



Global foundations for reducing nutrient enrichment and oxygen depletion from land based pollution, in support of the **Global Nutrient Cycle**



# GPNM Phosphorus Task Team Inaugural Meeting

15-16 September 2015

Prepared by the GPNM Secretariat

## Component A: Doc: A1-1

Partners:



September 2015

## About the GEF-Global Nutrient Cycle Project

**Project objective:** to provide the foundations (including partnerships, information, tools and policy mechanisms) for governments and other stakeholders to initiate comprehensive, effective and sustained programmes addressing nutrient over-enrichment and oxygen depletion from land based pollution of coastal waters in Large Marine Ecosystems.

**Core project outcomes and outputs:**

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

**Project partners:**

- Chilika Development Authority
- Energy Centre of the Netherlands
- Global Environment Technology Foundation
- Government of India - Lake Chilika Development Authority
- Government of the Netherlands
- Government of the Philippines
- Government of the United States
- Intergovernmental Oceanographic Commission of UNESCO
- International Nitrogen Initiative
- Laguna Lake Development Authority
- Partnerships in Environmental Management for the Seas of East Asia
- Scientific Committee on Problems of the Environment
- University of Maryland
- University of the Philippines
- University of Utrecht
- Washington State University
- World Resources Institute

**Implementing Agency:** United Nations Environment Programme

**Executing Agency:** UNEP- Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)

**Global Partnership on Nutrient Management (GPNM)  
Inaugural meeting of the  
Phosphorus Task Team**

# **Meeting Proceedings**

**15-16 September 2015  
Centre for Ecology and Hydrology  
Edinburgh, Scotland**

Supported under the  
GEF-funded Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion  
from Land-Based Pollution, in Support of Global Nutrient Cycle (GEF-GNC) Project



**September 2015**

Collaborators



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## Background

The Global Partnership on Nutrient Management (GPNM) was launched in 2009 to address the global challenges faced by the mismanagement of nutrients and nutrient over-enrichment. It is a global partnership of governments, scientists, policy makers, private sector, NGOs and international organizations. It responds to the 'nutrient challenge' – how to reduce the amount of excess nutrients in the global environment consistent with global development. The GPNM reflects a need for strategic, global advocacy to trigger governments and stakeholders in moving towards more efficient and effective nitrogen and phosphorus use and lower losses associated with human activities. It provides a platform for governments, UN agencies, scientists and the private sector to forge a common agenda, mainstreaming best practices and integrated assessments, so that policy and investment responses/options are effectively 'nutrient proofed'. The GPNM also provides a space where countries and other stakeholders can forge more co-operative work across the variety of international and regional fora and agencies dealing with nutrients, including the importance of impact assessment work. The work of the GPNM is advanced by a Steering Committee, a sub-set of the Partnership members and is supported by the GPA Unit of the Marine and Coastal Ecosystems Branch of the Division of Environmental Policy Implementation of UNEP, which serves as the Secretariat to the Steering Committee.

At its December 2014 Steering Committee meeting, the GPNM mandated the establishment of a special Task Team to focus on the issues of phosphorus management, its use-efficiency and impacts to the environment. This Task Team is chaired by Arnoud Passenier, GPNM Steering Committee member, and the current President of the European Sustainable Phosphorus Partnership. The proposed objectives of the task team are:

1. To create a global, dynamic and forward thinking team of multi-stakeholder representatives to work towards a shared vision of phosphorus sustainability for the world.
2. To ensure the GPNM uses its established connections and expertise to foster innovation and enhance pilot and demonstration projects that can support better global management of phosphorus.
3. Promote an enabling environment and evidence base for governments and international and intergovernmental organisations that wish to become involved in implementing solutions that will deliver better global management of phosphorus.

The workshop was hosted by the Centre for Ecology and Hydrology (CEH) and the United Nations Environment Programme (UNEP). The meeting took place at the CEH in Edinburgh, Scotland over the 15<sup>th</sup> and 16<sup>th</sup> September 2015. The workshop agenda is contained in Annex 2.

The meeting was supported through financial contributions from the GEF-funded Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion from Land-Based Pollution, in Support of Global Nutrient Cycle (GEF-GNC) Project.

## Meeting objective

To facilitate the establishment of a Phosphorus Task Team (PTT) of the GPNM to address the special issues of sustainable phosphorus management through its appropriate positioning within the GPNM and the global community, determination of core contributions of the PTT and definition of modalities for collaborative work of the PTT with stakeholders. The specific outcomes of the meeting were as follows:

- Define the role of the PTT;
- Outline milestones, outputs and deliverables of the PTT;
- Create a plan of action for the year ahead.

## Day 1 Proceedings

### Welcome remarks

*Arnoud Passenier of Ministry of Infrastructure and the Environment – Netherlands*

Mr. Passenier officially welcomed participants who gave a brief introduction of themselves (the participant list in in Annex 3). He noted that the Phosphorus Task Team (PTT) will take up from the now concluded Global TraPs initiative and use the shared knowledge to apply best practices for phosphorus management. He expressed hope that the discussion will lead to articulation of a plan of action for the next two years in the context of what can be done within the GPNM related to phosphorus management. He noted that the GPNM has a task team on nutrient use efficiency which is mandated to consider all nutrients in a holistic manner. The key question for the PTT is what should be done on the global level and what will the road map look like for phosphorus management. There has to be a clear indication with whom we collaborate and who are the other stakeholders out there we need to engage with; all this needs to feed into the roadmap. Hence the three key considerations are:

1. What can we do; the plan of action;
2. What can be addressed on a global level;
3. With whom; specifically those stakeholders that need to be engaged as part of the global network.

## Session 1: Viewpoints on Phosphorus Sustainability

**Note:** presentation slides are found in Annex 5.

### **Towards a Phosphorus-secure future: A review of Global Phosphorus Sustainability issues**

*Dr. Dana Cordell University of Technology, Sydney - Global Phosphorus Research Initiative (GPRI)*

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Dr. Cordell gave a review of the diverse challenges of phosphorus management. The issue may not be about resource depletion but rather about use efficiency. There are important geopolitical risks to be considered in phosphorus security in that the mineral resource is concentrated in a few countries. Clarity is needed around who needs to be involved in the phosphorus management framework; there may be sectors that are not currently engaged that need to be included. There is need to think about food and nutritional security which is very sensitive to phosphorus supply and noted that the system is quite dynamic with many factors related to fertilizer access. There are many collective goals that hinge on phosphorus security such as maintaining livelihoods, maintaining soil fertility, integrity of ecosystems and food security. The key consideration is how do we approach the issue of phosphorus security at the lowest cost to society? She compared the case of Australia that has naturally phosphorus-deficient soils where there is significant investment in intensive agricultural production with careful focus on phosphorus management, to Malawi, a country with less intensive agriculture and where phosphorus inputs are largely by manure inputs with negative consequences in terms of pollution. These cases underscore the need for different approaches depending on the local conditions.

She gave examples of opportunities for nutrient (and phosphorus) use efficiency. There have been efforts at engaging urban planners in Hanoi, Vietnam to optimize landscape management with favorable outcomes for sustainable nutrient management. She outlined the principles of sustainable change models in respect to sustainable phosphorus futures and presented a series of proposed phosphorus vulnerability indicators. She provided an overview of a systems approach toolbox for supply and demand for food security and environmental goals, outlining the considerations associated with production costs which have either direct or indirect social costs/externalities. There is a tendency not to consider externalities in sustainability costs. She highlighted possible interventions for mitigative measures and approaches for managing risks around market/policy socio-technical options.

#### **Questions and discussion comments:**

- **Q:** How might one consider all the relevant factors in a phosphorus balance sheet or model?
  - **R:** Advised to take a risk management approach rather than trying to put a dollar value on all factors. However, there would be difficulties in incorporating the externalities based on present knowledge gaps; case in point how to adequately factor in the ecosystem cycling.
- Fertilization in many places has resulted in phosphorus storage in soils and not necessarily lost from the system; it rather remains as a 'bank' or reserve. Phosphorus will be lost if there is erosion and this material is carried away by water. It is agreed however that there needs to be further research on how P is working in soils.

## Phosphorus Vulnerability and Tools for Sustainable P Management

*Dr. Tina-Simone Schmid Neset, Linköping University*

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Dr. Schmid Neset outlined the approaches for a sustainability framework and vulnerability assessment. There are three factors to consider; (i) exposure, (ii) sensitivity and (iii) adaptive capacity, which works at the national level and allow for comparison between countries and regions. She further outlined some of the various methodologies for assessing vulnerability which includes approaches such as multi-criteria weighing. There is need to address the challenge of linking the research on phosphorus from the micro to the meso scale. Work is emerging on phosphorus foot-printing and presented an example from Brazil based on a similar approach for water-foot printing. She discussed the approaches for knowledge brokerage; how to build the bridge between science and policy, and illustrated an interactive decision support modelling tool for phosphorus demand and supply at the global level.

### Questions and discussion comments:

- **Q:** What have been the results from the work on the modelling?
  - **R:** This is still relatively new and under validation. In Sweden where these tools have been introduced, there has been some lag in their uptake and adoption. Switzerland has made some progress in crafting policy for phosphorus recovery, which is planned to become mandatory by 1.1.2016 (10-year transition period)
- There is continuing debate and lack of consensus around how phosphorus scarcity is framed and how its meaning is interpreted. This is very important when it comes to communicating the issue to stakeholders. Originally the issue was framed in the context of depletion of the physical stocks (the rock assets), but there are always great uncertainties about the known and unknown reserves and resources, so it is better to discuss the access to phosphates (because of market deficiencies or political instability). It needs to be made clear that there are many other dimensions that need to be considered that define scarcity and sustainability of use.

## Policy and Governance Opportunities and barriers for enhancing phosphorus sustainability

*Arnoud Passenier - Ministry of Environment, Netherlands*

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Mr. Passenier presented perspectives of government and the challenges of merging the different political cultures of governments in the world (e.g. a more legalistic or non-legalistic approach), the interface between (regional or national) governments and the science interface around the phosphorus issue. In general, politicians only adopt an active policy if they agree not only on the urgency or severity of the issue involved, but also receive perspectives how to deal with the issue. Governments and the political leadership adopt in general risk-averse stances in decision making if it is perceived that there may arise problems in advancing policy that may have negative outcomes from the viewpoint of stakeholders. At least, we need to ensure that we have a common language to communicate to policy makers in assisting them to embrace the desired policy agenda. He acknowledged the different perspectives stakeholders will typically hold and the importance of effectively communicating the right message. He underscored the relevance of the Phosphorus Task

Team of the GPNM in conveying to the world how it can effectively influence policy around the issue.

