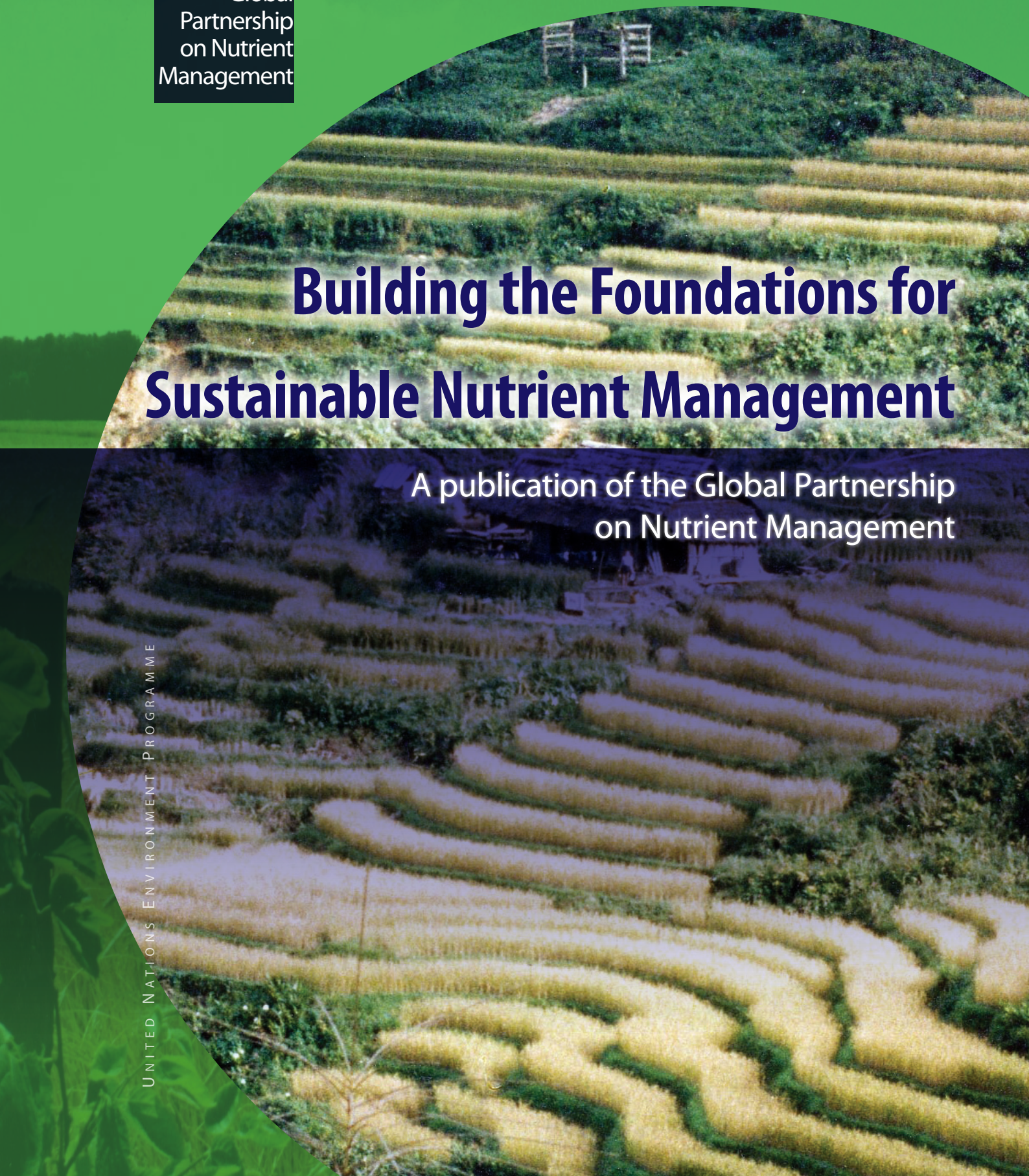
UNEP

Global Partnership on Nutrient Management



Building the Foundations for Sustainable Nutrient Management

A publication of the Global Partnership on Nutrient Management

United Nations Environment Programme

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Contents

The Global Partnership on Nutrient Management - GPNM

'Think globally, act locally' – global catalyst for effective national actions

The Global Partnership on Nutrient Management (GPNM) was launched at the United Nations Commission on Sustainable Development in May 2009, when the Commission was reviewing global consumption and production. The timing of the launch reflected the GPNM's aim of promoting the sustainable consumption and use of nutrients, notably nitrogen and phosphorous, and the need to trigger high level strategic interest and engagement among countries and stakeholders on the issue.

The Partnership represents a coming together of government policy makers, scientists, private sector, NGOs and UN agencies. It operates as a voluntary network of stakeholders, with a view to communicating the nutrient management challenge, and helping to build constituencies of interest and action among and in countries, agencies and donors around the goal of optimising nutrient use, including problems of shortage, and reducing its impacts. It held its inaugural meeting in The Hague in October 2009.

Its formation reflects the reality that nutrient management is complex and the related issues are not well known outside the scientific domain. Crucially, relevant agencies and sectors in countries may lack access not just to assessment information, but also to information about the available best practices and approaches –'the tools'- to effective nutrient management. They may be unclear where and how effective action can be taken and the costs, benefits of and possibilities for so doing. The Partnership is not a substitute for government action, but strategic attention in the international political domain to help stimulate attention to the importance of nutrient management in countries.

Specifically, the Partnership provides a platform to:

- Identify and foster best practice opportunities and tools which can be applied by countries or scaled up as part of a more concerted national and international effort;
- Help mainstream these best practices and approaches within countries so that effective nutrient management is embedded in the policies and related industries and benefits realized;
- Foster strengthened and integrated assessment and analysis at various levels; and
- More generally provide a place for nutrient stakeholders to network and build common interests.

The GPNM is led by a Steering Committee comprising government, scientific and UN agency representatives. UNEP/GPA coordination office based in Nairobi acts as the secretariat to the Partnership.

Executive summary

This booklet focuses on the use, effects and management of two key nutrients - nitrogen and phosphorous. Together they play an important role in the global and local sustainable development agendas.

On the one hand, their production and use means higher levels of crop production and food security. On the other hand, their excess use and production, the result of a range of important human activities, leads to severe pollution of air, water, land and sea around the world.

The present result is an apparent divide between societal needs for food and energy and a complex web of adverse environmental impacts which undermine ecosystems and the services and livelihoods they provide. This conundrum is set to intensify, to the cost of countries as demand for food and energy increase and the levels of demand for nitrogen and phosphorous grow.

The international community is faced with a nutrient management challenge – how to reduce the amount of excess nutrients in the global environment, but in a way that maximizes the contribution of nutrient management to global development, food security and a low carbon society.

The *Global Partnership on Nutrient Management* is a response to this challenge and need for a new focus. It recognizes the need for strategic, global advocacy to trigger productive discussion on the nutrient challenge based on a major shift towards sustainable consumption and production of nitrogen and phosphorous.

This booklet scopes out the nature of the nutrient management challenge, from food security to decaying lakes, rivers, deltas to marine dead zones. It aims to illustrate what is important, what works, and who needs to be persuaded in shaping effective nutrient management. It commends four main cornerstones - 'foundations' – focused around the building of a shared interest and agenda among and within countries; stakeholder engagement and partnerships and the communication and mainstreaming of best practice tools and integrated approaches to guide cost effective decision making. They aim to build a sustainable future where food and energy security can be achieved while preserving key ecosystem services.

Key Messages

The level of use of nutrients leads to a complex web of development benefits and problems. The problems will multiply as the demand for food and bio-fuels increases, and coastal populations increase.

'Business as usual' nutrient management will increase economic costs to countries in terms of the degradation of valuable natural resources and the services and jobs they provide.

There needs to be a new strategic focus among countries and stakeholders on the importance of the sustainable production and use of nutrients and the benefits communicated effectively to policy makers. This change will help the move towards a Green Economy.

Governments and stakeholders need to move urgently towards lower nitrogen and phosphorous inputs to human activities - limiting discharges, promoting efficiencies in production, and making full use of re-cycling opportunities.

Countries and stakeholders need to foster, and mainstream best practice opportunities and tools, underpinned by integrated assessment of nutrient sources and effects, helping distil the complexity and range of nutrient issues into a clearer governance focus and communicating the issue to the public.

Global and regional partnerships can help build constituencies of interest and action to trigger necessary action and communicate benefits.

There are key win – win investment opportunities. Increased fertilizer use efficiency could meet the projected 38% increase in global cereal demand by 2025 with a 25% decrease in Nitrogen fertilizer application.

Farmers can benefit directly in cost savings; countries can avoid costly adverse impacts to their natural resources from excess nutrients; fishermen can benefit from lower fish kills; the public benefits from ecosystem services and a healthy environmen.t

The conservation and rehabilitation of key nutrient sink habitats, such as wetlands, grasslands and forests will be an important feature of national and local nutrient management plans.

Food for thought - some facts and figures

Managing nutrients efficiently is relevant to food and energy security, water quality and availability, biodiversity and fisheries, and climate change.

It is estimated that the food security of half of the world's population is dependent on fertilizer use. But much of the fertilizer is not actually utilized by the crops to the cost of farmers and the environment.

Human activities produce around 120 m tonnes of reactive nitrogen each year, but only a third is used by the target plants. Some 20 m tonnes of phosphorous are mined every year and nearly half enters the world's oceans - 8 times the natural rate of input.

At the same time some areas suffer from nutrient shortages. In sub Saharan Africa agriculture is the primary industry but it has the lowest fertilizer application rate in the world, accounting for 1% of global use of synthetic fertilizer, with its consequent impact on food production.

