THE FUTURE OF PHOSPHORUS:
Implications of global fertilizer scarcity

Workshop Synthesis Report

National Workshop on the Future of Phosphorus,
Institute for Sustainable Futures, University of Technology, Sydney
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The organisers would like to thank the workshop participants for giving up a day from their busy schedules, and for their enthusiasm and creativity during the workshop.
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Executive Summary

This paper reports on the one-day national stakeholder workshop on the Future of Phosphorus held by the Institute for Sustainable Futures at University of Technology, Sydney and the Global Phosphorus Research Initiative on 14th November 2008. Input into this synthesis report is from workshop participants (i.e. discussions, notes and presentations during the workshop).

The intention of the workshop was to bring together key Australian stakeholders to discuss the implications of global phosphate scarcity (and related sustainability and ethical issues) for Australia’s food production and consumption system and vision possible future scenarios.

The group concluded that a sustainable phosphorus future in the long-term would need to take an integrated perspective on phosphorus, food and other pertinent issues such as water and climate change, which would require substantial restructuring of our institutional and economic systems and building of institutional capacity. The efficiency of phosphorus use throughout the agricultural and food system would also need to be maximised to secure future food needs, considering healthy soils means healthy food and a healthy economy. The vision also called for a ‘Ministry of Food’ reflecting the view that issues of food and resources are not considered sufficiently central in public policy, paying greater attention to health and diets and the resource intensity of producing certain types of food. Ensuring the sources and use of phosphorus were ethical was also paramount, as was building a community base of views, knowledge and preferences.

While there is a concerning lack of data and research in this area, participants highlighted the need for further data collection and research on the role of phosphorus in the economy and opportunities for capturing phosphorus losses for reuse.

1 Background

The Workshop was initiated by the Institute for Sustainable Futures at UTS, drawing from the ongoing research of doctoral candidate Dana Cordell on global phosphorus scarcity and sustainability implications. Through this research, the Institute for Sustainable Futures has launched with colleagues in Sweden the Global Phosphorus Research Initiative (GPRI). The main objective of the GPRI is to undertake quality transdisciplinary research on sustainable global phosphorus resources for future food security.

Given the short-term global food crisis the past year, including a sudden price rise of phosphate rock from US$50/tonne to US$400/tonne in 2007-08, it is timely to start the discussion on the implications for Australia. Australia has naturally phosphorus-deficient soils while simultaneously has invested in phosphorus-demanding export industries like beef and dairy (Cordell and White, 2008).
1.1 Introduction
The objectives of the workshop were to:

- Initiate a national discussion on implications of global phosphate scarcity;
- Share knowledge, drawing from the collective and diverse knowledge of the group;
- Deliberate on the key issues and challenges;
- Collectively develop a vision of a preferred, sustainable phosphorus future;
- Provide input to the ongoing research project on global phosphorus resources and the Australian context;
- Contribute to documentation of workshop findings and other publications; and
- Develop networks for those interested in following up discussions with action.

Trigger questions included:

- How can Australian agriculture adapt to increasing global phosphate scarcity?
- What are the implications for rural livelihoods?
- What will it mean for the environment and for the economy?
- What policy measures are appropriate for dealing with this and which sectors should be prioritised?
- Which actors are likely to play a role in a sustainable phosphorus future?
- What do we want a sustainable phosphorus future to look like in Australia?

1.2 Workshop Process
The workshop was designed to be highly participatory, drawing on the collective and diverse knowledge of the group.

Stakeholders were selected based on their key roles related to phosphorus sources, uses and outputs through the Australian food production and consumption system. This included representatives of: phosphate rock resources, mining and geopolitics, fertilizer production and use, farming, crop phosphorus use, diet and health, organic solids waste recovery, nutrient recovery from wastewater and general sustainable systems (see Appendix).

Participants were provided with a discussion paper prior to the workshop (see Cordell and White, 2008) and details of all stakeholder participants mapped against a conceptual diagram of phosphorus flows through the Australian food production and consumption system. This enabled participants to gain a preliminary idea of the roles represented at the workshop.

Following introductions, five-minute presentations covered:

1. Global phosphorus scarcity and sustainability implications for Australia (ISF, GPRI)
2. Australian Fertilizer Industry: Market and Public Policy (FIFA)
3. Strategies for improving the phosphorus-use efficiency of Australian crops (CSIRO Plant Industry)

A facilitated discussion followed, leading to participants identifying the key challenges and issues for further investigation (see Section 2).

