

Our Nutrient World

The challenge to produce more food and energy with less pollution



Prepared by the Global Partnership on Nutrient Management
in collaboration with the International Nitrogen Initiative

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About GPNM and INI

The Global Partnership on Nutrient Management (GPNM) is a multi-stakeholder
partnership comprising of governments, private sector, scientific community,
civil society organizations and UN agencies committed to promote effective
nutrient management to achieve the twin goals of food security through increased
productivity and conservation of natural resources and the environment. The United
Nations Environment Programme (UNEP), through the Coordination of Office of
the Global Programme of Action for the Protection of the Marine Environment from
Land-based Activities (GPA), provides the Secretariat of GPNM.

The *International Nitrogen Initiative* (INI) is a scientific partnership that addresses
the problems of too much nitrogen in some parts of the world and too little nitrogen
in others. It is a joint project of the International Geosphere-Biosphere Programme
(IGBP) and the Scientific Committee on Problems of the Environment (SCOPE).

This Global Overview has been prepared as a scientifically independent process. The
views and conclusions expressed are those of the authors, and do not necessarily
reflect policies of the contributing organizations. As an overview, this report does
not attempt to reach consensus on all issues. Its purpose is to raise awareness of the
challenges, pointing to possible options. It is hoped that the report will stimulate
further collection of evidence and trans-disciplinary dialogue with all stakeholders
as necessary future steps.

The report incorporates outcomes from several meetings, including: the Global Overview of
Nutrient Management Preparatory Workshop (Paris, November 2011), the Global Conference
on Land-Ocean Connections organised by UNEP (Manila, January 2012); the Third Inter-
Governmental Review meeting of the GPA (Manila, January 2012), the side-event 'Nutrients:
for food or pollution? The choice is ours' organized by the GPA Coordination Office and GPNM
during the United Nations Conference on Sustainable Development (Rio+20, Rio de Janeiro,
June 2012), the First Stakeholder Workshop toward Global Nitrogen Assessment (London, July
2012), and events at the 11th Conference of Parties of the Convention on Biological Diversity
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Contents

	Foreword	vi
	Executive Summary	vii
1	Introduction	1
2	Trends in nutrient supply, their benefits and future availability	8
3	Global nitrogen and phosphorus pollution	19
4	Environmental threats of too little and too much nutrients	32
5	Weighing up the benefits and costs of nutrient management activities	52
6	Practical options to reduce adverse effects by improving nutrient use	58
7	Current policies and barriers to change	75
8	Future needs, targets and opportunities	95
	Appendix: National Nitrogen Use Efficiency estimates and aspirational goals	108
	Affiliations of contributors	<i>inside back cover</i>



Foreword

Nutrients – such as nitrogen, phosphorus, potassium and micronutrients including calcium, sulphur, copper, zinc and others – are essential for plant growth, food production and ultimately adequate nutrition for humans.

Yet we live in a time of glaring contrasts – of excessive use of nutrients in some regions and insufficient use in others.

Many sub-Saharan African farmers struggle to access enough nutrients for quality crop production with knock on effects as more ecosystems are converted to cropland to try and maintain sufficient food supplies.

In the developed world and in several rapidly developing regions of South and East Asia, there is the problem of excessive nutrient use which is triggering a web of unforeseen consequences.

Excessive use of phosphorus is not only depleting finite supplies, but triggering water pollution locally and beyond while excessive use of nitrogen and the production of nitrogen compounds is triggering threats not only to freshwaters but the air and soils with consequences for climate change and biodiversity.

The Global Overview on Nutrient Management addresses the scientific complexity of how humanity can rise to these challenges and maximize the opportunities of improved nutrient management.

Its preparation has forged new links between communities, gradually building a network of institutions and actors for better scientific understanding to support future decision making in this field.

The work underpinning the report is an outcome from the Global Partnership on Nutrient Management (GPNM), which was launched during the 17th session of the UN Commission on Sustainable Development in 2009 as a global partnership of governments, policy makers, industry, science community, civil society

organizations and UN agencies with UNEP providing the Secretariat.

By building the global partnership, in particular with engagement of governments, the International Nitrogen Initiative and other groups the GPNM is sharing and generating knowledge. Both will be essential if citizens, companies and governments are to take the transformative actions needed.

The message of this overview is that everyone stands to benefit from nutrients and that everyone can make a contribution to promote sustainable production and use of nutrients. Whether we live in a part of the world with too much or too little nutrients, our daily decisions can make a difference.

Without swift and collective action, the next generation will inherit a world where many millions may suffer from food insecurity caused by too few nutrients, where the nutrient pollution threats from too much will become more extreme, and where unsustainable use of nutrients will contribute even more to biodiversity loss and accelerating climate change.

Conversely with more sustainable management of nutrients, economies can play a role in a transition to a Green Economy in the context of sustainable development and poverty eradication. The Global Overview develops these essential themes, to prepare societies to take the next steps.

Achim Steiner
*United Nations Under-Secretary General
and Executive Director
United Nations Environment Programme*

Executive Summary

Key Points

Nutrient Benefits and Threats

- The sustainability of our world depends fundamentally on nutrients. In order to feed 7 billion people, humans have more than doubled global land-based cycling of nitrogen (N) and phosphorus (P).
- The world's N and P cycles are now out of balance, causing major environmental, health and economic problems that have received far too little attention.
- Insufficient access to nutrients still limits food production and contributes to land degradation in some parts of the world, while finite P reserves represent a potential risk for future global food security, pointing to the need for their prudent use.
- Unless action is taken, increases in population and per capita consumption of energy and animal products will exacerbate nutrient losses, pollution levels and land degradation, further threatening the quality of our water, air and soils, affecting climate and biodiversity.

