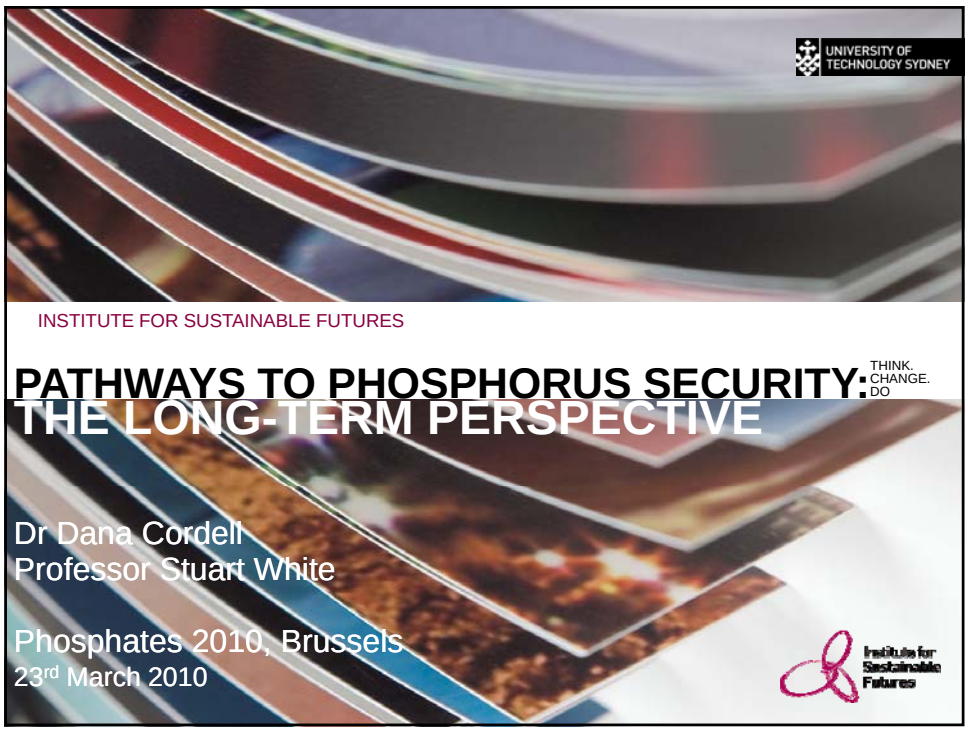


OVERVIEW: PATHWAYS TO PHOSPHORUS SECURITY

PART I: Phosphorus scarcity

- Background
- Peak phosphorus
- An inefficient food system
- Institutional & geopolitical challenges
- The Australian context

PART II: Phosphorus security

- Hard-landing vs soft landing
- Efficient phosphorus use
- Phosphorus recovery and reuse
- Institutional and Policy implications