**Questions and discussion comments:**

- Political solutions can be found in regulation, but sometimes we can find win-wins by putting together stakeholders in product value chains in a multi-stakeholder dialogue to let the network do the job.
- **Q:** How do we get more governments take an active role in the GPNM Platform in general and the P Task Team in particular?
  - **R:** At the global level, we could engage more regional platforms (e.g. in South-East Asia) but it would be great if government officials from China and India could get involved in GPNM/PTT

## **Phosphate Sector Supply challenges and Trends**

*Michel Prud'homme - International Fertilizer Industry Association (IFA)*

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Mr. Prud'homme, highlighting the elements of the phosphorus cycle underscored some of the issues raised by the other presenters on what needs to be done in terms of addressing the gaps in the P management agenda. He noted supply management among the range of issues across the phosphorus sector value chain. There are more than 1,000 producers/stakeholders in the sector with many peculiarities and operating at various economies of scales. The sector is highly fragmented so there is no "single voice" of the industry. He provided insights on P production and suggested that the reporting of phosphorus reserves is related to knowledge availability, referring to the wide variety in the data on supply reserves just between two years; 2009 and 2010. He also provided data on phosphate rock potential supply production. In recent years technologies have been developed that allow for use of lower-grade deposits to yield phosphorus fertilizer; this development therefore changes the P availability also. He noted that there are possibilities for recycling of co-products such as phosphogypsum for use. However, there are stockpiles of this material accumulating in some countries because there is no incentive to recycle. Brazil and China are noted to have policies introduced to encourage use of phosphogypsum (China mandatory). IFA acknowledges over-application and mismanagement, which can and should be addressed through a holistic approach.

**Questions and discussion comments:**

- Phosphoric acid production results in the production of phosphogypsum which can be used as a soil ameliorant. This alternative is useful when there are sulphur deficiencies in the soil. In India this product is being used. It can also be used for construction and the cement industry. China has significant recycling programmes for use of this material.
- **Q:** Has the US developed regulations on use of phosphogypsum?
  - **R:** This is yet to happen.
- It should be noted that there are site-specific feasibility issues regarding use of phosphogypsum that need to be taken into account.
- There needs to be better understanding of the market on a macro-level to advocate for suitable incentives to encourage the sustainable use of phosphorus; however not with intent to interfere with market positions of individual companies.

## Opportunities and Barriers for Enhancing P Sustainability

*Dr. Tom Bruulsema - International Plant Nutrition Institute (IPNI)*

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Dr. Bruulsema gave an overview of IPNI and its role at the global level. He highlighted the soil test results for phosphorus across North America noting that the soils are variable and how this factor needs to be considered in demand. He provided an overview of phosphorus input to output across the US and the cropland phosphorus balances, noting opportunities to more efficiently use phosphorus. He emphasized the importance of the 4R approach (right source, rate, place, time) to fertilizer management to protect water quality, noting that other agronomic techniques such as conservation tillage are also important. There are huge opportunities to better utilize the phosphorus in manure. Innovative technologies to transport (treated) manure are very important. Placement and timing are very important to prevent eutrophication. A key barrier to improving the recycling of phosphorus is economics.

### Questions and discussion comments:

- **Q:** What does the picture look like in terms of soil testing at the global level?
  - **R:** The level of sampling soil as exists for North America is just not practical for many parts of the world and as a result there are gaps in knowledge. Dr. Shen noted that in China, there is a mandatory soil testing programme in the north-eastern part of the country so there are data in that region.
  
- **Q:** How is it possible that there are high occurrences of algal blooms in some lakes where the sampling data shows that the phosphorus loading is low?
  - **R:** This phenomenon could be possibly attributed to the influence of temperature regimes that are enhanced/driven by climate change; the P loading threshold that may trigger algal blooms may therefore be lower, although it must be recognized that there are other interacting factors to be considered. There is need to better understand the drivers.

## The European Sustainable Phosphorus Platform (ESPP); successes, challenges and barriers

*Chris Thornton – European Sustainable Phosphorus Platform (ESPP)*

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Mr. Thornton highlighted the wide scope of stakeholder engagement on the phosphorus agenda. He pointed out that the stakeholders range from industry to utilities to governments to feed/fertilizer companies. However, what has been lacking to date is engagement of the downstream food industry stakeholders. Over the past two years, a platform has started to be built in Europe building on actions already underway in Netherlands, Flanders, and the Baltic. There are many initiatives in progress or on the way that provide opportunities for networking around the issue. He noted however, that there is need to introduce proper network management tools to manage this broad process. He outlined some of the tools already being used by the ESPP including various communication outreach products, the website and the SCOPE Newsletter.

The platform provides input to policy makers in areas that include environment protection, water and nutrient recycling, progress toward the circular economy framework in the context of

sustainable use of bio-nutrients. The platform also supports the consultative process to support the regulatory development process and provides a way to reach stakeholders and coordinate positions. An important role of the platform is providing supporting data and shared insights in issues and innovations for policy making. He acknowledged that there has been a challenge in engaging downstream users, notably the food supply sector. Activities should be linked to the SDG-goals set, particularly the SDGs on hunger and agriculture (Goal 2), water (Goal 6), sustainable consumption and production (Goal 12), and on oceans (Goal 14). Attention should also be paid to the linkage with SGD Goal 3 on health.

## **Sessions 2 & 3: The Role of the Phosphorus Task Team globally and within the GPNM**

The next sessions were facilitated by Dr. Christopher Cox around an open discussion on a series of questions that would contribute to clarity on defining the role and contributions of the task team in the context of the global setting and within the GPNM itself. The following were the key points of agreement among the participants:

- The PTT can play an important role in supporting the GPNM and the GPA in their mandates. The role is to address the right issues, to influence networks on putting those issues on the political and research agendas, create a shared vision on future sustainable use of phosphorus and enhance knowledge dissemination about sustainable innovations. The PTT does not execute research by itself, as GPNM itself doesn't execute research. The PTT should build upon existing knowledge, and influence stakeholders to integrate objective knowledge and insights into the political and business arena;
- The PTT's mandate may be structured around four guiding themes/pillars:
  - i. Securing sustainable access to phosphorus fertilizers,
  - ii. Promoting healthy diets for the global population,
  - iii. Promoting soil health/fertility and productive agriculture, and
  - iv. Promoting the health of rivers, lakes and oceans.
- We need to rely on existing networks first and not duplicate, but rather enhance the coordination and networking (between regional platforms, with scientific platforms) at a global level;
- There is a need to clearly identify possible strategic partners based on recognized gaps. Other sectors like tourism, food industry, nutritionists should be included;
- The P management agenda (from mine to field to fork) can be nested within the GPA mandate given relevance to nutrient loading to the oceans. This is an important leverage that UNEP has to contribute to the issue. This may also be connected to the United Nations Environment Assembly (UNEA) and advancing global positions by countries;
- It is important to consider the linkages to the Sustainable Development Goals (SDGs, esp Goal 12); but also on hunger and agriculture (2), 6 (water), 14 (oceans) and health (3) it is important to also note that the issue will not only have a pollution focus;
- The role of PTT is not to execute research and studies ourselves, but to address the most important issues on the political, business and science level: putting issues on the agenda, creating a shared vision and a shared language for the future, delivering the right

information to make political and research decisions and to disseminate the most relevant knowledge globally;

- Phosphorus supply security (global depletion of resources) is a long-term issue which should be addressed, engaging relevant industries and geological experts in the world in the context of sustainable access to phosphorus fertilizers in order to get transparent and independent data, to develop a strategy for consistent stock assessments. At the same time, the access to phosphorus is dependent on other elements, such as high prices because of transport costs, corruption, etc.;
- Phosphorus management must be integrated within wider nutrient use efficiency concepts. What concepts from nitrogen use efficiency can we adopt for P use efficiency? There has to be a good system of understanding towards development of a common model; economic modeling from the Global Traps initiative may be considered. This issue can be addressed within the NUE TaskTeam;
- Further work may be contributed to better understanding the phosphorus flows and budget including changes over time and full-cycle P management; a dedicated publication for P following a similar approach as presented in the GPNM *Our Nutrient World* (2013) publication may be something the PTT may consider;
- The PTT may also provide support to the development of global indicators for the food industry, with their engagement that would assist governments to implement appropriate policy in the scope of a global movement;
- It is important to realize that there will be unique issues for phosphorus and “map on” to other areas and ensure there is no isolation from other wider issues (e.g. the role of micronutrients). It should be noted however that solutions optimal for P management may not apply or be optimal for nitrogen management. The role of the GPNM is important in facilitating integration;
- Work of the PTT needs to be linked to the soils management group and contribute to, and gain from the global soil monitoring system, particularly in terms of methodological approaches for P assessment, links to soil erosion and soil organic carbon;
- Livestock/meat production is a significant driver of P use and considerations could be given to societal choices in terms of consumption patterns. This part of the issue should be taken into account; what options may be available?
- The P budget approach (material flows) will allow for assessment of the relationship between what is mined, what is actually consumed, where excess winds up. This budgeting will support decision making and allows us to determine when along the cycle and how to respond.

## DAY 2 Proceedings

### Session 4: Defining Milestones, Deliverables and Outputs

Dr. Will Brownlie of the Centre for Ecology and Hydrology (CEH) provided an overview of the previous day's discussions on the direction of the Phosphorus Task Team based on the core pillars for phosphorus security; (i) access to phosphorus fertilizers; (ii) healthy diets for the global population; (iii) maintaining soils fertility and agricultural productivity and (iv) health of rivers and oceans. It was agreed that these four pillars seem to be positioned at a vision statement level and should form the basis of a **Plan of Action** for the PTT. These cover the importance of P in agriculture, food security, soil and freshwater quality. There are many possible pathways towards these four goals. One important sustainable pathway highlighted by the group was the circular (P) economy and improve/secure access of phosphate for the agricultural and chemical sectors.

It was noted that there seems to be quite a bit of discussion among scientists about legacy phosphorus; that is phosphorus stored in soils. However, there are gaps in terms of how to proceed with policy development. There does not seem to be much in the way of advancing toward a "circular" economy with P management and this is the direction in which the P agenda must move. The human health dimension also needs to be kept in the discussion. There are emerging concerns on P intake and associated health impacts but the relationships are not very well understood. The macro-economic dimensions of the P agenda needs continued work as well.

