



Circle U.

European University Alliance

5 years!



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

Christmas lecture

26/11/25

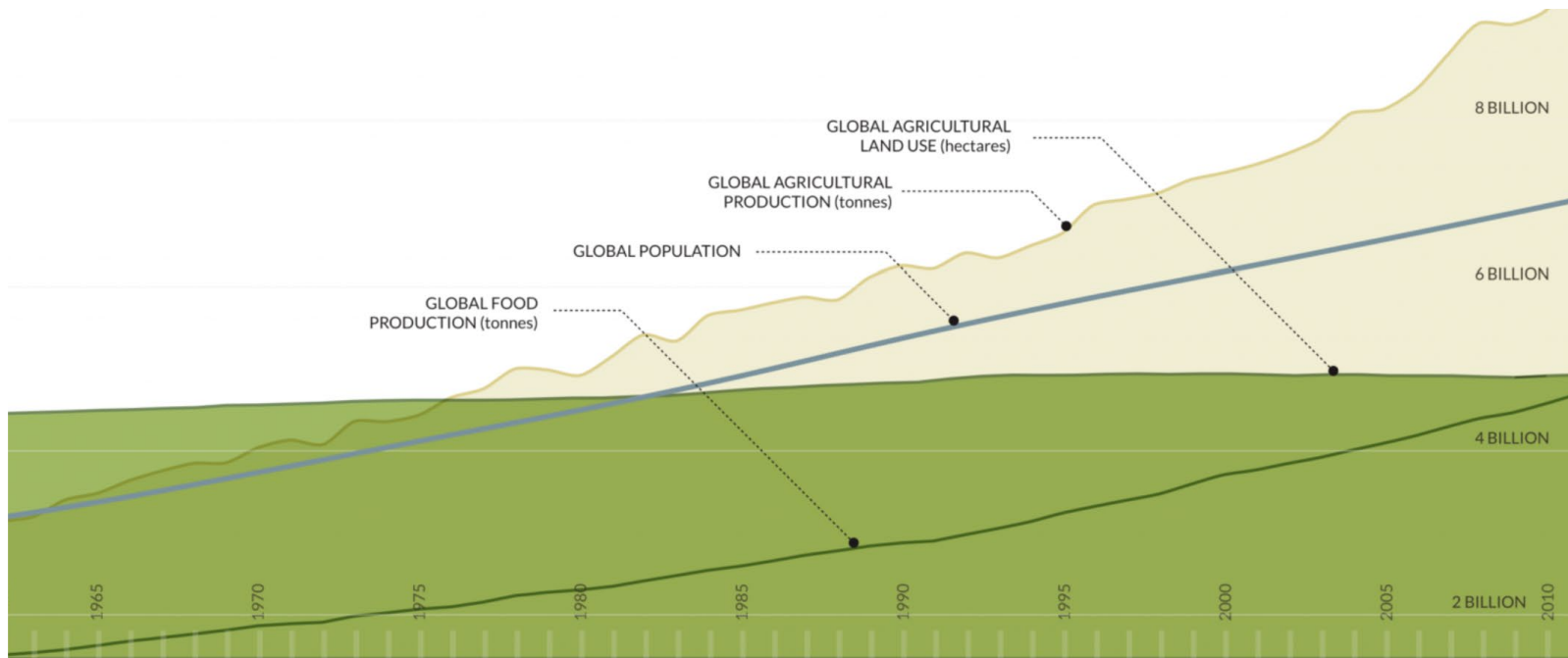
M. Vanclooster, UCLouvain – Earth and Life Institute



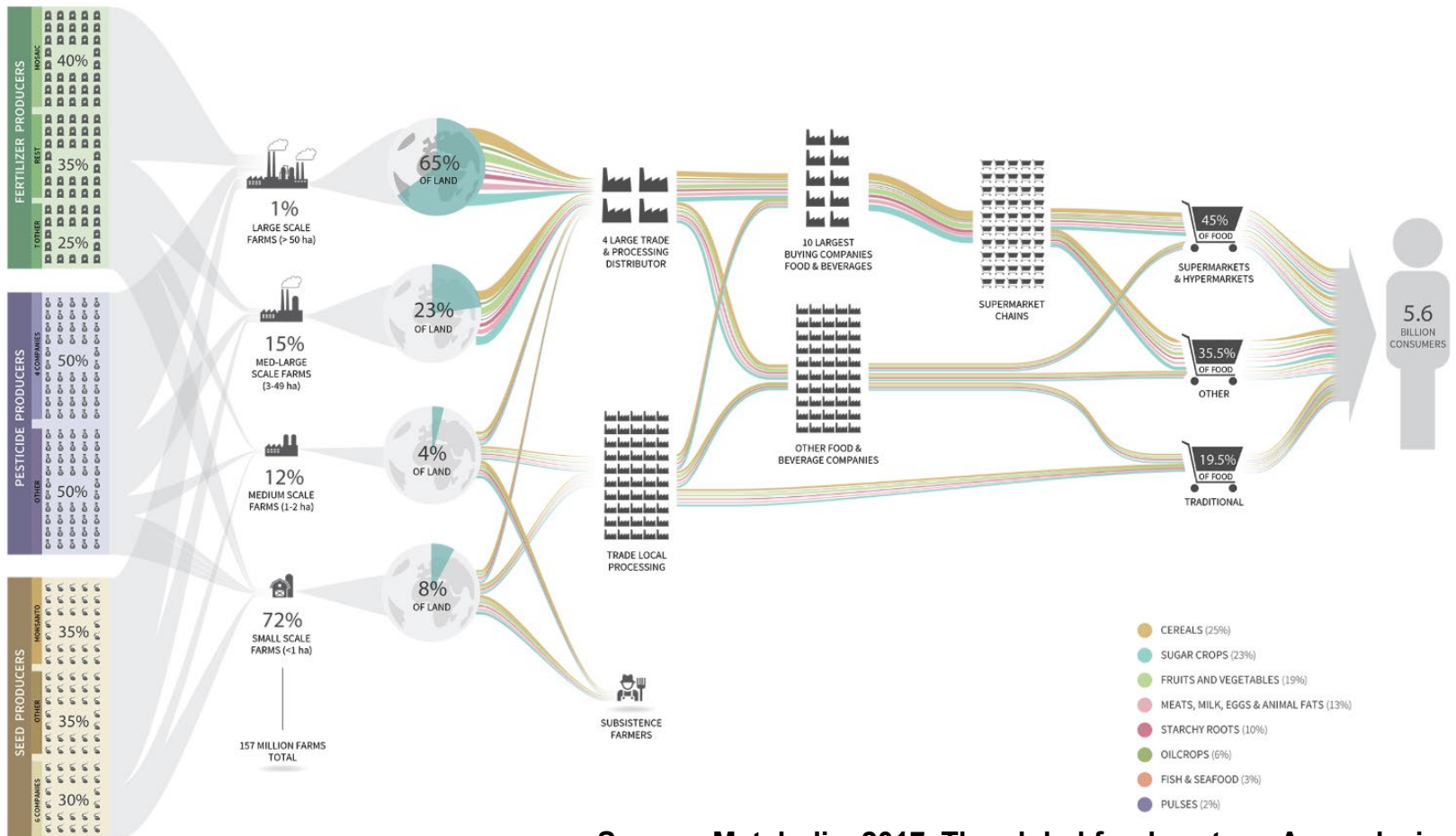
What are we going to eat at Xmas dinner?

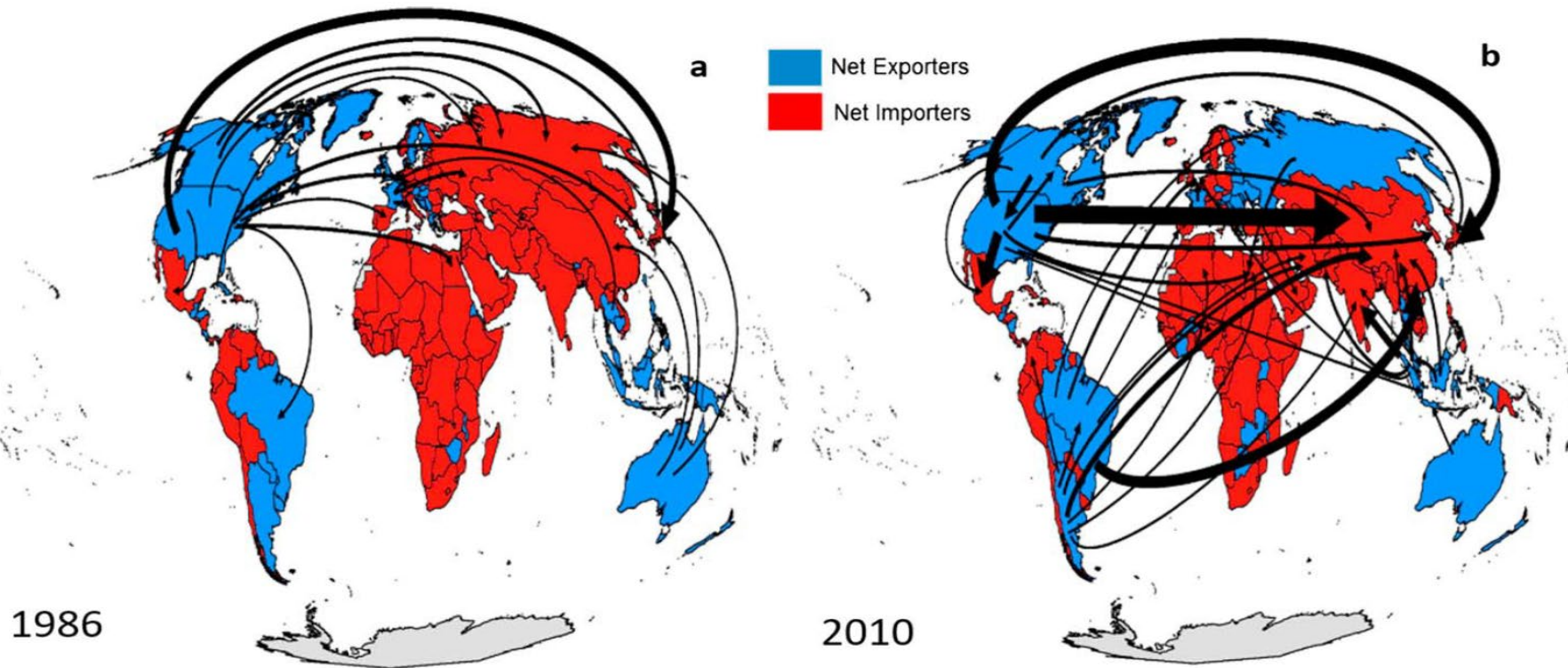


How was/is food produced at the global scale during our life-time?



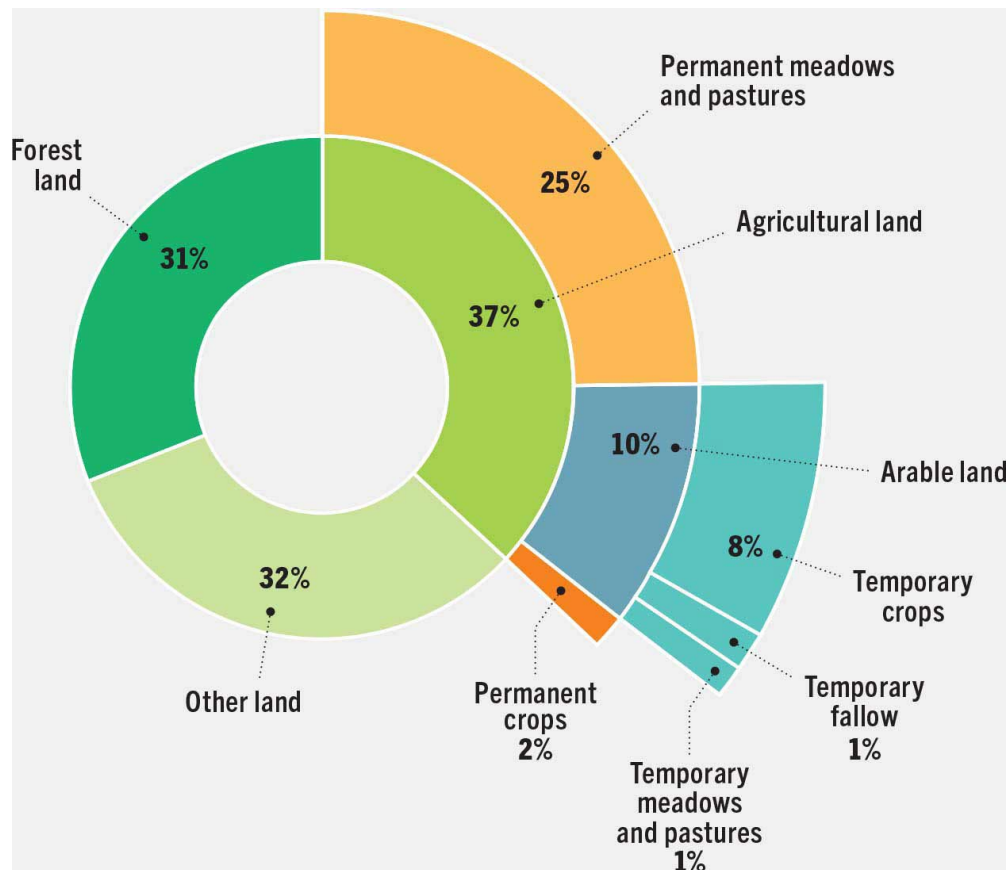
How is the global food system organised ?





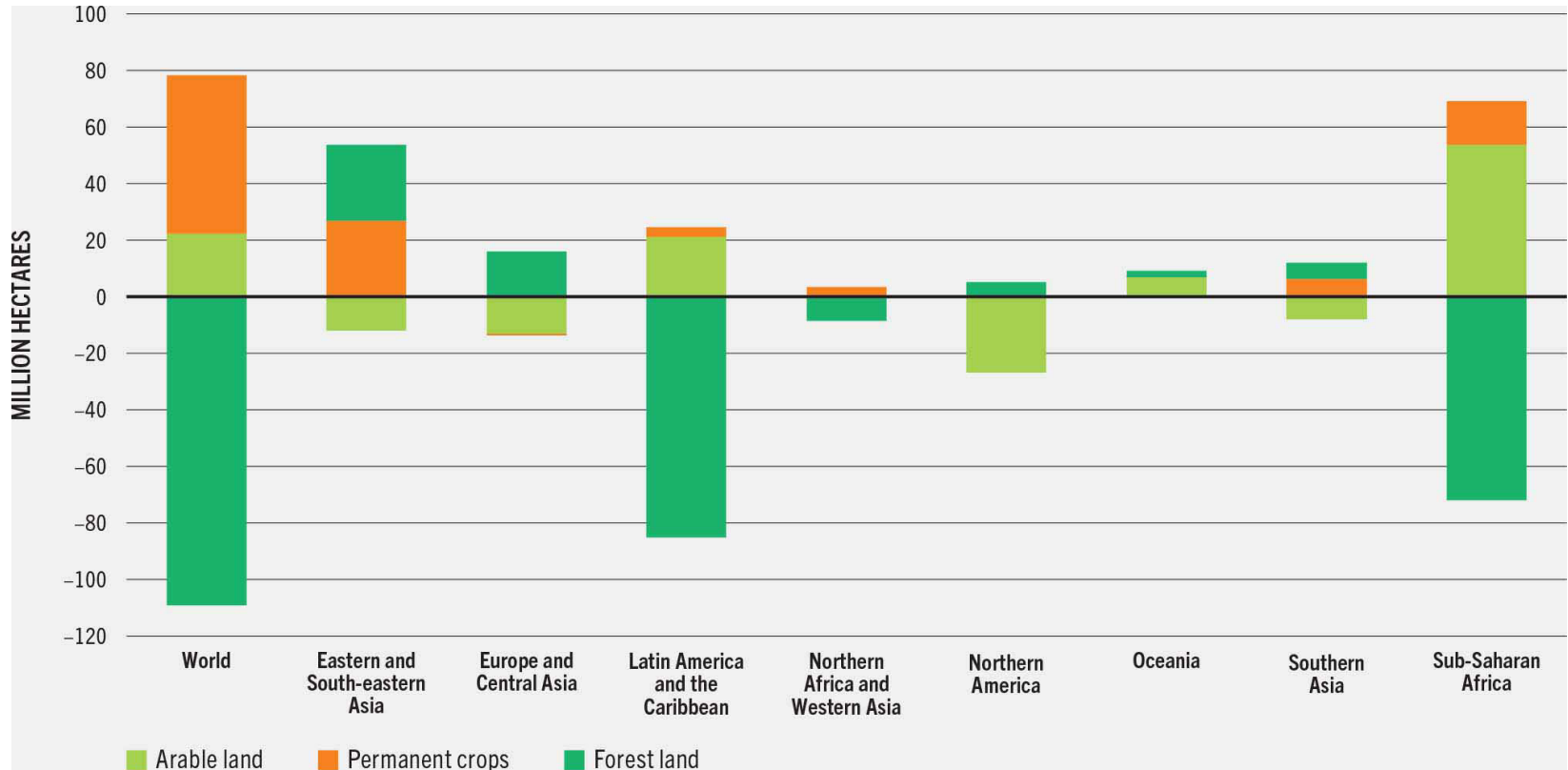
Source: D'Odorico and Mull 2014. Nature Geosciences

