SAFE – Safe Food Advocacy Europe

Update on Micro and Nano plastic soil contamination and migration through the Food chain

Luigi Tozzi, SAFE-Deputy Manager

11-12 June 2026 – EFSA Stakeholder Emerging Risk group - Granada

safe
Safe Food Advocacy Europe
STRIVING FOR SAFER FOOD FOR EUROPEAN CONSUMERS

SAFE

safe
Safe Food Advocacy Europe
STRIVING FOR SAFER FOOD FOR EUROPEAN CONSUMERS

Who we are

SAFE is an independent non-profit organization that **represents interests of European consumers** all over Europe on issues connected to food safety and agriculture.

Mission

We strives to **protect and advance consumers' rights** in **EU** food policy**.**

Activities and goals

- Lobbying to improve the EU legislative framework
- Raising public awareness and training consumers
- Leading several EU projects on food safety and agriculture

Micro and Nano plastics

- In **2016, EFSA** identified the need to generate more data on their occurrence levels in food and on their potential effects on human health following exposure.
- In the **25th EFSA Scientific Colloquium** on **2021**, the Italian Istituto Superiore della Sanità presented findings on the exposure of humans and animals to micro- and nano-plastics in food and feed.
- In **June 2023**, SAFE Food Advocacy Europe presented to EFSA's Stakeholder Panel on Emerging Risks a paper on *"Concerns the risk of food contamination by BPA through its release from micro- and nano-plastics in soils and irrigation water"*
- In **June 2024** SAFE Food Advocacy Europe presented to EFSA' Stakeholder Group on Emerging Risk a paper on *"Micro and nano plastics in agricultural soils could act as vectors of pollutants in the food chain?"*
- In **November 2025** SAFE Food Advocacy Europe presented to EFSA' Stakeholder Group on Emerging Risk a upgrade to the 2024 paper

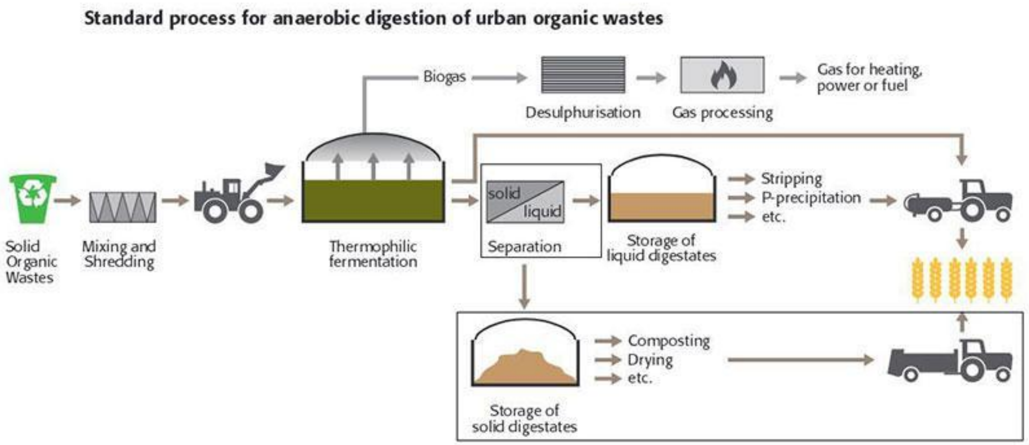
Micro and Nano in Organic Recycling

Value of organic recycling

- Conversion of organic waste into nutrient-rich agricultural amendments
- Reduction of landfill disposal and methane emissions
- Enhancement of soil fertility and crop productivity

Main feedstocks: food waste, green waste, animal manures

Processes: **Composting** → Compost | Anaerobic digestior
WWTP sludge → treated → Biosolids



Digestates: from biodegradable waste via anaerobic digestion
Biosolids: from treated wastewater sludge (sanitized)

Concern:

- Microplastics accumulation in soils
- Estimated 44,000–300,000 tonnes/year in Europe

Micro and Nano in Organic Recycling

Alessandro Rimmaudo et all published a scientific paper in **2026** on the quantification of contamination from **microplastics and cellulosic fibres** in organic fertilisers (**Digestate, compost, biosolid**) used in Scotland (compost, anaerobic digestate and biosolids **(***Water Air Soil Pollut (2026) 237:450 https://doi.org/10.1007/s11270-026-09145-5***)**

Many studies have quantified microplastic in organic waste-derived soil amendments (see reviews by Harley-Nyang et al., 2023; Porterfield et al., 2023; Rolsky et al., 2020).