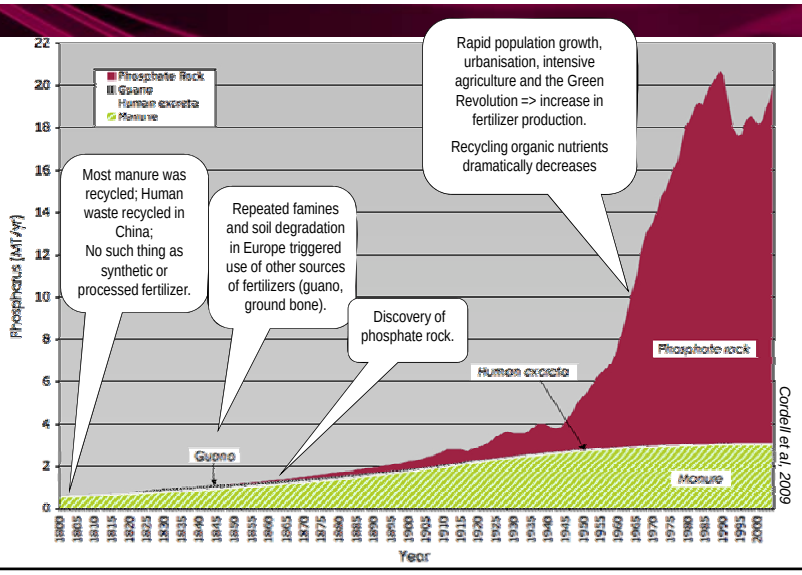
PART I: PHOSPHORUS SCARCITY

PART I:
Phosphorus scarcity

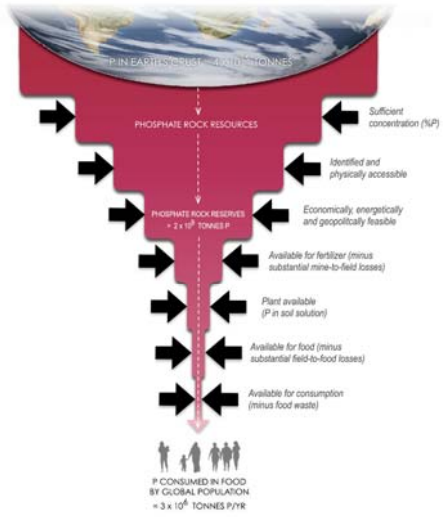
BACKGROUND: THE CURRENT SITUATION

- Phosphorus is essential to all living organisms
- Phosphorus has no substitute in food production & cannot be 'manufactured', therefore there will always be a global demand for phosphorus
- Chemical fertilizers (N,P,K) have contributed to feeding billions of people by boosting crop yields
- Awareness and response to phosphorus pollution (eutrophication), but little on long-term phosphorus security
- long-term: increased P demand
- short term: unprecedented price rise in 2008 from US$50/tonne to US$400/tonne

HISTORICAL GLOBAL SOURCES OF P FERTILIZERS



SCARCITY: MORE THAN JUST PHYSICAL



SCARCITY: MORE THAN JUST PHYSICAL

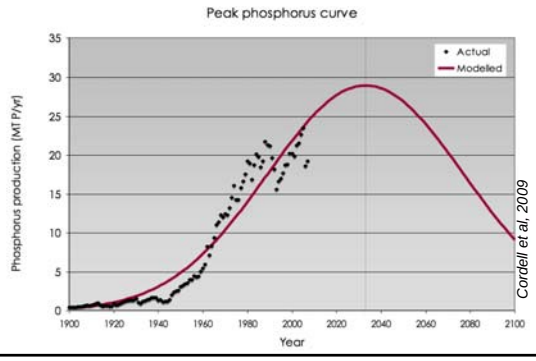
> **Phosphorus scarcity** is more than limited physical availability:

1. **Physical** scarcity
2. **Economic** scarcity
3. **Managerial** scarcity
4. **Institutional** scarcity
5. **Geopolitical** scarcity

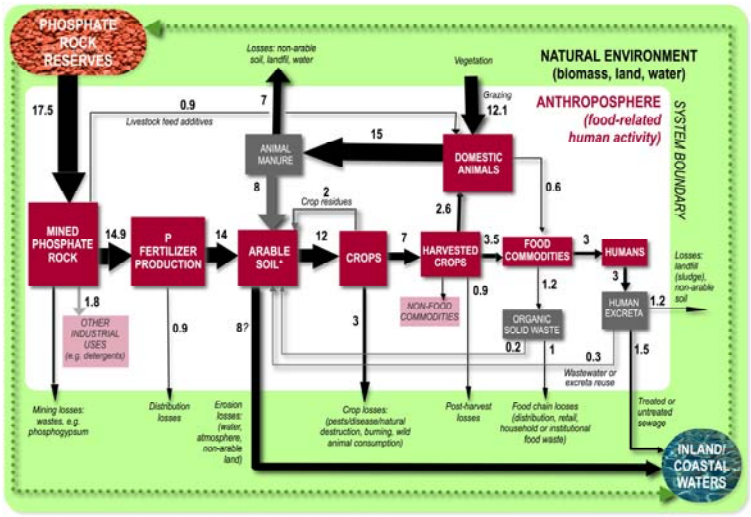
(**Data** scarcity)