Many of the world's freshwater lakes, streams, and reservoirs suffer from eutrophication (excess nutrients). Millions of people depend on wells for their water where nitrate levels are well above recommended levels.

Worldwide, the number of coastal areas impacted by eutrophication caused by excess nutrients stands at over 500 undermining the contribution of ecosystems to livelihoods and fisheries and to addressing climate change.

More than 90% of the world's fisheries depend in one way or another on estuarine and near-shore habitats and many of these habitats are vulnerable to the harmful effects of eutrophication and toxic algal blooms.

In developing countries an estimated 90% of wastewater, a major source of excess nutrients, harmful to health and ecosystems, is discharged as untreated into waterways and coastal areas.

Nitrous oxide is a powerful greenhouse gas –estimated to be responsible on current levels for about 10% of the net anthropogenic global warming potential from such gases.

Part 1: The nature and scope of the problem

Where we are: the global picture - too much of a good thing

Agriculture is the major driver of the greatly increased amount of nitrogen and phosphorous in the world though the use of synthetic phosphorous and nitrogen for fertilizer, key to crop production for food, animal and energy (bio-fuels) needs.

Large amounts of fertilizer, however, either escape into the atmosphere, leach to groundwater, or run off the land to create an excess of nutrients in the environment. Other major sources of excess nutrients result from the burning of fossil fuels, fibre production, and nutrients in wastewater produced by humans, livestock, aquaculture and industry.

Excess nutrients cause air pollution, water, soil and marine degradation, loss of biodiversity and fish, destruction of ozone and provide additional global warming potential. Toxic algal blooms and hypoxic (lack of oxygen) zones undermine coastal ecosystems and their contribution to meeting climate change.

Improvements have been made in relation to point sources (industrial plants) of excess nutrients and in limiting phosphorous from detergents. But results have been mixed and benefits achieved at high financial cost in many cases.

Impacts which were once largely confined to the industrialised areas of Europe and North America are now also prevalent in Asia and South America. In Asia, fossil fuel burning and high fertilizer use are main causes. In Latin America, excess nutrient hot spot areas have emerged from biomass burning, livestock production and bio-fuel production. Sub-Saharan Africa contends mainly with a shortage of available nutrients, though there are problem areas from sewage and fertilizer use. This imbalance needs to be addressed as part of an overall approach.

The problems of excess nutrients are expected to accelerate as the demand for food and bio-fuels increases, fossil fuel use continues and growing populations produce more wastewater. This will be at a growing economic cost to countries in the loss of natural resources, services and jobs.

Excess, ecosystems and economic costs - an everyday, strategic story

Some two thirds of the 120m tonnes of nitrogen produced by human activities makes its way into the air, inland waterways and the coastal zone, exceeding all natural inputs. Some half of the 20m tonnes of phosphorus mined each year makes its way to the ocean – some eight times the natural input.

There is growing concern about these higher than 'natural' levels, reflecting the:

- *Increasing geographical spread and deepening of environmental and health impacts – from air, soil and water pollution, to fish kills and dead zones;*
- *Cost to countries and their citizens both through remedial measures and loss of natural resources as well as income forgone to inefficiencies;*
- *Effects on the resilience and contribution of the world's ecosystems to global climate change and biodiversity – from additional greenhouse gases to undermining the ability of terrestrial and coastal ecosystems to absorb carbon;*
- *Need to address shortages of nutrients in some parts of the world.*

These impacts and costs are of particular importance in the context of coastal zones, which contain highly productive ecosystems as well as large urban centres. 21 of the world's 33 megacities are coastal and as well as the broader impacts of nutrient excess, these will provide all too evident nutrient impacts of additional human sewage, and waste from aquaculture and industry.

These growing concerns suggest a need for governments and stakeholders to move towards lower nitrogen and phosphorous inputs to human activities through agreed efforts to limit and treat discharges, promote efficiencies and incentives in production, and make full use of re-use and re-cycling options. These approaches can also help in areas of nutrient shortage and make the case for more effective distribution of nutrient availability to those areas.

Periodic inter-governmental reviews of the 1*995 Washington Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)* provide a key opportunity for governments to consider such approaches within a framework of integrated watershed and coastal zone management, including the role of coastal cities and deltas and hypoxic and eutrophic areas.

Nutrients and Ecosystems - eutrophication and 'dead zones'

Excess nutrients entering the marine environment cause phytoplankton and algae blooms which can block light – eutrophication. The toxicity pollutes water, kills fish and undermines ecosystems. This can lead to oxygen depletion (hypoxia) or 'dead' zones. In 2007, 415 eutrophic and hypoxic coastal systems worldwide were identified - 169 identified hypoxic areas, 233 areas of concern and 13 systems in recovery (WRI, 2008). Such areas are present not only in enclosed seas, such as the Baltic and Black Seas, but also in large coastal areas such as around the Changjiang and Mekong Deltas and Arabian Sea, including where there are internationally important fisheries.

Deltas - areas of strategic importance

Some 70 percent of the world's population lives and works in delta areas. They are important centres of agricultural production and where fishing is an important livelihood. Agriculture is intensive with irrigation channels drawn from the river systems that make up the delta. The deltaic coasts in Asia are often fringed with mangroves and also have sea-grass and coral reef ecosystems off shore in many places. These characteristics mean that deltas have large amount of nutrient inputs and experience direct adverse consequences. However, this also makes delta regions potential crucibles of change, including as components of integrated water and coastal management, and a transition to lower carbon societies. Effective nutrient management, including the contribution of agriculture and fisheries to food security and to ecosystem services can be an important part of catalysing this change.

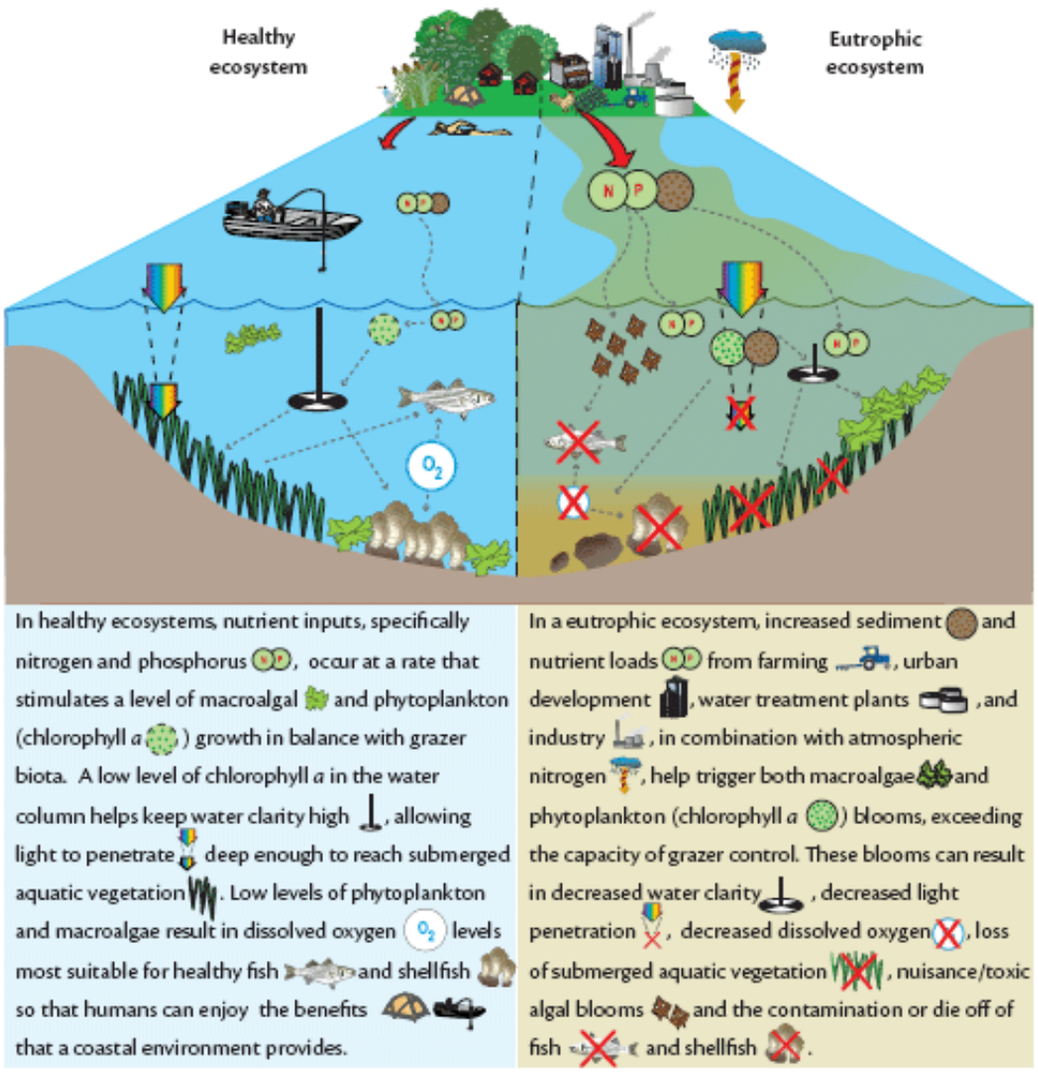


Figure 1:
Bricker, S., B. Longstaff, W.Dennison, A. Jones, K. Boicourt, C.Wicks and J. Woerner. 2007.

