

# AUSTRALIAN SUSTAINABLE PHOSPHORUS FUTURES

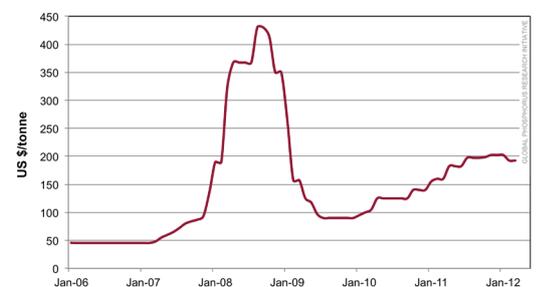
The Australian Sustainable Phosphorus Futures project aims to increase scientific knowledge on a range of issues relating to sustainable phosphorus use in Australia to inform policy. This will run over a period of 3 years, led by Dr Cordell and Prof White, and supported by a UTS Chancellor's Postdoctoral Research Fellowship.

## RESEARCH NEED

Impending global phosphorus scarcity will compromise the resilience of Australian food production and global food security if no changes to the way we currently use and manage phosphorus are made. As an essential nutrient in fertilisers for food production, phosphorus has no substitute. Australia and the world are currently dependent on phosphorus from finite phosphate rock reserves, which are becoming more expensive, scarce, difficult to access and geopolitically concentrated in only a few countries (Morocco alone controls 70% of the world's remaining phosphate rock). Yet research addressing the serious regional implications of phosphorus scarcity is lacking.

Peak phosphorus is predicted to occur this century (and as early as in the coming decades), yet there is no substitute for phosphorus in food production. Historically there has been very little awareness, research and policy debate on global phosphorus scarcity. However the 800% phosphate price spike in 2008 drew the world's

**Figure 1: Phosphate rock commodity price**



attention to the long-term phosphorus security issue. Today's price remains 400% higher than pre-2007 levels (figure 1).

Australia's naturally phosphorus-deficient soils and heavy reliance on imported sources of phosphorus to maintain productivity and exports, means food production and its value as an export industry for Australia will inevitably be threatened by declining availability and accessibility of phosphorus.

## RESEARCH SUPPORT

Since 2008, the sustainable phosphorus research undertaken by the Institute for Sustainable Futures has been supported by a range of national and international funders from industry, government, science and philanthropic organisations, including:

- > Commonwealth Department of Agriculture, Fisheries & Forestry
- > CSIRO Sustainable Agriculture Flagship
- > Rural Industries Research & Development Corporation
- > Grains Research & Development Corporation
- > Ian Potter Foundation
- > Mercedes-Benz Environmental Research Award
- > Swedish Research Council FORMAS
- > Wentworth Group of Concerned Scientists
- > Global Phosphate Forum
- > Novozymes
- > Minemakers Pty Ltd
- > Yarra Valley Water
- > University of Technology, Sydney
- > Commonwealth Department of Education, Science & Training



# SUSTAINABLE PHOSPHORUS FUTURES

## RECENT FINDINGS

Preliminary analyses in Australia suggests that even if Australia recovered 100% of phosphorus in human excreta for reuse as fertiliser, this would only represent around 2-3% of Australia's current total demand for phosphorus fertiliser (Cordell & White, 2010). Phosphorus is not only exported off our shores in food exports, it is also lost at all key stages in the food production and consumption system, such as in runoff from agricultural soils, food processing waste and household bins.

Achieving phosphorus security in Australia (and globally) is likely to require an integrated approach. This means recovering phosphorus from all sources (ranging from manure and excreta, to food waste and crop residues), and, finding innovative ways to substantially reduce the long-term demand for phosphorus (through wide ranging measures such as phosphorus use efficiency in agriculture, changing diets and reducing food waste in supermarket and household bins). Developing and implementing practical solutions to meeting long-term future phosphorus demand will involve substantial technical and institutional changes.

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Figure 2: Interactive future phosphorus scenarios







## PROJECT OBJECTIVES & APPROACH

This project investigates how Australia can manage phosphorus to ensure long-term food security, soil fertility and environmental protection. The intended outcome is to deliver sustainable adaptation strategies across a range of scenarios to increase the resilience of the Australian food system. An Australian phosphorus stocks and flows model, quantified and costed sustainable phosphorus measures and interactive future phosphorus scenarios, will enable stakeholders to identify policy implications and make informed policy decisions. The overall objectives of the project are to:

1. Analyse phosphorus stocks & flows through the Australian food system (from mine to field to fork);
2. Identify sustainable pathways for Australia to secure phosphorus for agriculture and food production in the long-term; and
3. Inform policy, through collaborative development of future scenarios.

This builds on previous recent research, including: Doctoral research by Dr Cordell on the implications of phosphorus scarcity for food security globally and in Australia (Cordell, 2010); National Workshop on the Future of Phosphorus, a high-level stakeholder workshop to share perspectives, key challenges and generate a shared vision (ISF, 2008); Securing a sustainable phosphorus future for Australia (collaborative project with CSIRO Sustainable Agriculture Flagship) (Cordell and White, 2010), and Phase 1 of this project (Cordell et al 2012).