The meeting deliberated on the key priority areas that should form the basis of a Plan of Action that will support the global phosphorus management agenda. The following are the key actions the PTT is positioned to address (within the context of the aforementioned role of PTT):

1. Provide internal support to the GPNM and other Task Teams;
2. Find champions and support their roles on the P issue. Need to think of the key messages that need to get out
3. Support the conduct of an evaluation of key phosphorus management approaches applicable to various world regions, how applied, determine the gaps and identify areas for improvement. This may be a short-term objective of the PTT. Soil erosion and P losses to the environment, particularly in the context of nutrient pollution to the marine environment may be another useful area to give attention; seems to be more research required in this area;
4. Contribute to assessing P soil stocks and understanding the dynamics; assess P interactions with micronutrients. Assess synergies and co-benefits of P management with other global cycles (N, K, C);
5. Investigate options to optimize bioavailability of P stocks locked in soils (soil P banks);
6. Advocate for use efficiency to the policy (political) agenda; provide support for decision and policy makers (at the scientific-policy interface);
7. Contribute to improving mechanisms to access P data (between countries and industries);
8. Promote inclusion of better P management within the SDG, (Goal 14 > Goal 14.1 re water pollution, and Goal 2 > 2.3 re food security, agricultural productivity and access to resources): <https://sustainabledevelopment.un.org/topics>;

9. Foster better understanding of P in health. This is an emerging issue on the science front; still to be considered by the mainstream medical fraternity. The issue remains on the margins of the nexus between environmental science and medicine;
10. Address the issue of feed additives and relationship to food consumption and diets;
11. Contribute to better understanding of the economics of phosphorus and theory drivers in relation to access and use by farmers;
12. Contribute to the agreement and development of appropriate indicators (i.e. sustainability indicators for industry, global/national indicators to demonstrate improvements, successes and sustainability impacts) and data needs and management towards development of decision tools for P management;
13. Develop a 'suite of policy options' for governments/stakeholders that outline 'quantified benefits' of committing to a particular combination of policy options to reduce a region's P vulnerability. This could build from existing tools, such as the interactive scenarios: <http://phosphorusfutures.net/interactive-future-phosphorus-scenarios/>;
14. Foster the development of appropriate P assessment approaches for water bodies and measures to account for impacts and losses associated with soil erosion. Investigate options to reclaim P from eutrophic waterbodies;
15. Advocate for assessment of full chain efficiencies and P footprint approaches (identify data gaps);
16. Facilitate knowledge transfer between stakeholders and governments (including the wider community).

## Session 5: Stakeholders, Team Members and the Planning the Way Forward

This session was an open plenary. The GPNM Secretariat facilitated discussion on a proposed process in engaging partners in moving forward.

There was a discussion on the how to approach global leadership and championing the P management agenda. It was agreed that the role of nutrients must be elevated to the top global agendas and frameworks such at the level of World Water Forum. The example of the championship approaches adopted by the World Water Forum was highlighted; there were key players/champions who drove the issues contributing to the success of the Forum. Leadership was shown from the top, which significantly contributed to moving the agenda, however, not to diminish the bottom-up approach. The issue of nutrient management similarly draws on the critical dimensions related to water. Potential opportunities to insert the nutrient management agenda include the OECD and European Union Ministerial conferences.

Additional stakeholders the PTT should engage with (i.e. those not represented at the meeting):

- Tourism (i.e. impacts to environments from eutrophication)
- Medical Profession/Nutritionists
- Geologists
- Mining industry
- Food industry
- More national governments.

The importance of individual connection and empowerment of ‘champions’ to engage with new stakeholders was highlighted (and illustrated with a P recycling project in Malawi).

It is noted that the role of the PPT is to facilitate stakeholder dialogue to define common assessments and proposals, incite action (among funding organisations, regulators, industry, R&D institutes) and disseminate results (e.g. case studies). While it is not the PTT’s role to carry out research projects the PTT may foster the production of scientific content via individual or collective members and associates.

Based on the foregoing discussions the work of the PTT may be formulated around the following (a) short-term and (b) longer-term goals:

(A) Short term goals:

- Identify benefits for stakeholders to engage with the PTT and engage with them;
- Distil, translate and repackage current knowledge into engaging material to activate stakeholders and the public;
- Produce a special annex of equivalent “Our Nutrient World” (Sutton et al., 2013) which focuses on Phosphorus (to include an update to the conceptual P flows model as seen in “Our Nutrient World” page 23) (See Action Plan below for material that may be relevant for inclusion in such a document).
- Promote an “Our Nutrient World: P Issue” at “The first circular for 5<sup>th</sup> Sustainable Phosphorus Summit” in Kunming (August 2016). Use to engage with UNEA.

(B) Long term goals to include:

- Support the global assessment of nutrient linkages, benefits and threats;
- Investigate practice options, agree indicators and set targets for improved P management;
- Quantify the multiple benefits of meeting the targets: including how these support other global policies and targets;
- Monitor time-bound achievement of the targets, increase visibility of successes;
- Address barriers to change, fostering education, stakeholder discourse and public awareness;
- Provide a ‘suite of policy options’ for decision makers that is diverse enough to cover the specific needs and resources of each region, whilst highlighting quantifiable benefits of their commitment for change.

Dr. Cordell provided insights of the North American Partnership for Phosphorus Sustainability. Mr. Passenier acknowledged the keen interest of the World Resources Institute (WRI) in participating on the PTT. An expression of interest from WRI is contained in Annex 4.

## Summarizing the next steps and the way ahead

The meeting Chair, Mr. Passenier stated that this first meeting laid the basis for a good start and thanked all for participation. The meeting was deemed by participants to have met its objectives with a key outcome being the arrival at a general consensus on how to lead a concerted approach among the global leaders on the P management issue.

The meeting agreed that there should be four main pillars around which the P management agenda for the PTT can be built:

1. Securing sustainable access to phosphorus fertilizers
2. Promoting healthy diets for the global population
3. Promoting soil health/fertility and productive agriculture
4. Promoting the health of rivers, lakes and oceans and reducing wastage in the whole value chain.

The following key actions were approved:

1. Chris Cox, Will Brownlie and Arnoud Passenier will draft a Terms of Reference to define the scope of the Task team and modes for collaboration. The proceedings and the recommendations will be presented to the GPNM Steering Committee on the 5<sup>th</sup> of October 2015. A consultation process will be organized to complete the list of possible actions and set the right priorities.
2. The PTT will comprise of specialists working on specific technical and policy issues on the P agenda; the Steering Committee of the GPNM will be the strategic body that will action the work of the PTT at the global level.
3. Will Brownlie (along with Bryan Spears) of the Centre for Ecology and Hydrology will lead a small drafting team to develop an 'Action Planning matrix'. The following criteria are to inform the priority activities to be contained in the action plan:
  - Must address the four pillars;
  - Fills an important gap rather than duplicating existing work;
  - Be consistent with the GPNM framework, GPNM Steering Committee defined objectives and other GPNM Task Teams;
  - Enable the identification of gaps, barriers, opportunities and priority recommendations.

The Action Plan must clearly define:

- 'what' – identify the critical issues,
- 'why' – establish the relevance of the interventions,
- 'what-how' – define the results and expected outputs,
- 'who' – identify who will take responsibility for executing the actions,
- 'when' – specify the anticipated timeframe for achievement.

The Plan of Action should be completed by the end of November 2015 in time for the next face-to-face meeting of the GPNM Steering Committee. An initial brainstorming of the drafting team

on the core elements of the Plan of Action is contained as a draft proposal in Annex 1 of this report.

4. Some specific directives that should guide the work of the PTT include:
  - Heighten the visibility of the P issue in the country context (e.g. use the United Nations Environment Assembly UNEA, as a forum to present a resolution on the issue and/or host a side event. The next UNEA is scheduled for May 2016);
  - Identify champions that would lead global advocacy on the P issue;
  - Design and implement the work of the task team within the frame of circular economy to build and link to the narrative on phosphorus;
  - Establish linkages with possible financing sources; use the UNEP-GPA mechanism to evaluate and access funding opportunities such as from the Global Environment Facility;
  - Plan for a combined event of the PTT within the 5<sup>th</sup> Sustainable Phosphorus Summit 2016, Kunming, China (16<sup>th</sup> - 20<sup>th</sup> August, 2016)<sup>1</sup>;
  - Make the work and deliverables of the PTT relevant to stakeholders (e.g. business and governments) and their needs, in such a context that they are willing to invest in the GPNM/PTT (seeing benefits of a useful network and getting the right information to support decision making).

UNEP GPA concluded by stating that it will continue to support the work of the P Task Team in its role as Secretariat to the GPNM.

The afternoon session was a field trip to the Linlithgow Palace and adjacent Linlithgow Loch that has had a history of phosphorus loading into the lake. Dr. Spears provided insights on the issues of land management and contributors to P loading and initiatives aimed at mitigating further contributions. More information on the catchment management strategy of the Loch is provided in the report ***Linlithgow Loch Catchment Management Plan - A plan for the improvement of water quality and biodiversity*** at [http://www.westlothian.gov.uk/media/7035/Linlithgow-Loch-Catchment-Management-Plan/pdf/Linlithgow Loch Catchment Management Plan.pdf](http://www.westlothian.gov.uk/media/7035/Linlithgow-Loch-Catchment-Management-Plan/pdf/Linlithgow_Loch_Catchment_Management_Plan.pdf)

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<sup>1</sup> <http://phosphorusfutures.net/announced-5th-sustainable-phosphorus-summit-to-take-place-in-kunming-china-august-2016/>



Meeting participants

## Annex 1: GPNM-Phosphorus Task Team workplan elements (initial draft – for completion)

WHAT	WHY	OUTPUTS GPNM PPT	OUTPUTS third parties promoted by GPNM PPT	Collaborators	Timeframe	Costs
<p><b>1. Indicators, models and transparent data</b></p> <p>a) A common conceptual model of P flows b) Update on P stocks and flows at global scale c) sustainability indicators for industry, indicators to demonstrate improvements and success, d) indicators of phosphorus vulnerability and sustainability to inform policy and research;</p>	<p>There are numerous global P flow models emerging and it would be highly beneficial to consolidate and produce one trustworthy/credible model that the global P community can use to inform future research and policy.</p> <p>This can provide decision-support for policy-makers, industry, researchers. Full chain footprint to understand gaps in knowledge quantify losses and efficiencies and provide context for decision makers and governments to engage in change.</p> <p>There is an urgent need to fill the gap in comprehensive, transparent, independent data sets related to phosphorus vulnerability and sustainability. Such indicators could provide evidence of vulnerabilities, stimulate targeted action, raise awareness, and evaluate effectiveness of future interventions.</p>	<p>Dialogue with stakeholders to define a common model, including shared definitions of losses, efficiency etc.</p> <p>Policy report to inform management practices and effective policy instruments.</p> <p>Expert Panel for validation of indicators; visually-engaging online indicators for annual tracking (similar to global water, climate, food security indicators) – wide-ranging sustainability dimensions from dependence on imports, price, market concentration, eutrophication potential etc.</p> <p>Engage with ISO, US standards (CEN SABE already underway in EU) and industry indicator organisation (TSC, FtF ...) and with stakeholders (including food industry) to develop shared indicator approaches</p>	<p>Policy paper to highlight gaps in knowledge</p> <p>Scientific project proposal to develop data and disseminate results</p>			

