



Phosphorus stocks in EU agricultural soils

Panos Panagos, European Commission

Global Symposium on Soils for Nutrition | 26-29 July 2022



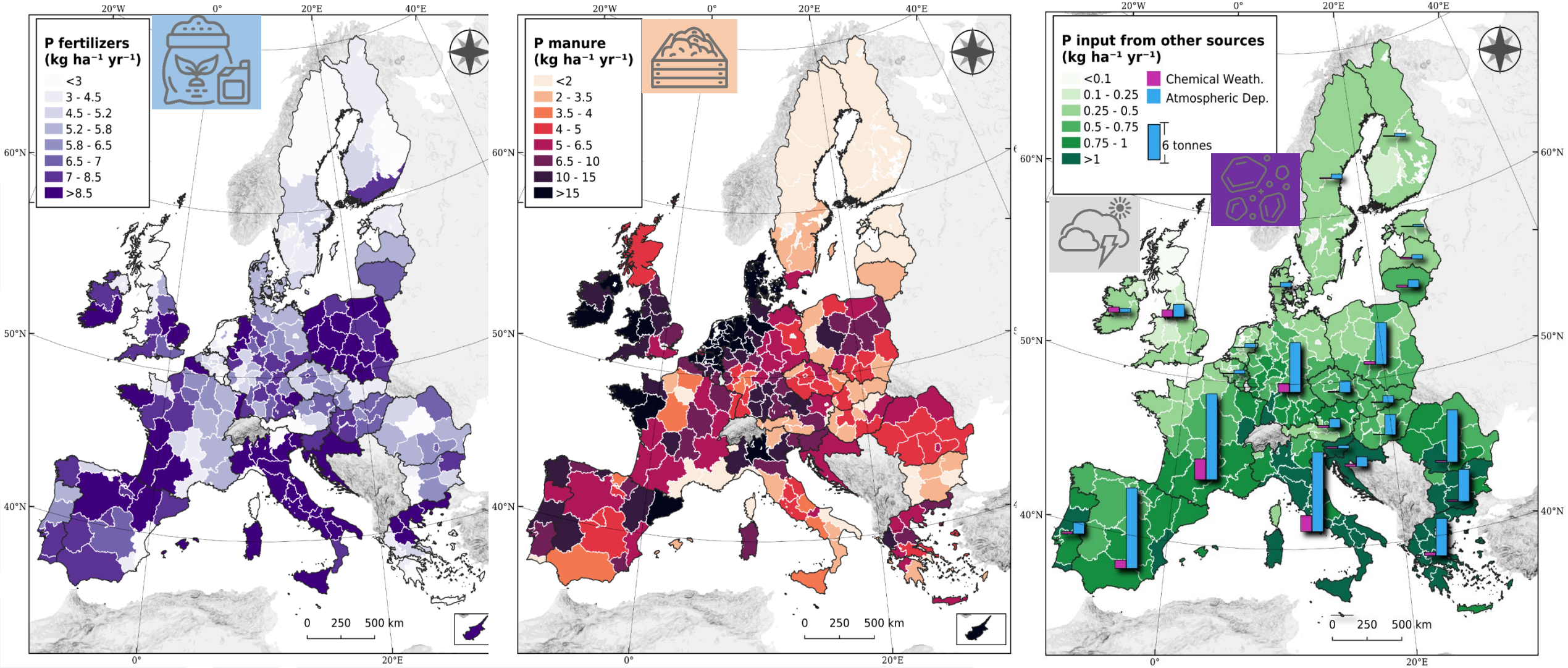
Phosphorus budget

How we estimate the budget: using the latest state of the art datasets at best available spatial resolution (Regions)

Use of improved **Empirical Model Phosphorus Balance (EMPBa)**

- Inputs: inorganic fertilizers, manure, atmospheric deposition, and chemical weathering
- Outputs: crop production, plant residues removal, losses by erosion