1. PHYSICAL SCARCITY: PEAK PHOSPHORUS

- Like oil, phosphate rock is finite resource and will eventually reach a production peak - estimated peak P by 2035
- No alternatives on market today could replace demand for P rock: significant institutional and physical infrastructure will be required
- Timing of peak uncertain, but widely recognised:
  - quality is declining;
  - costs increasing;
  - environmental impacts (eg energy, Cadmium, phosphogypsum)



2. MANAGERIAL SCARCITY: INEFFICIENT P USE IN THE GLOBAL FOOD SYSTEM



Cordell et al, 2009

3. ECONOMIC SCARCITY: LACK OF ACCESS TO PHOSPHORUS

- Farmers need both short- and long-term access to fertilizers
- Lack of *access* to phosphorus sources due to:
  - **financial** constraints - eg. lack of farmer purchasing power to access, access to credit)
  - **market** constraints – eg. market dominance
  - **labour** constraints - eg. time to source/apply
- Global picture: 'silent' demand from farmers with low purchasing power in sub-Saharan Africa, where soil fertility is low

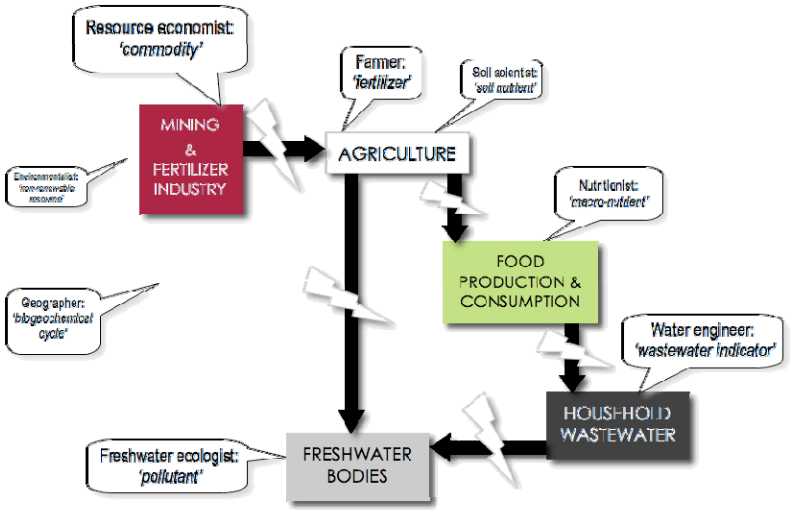
4. INSTITUTIONAL SCARCITY: WHOSE RESPONSIBILITY?

> Scarcity resulting from a lack of appropriate and *effective* institutional structures to ensure P supply will meet long-term demand.

eg. there are currently no explicit international or national policies, regimes, guidelines or organisations responsible for securing long-term availability and accessibility of phosphorus for food production

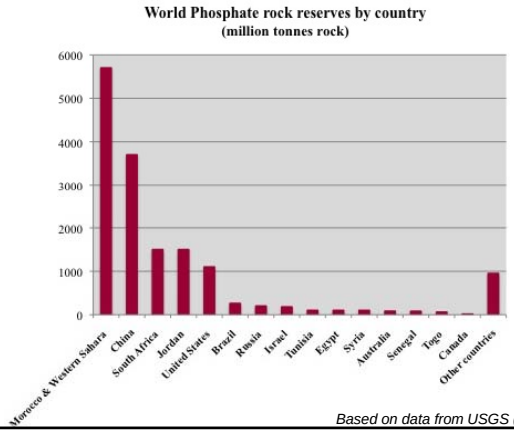
> Whose responsibility is long-term phosphorus security? Governance of phosphorus is fragmented between many different sectors…

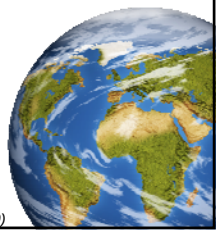
4. INSTITUTIONAL SCARCITY: WHO'S RESPONSIBILITY?