Land use



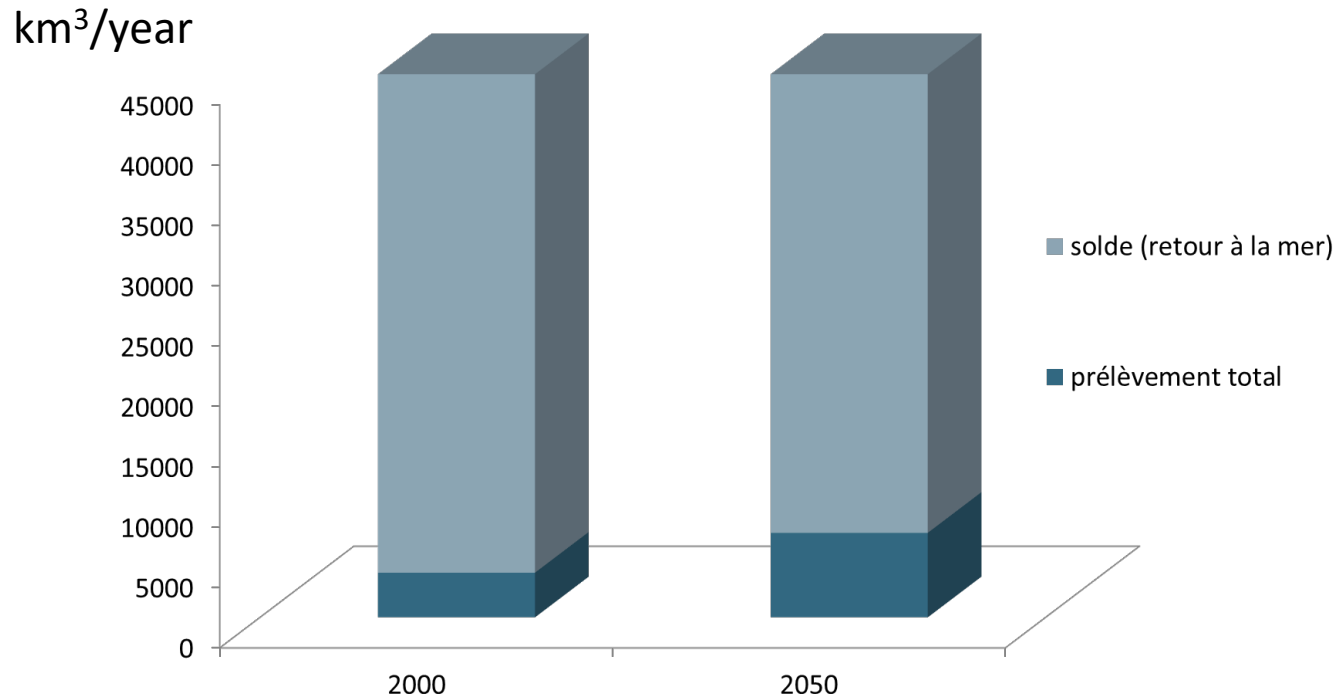
Source: FAO 2025. The state of food and agriculture 2025

Land use change (2001-2023)

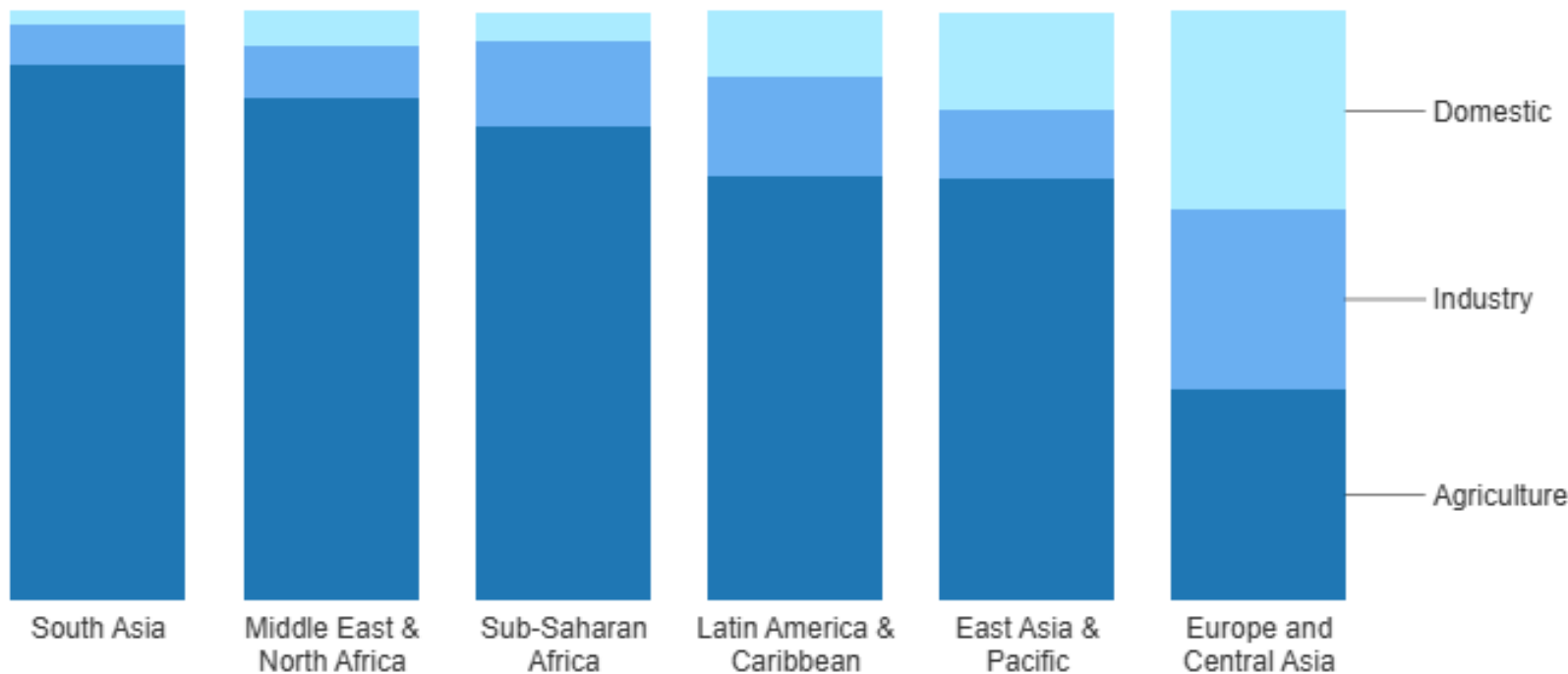


Source: FAO 2025. The state of food and agriculture 2025

Water use



Water use

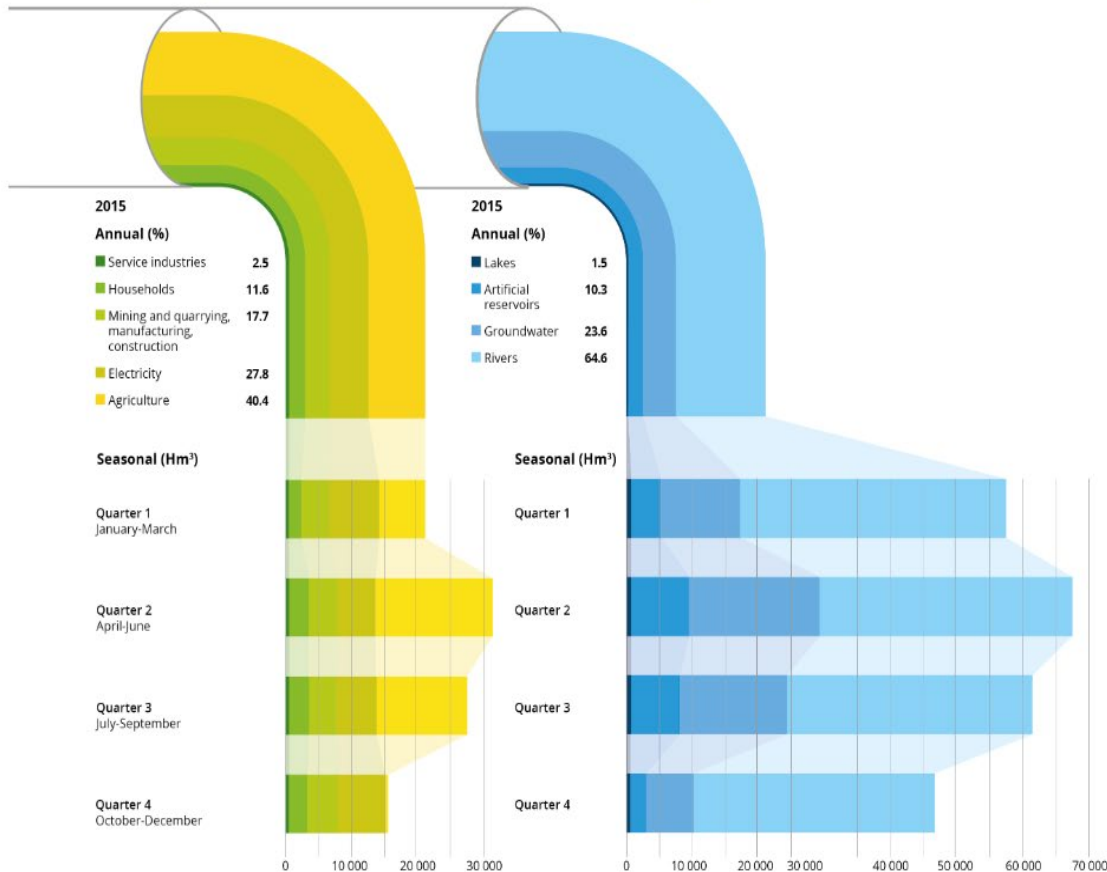


Water use in Europe

Water use by economic sectors

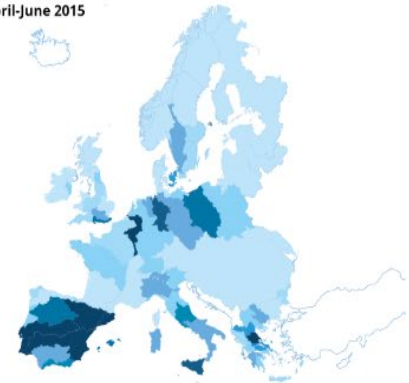
Freshwater abstraction by source

Water exploitation by river basin (*)