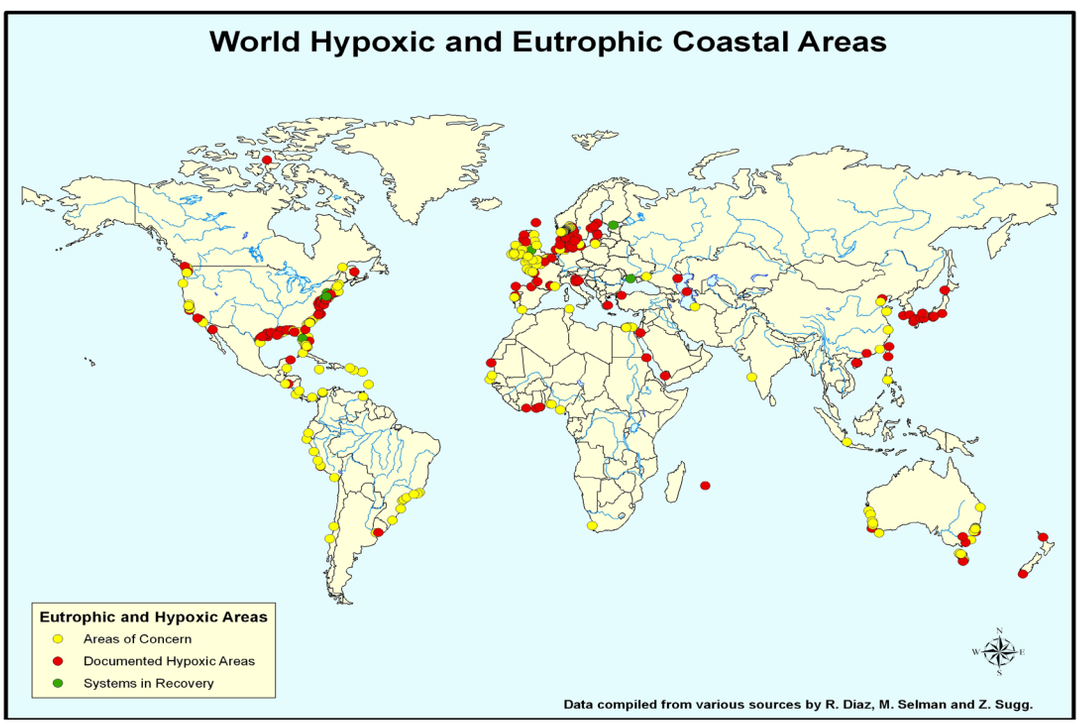


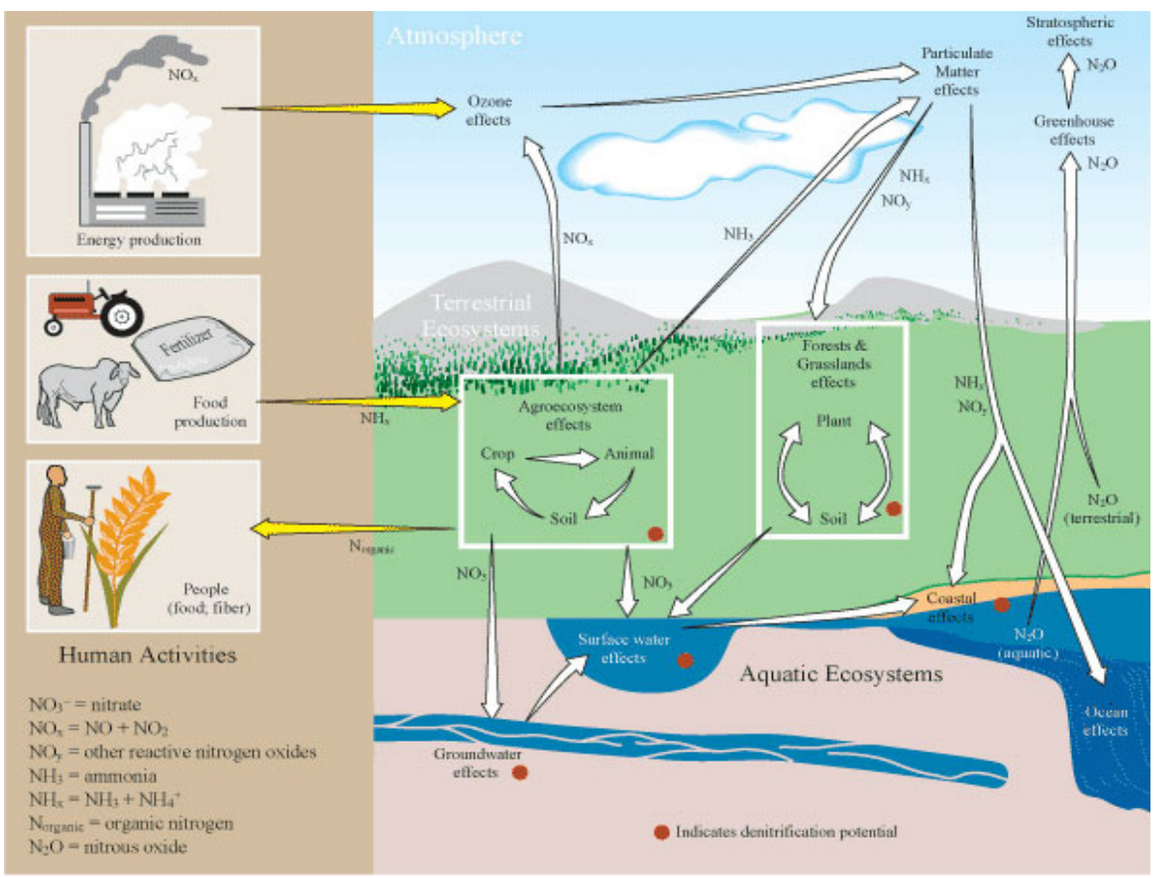
Figure 2:
World Hypoxic and Eutrophic Areas

Cascade, cost and complexity - a watershed model

Reactive nitrogen is particularly challenging. A single molecule of reactive nitrogen may move successively through the environment in a variety of ways causing in turn a succession of harmful impacts – the nitrogen cascade. In the air, this means more ozone causing respiratory ailments and vegetation damage. From the air, nitrogen falls to the surface acidifying buildings, soils and water bodies, and fertilizing trees and grasslands, creating nutrient imbalances and changing biodiversity. On reaching coastal zones it can harm fish stocks and biodiversity. Finally, part of the reactive nitrogen converts to nitrous oxide, contributing to greenhouse gases and ozone depletion.

This illustrates the need for approaches such as integrated watershed/coastal zone management, which address multiple impacts, and the trade-offs and synergies that arise between ecosystem services and human well-being.

Figure 3: The Nitrogen Cascade (Galloway and others 2003)



Part II: Engaging with the drivers of nutrient use

EXCESS AND SHORTAGE - A PRICE WORTH PAYING?

Foodsecurity

The growing cost of excess nutrients needs to be better understood and reversed by governments and stakeholders acting across a broad spectrum of nutrient activities. This means engaging with the prime driver of nutrient use - food security – and demonstrating that the approach towards more sustainable nutrient use advocated here can play an important role.

There are a number of contextual issues. First, the food security of one half of the world's population rests on the application of nitrogen and phosphorous fertilizers.

Secondly, nearly one billion people are affected by insufficient food production, a major factor being a shortage of the nutrients from fertilizers. In sub-Saharan Africa, agriculture is the region's primary industry, but it has the lowest fertilizer application rate in the world, accounting for 1% of global use of synthetic fertilizer on some estimates.

Many countries in the region appear to have negative annual nutrient balances, meaning that more essential plant nutrients are being removed through harvests or being inadvertently lost from agricultural fields than are being introduced into the system. Effective solutions to fertilizer deficiencies in these areas, and the resulting increase in food production, can have positive impacts on poverty reduction and meeting the Millennium Development Goals.

In the face of these problems (which are not confined to sub-Saharan Africa), and the forecast growth in world population, the 2009 World Food Summit set an increased food production target of 70% by 2050. This would require significant improvements in agronomic management and crop yield with the implication that fertilizer use will increase as land use intensifies.

If the challenge of more effective nutrient management is to be met and the overall excess of nitrogen and phosphorous is to be controlled and reduced, it will be key to show that using fertilizer more efficiently can make a real contribution to sustainable food security, including in areas of overall shortage of nutrients.

The central argument in this regard is that generally fertilizers are often over-applied, or applied when they cannot be effectively utilized by crops, even in areas of overall nutrient shortage. Some 20% of nitrogen fertilizer is lost through surface runoff or leaching into groundwater, while phosphorus binds to the soil

and is lost through soil erosion. Moreover, in areas of negative nutrient balances, nutrient losses are due to a variety of factors, not only shallow and highly weathered soils, but also ineffective and inefficient approaches to soil and plant conservation and fertilizer application.

In all areas, therefore, there is scope for more efficient and best practice use of nutrients and associated benefits to farmers in maximising their expenditure on fertilizer. More effective use and application of better methods can mean not only better yields but additional resources to farmers in cost savings. This frees up valuable cash resources.

The Global Partnership on Nutrient Management seeks to draw attention to the need for more nutrients in areas of shortage in order to meet the growing demands for higher levels of food production. In so doing, however, it will promote the fundamentally important message, and means to achieve it, that in moving to higher levels of food production countries need to build in and embed the application of best practices and approaches to crop and soil management.

In this way, farmers can benefit directly in cost savings, while countries can avoid costly adverse impacts to their natural resources from excess nutrients, including harm to fisheries which are also an important part of food security. There are real win - win investment and development opportunities if these approaches are taken.

This message is consistent with the work of FAO, the International Fund for Agricultural Development and the International Fertilizer Industry Association. They have shown that it is possible to engage large numbers of farmers in identifying and applying locally-specific solutions involving the use of simple and improved technologies in agriculture to address problems of improved crop yield and food security.