P inputs in agricultural soils

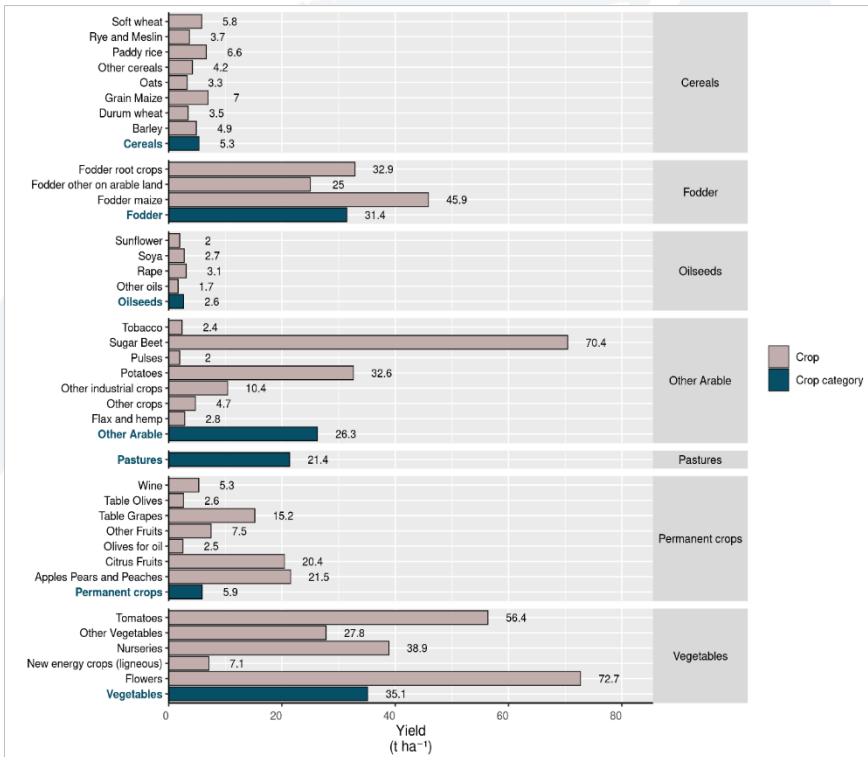


Inorganic fertilizers and manure contribute almost equally to P inputs (Total: 96%).
Atmospheric Deposition & Chemical weathering: minor inputs

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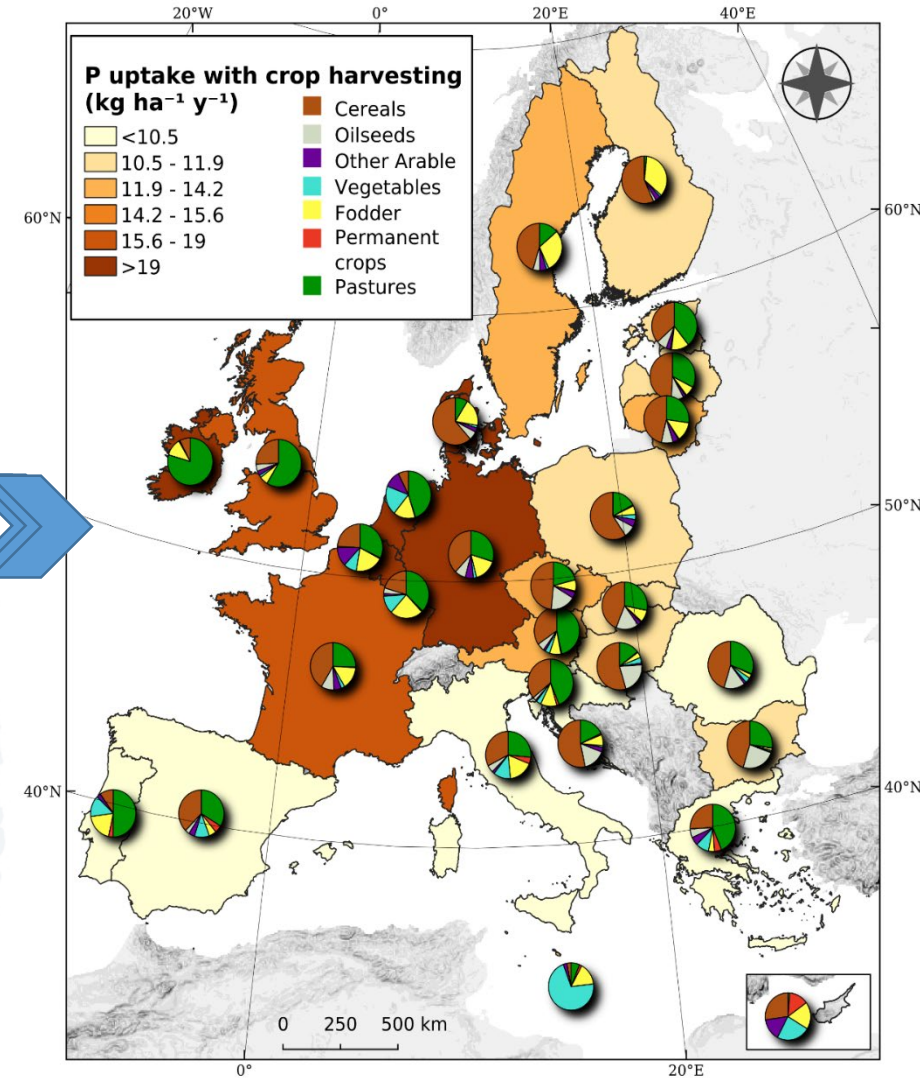
P outputs by crop harvesting



