Circle U.
European University Alliance
5 years!

How Healthy Are Water Resources in the Global Food Production System?

Christmas lecture

26/11/25

M. Vanclooster, UCLouvain – Earth and Life Institute

UCLouvain

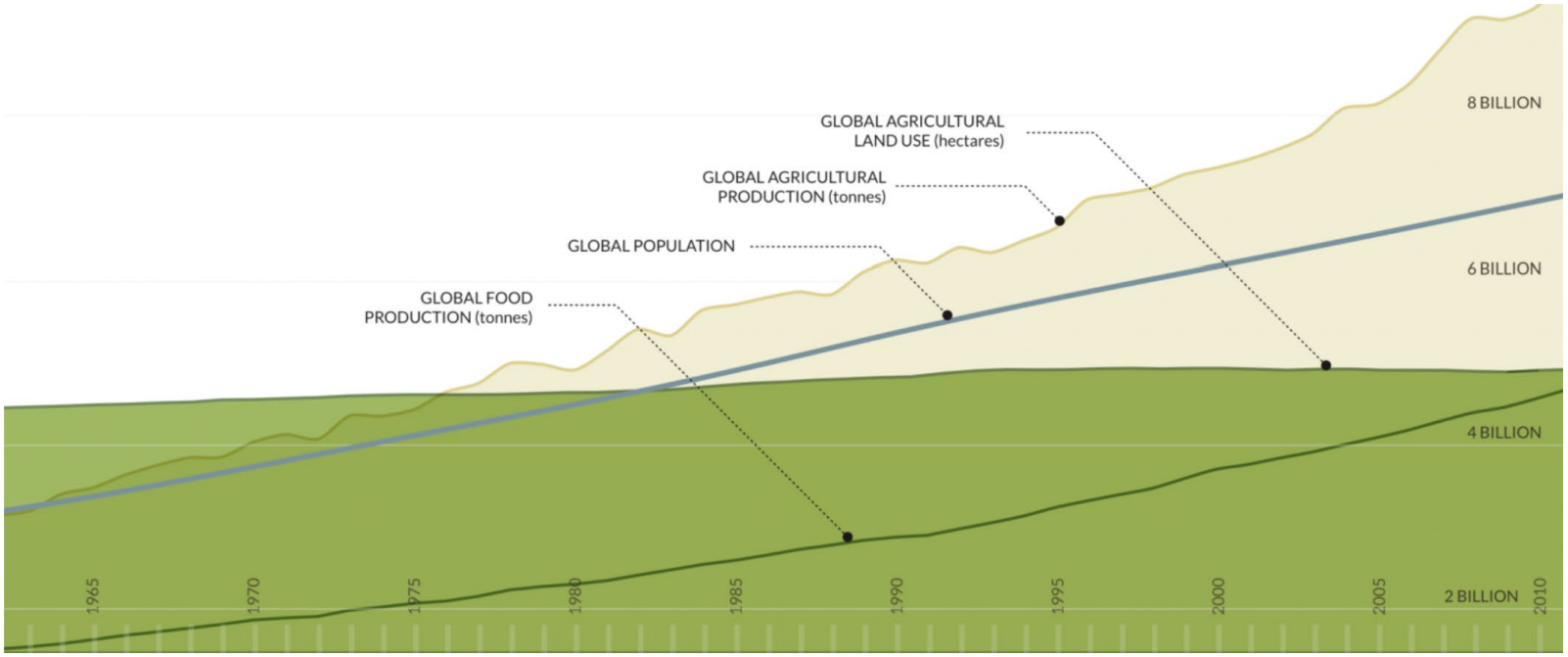
LOUVAIN Water

UCLouvain

Earth and Life Institute (ELI)

What are we going to eat at Xmas dinner?

How was/is food produced at the global scale during our life-time?



Source, FAO, 2015

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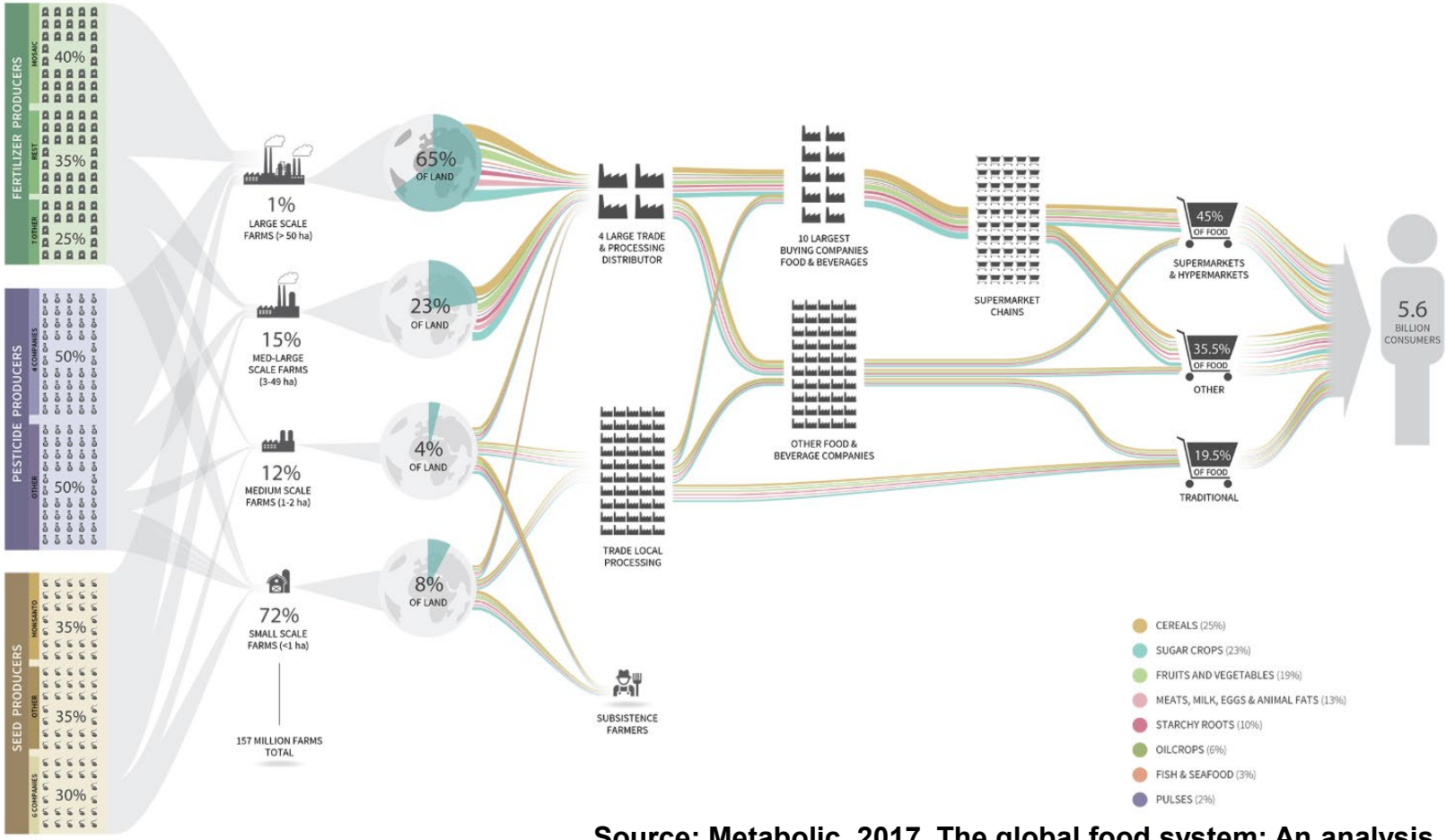
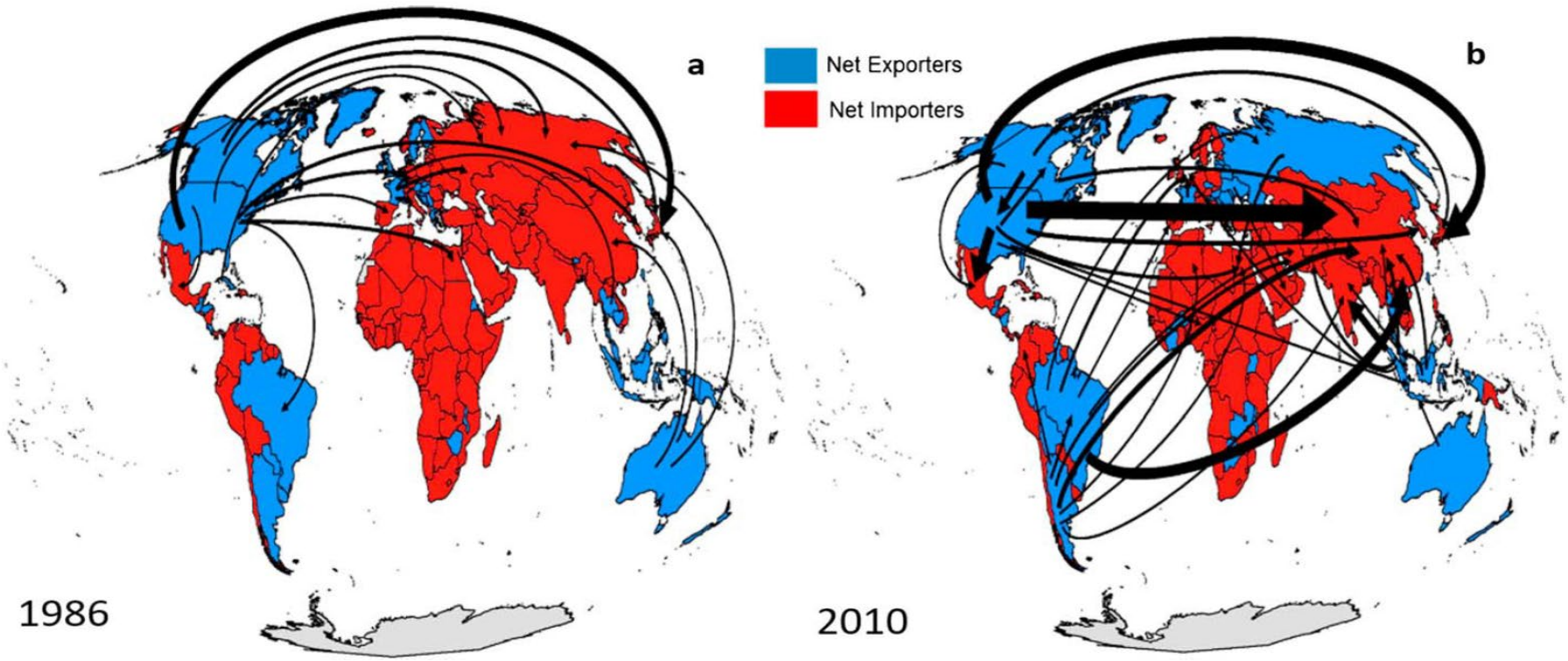
How is the global food system organised ?

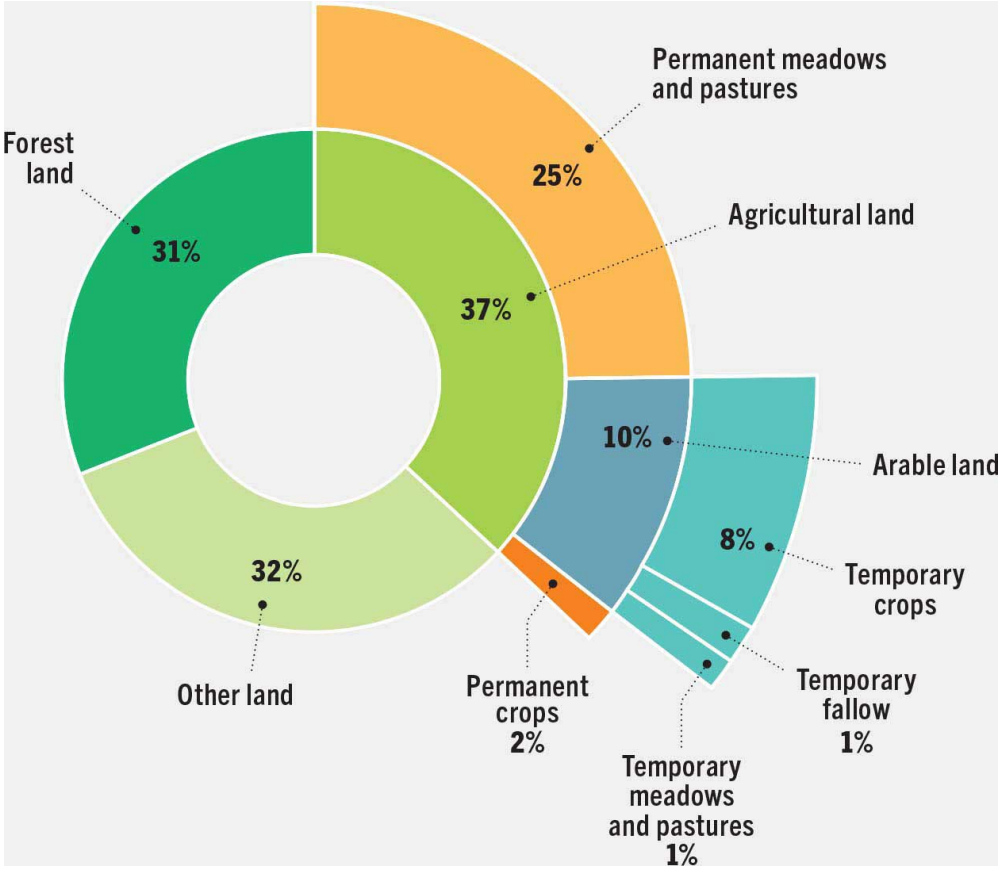


Source: Metabolic, 2017. The global food system: An analysis



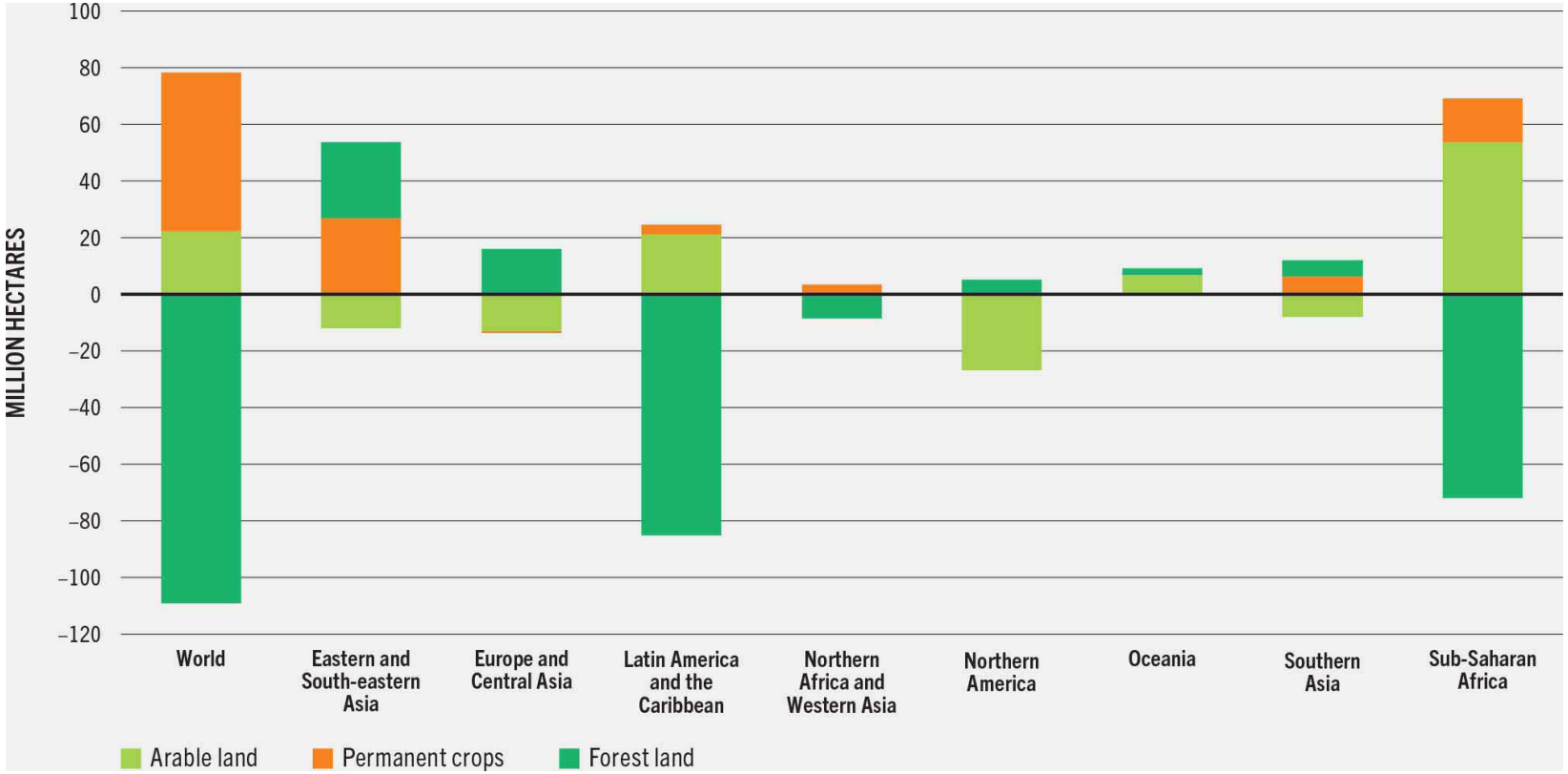
Source: D'Odorico and Mull 2014. Nature Geosciences