Energy Security and Climate Change

The growth in the amount of nutrients in the environment, specifically nitrogen, has also been driven in large part by the demand for energy derived from the burning of fossil fuels. As in the case of food security, attempts to address excess nutrients will also need to meet the concerns of countries over energy security.

Indeed, there is a close relationship between fossil fuel use and nitrogen production. More fossil fuel combustion for transportation, and industrial and energy production results in the formation of nitrogen oxide (NO_x), which apart from contributing directly to the range of environmental problems previously described, also constitutes a powerful greenhouse gas.

Historically, as the industrial revolution progressed, the very availability of fossil fuels helped trigger and enable the amount of industrial production of synthetic nitrogen to be greatly accelerated. Carbon dioxide resulting from the production of fertilizer is as we shall see in the case study on Chinese agriculture, an important component of some countries overall greenhouse gas emissions.

Finally, the shift towards renewable energy sources has led to the additional use of fertilizer for the production of crops and biomass for bio-energy and bio-fuel production. Currently, bio-energy contributes 13% to the global energy use, while bio-fuels contribute 2.5%. The influence on global fertilizer use is still relatively marginal, but as present climate and energy policies tend to stimulate bio-fuel production, the influence on fertilizer use and production of nitrogen will tend to grow, depending on which soils and crops are used and in how far nitrogen efficiencies in food production can be increased. There is also evidence that local changes in land use changes, e.g. changes in the US towards using types of land for bio-fuels, can have important and relatively swift effects in terms of eutrophication such as in the Gulf of Mexico, affecting ecosystems and biodiversity.

There is, moreover, growing evidence that the amount of reactive nitrogen in the environment is playing an important role in relation to climate change and that there are important win to win investment opportunities in investing in limits on emissions of NO_x and efficiency of nutrient use and moves away from reliance on fossil fuels and towards a lower carbon society. The various relationships, including the possible impacts of excess nutrients on ecosystem health, were profiled by a side event at the UN Climate Change Convention meeting in Copenhagen in December 2009, hosted by the International Nitrogen Initiative (INI) and the governments of the United States and Netherlands.

The Intergovernmental Panel on Climate Change has requested further research on climate change and nutrients linkage. Work is being taken forward under the auspices of INI.

Key issues which are being addressed are:

- *The formation of nitrous oxide (N_2O):* one molecule has approximately 330 times the greenhouse warming potential of one molecule of carbon dioxide. N_2O levels are estimated as responsible for some 10% of global warming potential. All forms of nitrogen can emit N_2O, including fertilizers and animal manures. At the same time, excess nitrogen sometimes counteracts warming by helping to reflect incoming radiation and by increasing CO_2 uptake;
- *The benefits of more efficient fertilizer use* both in terms of nitrous oxide reduction, and in terms of reducing the large fossil energy input (and thus carbon emissions) into the production and manufacturing of fertilizers;
- *Increased use of bio-fuels* (and thus fertilizer) as a source of renewable energy in response to concerns about climate change, and whether there are overall lower greenhouse gas benefits;
- *The relationship between nutrients and biodiversity loss* and the role of biodiversity ecosystems in carbon sequestration. Nutrients can contribute to plant growth and to the role of forests and soils in sequestering carbon. But nitrous oxide has also damaged grasslands and under the Convention on Biological Diversity levels of nutrients are a negative conservation indicator;
- *Blue carbon:* impacts of excess nutrients in *undermining the resilience of estuarine, coastal and marine ecosystems and their ability to play an important role in both climate change adaptation and mitigation,* e.g., the potential of ecosystems such as sea-grasses to absorb and sequester carbon.

Part III: Current approaches to meeting the nutrient challenge

Where we are:

A broad range of interventions could reduce nitrogen releases to the environment by some 50m tonnes, one-third of human-induced increases

The previous part has set out the nature of the 'nutrient challenge', the problems which arise and how key drivers such as food and energy security need to be addressed. This Part focuses on current best approaches, strategies and practices – 'tools' in the broad sense - to nutrient management, drawing on material from GPNM partners.

The examples are far from exhaustive. The aim is to give a flavour of the breadth of activity on nutrient issues, and what is possible, using examples which illustrate:

1. *How the main sectoral drivers involved in nutrient issues*, such as agriculture, energy and wastewater, can be focused on the nuts and bolts of achieving sustainable nutrient use and production, namely: avoiding unnecessary emissions and injections of nitrogen and phosphorous into the environment where possible; their necessary use in the most efficient, cost effective way; the re-use of any surplus of these nutrients from necessary use; and
2. *How these approaches contribute to national goals* such as human and ecosystem health, a low carbon society, and to food security, including where countries face nutrient shortages.

The reason for this focus is that a central role and goal of the Global Partnership on Nutrient Management is to help:

- *Identify and foster opportunities which can be applied by countries or scaled up as part of a more concerted national and international effort; and*
- *Mainstream these best practices and approaches within countries so that effective nutrient management is embedded and benefits realized.*

Accordingly, the final part of this booklet then goes on to show how these best practices can be brought together, strengthened and indeed mainstreamed to the wider benefits of countries and stakeholders.

A: Efficiency of nutrient use-Putting the farmer first: agriculture and a low carbon economy

Increasing fertilizer use efficiency could meet the projected 38% increase in global cereal demand by 2025 with a 25% decrease in N fertilizer application. This would reduce fertilizer used by about 15m tonnes of N per year.

Better animal feeding and manure management - low protein animal feed, barn adaptations, covered manure storage, air purification, better manure application) could decrease nitrogen releases by some 17m tonnes a year.

There are a wide range of approaches available for increasing fertilizer use efficiency. These include the right form, rate, method and time of application; matching nutrient supply with crop demand; minimizing application in the wet season to reduce leaching; and supplying fertilizer to the plant rather than the soil. They also include practices that improve early crop growth through higher quality seeds and higher plant densities, reduction in pests, and improved water management.

These techniques are applied in various parts of the world and have resulted in increased nutrient efficiencies. The challenge, therefore, is not necessarily a need to create new approaches or technologies but *improve access and the rationale, including supportive policy and investment frameworks, for using and scaling up practices, tailored to the needs of users.*

Two examples, from the USA and the European Union seek to illustrate how access and rationale can be improved with a focus on whole farm approaches, one illustrating how new media can complement that approach, the other how a range of benefits can derive from regulatory action. Both illustrate the importance of stakeholder engagement to communicate direct benefits to farmers. A third example comes from a partnership approach in China. It illustrates the full potential of fertilizer use efficiency as a lever for a range of win to win national and sometimes global benefits – from additional income to farmers to lowering pollution, to the major step of a low carbon economy.

The work of FAO and the International Fertilizer Industry Association are highlighted to show wider benefits of similar best practice approaches.

An US experience - 'whole farms' and web based access to information, tools, technologies and training

'Meeting the needs of people in ways and in formats of their choosing - right nutrient, right time, right place, right rate'

Central to the U.S. approach to excess nutrients is the development of a "whole farm" integrated nutrient management plan. This is where policy and practice intersect – and where extension and outreach are critical to voluntary adoption of Best Management Practices (BMPs). A key goal is to seek win-win outcomes – where farmers save money on nutrient inputs and maintain local water quality that is valuable for the community.

EXtension, is a collaboratively built Internet-based learning environment delivering sound, science-based information on a 24/7/365 basis. It has been successful in the USA in bringing stakeholders together in sharing information and in providing training, in particular by fostering the sense of communities of practice and communities of interest.

The US Department of Agriculture and the National Institute for Food & Agriculture have worked with eXtension to incorporate the formation of communities of practice as a part of integrated competitive grant programs.

The system allows users to search for answers to their questions and if the answers presented do not answer their question, then the user can submit their question to an expert using the Ask an Expert system.

At the heart of eXtension is its Communities of Practice, groups of eXtension professionals, researchers, industry professionals and others interested in the topics who offer expertise on best practice. These groups work virtually, represent a variety of institutions and disciplines, and are flexible.

The system can be of particular value in areas where resources and capacity are constrained, along with access to the right tools and technologies. Specific problems can be identified and addressed, and information and expertise re-purposed to reflect different needs and circumstances.

The bottom line is that the Communities of Practice can *respond to the needs of their public...the Community of Interest.*

The Nitrate Directive of the European Union

The introduction of European Union's nitrate directive represents a mixture of setting discharge limits through regulation, incentives towards environmental improvements, and stakeholder engagement. Its application has seen a growing awareness in the farming industry about the importance of nutrient management leading to:-

- Better nutrient management resulting in reduced inputs and increased efficiency;
- Increased application of agri-environmental schemes in rural development programmes;
- Understanding that productive farming can go hand in hand with environmental protection through better management while keeping production at similar levels; and
- Introduction of innovative agricultural practices resulting in improved Nitrate management and significant overall savings by farmers.

There is a clear message about the benefits of use efficiency to both wider national and regional goals and to user groups themselves.

The Baltic Sea and the Helsinki Convention - agricultural hot spots

Agriculture remains a major source of nutrient inputs to the Baltic Sea and is mainly considered a diffuse source of pollution, as the nutrients affecting the Baltic Sea enter indirectly via runoff in the watershed area. The impacts of agriculture can be reduced by means of broad application of Good Agricultural Practices at farmlands within the catchment of the Baltic Sea.

Nevertheless, intensified development of industrial production of cattle, pigs and poultry within the Baltic Sea area has led to the creation of a new segment of pollution point sources, contributing significantly to the amount of nutrient loads. Therefore, these are being addressed in the same manner as industrial point sources, for example *through establishment of the list of priority hot spots to be remediated first.*

China and the contribution of agriculture to a Low Carbon Economy - China and UK Partnership

Trials show that nitrogen use could be cut by at least 30% with no loss of crop production, achieving savings of 2-3% in China's total GHG emissions as well as boosting net farm incomes and reducing pollution.