Mean annual crop productivity (t ha⁻¹)

Humidity rates (%) per crop and region

Agricultural utilized area per crop and region



Literature review of Phosphorus concentration in plant tissue as dry production

Phosphorus plant removal from European agricultural land

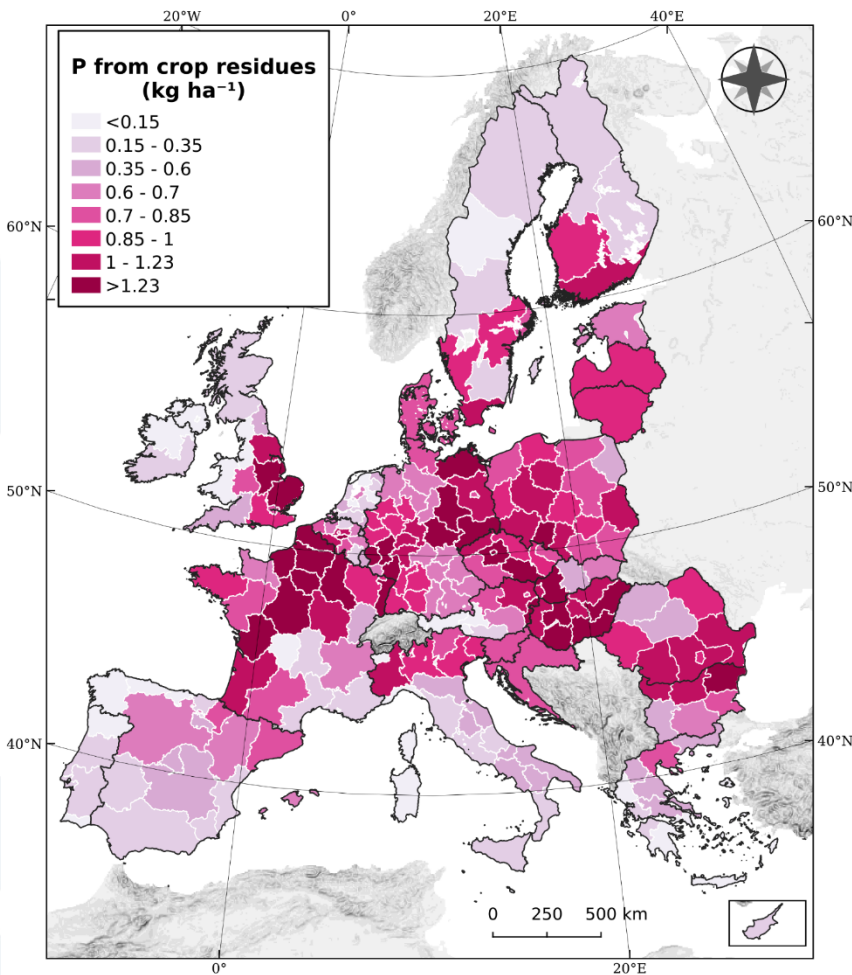
Table 1 Phosphorus concentration of marketable crop products (based on literature reviews)