Land use



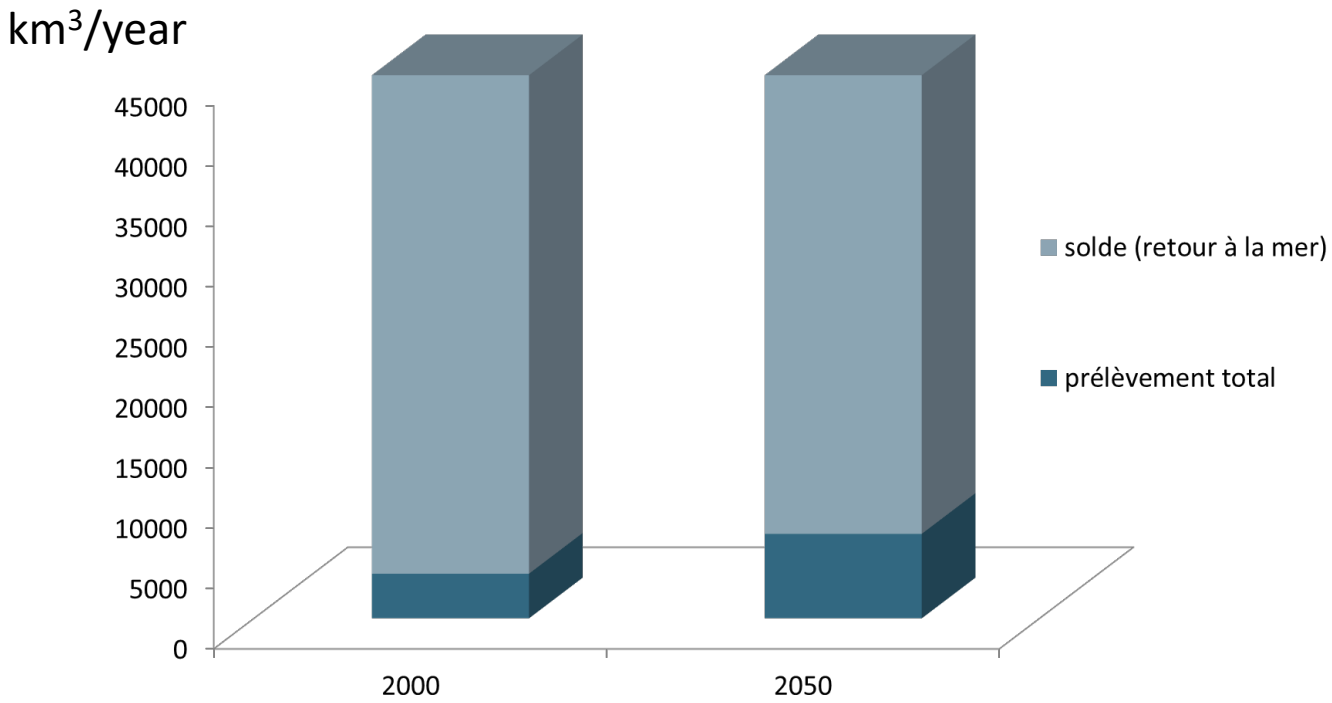
Source: FAO 2025. The state of food and agriculture 2025

Land use change (2001-2023)

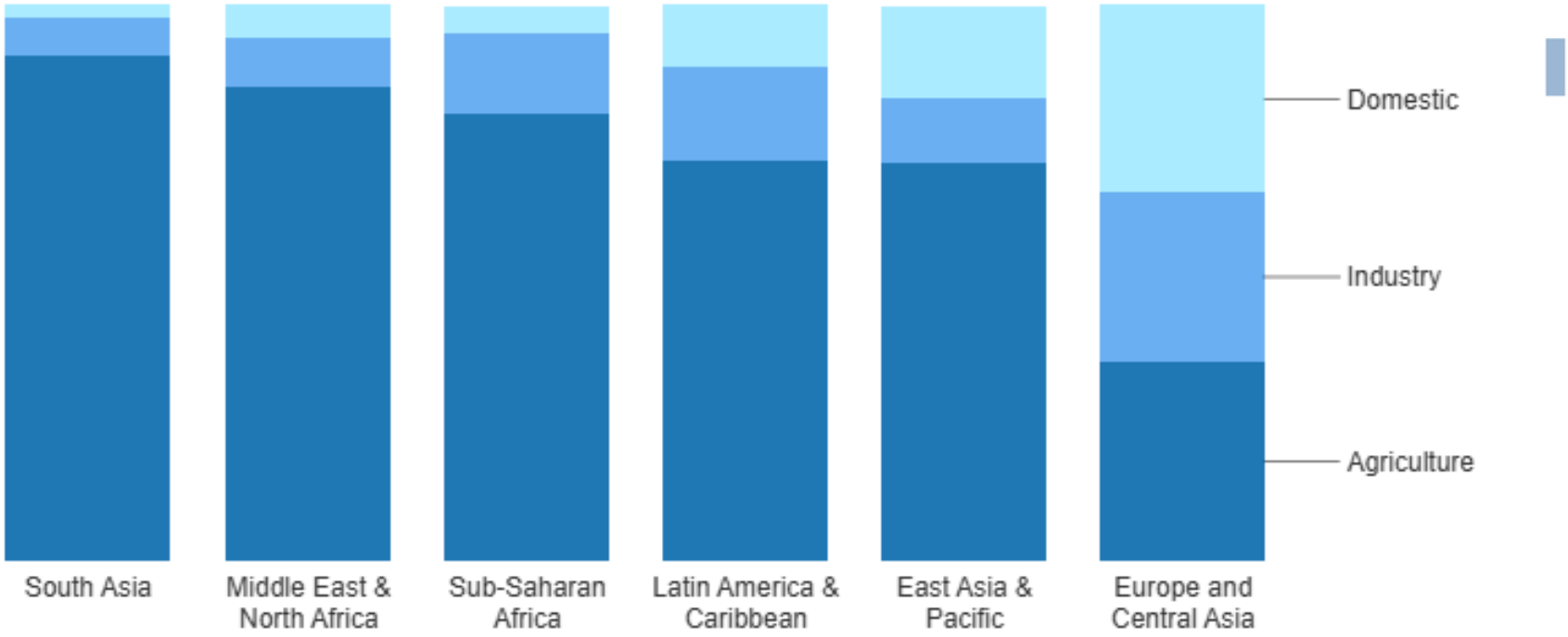


Source: FAO 2025. The state of food and agriculture 2025

Water use

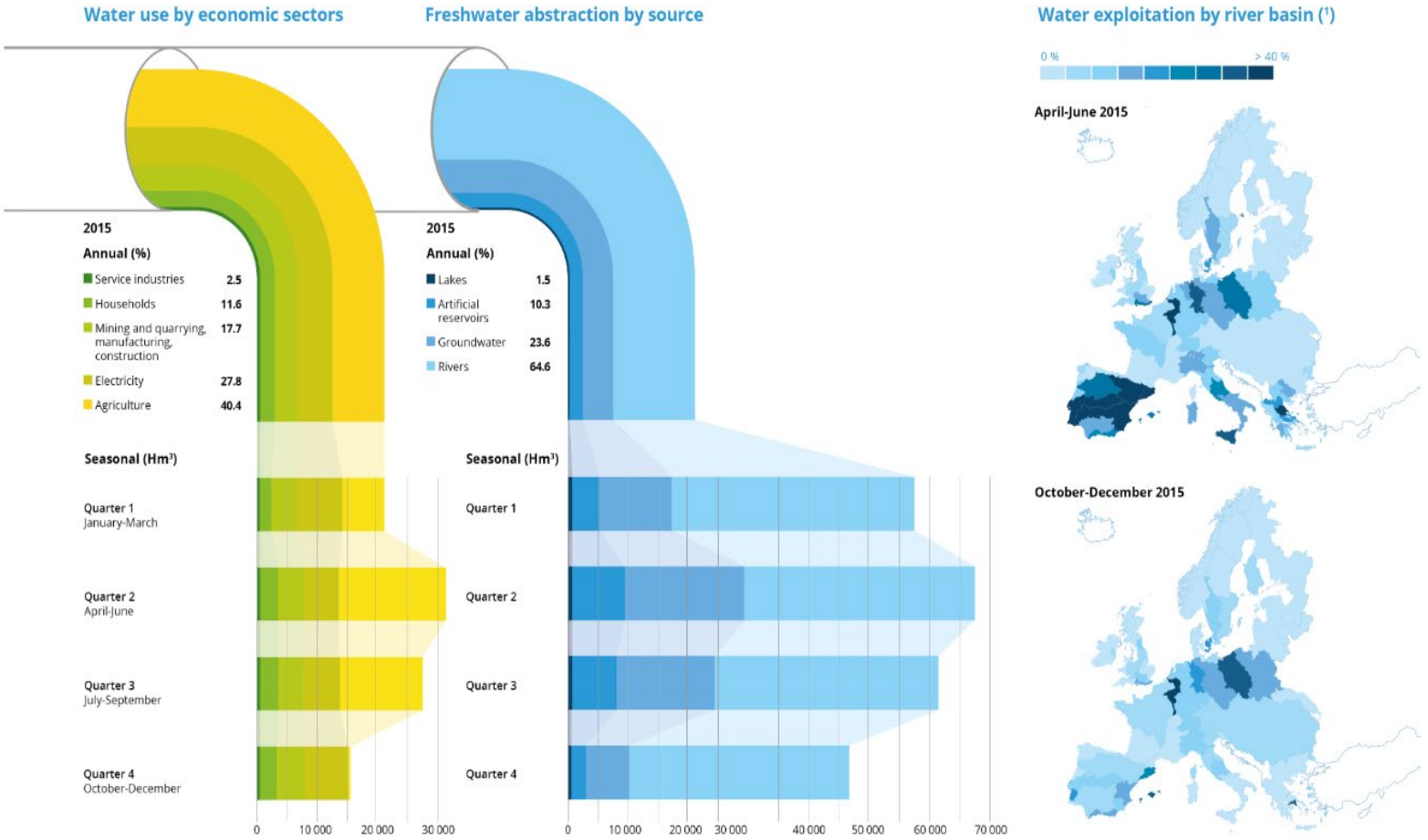

km3/year
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2000
2050
solde (retour à la mer)
prélèvement total

Water use



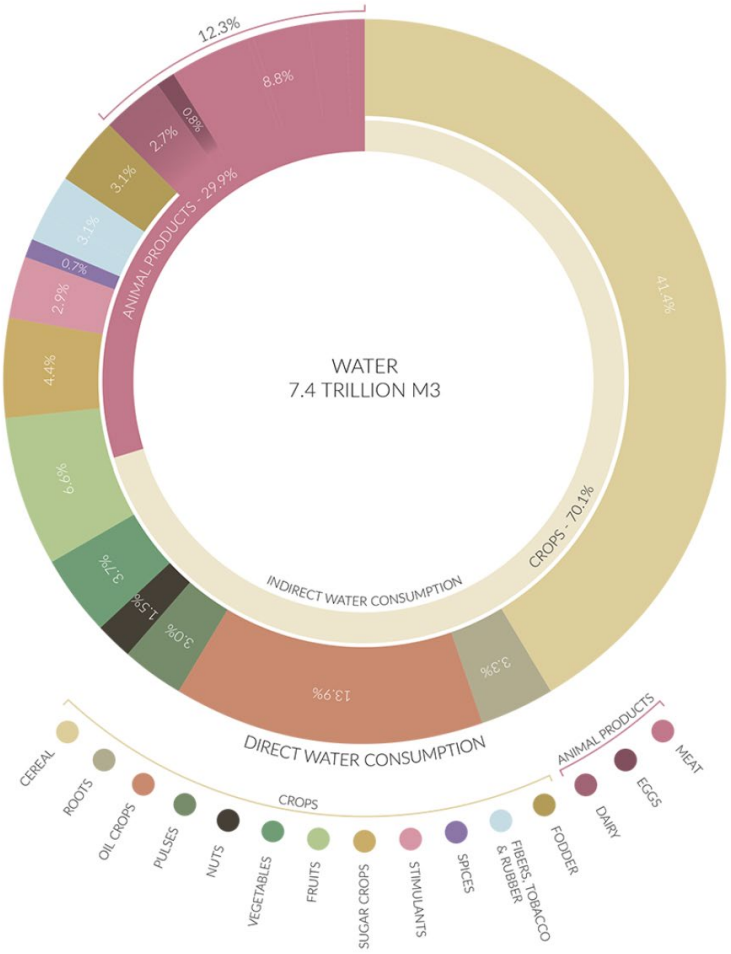
Source: World Development Indicators, Consulted on 10/11/25

Water use in Europe

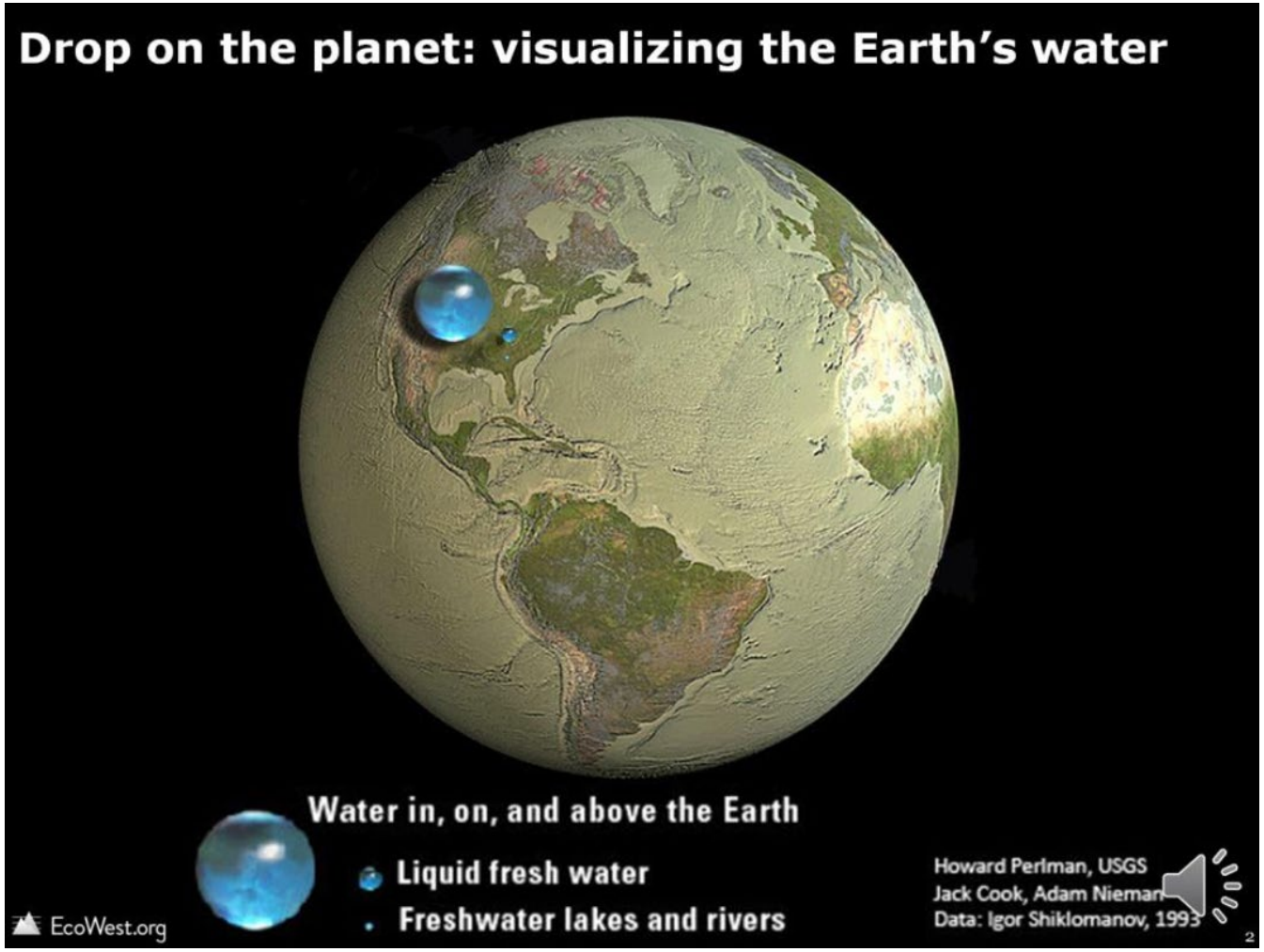


Source:Water use in Europe — Quantity and quality face big challenges, EEA, 2018 (update 2023)

Global water footprint for food production



Water use

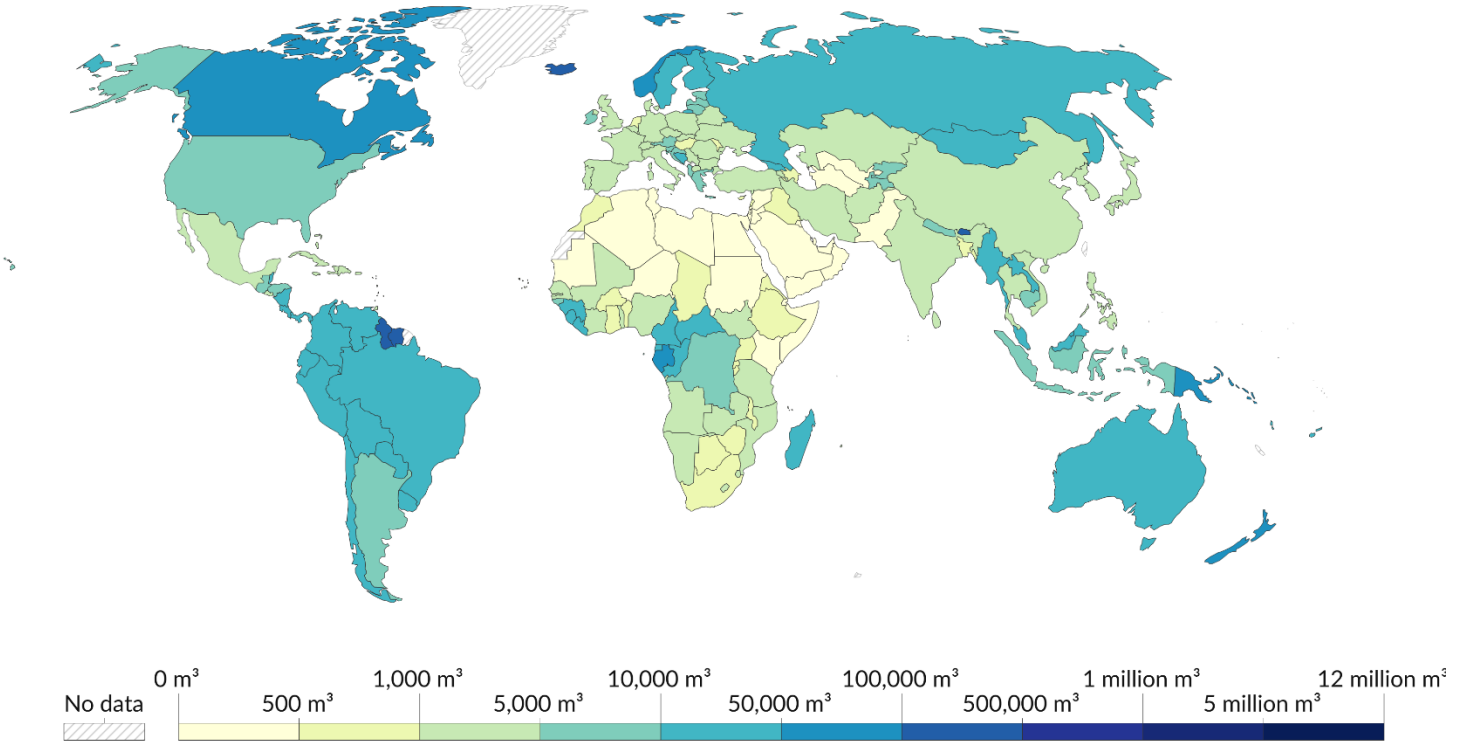

Drop on the planet: visualizing the Earth's water
Water in, on, and above the Earth
Liquid fresh water
Freshwater lakes and rivers
EcoWest.org
Howard Perlman, USGS
Jack Cook, Adam Nieman
Data: Igor Shiklomanov, 1993