5. GEOPOLITICAL SCARCITY: REMAINING RESERVES

> All farmers need phosphorus, yet just 5 countries control around 85% of the worlds remaining phosphate rock reserves





Based on data from USGS (2010)

DATA SCARCITY

> Long-term planning requires reliable and trustworthy data – farmers, policy-makers, industry, scientists

> Lack of reliable, independently produced, publically-available data

> Phosphate rock AND other sources of P (manure, excreta, food waste, crop residues)

> Long-term trends?

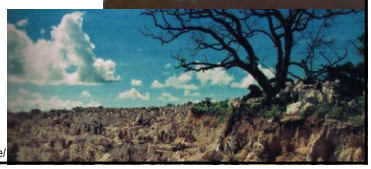
> Lack of global monitoring, reporting, feedback

THE AUSTRALIAN STORY OF PHOSPHORUS

> Naturally phosphorus-deficient soils

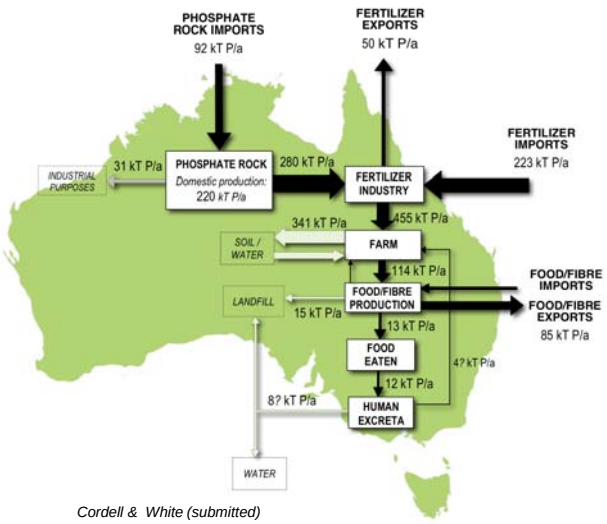
> Simultaneously invested heavily in 'phosphorus intensive' agricultural export industries like beef, wheat, wool

- High crop yields the past century made possible by mining phosphate-rich guano on Nauru



www.janeresture.com/nauru_home/

PHOSPHORUS FLOWS THROUGH THE AUSTRALIAN FOOD PRODUCTION AND CONSUMPTION SYSTEM



Cordell & White (submitted)