WHAT	WHY	OUTPUTS GPNM PPT	OUTPUTS third parties promoted by GPNM PPT	Collaborators	Timeframe	Costs
<p><b>2. P and Diets</b></p> <p>a) Quantify changes in societal behaviour that can reduce P requirements b) provide a P foot-printing methodology for foods and food production types c) Assess the impact food waste has on P demand for different regions d) Assess health risk associated with high P content of diets, and impacts to different global communities</p>	<p>A dietary choice is one of the biggest drivers of global phosphorus demand (e.g changing preferences in India and China).</p> <p>Enable society to engage in a movement towards lowering societal P requirements through dietary and lifestyle choices To provide guidance to decision and policy makers on increasing use of P additives in foods.</p> <p>Emerging studies suggest excess P consumption (linked to food additives) can contribute to kidney and other disease in vulnerable people.</p>	<p>Engage with farmers, food industry, “fast food” industry, other groups working on ‘environmental impacts’ of meat consumption, kidney patients’ associations, environmental NGOs, organic food associations etc.</p> <p>Try to agree areas where further research or action is needed.</p> <p>EFSA just published an Opinion in Europe ... GPNM is not competent to do better</p>	<p>Collate existing literature and publications on these different areas into a scientific assessment covering both approaches (health, P-footprint): NOTE CRC book currently underway</p>			
<p><b>3. P accessibility for farmers</b></p> <p>a) Drivers &amp; mechanisms for lack of access, policy implications; b) National and catchment scale size projects to recycle existing P domestic supply in regions with: high dependence on imported P fertilizers, high farm-gate prices and that lack infrastructure and resources to secure P fertilizer c) identify champions in this regard (i.e. Malawi project) c) provide guidance on best practice</p>	<p>Importance of visible projects GEF funding is potentially more focused on higher productivity and lower environmental footprint through precision management.</p> <p>Successful project can provide “demonstrations areas” to encourage upscaling/national adoption</p>	<p>Case-studies of model small scale projects, dissemination</p>	<p>Collective agenda to develop proposals for funding for projects</p>			

WHAT	WHY	OUTPUTS GPNM PPT	OUTPUTS third parties promoted by GPNM PPT	Collaborators	Timeframe	Costs
<p><b>4. P in the environment</b>  a) improve 1. understanding of P legacy potential in different parts of the world and 2. potential to access significant P stocks in soil, also associated with historical over-application (in some regions, e.g. N America, W Europe, parts of Asia), while managing the risk of P loss to water; b) optimizing bioavailability of P in soils (in both regions in surplus and deficiency) b) Quantification of the global impacts of eutrophication resulting from P over use c) identification of global areas of high risk d) review leading technologies and innovations to reduce P loading to waterbodies (i.e. sanitation in developing countries) and to harvest/extract P from eutrophicated waterbodies d) improve understanding of recycling potential of different P pools in the environment (quantifications)</p>	<p>Acknowledging P locked in soils as a huge potential resource (soil P bank), that can be unlocked as a source of bioavailable P to plants.</p> <p>Informs innovation &amp; technology, decision-making to support farmers (e.g. directly and via extension services), and policy-makers</p> <p>Address future concerns of potential impacts of P stores on global water quality, in terms of economics, health risks, water conflicts and climate change</p> <p>Public awareness increasing in US (i.e. Lake Eerie, Everglades and California Water shortages)</p>	<p>Policy briefing</p> <p>Case studies – dissemination</p>	<p>Scientific paper to highlight gaps in knowledge</p> <p>Work with other groups already doing this (e.g. P-RCN and WRI)</p>			

WHAT	WHY	OUTPUTS GPNM PPT	OUTPUTS third parties promoted by GPNM PPT	Collaborators	Timeframe	Costs
<p><b>5. Technologies and Policy Options</b></p> <p>a) Review leading and step change technologies that may be ‘main-streamed’ to improve P use efficiencies for different regions b) identifying barriers imposing the main streaming of such technologies c) Provide “choices” (a menu of policy options) for how governments can reduce P requirements/use and achieve P security; options must be varied enough to give decision makers a choice in how they feel they can meet the different needs, resources, P efficiencies and sufficiency’s of their region d) Development of a framework to identify top 10 (?) recommendations on reducing P vulnerability specific to region (i.e. context matters)</p>	<p>There is a whole toolbox of existing and emerging sustainable P technologies &amp; innovations which could be up-scaled and/or implemented. However there is a need to identify which are the lowest hanging fruit in each context. Further, technologies and innovations may be blocked by a whole range of barriers, such as historic legislation (i.e. issues with P reclamation from wastes, use of phosphogypsum).</p> <p>There is also a whole toolbox of policy interventions and options available, however importantly, there is a need to identify the appropriate suite for a given country or region to avoid investing in inappropriate or ineffective solutions.</p> <p>Findings can inform a ‘Suite of Policy Options’ documentation</p> <p>Input into the United Nation Environment Assembly (UNEA) Support GPA</p>	<p>Policy Report: A ‘Suite of Policy Options’ documentation</p>	<p>A tool to allow decision makers to quantify the net impacts of choosing different options</p>			

WHAT	WHY	OUTPUTS GPNM PPT	OUTPUTS third parties promoted by GPNM PPT	Collaborators	Timeframe	Costs
<p><b>6. Preparing for Future PR supply risk</b>            Potential risks to global P demand from a) step change technologies that may require P from PR (i.e. Bioenergy, P containing car batteries, etc).            b) Security of supply (reducing vulnerability) because of instable or disputed regions. Dealing with population and economic growth and increasing meat consumption d) climate change and synergies and co benefits of better P management for other global cycles (micronutrients, N, C, K etc.)            e) <i>establish long term knowledge-anchoring mechanisms and policies</i></p>	<p>Instigate discussions on what are the future risks and prioritise actions to address them</p> <p>Support decision and policy makers</p>	<p>Policy Report</p>	<p>Scientific Paper</p>			

## Annex 2 - Workshop Agenda

### GPNM Phosphorus Task Team Inaugural Meeting

15-16 September 2015

Venue – Centre of Ecology and Hydrology in Edinburgh, UK

Time	Session	Detail / Objectives	Lead Resource person(s)
<b>DAY 1: 15<sup>th</sup> September, 2015</b>			
9:00 - 9:10	Opening remarks	Welcome and Introductions	Arnoud Passenier
<b>Session 1: Viewpoints on Phosphorus Sustainability</b>			
9:10 - 9:30	Participants Introductions	<i>A review of the global issues on P sustainability</i> (15 mins + 5 mins discussion)	Dana Cordell
9:30 – 9:50		<i>Phosphorus vulnerability and synergies with other sustainable development goals</i> (15 mins + 5 mins discussion)	Tina-Simone Schmid Neset
9:50 – 10:10	BREAK		
10:10 – 10:30	Participants Introductions	<i>Policy and governance opportunities and barriers for enhancing P sustainability</i> (15 mins + 5 mins discussion)	Arnoud Passenier
10:30 – 10:50		<i>A viewpoint from industry on the opportunities and barriers for enhancing P sustainability (*provisional title)</i> (15 mins informal briefing + 5 mins discussion)	Michel Prud'Homme
10:50 – 11:10		<i>The European Sustainable Phosphorus Platform (ESPP); successes, challenges and barriers</i> (15 mins + 5 mins discussion)	Chris Thornton
<b>Session 2a: The Role of the Phosphorus Task Team</b>			
11:10 – 12:30	Group Discussion	<b>Questions for discussion:</b> <ul style="list-style-type: none"> <li>• <i>What support does the global community need in order to reduce phosphorus vulnerability?</i></li> <li>• <i>How do the issues surrounding P resource use differ between geographic regions and how can we ensure our role serves the needs of all regions? (i.e. not just those regions using excess P)</i></li> <li>• <i>What is the role of the PTT in supporting the different</i></li> </ul>	Chaired: Chris Cox

Time	Session	Detail / Objectives	Lead Resource person(s)
		<p><i>regions to improve P sustainability? (see suggested considerations below)</i></p> <ul style="list-style-type: none"> <li>• <i>Will our role be unique and are we best positioned to provide this service? (i.e. are other groups/platforms already covering certain roles?)</i></li> <li>• <i>What is our overarching mission statement?</i></li> </ul>	
12:30 – 1:30	LUNCH		
<b>Session 2b: The Role of the Phosphorus Task Team (Continued)</b>			
1:30 – 3:00	Group Discussion	<p><b>Questions for discussion:</b></p> <ul style="list-style-type: none"> <li>• <i>Should we function as a platform to disseminate information to stakeholders?</i></li> <li>• <i>What do stakeholders gain from engaging with GPNM, and the PTT in general?</i></li> <li>• <i>How can we make the results of our efforts visible in both the short and long term?</i></li> </ul>	<b>Chaired: Chris Cox</b>
3:00 – 3:20	BREAK		
<b>Session 3: The Role of Phosphorus Task Team within the GPNM</b>			
3:20 - 4:50	Group Discussion	<p><b>Questions for discussion:</b></p> <ul style="list-style-type: none"> <li>• <i>What are the other GPNM task teams and how do they currently function?</i></li> <li>• <i>How can the PTT input in to other task teams within GPNM? (Numerous issues concerning phosphorus (and other nutrients) are already discussed in other GPNM Task Teams)</i></li> <li>• <i>What is the potential to share events and milestones, and what do we expect from the other task teams in return?</i></li> </ul>	<b>Chaired: Chris Cox</b>
4:50 – 5:00	Sum-up of day one	Summarizing key points of the day and plans for dinner	<b>Arnoud Passenier</b>

\*suggested considerations for discussion in Session 2.

