Present and future phosphorus use in Europe: food system scenario analyses

Kimo van Dijk

Oene Oenema & Jan Peter Lesschen

Wageningen University, kimo.vandijk@wur.nl

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Overview

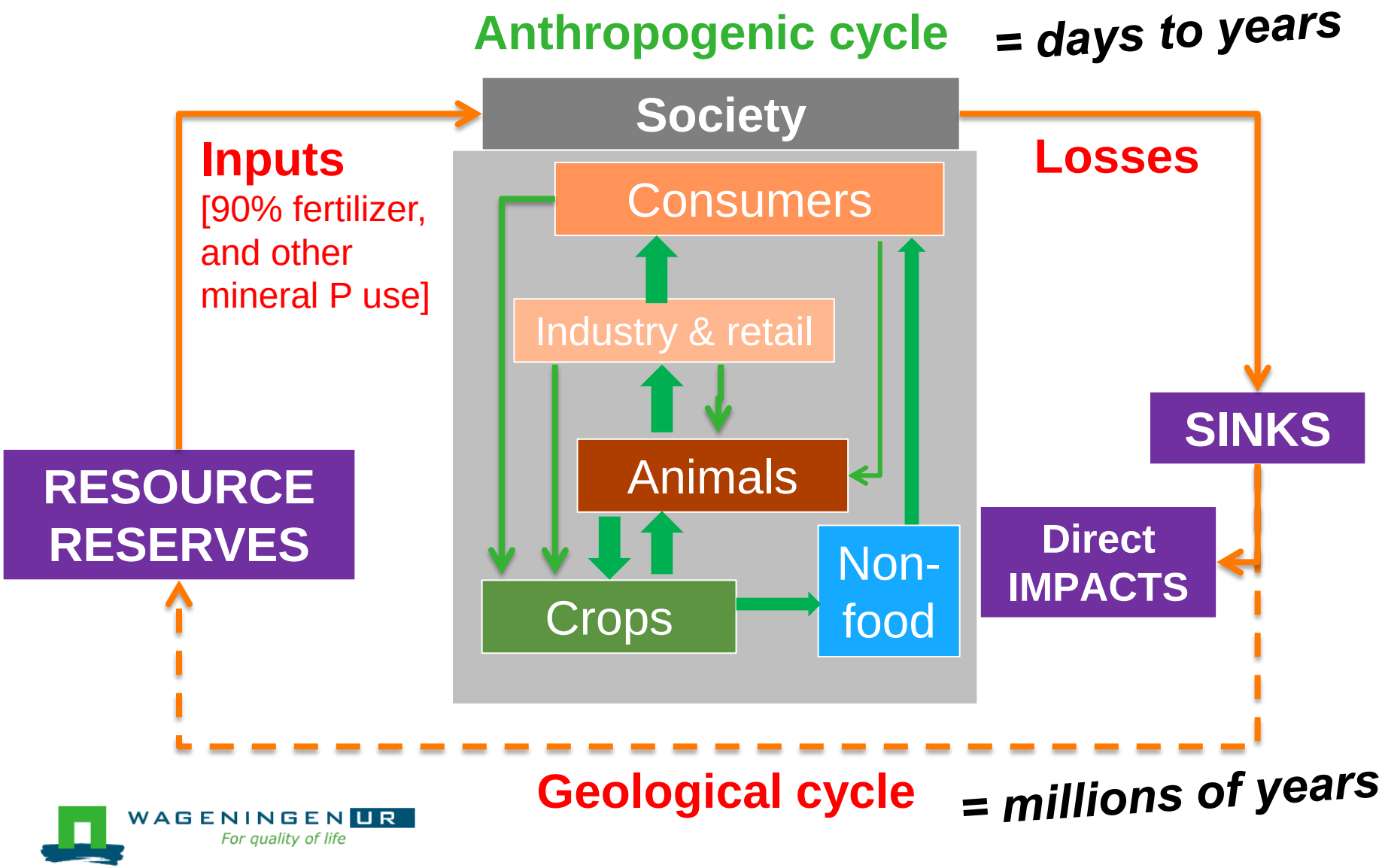
- Phosphorus (P) cycling

- Present P flows in Europe
- Sustainable P use options in society

- Dynamic food system model
- Future P use scenario analyses

- Summary & conclusions

Geological versus anthropogenic cycles



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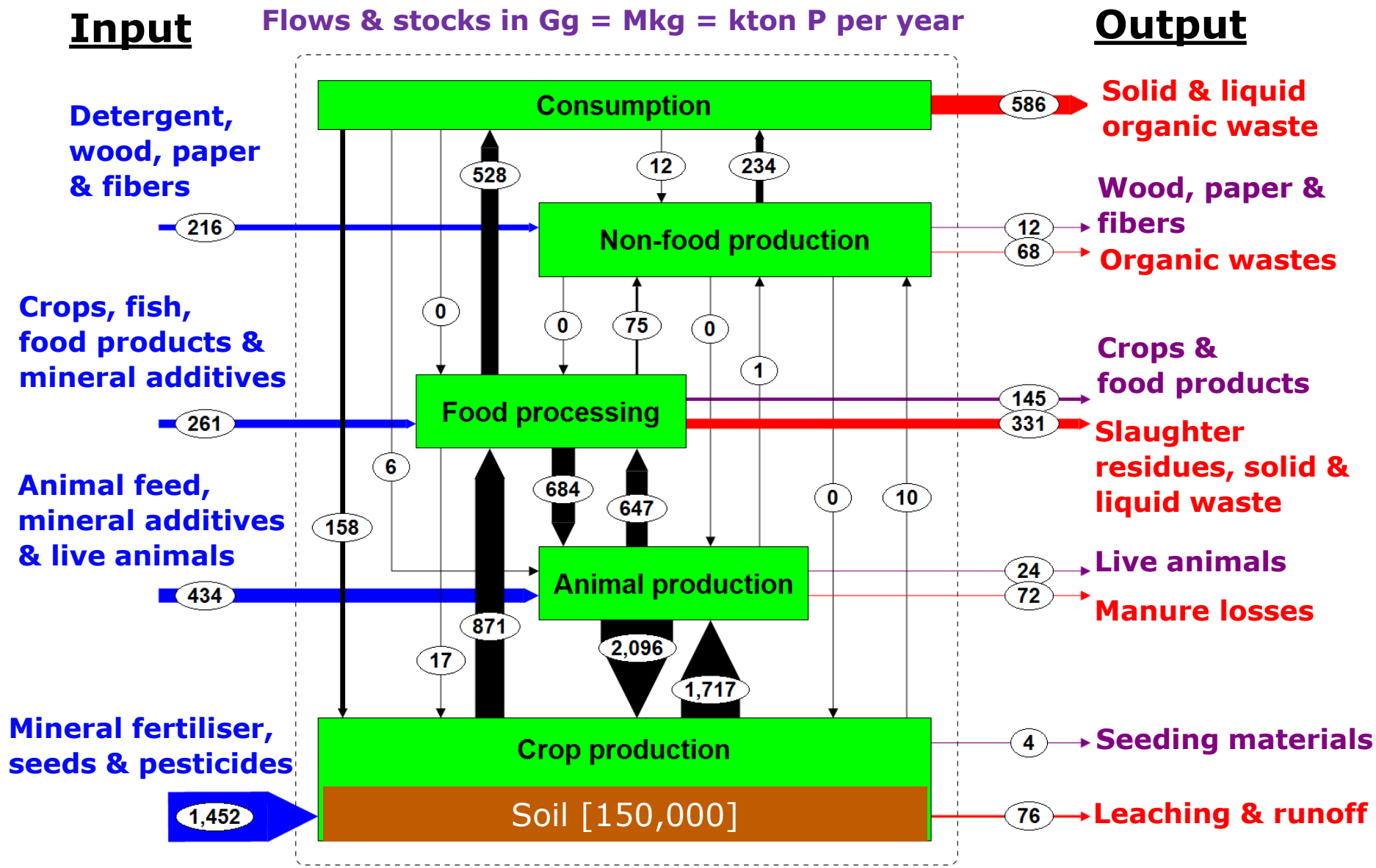
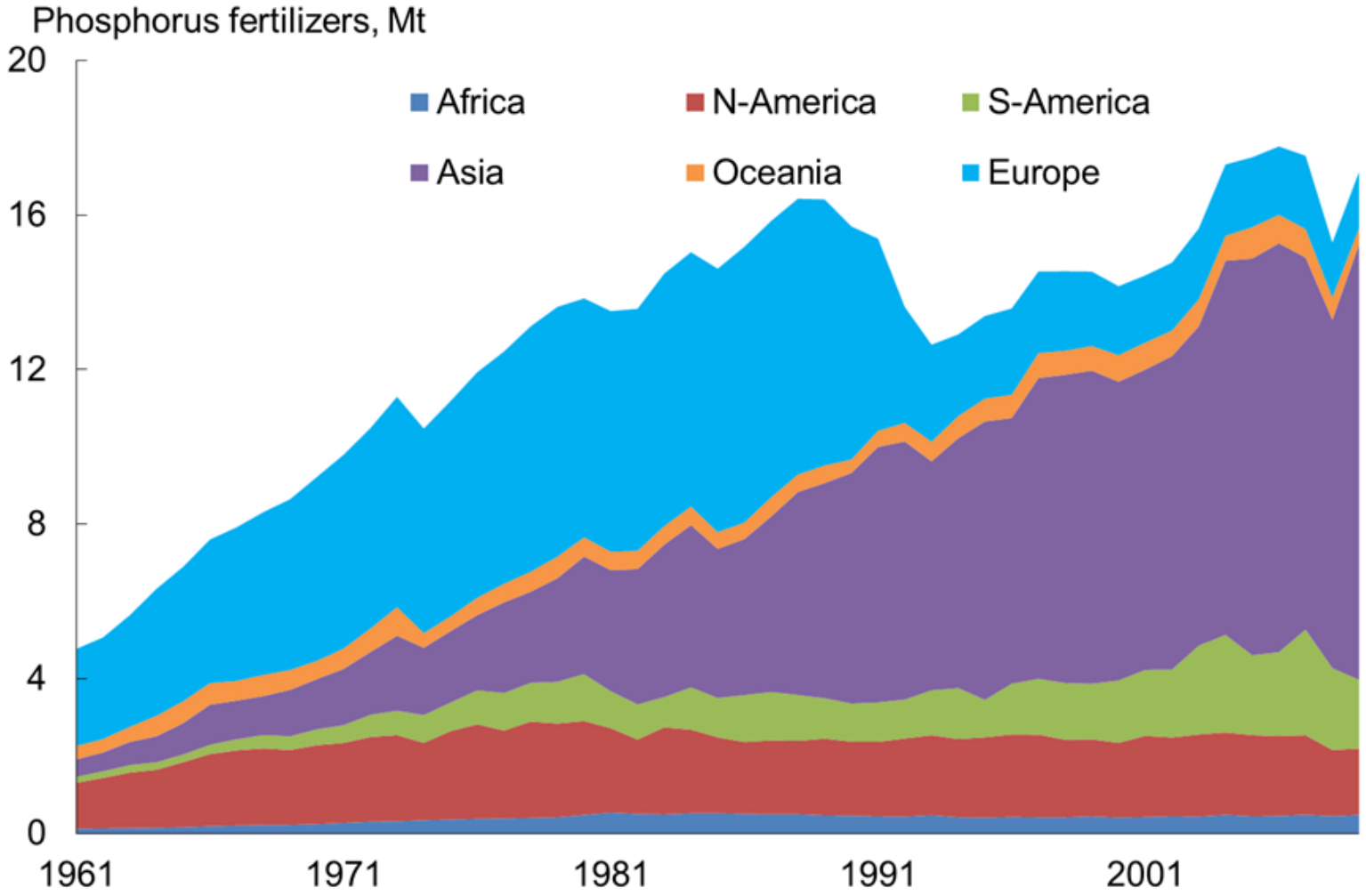
Phosphorus use in the EU-27 in 2005