Water stress at global scale

Renewable freshwater resources per capita, 2021

Our World in Data

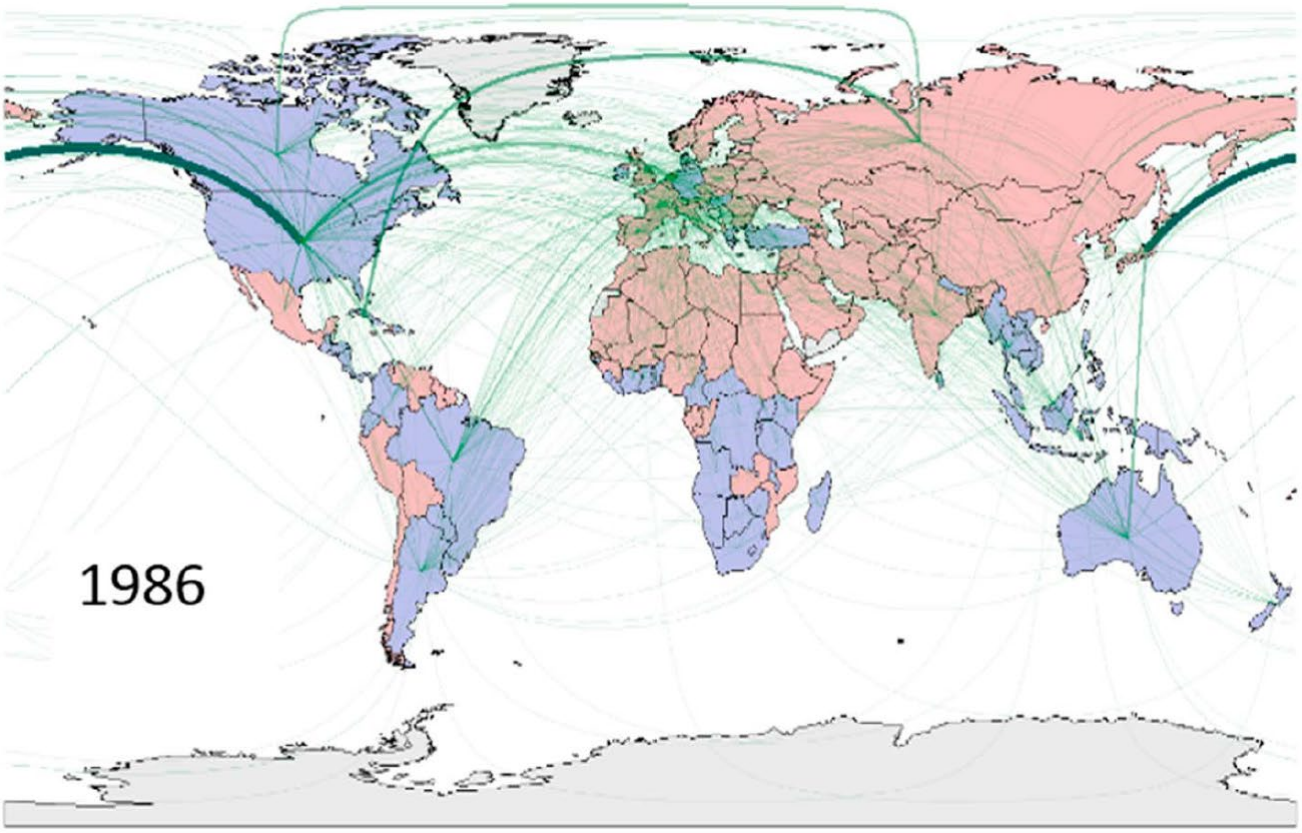
Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country.



Data source: Food and Agriculture Organization of the United Nations (via World Bank) (2025) OurWorldinData.org/water-use-stress | CC BY

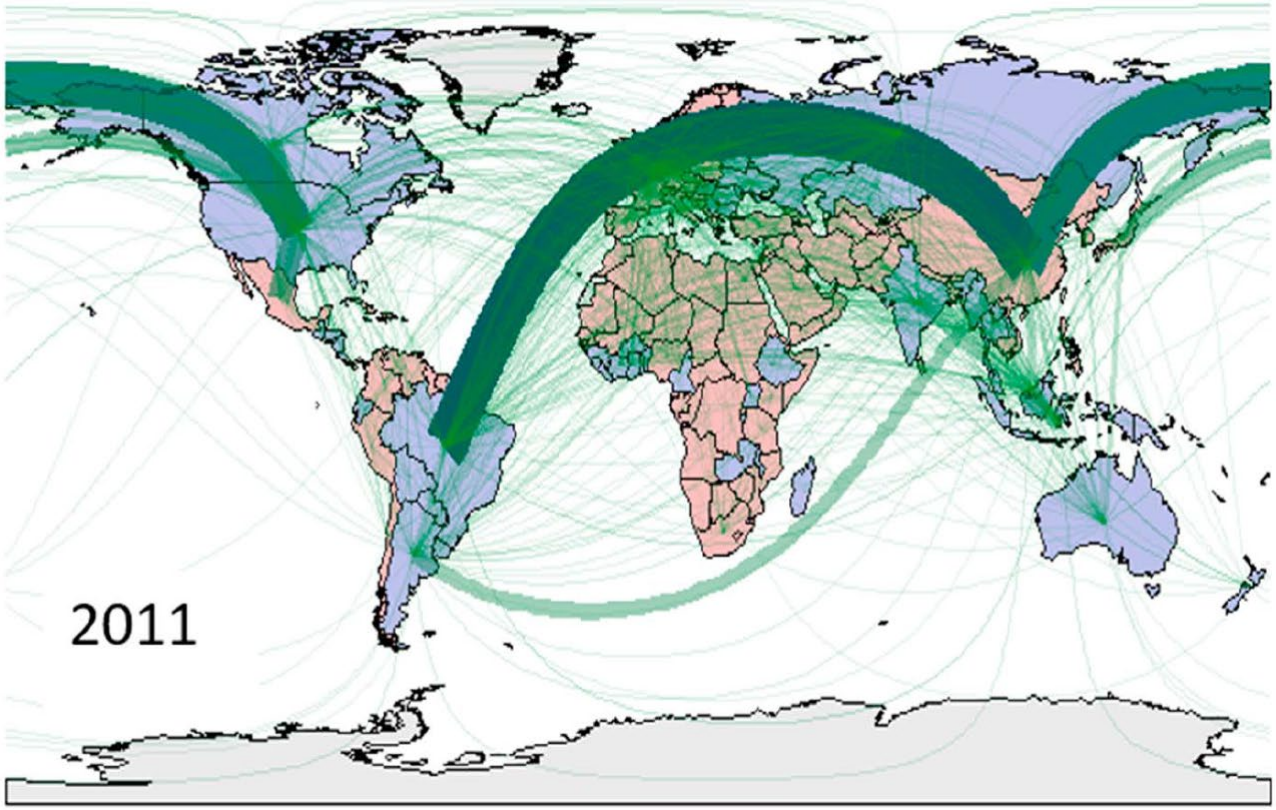
Source: https://ourworldindata.org/, 28/2/2025

Virtual water transport at global scale



Source: D'Odorico et al. 2018. Geophysical reviews

Virtual water transport at global scale



Source: D'Odorico et al. 2018. Geophysical reviews

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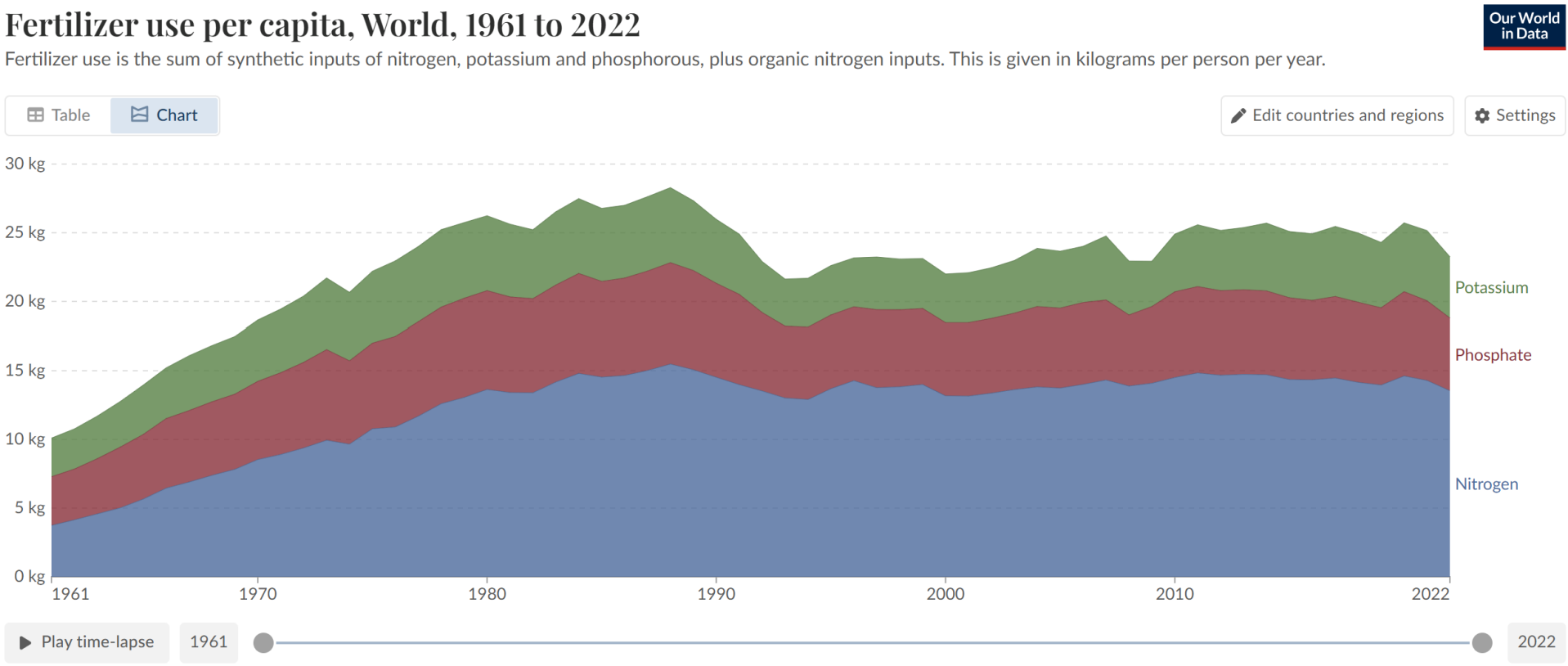
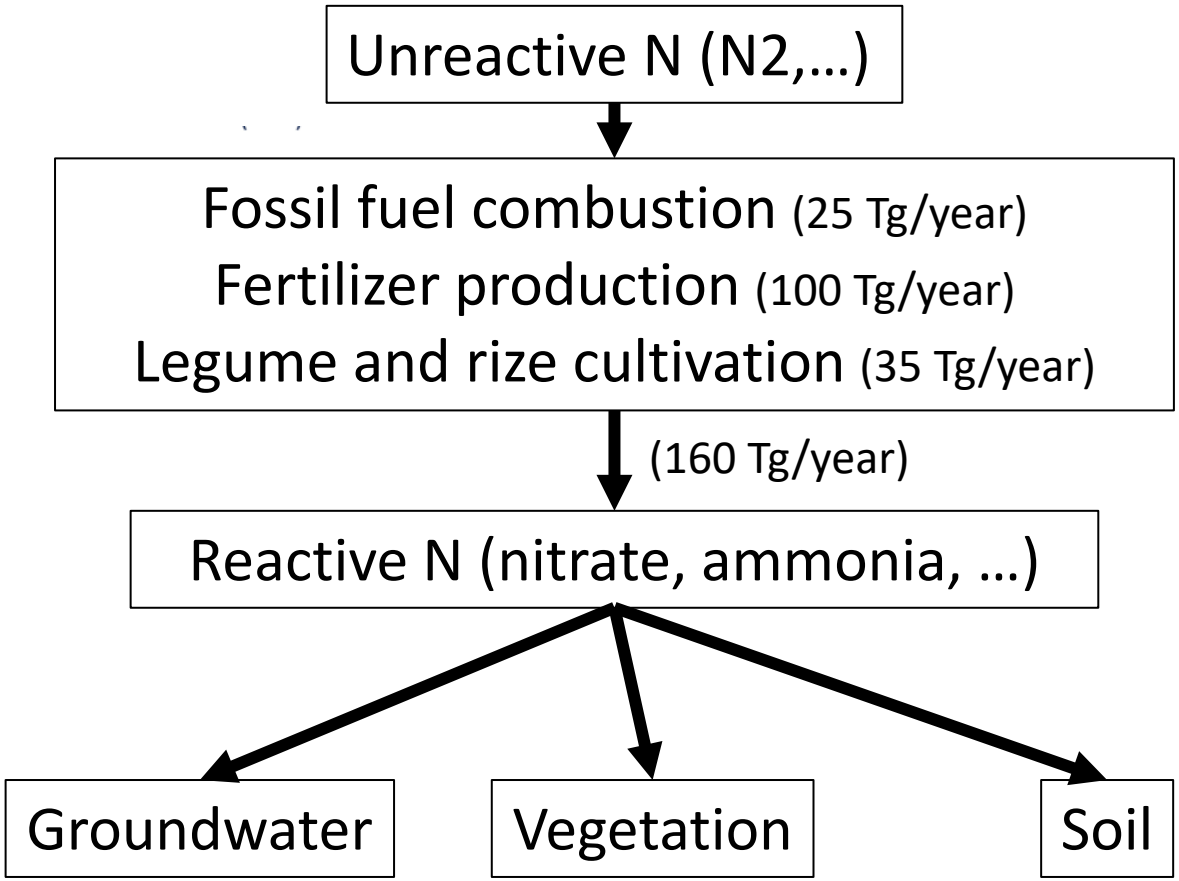
Fertilizer use

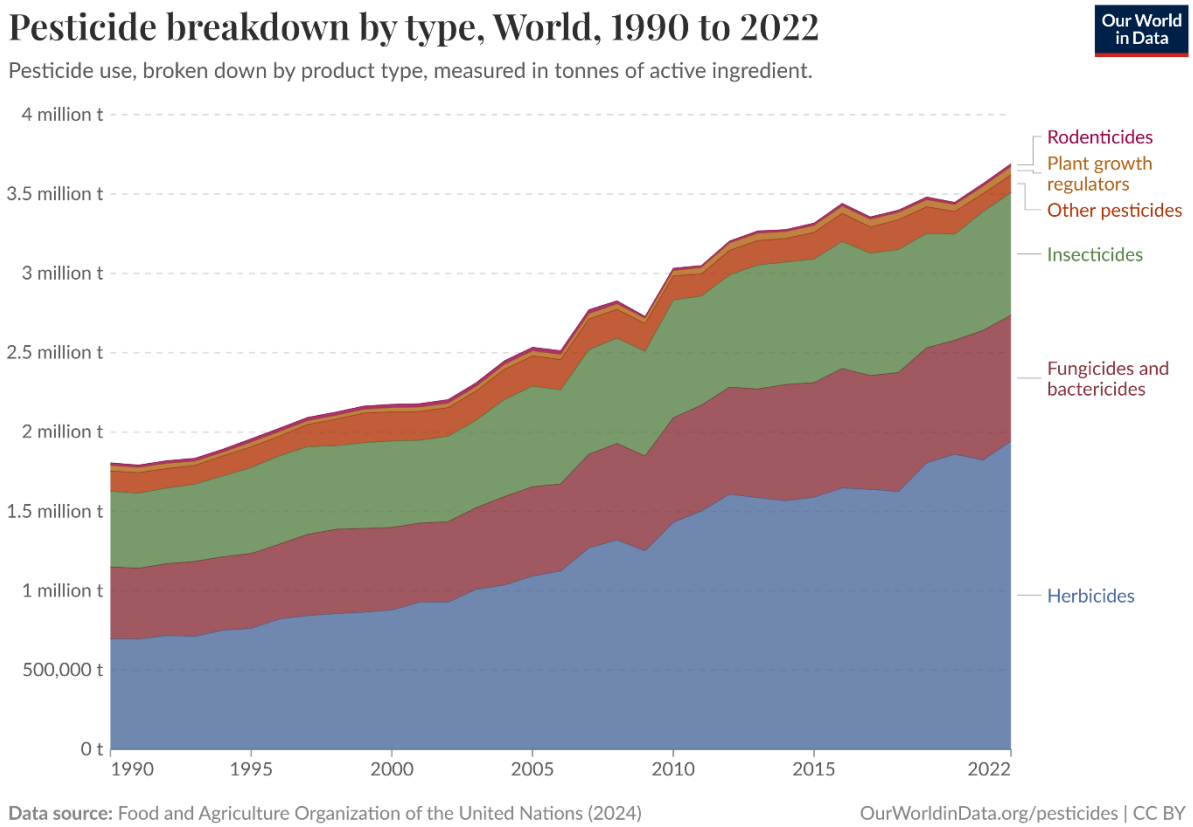


Source: Our world in Data, 2025 (Consulted on 21/11/25)