- *Helping to create a global policy framework for P-stewardship.*
- *Monitoring P-flows: from soil to dump.*
- *Mapping types of P risk by geographic region.*
- *Raising the agenda of specific environmental issues connected to the use of phosphorus.*
- *Fossil and urban mining: possibilities to make both more sustainable.*
- *Markets & geopolitical perspectives (scarcity, disruptions of supply, product value chains).*
- *Product value chains: improving phosphorus use efficiency and identifying champion/influential partners in the value chain?*
- *Connecting global groups: GEF, The World-Bank, The International Hydrological Programme (IHP) and coordinating with global work on nitrogen (INI, TFRN, TFIAM etc.) specifically providing input to preparation of the UN Convention Task Force LTRAP and UNEP GPA "Land Based Activities".*
- *Raising public awareness, coordinating global awareness in the media*

Time	Session	Detail / Objectives	Lead Resource person(s)
<b>DAY 2: 16<sup>th</sup> September 2015</b>			
9:00 – 9:10	Recap of Day one		Arnoud Passenier
<b>Session 4: Defining Milestones, Deliverables and Outputs</b>			
9:10 – 10:30	Group Discussion	<p><b>Questions for discussion:</b></p> <ul style="list-style-type: none"> <li>• <i>What is our 'plan of action' to ensure our deliverables are SMART and help us focus to show results.</i></li> <li>• <i>What is the priority list of our ambitions on day 1?</i></li> <li>• <i>Who can help with setting up concrete actions?</i></li> <li>• <i>What milestones can we create, to accelerate actions towards those milestones (e.g. a World Nutrient Forum as counterpart of the WEF and WWF) ?</i></li> </ul>	Chaired: Arnoud Passenier
10:30 – 10:50	BREAK		
<b>Session 5: Stakeholders, Team Members and the Planning the Way Forward</b>			
10:50 – 11:50	Group Discussion	<p><b>Questions for discussion:</b></p> <ul style="list-style-type: none"> <li>• <i>Which stakeholders are essential to meet our goals and which stakeholders are we currently not engaging with? (Try to think out of the box: who would be the beneficiary of a sustainable phosphorus system in the world?)</i></li> <li>• <i>How do we proceed further? (A small Task Team and a bigger network, or a broad network?)</i></li> <li>• <i>What will be the frequency of our (physical and skype) meetings?</i></li> <li>• <i>How do we convene in the meantime and what are the roles of members and how can we create an enabling environment to support the views of all members?</i></li> </ul>	Chaired: Arnoud Passenier
11:50-12:00	Summing up	Summarizing the next steps and the way ahead	Arnoud Passenier

## Annex 3 - Meeting participants

Name	Country	Organisation	E-mail
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## Annex 4 - World Resources Institute Expression of Interest



### Global Partnership on Nutrient Management Phosphorus Task Team

#### Expression of Interest

##### *Overview of the World Resources Institute*

The World Resources Institute (WRI) is pleased to continue its work with GPNM through the Phosphorus Task Team.

WRI is the top-rated environmental think tank in the world. Its Water Program has been working on eliminating eutrophication for more than a decade. It has published on the extent of eutrophication worldwide, the drivers and sources, and policy mechanisms for addressing eutrophication. In addition, WRI has an interactive global map of over 700 eutrophic and hypoxic coastal zones. WRI is an expert on flexible, market-based solutions to cost-effectively achieve water quality goals, such as water quality trading and geographic and cost-effective targeting of conservation and restoration efforts. It is also strong in policy analysis, program evaluation, and analyses on barriers to change.

Recently, WRI was contracted by the Global Environment and Technology Foundation under the “Global Nutrient Cycles” GEF grant to develop a global database of nutrient-reducing practices and nutrient-reducing programs and policies. WRI presented these databases as well as the larger GPNM “toolbox” at the Chilika Lake workshop in India in July where it was well received. WRI is also starting development of a country-level nutrient management template for the “Global Nutrient Cycles” GEF project. We look forward to continuing these lines of work with the GPNM.

In addition to eutrophication policy expertise, WRI has unique skills in data visualization, specializing in creating accessible, user-friendly online platforms for decision makers, the private sector, and others. Through these platforms and other points of engagement, WRI brings valuable partnerships with the private sector, foreign governments, and other NGOs.

Finally, with offices in India, China, Brazil, Belgium, and Indonesia, WRI has an international presence and many local partners in developing countries.

### ***Interest in Phosphorus Management***

WRI is keen to build off of the work it's completed so far with the Global Partnership on Nutrient Management. With the existing databases and toolbox as a foundation, the Phosphorus Task Team is well poised to conduct additional research and outreach on successful, cost-effective, and replicable phosphorus management efforts.

In addition, WRI has a number of other projects outside of the GPNM that may be of interest to the Phosphorus Task Team. WRI is currently conducting a scoping exercise to formulate plans for development of a global food and water security analyzer: a web-based, publicly available interactive platform designed to inform government officials and other analysts on current and future threats to water and food security worldwide over the coming decades. Phosphorus availability and use have a significant role in global food security and could be an important component in this analyzer.

WRI is also conceptualizing a global, web-based platform to provide governments, businesses, nongovernmental organizations, scientists, and citizens with near-real time, systematic data at their fingertips on the water quality of every major lake, river, and estuary on the planet (funding dependent). By using satellite-based remote sensing to detect surface water extent, water clarity and total suspended solids, and potential algal blooms, we can derive phosphorus loads and provide a timely, large-scale global water quality monitoring system for fresh and coastal waters.

WRI looks forward to exploring these and other opportunities for collaboration via future GEF or other funding prospects and to continuing to engage with members of the GPNM and Phosphorus Task Team.

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# Annex 5 Presentations

## 1. Dana Cordell

**TOWARDS A PHOSPHORUS SECURE FUTURE**  
A REVIEW OF GLOBAL PHOSPHORUS SUSTAINABILITY ISSUES

UTS  
UNIVERSITY OF TECHNOLOGY SYDNEY

Dr Dana Cordell  
Institute for Sustainable Futures  
University of Technology Sydney

UTS:ISF  
INSTITUTE FOR SUSTAINABLE FUTURES

17P, September 2015, Edition 1  
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**THE GLOBAL PHOSPHORUS CHALLENGE**

The phosphorus challenge has many dimensions:

- Environmental pollution
- Physical scarcity – finite resource
- Mismanagement & inefficiency
- Geopolitical risks
- Fertilizer access for farmers
- Whole food system – mine to field to fork
- Governance – who is responsible?

**PHOSPHORUS DICHOTAMIES**

1. **Global challenge:** scarcity ★ pollution
2. **Food security:** obesity ★ undernourishment
3. **Distribution of reserves:** producers ★ importers
4. **Fertilizer use:** over-application ★ under-application
5. **Soil phosphorus:** surplus ★ deficiency
6. **Farmer issues:** accessibility ★ managing excess
7. **Fertilizer demand:** increasing ★ decreasing

Global phosphorus fertilizer consumption

**2008 PRICE SPIKE: CAUSES & EFFECTS**

Phosphorus rock commodity price

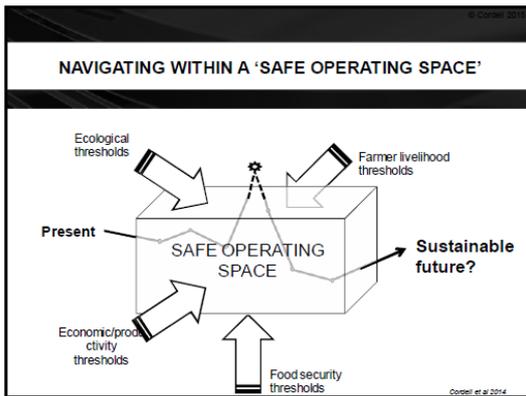
Cordell, Turner & Chong (2015)

**Phosphorus security:**

- farmers can access phosphorus fertilizers
- 9 billion people have healthy diets
- Soils are fertile & agriculture productive
- Rivers and oceans are clean

**COLLECTIVE GOALS FOR PHOSPHORUS SECURITY**

- > **Agricultural productivity:** Increase overall phosphorus use efficiency of the food system by increasing the number of people fed per tonne P input, or reduce total P demand while maintaining food/agricultural output
- > **Soil fertility:** Ensure soils are fertile in terms of total bioavailable phosphorus and C:N:P ratio, organic matter, moisture
- > **Farmer livelihoods:** Ensure farmers have access to affordable phosphorus fertilizers and in a bioavailable & manageable form
- > **National security:** Reduce dependence on phosphorus imports through diversification of sources, to buffer against price fluctuations and geopolitical risks in producing countries
- > **Environmental productivity:** Close phosphorus cycles by reducing phosphorus losses/waste throughout the food system, from mine to field to fork
- > **Ecological integrity:** Reduce leakage of phosphorus from land to avoid eutrophication & pollution of rivers, lakes and oceans



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What is the best way to get there,  
at the lowest cost to society?

...depends on the **context**  
(region, country, city)

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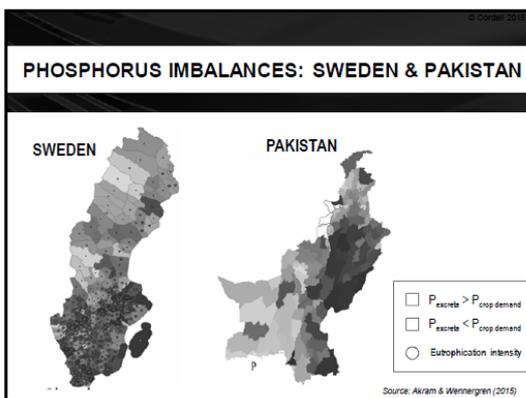
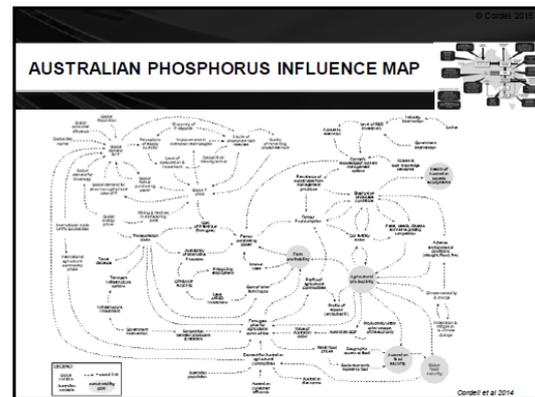
### NATIONAL PHOSPHORUS CONTEXT

**AUS I KALIA:**

- Net food exporter
- but net phosphorus importer – world's 5<sup>th</sup> largest
- Naturally phosphorus-deficient soils
- Invested in phosphorus-intensive agricultural exports (beef, live animals, wheat, dairy)

**MALAWI:**

- Subsistence farming (maize)
- Fertilizer subsidy
- Landlocked, and high dependence on P imports via Mozambique or SA
- Widespread water pollution
- P in excreta ~ P fertiliser demand
- 1 major fertilizer company (in Blantyre)



**P-FUTURES**  
Transforming the way cities secure food and water through better phosphorus governance

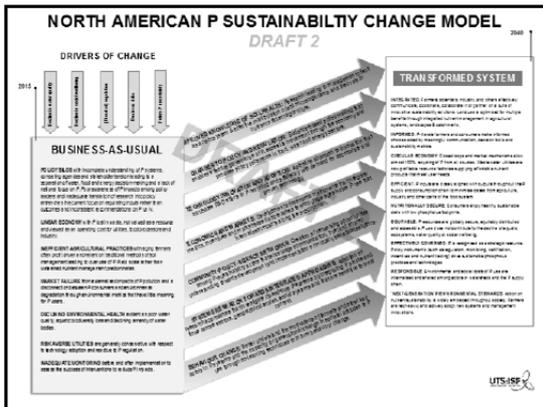
Sydney, Australia

Blantyre, Malawi

Phoenix, USA

Funding Partners: ISSC, UTS-ISF, ASU

Research Partners: UTS-ISF, ASU



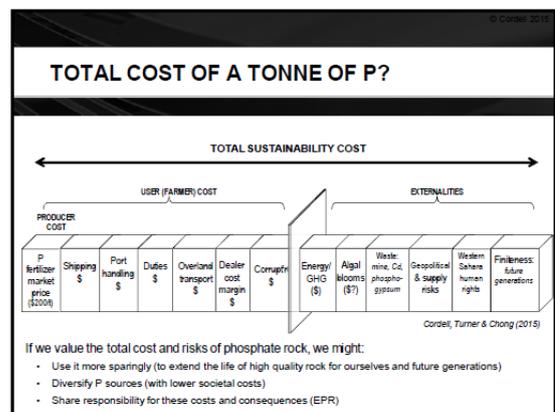
### MONITORING & TRACKING PHOSPHORUS INDICATORS FOR FOOD SECURITY & THE ENVIRONMENT

