EU wide overview of phosphorus flows & data quality

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Overview

- Phosphorus (P) flows and balances in the EU-27 Member States
- Data & methods used
- Data quality & monitoring challenges
Phosphorus use in the EU-27 in 2005

**Input**
- 2392
  - Detergent, wood, paper & fibres
  - Crops, fish, food products & mineral additives
  - Animal feed, mineral additives & live animals
  - Mineral fertiliser, seeds & pesticides

**Output**
- 1468
  - Solid & liquid organic waste
  - Wood, paper & fibres
  - Organic waste
  - Crops & food products
  - Slaughter residues, solid & liquid waste
  - Live animals
  - Manure losses
  - Seeding materials
  - Leaching & runoff

**Flows & stocks in Gg = Mkg = kton P per year**

Van Dijk et al. (2015)
Per capita P supply per country in 2005

EU-27 consumption sector P losses in 2005

Van Dijk et al. (2015)
Agricultural P balances per country for 2005 & period 1905 - 2005

128 Mtons P accumulated in agricultural soils between 1905 -2005

Van Dijk et al. (2015)
Data & methods used

- For EU-27 and individual Member States
- As detailed as data allows: 93 sub flows
- Imports, exports, losses and internal flows
- Entire food system + non-food (e.g. forestry, detergents, pet food, etc.)
- Main data sources: Miterra-Europe, CAPRI, FAOSTAT, Eurostat, reports, articles and experts
- Time series if present in data (e.g. FAOSTAT, Eurostat)
- Data for 2005 complete and checked, other base years possible with additional data input
- Raw data is balanced based on mass balance principle
- EU-27 corrections for intra/extra trade
Data quality & monitoring challenges

- Data quality: trade > production > consumption > recycling
- Unclear definitions & not enough detail in data
- Eurostat data is incomplete and inconsistent
- Data gaps for waste flows & (new) recycling flows
- Literature data mostly not recent and only specific base years
- Trade databases not available for all products/materials
- Data gaps requires data filling procedures & flow balancing
- Industry data not publically available, sometimes commercially, but no peer reviewed
- Uncertainties for most data unknown
- Nutrient concentrations not monitored
- From quantity to quality, from theory to practise
Thank you for your attention

Questions? Comments? Suggestions?

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Extra additional slides as background
## EU-27 system & primary P flows in 2005

<table>
<thead>
<tr>
<th></th>
<th>Absolute quantity [Gg P/year]</th>
<th>Relative fraction of total system import, export &amp; losses [%]</th>
<th>Primary P import</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Import</td>
<td>Export</td>
<td>Losses</td>
</tr>
<tr>
<td>CP</td>
<td>1399</td>
<td>4</td>
<td>84</td>
</tr>
<tr>
<td>AP</td>
<td>440</td>
<td>21</td>
<td>62</td>
</tr>
<tr>
<td>FP</td>
<td>338</td>
<td>216</td>
<td>339</td>
</tr>
<tr>
<td>NF</td>
<td>215</td>
<td>11</td>
<td>77</td>
</tr>
<tr>
<td>HC</td>
<td>-</td>
<td>-</td>
<td>655</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2392</strong></td>
<td><strong>251</strong></td>
<td><strong>1217</strong></td>
</tr>
</tbody>
</table>

Van Dijk et al. (2015)
## EU-27 lost P destination per sector in 2005

<table>
<thead>
<tr>
<th></th>
<th>Ashes</th>
<th>Landfills</th>
<th>MSW</th>
<th>Hydrosphere</th>
<th>Lithosphere</th>
<th>Undefined</th>
<th>Total losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>84</td>
<td>0</td>
<td>0</td>
<td>84</td>
</tr>
<tr>
<td>AP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>62</td>
<td>0</td>
<td>0</td>
<td>62</td>
</tr>
<tr>
<td>FP</td>
<td>294</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>41</td>
<td>339</td>
</tr>
<tr>
<td>NF</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>66</td>
<td>77</td>
</tr>
<tr>
<td>HC</td>
<td>104</td>
<td>59</td>
<td>221</td>
<td>54</td>
<td>74</td>
<td>143</td>
<td>655</td>
</tr>
<tr>
<td>Total</td>
<td>408</td>
<td>59</td>
<td>221</td>
<td>204</td>
<td>76</td>
<td>250</td>
<td>1217</td>
</tr>
</tbody>
</table>

Relative share [%]

|           | 34    | 5       | 18  | 17          | 6            | 21        |

Van Dijk et al. (2015)
## EU-27 P use efficiency per sector in 2005

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>AP</th>
<th>FP</th>
<th>NF</th>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PUE-1 Output flows minus losses</strong></td>
<td>70</td>
<td>97</td>
<td>80</td>
<td>76</td>
<td>21</td>
</tr>
<tr>
<td><strong>PUE-2 Upward output flows plus export</strong></td>
<td>70</td>
<td>24</td>
<td>52</td>
<td>76</td>
<td>-</td>
</tr>
</tbody>
</table>

\[
PUE_{\text{sector}} = \frac{Output_{\text{effective}}}{Input_{\text{total}}} \times 100
\]
Changes in EU-27 P inputs 1961-2009

Van Dijk et al. (2015)
Geological versus anthropogenic cycles

Anthropogenic cycle

- **Inputs**
  - [90% fertilizer, and other mineral P use]
- **Society**
- **Consumers**
- **Industry & retail**
- **Animals**
- **Crops**
- **Non-food**

Losses

Sinks

Direct IMPACTS

Geological cycle

- **RESOURCE RESERVES**
- **Geological cycle = millions of years**
- **Anthropogenic cycle = days to years**
Phosphorus challenge

- Non-renewable at human time scale
- Spatially concentrated: geopolitical dependency and tension
- Relatively low price, but price volatility (2008 case)
- Lower P-rock quality:
  - decreasing P content
  - impurities (e.g. cadmium, uranium)
- Pollution and eutrophication

Cordell et al. 2009
Global fertilizer P consumption 1961-2010

Phosphorus fertilizers, Mt

- Africa
- N-America
- S-America
- Asia
- Oceania
- Europe

FAOSTAT data 2010
Fertilizer P consumption in EU-27 in 2010

FAOSTAT data 2010
Animal feed P origin in EU-27 in 2005

Source: Miterra-Europe model, CAPRI & FAOSTAT data 2003-2005
Agronomic P balances in the EU

Estimated cumulative P balances [kg P/ha] of EU countries during 1991–2005

Source: Csathó & Radimszky 2012

Annual regional agricultural P balances [kg P/ha] for EU-15 in 2000

Source: Csathó & Radimszky 2012
Domestic food P supply in EU-27 in 2005

Domestic food P supply necessary to fulfill human dietary P intake requirements at consumption level

Van Dijk et al. (in preparation)
Reuse of organic waste in EU-27 in 2005

Compost use as fraction of total potential organic waste quantity [%]

Based on Barth et al. 2008
Sludge destinations in EU-27 in 2010

P concentrations in rivers and lakes in EU regions, period 1990 - 2005