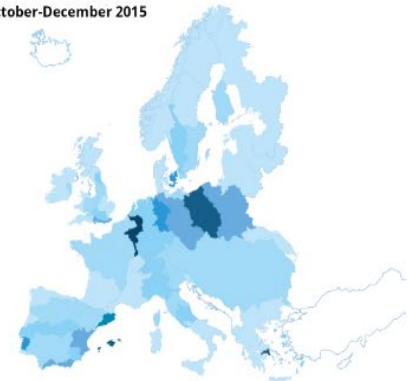


0 % > 40 %

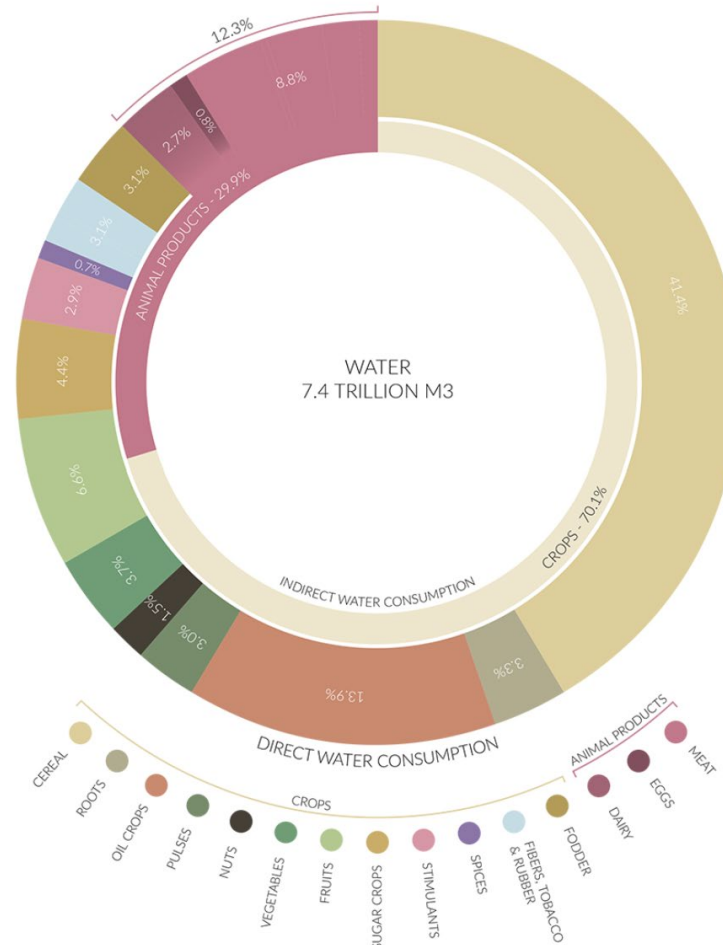
April-June 2015



October-December 2015

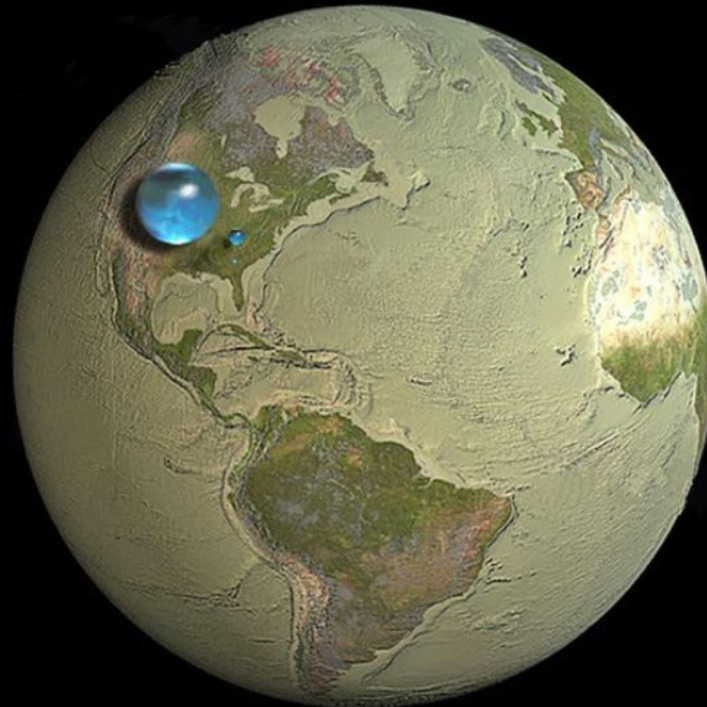


Global water footprint for food production



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

Howard Perlman, USGS
Jack Cook, Adam Nieman
Data: Igor Shiklomanov, 1993

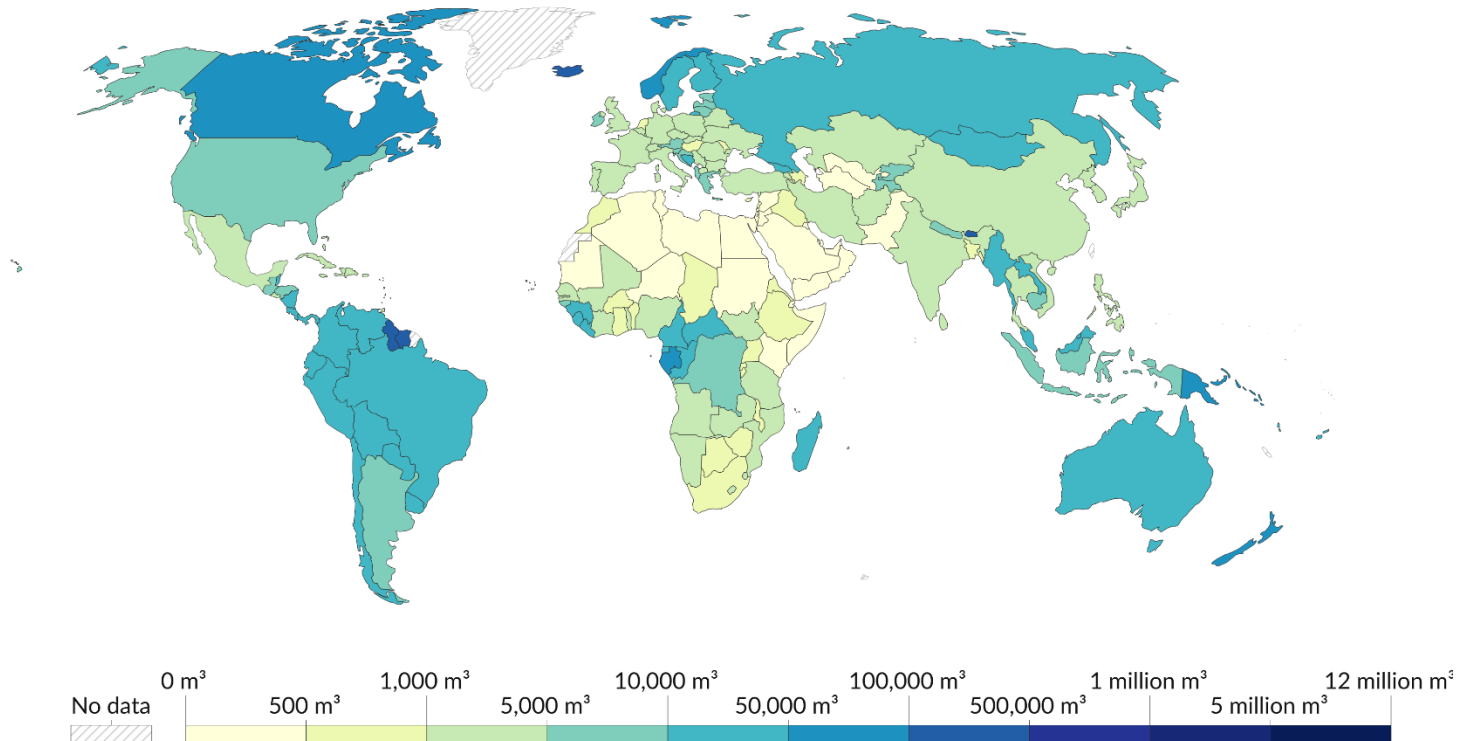


Water stress at global scale

Renewable freshwater resources per capita, 2021

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

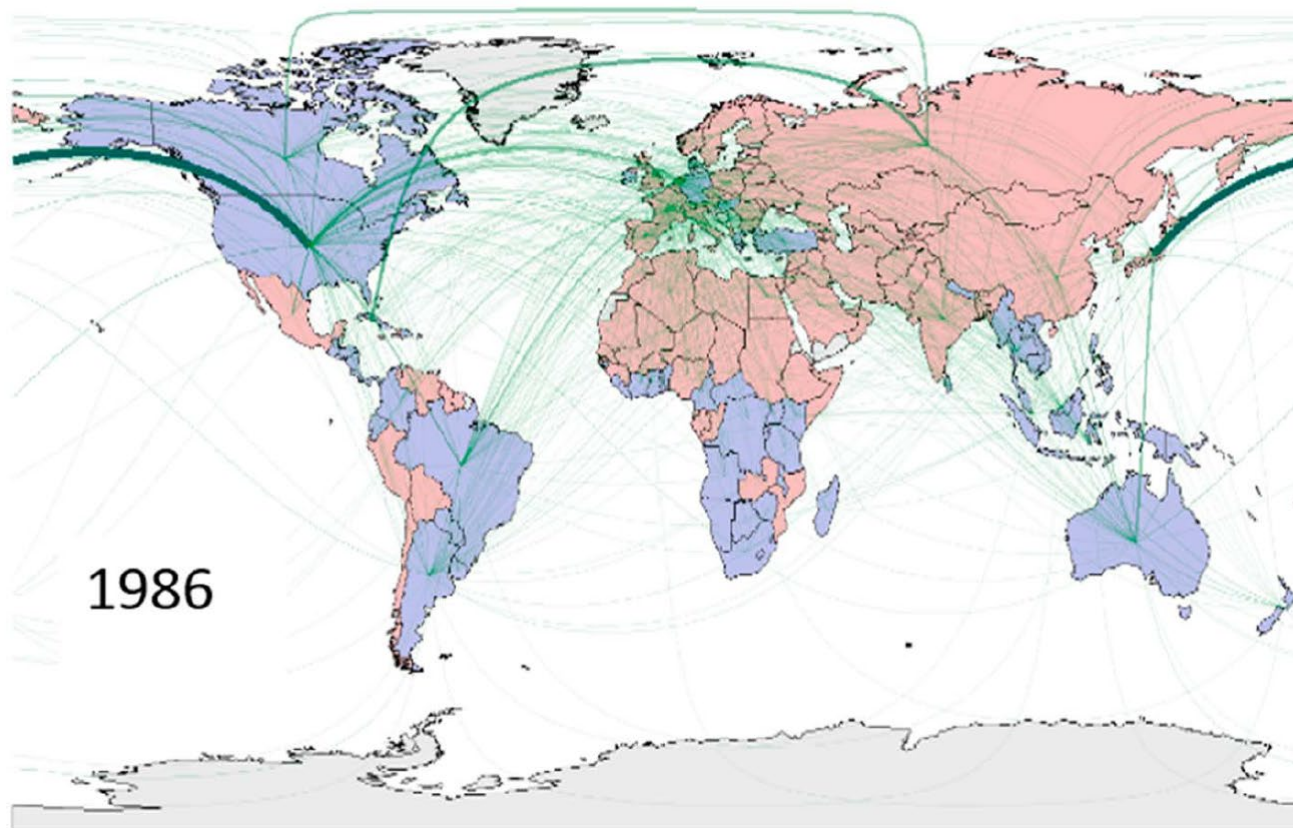
Our World in Data



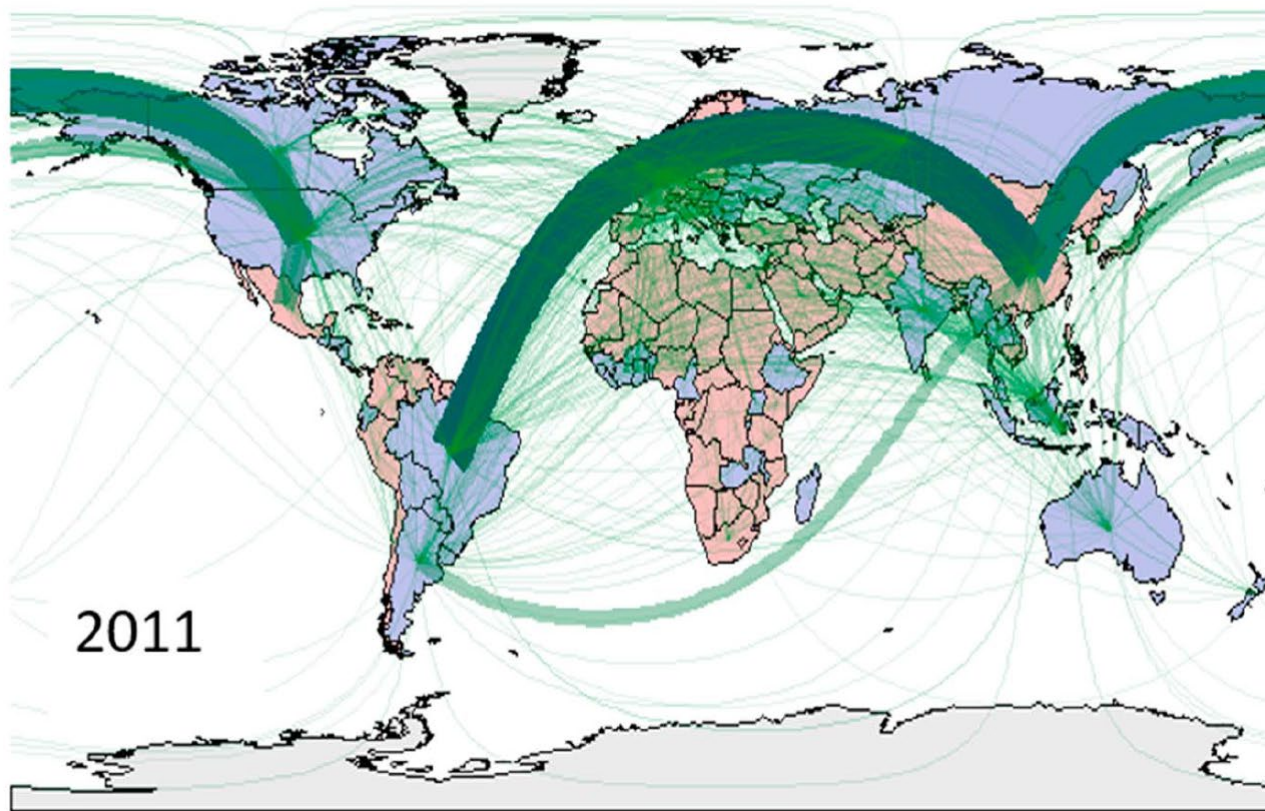
Data source: Food and Agriculture Organization of the United Nations (via World Bank) (2025) OurWorldinData.org/water-use-stress | CC BY

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

Virtual water transport at global scale



Virtual water transport at global scale



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

Fertilizer use

Fertilizer use per capita, World, 1961 to 2022

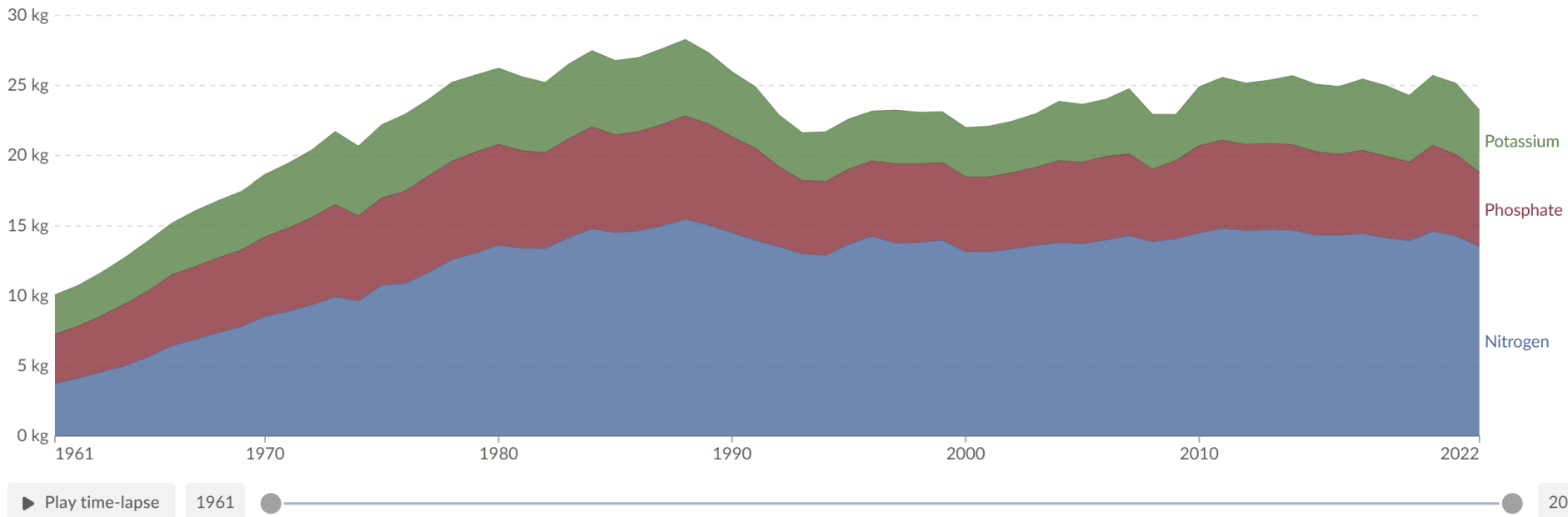
Our World in Data

Fertilizer use is the sum of synthetic inputs of nitrogen, potassium and phosphorous, plus organic nitrogen inputs. This is given in kilograms per person per year.

Table Chart

Edit countries and regions

Settings



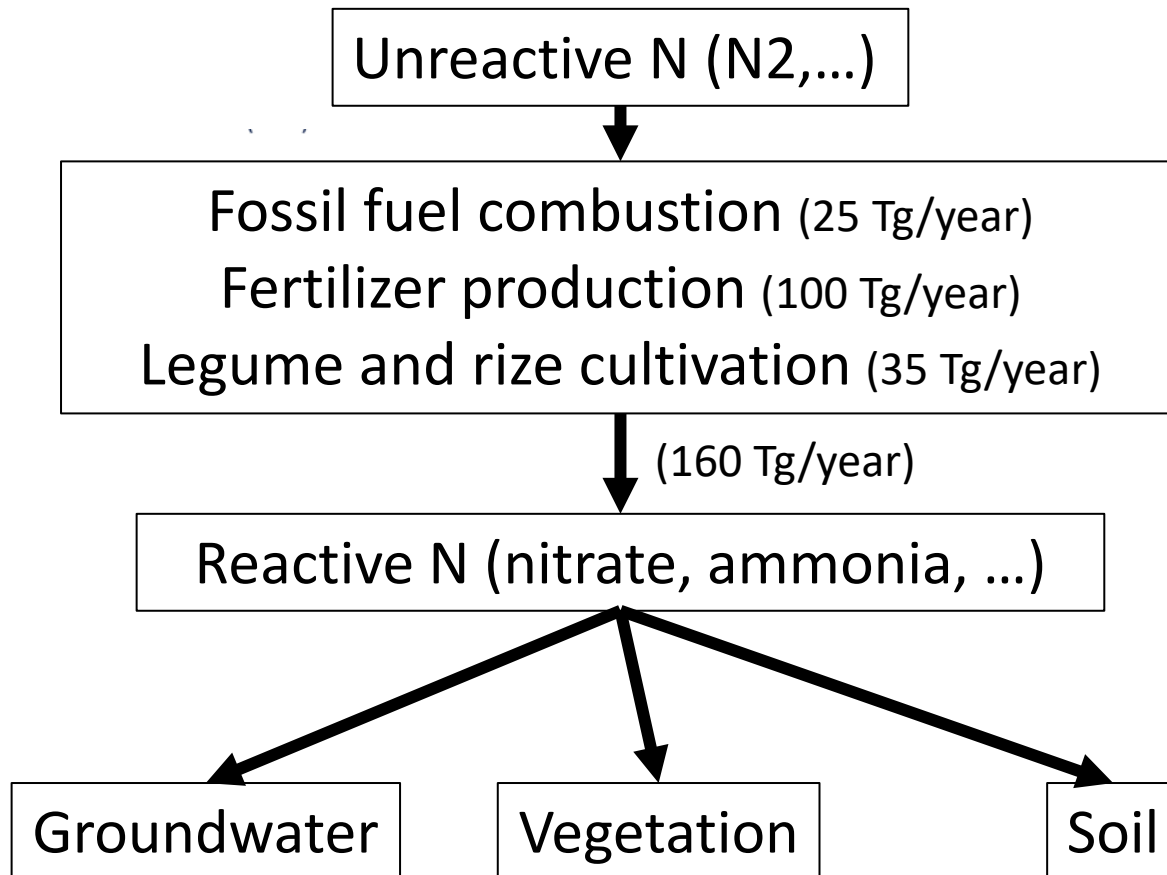
Play time-lapse

1961

2022



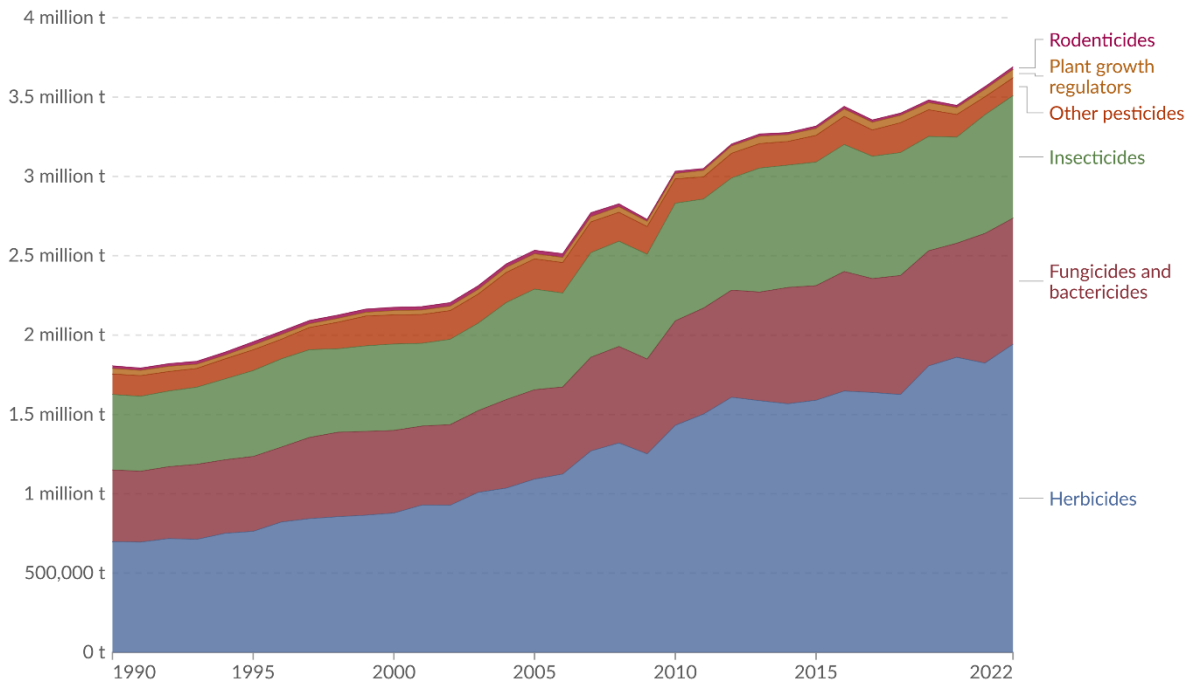
The N problem in a nutshell



Plant protection products

Pesticide breakdown by type, World, 1990 to 2022

Pesticide use, broken down by product type, measured in tonnes of active ingredient.