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GLOBAL PHOSPHORUS INDICATORS	
<b>A. Phosphate price</b>	A.1 Phosphate commodity spot price (US\$/tonne) A.2 Nonmarket mechanism price level
<b>B. Market concentration &amp; supply risk</b>	B.1 % reserves controlled by the top 5 countries B.2 % production controlled by top 5 producers B.3 Individual country supply concentration
<b>C. Relative physical phosphorus scarcity</b>	C.1 Reserves by country C.2 Consumption: availability, production/leaves ratio C.3 Peak phosphorus curve
<b>D. Eutrophication potential</b>	D.1 Reported algae blooms (frequency, severity) D.2 Visible hypoxia (percentage of blooms) D.3 Language use from zero to water quality index

provide evidence of key phosphorus vulnerabilities or 'hotspots' in the food system  
stimulate effective phosphorus governance & targeted action  
raise awareness of this food security challenge  
evaluate the effectiveness & performance of global/national sustainable phosphorus projects

NATIONAL PHOSPHORUS INDICATORS	
<b>E. Farmer phosphorus vulnerability</b>	E.1 Farm income/profit (percentage cover ratio) E.2 Proportion of farm income spent on fertilizers, or % farmers not applying fertilizers due to lack of affordability E.3 Farm P budget (nutrient-use, soil P stock) E.4 Farm gate price of P fertilizers relative to market price
<b>F. National phosphorus vulnerability</b>	F.1 Dependence on foreign phosphate F.2 World share as P importer (per capita) F.3 National economic dependence of P F.4 Capacity for alternative sources of P (qualitative assessment of infrastructure in place) F.5 P lost system efficiency (P lost/tonne of P applied/fertilizer, %) F.6 State of infrastructure (ports, rail, road, storage) F.7 Effective demand policies in place (qualitative assessment)
<b>G. National phosphorus equity</b>	G.1 National P consumption relative to global consumption (per capita) G.2 National reserves: global reserves (per capita) G.3 Dietary P (protein, nutrient/energy, per capita)
<b>H. Soil phosphorus legacy</b>	H.1 Surplus/deficit, soil P stock H.2 Bioavailability: soil-to-P (nutrient) H.3 Crop yield (associated with P fertilizer)



### IMPLICATIONS & OPPORTUNITIES

© Cordeil 2015

- The sustainable phosphorus challenge spans the **whole food system**, and **ecological to geopolitical**, hence diverse stakeholder set need to be engaged and collective goals
- Different regions **vulnerable in different ways**, hence need locally appropriate priorities & transformations
- Innovative **tools & frameworks** can guide identification of local priorities and transformation pathways
- Urgent need for global/national **monitoring** based on transparent, independent and trustworthy data (whole food system - mine to field to fork)

### PHYSICAL SCARCITY: PEAK PHOSPHORUS

- Global demand for phosphorus fertilizers will surpass supply of phosphorus this century, estimated between 2035-2075
- Timing of peak uncertain, but widely recognised:
  - quality is declining
  - access is more difficult
  - energy increasing
  - costs increasing
  - wastes increasing

© Cordell 2010

### ECONOMIC SCARCITY: LACK OF ACCESS TO PHOSPHORUS

- Farmers need both short- and long-term access to fertilizers
- Almost a billion farmers lack purchasing power to access fertilizer markets
- African farmers in some landlocked countries can pay 2-5 times more than European farmers for fertilizers, due to: high transport costs (road/rail), handling, duties, corruption

Country	2007	2008	2009	2010	2011	2012
USA	120	110	100	110	120	130
India	150	160	170	180	190	200
Kenya	250	260	270	280	290	300
Uganda	300	310	320	330	340	350
Malawi	350	360	370	380	390	400
Zambia	400	410	420	430	440	450
DR Congo	450	460	470	480	490	500
Madagascar	500	510	520	530	540	550
Senegal	550	560	570	580	590	600
Chad	600	610	620	630	640	650
Yemen	650	660	670	680	690	700
Uganda	700	710	720	730	740	750
Kenya	750	760	770	780	790	800
India	800	810	820	830	840	850
USA	850	860	870	880	890	900

© Cordell 2010

### ECONOMIC SCARCITY: LACK OF ACCESS TO PHOSPHORUS

Phosphorus inequity: African continent

- > largest high quality phosphate rock
- > Low soil fertility
- > Poorest farmers
- > lowest P fertilizer application rates
- > High food insecurity

© Cordell et al., 2009

### MISMANAGEMENT: INEFFICIENT PHOSPHORUS USE IN THE GLOBAL FOOD SYSTEM

© Cordell et al., 2009

### GEOPOLITICAL SCARCITY: REMAINING RESERVES

Distribution of World Phosphate Rock Reserves

Morocco: 75% share & controls Western Sahara (contrary to UN resolutions)

All farmers need phosphorus, yet just 5 countries control around 85% of the world's remaining phosphate rock reserves

India, Australia, EU: all dependent on imports (vulnerable to price fluctuations and supply disruptions)

WS importers: companies, farmers and consumers knowingly or unknowingly supporting the conflict

Sustainable world? - companies, farmers, consumers: how long? 100 years left of own reserves?

© Cordell 2010

### LACK OF EFFECTIVE GLOBAL P GOVERNANCE

- there are currently no international or national policies, guidelines or organisations responsible for ensuring long-term **availability** and **accessibility** of phosphorus for food production
- "The market will take care of it" Market system governing by default – alone not sufficient to ensure **equitable, timely, sustainable**
- Whose responsibility is long-term phosphorus security? Governance of phosphorus is **fragmented** between many different sectors and stakeholders

Mining & fertilizer companies? Investors? Farmers? Food retailers? Consumers? Wastewater service providers? UN?

3rd Sustainable Phosphorus Summit, 2012

## 2. Tina-Simone NESET

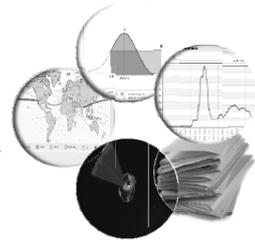
# Phosphorus Vulnerability & Tools for Sustainable P Management

Tina Simone Neset  
Centre for Climate Science and Policy Research  
Department of Thematic Studies – Environmental Change  
Linköping University  
Sweden



### Frameworks and Tools for Sustainable P Management

- Vulnerability Assessment
- Identifying Synergies
- Visualizing Virtual Flows
- Decision Support Tools
- Interactive Data Exploration
- Visualization Supported Dialogues



### Frameworks and Tools: Sustainability Attributes

- integrated (coupled human-environment systems),
- complex (multiple interacting stressors, nested scales, inherent uncertainty),
- participatory (involves the right stakeholders at the right time)
- future-oriented (present & future),
- solutions-oriented (adaptation, resilience)
- policy-relevant



### Dimensions of P Vulnerability

**Phosphorus vulnerability** refers to the degree to which a given food system is susceptible to harm due to the dimensions of global phosphorus scarcity

Phosphorus vulnerability is a measure of

**EXPOSURE** to external hazards (e.g. market price volatility of fertilizers)

**SENSITIVITY** (e.g. soil fertility) and

**ADAPTIVE CAPACITY** (e.g. financial assets)



3 types of factors:

- **Exposure factors:** exposure of the system to external P stressors/drivers (physical, geopolitical, macro-economic)
- **Sensitivity factors:** degree to which the system is modified or affected by external exposures
- **Adaptive capacity factors:** ability of the system to cope (short-term) or adjust (longer-term) to the hazard, due to internal factors.

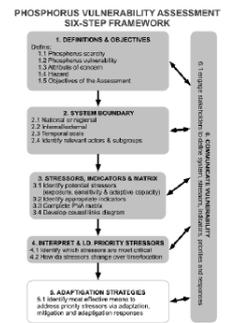
Factor	Indicator	Value	Unit	Scale	Weight	Score
1.1 Phosphorus scarcity	1.1.1 Phosphorus availability	0.8	kg P <sub>2</sub> O <sub>5</sub> /ha	Global	0.3	0.24
1.1 Phosphorus scarcity	1.1.2 Phosphorus availability	0.7	kg P <sub>2</sub> O <sub>5</sub> /ha	Regional	0.3	0.21
1.1 Phosphorus scarcity	1.1.3 Phosphorus availability	0.6	kg P <sub>2</sub> O <sub>5</sub> /ha	Local	0.3	0.18
1.2 Phosphorus availability	1.2.1 Phosphorus availability	0.5	kg P <sub>2</sub> O <sub>5</sub> /ha	Global	0.3	0.15
1.2 Phosphorus availability	1.2.2 Phosphorus availability	0.4	kg P <sub>2</sub> O <sub>5</sub> /ha	Regional	0.3	0.12
1.2 Phosphorus availability	1.2.3 Phosphorus availability	0.3	kg P <sub>2</sub> O <sub>5</sub> /ha	Local	0.3	0.09
1.3 Phosphorus use efficiency	1.3.1 Phosphorus use efficiency	0.2	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Global	0.3	0.06
1.3 Phosphorus use efficiency	1.3.2 Phosphorus use efficiency	0.1	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Regional	0.3	0.03
1.3 Phosphorus use efficiency	1.3.3 Phosphorus use efficiency	0.05	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Local	0.3	0.015
1.4 Phosphorus recycling	1.4.1 Phosphorus recycling	0.1	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Global	0.3	0.03
1.4 Phosphorus recycling	1.4.2 Phosphorus recycling	0.05	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Regional	0.3	0.015
1.4 Phosphorus recycling	1.4.3 Phosphorus recycling	0.02	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Local	0.3	0.006
1.5 Phosphorus recovery	1.5.1 Phosphorus recovery	0.05	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Global	0.3	0.015
1.5 Phosphorus recovery	1.5.2 Phosphorus recovery	0.02	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Regional	0.3	0.006
1.5 Phosphorus recovery	1.5.3 Phosphorus recovery	0.01	kg P <sub>2</sub> O <sub>5</sub> /kg P <sub>2</sub> O <sub>5</sub>	Local	0.3	0.003



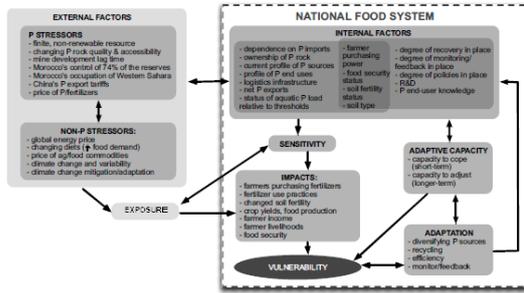
### P Vulnerability Framework

Objectives:

- **National assessment** – e.g. in what ways is Australia or India or Europe most vulnerable to P scarcity, and therefore which aspects could be prioritized for adaptive strategies to increase resilience?
- **Comparative assessment** – e.g. which regions of the world are most vulnerable to P scarcity? (based on high-med-low rankings) and should therefore be prioritized at the global scale?