The N problem in a nutshell

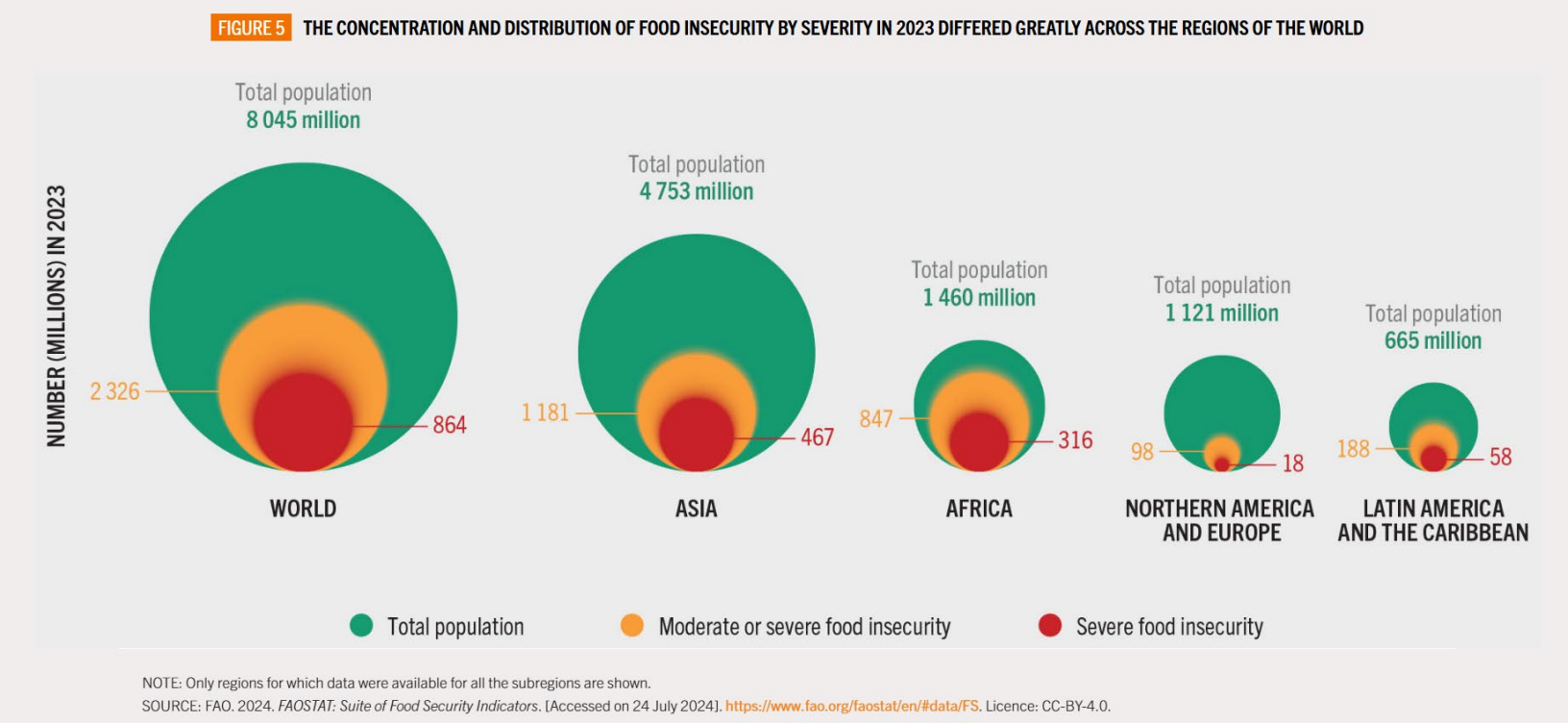


Plant protection products



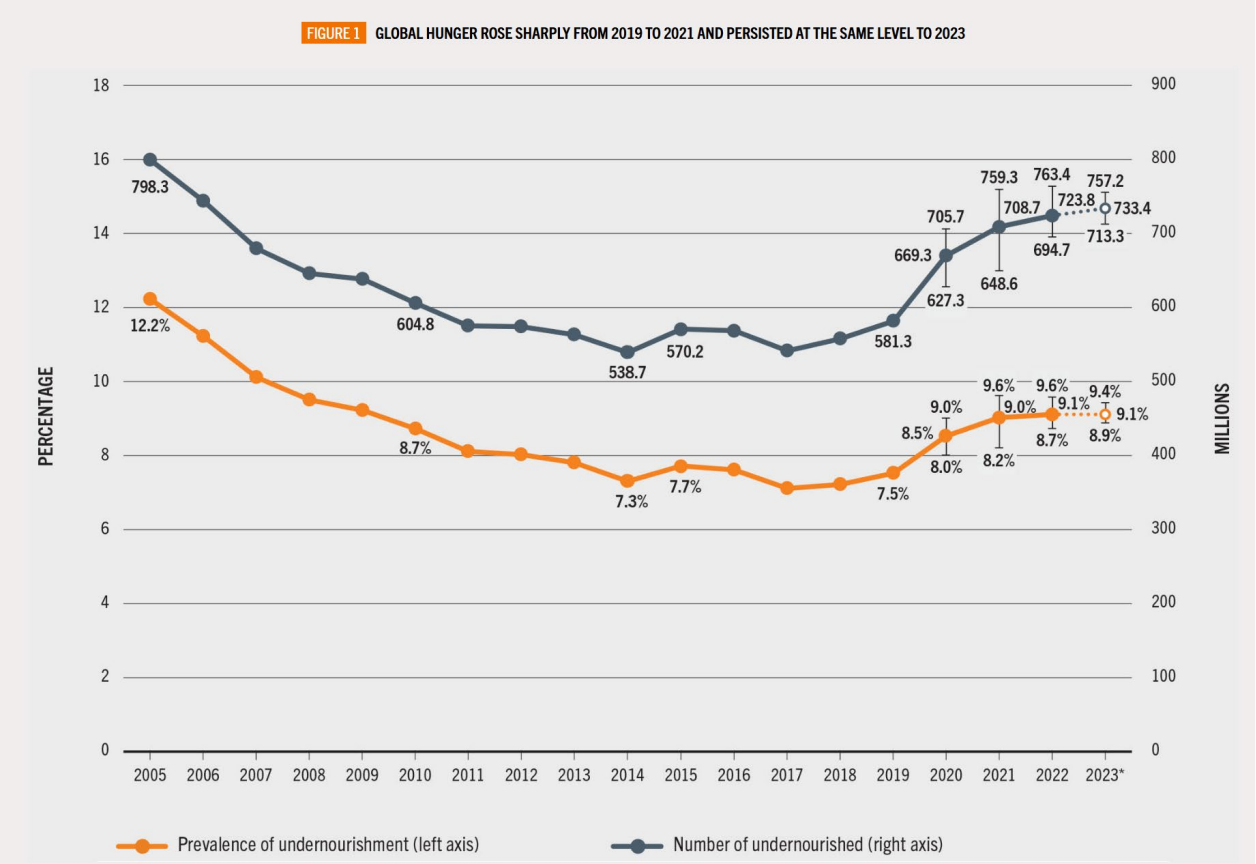
Source: Our Wold in Data, 2025 (Consulted on 16/11/25)

Not really a success story



Source: FAO,2024 The State of Food Security and Nutrition in the World 2024

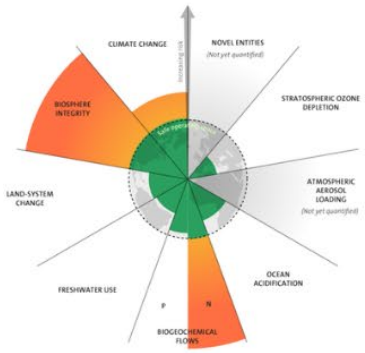
Not really a success story



Source: FAO,2024 The State of Food Security and Nutrition in the World 2024

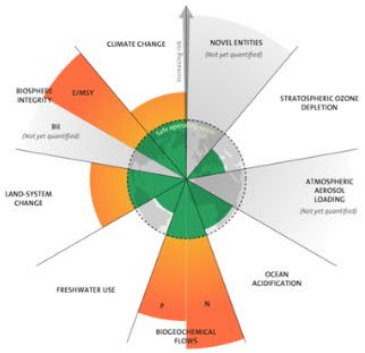
Not really a success story

2009



7 boundaries assessed,
3 crossed

2015

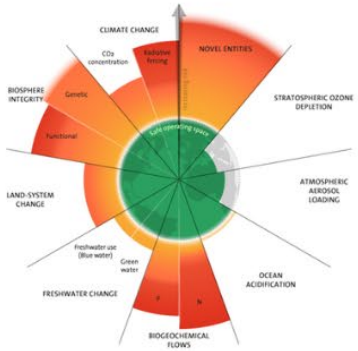


7 boundaries assessed,
4 crossed

2023

9 boundaries assessed,
6 crossed

2025



9 boundaries assessed,
7 crossed

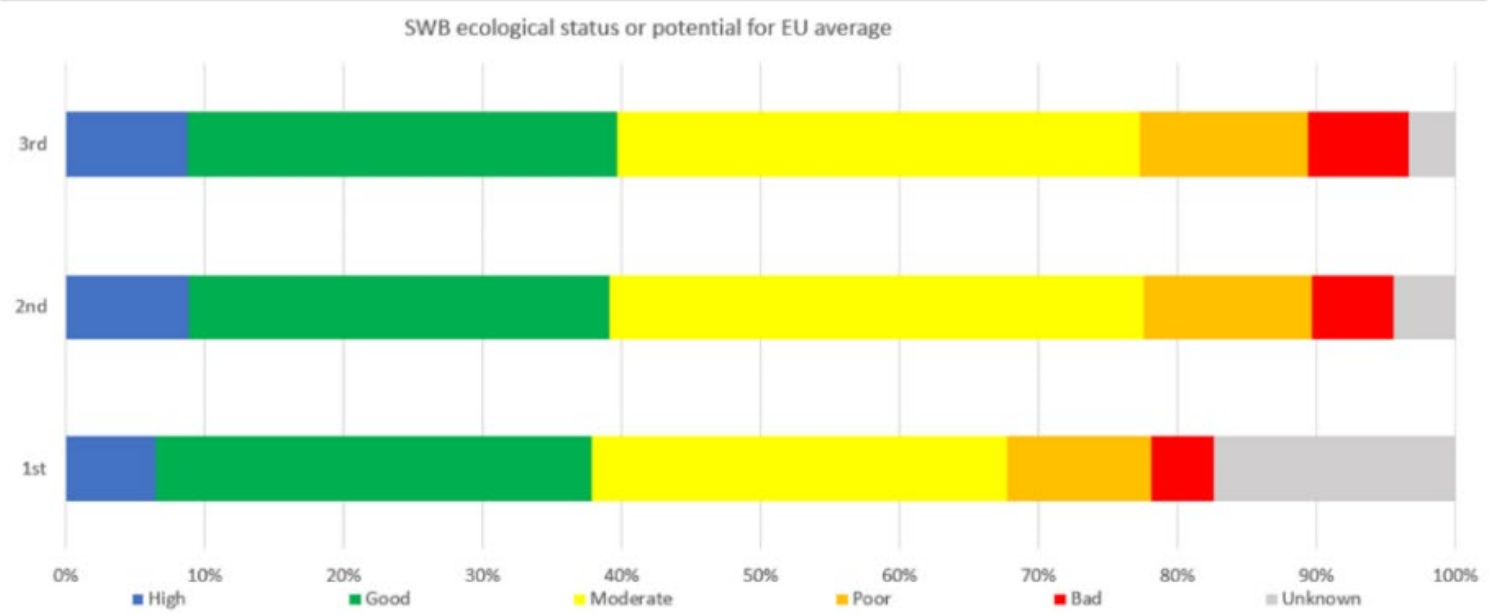
In the studies at ELI-UCLouvain

N studies at GERU

- Laftouhi N
- Sall M
- Fetouani S
- Mfumu A
- Vandervelde M
- Mattern S
- Leterme B
- Petit S
- Vanclooster M
- Vanclooster M
- Sangare S
- Chabaane S
- Bouklab M
- Bah A
- Batungwanyo P
- Douze Manouche
- Voahangininirina H

In Europe

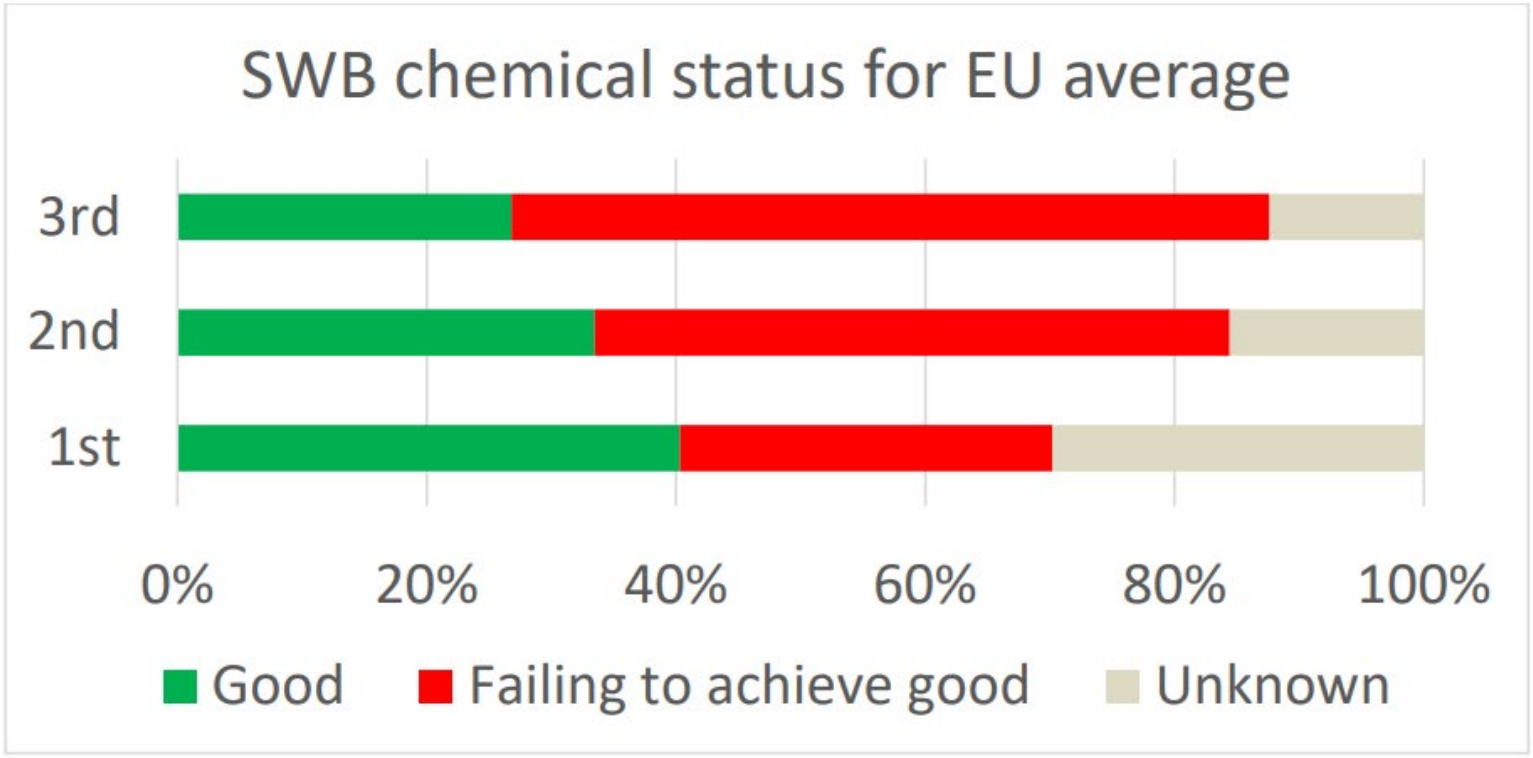
Figure 3-5. Change in ecological status assessment of EU's surface water bodies from first, second and third RBMPs (source: WISE freshwater and PDF data mining)



Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

In Europe

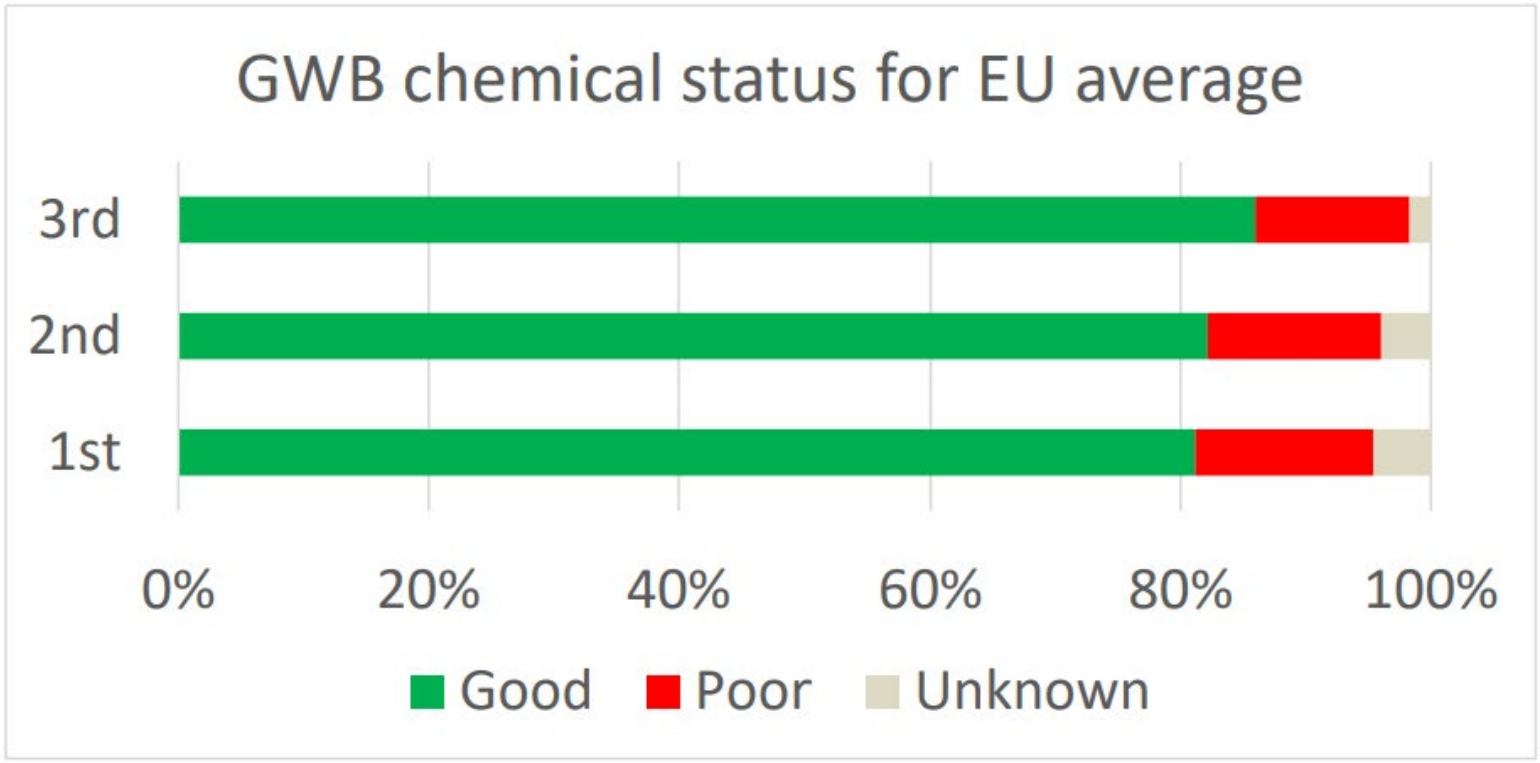
Figure 3-22. Change in the chemical status assessment of EU surface water bodies from the first, second and third RBMPs (all substances including uPBTs) (source: WISE freshwater and PDF data mining)



Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

In Europe

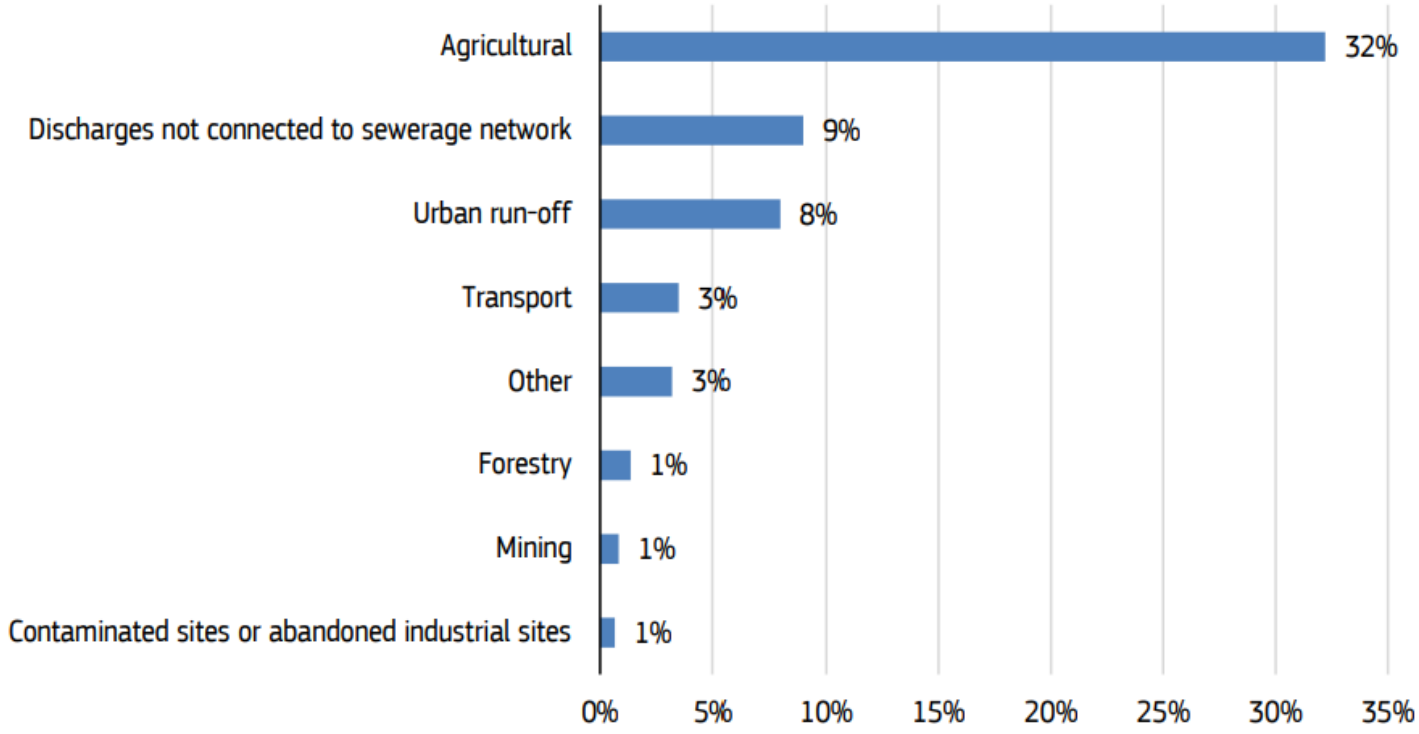
Figure 3-26. Change in the chemical status assessment of EU groundwater bodies from the first, second and third RBMPs (source: WISE freshwater and PDF data mining)



Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

In Europe

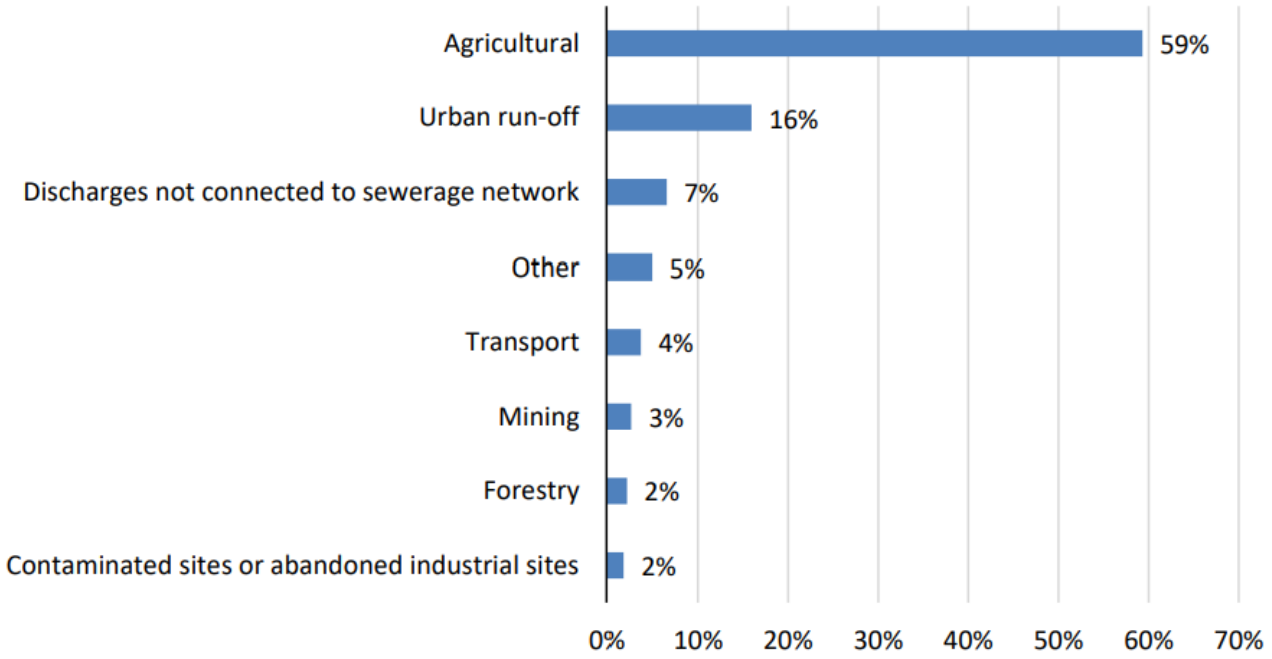
Figure 2-6a: Diffuse pollution pressures for surface water bodies in 3RBMPs (from WISE Freshwater – only countries with electronic reporting)



Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

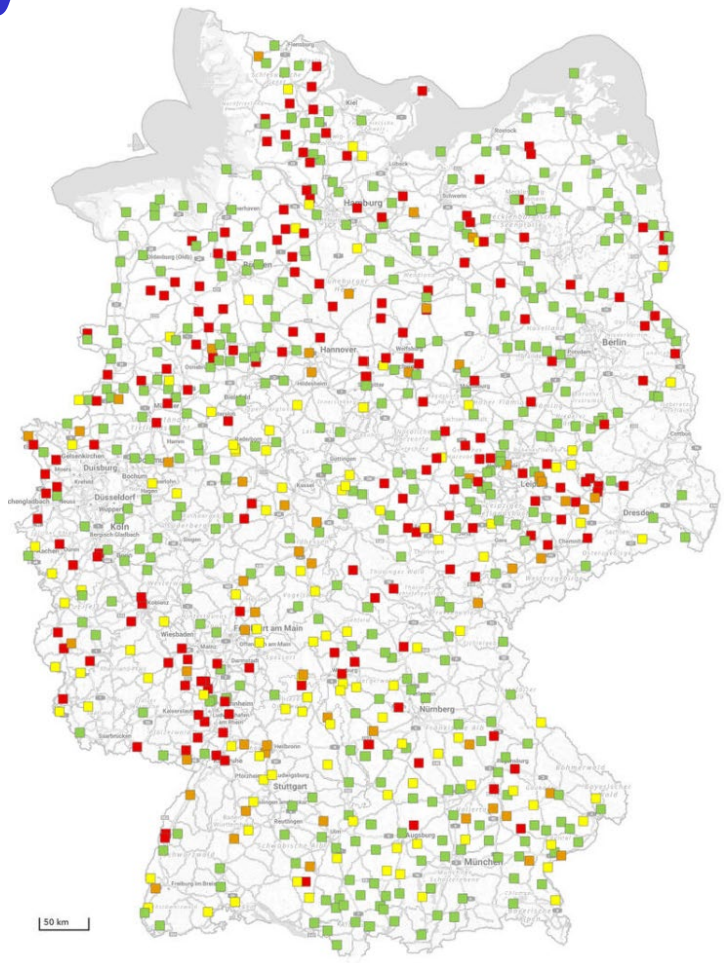
In Europe

Figure 2-7a: Diffuse pollution pressures for groundwaters in the third RBMPs (from WISE Freshwater – only countries with electronic reporting)



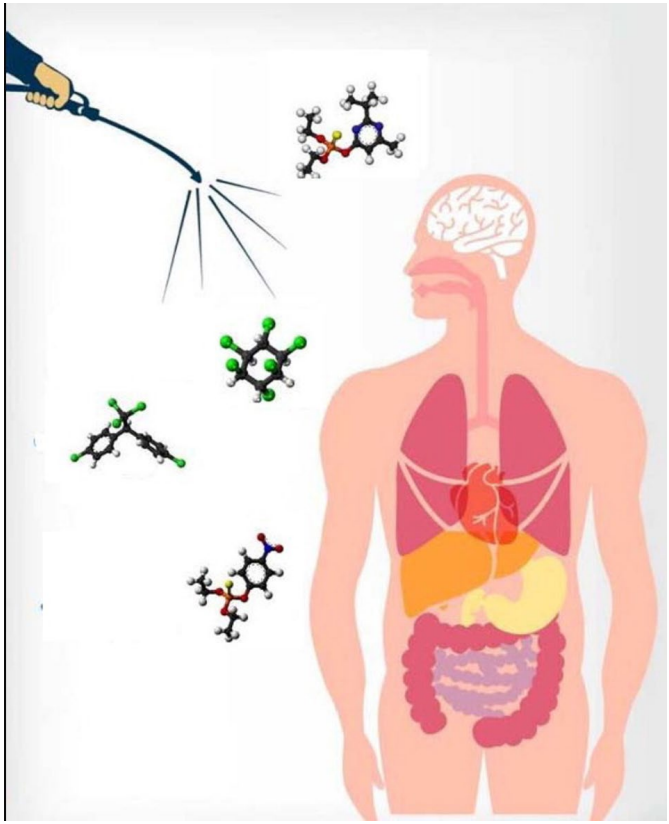
Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

In Germany



Source: Melkveebedrijf.nl. Consulted on 22/11/25

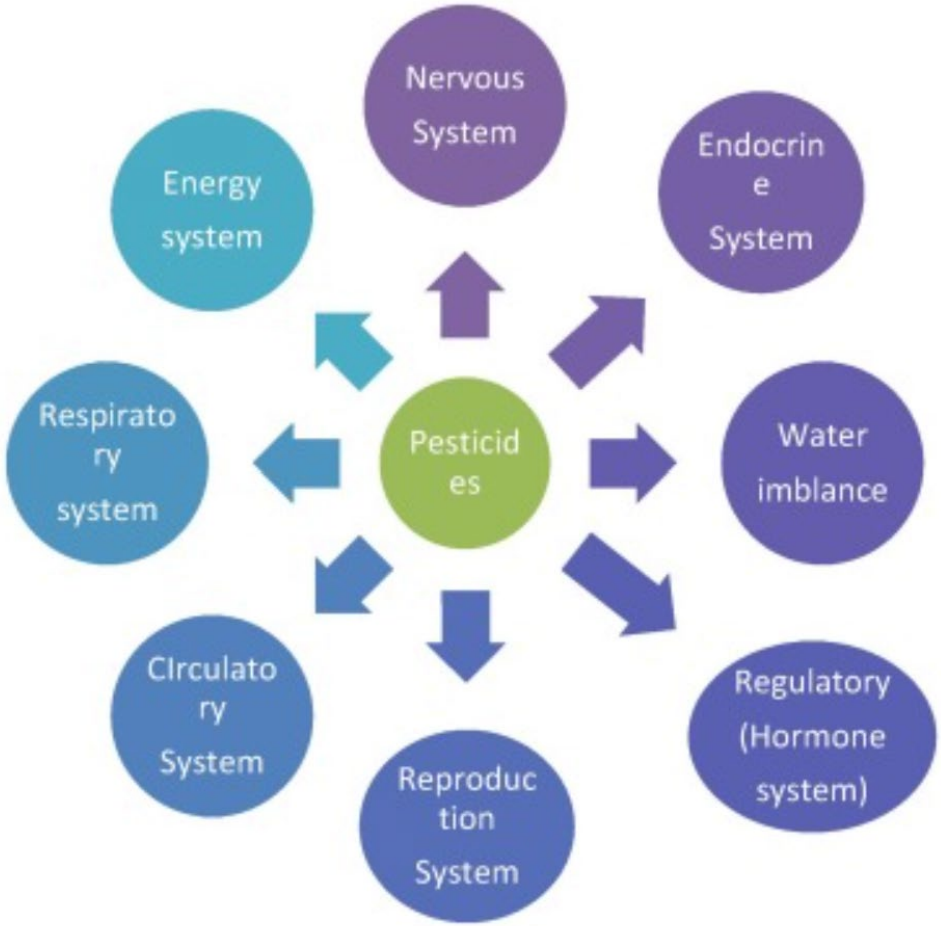
Impacts



be more at risk than others. Evidence suggests that much of this exposure is presented as multiple mixtures of chemicals and that the toxic effect of such exposure is unknown, particularly over longer time scales. It is very important to develop the precision and accuracy in the quantitation of pesticides along with improved safety profiles to reduce possibly adverse effects on human health and the environment. Furthermore, there should be a focus on determining

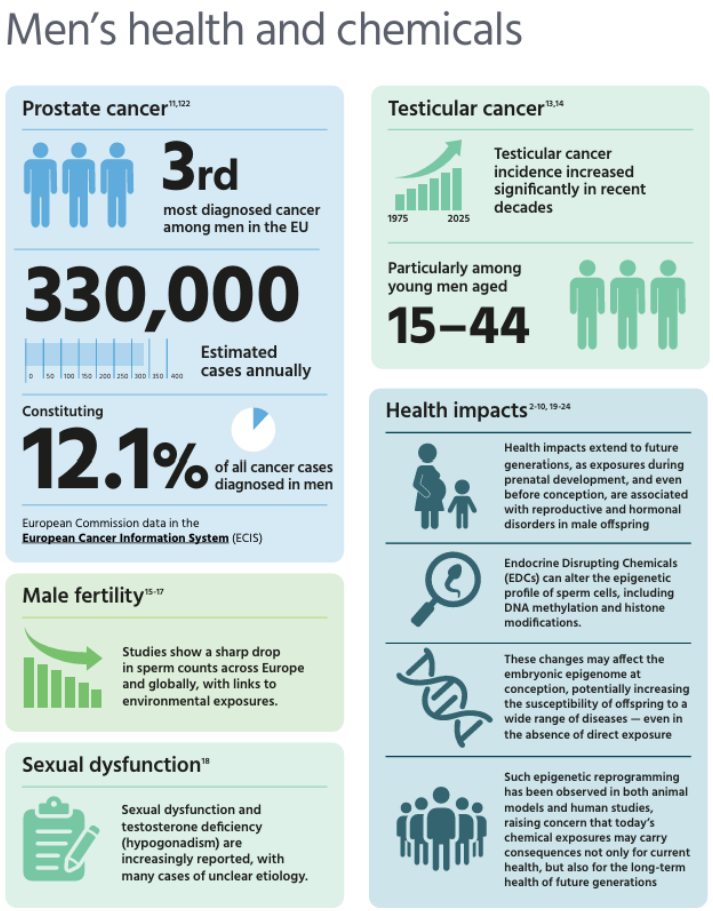
Source: Kim et al., 2017, Science of total environment

Impacts



Source: Dankhar et al, 2023, Materials Today, Proceedings

Impacts



Source: Cannarella et al, 2025, HEAL

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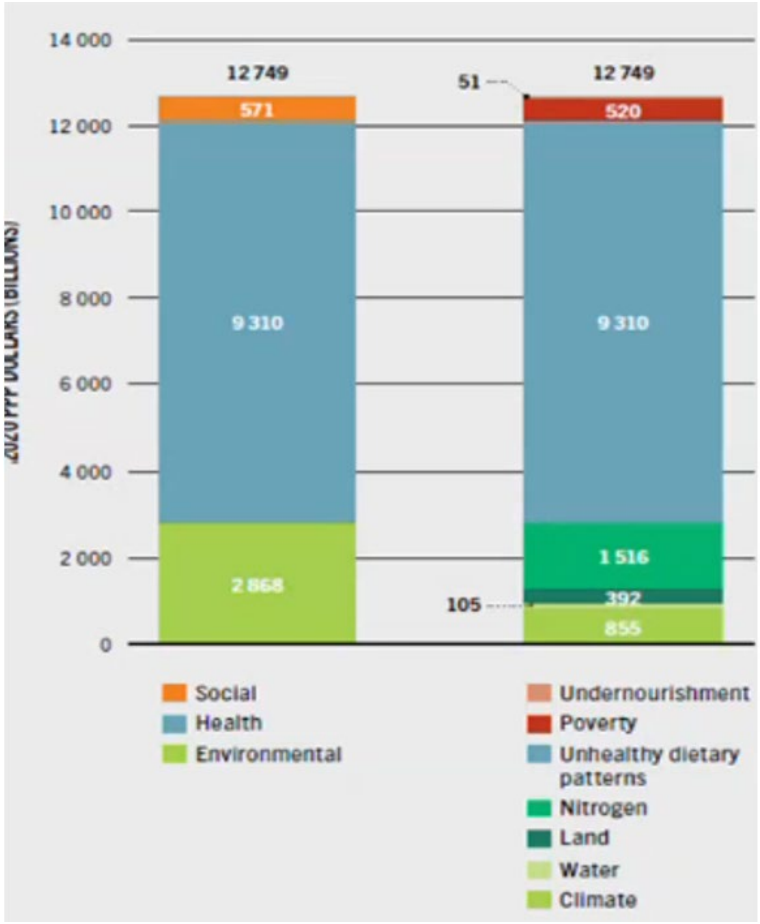
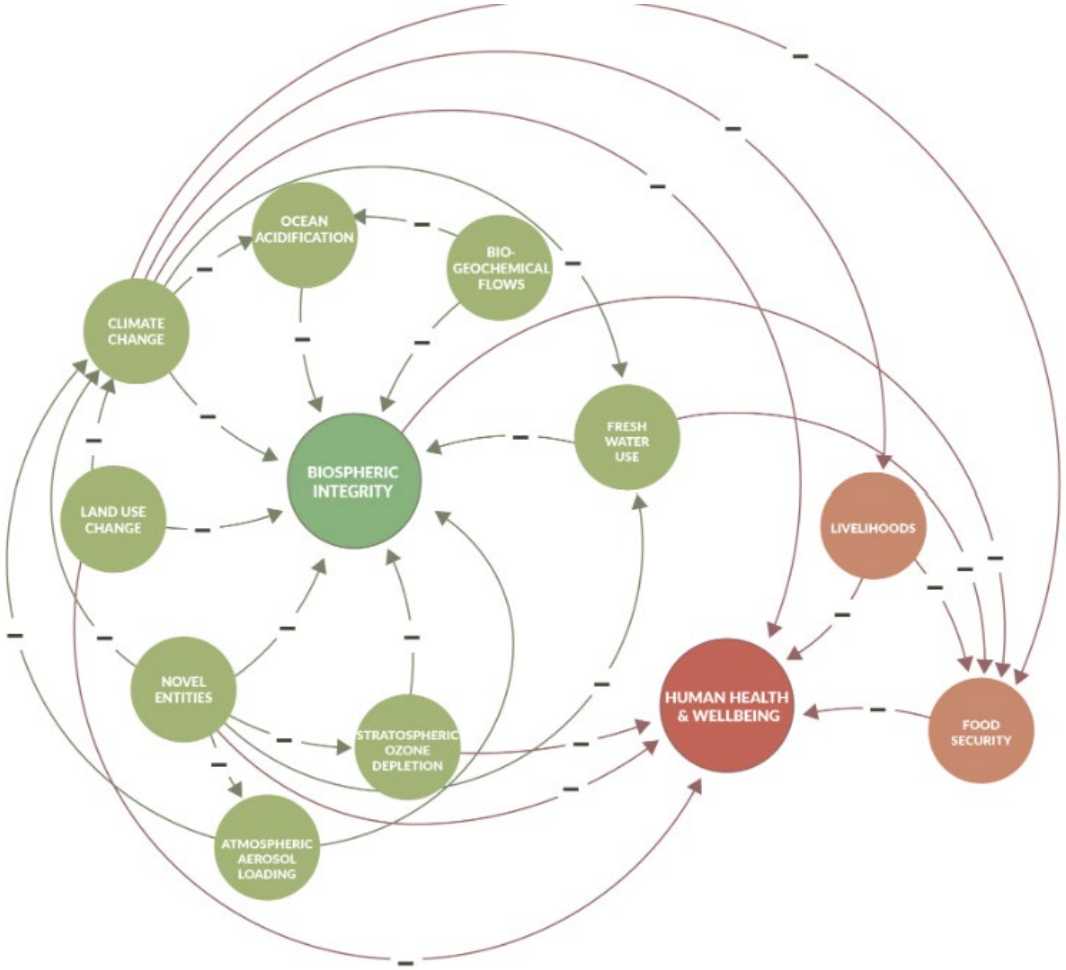
Impacts