Global fertilizer P consumption 1961-2010



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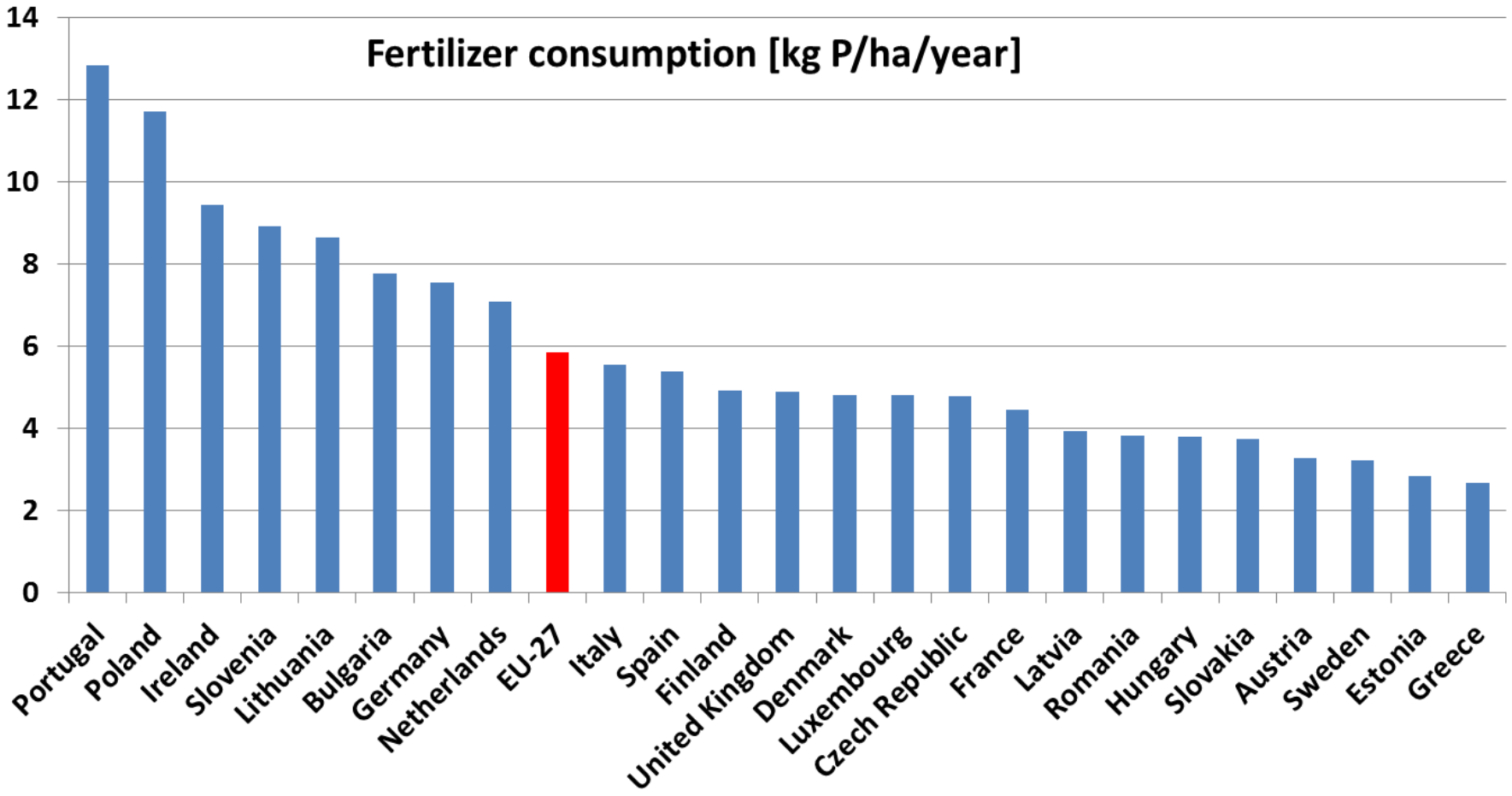
FAOSTAT data 2010