	P concentration (%) on dry matter yield (Pc)	Standard deviation (SD of Pc)	No of samples	References	Comment
<i>Cereals</i>					
Soft wheat	0.3559	0.0594 ^a	332	Gallet et al. (2003), Sauvant et al. (2004), Piccoli et al. (2021) and Ehler et al. (2009)	
Durum wheat	0.3881	0.0571 ^b	1	Sauvant et al. (2004)	
Rye and meslin	0.3597	0.0023 ^a	52	Sauvant et al. (2004) and Ehler et al. (2009)	
Barley	0.4058	0.0245 ^a	289	Gallet et al. (2003), Sauvant et al. (2004) and Ehler et al. (2009)	
Oats	0.4392	0.0076 ^a	102	Sauvant et al. (2004) and Ehler et al. (2009)	
Grain maize	0.2380	0.0484 ^a	317	Sauvant et al. (2004), Fageria et al. (2013), Piccoli et al. (2021) and Giardini (2002)	
Other cereals	0.3559	0.0594 ^a	332	Gallet et al. (2003), Sauvant et al. (2004) and Ehler et al. (2009)	Similar to wheat

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P outputs by Crop residues

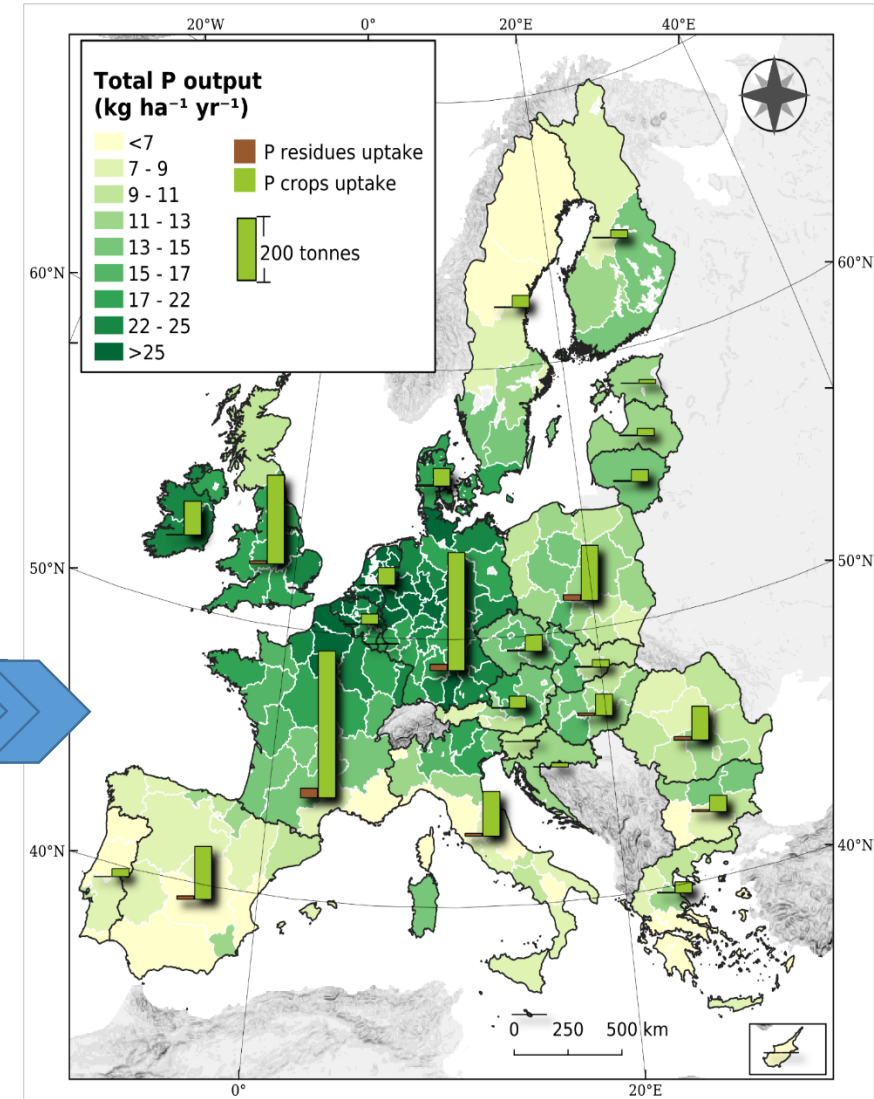
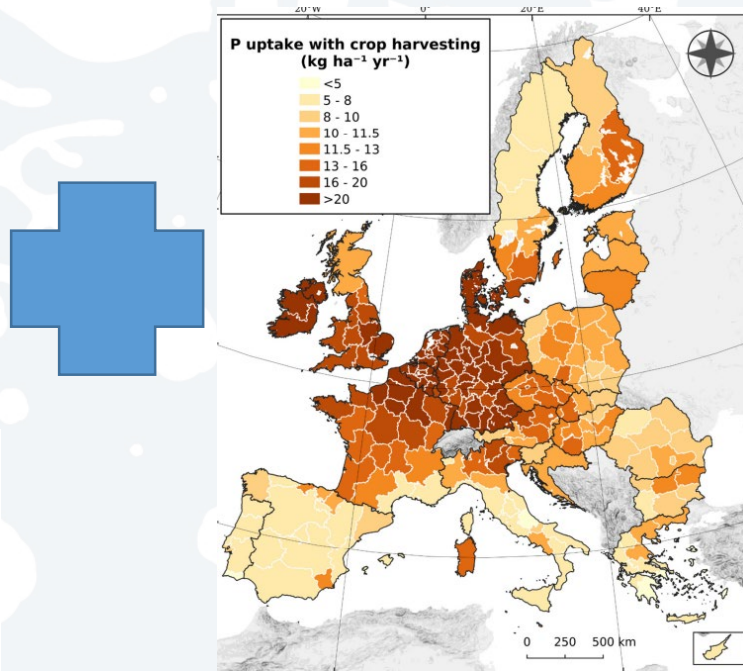