Following a break, participants were then asked to envisage a sustainable phosphorus future in 2030 and describe the key characteristics of this vision. The visions were prepared based on backcasting a ‘preferred’ future, that is, working backwards from a specified preferred
future to the present. These visions were first prepared individually, discussed in pairs and finally synthesized in a plenary discussion, leading to prioritisation of their key visions and characteristics (participants were each given 5 green dots to place next to their priority items). Section 3 outlines the findings.

In small groups after lunch, participants were asked to consider:

1. Implications and key challenges of the preferred future visions?
2. What actions would need to happen between now and 2030 in order to meet the visions?

A plenary discussion then clarified and prioritised these actions, identifying potential responsible sectors (see Section 4).

Finally, a wrap up session then distilled some concrete actions that the group could take, followed by an evaluation of the workshop. Drinks and mingling continued informal discussions after the workshop formally closed.

2 Key issues and challenges facing Australia

“there are no sustainable parts of unsustainable wholes” – Workshop participant

“there are enormous impacts of trade flows, you don’t move stuff from one place to another without large energy costs” – Workshop participant

Early on in the workshop (following the keynote presentations), participants identified key issues and challenges facing Australia related to global phosphorus sustainability requiring further exploration.

These have been grouped under common issues in table 1.

Table 1: key issues and challenges facing Australia in relation to global phosphorus scarcity.

<table>
<thead>
<tr>
<th>Key issue</th>
<th>Description</th>
</tr>
</thead>
</table>
| P and water demanding export industries| • How can Australia restructure the economy to not rely on phosphorus (and water) intensive export industries?  
• There is a need to look for more sustainable industries; to change demand such as reducing food exports like grain-fed meat to the U.S or refined sugars to Asia; |
| Efficiency of entire system            | • Need to be conscious of where inefficiencies in the system are, e.g. crops are big exporters of P, wool is less so (even though still inefficient);  
• Need to prevent losses of P through all processes; |
| Healthy soils                          | • Learning from Cuba’s response to embargos on fertiliser imports: a focus on the health of soils and food and the health of people;  
• How do we unlock used phosphorus in the soil? |
| Whole system approach                  | • Need to look at whole system – even climate change is becoming a narrow discussion;  
• Impact of energy requirement and emissions trading on supply and trade of phosphate rock;  
• Implications of phosphorus recovery for alternative wastewater management and environmental protection. |
| Public awareness and sound research    | • Need to raise public and political profile of the issue; highlight the seriousness of the issue;  
• Need good facts to support arguments (eg. peer-reviewed economic and technical data and analyses) |
## Key issue Description

**Learning from other cultures**
- What can we learn from cultures with long history of recycling nutrients (e.g. China);
- There are different contexts for water utilities (inland, coastal) and regulatory environments.

**Reuse opportunities**
- As fertilizer prices increase, this encourages the reuse of manure (and chemical efficiency) – ‘city to soil’;
- Need to maximise the capture of existing P from all waste streams;
- Need innovation and to identify alternative sources of P;
- Are their multi-value products to consider? (e.g. fertilizer and soil conditioning properties)

**Potential of organic agriculture**
- How does organic farming compare? Need local data (currently very little research funds for monitoring and analysing organic agriculture);
- Many organic growers suffer from P deficiency.

**Demand and supply**
- Are there sufficient sources of alternatives to phosphate rock to replace our phosphorus needs?
- Currently, outputs of pig and chicken industries could only supply 1/20th of the P requirements for our farms;

**Ethics of importing Western Saharan P rock**
- Australia currently depends heavily on imports of phosphate rock from Western Sahara;
- There are business, legal and ethical issues of Australian companies involved in importing rock from Western Sahara via Morocco: Australia is risk exposed to fragile situation in the region, Morocco controlling Western Sahara (and their phosphate rock) concentrates their bargaining power, supporting an occupation contrary to international law.

**External future changes**
- Australian agriculture is likely to change dramatically in the future: total agricultural area has been doubling every 3 decades;
- Population is likely to increase by 50% by 2030.