Fertilizer P consumption in EU-27 in 2010



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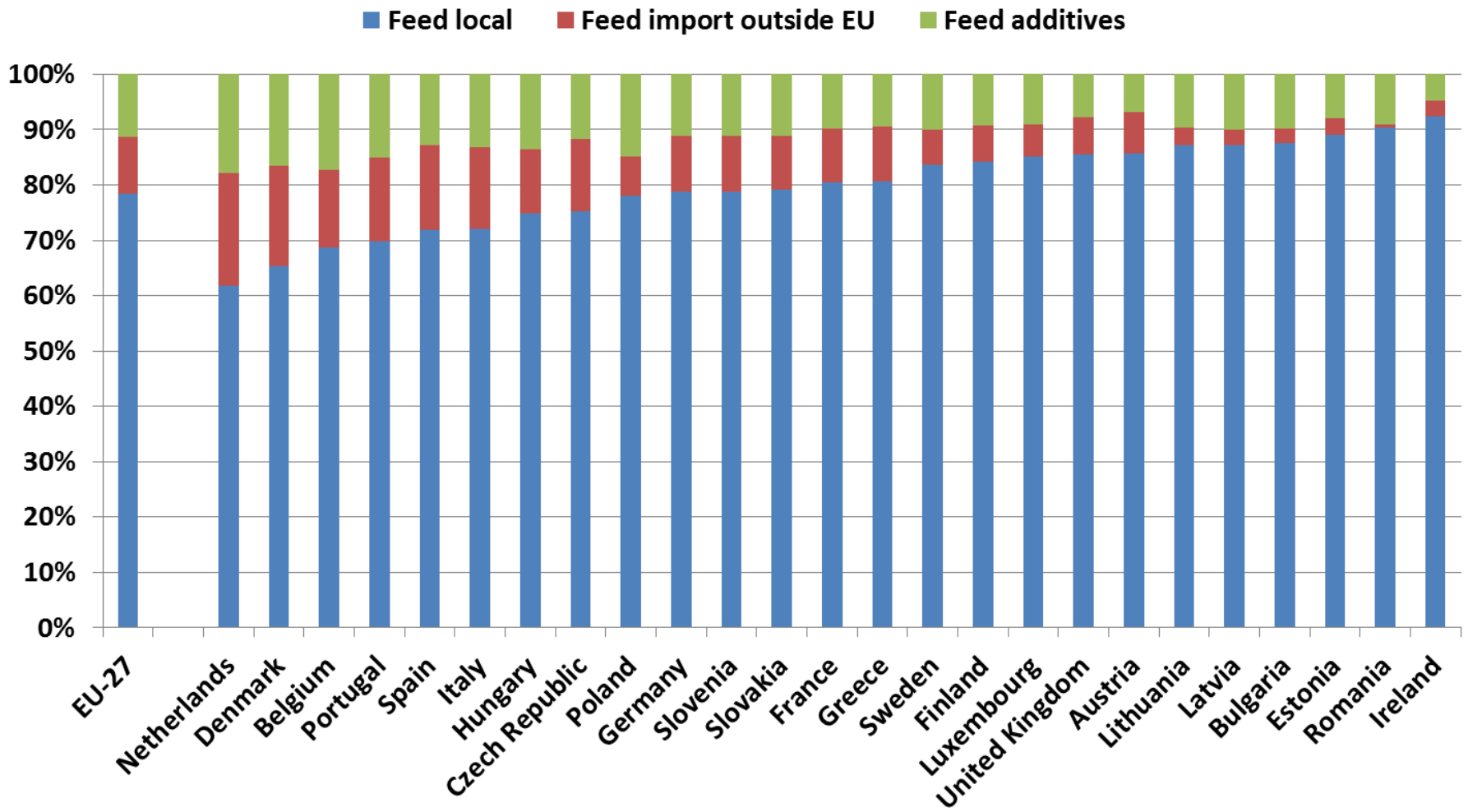
FAOSTAT data 2010

Animal feed P origin in EU-27 in 2005



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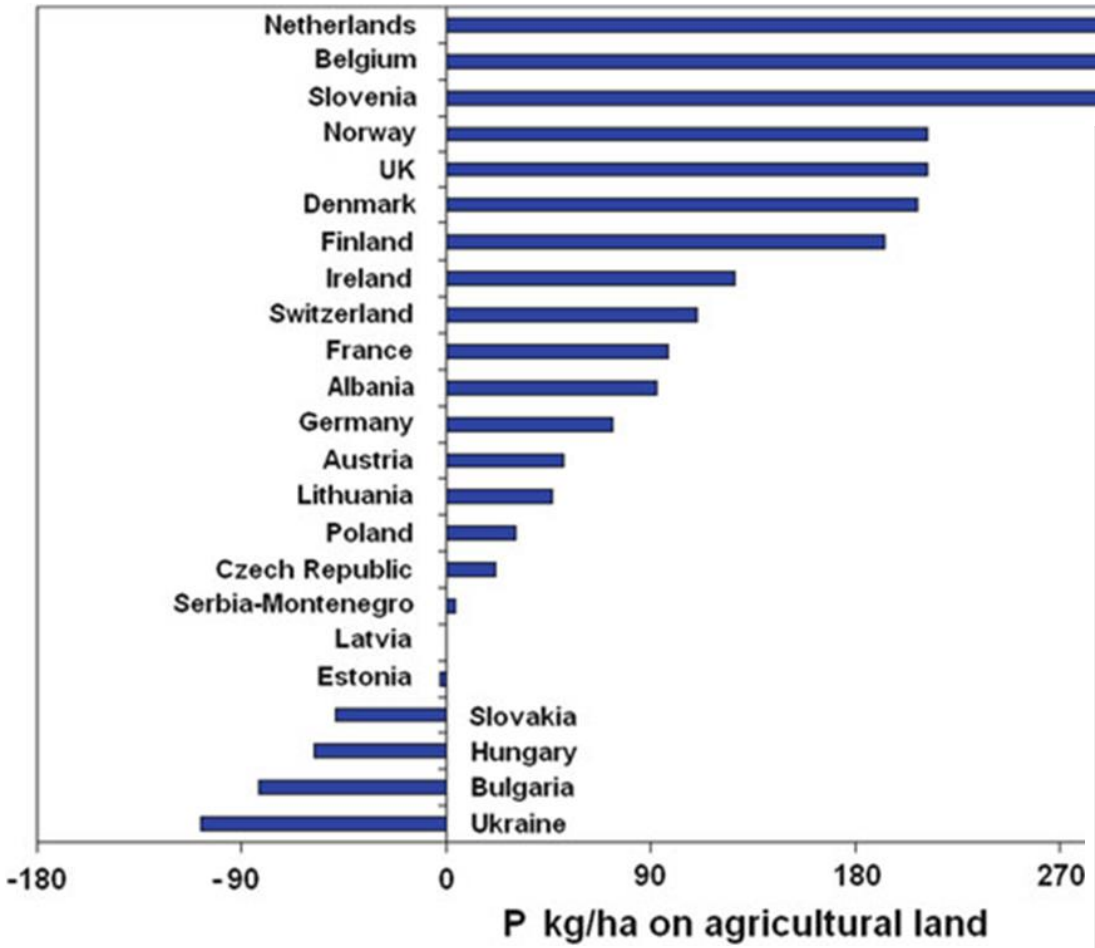
Source: Miterra-Europe model, CAPRI & FAOSTAT data 2003-2005

