The Austrian P-budget as a basis for resource optimization

Paper in preparation

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System boundaries
- Austrian national boundaries
- 30 cm soil; atmosphere not considered
- Average year 2004-2008
- Population: 8.3 Mio inhabitants

System components
- 9 processes (analyzed as sub-processes)
- 6 stocks
- 64 external flows

Calculation
- Mass flow of goods/materials + uncertainty
- P concentration + uncertainty
- Cross-checking, when possible
- Balance, reconciliation and error propagation by STAN
Results

**Total system**
- Total import: $8.4 \pm 5\% \text{ kgP/cap\text{*yr}}$
- Total export: $6.3 \pm 6\% \text{ kgP/cap\text{*yr}}$
- Total stock change: $+2.2 \pm 5\% \text{ kgP/cap\text{*yr}}$
- Full dependency on P-import, but only 1/3 of imported phosphate ore is used in Austria

**Food production and Consumption**
- Major flows between Animal husbandry, Crop farming and agrifood industry
- 36% of total P fertilizers are mineral fertilizers
- Stock increase in agr. soils: $+0.7 \pm 9\% \text{ kgP/cap\text{*yr}}$
- 21% efficiency of food supply chain
- Stock increase in households (home composting?)

**Waste and wastewater**
- P removal from wastewater $> 85\%$
- Reduced impact on water bodies, more affected by erosion/diffuse sources
- Municipal sewage sludge and carcass meal have a potential of substituting 75% of P-mineral fertilizers
- Highest stock increase in Waste management
Waste management

- Distribution / treatment / storage processes
- P is highly distributed
- Final destinations are: Landfill/Cement kilns 44%; Agriculture 29%; Export 12%; Landscaping 10%; Gardening 5%
Results

- Municipal sewage sludge flow: 0.8 ± 5% kgP/cap*yr
- Potential of substitution of P-mineral fertilizers: 40%
- 27% is reused in agriculture (16% direct application)
- 11% is reused in landscaping
- 2% is exported
- 60% is lost in landfills and cement kilns

Distribution of P from Municipal sewage sludge. All values expressed in %, referred to the initial P content of Municipal sewage sludge (100%).
Animal waste

Results

• Animal wastes flow: 0.72 ± 10% kgP/cap*yr
• Potential of substitution of P-mineral fertilizers: 35%
• 13% is reused in agriculture
• 36% is exported
• 51% is lost in cement kilns

Distribution of P from Animal waste. All values expressed in %, referred to the initial P content of Animal waste (100%).
Ongoing work

Next research question
• How has the Austrian P-budget changed in the last 20 years?

Methodology
• Same conceptual model, with optimizations (e.g. more detailed research in the Consumption/Household process)
• Collection/Estimation of time series-data for all the flows and stocks
• Balance, data reconciliation and error propagation with STAN for every year

Expected results
• Single MFA, displaying time series for every flow and every stock
• Trends in flows of goods/materials
• Changes/trends of P-concentration in flows of goods/materials, due to different composition in time → Dilution of P
• Different uncertainty ranges, according to heterogeneous data availability in the past
Example: P-flows related to treatment of organic material in biogas plants

- Market boom after Green electricity law in 2002
- Stagnation of new projects after new law in 2006
- Main use of manure and organic wastes until 2002
- Rapid increased use of energy crops after 2002

Source: E-Control-Ökostrombericht 2010
Example: P-flows related to treatment of organic material in biogas plants

Preliminary results

• Sharp increase of total material and energy crops consumption after 2003 (delay of 1 year from the law in 2002)
• Slower increase of other materials
• Sharp increase of P load after 2003
• Variations of P concentration of the flows, given to their changing composition
Thank you for your attention!

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