The Nutrient Challenge

- *A new global effort is needed to address 'The Nutrient Nexus', where reduced nutrient losses and improved nutrient use efficiency across all sectors simultaneously provide the foundation for a Greener Economy to produce more food and energy while reducing environmental pollution.*
- The new effort must cross the boundaries between economic sectors and environmental media, be underpinned by scientific and other evidence from a robust global assessment process, share best practices, and address the substantial cultural and economic barriers that currently limit adoption.

Actions and Outcomes

- *The global community of all relevant stakeholders now needs to agree which existing inter-governmental process is best suited to take the lead in improving nutrient management for the 21st century, or whether a new policy process is needed.*
- One option is to strengthen the mandate of the 'Global Programme of Action for the Protection of the Marine Environment from Land-based Activities' (GPA) to address the inter-linkages between land, air and water, in relation to the global supply of all nutrient sources and Nutrient Use Efficiency (NUE) across the full chain, considering their regional variation.
- Nutrient Use Efficiency represents a key indicator to assess progress towards better nutrient management. An aspirational goal for a 20% relative improvement in full-chain NUE by 2020 would lead to an annual saving of around 20 million tonnes of nitrogen ('20:20 by 2020'), and equate to an initial estimate of improvement in human health, climate and biodiversity worth around \$170 billion per year.

Developing the Mandate

- A central objective of the new inter-governmental effort must be to show how improved management of N and P at different scales over the whole cycle would simultaneously make quantified contributions toward meeting existing commitments for water, air, soil, climate and biodiversity, while underpinning improved food and energy security – with net social and economic benefits.
- *International consensus and authorization of the global nutrient focus is now essential, emphasizing the need for a mandate to assess the scientific evidence, share best practices, and work towards inter-governmental agreements that make quantifiable steps toward the sustainable development of Our Nutrient World.*

Too much and too little nutrients

Nutrients feed the world

1. The world needs nutrients, especially nitrogen (N) and phosphorus (P), which are essential to raise crops and animals to feed an increasing world population (Chapters 1 and 2).
 - It is estimated that nitrogen and other mineral fertilizer is essential to feed around half of the world's population, and will be fundamental to ensure global food security through the 21st century.
 - Natural nutrient sources and recycling have been insufficient for increasing human needs since the 19th century. The 18th-19th century agricultural and industrial revolutions laid the foundation for exploitation of mined sources of N and P, and for development of the Haber-Bosch process, where energy is used to convert otherwise unreactive atmospheric di-nitrogen (N₂) into reactive nitrogen (N_r) compounds.
 - The 20th century 'green revolution' has depended critically on these additional nutrient sources, while becoming the basis for an ongoing 'live-stock revolution', where relatively cheap grain and other produce (surplus to regional food requirements) are allowing intensification of live-stock farming, greatly increasing per-capita meat and dairy production.
 - While recent trends in nutrient consumption are relatively stable in developed countries, growing human population and rising per capita meat/dairy consumption as a result of increasing incomes are together causing a rapid increase in nutrient consumption in transitional and developing countries. It is anticipated that these countries may account for ¾ of global nutrient consumption by 2050.
 - Around 2% of world energy use is dedicated specifically to the industrial manufacture of N_r, mainly through the Haber-Bosch process, so that N_r prices are closely coupled to global energy prices.
 - Phosphorus is obtained from mining of finite phosphate rock deposits with concentrated demand

South and East Asia and Latin America (Chapters 3, 4 and 8).

- The efficiency of nutrient use is very low: considering the full chain, on average over 80% of N and 25-75% of P consumed (where not temporarily stored in agricultural soils) end up lost to the environment, wasting the energy used to prepare them, and causing pollution through emissions of the greenhouse gas nitrous oxide (N₂O) and ammonia (NH₃) to the atmosphere, plus losses of nitrate (NO₃⁻), phosphate (PO₄³⁻) and organic N, P compounds to water.
- Oversupply of nutrients, or imbalance between nutrients, reduces the efficiency of nutrient use. Efficiency is further reduced by including live-stock in the food chain, substantially increasing N and P pollution levels.
- Burning fossil fuels produces a significant additional N_r resource (~20% of human N_r production) part of which could be captured and used, but which is currently wasted as emissions of nitrogen oxide (NO_x) to air, contributing to particulate matter and ground-level (tropospheric) ozone, which adversely affect human health, ecosystems and food production systems.
- Many thresholds for human and ecosystem health have been exceeded due to N_r pollution. Each of these environmental effects can be magnified by the 'nitrogen cascade', where a single atom of N_r can trigger a cascade of negative environmental impacts.

Insufficient nutrients exacerbate land degradation

3. In Africa, Latin America and parts of Asia there are still wide regions with too little nutrients. In particular (Chapters 2 and 4):
 - Many farmers do not have access to affordable mineral fertilizers, where lack of local sources and poor supply infrastructure increases prices, limiting agricultural yields. Biological nitrogen fixation and manure recycling are key local nutrient sources which are not always optimally exploited.
 - The inability to match crop harvests with a sufficient nutrient return leads to depletion of nutrients and organic matter, reducing soil quality and

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