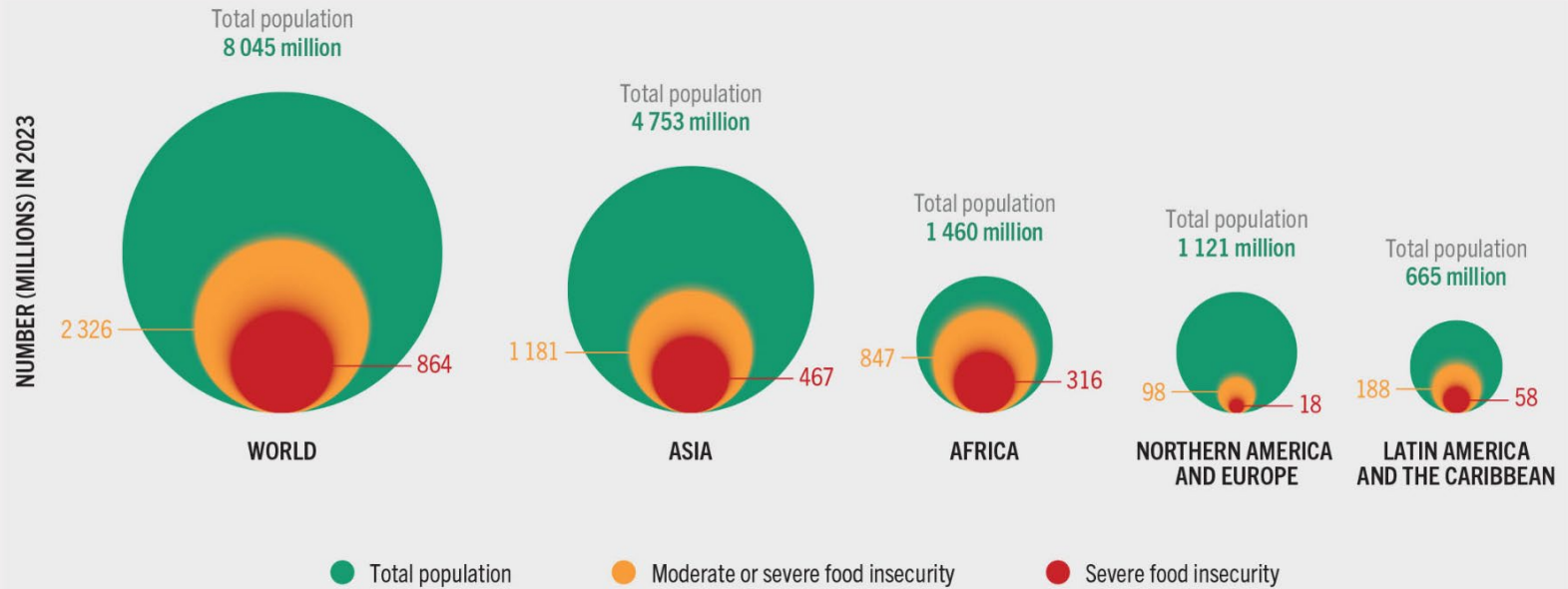
Data source: Food and Agriculture Organization of the United Nations (2024)

OurWorldinData.org/pesticides | CC BY

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

Not really a success story

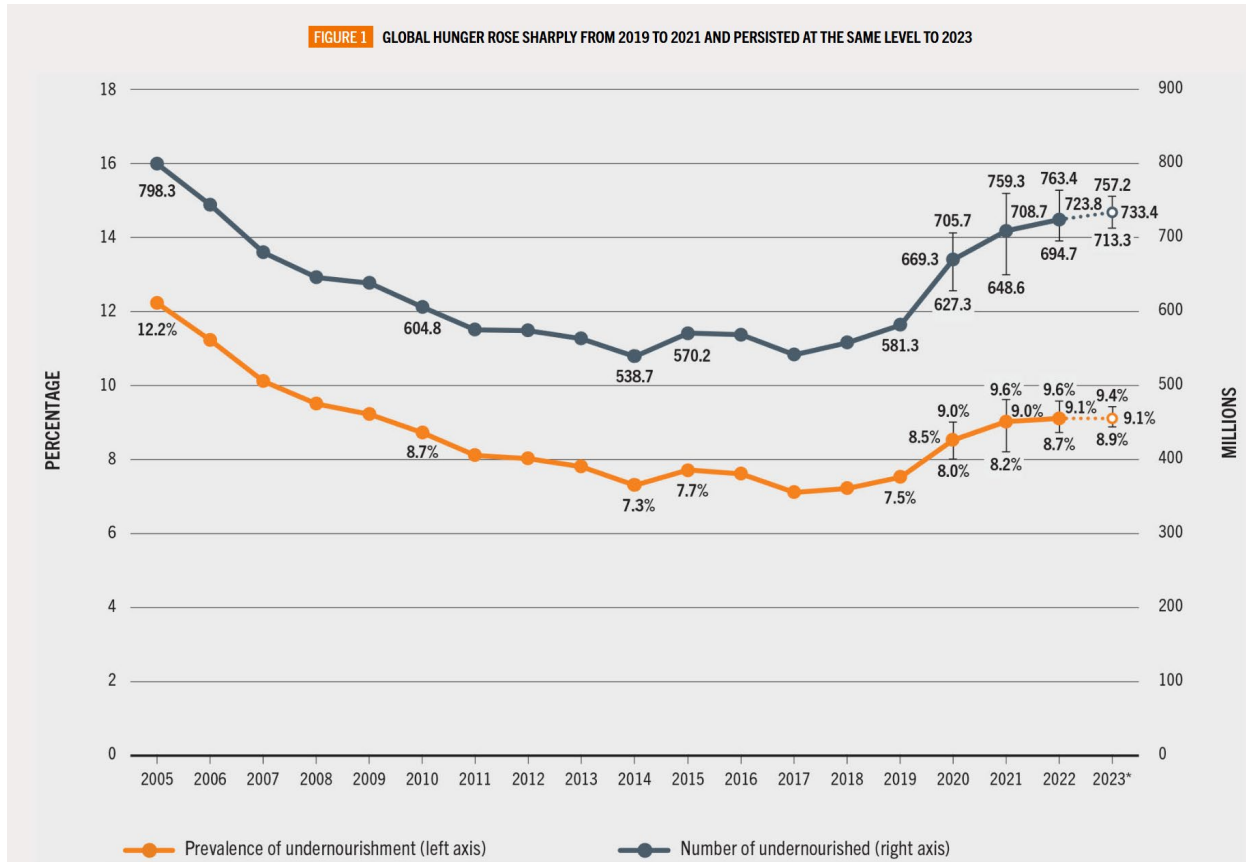
FIGURE 5 THE CONCENTRATION AND DISTRIBUTION OF FOOD INSECURITY BY SEVERITY IN 2023 DIFFERED GREATLY ACROSS THE REGIONS OF THE WORLD



NOTE: Only regions for which data were available for all the subregions are shown.

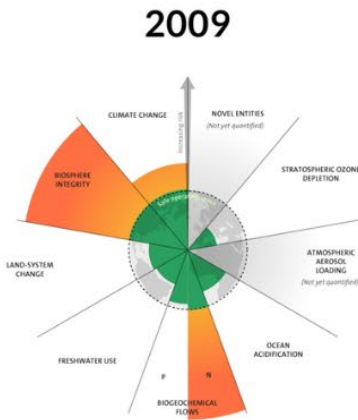
SOURCE: FAO, 2024. FAOSTAT: Suite of Food Security Indicators. [Accessed on 24 July 2024]. <https://www.fao.org/faostat/en/#data/FS>. Licence: CC-BY-4.0.

Not really a success story

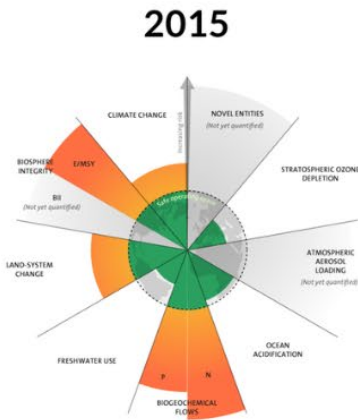


Source: FAO, 2024 The State of Food Security and Nutrition in the World 2024

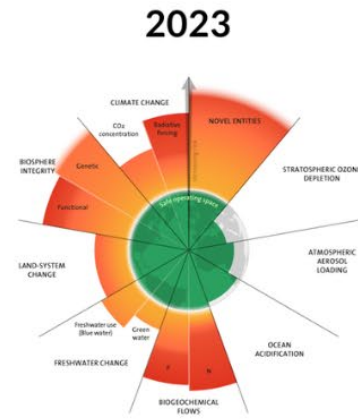
Not really a success story



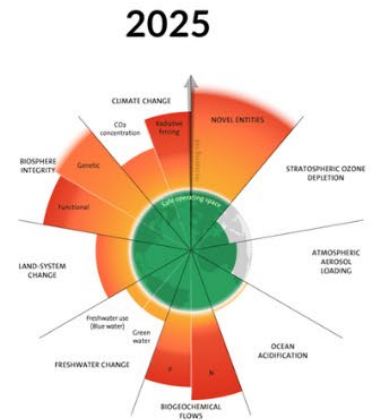
7 boundaries assessed,
3 crossed



7 boundaries assessed,
4 crossed



9 boundaries assessed,
6 crossed



9 boundaries assessed,
7 crossed

In the studies at ELI-UCLouvain

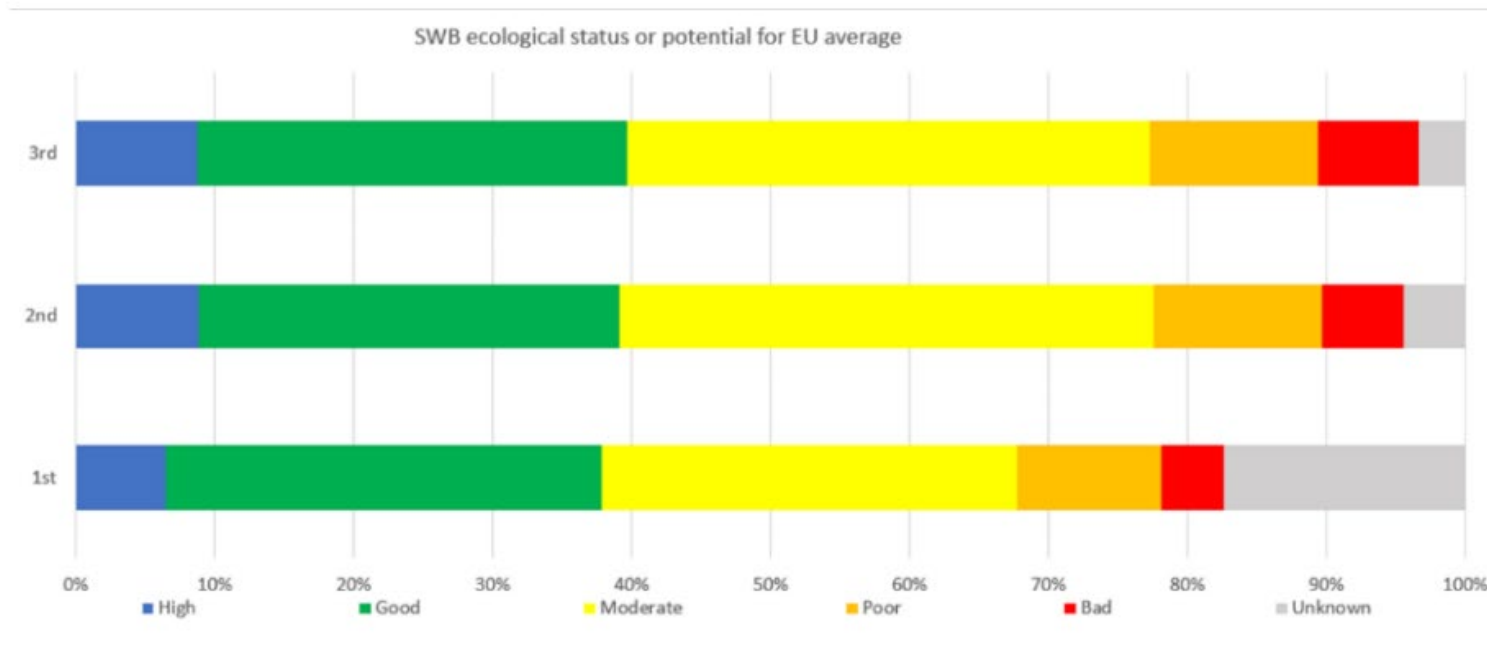
N studies at GERU

- 📍 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

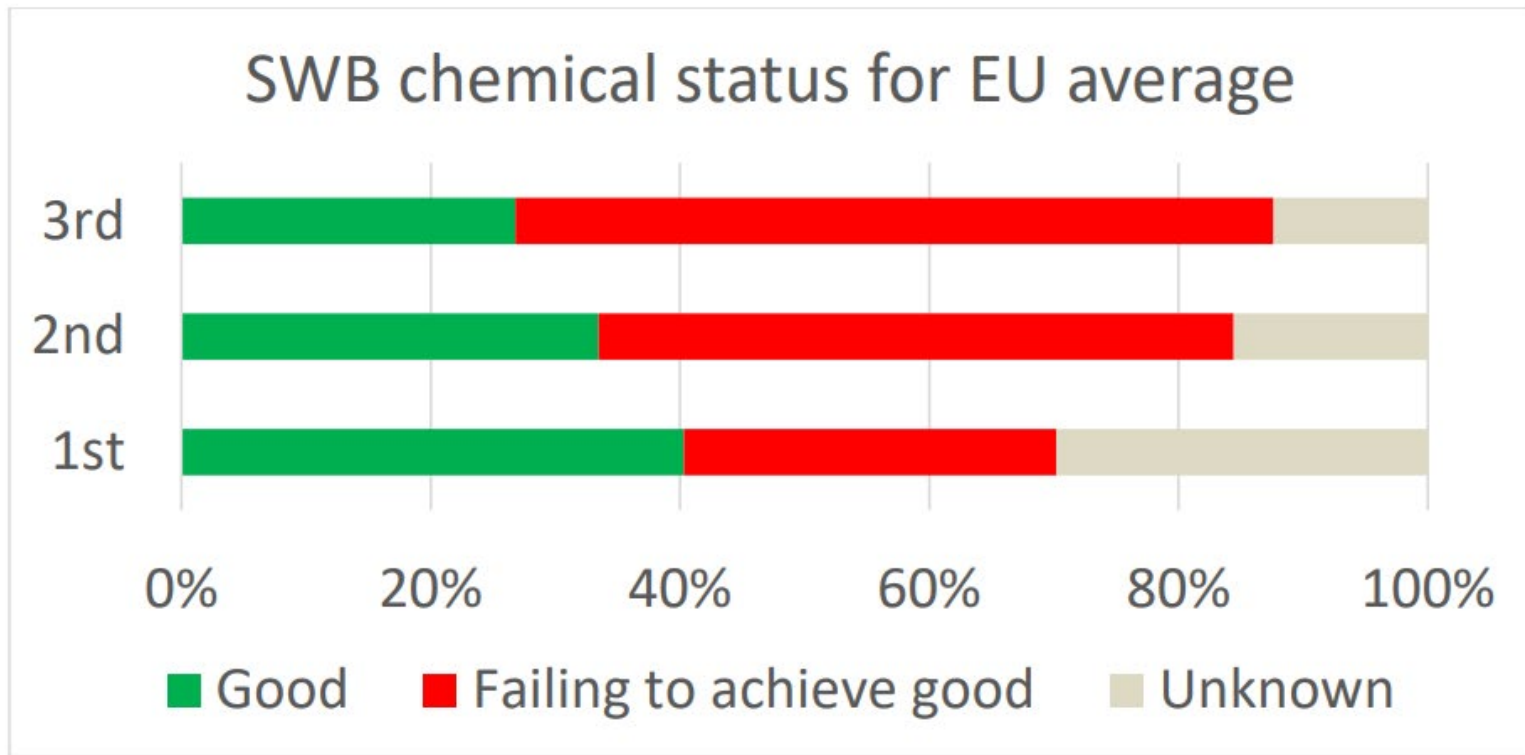
Figure 3-5. Change in ecological status assessment of EU's surface water bodies from first, second and third RBMPs (source: WISE freshwater and PDF data mining)



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

In Europe

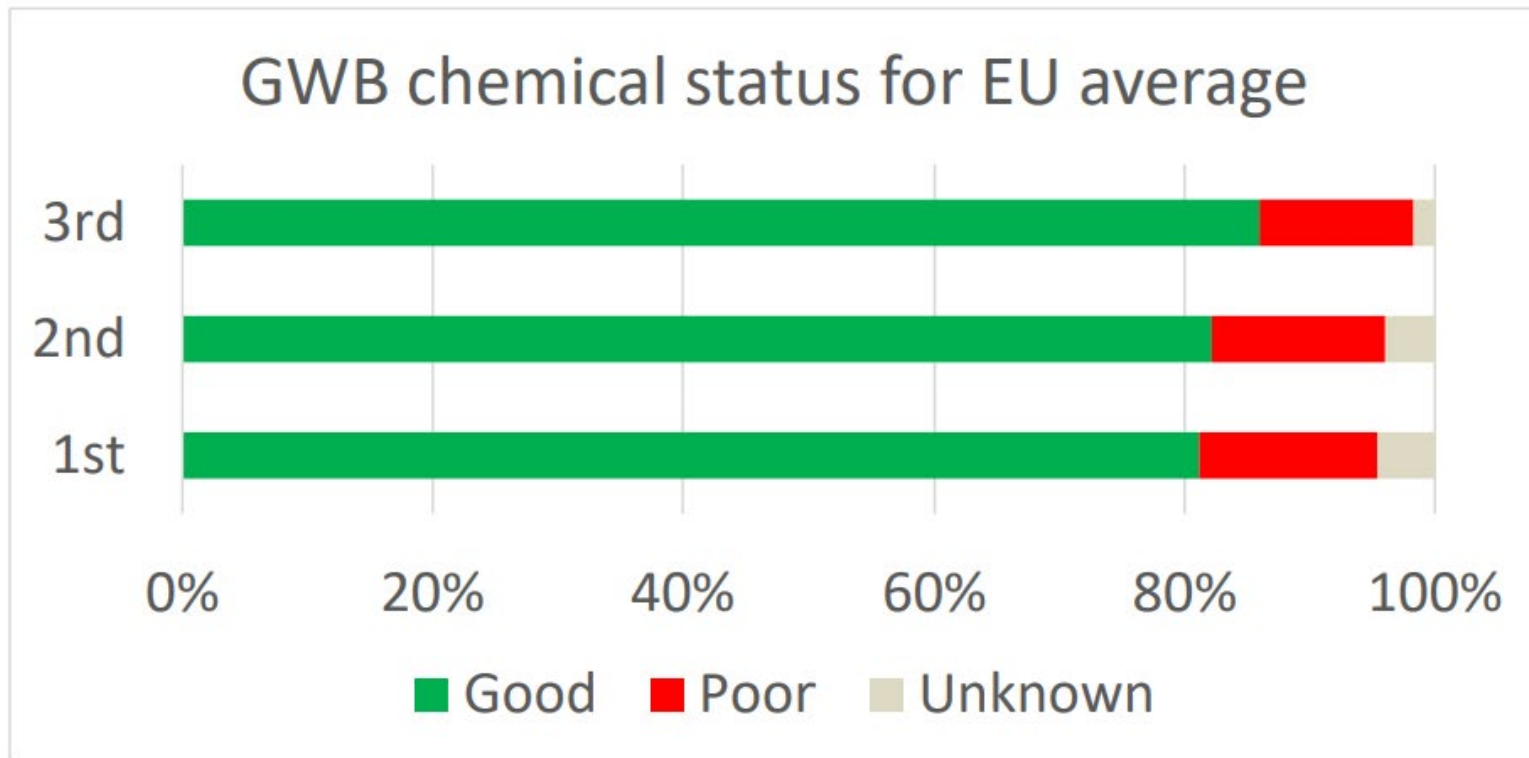
Figure 3-22. Change in the chemical status assessment of EU surface water bodies from the first, second and third RBMPs (all substances including uPBTs) (source: WISE freshwater and PDF data mining)



