from 80 partner organizations.

Overall, investment in developing a coordinated approach to nitrogen management provides excellent value for money. For example, achieving a global goal to halve nitrogen waste would be expected to save cash costs of around USD 100 billion per year (e.g. reducing subsidy requirements), while mobilizing investment in nitrogen circular economy opportunities (e.g. promoting cost effective recycling of available nitrogen resources).

V. Main addressees of the Nitrogen Resolution

Member States, UN Environment Programme

VI. Key expected actions and socio-economic impacts in the short and long-term

Short term

- The draft Nitrogen Resolution is formulated to foster an international policy focus on nitrogen, which allows sharing of options for further consideration. The aim is to encourage universal membership as a foundation for awareness-raising.

Medium Term

- **Establishment of an innovative focal area for policy coordination across the nitrogen cycle** seeking to take “*advantage of synergistic effects of efficient nitrogen management on reducing air, marine and water pollution*” (UNEP/EA.3/Res.8), while offering quantified co-benefits for climate, biodiversity, health as well as food energy security, as a contribution to meeting multiple sustainable development goals.
- **Providing a discussion forum for Member States** on the most appropriate ways to coordinate nitrogen policies, considering the relative merits of Options 1 to 4 (or other options) to achieve effective and coherent coordination across the nitrogen cycle.
- **Establishment of an intergovernmental coordination mechanism on nitrogen** that is focused on overcoming barriers, improving environmental protection, and fostering development of a more circular nitrogen economy.
- **Promote sharing of existing programmes and goals** by Member States and others

Long Term

- **Foster coherency of national and international policies** across the nitrogen cycle, by sharing of experiences and best practices between Member States.
- **Provide a foundation for Member States to consider possible future shared goals** considering the urgency of improving nitrogen management for climate, air quality, water quality, biodiversity, soil security, food security, health, sustainable food and energy, circular economy, and the relevant sustainable development goals.
- **Depending on ambition, to consider a goal to halve nitrogen waste, saving USD 100 billion per year with quantified co-benefits relevant across SDGs.**