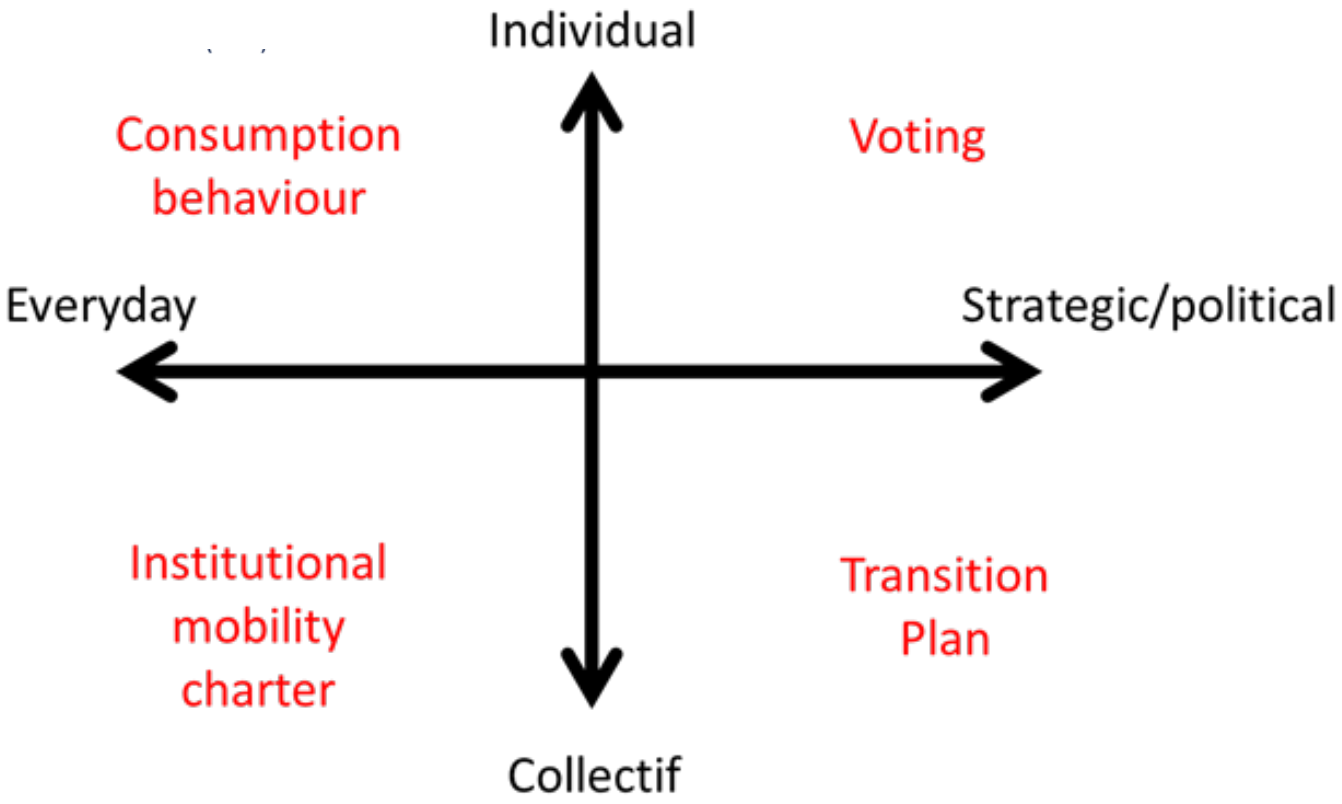
Source: Lords, S. 2023. FAO Agricultural Developmenent EconomicsTechnical Study 31

It's a wicked complex problem



Source: Metabolic, 2017. The global food system: An analysis

Agency space: Yes we can!

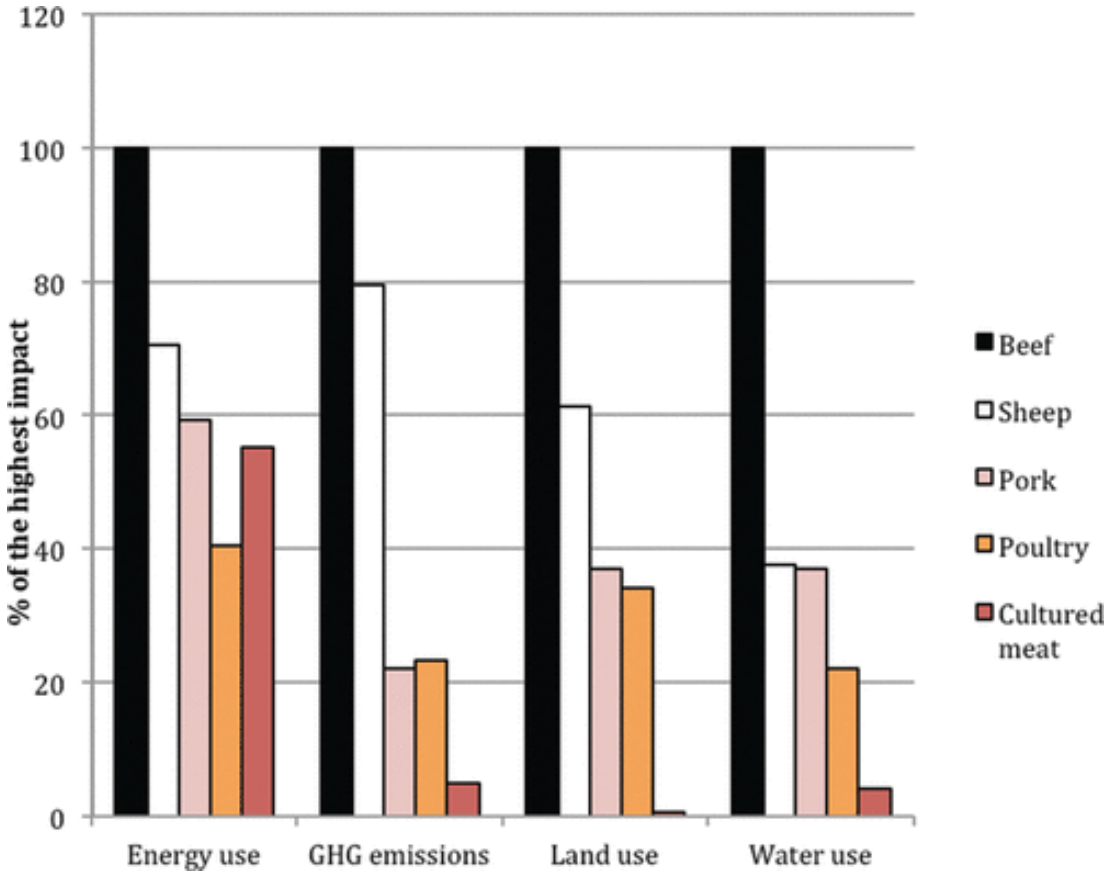



You
The farmer
The industry
The public authority


You
The farmer
The industry
The public authority

35000 decisions a day…
Are you taking the good decisions ?

Changing diets



Source: Tuomisto and Taxeira, 2011. EST. https://doi.org/10.1021/es200130u


You
The farmer
The industry
The public authority

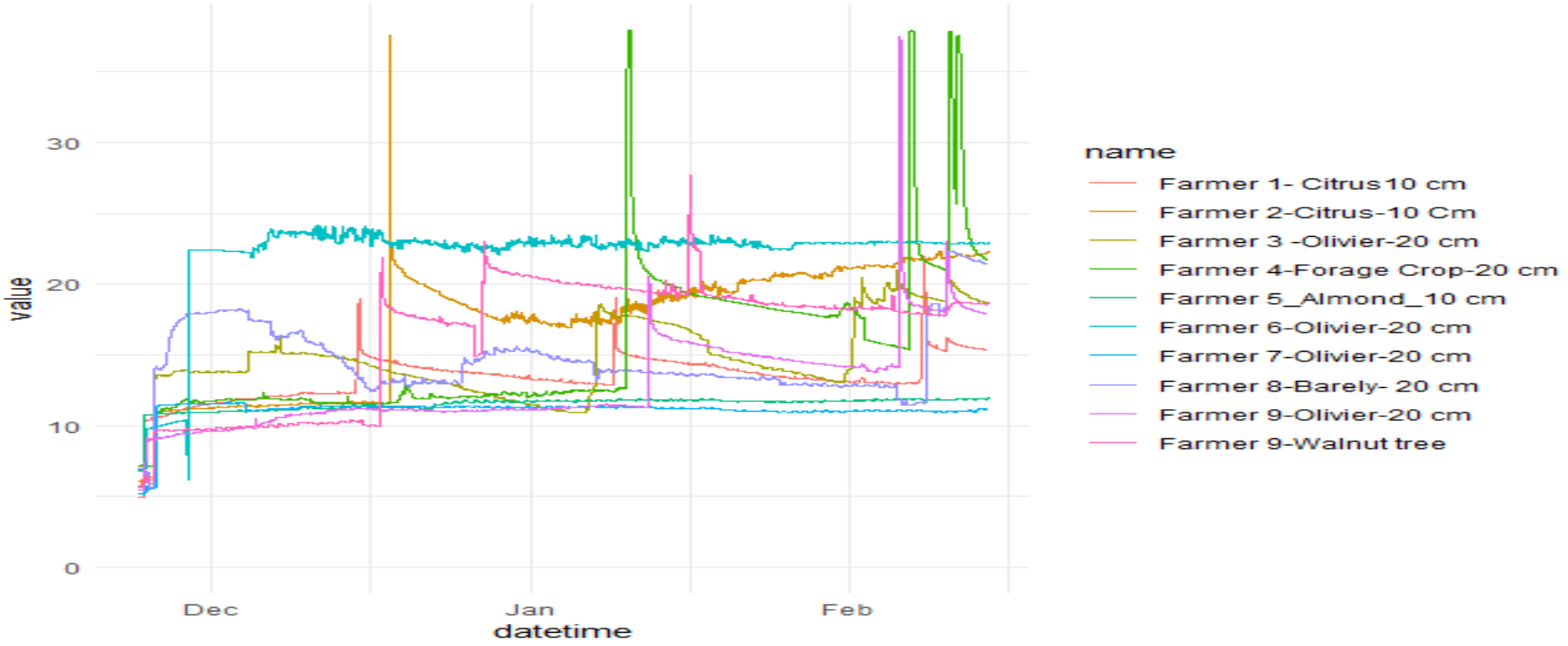
Conservation – regenerating – ecological agriculture

Criterium	Conservation agriculture	Agro-ecology	Regenerative agriculture	Bio-agriculture
Use of pesticides	Sometimes authorized	No	Limited or avoided	Forbidden
Labour	No	Limited	No	Sometimes
Official certification	No label	No label	Sometimes	Label
Main objective	Soil conservation and production	Integrating ecology and agriculture	Restaure ecosystems	Sustainable and healthy production
Social – political approach	Weak	Strong	Moderate	Moderate

Irrigation practice

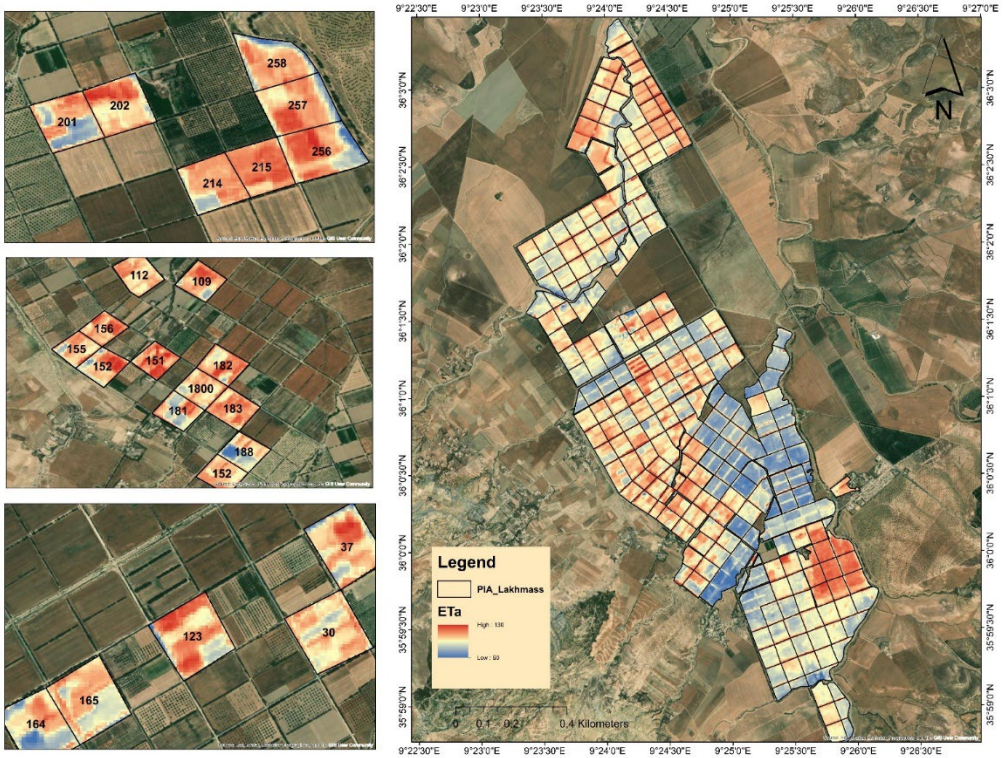
Soil moisture monitoring with engaged farmers in 9 different field parcels in the Siliana basin. Source: Amani Belhaj, Vanclooster et al, 2023. Work in progress

Irrigation practice



Observed soil moisture in top soil of 9 different field parcels in the Siliana basin. Source: Amani Belhaj, Vanclooster et al, 2023. Work in progress

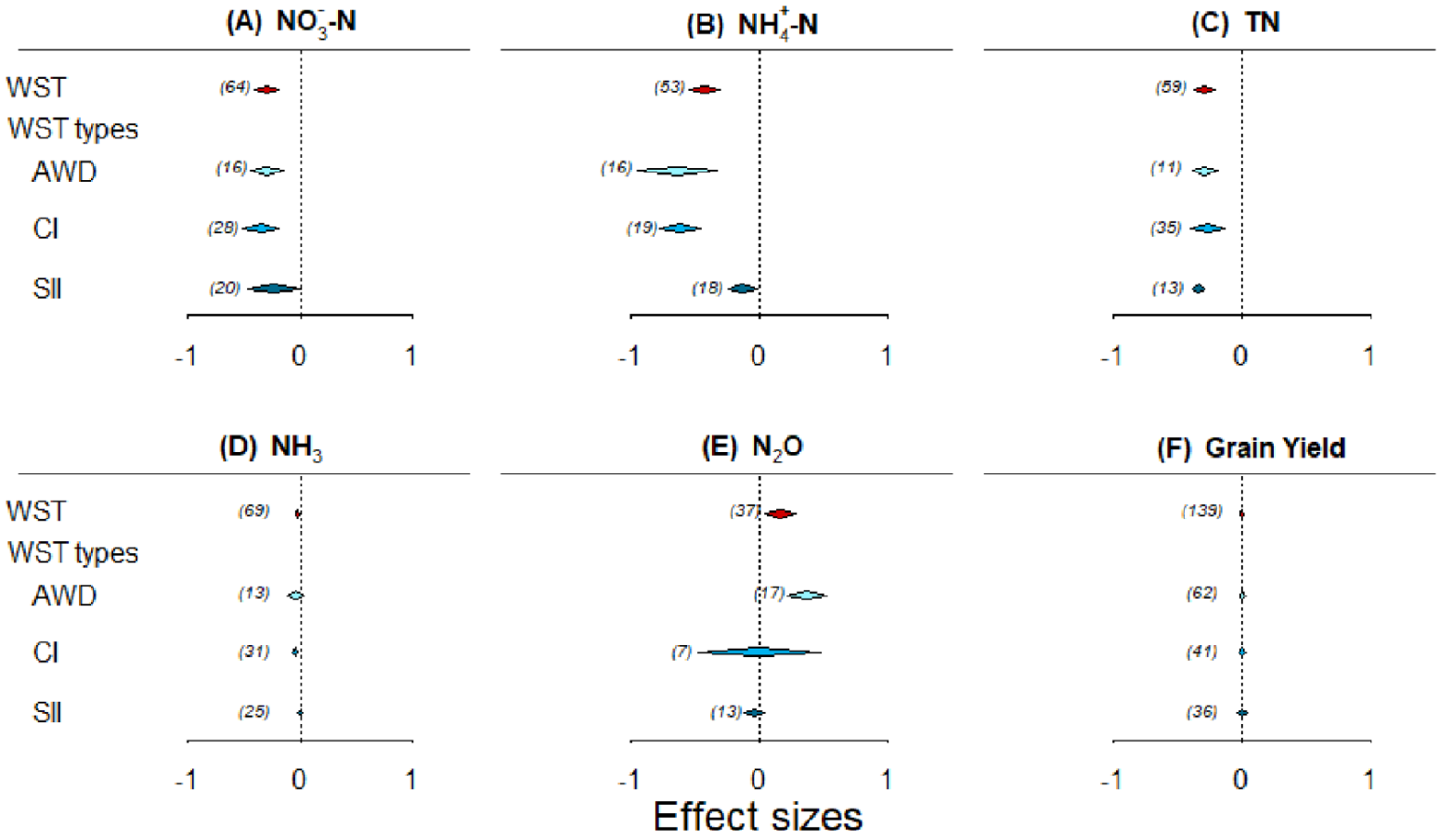
Irrigation practice



Observed soil crop evapotranspiration in the Siliana basin using remote sensing technology.
Source: Amani Belhaj, Vanclooster et al, 2023. Work in progress