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

In Europe

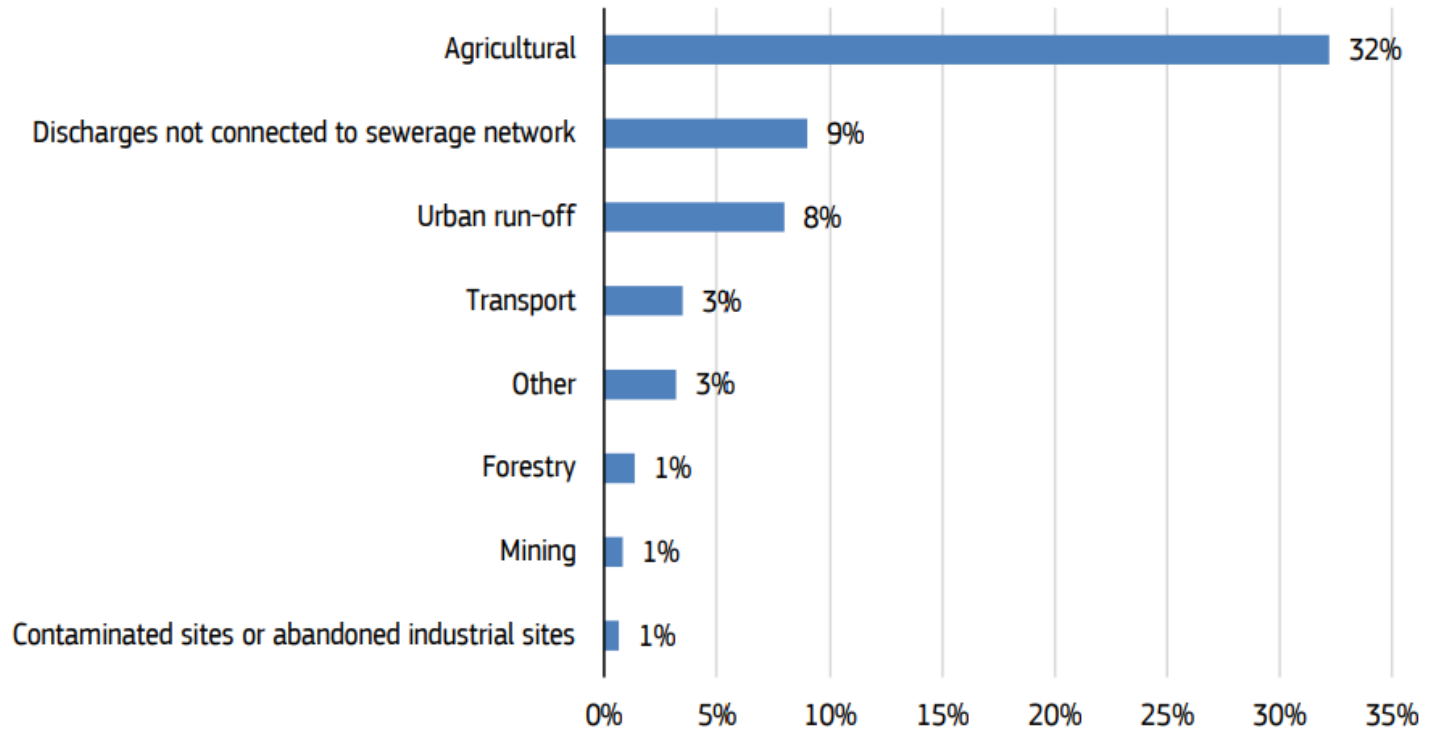
Figure 3-26. Change in the chemical status assessment of EU groundwater bodies from the first, second and third RBMPs (source: WISE freshwater and PDF data mining)



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

In Europe

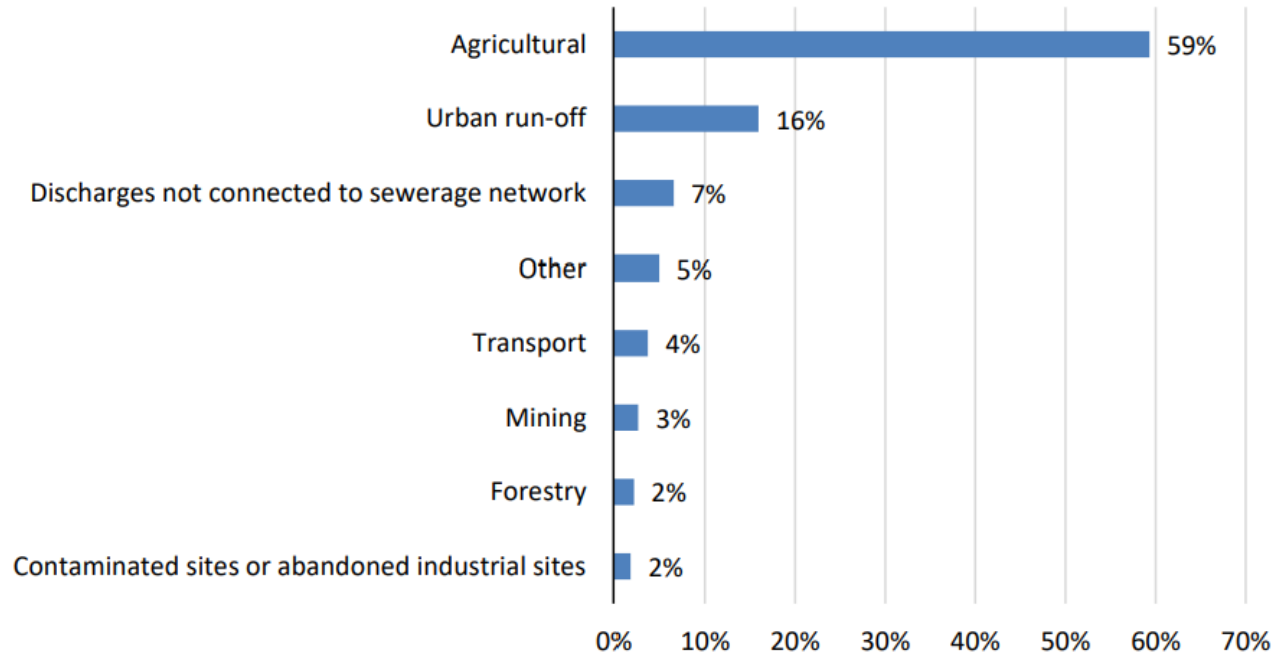
Figure 2-6a: Diffuse pollution pressures for surface water bodies in 3RBMPs (from WISE Freshwater – only countries with electronic reporting)



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

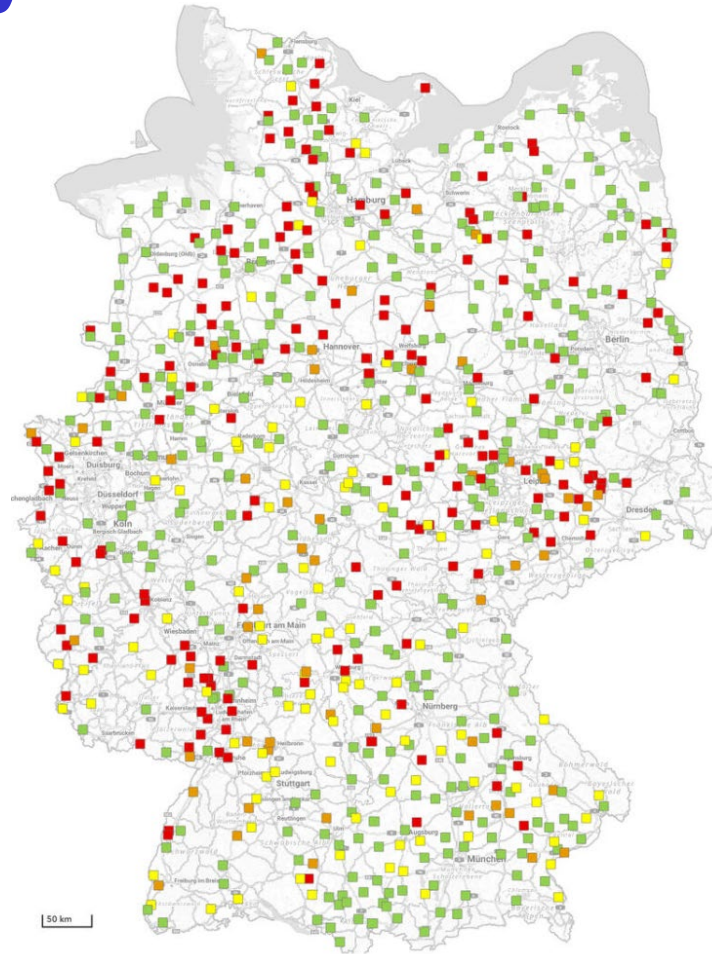
In Europe

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



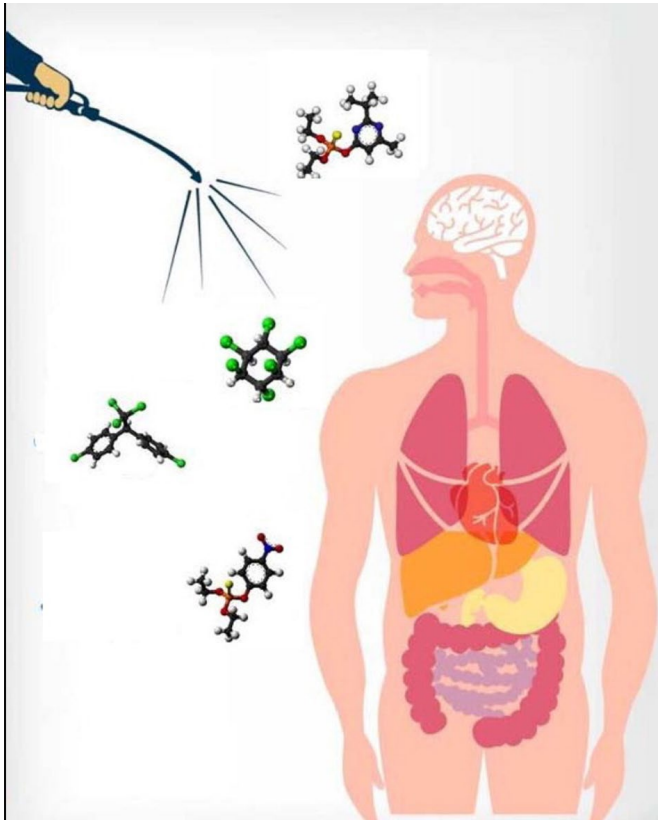
Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

In Germany



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

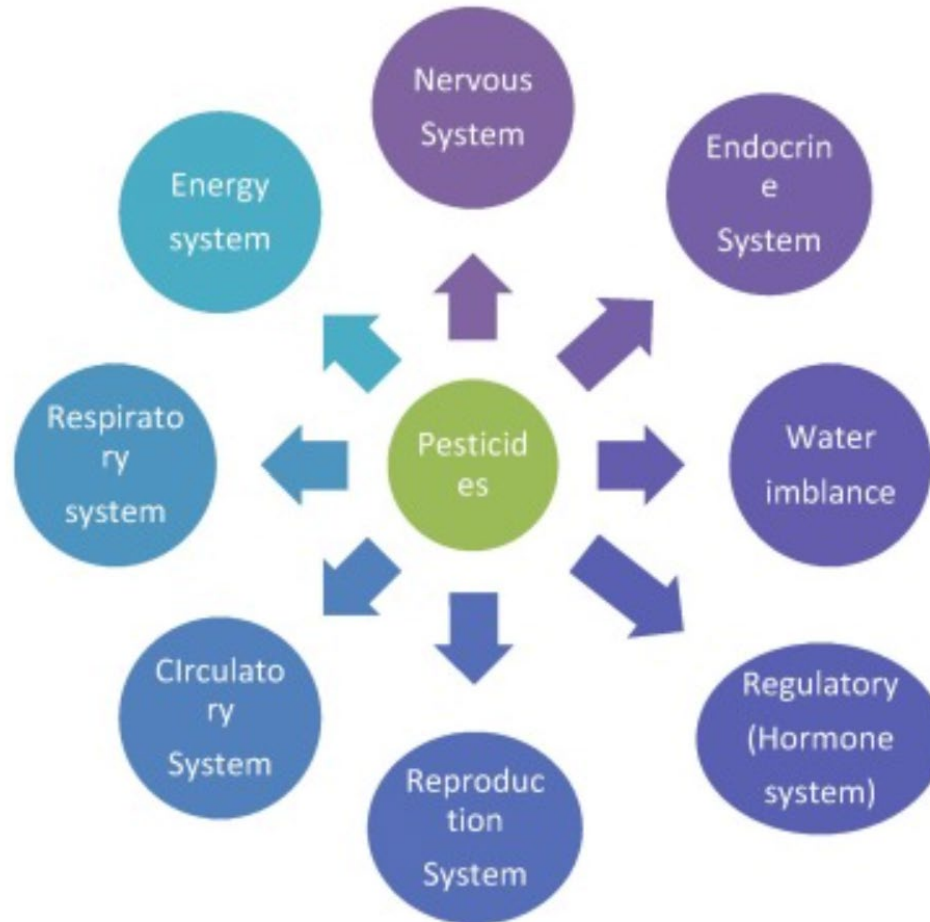
Impacts



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

Men's health and chemicals

Prostate cancer^{11,122}

3rd
most diagnosed cancer among men in the EU

330,000
Estimated cases annually

Constituting **12.1%** of all cancer cases diagnosed in men

European Commission data in the **European Cancer Information System (ECIS)**

Male fertility¹⁵⁻¹⁷

Studies show a sharp drop in sperm counts across Europe and globally, with links to environmental exposures.

Sexual dysfunction¹⁸

Sexual dysfunction and testosterone deficiency (hypogonadism) are increasingly reported, with many cases of unclear etiology.

Testicular cancer^{13,14}

Testicular cancer incidence increased significantly in recent decades

Particularly among young men aged **15-44**

Health impacts^{2,10,19-24}

Health impacts extend to future generations, as exposures during prenatal development, and even before conception, are associated with reproductive and hormonal disorders in male offspring

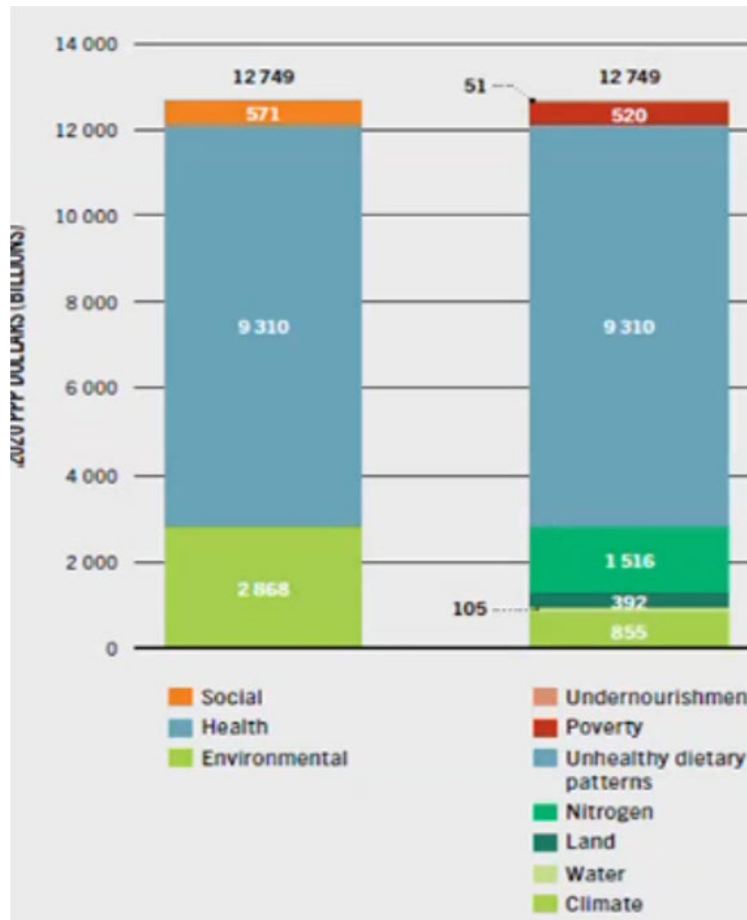
Endocrine Disrupting Chemicals (EDCs) can alter the epigenetic profile of sperm cells, including DNA methylation and histone modifications.