PART II: PHOSPHORUS SECURITY

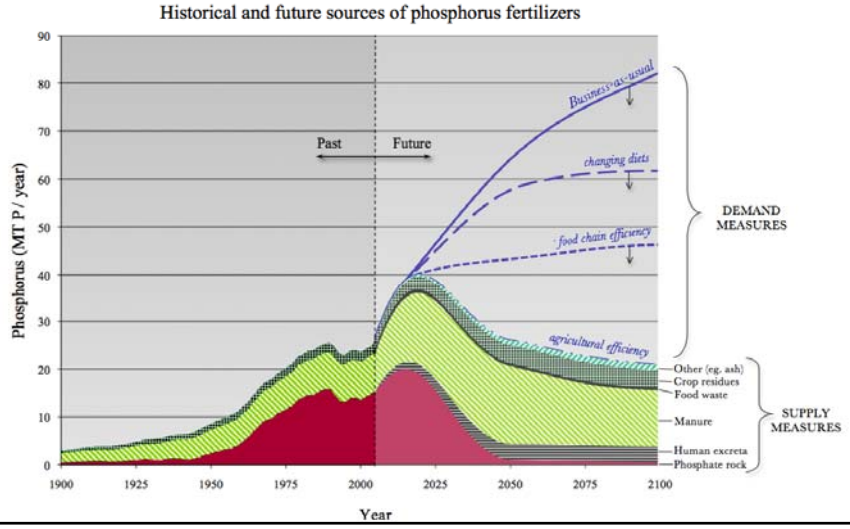
PART II:
Phosphorus security

HARD LANDING VS SOFT LANDING

- Hard landing:
  - Increased energy to obtain same nutrient value
  - Increased waste generation (incl eutrophication!)
  - Increased prices in long-term
  - Increased short-term price spikes
  - Reduced farmer access to fertilizer markets
  - Lower crop yields
  - Increased food insecurity
- Soft landing:
  - Phosphorus security *ensures all farmers have short- and long-term access to sufficient phosphorus to grow enough crops to feed to world*

FROM PHOSPHATE SCARCITY TO PHOSPHORUS SECURITY

PREFERRED FUTURE PHOSPHORUS SCENARIOS



REDUCING PHOSPHORUS DEMAND: BEYOND EFFICIENT FERTILISER USE

> Increasing phosphorus use efficiency in **agriculture** will be key (eg. optimizing soil-plant chemistry, plant selection, fertilizer application techniques)

> Some existing innovations – eg. *IFA's 4Rs* (BMP)

(but driven by P pollution, not mainstream)

> Also key:

- Efficiency in the entire **food chain** (eg. losses in food processing, supermarket and household bins)
- Influencing **diets** towards more plant-based food

MAXIMISING PHOSPHORUS REUSE: BEYOND RECOVERY

> Recovering phosphorus from **wastewater/excreta** will be key (e.g. composted, struvtite, ash)

> Some existing innovations – e.g. *Ostara*, *Thermphos-SNB*

(driven by P pollution, not mainstream)

> Also key, beyond goal of reducing eutrophication:

- Reusing **food/organic** waste in the entire food chain
- Reusing **manure**, **crop residues**
- Reusing **algae**, **ash** (eg. from animal meal)

AN INTEGRATED APPROACH IS REQUIRED

- There is **no single** solution to meeting future phosphorus demand
- Strategies need to respond to **global** issues but designed to be **context** specific (eg. Australia vs North America, vs Africa)
- What are the most **cost-effective**, **energy efficient**, **equitable**, **environmentally** compatible means of using and reusing phosphorus in a given food production & consumption?

IN SUMMARY

- Achieving global and national phosphorus security involves a number of pertinent **challenges** and **opportunities**….

CHALLENGES: SUSTAINABLE PHOSPHORUS FUTURES

Achieving sustainable phosphorus futures for food production will mean addressing:

>Beyond the **market** focus

>Beyond 'the **field**' focus (eg. more than ag efficiency)

>Beyond **eutrophication** to **scarcity**

>Beyond short-term to **long-term**

>current institutional fragmentation – lack of clear **roles** and **responsibilities**

>Data scarcity: lack of **data**, lack of **transparency**

OPPORTUNITIES: SUSTAINABLE PHOSPHORUS FUTURES

Opportunities for achieving sustainable phosphorus futures for food production:

>New sustainable **technologies** and **practices** for efficient phosphorus use and recovery

>New **partnerships** between fertilizer sector, wastewater, urban planning, scientists, etc

>Evolution of the industry from **product** (fertilizer commodity) to **service** (soil fertility, food security)

>New **actors** and **policies** for ensuring short- and long-term phosphorus security for crop production

GLOBAL PHOSPHORUS RESEARCH INITIATIVE

- Joint initiative between 5 research organisations across Australia, Europe and North America
- Aim: *to facilitate interdisciplinary research on sustainable global phosphorus resources for future food security*
- To facilitate networking and dialogue between diverse industry, government, scientific and community stakeholder groups
- Eg. National Phosphorus Stakeholder Workshop, Public lectures, joint paper on future scenarios, Global Phosphorus Network

GLOBAL PHOSPHORUS RESEARCH INITIATIVE

For more information visit:
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THANK YOU!