China and the UK are committed to achieving a low carbon economy and slowing down climate change. Low carbon agriculture has a central role to play in achieving these objectives and one of the most critical actions is to improve nitrogen management.

China's agriculture and agro-chemical industries account for about 15% of China's total fossil energy use and 20% of total GHG emissions. The manufacture and use of synthetic nitrogen fertilizer is currently estimated to account for some 9-15% of China's total greenhouse gas (GHG) emissions as well as contributing to acid rain, water pollution, the increasing frequency of red tides and reduced farm incomes.

One of the key actions to achieve low carbon agriculture in China is to reduce inefficiencies in the production and use of nitrogen fertiliser. Trials show that nitrogen use could be cut by at least 30% with no loss of crop production, achieving savings of 2-3% in China's total GHG emissions as well as boosting net farm incomes and reducing pollution. The global benefits would be equally significant as China accounts for some 30% world N fertilizer production and 27% of global N fertilizer use.

China and the UK launched this three year joint project in April 2009 to produce a more comprehensive evidence base to help China's national and provincial policy makers to formulate and implement measures to improve nutrient management, lower direct and indirect GHG emissions and slow down climate change. The focus will be on synthetic nitrogen fertiliser use for crops, and will also consider links between crop and livestock production and the potential for improved manure use and organic fertiliser production.

The project is funded by the UK's Foreign and Commonwealth Office and by China's Ministry of Agriculture. The project forms part of the China-UK Sustainable Agriculture Network (see www.sainoline.org).

WORK OF THE FOOD AND AGRICULTURAL ORGANIZATION (FAO)

The Special food programme: Initially, the programme focused on helping countries promote and disseminate simple, low-cost technologies to improve the yields and income of poor farming households through the application of pilot demonstration projects. Subsequently, the programme has shifted away from a project focus towards active advocacy and support to large-scale, multi component National Programmes for Food Security and Regional Programmes for Food Security. Over 100 countries have engaged in the SPFS with more than half adopting National Programmes (NPFS).

Consistent with the best practice dissemination advocated here, the key importance of the programme is that is shows it is possible to engage large numbers of rural people in identifying and applying locally-specific solutions involving the use of simple and improved technologies in agriculture to address problems of hunger. It also shows that such solutions can in due course be mainstreamed as part of broader national and regional programmes.

Sustainable crop production: In search for solutions to practices causing degradation of ecosystems, FAO Member Countries have adopted "Sustainable Crop production Intensification" as a strategic objective of the Organization. The concept of SCPI, elaborated in a brochure and published by FAO (http://www.fao.org/agriculture/crops/core-themes/theme/spi/en/).

The approach emphasizes production intensification, to feed a growing human population, but to be done a sustainable way based on an ecosystem approach. SCPI has been presented to delegates during the recent meeting of the Committee of Agriculture (COAG) held in June 2010 in a document entitled "Sustainable Crop Production Intensification through an ecosystem approach and an enabling environment: capturing efficiency through ecosystem services and management" with a proposed programme for the period 2010-2025.

IFA - THE INTERNATIONAL FERTILIZER INDUSTRY ASSOCIATION

The International Fertilizer Industry Association (IFA) is a not-for-profit organization representing the global fertilizer industry. IFA has some 525 members in about 85 countries. About half of the membership is based in developing countries. IFA member companies represent all activities related to the production, trade, transport and distribution of every type of fertilizer, their raw materials and intermediates. The global fertilizer industry produces some 170 million tonnes of fertilizer nutrients annually.

The industry encourages the adoption of Fertilizer Best Management Practices (FBMPs) as part of good agricultural practices. The most important components of good agricultural practices are: choosing high-quality, high-yield seed; choosing the best time to sow and appropriate methods, with optimum seed rate and plant population; choosing appropriate fertilizers with balanced rates, methods and times of application; replenishing organic matter; adopting appropriate management practices.

B. Avoidance of nutrient emission - Energy and transport, burning of fuels, air quality and human health

Using best available technologies nitrogen release during fossil fuel combustion can be reduced by one third, from about 24m to about 16m tonnes a year.

The United States Environment Protection Agency estimates the net benefits of the Clean Air Act Amendments of 1990 at $690 billion for the period 1990-2010.

A study by the Ontario Medical Association found that air pollution, due to excess reactive nitrogen and other pollutants, cost Ontario citizens more than $1 bn a year in hospital admissions. Such studies are needed in all countries.

Nitrogen oxides (NO_x) form when fuel is burned at high temperatures. The primary sources of NO_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels. In Europe in 2005 shares were road transport (40%) , power plants (22%), industry (16%), off-road transport (15%) and residential sector (7%) (Vestreng et al., 2007a). Action on curbing NO_x emissions have been largely concentrated in the early industrializing countries and regions of the US and Europe, reflecting the high levels of emissions and recognition of the damage to human health and the environment through acid rain. Seminal moves have been through Clean Air legislation by countries, the development of specific technologies to limit and prevent emissions, and regional co-operation, e.g. through the UN ECE Long Range Trans-boundary Air Pollution Convention.

These efforts are instructive because of the contribution made by such regions to overall NO_x levels -European emissions of NO_x appear to have contributed to about 30% of global NOx emissions in 1990 (Olivier et al., 1998; Cofala et al, 2007). The US and European experiences show that appropriate actions and technology can be taken and applied to reduce and prevent emissions. Concerted regulatory action, notably in relation to acid rain has meant lower levels of emission from coal fired plants, and auto-emission controls and cleaner burning engines have helped check the growth of transport emissions.

Much effort has also been invested in Europe (as well as in the US and Canada), both at national and at European wide level within the framework of the Convention of Long-range Trans-boundary Air Pollution (LRTAP). Two Protocols regulating NO_x have entered into force; the 1988 Sofia Protocol sets a limit to national annual emissions or trans-boundary flux of nitrogen oxides at the 1987 level, while the effect-based 1999 Gothenburg Protocol sets fixed emission ceilings for 2010.

Within the EU, a number of Directives have been implemented - the National Emission Ceilings Directive defines slightly more ambitious 2010 emission ceilings for some of the Member States than the Gothenburg Protocol, while the Large Combustion Plant Directive and Waste Incineration Directive, as well as standards for road vehicles target specific sectors. Vestreng et al., 2006; Schultz et al., 2007 conclude that the implementation of strict measures to control NO_x emissions is a main reason for the continued Western European emission reductions, even allowing for slow vehicle turnover, loopholes in the type-approval testing, and an increase in diesel consumption. There appears to be a similar outcome in the US, though lowering overall vehicle emission levels have been problematic.

These positions can be contrasted with the evolution of emissions in Asia, Latin America, Middle East and Africa, where less policy regulations are in place and NO_x emissions are increasing (Naja et al., 2003; Cofala et al., 2007). The cost of applying technology, the spread of fossil fuel use and industrialization, and the sheer increase in vehicles have undermined efforts. This said cities around the world are grappling with various, sometimes low cost solutions, sometimes higher cost – such as replacement of taxi fleets – to air pollution from vehicles. The application of technological solutions backed by concerted national and regional strategies and regulations can make a real difference. In the face of concerns that such approaches can be expensive, countries and stakeholders need to be aware of the wider cost benefits of taking action, not just the health benefits but those derived from reducing the impact of excess nitrogen on coastal and marine ecosystems and effects on climate change. National and regional agencies and bodies dealing with such impacts can usefully help make the case for the added value of taking action and increase political momentum.

C. Re-use - wastewater, water quality and human and ecosystem health

Humans produce about 20m tonnes of nitrogen each year in human waste. Less than 1% undergoes tertiary sewage treatment that makes it harmless.

In the developing world, some 90 percent of sewage is discharged untreated into rivers. Less than 35 percent of cities treat sewage.

The discharges and impacts of excess nutrients contained in wastewater – from water quality to algal blooms and loss of fisheries and tourism - are part of a wider set of problems about the content and lack of treatment of wastewater. These centre on the need to meet the basic sanitation and health needs of many millions of people. However, there are real resource and livelihood advantages to governments and their citizens from a more co-ordinated, integrated approach to wastewater management. This means positioning actions on tackling the adverse impacts of excess nutrients as part of the overall solution and approach to improved sanitation and human health arising out of wastewater discharges more generally.

The reality, for example, is that full treatment sewage systems following traditional models of primary to tertiary treatment are very expensive and often prohibitively so. Re-use of the nutrients in wastewater could help avoid excessive treatment costs whilst providing benefits in terms of organic fertilizer. The 'nutrient cleaning' capacity of natural systems for treatment of wastewater, such as lagoons, ponds, and wetlands could be utilized. Systems exist, operated in both developing and developed countries, for the conversion of wastewater into useable resources. These integrated systems combine processes and practices to optimize resource use by recycling wastewater so that water and nutrients can be re-used. Clean bio-solids can be used in agriculture as fertilizer and to improve the soil structure.

There are many examples of re-use. In China, for example, there are very large farms that are almost self-sufficient in terms of energy and nutrients because of the effective recycling of their waste streams. In India, the Calcutta wetland system provides the world's largest example of wastewater fed aquaculture. The wetlands receive about 555,000 cubic metres of untreated wastewater per day which flows through about 3,000 hectares of constructed fish ponds. Annual fish production amounts to 13,000 tons.