Agronomic P balances in the EU



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

Source: Csathó & Radimszky 2012

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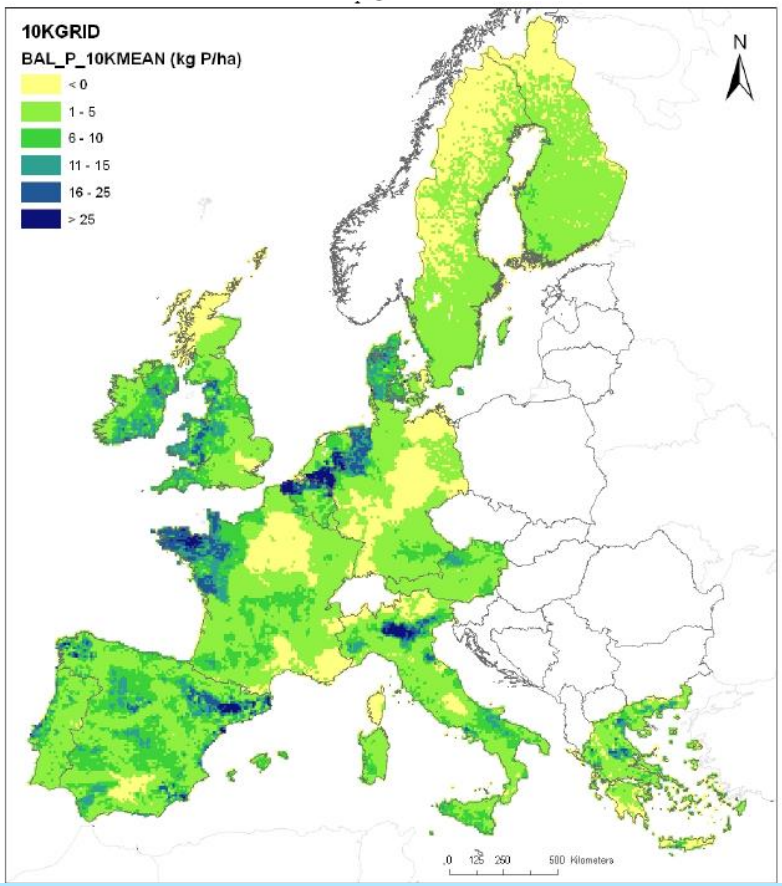
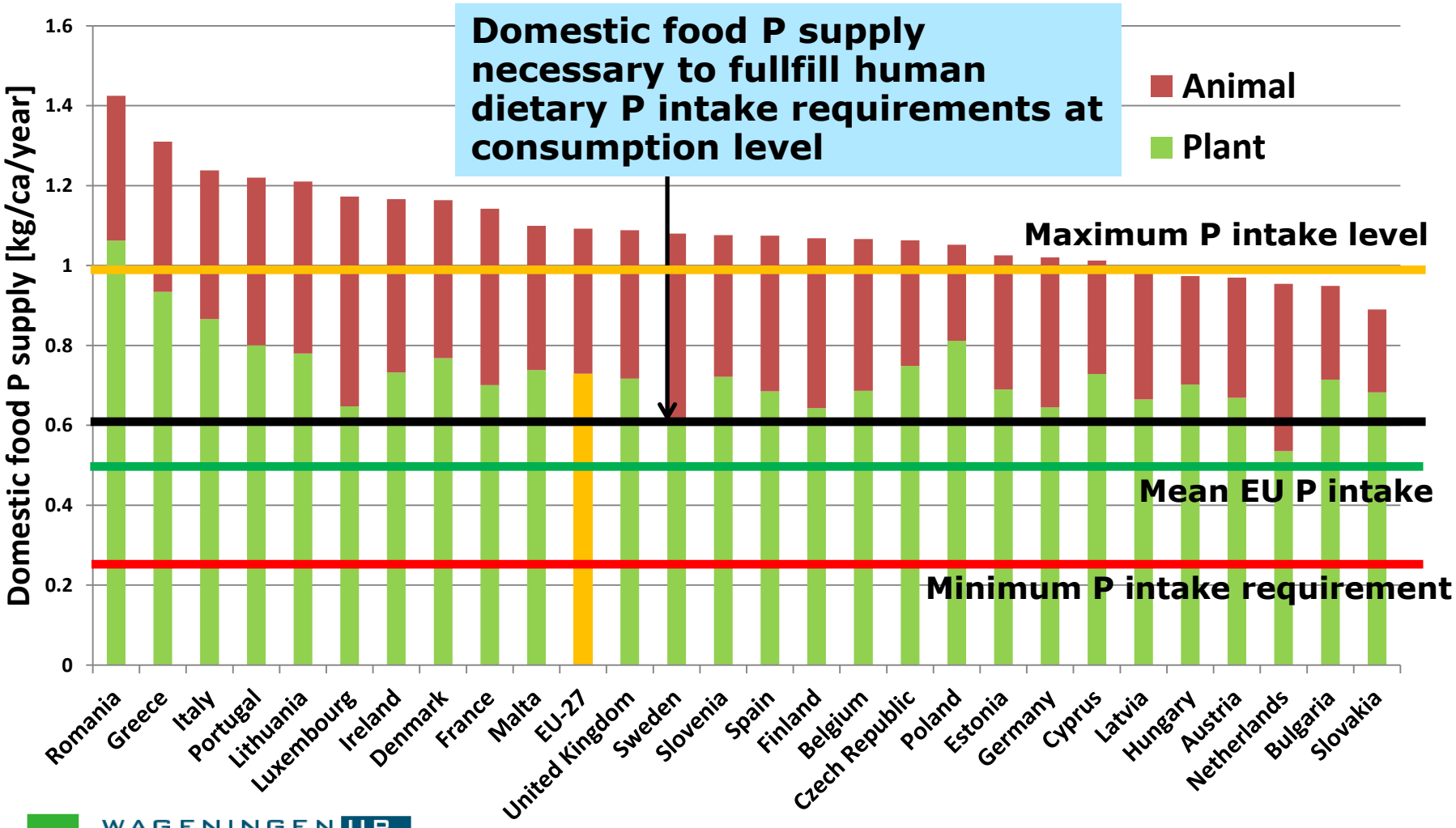


Annual regional agricultural P balances [kg P/ha] for EU-15 in 2000

Domestic food P supply in EU-27 in 2005



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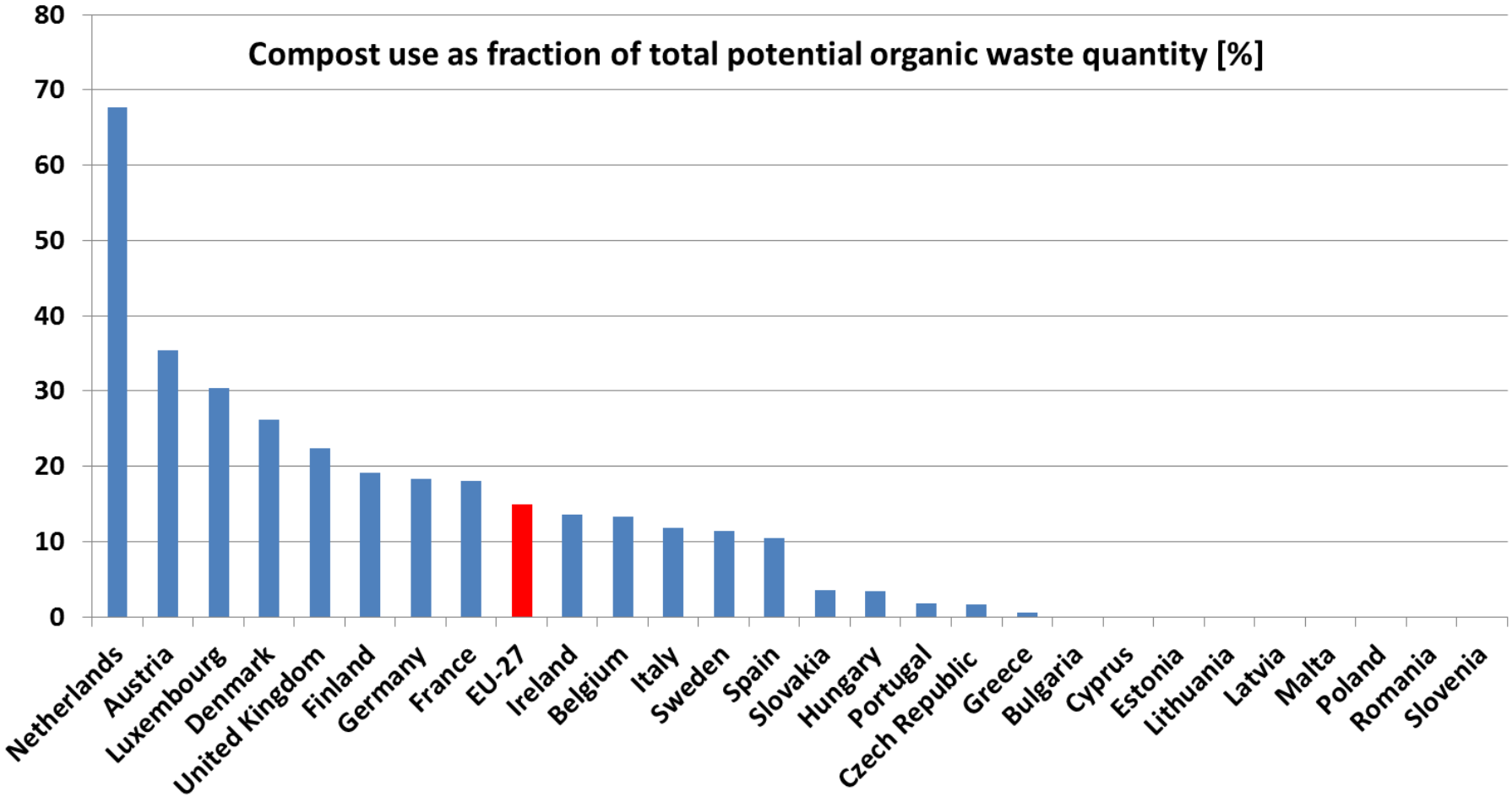
Van Dijk et al. (in preparation)