These changes may affect the embryonic epigenome at conception, potentially increasing the susceptibility of offspring to a wide range of diseases — even in the absence of direct exposure

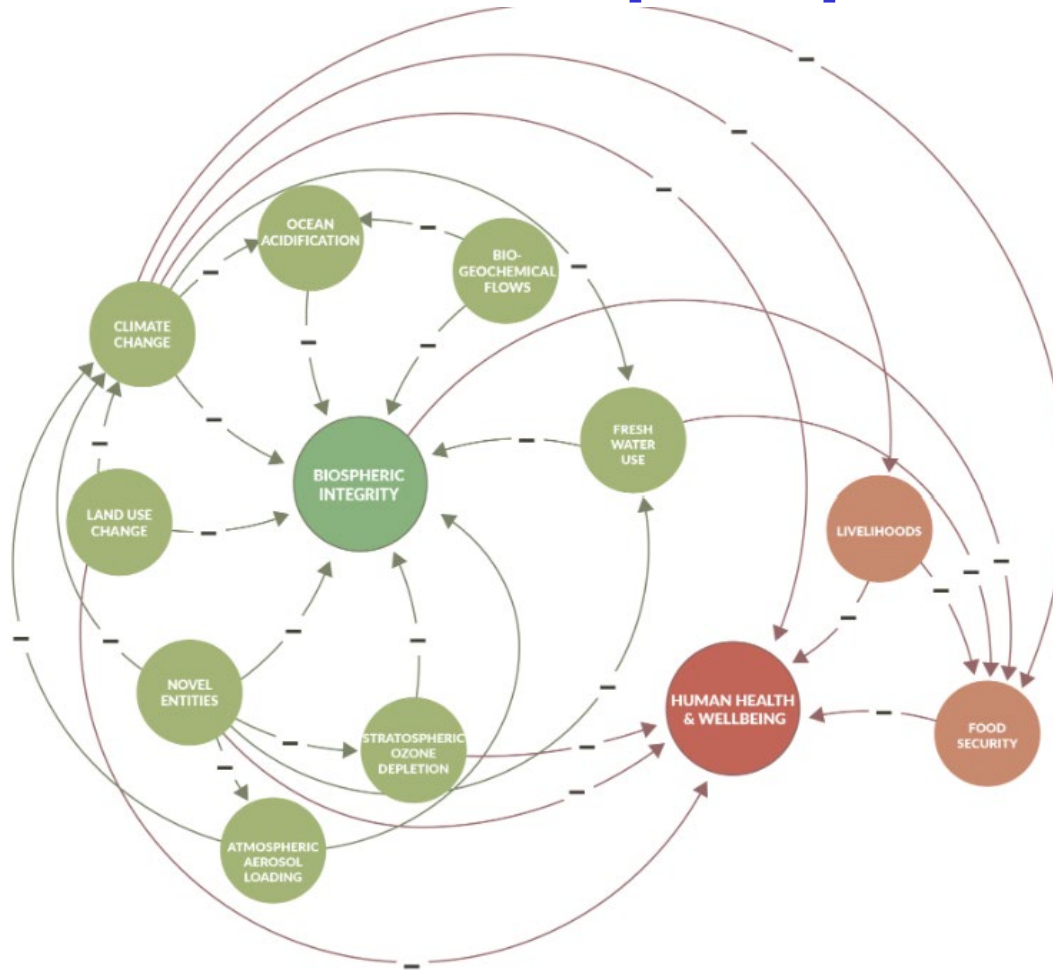
Such epigenetic reprogramming has been observed in both animal models and human studies, raising concern that today's chemical exposures may carry consequences not only for current health, but also for the long-term health of future generations

Source: Cannarella et al, 2025, HEAL

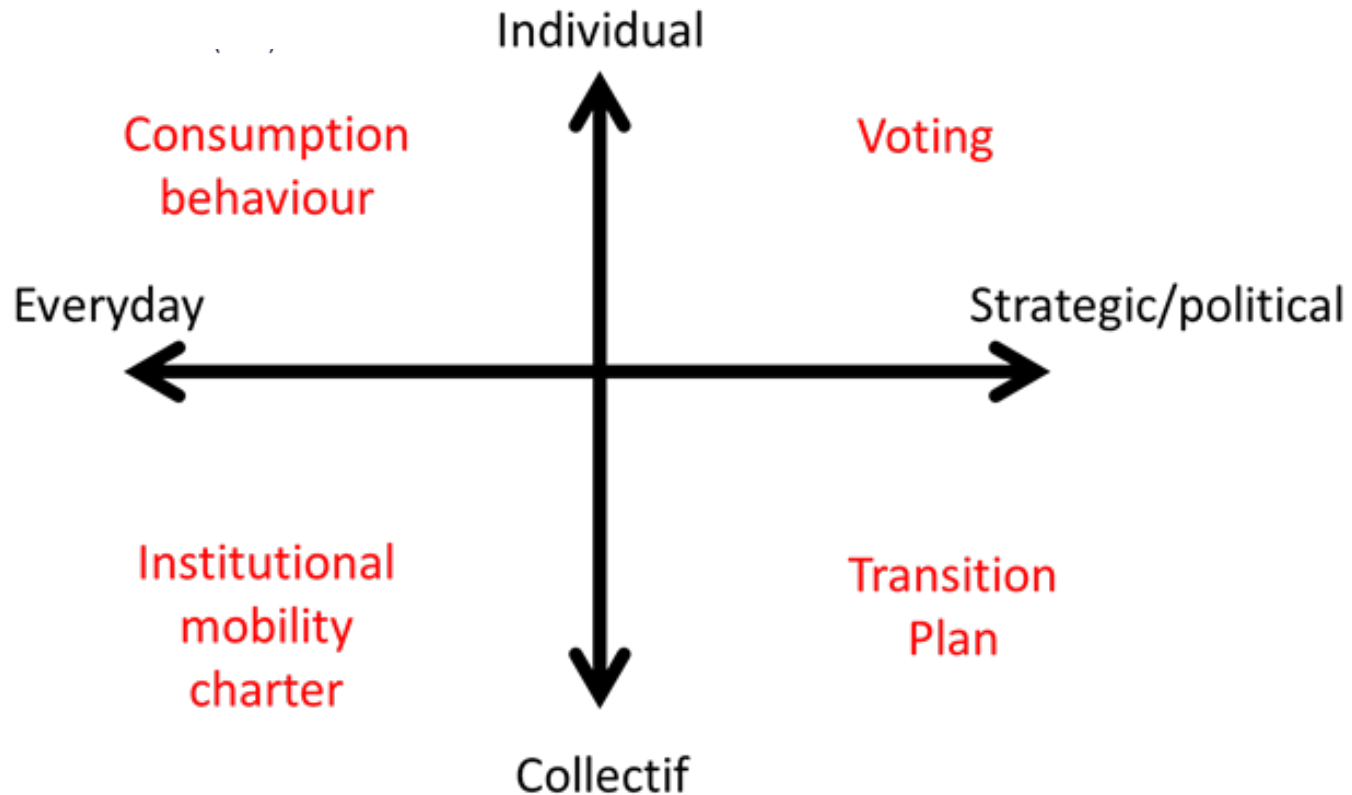
Impacts



It's a wicked complex problem



Agency space: Yes we can!



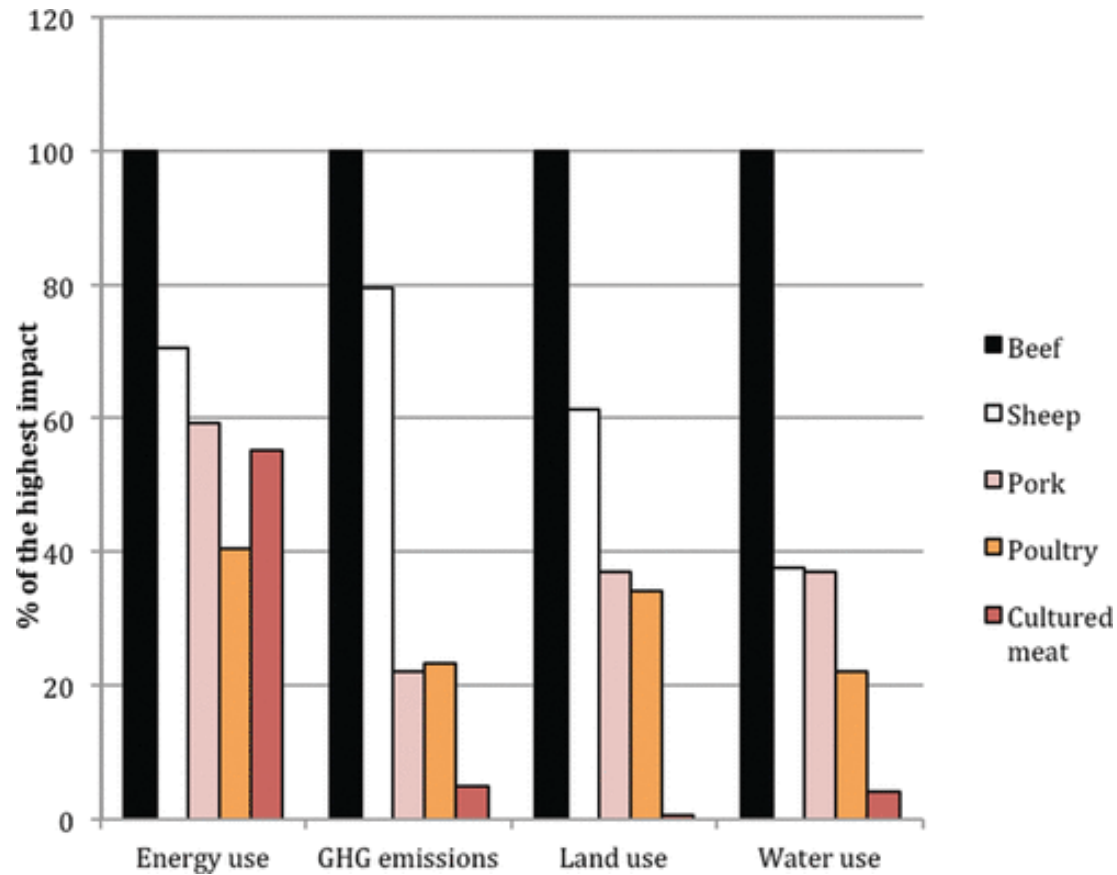




35000 decisions a day... Are you taking the good decisions ?



Changing diets



Source: Tuomisto and Teixeira, 2011. EST. <https://doi.org/10.1021/es200130u>



Conservation – regenerating – ecological agriculture

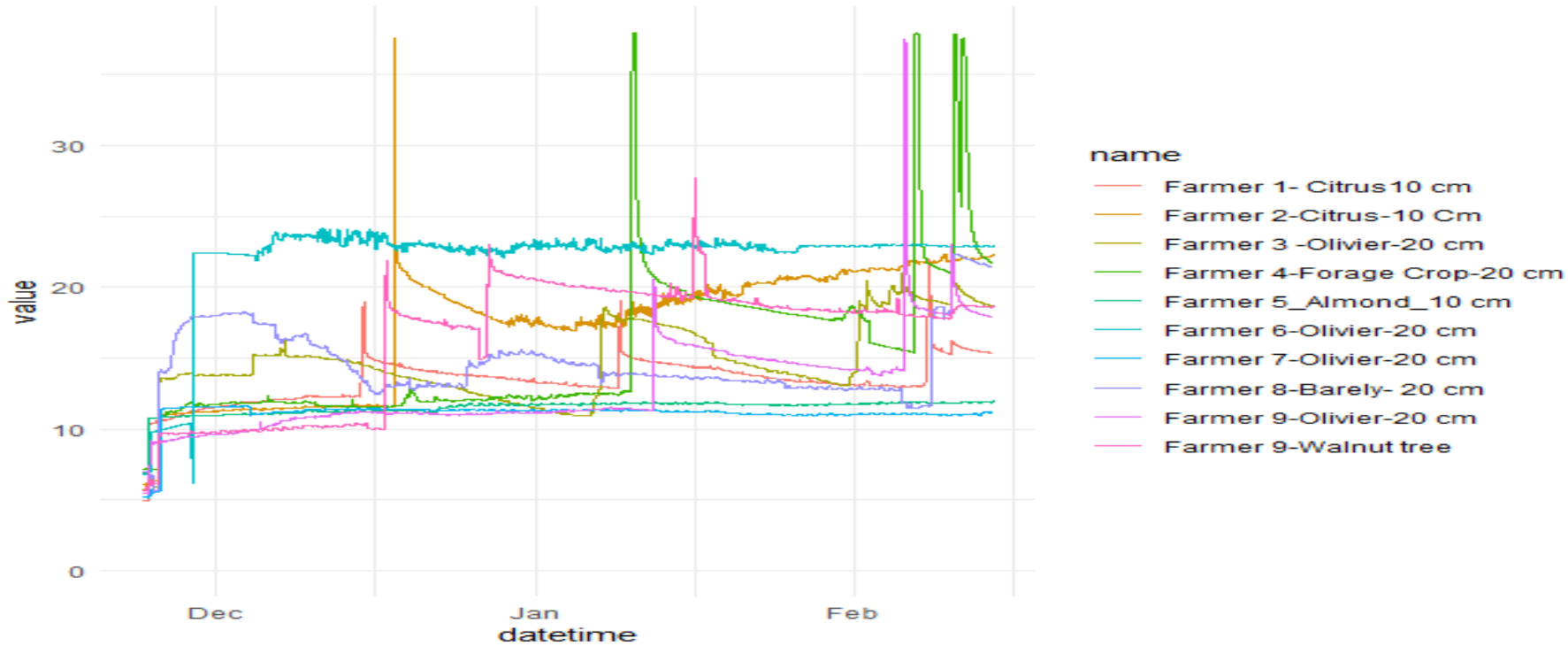
Criterion	Conservation agriculture	Agro-ecology	Regenerative agriculture	Bio-agriculture
Use of pesticides	Sometimes authorized	No	Limited or avoided	Forbidden
Labour	No	Limited	No	Sometimes
Official certification	No label	No label	Sometimes	Label
Main objective	Soil conservation and production	Integrating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

Irrigation practice



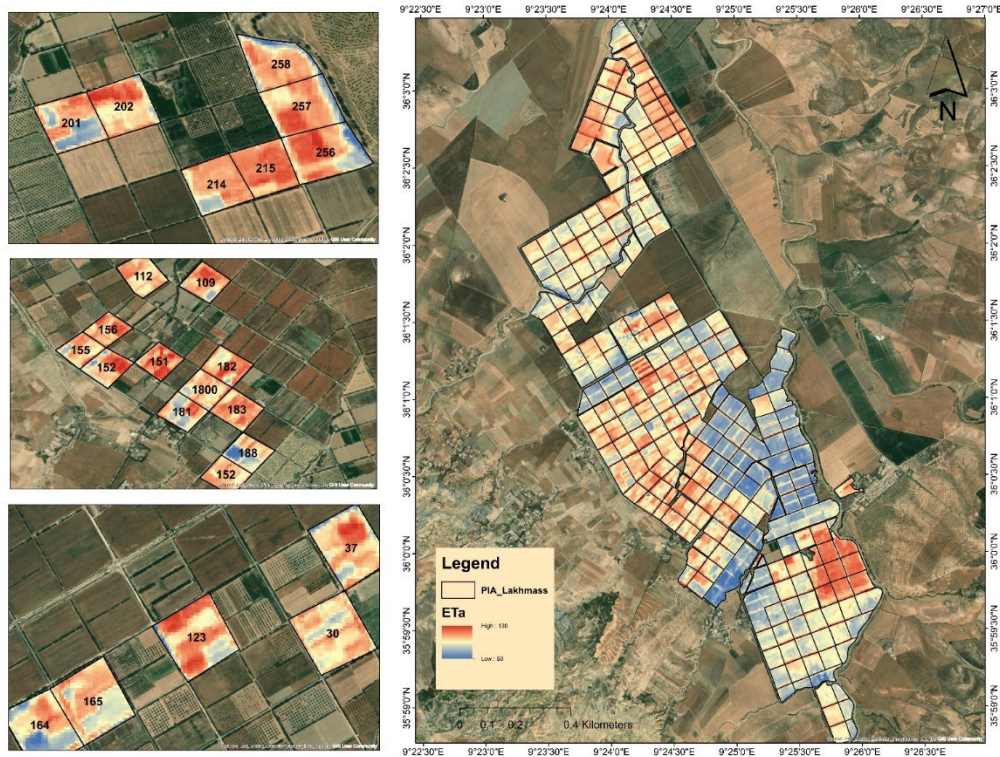
Soil moisture monitoring with engaged farmers in 9 different field parcels in the Siliana basin. Source: Amani Belhaj, Vanclooster et al, 2023. Work in progress