Scenarios will be developed together with key stakeholders to determine concrete priority options, such as investing in agricultural phosphorus use efficiency, or alternative renewable fertilisers derived from phosphorus recovered from wastewater and food waste. State-of-the-art sustainability visualization tools being developed in collaboration with Swedish colleagues at Linköping University will be employed. Sustainable phosphorus options will also need to take into account trade-offs and other pertinent challenges,

such as climate change, water scarcity, life-cycle energy costs, land-use changes, environmental damage and other resource use. This project will address how global trends, drivers and challenges are likely to affect the Australian phosphorus situation, and conversely how different future Australian pathways are likely to affect global and regional contexts. Identifying both the barriers and opportunities and determining the cost-effectiveness of preferred options will also be investigated.

Phosphorus demand and supply vary significantly across the Australian physical and demographic landscape. Agricultural soils are P-deficient in some areas, contain excess P in other areas, while urban areas are 'P hotspots' of human excreta and food waste. Geospatial modeling can therefore identify these 'hotspots' and their dynamic relationships, including different phosphorus status of soils, phosphorus associated with different land-use systems and the feasibility of transporting virgin and recycled phosphorus (from an energy and cost perspective).

An interdisciplinary and sustainability research project requires multi-sector involvement to increase legitimacy of the outcomes and ensure their implementation. Key stakeholders will be involved through participatory scenarios development (in addition to ongoing involvement through NSPAG). Key project findings and recommendations will be communicated to target stakeholder groups, including policy-makers, the food and agriculture sector, fertiliser industry, sanitation sector and the public.





## PROJECT TASKS & OUTPUTS

Priority research project tasks and associated outputs & deliverables include:

TASK	OUTPUTS & DELIVERABLES
1. Analysis of phosphorus stocks & flows through food production & consumption system	P stocks and flows model v2.0 (improvements to v1.3 model), report, presentation & media
2. Analysis of sustainable phosphorus measures (quantified potential phosphorus yielded or saved, in kt P/a)	Toolbox of demand-side and supply-side measures for meeting future food-related phosphorus demand (ranging from efficiency in agriculture and mining to P recovery from food waste and excreta), report, stakeholder resource materials, media
3. Analysis of costs and policy implications of sustainable phosphorus measures	Costed and prioritised options (including recommended policy instruments), report, presentation, stakeholder specific implementation plan
4. Develop a geospatial model of phosphorus hotspots	Geospatial model indicating dynamic relationship between phosphorus 'hotspots' across Australia (P sources, demand and 'sinks'), and the energetic and economic feasibility of transporting virgin versus recycled phosphorus
5. Participatory development of interactive future phosphorus scenarios	Interactive future phosphorus scenarios (building on v1.0 model), interactive workshop, website, report, presentation and media
6. Policy Forum	National one-day forum; support the development of policies and initiatives to improve phosphorus use; priority options
7. Embodied phosphorus in Australian foods	The P footprints of key Australian animal and crop-based food products (i.e. phosphate rock mined to produce a kg of grazed beef, kangaroo, eggs, wheat, vegetables etc)
8. Phosphorus Vulnerability Assessment (PVA)	Novel Phosphorus Vulnerability Assessment (PVA) framework; Identification of how and in what ways Australia is vulnerable to phosphorus scarcity (including geopolitical, economic, physical and institutional dimensions)
9. Farmer engagement and vulnerability assessment	Farmer preferences, needs, vulnerability to P scarcity and implications for sustainable P options
10. Phosphorus recovery from wastewater	Most cost-effective and appropriate means of recovering P from wastewater in Australia





## WHO IS LEADING AND MANAGING THE PROJECT?

The project is led by Dr Dana Cordell (Research Principal & Chancellor's Postdoctoral Research Fellow) and Professor Stuart White (Director) at the Institute for Sustainable Futures (ISF), University of Technology, Sydney ([www.isf.uts.edu.au](http://www.isf.uts.edu.au)). ISF is a co-founder of the Global Phosphorus Research Initiative (GPRI) ([www.phosphorusfutures.net](http://www.phosphorusfutures.net)), which aims to facilitate interdisciplinary research, networking, dialogue and awareness-raising among policy makers, industry, scientists and the community on the implications of global phosphorus scarcity for food security and possible sustainable solutions.

Strategic input will be provided from other national and international experts,

including the National Strategic Phosphorus Advisory Group (NSPAG) and Dr Tina S Neset at Centre for Climate Science & Policy Research, Linköping University, Sweden

## OPPORTUNITIES FOR SUPPORT

The Institute for Sustainable Futures is now seeking industry, government and philanthropic funding partners for the project tasks 1-10 outlined above. Most tasks can be undertaken either in isolation or in conjunction with other tasks.

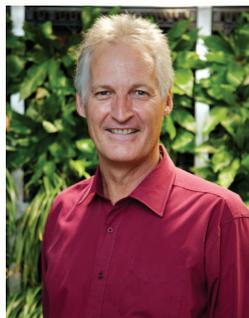
Funding arrangements are flexible and could include contractual research, PhD scholarships or ARC Linkage Grants. For more information, contact: Dr Dana Cordell ([Dana.Cordell@uts.edu.au](mailto:Dana.Cordell@uts.edu.au)) or Prof Stuart White ([Stuart.White@uts.edu.au](mailto:Stuart.White@uts.edu.au)).