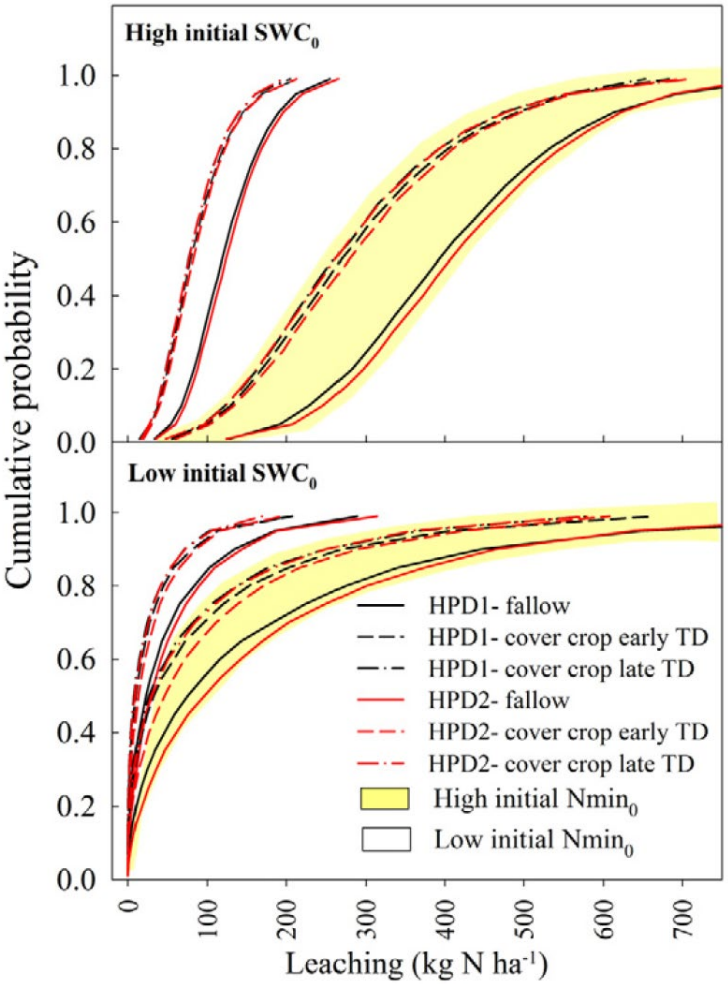
Irrigation practice

Irrigation practice



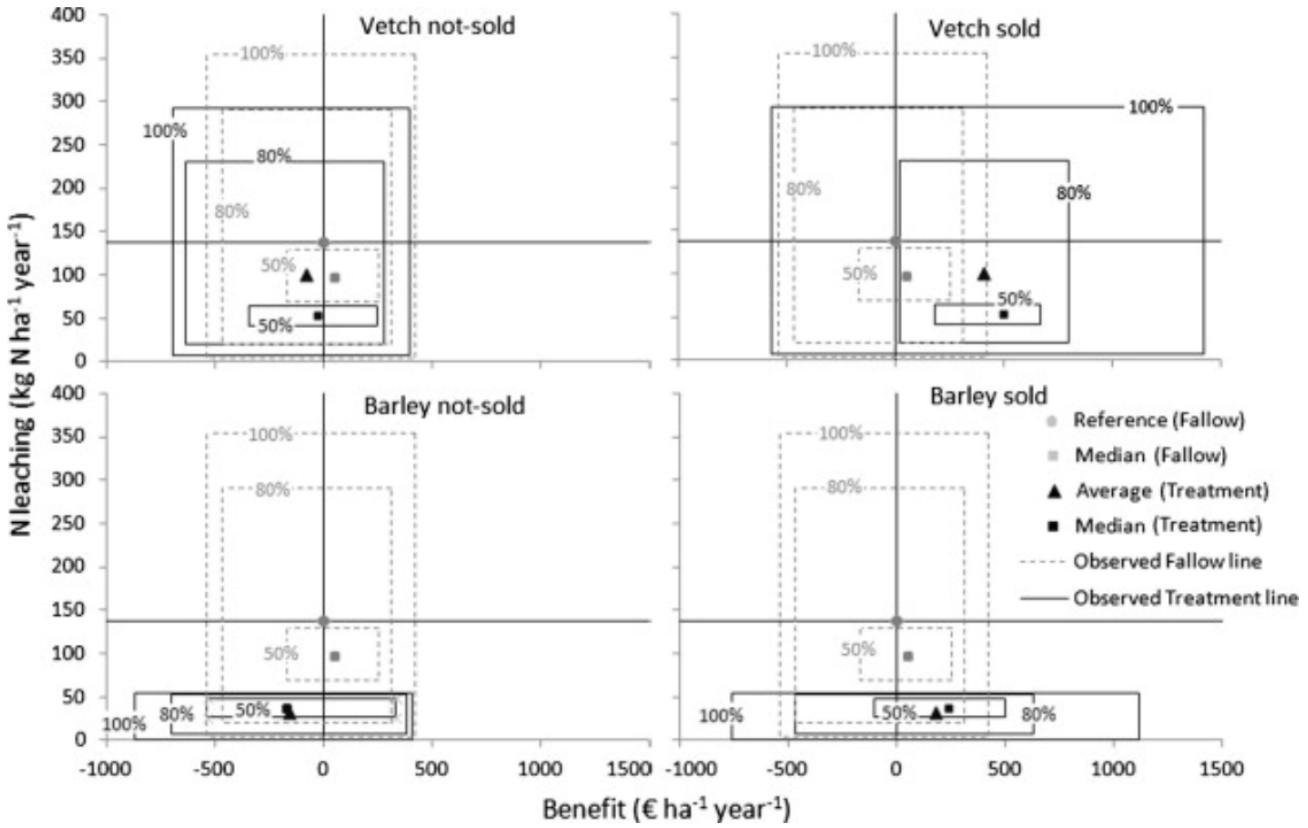
Source: Gbedourou et al, 2025. AGWAT

Effect of cover crops on N leaching



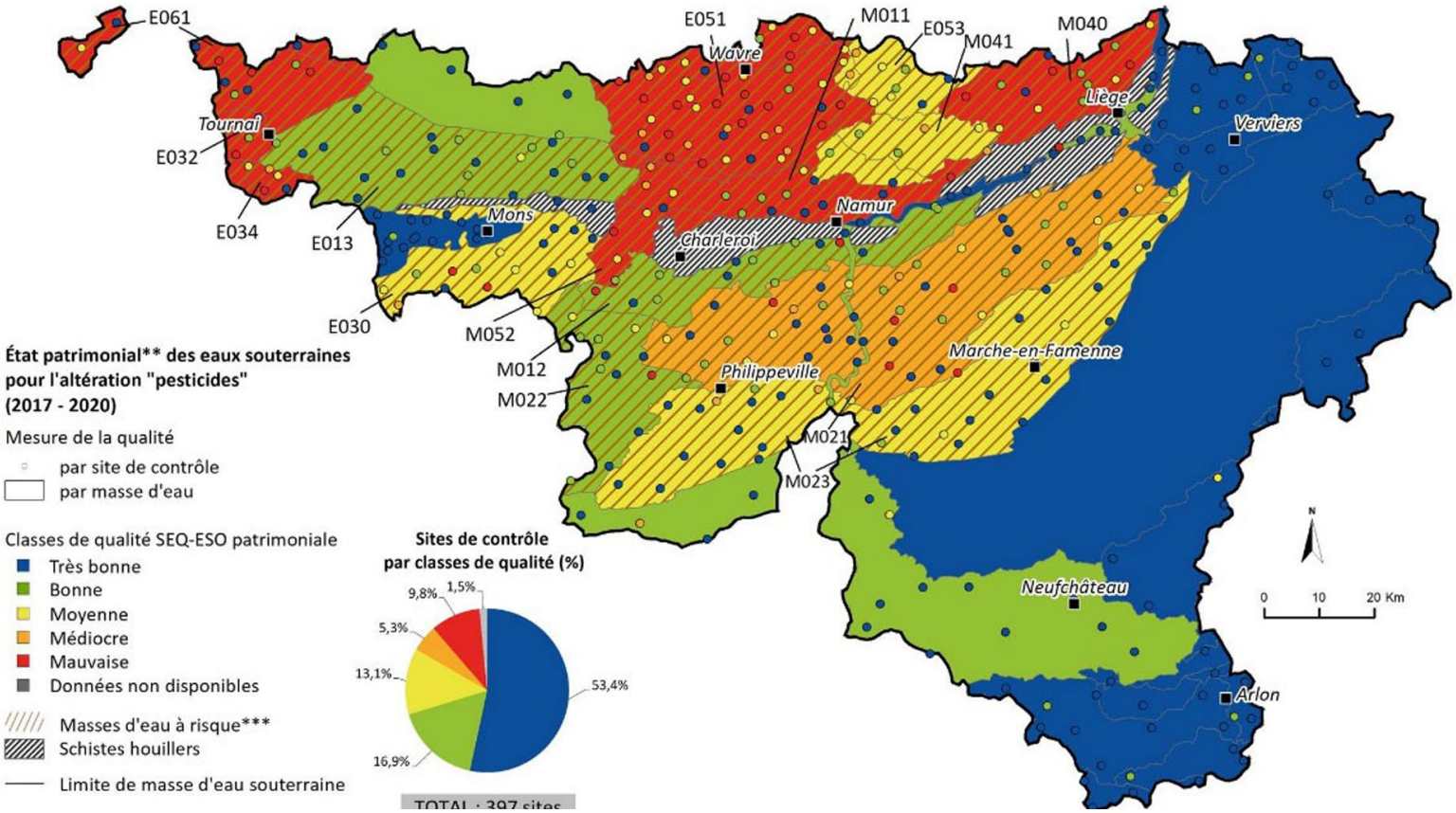
Source: Alonso-Ajuso et al., 2018, EST

Effect of cover crops on N leaching and economic benefit



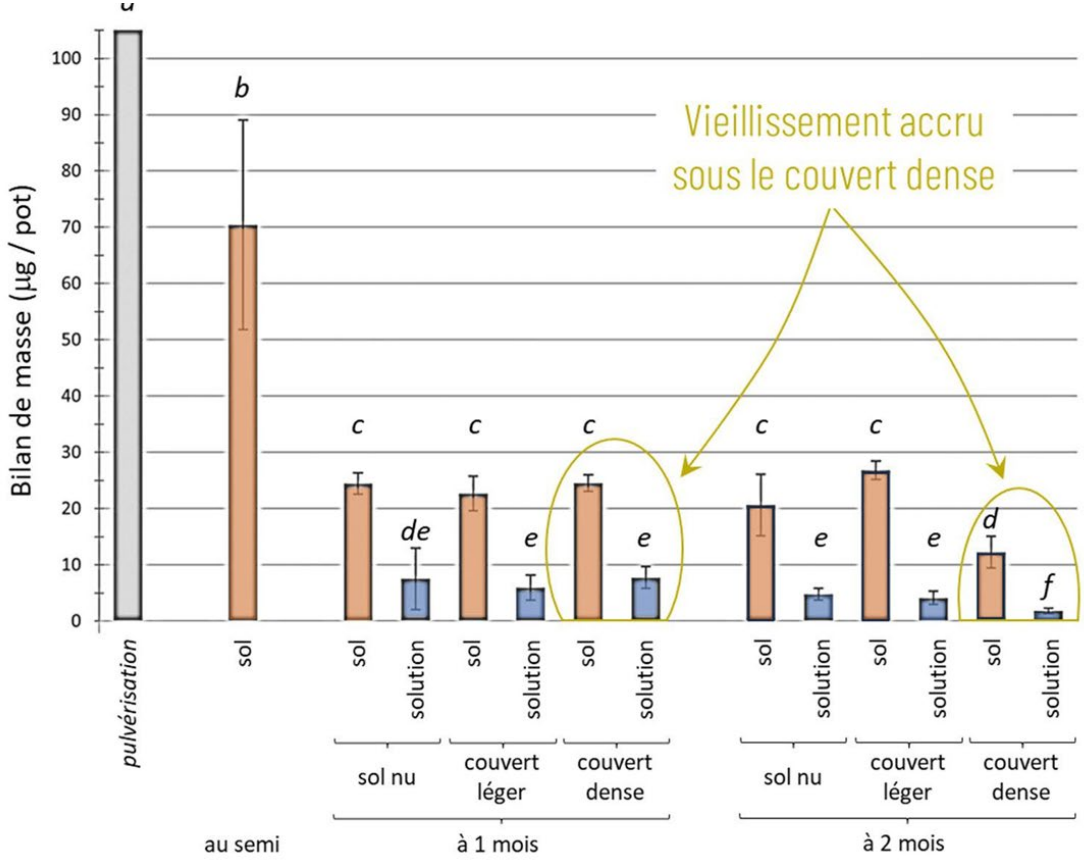
Source: Gabriel et al., 2013, Agricultural systems

Effect of cover crops on pesticide residues



Source: Vandevoorde et al., 2024

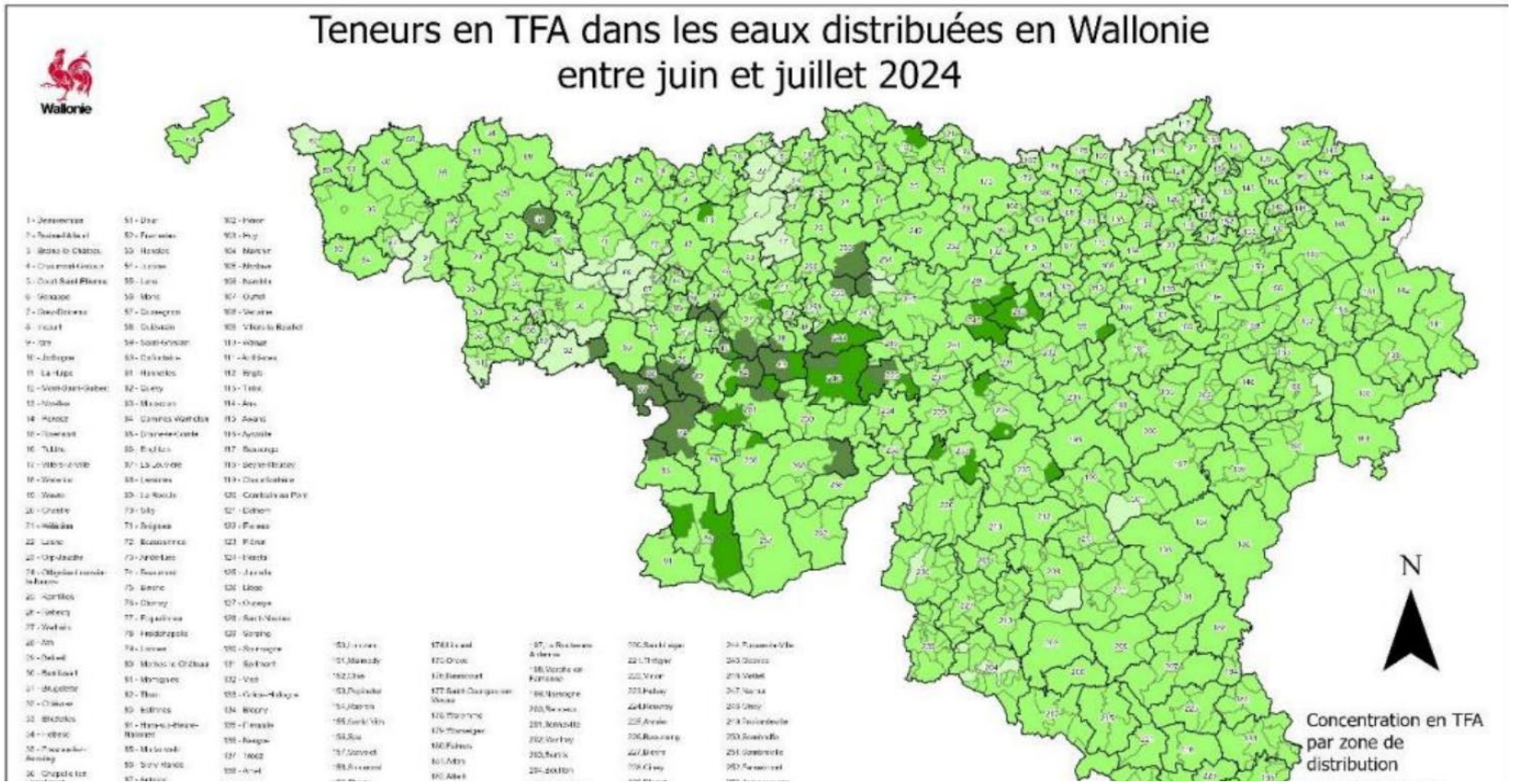
Effect of cover crops on pesticide residues



Source: Vandevoorde et al., 2024


You
The farmer
The industry
he public uthority

PFAS



Source: SPW, 2025

PFAS : The Flanders case

- Biomonitoring of PFAS since 2006
- PFAS are found in 99% of blood samples
- Recent study on PFAS in teenagers living near 3M production site:
  - Correlation found with PFAS levels and delayed puberty
  - Immunity response effects
  - Liver toxicity
  - Etc..

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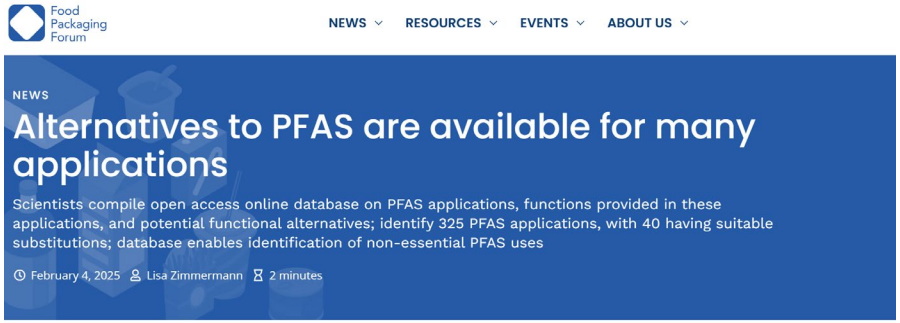
SUBSTITUTION

With over 100 new alternatives to PFAS, ChemSec Marketplace becomes key industry resource

PRESS RELEASE: As global pressure mounts to eliminate harmful PFAS chemicals from products and supply chains, ChemSec announces a major update to its online chemical substitution platform — ChemSec Marketplace.