Demonstrating the specific added value of re-use can also help address a main problem with wastewater treatment in that the result obtained after treatment is not recognised as a valuable product. Key to demonstrating and realizing added value is seeing wastewater management and nutrient impacts within an integrated approach that considers all human activities and their threats to ecosystem services and takes all ecosystem components and their interactions into account. For example, the interface between freshwater and coastal systems generates some of the most productive ecosystems on earth - estuaries, deltas, and mangroves, which depend on the balance between the two systems. An ecosystem based approach – as highlighted for deltas in Part 1 - can deliver a win - win investment opportunities and sustainable resource benefits across a range of activities.

'Sick Water ? – The central role of wastewater in sustainable development', a co-operative rapid assessment report between UN Habitat, UNEP and UNSGAB in partnership with UN Water sets out such an integrated, ecosystem based approach and the benefits it brings. It suggests how wise investments in wastewater management will generate significant returns, a key step in reducing poverty and sustaining ecosystem services.Instead of being a source of problems, well-managed wastewater can be a positive addition to the environment which in turn will lead to improved food security, health and economic benefits. It focuses on solutions and how challenges, including dealing with excess nutrients, can be turned around. It finds that appropriate solutions will require innovation at both ends of the pipe, to reduce the volume and contamination of wastewater produced, how to treat or reuse the waste, and how to do it in an affordable sustainable way. Required reading which illustrates how UN agencies can not only share goals but pool expertise and make the most of investment opportunities.

The Caribbean Regional Fund for Wastewater Management - a Regional Seas approach

The degradation of the Caribbean marine environment including through the discharge of untreated wastewater is a serious concern for those countries whose livelihoods depend heavily on their natural marine resources. Scientists have identified a number of serious consequences of marine pollution caused by untreated wastewater. In 2001, UNEP/GPA concluded that pathogenic organisms in waters contaminated by wastewater discharges cause "massive transmissions of infectious diseases to bathers and consumers of raw and undercooked shellfish"; researchers estimated the global impact at US$10 billion per year. The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) scientists concurred that infection of seafood and shellfish occurs through the disposal of urban/domestic wastewater. They also advised that "there is massive epidemiological evidence that enteric and respiratory diseases can be caused by bathing/swimming at marine coastal beaches contaminated [through] exposure to pollution from domestic wastewater sources." The UNEP/GPA 2006 report on the State of the Marine Environment, singled out untreated wastewater entering the world's oceans and seas as the most serious problem contributing to marine pollution including the Caribbean.

Discharge of untreated wastewater has other impacts as well -sewage was one of the main factors that had caused some 80 percent of living coral in the Caribbean to be lost over the past twenty years. Damage by untreated wastewater to the marine environment including living coral can bring about severe economic consequences for people in the Caribbean. The Caribbean Sea Assessment (CARSEA) study found that "the Caribbean is the region in the world most dependent on tourism for jobs and income," while "fishing is also a significant source of both income and subsistence." Yet both of these sectors are directly threatened by wastewater discharge.

In response to the above mentioned situation, the Inter-American Development Bank (IDB) and the UNEP are co-implementing a regional project funded by the Global Environmental Facility (GEF) entitled "Testing a Prototype Caribbean Regional Fund for Wastewater Management (CReW). UNEP's Regional Seas Caribbean Environment Programme will be the lead co-executing agency for the regional project activities. The CReW project will consist of five components (www.cep.unep.org):

- *A flexible and innovative investment and financing mechanism for wastewater management in the context of the Cartagena Convention and its Protocol on Marine Pollution from Land-based Sources and Activities (LBS) including a pilot financing mechanism for wastewater projects.* A project development facility window will provide technical assistance to project sponsors to help bring projects to "bankable" status; and a technical capacity strengthening subcomponent for wastewater pilots;
- *A policy, institutional and legislative reform component which will finance actions for improved wastewater management that is consistent with the Global Programme of Action Plan Guidelines on Municipal Wastewater Management through:* capacity building for policy and institutional strengthening at national and local level; a legislative reform subcomponent reviewing existing legislative frameworks for wastewater management and developing toolkits for improving wastewater legislation, regional training on enforcement and improving compliance with obligations of the LBS Protocol and its Annex III on wastewater management; and awareness raising using best practices from other countries , internationally and within the region to increase the effectiveness and sustainability of the interventions.
- *A communications, outreach and information exchange component that would permit regional dialogue, linkages, coordination, communications and liaison between CReW staff, counterpart agencies, implementing partners, related programs (e.g., in integrated water resources management), and relevant Caribbean stakeholders including the private sector through:* training on documentation of project results; and an integrated information system (clearing house mechanism and information system);
- *A monitoring and evaluation component for related activities:* reviewing proposed indicators and determining the methodology for establishing the baseline and reporting arrangements; and
- *A project management component,* under which a governance structure would be established as the primary coordination mechanism for launching and implementing the CReW.

Part IV: Where we need to go now - mainstreaming the best practices - the Foundations

'Lack of an overview of available information and tools is a key barrier to effective nutrient management' - 2006 Beijing Review meeting of the GPA

Earlier parts have illustrated the scope, scale and importance of the challenge, but that there are practices and approaches and a willingness to address them. The aim has been to show that the 'nutrient challenge' can be reconciled through a focus on sustainable nutrient consumption and production - avoiding unnecessary production, maximizing efficiency of use, and capturing excess through re-use, including working with natural systems to optimize their nutrient recycling role.

However, the landscape of nutrient information is dispersed, lacking an overall approach to information generation and its use. Information needs to be consolidated and synthesised, including as to which management approaches work and why, and knowledge gaps identified for all regions. There is also a need for more integrated and multi-disciplinary assessment of nutrient sources and effects which can help distil the complexity and range of nutrient issues into a clearer governance and management focus. There is also a lack of information on nutrient issues and effects in relation to the wider public, including as consumers of end products from diets to clean water.

Success, however, requires more than identifying best practice opportunities, and better information. It will turn on the extent to which best practices and approaches are embedded – mainstreamed – into the way countries and their constituent parts operate. Success also requires a strategy of engagement with those who influence the patterns of nutrient demand and supply.

As the 'nutrient challenge' is connected to national goals of development, food security, and the management of natural resources, this means influencing the policy making and resource levers available to governments - from national and sectoral planning to thematic approaches such as coastal zone management. It also means the triggering the direct interest of the main industries, and user groups involved in nutrient activities, from wastewater treatment to tourism from farmers to fishermen. Establishing 'constituencies of shared interest and action' focused on effective nutrient management, its contribution to sustainable development and their needs, including access to necessary 'tools'.

The final part of this booklet – its essence - in the light of the previous parts charts a strategy of engagement and collaboration to successfully build the foundations on which sustainable nutrient management can be realized. The primary goal is the embedding of best practices and approaches to nutrient management, identifying what needs to be set in motion by and within countries and how those actions can be triggered. Global advocacy is complemented by pressure from the ground reinforcing arguments for change at the higher levels and vice versa, sharing a common theme of mainstreaming effective nutrient management.

A number of steps are set out interspersed by examples of integrated approaches – both management and assessment – culminating in the advocacy of an overall tool box, which can help guide policy makers to make cost effective investment decisions.

1. Building a shared interest and agenda among countries Energy Security and Climate Change

The full scale of the nutrient challenge is not well known. A first step is to catalyse a new strategic focus among countries on nutrient management - a shared interest and agenda at the global level around why sustainable production and use of nitrogen and phosphorous is important to global sustainable development and to the benefit of countries, and to communicate that information effectively to policy makers/ stakeholders. This requires:

- *The articulation of high level, evidence based policy messages, which resonate with the needs and approaches of countries.* The messages need to demonstrate (a) the importance of effective nutrient management to key global and country interests such as food security, ecosystem and human health, and a low carbon economy; (b) that there are real costs of inaction to be incurred but also benefits to be obtained from co-operation.
- *Insertion into inter-governmental fora.* The nutrient challenge and the policy messages need to be communicated and brought to bear in the work of bodies in which nutrient issues impact. These include, inter alia, the UN Commission on Sustainable Development, the Conventions on Biological Diversity and Climate Change, Regional Seas Conventions and Action Plans, the Global Environment Facility (GEF) and UN agencies.

In this way, a shared interest and agenda can be built up among governmental processes dealing with sustainable development and poverty reduction as to the contribution of effective nutrient management. Inter-governmental agreements and partnerships can reflect this interest and spur national efforts.

Global advocate: for this to happen there needs to be a catalyst to articulate and communicate these messages. The Global Partnership on Nutrient Management –governments, UN agencies, private sector, scientists and NGOs –meets this need, providing a platform for stakeholders to disseminate information and best practices across a range of processes and sectors. The scientific community can play a key role in underpinning and helping this catalytic and advocacy role by instigating policy relevant nutrient assessment based on integrated regional processes and needs.

THE INTERNATIONAL NITROGEN INITIATIVE AND INTEGRATED NITROGEN ASSESSMENTS

The role of the INI is to help minimize the adverse environmental and human health impacts of nitrogen (N) while optimizing its role in sustaining food production and energy use. It works through 6 regional centres - Africa, East Asia, South Asia, Europe, Latin America, and North America, along with a global co-ordination office.

It aims to communicate a new 'sustainability' relationship with nitrogen under which the international community works out ways to use N more efficiently, with far less damage than current usage entails - the benefits and threats of nitrogen to modern society.

The European Nitrogen Assessment (www.clrtap-tfrn.org) will be launched in Spring 2011 under the auspices of the UNECE's Convention on Long Range Trans-boundary Air Pollution. It reflects recognition of the need among European governments and institutions for a more holistic research and management strategy in relation to nitrogen given the complex web of nutrient related issues and the range of instruments and bodies they involve. The underlying goals is to contribute to key development themes, such as food security and ecosystem health. A Rapid African Assessment is currently being taken forward and inter alia will help form the basis for the development of nutrient related partnerships. An US integrated assessment has been conducted by the Scientific Advisory Board of the EPA.