Fewer studies analysed microplastics in compost and digestate, reporting concentration usually lower than for biosolids but with larger interstudy variation.

The **guidelines** proposed by the ***Marine and Environmental Research Institute*** (Maine, USA) (MERI,2020) were used to analyse the samples and **identify microplastics**.

Micro and Nano in Organic Recycling

safe
Safe Food Advocacy Europe
STRIVING FOR SAFER FOOD FOR EUROPEAN CONSUMERS

Key findings:

- All three materials contain significant quantities of microplastics;
- **Biosolids** show the highest levels, with a predominance of high-density fibres and fragments;
- **Resistant cellulosic fibres** in biosolids exceed microplastic counts by more than **100 times**, representing an often overlooked contamination pathway;
- Reported concentrations are likely **underestimated** due to methodological constraints

Implications:

Organic waste-derived fertilisers represent a significant and unregulated source of anthropogenic contamination of agricultural soils, with a continuous and persistent transfer of particles.

Micro and Nano in Organic Recycling

A **2026** study by **Collin J. Weber et all** investigated Swiss agricultural soils fertilized since 2018 with liquid or solid digestate from a non-agricultural biogas plant, comparing them with an unfertilized control soil. (*Weber et al. Microplastics and Nanoplastics (2025) 5:30 https://doi.org/10.1186/s43591-025-00136-7*)

Key findings:

Digestate application contributed only **0.9–4.0%** of the total microplastic stocks already present in the soil.
This contribution was so small as to be **statistically undetectable** against background variability
High microplastic concentrations were already present in soils **prior to digestate application**, accumulated over decades from sources such as sewage sludge and other diffuse inputs.

Conclusion

While digestate is a measurable source of microplastics, its contribution is **masked by a substantially elevated pre-existing background**, suggesting that soil microplastic contamination is a long-standing and widespread problem largely independent of recent digestate application.

Micro and Nano in Organic Recycling

A **2025** study by **Tian-Gui Cai et a**l., published in *Environmental Science & Technology (Environ. Sci. Technol. 2025, 59, 36, 19295–19306)*, found that increasing microplastic type diversity in soil significantly reduces plant-available nitrogen.

Key findings

- Soils typically contain **multiple coexisting microplastic (MP) types**, yet most studies have examined their effects in isolation
- Increasing MP diversity significantly alters soil properties: **higher pH, increased organic carbon, and reduced plant-available nitrogen**
- Greater MP diversity stimulates **bacterial denitrification**, driven predominantly by Rhodocyclaceae, leading to further nitrogen loss from the soil
- The **combined effect of multiple MP types is more damaging** than that of any single type, with direct implications for soil fertility and agricultural management

Micro and Nano in Organic Recycling

- Incomplete denitrification produces nitrous oxide (N_2O), a greenhouse gas approximately **300 times more potent than CO_2**, representing a significant atmospheric pollutant rather than a groundwater threat.

- The preceding nitrification process poses the **primary risk to groundwater**: ammonium (NH_4^+) is first converted into nitrates (NO_3^-), which are highly soluble and mobile in soil, readily leaching into aquifers and causing **eutrophication** and human health hazards, including methaemoglobinaemia (**blue baby syndrome**)

Conclusion

Microplastics — including those introduced through digestate application — may disrupt the balance between nitrification and denitrification, **paradoxically increasing the intermediate accumulation of nitrates in the soil** and thereby raising the risk of leaching into groundwater before denitrification can complete the conversion to inert nitrogen gas.

Micro and Nano in Organic Recycling

- Incomplete denitrification produces nitrous oxide (N_2O), a greenhouse gas approximately **300 times more potent than CO_2**, representing a significant atmospheric pollutant rather than a groundwater threat.

- The preceding nitrification process poses the **primary risk to groundwater**: ammonium (NH_4^+) is first converted into nitrates (NO_3^-), which are highly soluble and mobile in soil, readily leaching into aquifers and causing **eutrophication** and human health hazards, including methaemoglobinaemia (**blue baby syndrome**)

Conclusion

Microplastics — including those introduced through digestate application — may disrupt the balance between nitrification and denitrification, **paradoxically increasing the intermediate accumulation of nitrates in the soil** and thereby raising the risk of leaching into groundwater before denitrification can complete the conversion to inert nitrogen gas.