### 3 Visioning a sustainable phosphorus future

“the most fundamental part of any economy is our ability to produce food. And the ability to produce quality food relies on all of the things that are in the soil, including P” – Workshop participant

“Would be good if we had a Ministry of food, wouldn’t it” – Workshop participant

Participants considered their vision individually, followed by paired discussions and finally a plenary discussion to capture the priority vision.

The characteristics of a sustainable phosphorus future for Australia are outlined in table 2 under themes (number of dots indicates the group’s priority characteristics).
Table 2: key characteristics of a sustainable phosphorus future in 2030.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Descriptions</th>
</tr>
</thead>
</table>
| Integrated approach                                  | • P used in keeping with other constraints (as part of integrated review (e.g. energy, water, health, labour) (9 dots)  
• Hard to have a vision for a sustainable part of an unsustainable whole (2 dots)  
• P included in integrated material balance for Australia;  
• P is seen as fundamental building block of Australian society.  
• Energy efficient and low emission and impact across the cycle  
• Efficiency is part of the problem if not considered in the whole system – rebound effect  
• Can’t be business as usual, need to overcome status quo inertia  
• Broader-based policy decisions  
• New market-based rules which work; method for equitable distribution of resource, eg. protocol; Phosphorus cap and trade system |
| Institutional/economic restructure                   | • World economy will be restructuring (e.g. as a result of climate change, changed land use, may act to help P) (4 dots)  
• Institutional capacity enabled to deal with these issues (currently we carry on in silos; in the absence of this market forces operate) (4 dots)  
• Rethink global economic system (P is part of larger problem) (3 dots)  
• Our economy will internalise environmental harm (2 dots)  
• Australia as an island (self-sufficient) vs imports and exports (1 dot) |
| Agricultural use efficiency and food security         | • Ability to produce food is central to healthy economy and on political agenda (8 dots)  
• Optimising P use through better understanding of soil processes, input requirements and plant needs (7 dots)  
• Lower reliance on P input without loss of overall productivity (inputs more closely match outputs) (2 dots)  
• Consider GM and organic together (2 dots)  
• More than 200 MT of new phosphate rock identified in Australia (2 dots)  
• Population – how many people to feed? (P or N) (2 dots)  
• Close loops, capture and recycle all solid/liquid waste in urban/rural communities  
• P derived and used locally (at least within Australia) |
| Food and diet                                         | • Education – national cooking and cuisine (4 dots)  
• Ministry for food (and Ministry for C, N, O, K, P) (3 dots)  
• we can influence: organic at parity cost, price linked to health cost, quantity important (smaller portions), kids will know where milk comes from (1 dot) |
| Ethical sources and use                               | • Ethical input, use and output (5 dots)  
• Treat animals better with respect to food production (1 dot) |
| Community engagement                                  | • Build community base to prompt more radical system change (problem and opportunity to handle structure) (4 dots)  
• Greater community awareness of P as part of healthy soil, healthy food, healthy people (1 dot) |
| Research capacity                                     | • Overcome current lack of soil scientists (1 dot)  
• We would have enough research capacity in sustainability, professional capacity  
• More integrated R&D (top down strategy, innovative bottom-up projects) |
4 Policy challenges and actions

“Efficiency is part of the problem. Making things more efficient if you don’t change anything else leads to more growth, and pollution and environmental impacts outstrips the gains from efficiency…the rebound effect” – Workshop participant

Small groups discussed key challenges and implications of achieving the visions in table 2. The groups identified the following implications and challenges (table 3).