Reuse of organic waste in EU-27 in 2005



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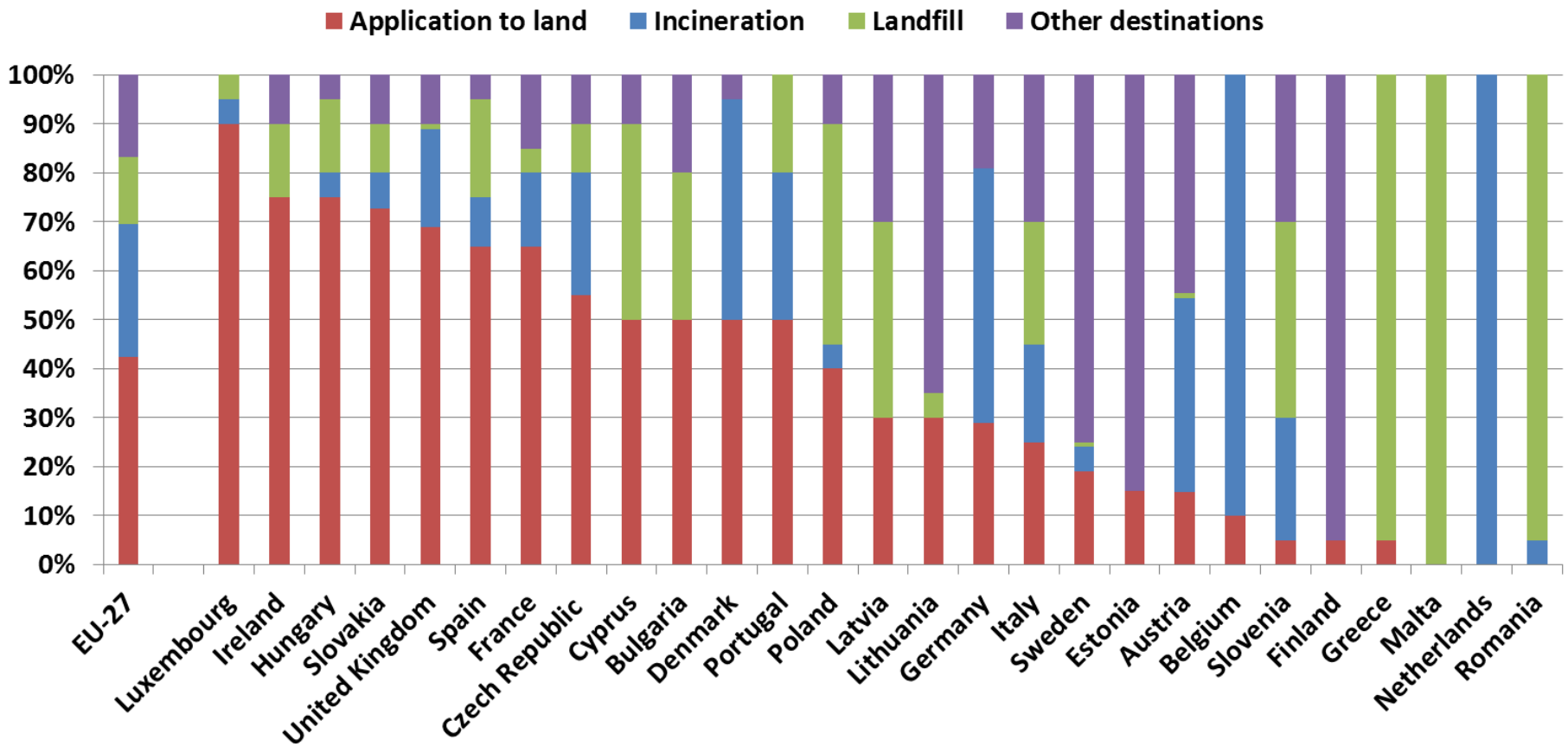
Based on Barth et al. 2008

Sludge destinations in EU-27 in 2010



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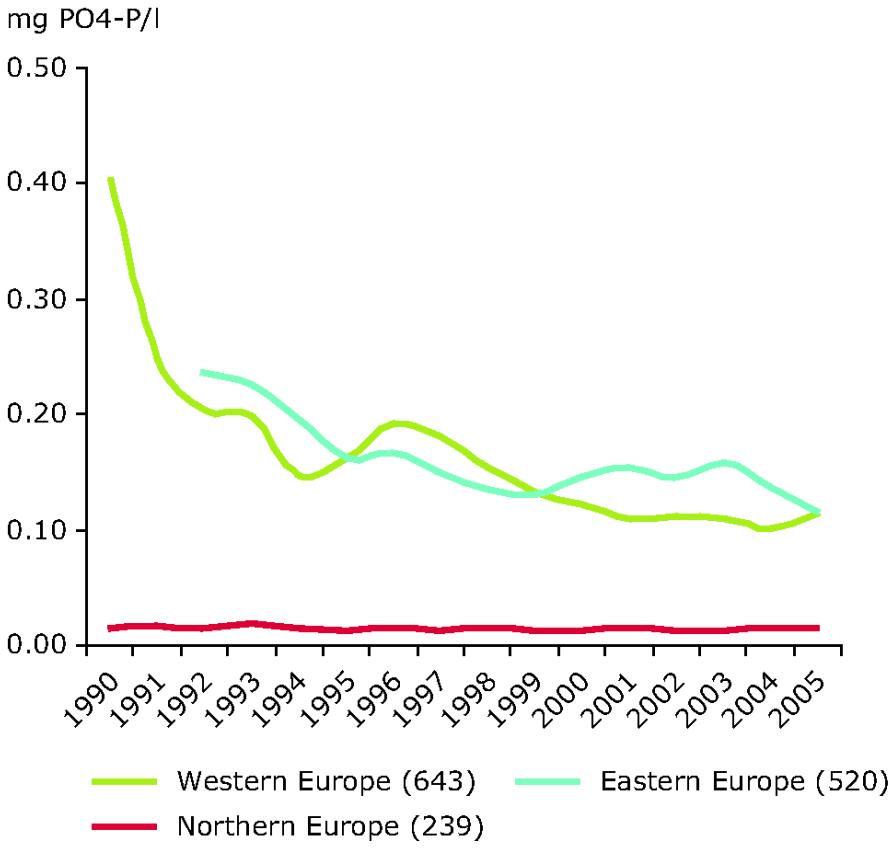
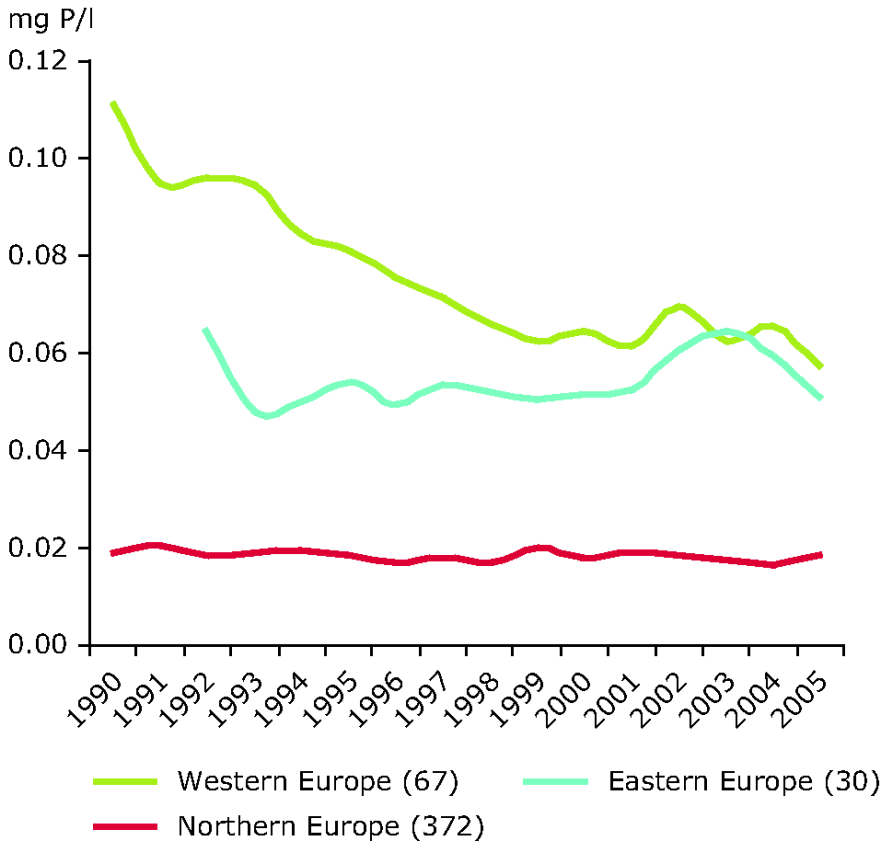
Source: P-Rex, FP7 project, www.p-rex.eu; based on Eurostat 2010, Milieu Ltd 2010 & Destatis 2011

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





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Source: European Environment Agency, 2007

Potential phosphorus losses in society

- Three 'types' of potential P losses:
  - Sequestration: incineration, landfilling, co-firing or use in the cement industry
  - Accumulation: in agricultural soils or the environment
  - Export: flows with unclear destinations
- Avoidable and unavoidable losses
- Point and diffuse sources
- Direct and indirect actors