**Dr Dana Cordell** is a Chancellor's Postdoctoral Research Fellow and Research Principal at the Institute for Sustainable Futures at the University of Technology, Sydney, where she leads research on sustainable phosphorus futures in Australia and internationally. She co-founded the Global Phosphorus Research Initiative (GPRI) and public website [www.phosphorusfutures.net](http://www.phosphorusfutures.net) in 2008 with colleagues in Sweden and Australia, as an outcome of her doctoral research on the 'Sustainability implications of global phosphorus scarcity for food security', which she undertook jointly at the Institute for Sustainable Futures and Linköping University in Sweden.

Dana also has 11 years of sustainability research experience leading and undertaking interdisciplinary sustainable water, sanitation and waste management projects many of which involved high-level stakeholder engagement.

See: <http://datasearch.uts.edu.au/isf/staff/details.cfm?StaffId=2446>



**Professor Stuart White** is Director of the Institute for Sustainable Futures at the University of Technology, Sydney, where he leads a team of researchers who create change towards sustainable futures through independent, project-based research. With over twenty years experience in sustainability research, Professor White's work focuses on achieving sustainability outcomes at least cost for a range of government, industry and community clients across Australia and internationally. This includes both the design and evaluation of programs for improving resource use efficiency and an assessment of their impact. Professor White has written and presented widely on sustainable futures and is a regular commentator on sustainability issues in the media.

See: <http://datasearch.uts.edu.au/isf/staff/details.cfm?StaffId=2309>



## KEY REFERENCES

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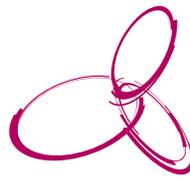
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## About the Global Phosphorus Research Initiative

The Global Phosphorus Research Initiative (GPRI) is a collaboration between independent research institutes in Australia, Europe and North America. The main objective of the GPRI is to facilitate quality interdisciplinary research on global phosphorus scarcity and sustainable responses for future food security. The GPRI also facilitates networking, dialogue and awareness raising among policy makers, industry, scientists and the community on the implications of global phosphorus scarcity and possible solutions.

The GPRI was co-founded in early 2008 by researchers at the Institute for Sustainable Futures at the University of Technology, Sydney (UTS), and the Department of Thematic Studies - Water and Environmental Studies at Linköping University, Sweden. Today, GPRI members also include Wageningen University in The Netherlands, the Stockholm Environment Institute (SEI) in Sweden, University of British Columbia (UBC) in Canada, and the French National Institute for Agricultural Research (INRA) in France. Nobel Prize laureate Prof Paul J Crutzen is the first GPRI ambassador.

GPRI members have researched and written extensively on the sustainability dimensions of phosphorus scarcity and security, including the Sustainable Use of Phosphorus Report for the European Commission D.G. Environment. Relevant publications, ongoing news and events can be found at our website: <http://phosphorusfutures.net>. Due to growing international interest in this emerging field, the GPRI also launched the Global Phosphorus Network in 2010 (<http://globalpnetwork.net>), which currently has more than 500 members of concerned scientists, practitioners, policy-makers, industry, NGOs and citizens from around the world.



## BENEFITS OF WORKING WITH ISF

### Track record:

We have been conducting project based research for Australian and international clients for over a decade and have an excellent reputation for innovative, solution-focused work.

### Applying current thinking and practice:

Our researchers are not only up to date with best practice and current thinking - they contribute to it. Their research is published regularly in academic journals as well as industry and scientific publications and the popular media.

### Practical and diverse experience:

Our researchers come from varied backgrounds, including: engineering architecture, management, economics, science, social sciences, international studies and political studies. Most have worked in both government and commercial environments, so know how to deliver independent and feasible solutions to suit the needs of a diverse range of clients. We are small enough to offer our clients personalised service and large enough to offer a diversity of research skills.

### Collaborative approach:

We seek to create change towards a sustainable future by building capacity in organisations and individuals, and in the broader community. This means that we actively aim to pass on our knowledge and skills to our clients through close collaboration.

## WAYS WE CAN HELP

### Consulting and research services:

We can provide the research you need to move towards sustainable futures. We provide consulting services under both negotiated and tendered contracts.

### Professional advice:

You may need assistance with preliminary work before embarking on a larger project or an external review of an existing program. Our professional advice is available either for an hourly rate or on a package basis.

### Partnerships:

We have many ongoing partnerships across a range of technical fields and can coordinate a specialist team to meet your requirements. Our researchers are also available to join new or existing partnerships as needed.

### Guest speakers:

We are experienced in communicating complex issues in an accessible and engaging way. Our researchers are often invited to speak at conferences, forums, workshops and seminars. We are also frequently called upon by print, radio and television journalists for expert opinion

## PUBLICATIONS

We are committed to sharing the results of our work in the interests of a more sustainable future for all. Many of our reports, discussion papers, journal articles and conference papers can be downloaded from our website.

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