## A FRAMEWORK FOR ASSESSING NATIONAL PHOSPHORUS VULNERABILITY

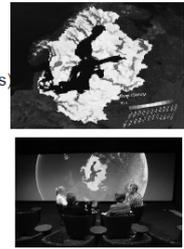


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© 2012 & Revised 2014

Numerous methods for interpreting vulnerability:

- Quantitative multi-criteria analysis (weightings)
- Quantitative indices (composite indicators)
- Qualitative participatory methods (ranking, exercises)
- Exploring adaptive strategies (e.g. participatory visualization-supported stakeholder dialogues)



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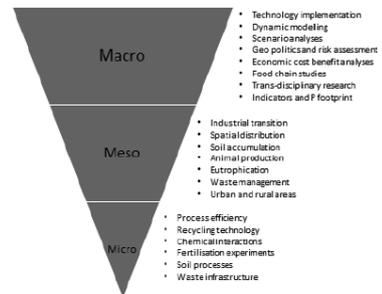
## Identifying Trade-offs and Synergies

	P Scarcity	Eutrophication	Climate change	Food security	Water scarcity	Energy scarcity	Sanitation
Reduction in mining/fertilizer losses							
Efficient fertilizer use in agriculture							
Manure reuse							
Reduction of harvest losses							
Changing diets							
Reduction of food waste							
Food/organic waste reuse							
Source-separated excreta reuse							

Neset&Cordell 2012

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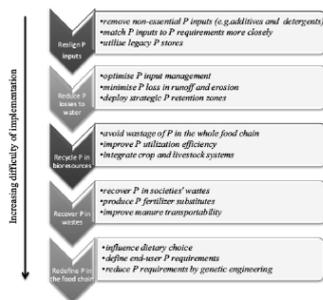
## Linking Scales



Withers *et al.*, 2015

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## Re-Framing Phosphorus



Withers *et al.*, 2015

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## Knowledge Brokerage



Norrköping Decision Arena  
www.cspr.se/nda

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Knowledge Brokerage

Neset *et al*, *fc*

h.u. LINKÖPING UNIVERSITY

### 3. Arnoud PASSENIER

Policy and governance opportunities & barriers for enhancing P sustainability

Arnoud Passenier  
Ministry of Environment NL

GPNM - PTT 15092015

**Government perspective**

- Politicians hate problems
- If you address an issue like P: give options to do something about it
- Politicians hate to regulate
- Broad political and societal support necessary, multistakeholder dialogue crucial

2

**Different perspectives, interests and drivers**

- Different stakeholders (producers-consumers), different perspectives:
  - Economic
  - Ecological
  - Geopolitical
- Different interests and drivers
- What does our common future look like? Shared vision, shared ambitions

**Relevance for GPNM-PTT**

- Role of government is changing: more connecting interests and ambitions: content, relations, finance
- Other stakeholders have to change as well: actively using networks, sharing knowledge and experiences

WRF-2013 - Davos 7 October 2013

### 4. Michel PRUD'HOMME



International Fertilizer Industry Association

## Phosphate Sector Supply Challenges and Trends

Michel Prud'homme, IFA

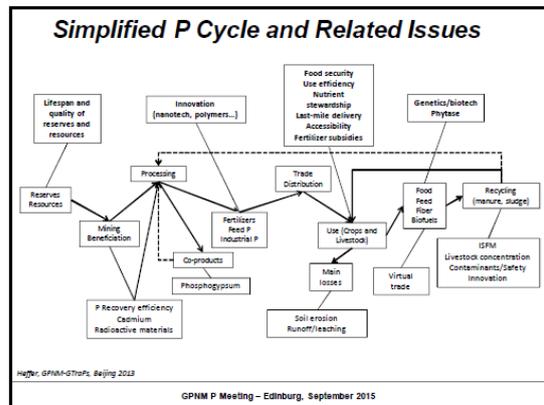
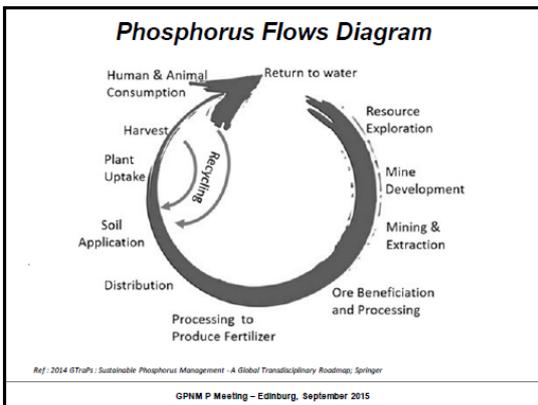
GPNM P Meeting – Edinburg, September 2015

## International Fertilizer Industry Association

- IFA promotes the efficient and responsible production, distribution and use of plant nutrients and provides support to the fertilizer supply-chain through its research and outreach initiatives.
- IFA memberships comprises 550 member companies in 80 countries.
- IFA aims to :
  - Improve the operating environment along the fertilizer supply chain
  - Encourage expertise-sharing among members
  - Inform and contribute to public policy-making at an international level



GPNM P Meeting – Edinburg, September 2015



### Sustainable P Issues Management- Supply

Supply		Distribution		Uses			Stewardship
Resources	Mining Processing	Sales and distribution	Fertilizer use	Soil behavior	Recycling	Governance	
Scarcity Geopolitics	Inefficiency Losses	Affordability	Losses	Soil erosion		Planetary Boundaries	
Resource assessment	PPG	Distribution inefficiencies		Cadmium			
Opportunities	PPG recycling Energy & water efficiency	Fair/open trade Fair competition	Extension services 4R	Soil analysis Cd (de cadmination)	Innovative products	Global/ Regional partnership	

Sector data

PPG Study

Trade Study

Innovation

Nutrient Stewardship

GPNM P Meeting – Edinburg, September 2015

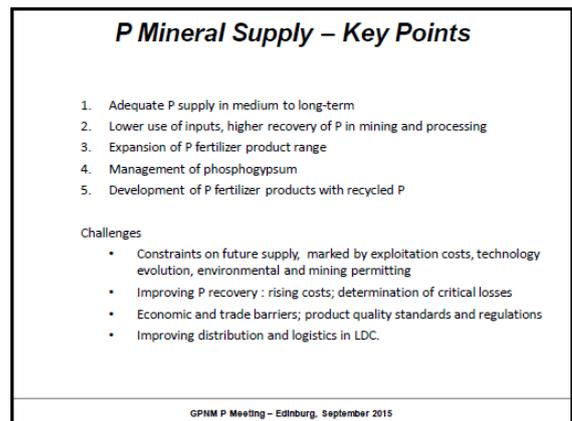
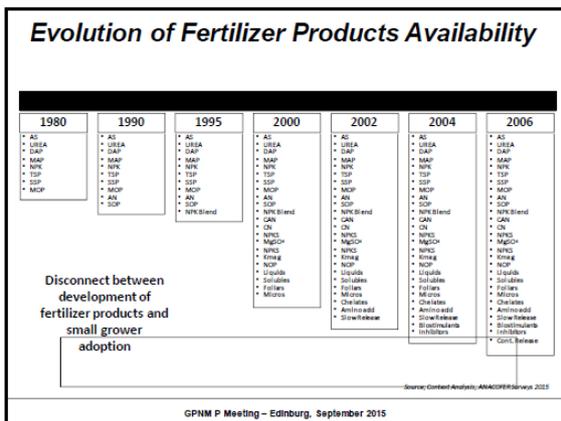
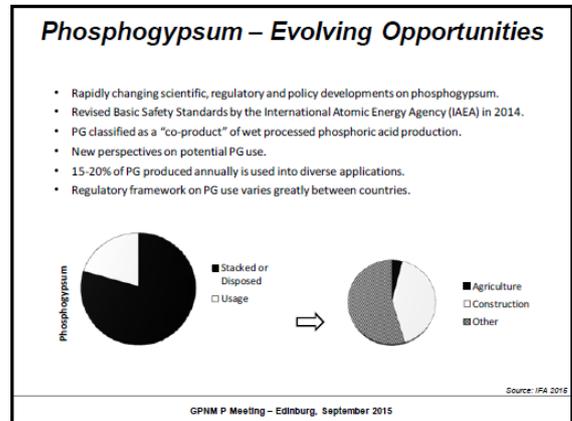
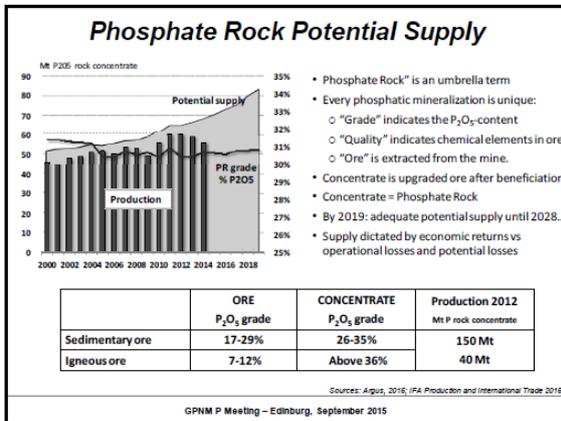
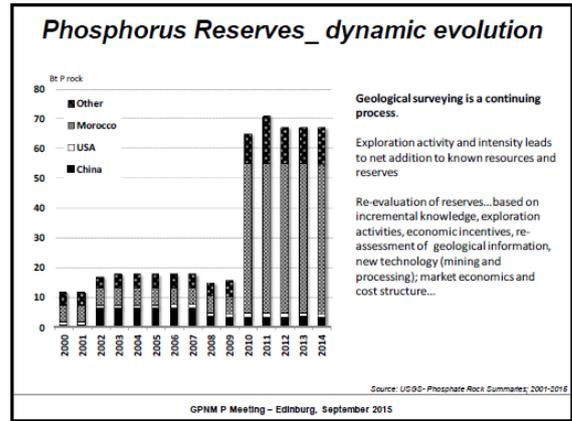
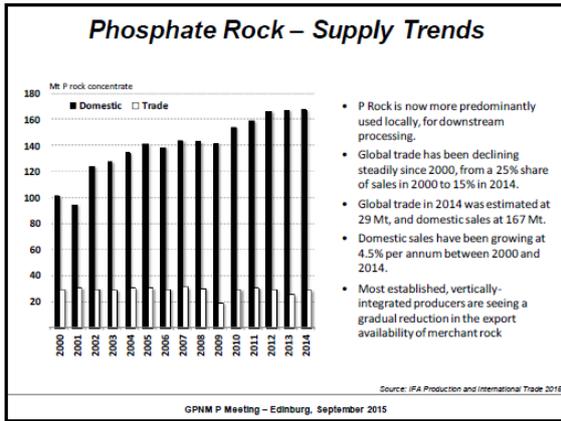
### Phosphate Sector- Structure and Trends