Mean annual crop productivity (t ha⁻¹)

Residue production per tonne of crop production

Ratio of residue removal from the field

P concentration of residues



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RESEARCH ARTICLE

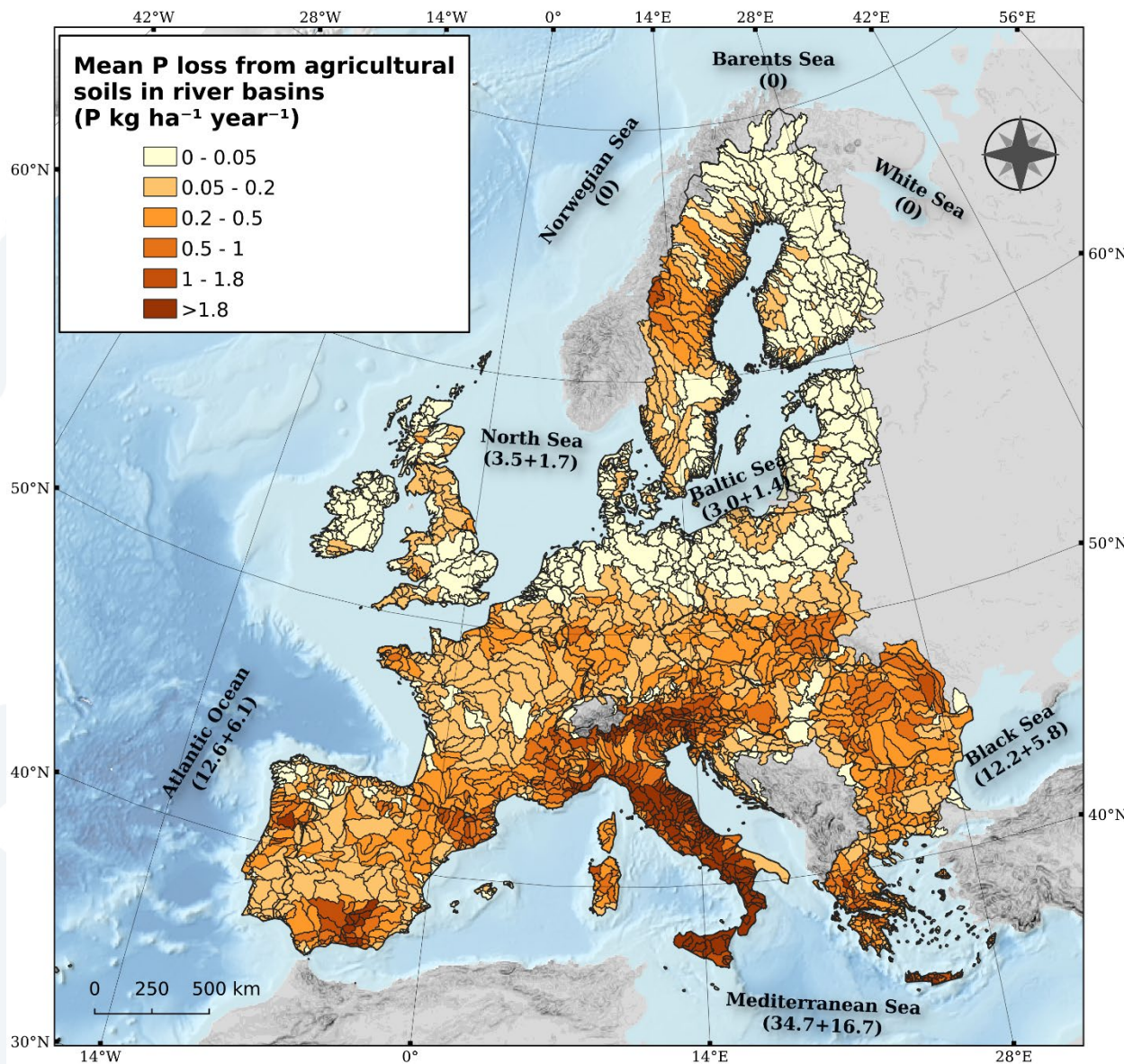
Phosphorus plant removal from European agricultural land