<table>
<thead>
<tr>
<th>Characteristic of vision</th>
<th>Challenges and implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural use efficiency and food security</td>
<td>• Significant R&amp;D effort, resource support to effect change;</td>
</tr>
<tr>
<td></td>
<td>• Exporting expertise rather than products;</td>
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<tr>
<td></td>
<td>• Prioritisation; integration and management;</td>
</tr>
<tr>
<td></td>
<td>• Science need to be supported to enable better use of ‘P’ in agricultural systems</td>
</tr>
<tr>
<td></td>
<td>• Is there enough scientific skill?</td>
</tr>
<tr>
<td></td>
<td>• Quantity of available P</td>
</tr>
<tr>
<td>Integrated view and Institutional/economic restructure</td>
<td>• Need to define an integrated view of ‘sustainability’, if business as usual is abandoned (eg. TBL environmental, economic, social);</td>
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<tr>
<td></td>
<td>• Accepting long pay back periods;</td>
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<tr>
<td></td>
<td>• Need to find a starting point (such as a crisis, increased prices);</td>
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<tr>
<td></td>
<td>• Vested interests control the system;</td>
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<tr>
<td></td>
<td>• Create understanding of the urgency for change – civil disobedience?</td>
</tr>
<tr>
<td></td>
<td>• Need for institutional and political redesign to handle the change.</td>
</tr>
<tr>
<td>Food and diet</td>
<td>• Reduce wastage of food;</td>
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<tr>
<td></td>
<td>• Increase food global population;</td>
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<tr>
<td></td>
<td>• Food quantity vs quality issues;</td>
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<tr>
<td></td>
<td>• Input use efficiency for comparison of grain vs meat.</td>
</tr>
<tr>
<td>General</td>
<td>• National leadership (triggers might be market collapse, food security crisis);</td>
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<tr>
<td></td>
<td>• Getting the issue back on the national agenda, then gaining agreement across scales.</td>
</tr>
</tbody>
</table>
Key actions (ie. what would need to happen to achieve the visions) and potential responsible parties are summarised in table 4.

Table 4. Actions required in order to reach long-term visions, and identification of responsible parties.

<table>
<thead>
<tr>
<th>Action</th>
<th>Possible responsible parties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raise awareness of link between food and resources and of wastage [reduce, reuse, recycle]</td>
<td>Australian Food and Grocery Council (APGC); Food media, ACF; retailers; NH&amp;MRC; CSIRO; local government, NSW Dept of Environment and Climate Change, Schools, FAO, SANZ, DAFF, Industry groups</td>
</tr>
<tr>
<td>Stop talking about ‘consumers’ (= takers, rights to consume), start talking about citizens (= sense of responsibility)</td>
<td>Education sector</td>
</tr>
<tr>
<td>More exploration (to better quantify peak P); better public data and understanding</td>
<td>GeoScience Australia*</td>
</tr>
<tr>
<td>Further work on resource use efficiency and investment (and education of professionals eg. soil science agronomy)</td>
<td>CSIRO, universities (ARC); Fertilizer companies; RDCs; AWA and professional associations</td>
</tr>
<tr>
<td>Beneficial resource recovery – alternative approaches (R&amp;D); pilot scale demonstration</td>
<td>Urban Planning agencies, water utilities, CRCs, WSAA</td>
</tr>
<tr>
<td>Capture pollution cost (especially near sensitive waterways)</td>
<td>EPA; DECC</td>
</tr>
<tr>
<td>Research the role for organic systems</td>
<td>RDCs; NH&amp;MRC; CSIRO</td>
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<tr>
<td>Language is important</td>
<td></td>
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<tr>
<td>Create urgency/revolution; convert problems into opportunities</td>
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<tr>
<td>Price incentives; (hypothecation) support P reduction</td>
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<tr>
<td>Nutrient caps and P trading scheme</td>
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</tbody>
</table>

* GeoScience Australia does not undertake mineral resource exploration work. Geoscience Australia undertakes geoscientific research and maintains, develops, allows and encourages access to geoscientific data. Exploration and primary data collection is up to mining companies and State governments.

5 Conclusions and next steps

Due to the full program of the workshop, there was limited time to discuss next steps in depth. However participants did recommend the following initial actions:

- Further research on the role of P in the economy. This should be written up as a position paper or a green paper;
- Further research to clearly establish the problem, particularly in relation to the actual level of phosphate scarcity as prices increase;
- Further work on the potential role of nutrient capture from the whole system, such as source separation.

All participants who completed evaluation forms suggested the workshop met their expectations and they particularly appreciated the diversity and balance of views represented at the workshop. All responding participants were interested in continuing involvement to some extent.

Reference

APPENDIX

Government, industry, community-based and research organisations represented at the workshop included:

- GeoScience Australia
- Fertilizer Industry Federation of Australia
- Department of Agriculture Fisheries and Forestry
- Australian Peak Oil Association
- Polisario (Western Sahara Independence Front)
- leading diet and nutrition consultant
- Organic Federation of Australia
- Zero Waste Australia
- CSIRO Plant Industry
- CSIRO Sustainable Ecosystems
- Natural Resource Commission
- Wentworth Group of Concerned Scientists
- Sydney Water Corporation
- CSIRO Land and Water
- Institute for Sustainable Futures (UTS) and Global Phosphorus Research Initiative