Published on 30 Jun 2025



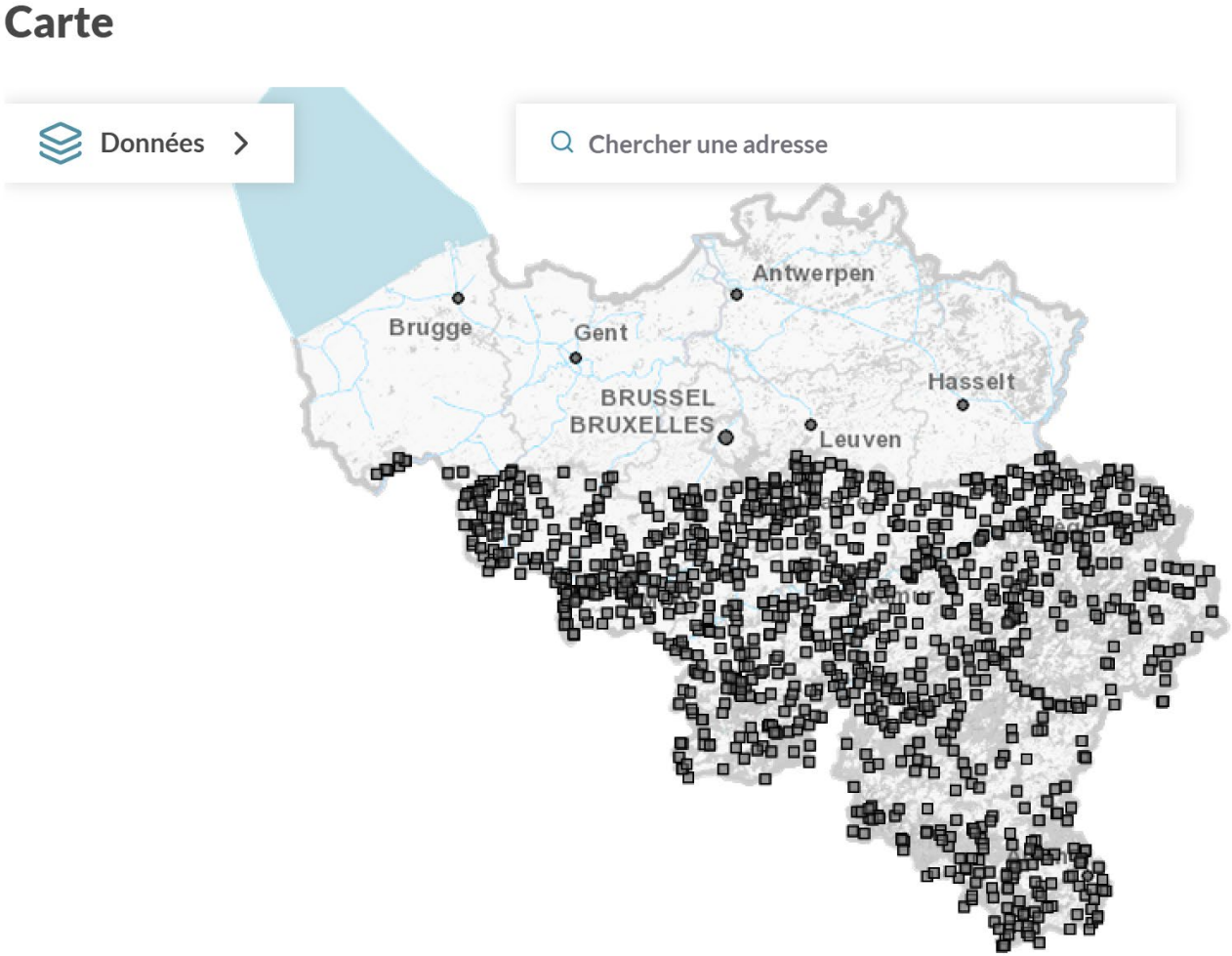
With their article published January 24, 2025, in the journal *Environmental Science & Technology*, Romain Figuière and co-authors from *Stockholm University*, Sweden, take an important step towards the phase-

Related articles


You
The farmer
The industry
The public authority

Source: Herrero et al., 2020. Nature Food. https://doi.org/10.1038/s43016-020-0074-1

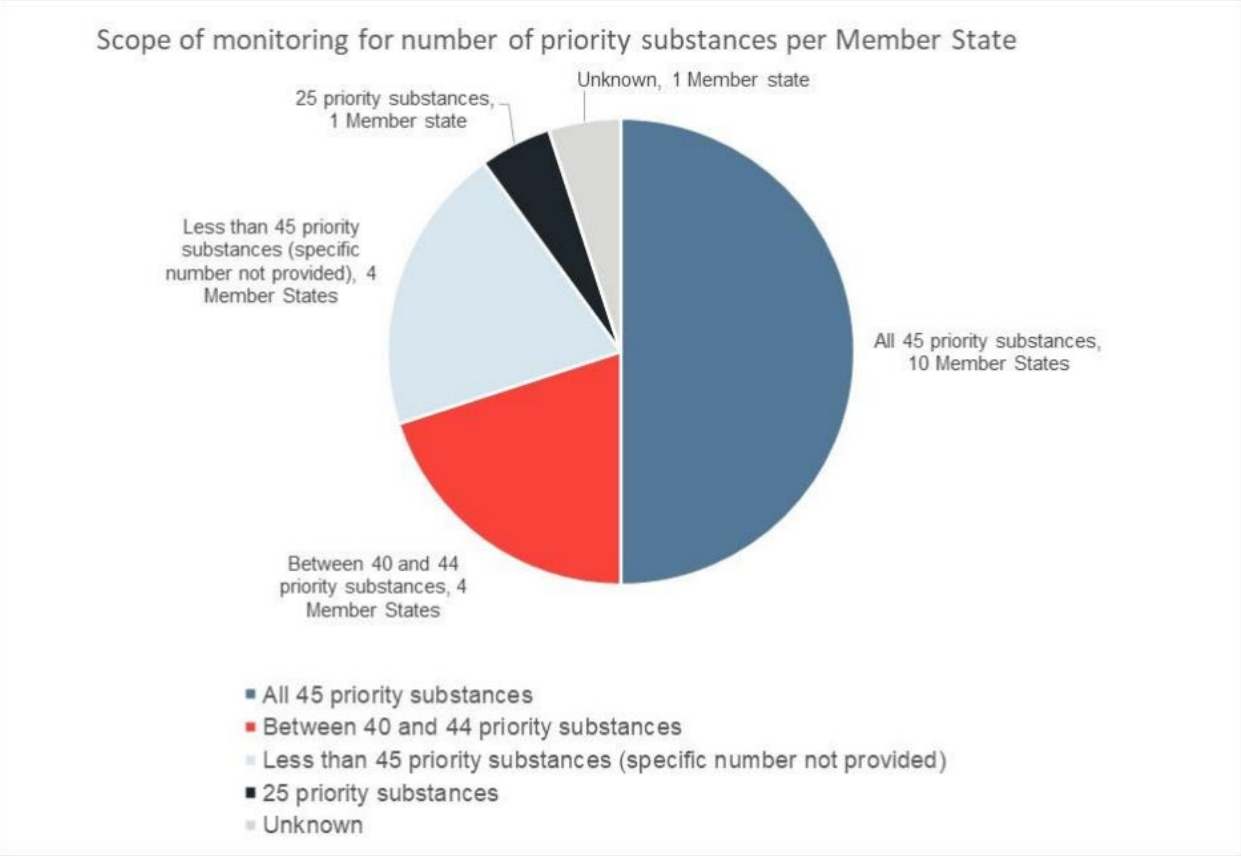
Monitoring capacity



Source: WallOnMap, 2025

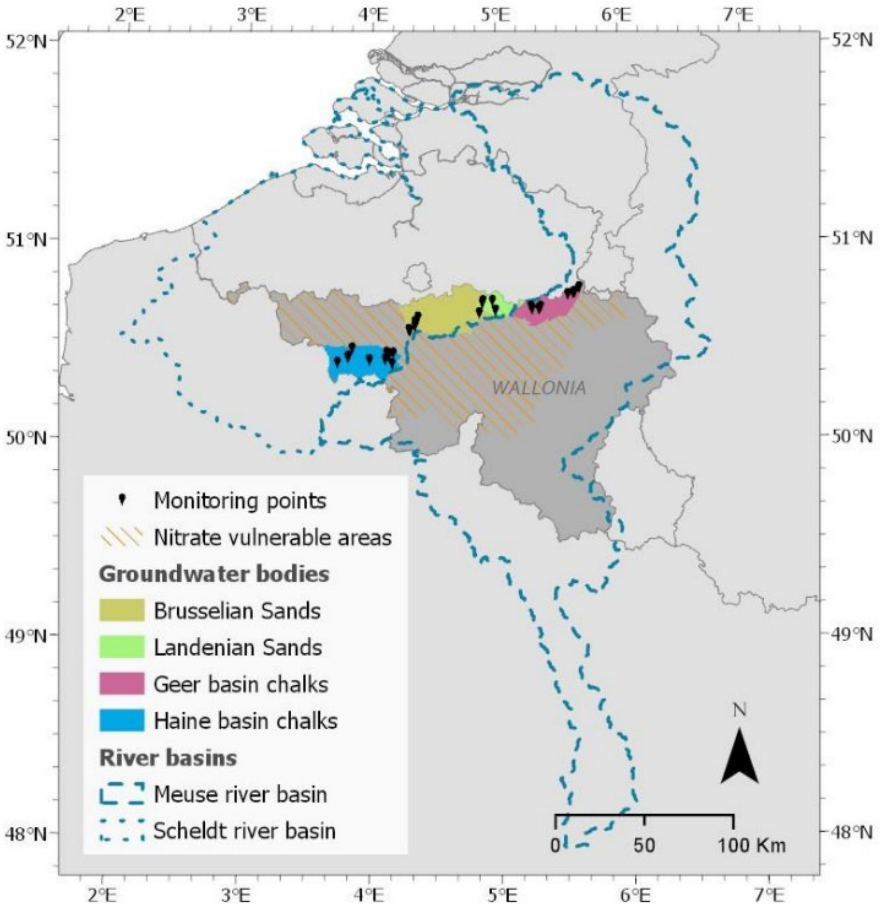
Monitoring capacity

Figure 3-20. Coverage of monitoring for priority substances across the Member States for the third RBMP*



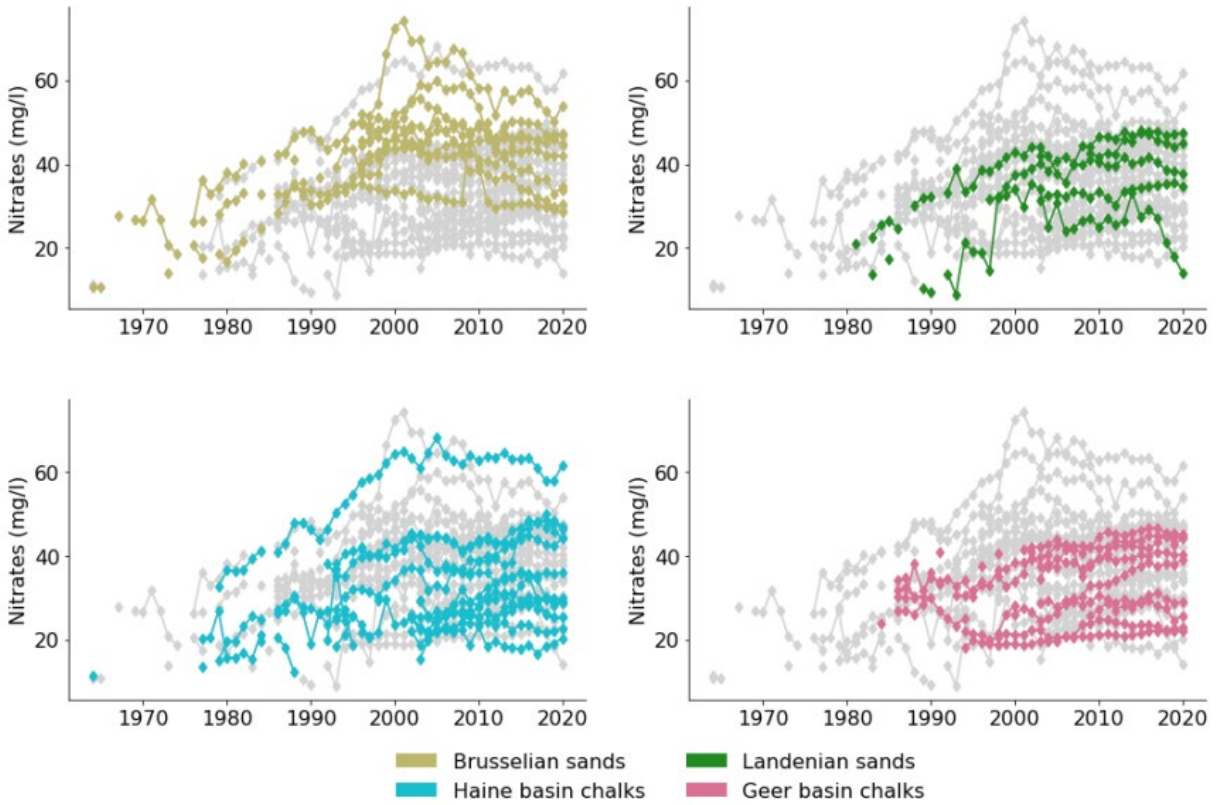
Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

Phasing out: Brusselean sands, Wallonia



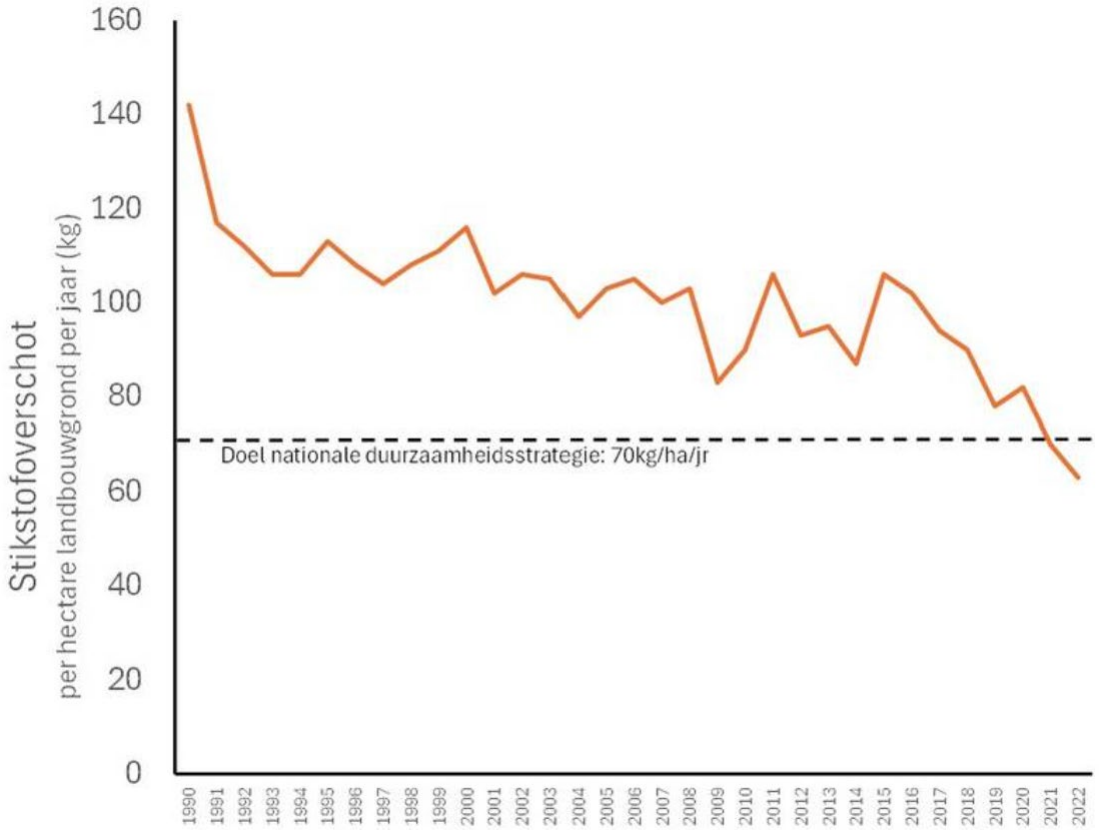
Source: Verstraeten et al., 2025

Phasing out: Brusselean sands, Wallonia



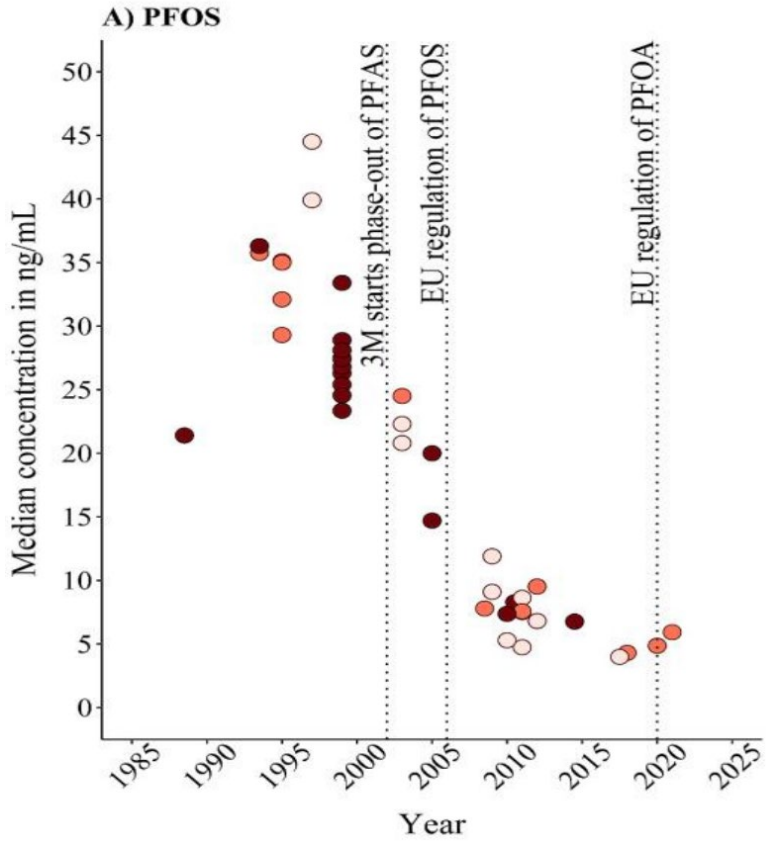
Source: Verstraeten et al., 2025

Phasing out: Germany



Source: Melkveebedrijf.nl. Consulted on 22/11/25

Phasing out – legacy effects



Source: Hull, S.D, et al., 2023. Env. Research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The farmer
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