Panos Panagos¹ · Anna Muntwyler¹ · Leonidas Liakos¹ · Pasquale Borrelli² · Irene Blavetti¹ · Marlia Bogonos³ · Emanuele Lugato¹

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P losses by water erosion



P Total stocks in EU agricultural soils (Source: LUCAS)

A sediment distribution model (WATEM/SeDEM)

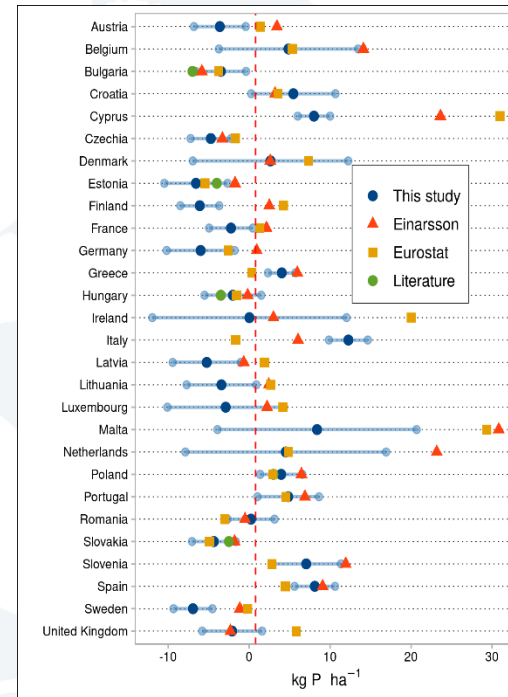
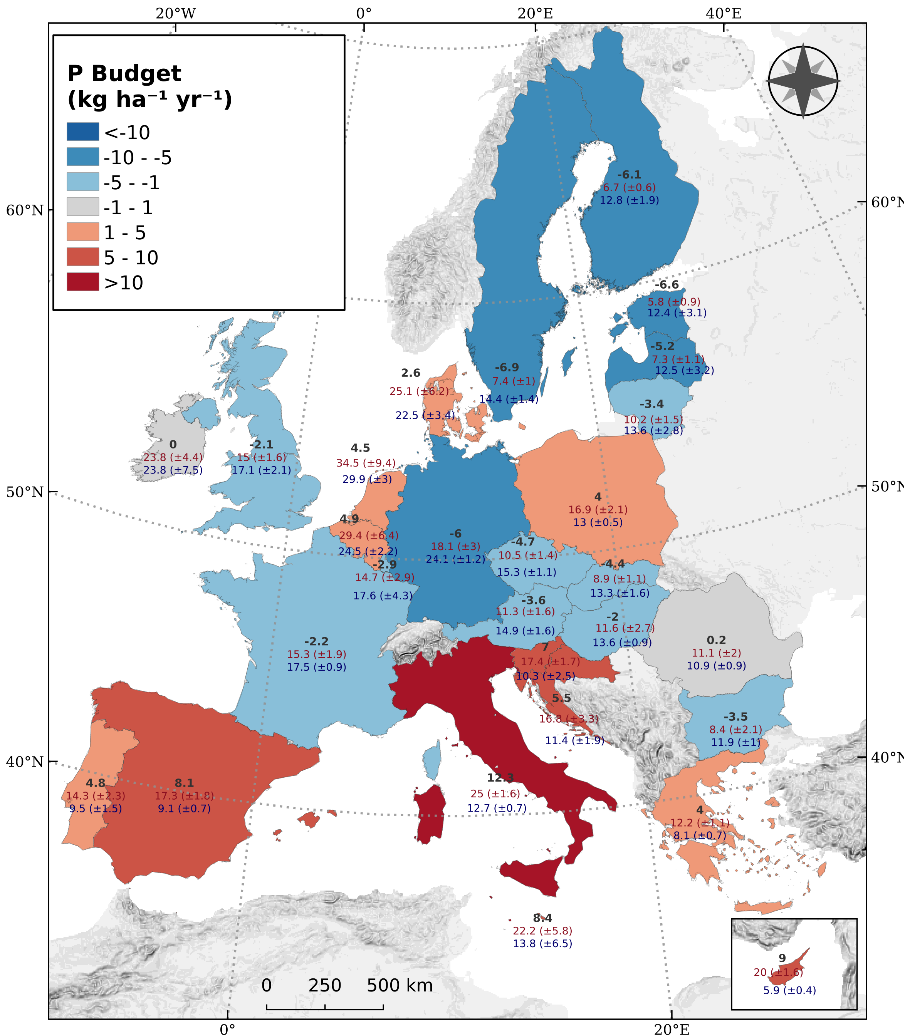
Catchment delineation: 6,000 in EU (source: CCM)