	P Rock	P Fertilizers	Industrial P
Country	35	60	20
Producers	Over 50 + China (225)	Over 300 +China (340) 125: SSP 170: NPK 100: PP	Over 100 +China (150) 20: YP 30: Industrial 60: P Feed

- Fragmented industry; large number of producers and a wide range of products
- More vertical integration and downstream diversification
- Economies of scale: large capacity developments; bigger units
- Structural rationalisation: costs; environmental pressures; competition
- Competitive advantages: inputs and resources, access to markets; logistics
- Wider range of P fertilizer products: competition between complex and bulk blends

Source: IFA Production and International Trade 2016

GPNM P Meeting – Edinburg, September 2015

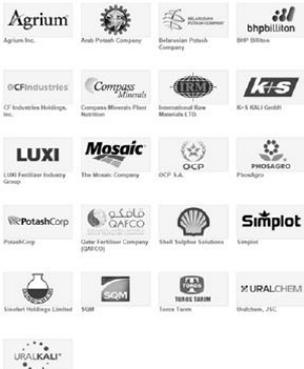


GPNM Phosphorus Task Team Inaugural Meeting  
15-16 September 2015  
Centre of Ecology and Hydrology  
Edinburgh, UK

## Opportunities and barriers for enhancing P sustainability



Tom Bruulsema, Phosphorus Program Director  
International Plant Nutrition Institute  
Guelph, Ontario, Canada



Formed in 2007 from the Potash & Phosphate Institute, the **International Plant Nutrition Institute** is supported by leading fertilizer manufacturers.

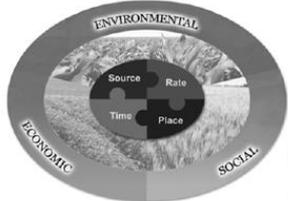
Its mission is to develop and promote science for responsible management of crop nutrition



### IPNI's Regional Programs




### 4R Nutrient Stewardship: "right" means sustainable




The Keystone Alliance for Sustainable Agriculture



Home Our Goals How To Make A Difference Share What You're Doing How To Make A Difference Partner Opportunities

**How to Make a Difference - Fertilizer optimization**




Position Paper  
**Nitrogen Use Efficiency and Nutrient Performance Indicators**

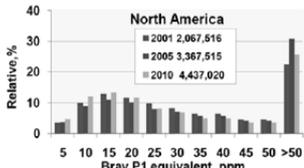
A publication of the  
**Global Partnership on Nutrient Management**



Lead authors:  
Rob Norton, Eric Davidson, and Terry Roberts

2015





**North America**  
■ 2001 2,067,516  
■ 2005 3,367,515  
■ 2010 4,437,020

Relative, %

Bray P1 equivalent, ppm



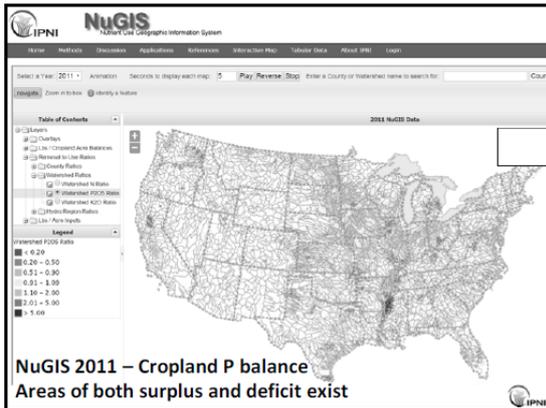
North America  
**25 ppm**  
4.4 million samples

**Soil test P is not uniformly distributed.**

There are areas above and below recommended ranges.

Median Bray P1 equivalent soil test levels in 2010





### North American Cropland P Balance 2011

- Inputs: Tg P
  - Fertilizer 1.9
  - Manure applied 0.8
  - Manure excreted 2.0
- Outputs:
  - Crop removal 2.6

*The opportunity to better utilize manure P is large*

### Protecting water quality with 4R

- Placement most critical
- Timing also significant
- Source needs to be a form that can be applied in the right place at the right time

Version 2.0  
October 2013

### Fall Strip-till Banding

- Puts the P in the soil
- Keeps residue on the soil
- RTK GPS for precision planting

Greg LaBarge, Ohio State University Extension

### Some Industry Perspectives

1. The crop nutrition industry has adopted the concept of 4R Nutrient Stewardship as its approach to sustainability.
2. For minimizing losses of P that impact water quality, timing and placement matter at least as much as rate.
3. Opportunities:
  - improving timing and placement
  - recycling P in manure & biosolids
4. Barriers: economics

phosphorus.ipni.net



European Sustainable Phosphorus Platform (ESPP) Edinburgh 15<sup>th</sup> September 2015 - n° 7

### Nutrient Platforms established in Europe

ESPP (European Sustainable Phosphorus Platform) 2013  
[www.phosphorusplatform.eu](http://www.phosphorusplatform.eu)  
 Netherlands 2010 <http://www.nutrientplatform.org/>  
 Flanders 2012 <http://www.vlaqua.be/en/initiatives/nutrientplatform/>  
 Germany 2015 [www.deutsche-phosphor-plattform.de](http://www.deutsche-phosphor-plattform.de)  
 Baltic: Baltic: work with Baltic Sea Action Group [www.bsag.fi](http://www.bsag.fi)  
 Projects: UK, France, Norway, Czech Republic, Spain / Portugal ...

European Sustainable Phosphorus Platform (ESPP) Edinburgh 15<sup>th</sup> September 2015 - n° 8

### 1. What does ESPP do ?

European Sustainable Phosphorus Platform (ESPP) Edinburgh 15<sup>th</sup> September 2015 - n° 9

### ESPP in action in Europe: Networking

→ priority identified by ESPP members

- Reference and manage contacts & knowledge: innovation, experience, competence, solutions, projects
- Tool to develop: IT data management/access system with different access levels: members, network, others
- Direct contacts: meetings, technical webinars, ...
- Inventory of R&D projects, networks

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### ESPP in action in Europe: communications

→ meetings and conferences

- ESPC2 – 2<sup>nd</sup> European Sustainable Phosphorus Conference, Berlin, March 2015
- EU Green Week
- Industry, science and regional conferences

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### ESPP in action in Europe: communications

- Twitter [@phosphorusfacts](https://twitter.com/phosphorusfacts)
- ESPP website [www.phosphorusplatform.eu](http://www.phosphorusplatform.eu)  
 - "Opportunities", Events (agenda), Members Pages, EMarket ...
- SCOPE Newsletter  
 - innovation, policy, practice  
 - ESPP Members actions  
 50 000 email listing

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### ESPP in action in Europe: European policies

→ ESPP recognised for input by policy makers

- Environment & water
- Agriculture
- Critical Raw Materials
- EU Investment Fund
- Horizon 2020 R&D
- Circular Economy

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### ESPP in action in Europe: Regulatory

→ ESPP officially or informally recognised as expert / contributor

- **EU Fertiliser Regulation recast:** taking recovered nutrient products into account and EU criteria development (JRC) for struvite, biomass ashes
- **Nitrates Directive:** "processed manure"
- **Organic Farming Regulation:** proposed validation of recycled P products
- **REACH (EU chemicals regulation):** Art 2(7)d "recovered" substances, by-products
- **BAT BREFs (Industrial Emissions Directive):**
  - waste incineration, - pig & poultry production
- **BEMPs:** EMAS (EU Eco-Management and Audit Scheme Regulation) "agriculture"
- **EIP-AGRI Focus Group proposal:** agronomic use of recovered nutrient products
- **Standards:** CEN SABS, ISO 275 ...



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### ESPP in action in Europe: Innovation

→ Recognised role in innovation dissemination

- **EU Commission DG Research:** joint workshop on P-recovery from R&D to market, conclusions published by EU <http://bookshop.europa.eu/en/circular-approaches-to-phosphorus-p880116326/>
- **Inventory of R&D projects:** online ESPP website
- **Linking R&D / resource recovery networks:** IWA, WssTP, ARREAU, BioRefine
- **Dissemination:** SCOPE Newsletter, ESPP website ... ARREAU, BioRefine
- **Implementation:** ESPP industry meetings




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### ESPP in action in Europe: DONUTSS

**Data on Nutrients to Support Stewardship**

- Conclusion of EU Commission Consultative Communication and of DG RTD Berlin joint workshop
- Input to Critical Raw Materials MFA
- Data on nutrient flows, to identify key points for management, recycling
- **Support decisions:** policies, targets, monitoring, industry indicators, markets and investments




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### 1. Challenges and obstacles




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### Lessons from experience - platform

- **Importance of multiple helix**
  - companies, government, R&D, farmers organisations, NGOs
  - network, dialogue, exchange
  - independence/recognition
- **Different expectations**
  - a platform is not a lobbying organisation



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### Lessons from experience - targets

- **Difficulties to engage agri-food sector**
  - DG agriculture, DG SANCO
  - food industry
- **Communications**
  - high receptivity of regulators, industry
  - not general public



**Lessons from experience - organisation**

- No single model
  - national challenges are different
  - different funding models possible
- Need for clear definition of what platform will do
  - what are benefits for members ?
  - what is added value vs. existing structures and networks ?
  - target legitimate, identified policy levels



**Lessons from experience - structure**

- Need for statutes and legal structure
  - clarity and visibility
  - independence
- Difficult to obtain useful input “for free”
  - in-kind partnerships unreliable, non productive
  - need to be part of external funded contract or similar
  - necessity of dedicated secretariat and resources



**Lessons from experience - objectives**

- Progress on technical regulatory revisions
  - ESPP recognised by EU Commission services
  - progress on regulation
- Real change will require policy change
  - current mantra: less regulation, no tax
  - repeated conclusion of discussions is that policy change is needed
  - deep changes needed for Circular Economy (e.g. fiscal policy)



**Chris Thornton, ESPP Secretariat**

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[www.phosphorusplatform.eu](http://www.phosphorusplatform.eu) @phosphorusfacts