Transition towards sustainable P use

Realign P inputs	• remove non-essential P inputs (e.g. detergents) • match P requirements more closely (precision agriculture) • utilise legacy P stores
Reduce P losses to water	• optimise input management • minimise runoff and erosion • strategic retention zones
Recycle P in bioresources	• avoid wastage • improve utilization efficiency • adopt integrated production systems
Recover P in wastes	• recover P in societies' wastes • produce fertilizer substitutes
Redefine P in the food chain	• influence dietary choice • define end-user P requirements • re-connect crop and animal production systems

Withers, Van Dijk, et al. (submitted)

P recycling potential in EU-27

[Gg P/year]	Total	Recycled	Potential
Sewage sludge	297	115	182
Biodegradable solid waste	130	38	92
Meat & bone meal	128	6	122
Total (minimum)	427	153	274
Total (maximum)	555	160	396
Mineral fertiliser use	1448		
Manure use	1763		

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Van Dijk et al. (in preparation)

EU-27 P use scenario analyses

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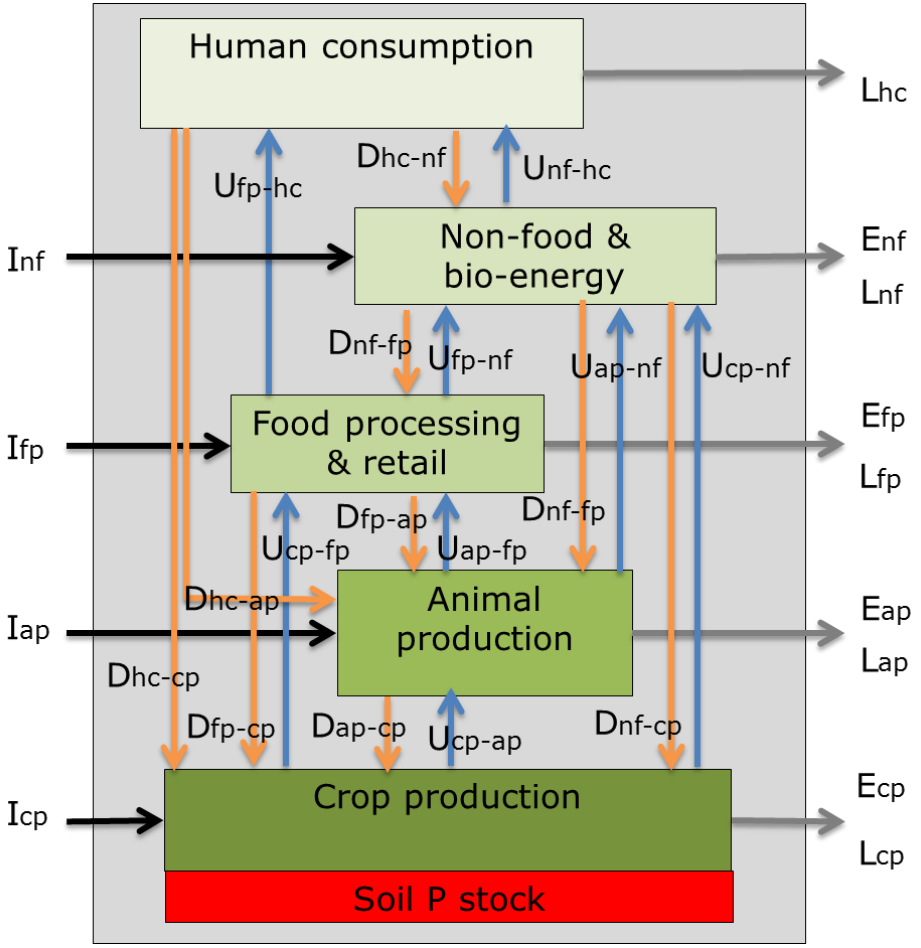
Objectives & research questions

- To develop a dynamic model for the analysis of the effects of changes in drivers and nutrient management strategies on P dynamics in the food chain.

- What would be the P dynamics & food production in EU-27 in case of a stop of P import via
  - Q1: mineral fertilizers?
  - Q2: mineral fertilizers and animal feed?
- Q3: What are effects of best management practices (BMPs) on food production and P use efficiency?

Dynamic Food System model

- **Mass balance principle**
- **Data: Miterra-Europe, CAPRI, FAOSTAT, Eurostat, reports, articles and experts**
- **EU-27 at country level, timesteps of one year**
- **Entire food system + non-food**
- **P imports, exports, losses and internal flows**
- **Flows described dynamically as function of sector input**
- **Crop P uptake as function of soil P stock and P application**



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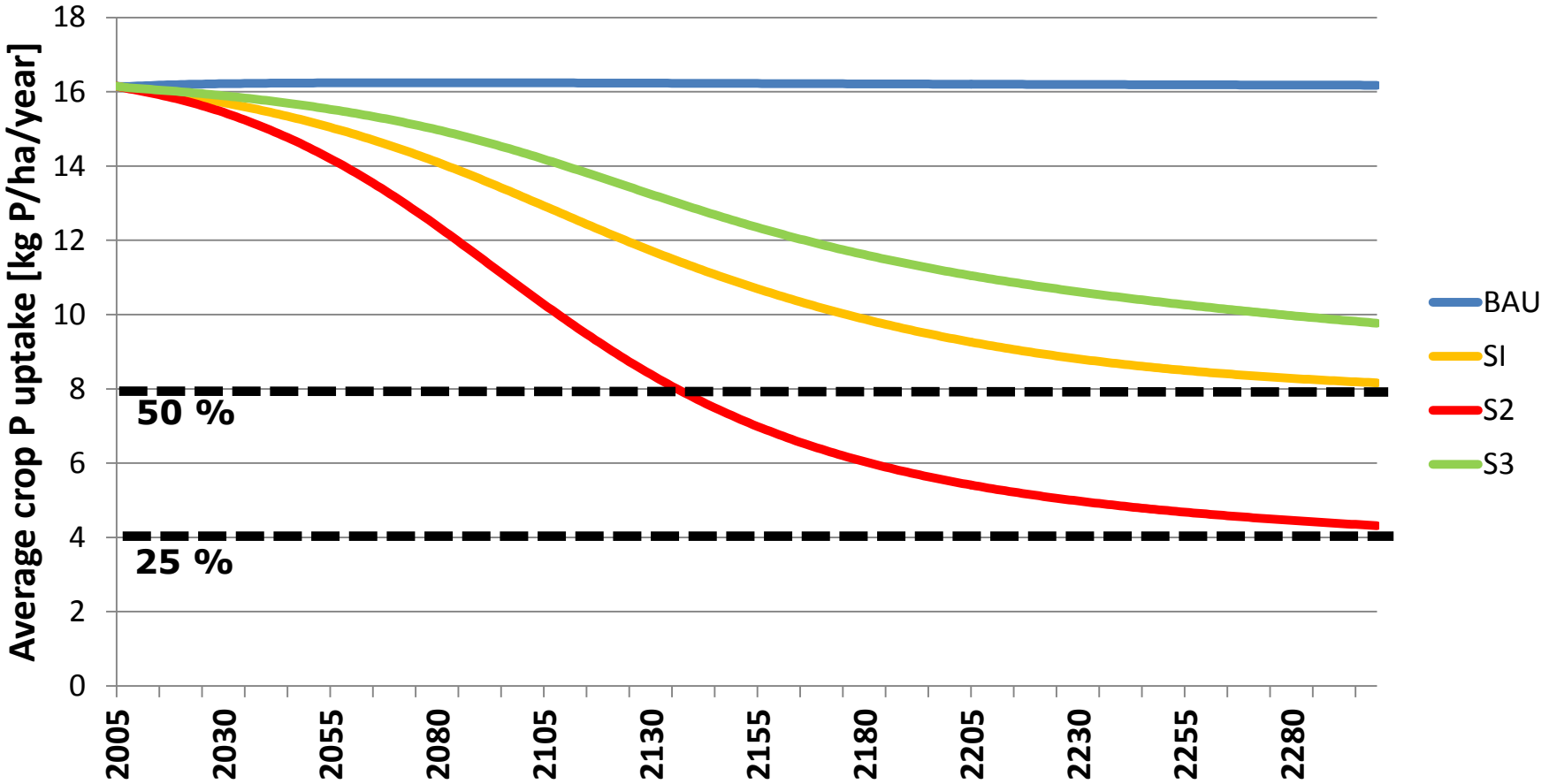
Scenarios & best management practices

- The scenarios are:
  - BAU: present (~2005), Business as Usual
  - S1: no P import via fertilizer
  - S2: no P import via fertilizer + compound feed
  - S3: as S2 + BMPs
- The best management practices (BMPs) are 90 % less:
  - biowaste + waste water P losses (HC)
  - forestry sector losses (NF)
  - slaughter waste losses (FP)
  - stable manure losses (AP)
- No changes in other drivers and factors, such as population, agricultural area, crop types etc.