2. Building a shared national interest and agenda - government advocacy and engagement: policy frameworks and proofing

The emerging shared interest and agenda at the global level needs to be translated by governments into a similar strategic focus at the national level, attuned, however, to their own priorities, means and constituents.

A key step is for governments to incorporate effective nutrient management in their policy, institutional and investment frameworks, the ways in which they seek to direct national goals and engage with sectors. This means inserting the value of effective nutrient management into governmental institutions and approaches aimed at achieving food security, management of natural resources, human health, water quality, low carbon use and so on.

In this regard, it is important to position nutrient management within (and as an added value contribution) to broader efforts to include environmentally sustainable natural resource management as a core objective in government planning, so helping to ensure development aims are not undermined by the unsustainable use of natural resources.

Policy making and execution can then start to be 'nutrient proofed' whereby governmental processes consider the need to avoid harmful impacts and identify benefits of efficient nutrient use. For this to happen, however, policy makers, planners, major sectors and groups need to be convinced there are:

- Economic costs to the country in terms of the degradation by excess nutrients of valuable natural resources and the services and jobs they provide;
- Win - win investment opportunities across sectors such as re-use of wastewater for agriculture, and benefits from more efficient nutrient use – farmers from avoidance of lost income, fishermen from tackling dead zones; and
- Availability of cost effective tools and information so that improvements can be identified, realized and scaled up.

The global level advocacy can help stimulate this conviction. But countries' own stakeholders need to be engaged, building constituencies of interest and action on nutrient management, including through stakeholder partnerships, facilitating access to and the benefits of good practices and approaches. The Regional Seas Conventions and Action Plans could play an important role for advocacy at a regional level through the provision of: regional science/policy interface; raising awareness on relevant issues; and working through demonstration projects on the ground.

3. Building constituencies of interest and action - wider stakeholder advocacy and engagement at national and regional levels

The high level policy shifts are necessary foundations in providing leadership and enabling and legitimizing frameworks – sectors, major groups and other stakeholders need to know they have the support of government and investment processes if they are to take forward on the ground interventions.

However, if the arguments for more effective nutrient management and the accompanying interventions are to take root they need to be reflected in more directly relevant sectoral and cross sectoral policy frameworks such as soil and air quality plans and integrated water and coastal zone management planning. These provide directly relevant access points for nutrient management drawing on a supportive framework of ecosystem based resource management and stakeholder engagement.

Good practice strategies and more specific tools for avoiding nutrient leakage, increasing use efficiency, and re-use of excess nutrient production can be built up in this context, consistent with broader sustainability policy frameworks which can lend overall investment and political support. Best practice, for example, might suggest the development of nutrient business planning by farms, which might complement actions

at the watershed and national levels. A broader national approach might entail the development of national nutrient plans or committees, and/or regional maximum nutrient loads.

Regional co-operation: nutrient impacts related to marine and air have strong regional contexts, and inter-governmental co-operation at the regional level provides an interface between global and nationally relevant policy messages and approaches. Backed up by integrated regional nitrogen and phosphorous use assessments, there is scope for the development of regional stakeholder platforms making full use of the regional seas agreements, regional air quality bodies, and large marine ecosystems mapped out by the Global Environment Facility. This is already beginning to happen with moves to establish regional nutrient management platforms in India, Asia and Africa supported by parallel efforts on regional nutrient assessment.

THE GLOBAL ENVIRONMENT FACILITY AND THE BLACK SEA – THE ECONOMIC COSTS OF DEGRADATION AND THE WIN TO WIN REMEDIAL BENEFITS

The Black Sea Basin is a trans-boundary example of how ecosystem based co-operation among the UN agencies and countries can promote and mainstream effective nutrient management. The Sea has been degraded by massive over-fertilisation and eutrophication from nitrogen and phosphorus, largely as a result of agricultural, domestic and industrial sources, including sewage.

The growth in the amount of nutrients in the environment, specifically nitrogen, has also been driven in large part by the demand for energy derived from the burning of fossil fuels. As in the case of food security, attempts to address excess nutrients will also need to meet the concerns of countries over energy security. The GEF funded Partnership has been established with the cooperation of the World Bank, UNDP, UNEP and other multilateral and bilateral financiers and basin countries. It aims to address the root causes of environmental degradation in the region and promote investments and capacity building to return the Black Sea/Danube Basin environment to its 1960s condition. The GEF - World Bank Investment Fund for Nutrient Reduction in the region represents more than $82 million in GEF investment and entail the most important efforts to reduce nutrient stresses in the region.

To reach the overall goal of the project countries are required to adopt strategies and measures that permit economic development whilst ensuring the rehabilitation of coastal and marine ecosystems through pollution control and reduction of nutrients.

The Black Sea Basin

INTEGRATED WATERSHED AND COASTAL MANAGEMENT IN PRACTICE

The potential policy benefits of taking a more integrated management approach to nutrient causes and effects can be illustrated by work of US scientists, undertaken under the auspices of the US National Oceanic and Atmospheric Administration (NOAA).

They found that the ecological health of US coastal waters was seriously threatened by nutrient pollution, and that there was a need to address in a comprehensive way the influx of excess nutrients from upland watersheds to protect the nation's estuaries. They concluded that reducing eutrophic conditions would require coordinated and integrated action that balances management action, efficient monitoring to assess the effectiveness of the management, targeted research, and a communication campaign aimed at engaging the broader community. Recommendations were to:

- Implement more aggressive management actions to reduce nutrients for improvements in eutrophic condition;
- Capitalize on monitoring technological innovations (observing systems, remote sensing, web resources) to improve comprehensive assessment of eutrophication status in a coordinated and timely fashion;
- Focus research on improving assessment: resolving uncertainty, establishing criteria/ thresholds, and engaging managers, researchers, policy makers, and the community with assessment updates at local, regional, and national levels; and
- Develop tools to quantitatively relate the effectiveness of policy approaches.

The example of Chesapeake Bay (p.26) illustrates how such approaches can be articulated and supported against a model – based on the nitrogen cascade described in Part I – of quantifying nutrient inputs and their costs. In this way policy approaches can be better assessed for cost effectiveness. It is as such a best practice tool and model which has potential for wider application. It can also help meet one of the main challenges of nitrogen management resulting from the nitrogen cascade, the need for a concerted effort across the major sectoral sources which close off sources of reactive nitrogen as much as possible and do not result in pollution swapping.

4. Building an implementation aid - on the ground advocacy and engagement: an integrated best practices tool box

A supportive policy environment in which good practice interventions can be advocated, made and nurtured is not enough. Embedding of good practices needs to reflect the needs and circumstances of users at the business end of the process, implementation.

The implementation reality may be one of give and take, with specific interventions helping to shape broader policies and approaches and interventions and accompanying tools having to be adapted to and shaped by local circumstances. This is perhaps how it should be with no one model, approach or practice fitting all. Moreover, users need access to the right tools in order to carry out effective changes.

The development of a systematic and comprehensive nutrient management tool box can help meet this adaptive and interactive process, complementing the broader changes, including lending specificity to those messages outlined earlier about costs and benefits. It should cover the full range of tools, from nutrient strategies and partnerships, to best soil management practices, technologies, financial mechanisms, modelling and assessment. And should incorporate the preparation of training packages to help countries and users to implement best practices and approaches.

In embracing the exchange of lessons learned and best practices and approaches from initiatives from around the world, tools, moreover, can be offered relevant to the type of action being sought, or re-purposed to meet the needs of users and producers at the appropriate level, such as farms and watersheds. Partnerships among nutrient stakeholders can play an important role in facilitating such exchange and re-purposing.

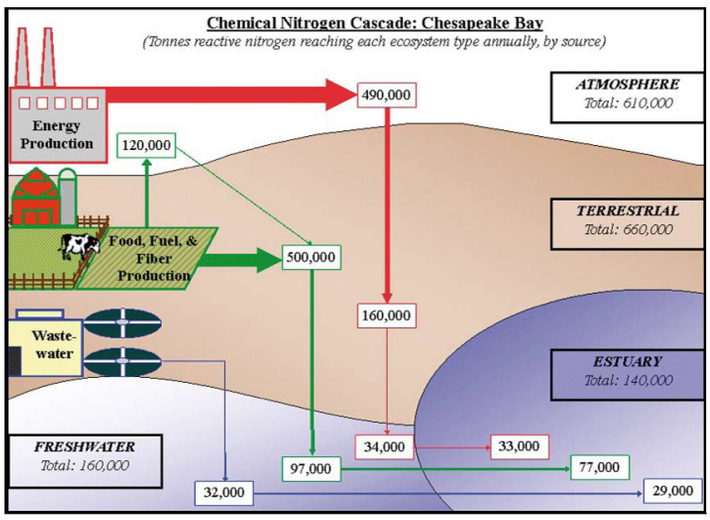


Figure 5: Chemical Nitrogen Cascade: Chesapeake Bay - costs of excess nutrients (Moomaw & Birch, 2005)

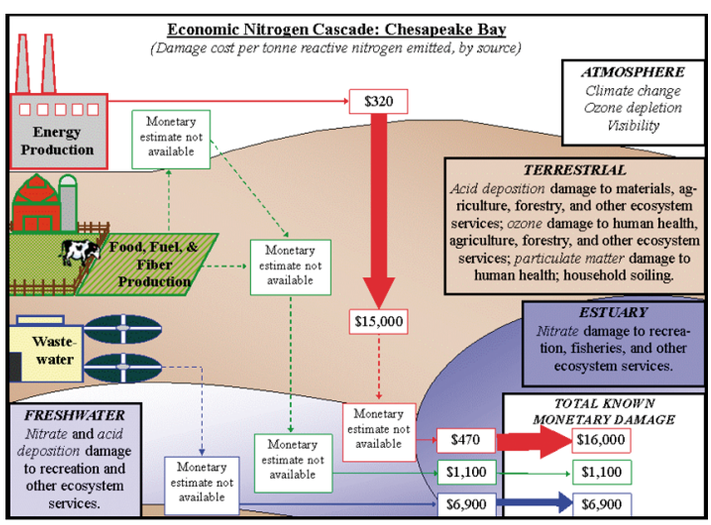


Figure 6: Economic Nitrogen Cascade: Chesapeake Bay - costs of excess nutrients (Moomaw & Birch, 2005)

A key step in this process should be the linking of best practice measures with the models now available for quantifying and analyzing the sources and impacts of excess nutrients. Two of those models are illustrated here– the Global NEWS2USE and the Land Ocean Interactions in the Coastal Zone programme (LOICZ) both of which operate under the auspices of IOC/UNESCO, reflecting concerns about impacts felt on coastal areas.