Phosphorus routed in rivers and sea outlets is a small portion compared to the total P displaced

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Phosphorus budget (data validation - uncertainties)



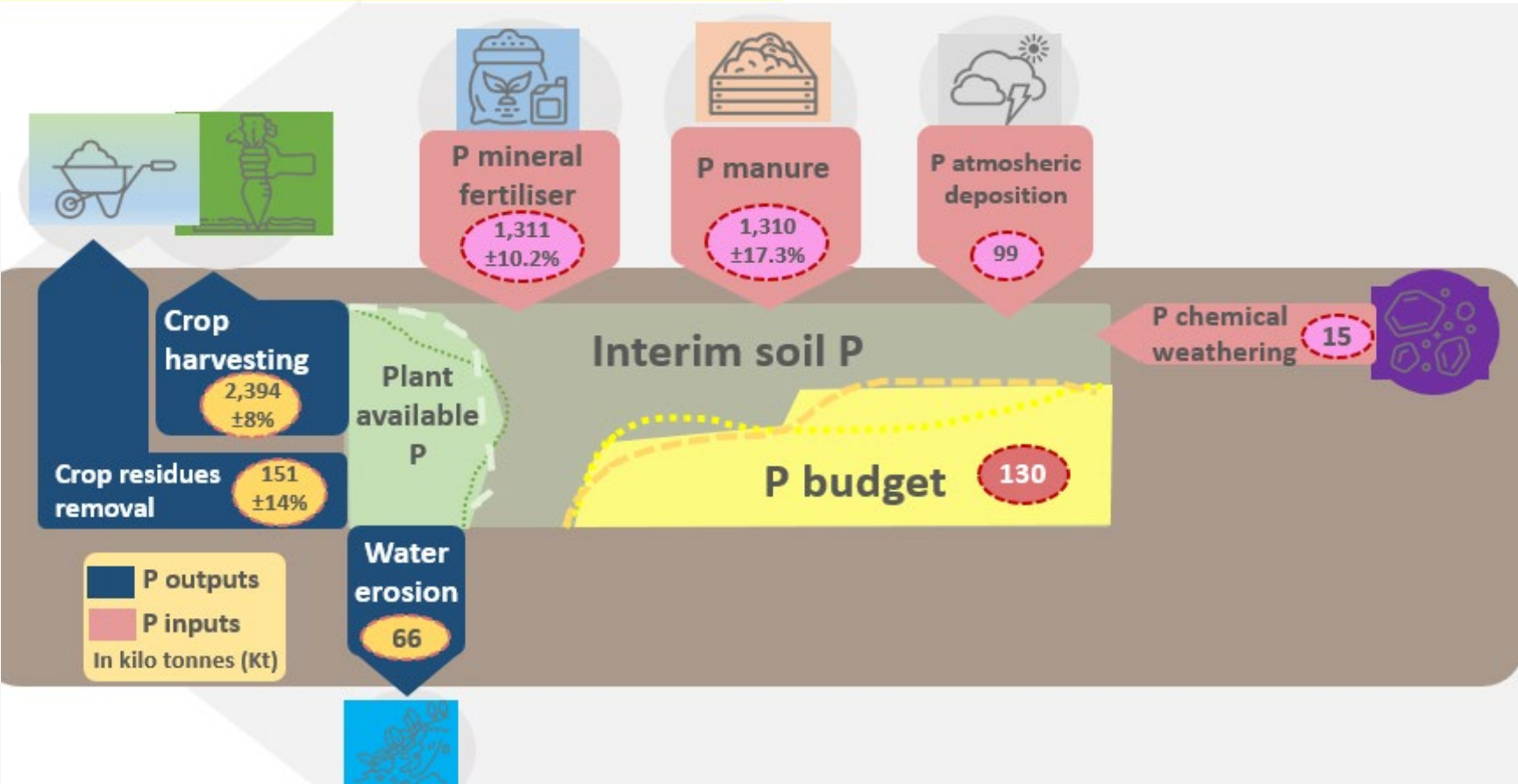
Compared with other sources: Recent study of Einarsson (pan-European), EUROSTAT statistics, Literature studies