Per ha EU-27 crop P uptake per scenario for 2005-2300



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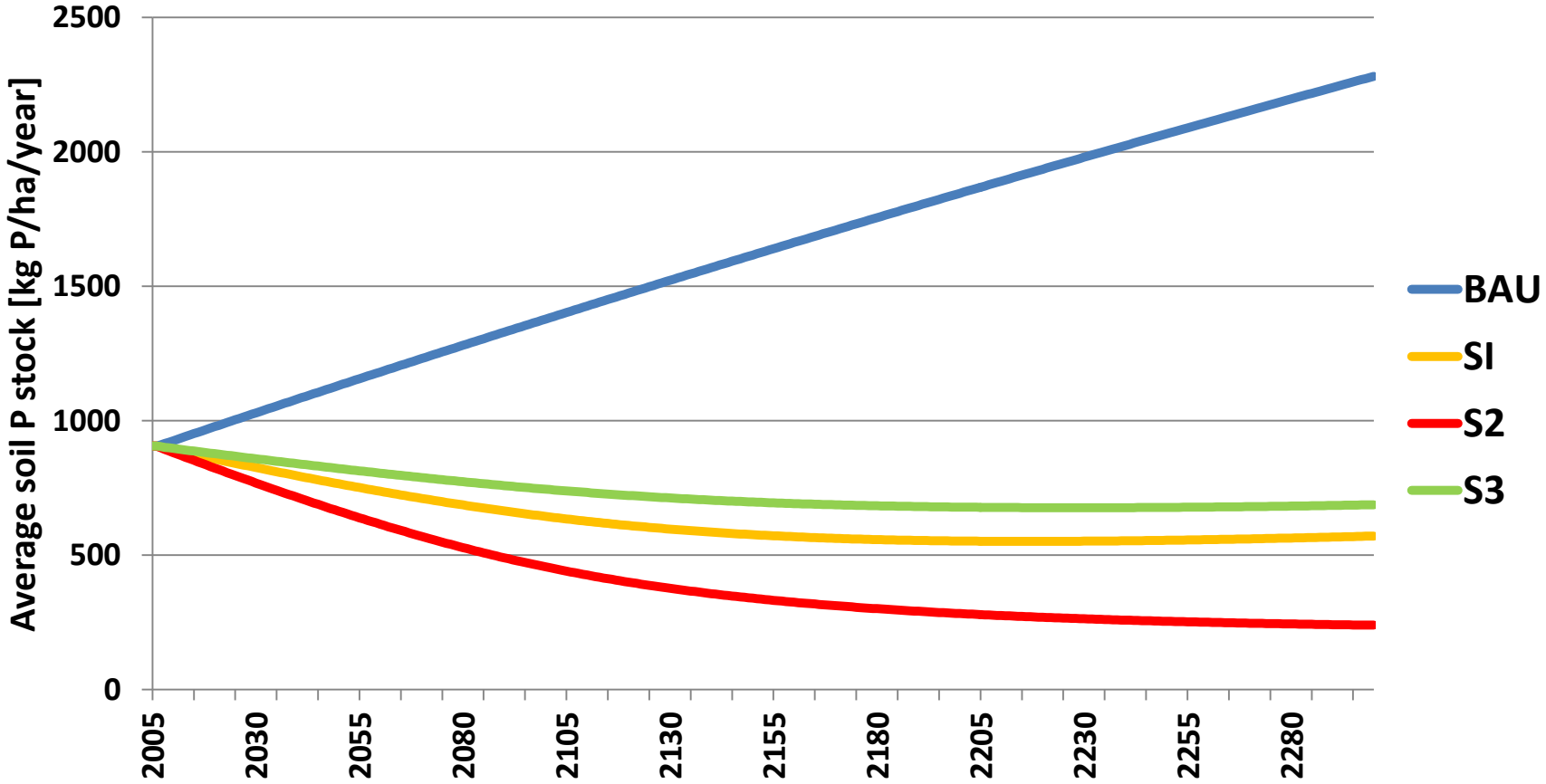
Per ha EU-27 soil P stock per scenario for 2005-2300



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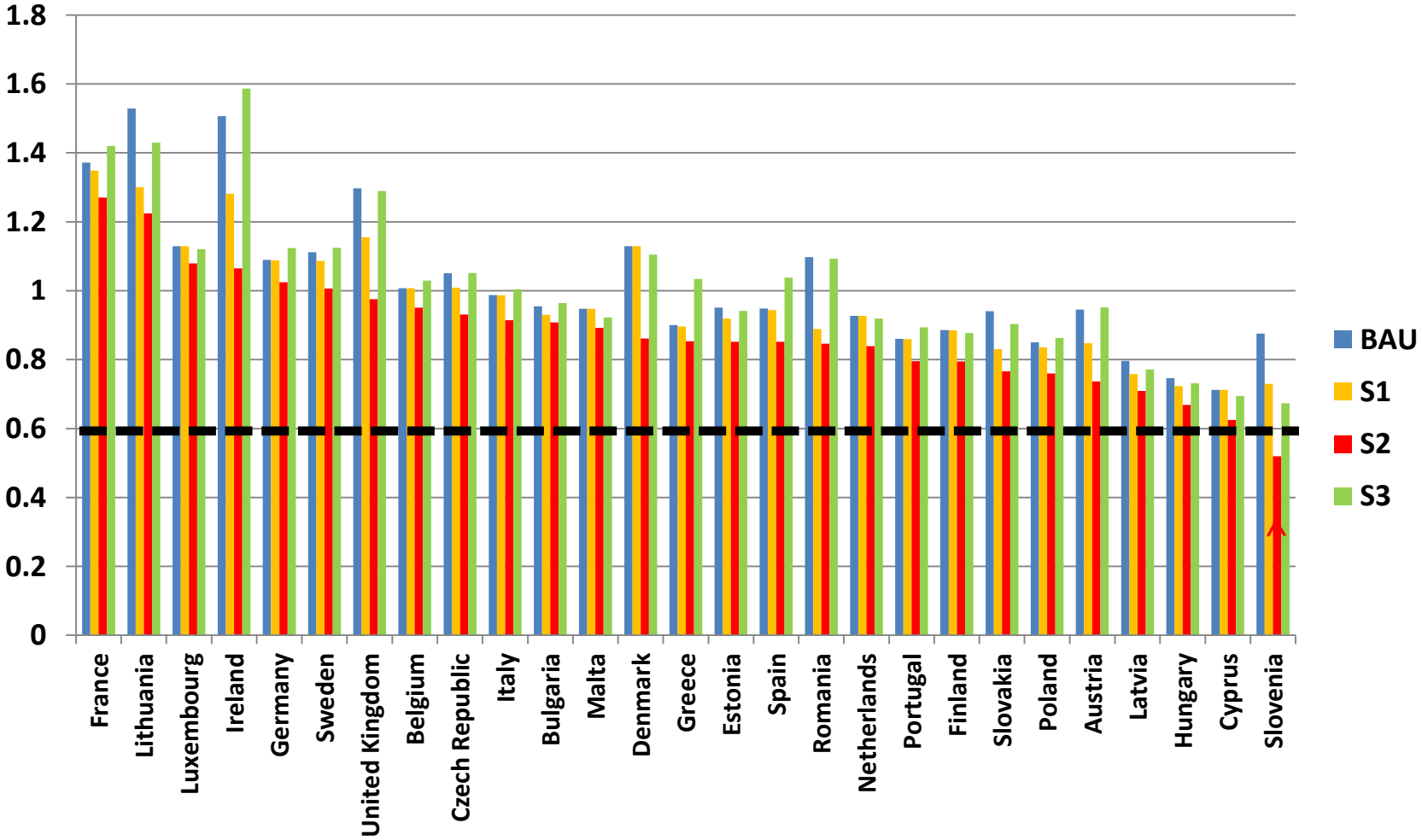
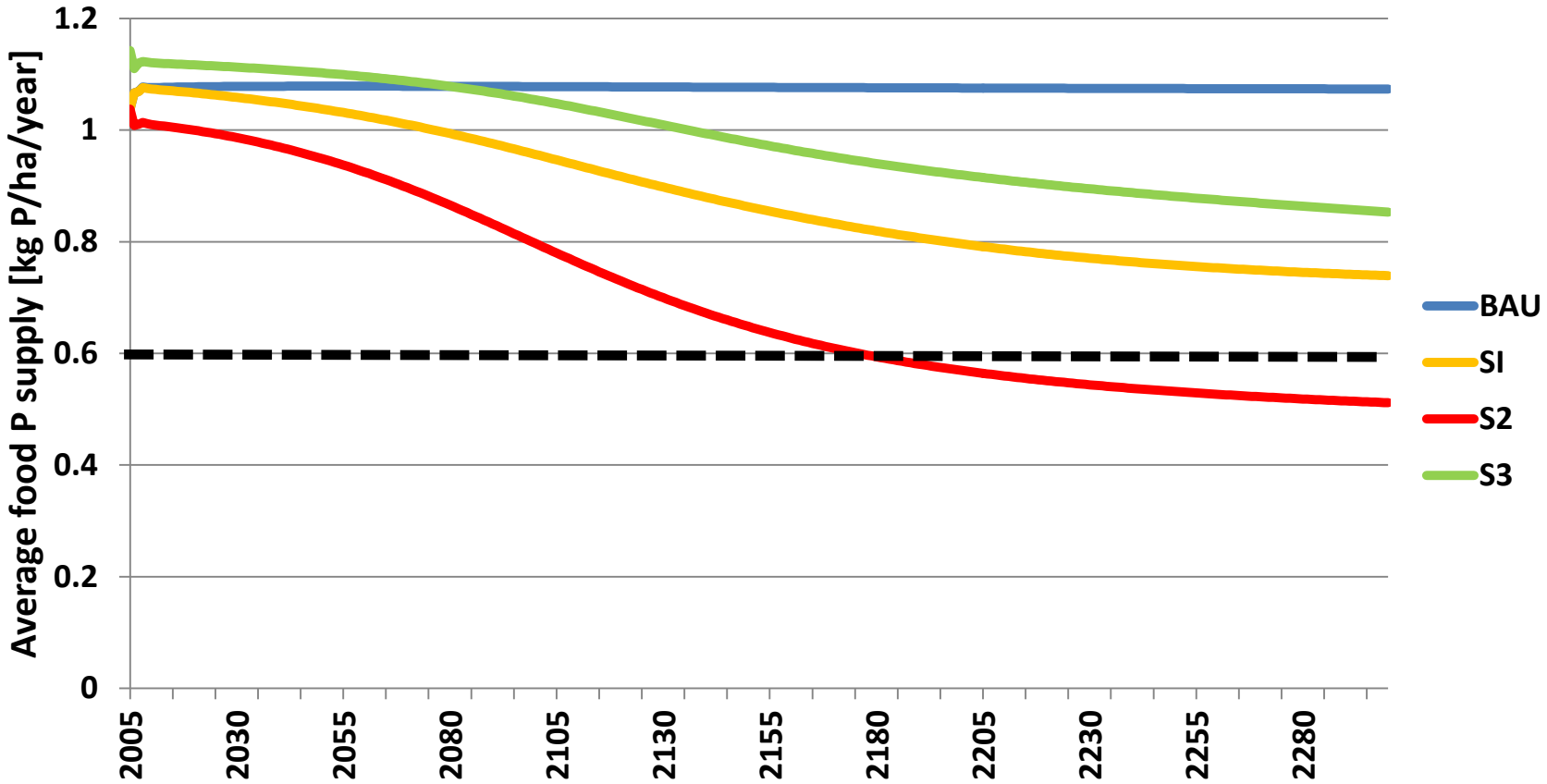
Per capita food P supply per Member State per scenario in 2050