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



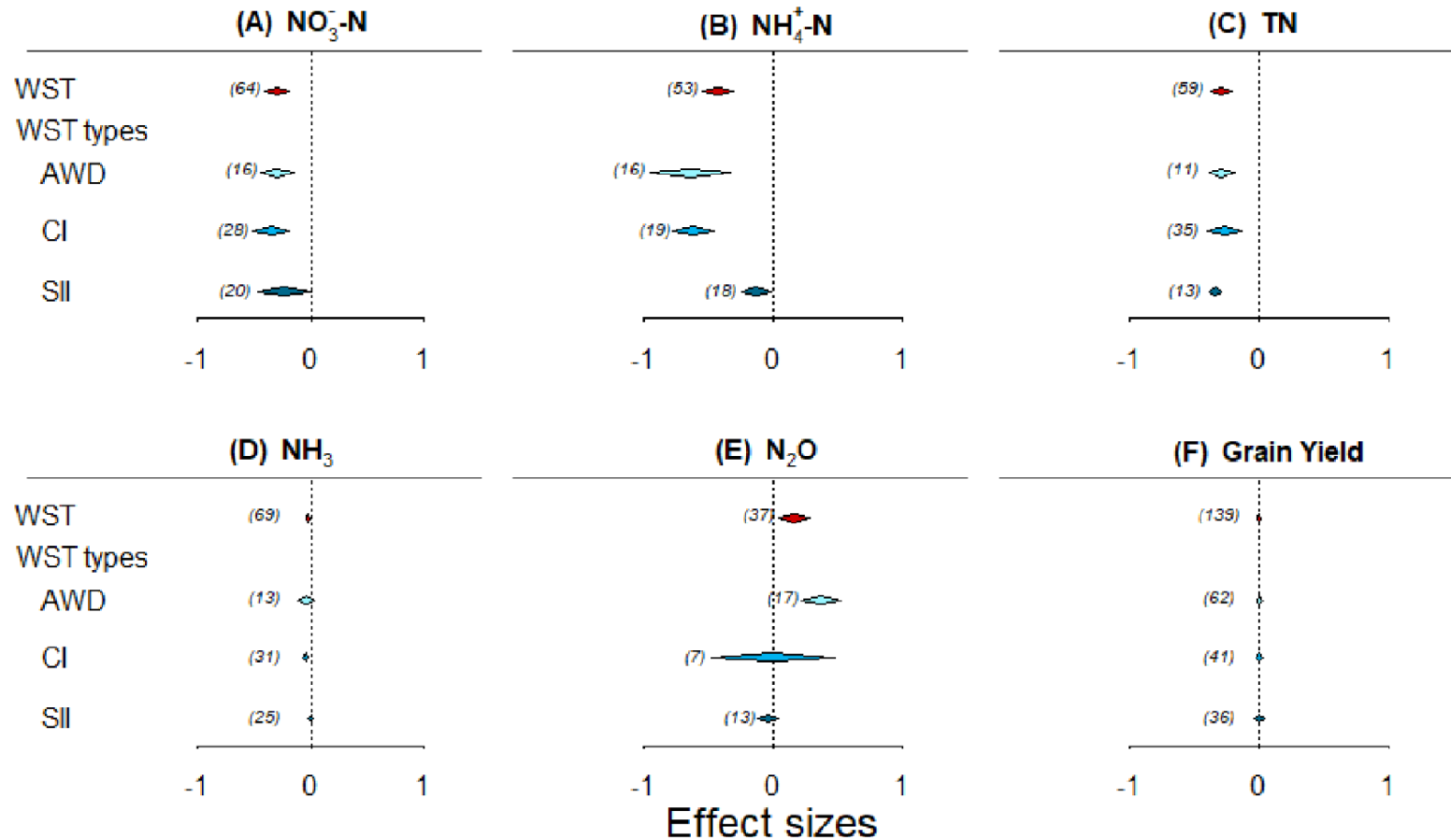
Observed soil crop evapotranspiration in the Siliana basin using remote sensing technology.
 Source: Amani Belhaj, Vanclooster et al, 2023. Work in progress



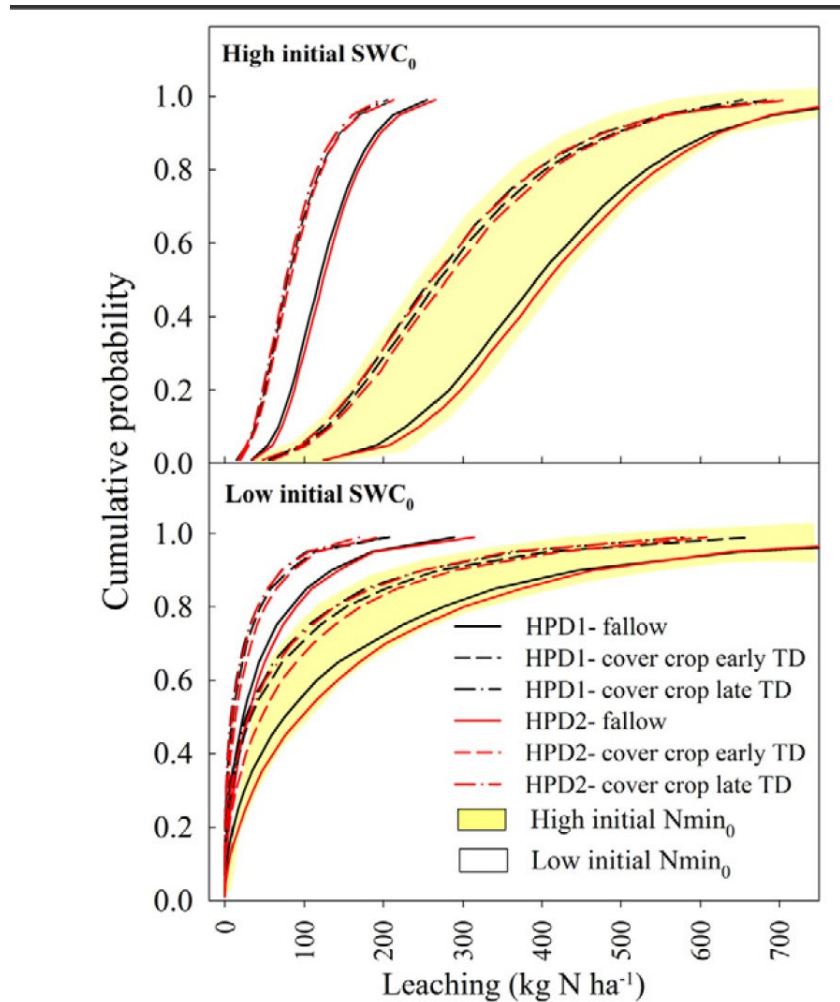
Irrigation practice



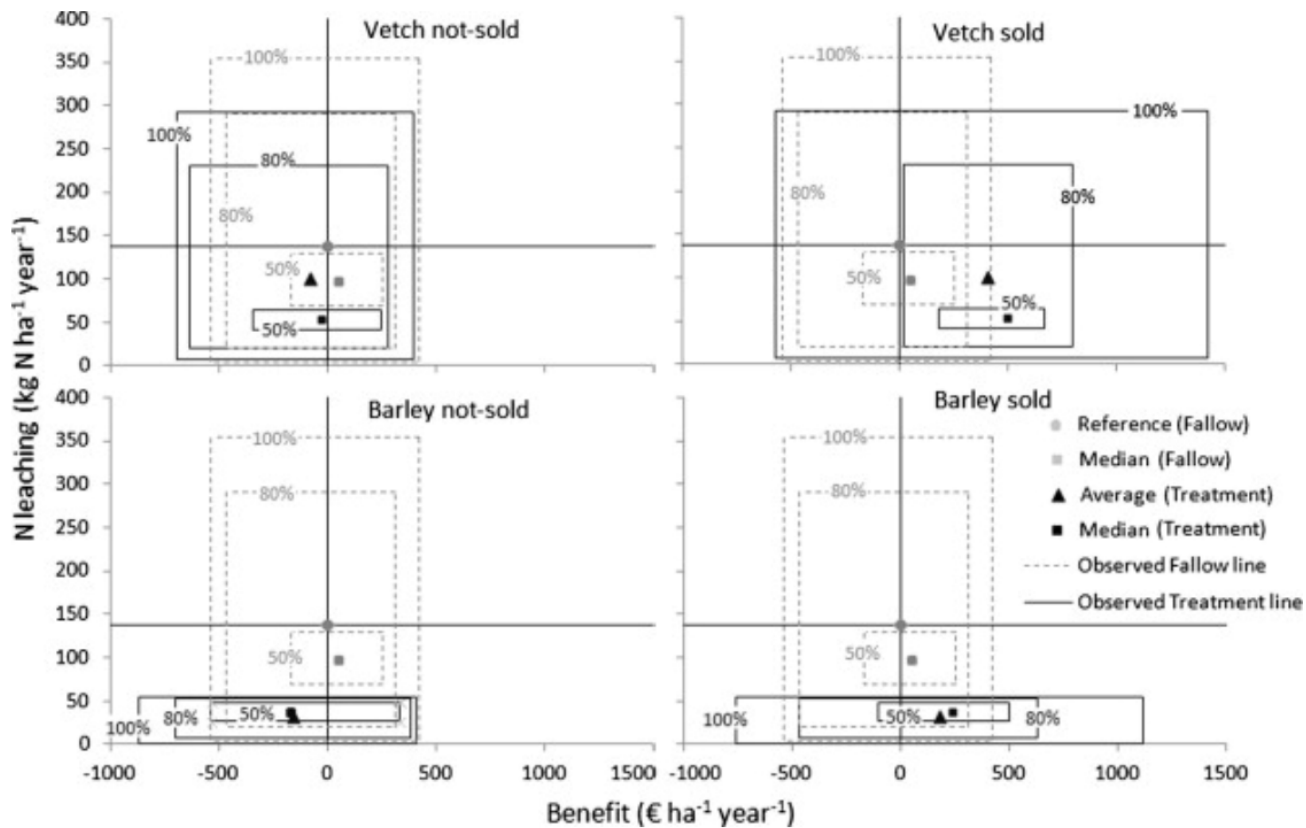
Irrigation practice



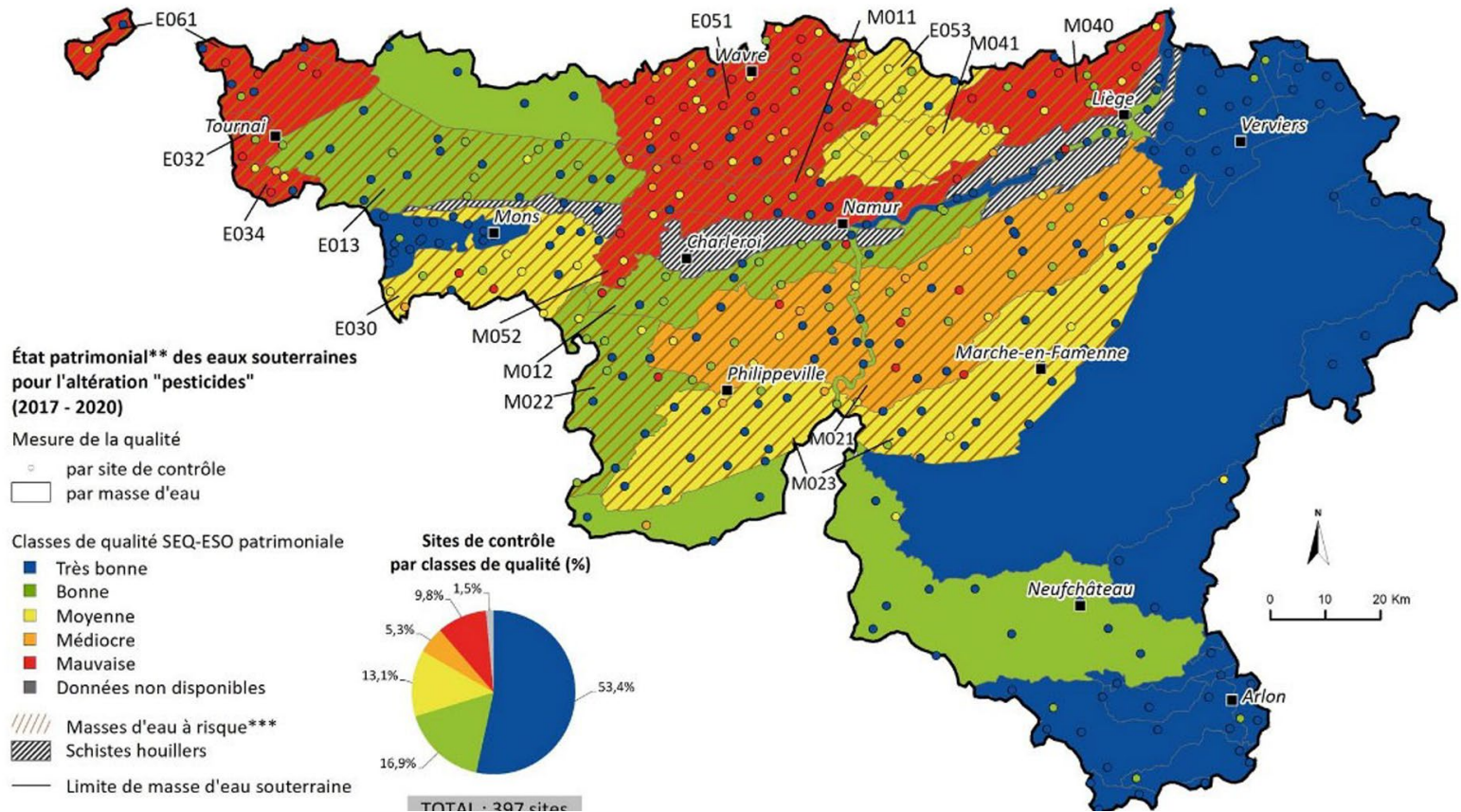
Effect of cover crops on N leaching



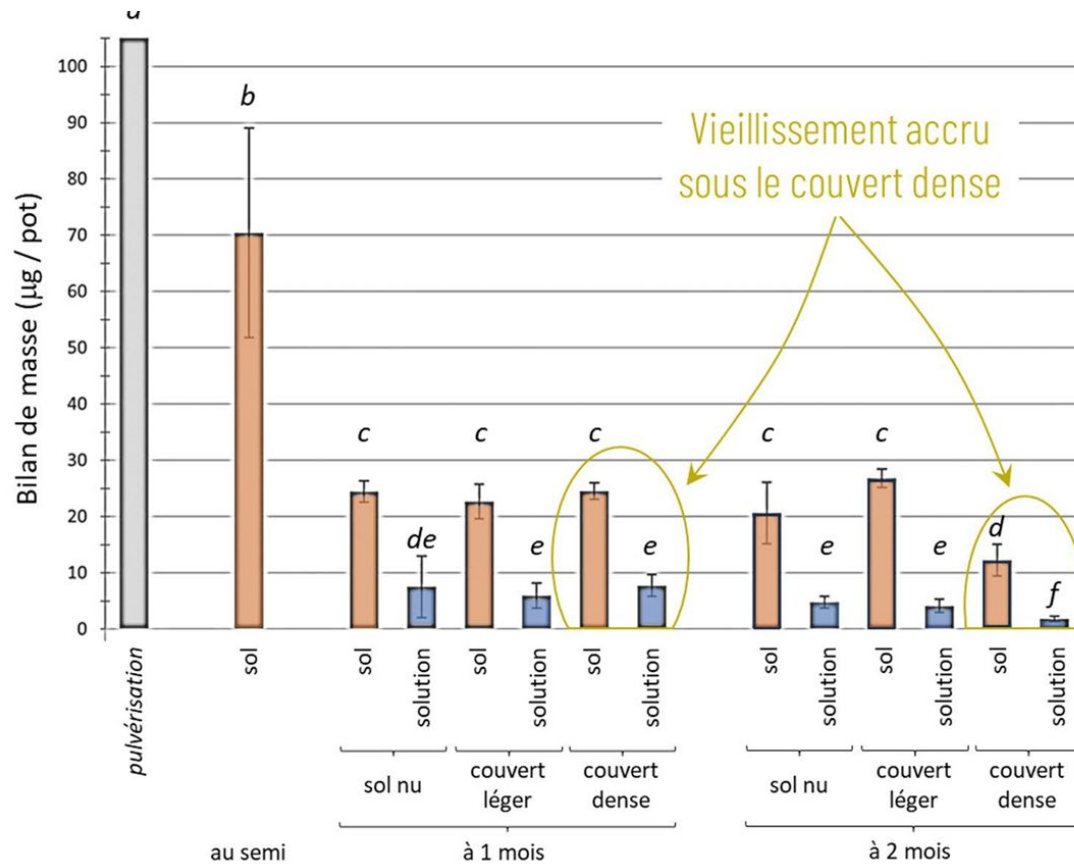
Effect of cover crops on N leaching and economic benefit



Effect of cover crops on pesticide residues



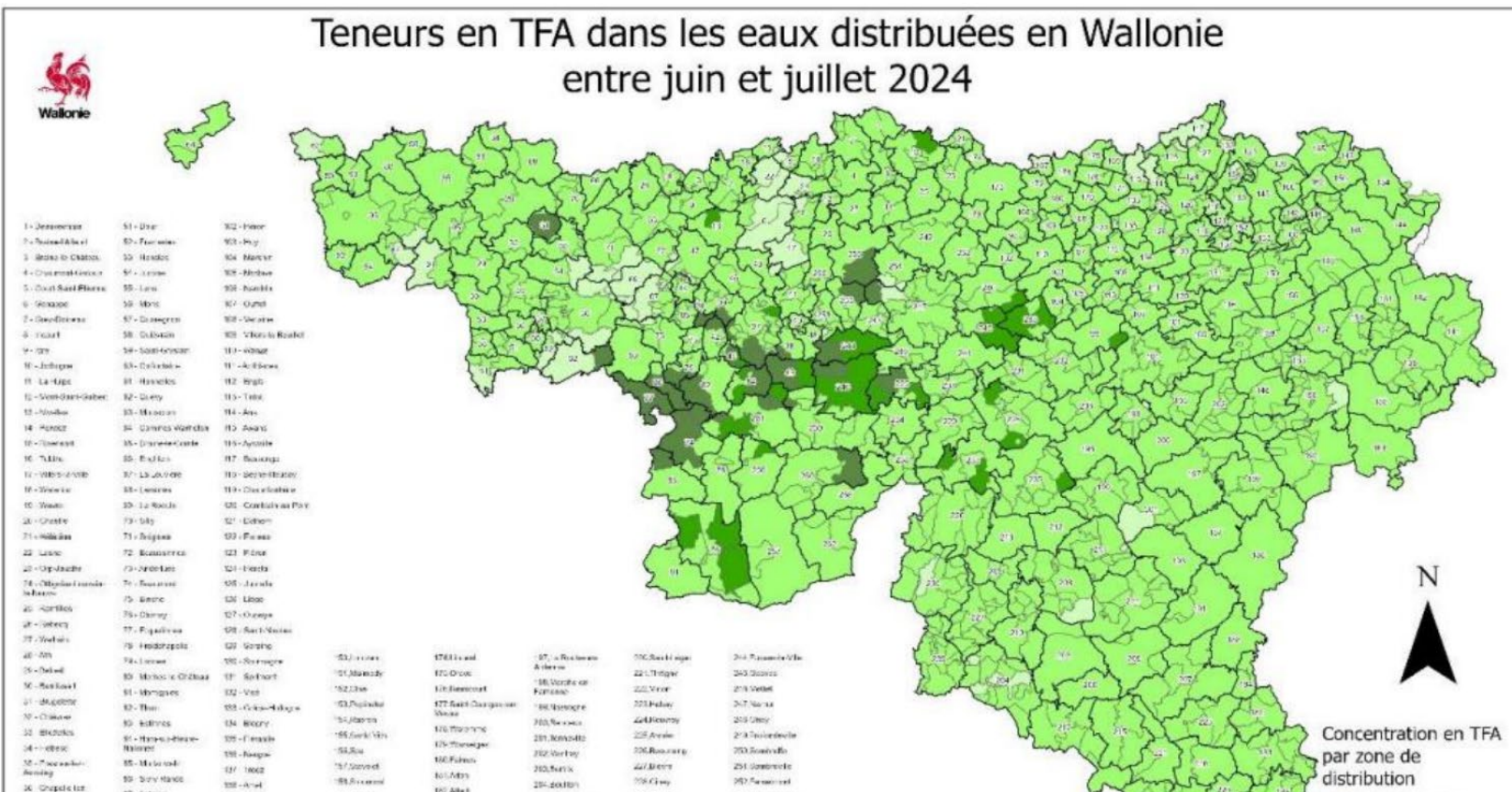
Effect of cover crops on pesticide residues





PFAS

Teneurs en TFA dans les eaux distribuées en Wallonie entre juin et juillet 2024



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..