These approaches, bringing together the currently dispersed data sets about nutrient effects, can help provide policy makers with a method to analyze and predict the likely impact of specific measures and tools. This has the potential to help provide a road map of what investments policy makers can better make in addressing nutrient management across the various sectors involved.

Consistent with the One UN message of this booklet, the Global Partnership on Nutrient Management will be used to help develop such a tool box and associated analysis and modelling in conjunction with the work of the UN agencies involved in nutrient related work, the expertise of partners and the support of the GEF drawing on its own learning networks.

QUANTITATIVE NUTRIENT MODELLING - GLOBAL NEWS2USE : IOC/UNESCO

Conceptual and quantitative models can integrate information about the interactions between people and ecosystems and the markets that heavily influence the patterns of resource use. The Intergovernmental Oceanographic commission of UNESCO has developed the GlobalNEWS2USE to produce more coherent analysis, along with the associated development of cost effective policy measures and scenarios, in order to inform more integrated nutrient management.

NEWS2USE aims to provide a quantitative approach to analyze spatial correlations between nutrient loading and effects such as hypoxia occurrences. It will examine how coastal ecosystems are likely to respond to expected changes in coastal nutrient loading over the next several decades.

The main outcomes will be quantitative analysis of impacts of nutrient loading and changing nutrient ratios in coastal systems on chlorophyll hypoxia, harmful algal blooms and fisheries. Regional and local watershed/coastal zone maps and models can be developed to provide an assessment of the effects of various measures and assist countries in taking an integrated management approach.

LAND OCEAN INTERACTIONS IN THE COASTAL ZONE PROGRAMME (LOICZ)

LOICZ aims to provide the knowledge, understanding and prediction needed to allow coastal communities to assess, anticipate and respond to the interaction of global change and local pressures which determine coastal change.

One significant and emerging development from this approach is a proposed 'nutrient budget' model for estuaries and deltas. Such approaches can also foster links between different user groups, such as farmers and fishermen, who may share the same watershed and develop shared interests in nutrient management.

Reflections - a road ahead and inter-governmental action

The aims and steps described above do not seek to capture or articulate all that is happening in relation to nutrient issues and their management. The breadth of those issues and related activities, which go to the heart of how countries operate and develop, make that impractical.

The reality around the world is a fluid mosaic of initiatives, actions and processes, sometimes connected, sometimes not and responsive to a range of sometime contradictory drivers. It is why this booklet has concentrated on a strategy of engagement focused on mainstreaming and implementing best practices and approaches, a structure for countries and stakeholders to use.

It is an aid to absorbing the flow of information, discerning the essential current and needs – a new focus on sustainability of use and production – and helping decide what is important, what works and who should be persuaded, shaping nutrient management in a productive way but without losing the energy of on the ground efforts.

This approach also reflects a key observation of wider relevance. Some initiatives to improve environmental resource management have favoured either the need for high level strategic engagement to change broad governance approaches or the introduction of on the ground projects focused on a particular issue. The approach suggested here seeks to move the two elements forward together – strategic support for what works and access to tools which can work.

The booklet outlines four main foundations on which successful nutrient management can be realized. They are complementary, though the last – on the ground advocacy – building the tool box – can be seen as key. Governments and their stakeholders require the right tools and approaches in order to focus on what is cost effective and can deliver benefits. They need to be able to develop cost effective and sustainable nutrient reduction and management plans and strategies to improve environmental quality, be it air, or coastal waters, and in a way that realises benefits to stakeholders, from farmers to fishermen.

Governance is increasingly complex and agencies compete for resources. An approach which helps analyze and predict the impact of best practice measures (brought together in a Policy Tool Box) affords the opportunity to provide a road map of what investments policy makers can better make in addressing nutrient excess and its shortage.

This meeting of the International Nitrogen Initiative is an important opportunity to help develop that approach and support it through improved assessments. The review by governments of the 1995 Washington Global Programme in 2011 will be a key opportunity for governments and other stakeholders to illustrate how the foundations for sustainable nutrient management are being put into effect.

New Delhi

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Useful websites:

http://www.wri.org/project/eutrophication

http://gesamp.org/

http://www.gpa.unep.org/

http://ioc-unesco.org/

http://www.ozcoasts.org.au/indicators/water_column_nutrients.jsp

http://www.initrogen.org

http://www.nine-esf.org

http://www.sainoline.org

http://www.clrtap-tfrn.org

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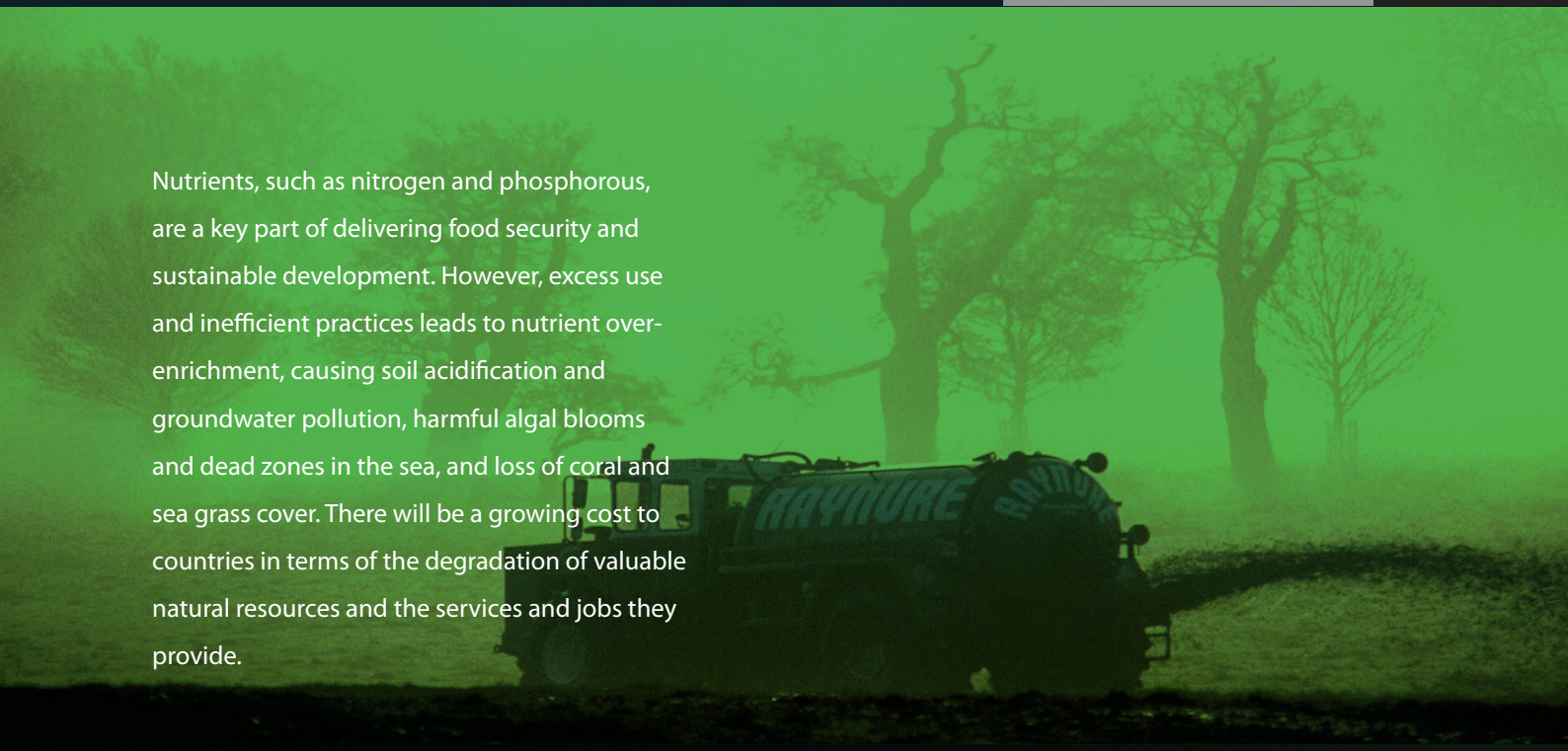

Nutrients, such as nitrogen and phosphorous, are a key part of delivering food security and sustainable development. However, excess use and inefficient practices leads to nutrient over-enrichment, causing soil acidification and groundwater pollution, harmful algal blooms and dead zones in the sea, and loss of coral and sea grass cover. There will be a growing cost to countries in terms of the degradation of valuable natural resources and the services and jobs they provide.

This booklet focuses on the use and effect of two key nutrients - nitrogen and phosphorous.

'Building the Foundations for Sustainable Nutrient Management' is a crosscutting contribution to sustainable development and global advocacy for productive discussion and action by countries and their stakeholders.