Van Dijk et al. (in preparation)

Changes in per capita food P supply in EU-27 per scenario for 2005-2300



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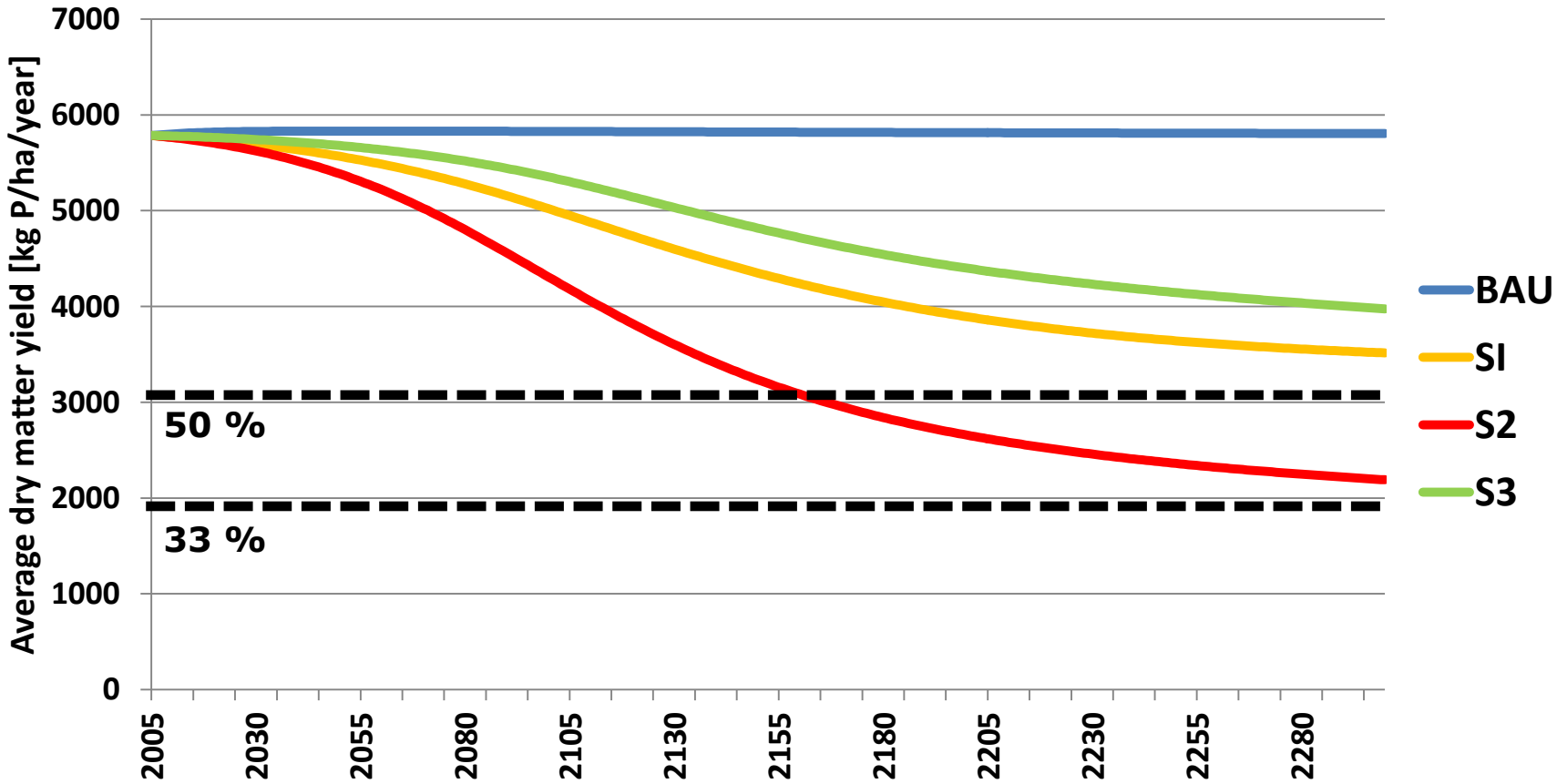
Changes in dry matter crop yield in EU-27 per scenario for 2005-2300



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Conclusions for the present state

- Europe is largely dependent on P imports via:
  - Mineral fertilizers (60%), animal feed & additives (20%), food (10%) & non-food materials (10%)
- Ongoing P accumulation in agricultural soils, especially in western Europe by P surplusses
- Various recycling rates, generally low (except manure):
  - Sewage sludge P recycling ranging from 0 - 90%
  - Compost P re-use ranging from 0 - 70%
- Significant P losses via:
  - Waterways: sewage discharge, leaching & erosion
  - Sequestration: incineration, landfilling, infrastructure
- High potential to improve P use efficiency

Conclusions for future scenarios

- Soil P is an important stock to take into account in P dynamics, because of its buffering capacity and large size (~150.000 Gg P)
- A stop on P fertilizer import has a large effect on food production, mainly on the longer term
- A stop on P import via fertilizer and animal feed makes the effect even more pronounced, causing a larger and earlier drop in food production
- The effects can be mitigated by the implementation of best management practices in nutrient management
- Additional data is necessary, especially for downscaling to the regional level

Thank you for your attention

Questions? Comments? Suggestions?

kimo.vandijk@wur.nl / kimovandijk@xs4all.nl

Twitter: @kimovandijk

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