Topics Analysis and data Countries



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



NEWS ▾ RESOURCES ▾ EVENTS ▾ ABOUT US ▾

NEWS

Alternatives to PFAS are available for many applications

Scientists compile open access online database on PFAS applications, functions provided in these applications, and potential functional alternatives; identify 325 PFAS applications, with 40 having suitable substitutions; database enables identification of non-essential PFAS uses

🕒 February 4, 2025 👤 Lisa Zimmermann ⌛ 2 minutes

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

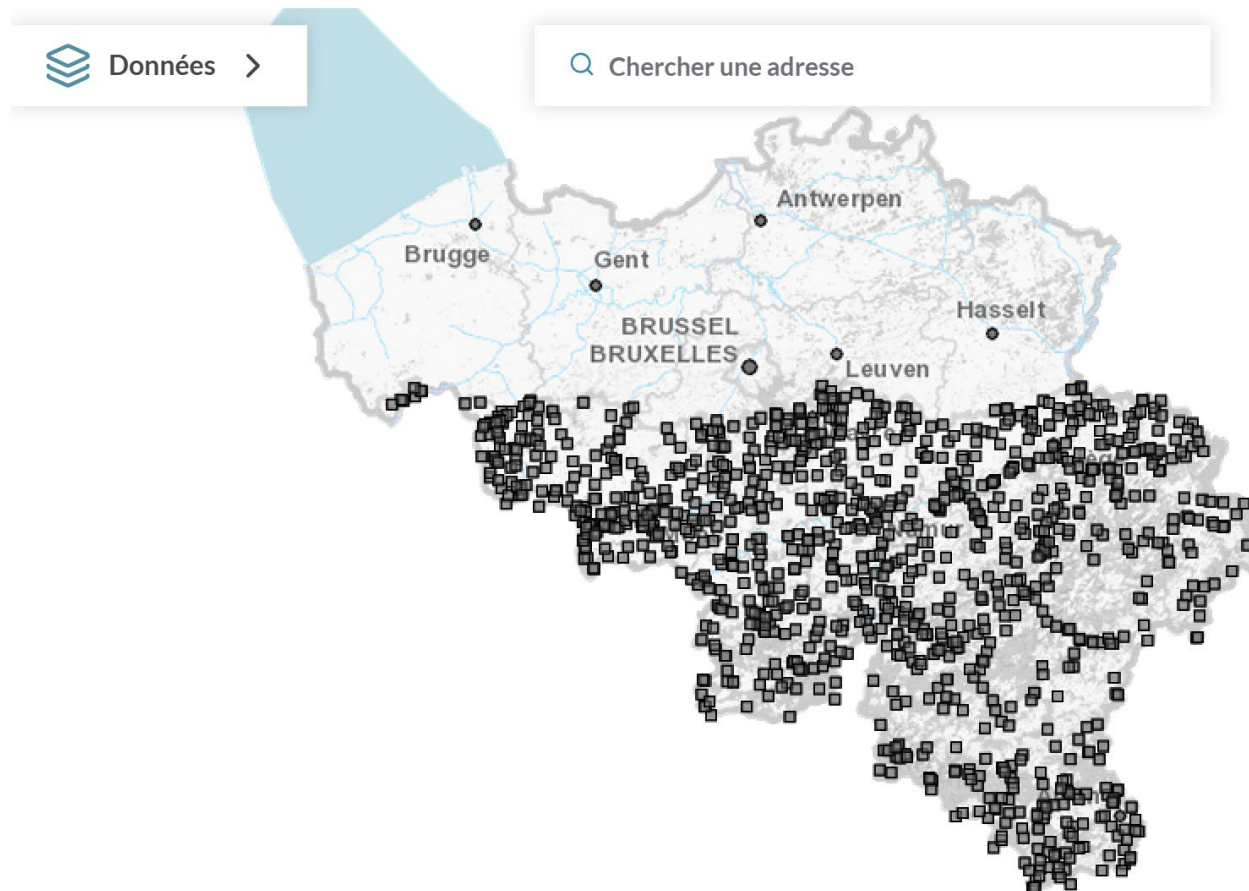
Related articles





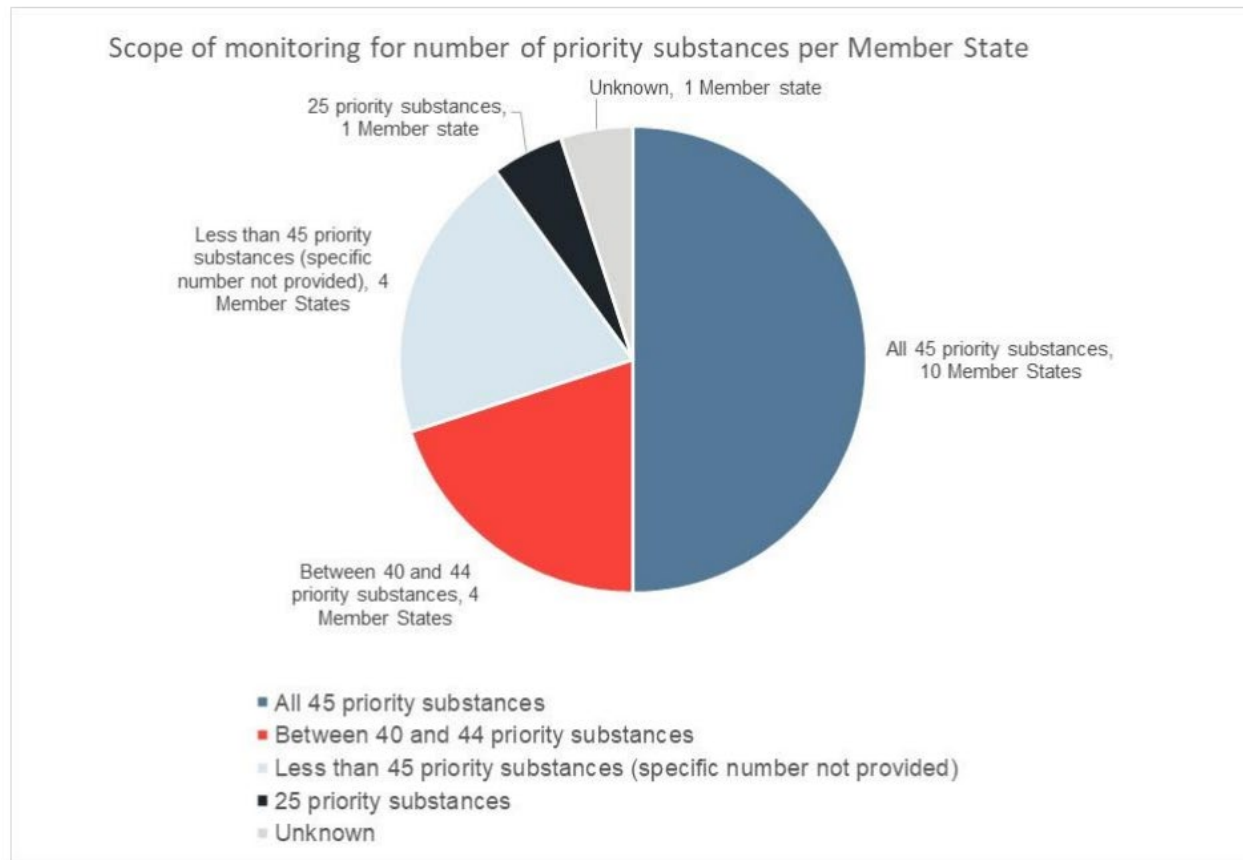
Monitoring capacity

Carte



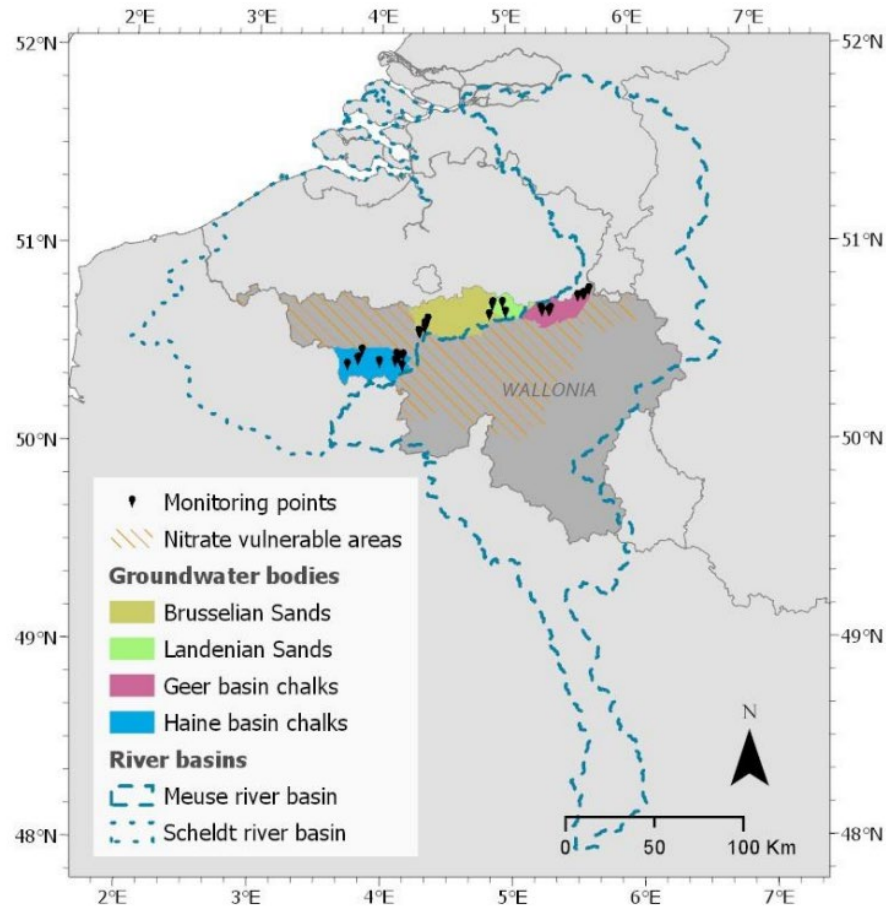
Monitoring capacity

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

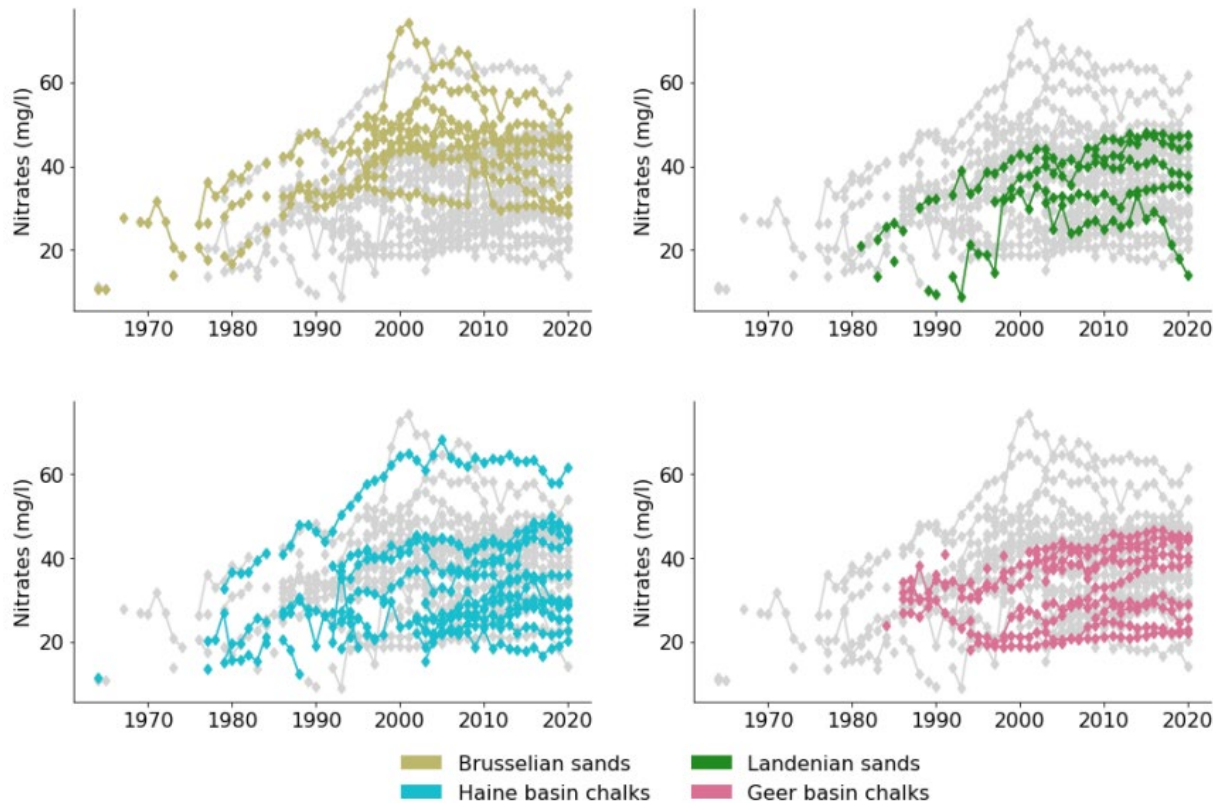


Source: EU, 2025. COMMISSION STAFF WORKING DOCUMENT EU Overview Third river basin management plans

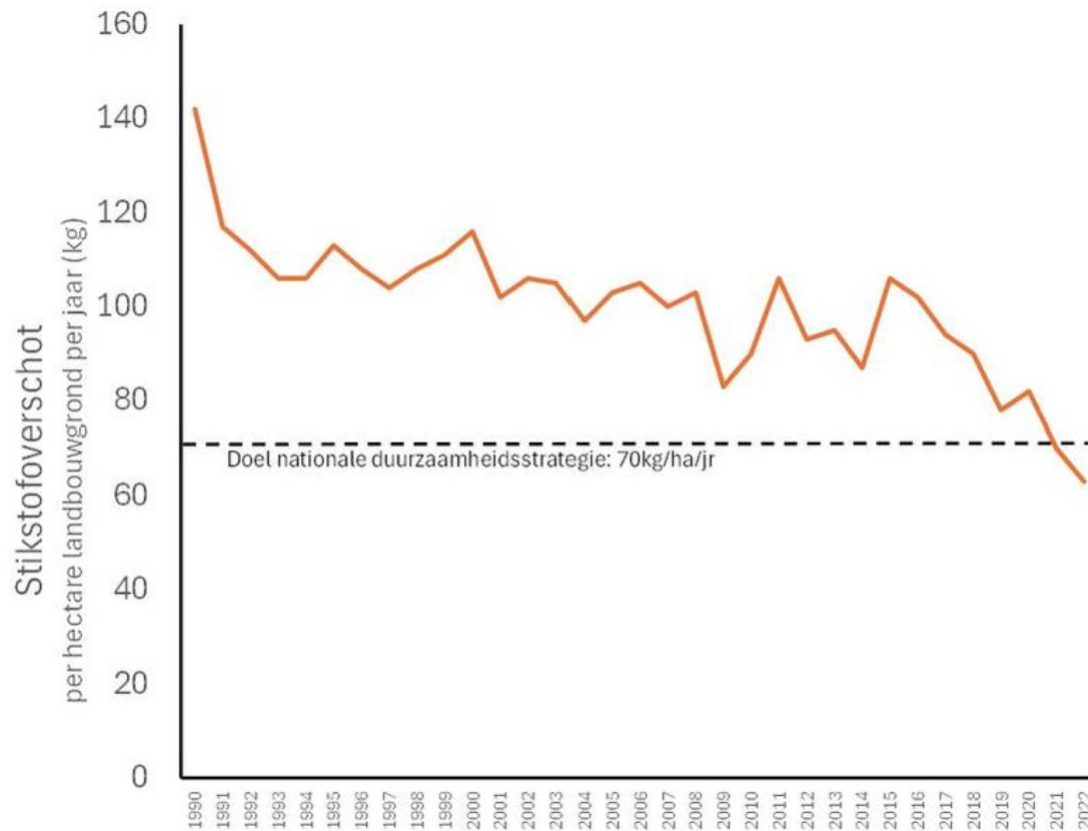
Phasing out: Brusselean sands, Wallonia



Phasing out: Brusselean sands, Wallonia



Phasing out: Germany



Phasing out – legacy effects