High uncertainties:

- Lack of spatial data on P inorganic fertilizers
- Livestock excretion rates for phosphorus
- Annual variability in crop production, humidity rates, and the P concentration of plant tissues

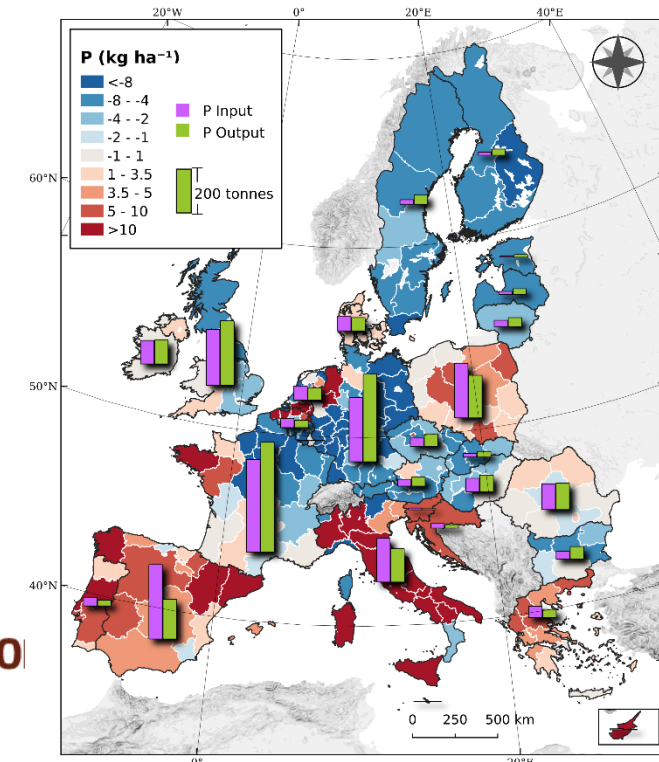
P budget currently omits two inputs (P solubilisation of microorganisms, P content in seed) and one output (burned plant residues)

Phosphorus budget: aggregated results



In the EU and UK, we estimated an average surplus of $0.8 \text{ kg P ha}^{-1} \text{ yr}^{-1}$ with high variability between countries & some regional variations

Ample possibility to improve P management at regional scale by reducing inputs in regions with high surplus rebalancing fertilization



Use of this study in EU policy:

- Integrated Nutrient Management Plans
- Farm to Fork
- Zero Pollution Action Plan

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panos.panagos@ec.europa.eu

<http://esdac.jrc.ec.europa.eu>

@PanosPanagos33

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