Micro and Nano in Organic Recycling

Safe Food Advocacy Europe
STRIVING FOR SAFER FOOD FOR EUROPEAN CONSUMERS

Other sources

Microplastics degrade soil quality and disrupt the nitrogen cycle, reducing fertility and dispersing into the atmosphere — in the form of **ammonia** — the nitrogen that plants can no longer absorb
September 2025 Frontiers in Plant Science 16 DOI: 10.3389/fpls.2025.1621542

Microplastics in coastal aquifers are not passive pollutants: they actively disrupt the nitrogen cycle, amplifying the conversion of nitrates into ammonium and increasing the risk of **eutrophication** in coastal marine waters.
December 2025 Journal of Hydrology 667:134871 DOI: 10.1016/j.jhydrol.2025.134871

Microplastics impair biological nitrogen fixation by disrupting soil **bacterial communities** and reducing root nodulation in legumes, with negative effects on plant growth that vary depending on the polymer type.
January 2026 Applied Soil Ecology 219 DOI: 10.1016/j.apsoil.2025.106772

Polyethylene microplastics reduce **soil structural stability** while increasing microbial respiration and total nitrogen, with effects driven more by **soil texture** than by **plastic concentration**.
June 2026 Water Air and Soil Pollution 237(16) DOI: 10.1007/s11270-026-09620-z

EU Nitrates Directive — Groundwater Monitoring Stations

Number of GW monitoring stations per member state · Nitrates Directive 91/676/EEC · Reporting period 2016–2019

EU-22 water bodies (2007–2023)	Last consolidated period	2020–2023 data
2,104	**2016–2019**	**Submitted · Pub. 2026**

≥ 25% stations > 50 mg/l · 15–24% · 5–14% · < 5%

#	Country	GW Stations 2016–2019	Water Bodies (EEA series)	% > 50 mg NO3/l	2020–23 Reported
1	ES Spain	**3,538**	226	22%	Yes ✓
2	FR France	**2,598**	522	15%	Yes ✓
3	IT Italy	**2,546**	176	13%	Yes ✓
4	BE Belgium	**2,005**	52	28%	Yes ✓
5	DK Denmark	**1,484**	8	10%	Yes ✓
6	AT Austria	**1,327**	17	9%	Yes ✓
7	HU Hungary	**1,272**	n.a.	6%	Yes ✓
8	DE Germany	**1,213**	413	25%	Yes ✓
9	IE Ireland	**1,199**	95	3%	Yes ✓
10	NL Netherlands	**812**	15	17%	Yes ✓
11	PL Poland	**812**	47	5%	Yes ✓
12	CZ Czechia	**562**	157	11%	Yes ✓
13	RO Romania	**527**	25	8%	Yes ✓
14	GR Greece	**463**	n.a.	12%	Yes ✓

#	Country	GW Stations 2016–2019	Water Bodies (EEA series)	% > 50 mg NO3/l	2020–23 Reported
15	SK Slovakia	**374**	73	7%	Yes ✓
16	PT Portugal	**342**	72	20%	Yes ✓
17	SE Sweden	**304**	34	1%	Yes ✓
18	BG Bulgaria	**253**	65	8%	Yes ✓
19	CY Cyprus	**241**	22	38%	Yes ✓
20	HR Croatia	**196**	n.a.	2%	Yes ✓
21	LV Latvia	**156**	14	3%	Yes ✓
22	LT Lithuania	**148**	17	4%	Yes ✓
23	SI Slovenia	**137**	6	7%	Yes ✓
24	LU Luxembourg	**91**	n.a.	32%	Yes ✓
25	EE Estonia	**76**	21	4%	Yes ✓
26	FI Finland	**72**	27	2%	Yes ✓
27	MT Malta	**26**	n.a.	42%	Yes ✓

Sources: Eurostat SDG_06_40 (2026) · EEA/JRC Nitrates Directive period 7 (2016–2019) · EP study PE 734.713 (2022) · COM/2021/1000 | n.a. = no continuous EEA time series (data reported to JRC) | 2020–2023 submitted, publication expected 2026

Nitrogen in ground water Official Data

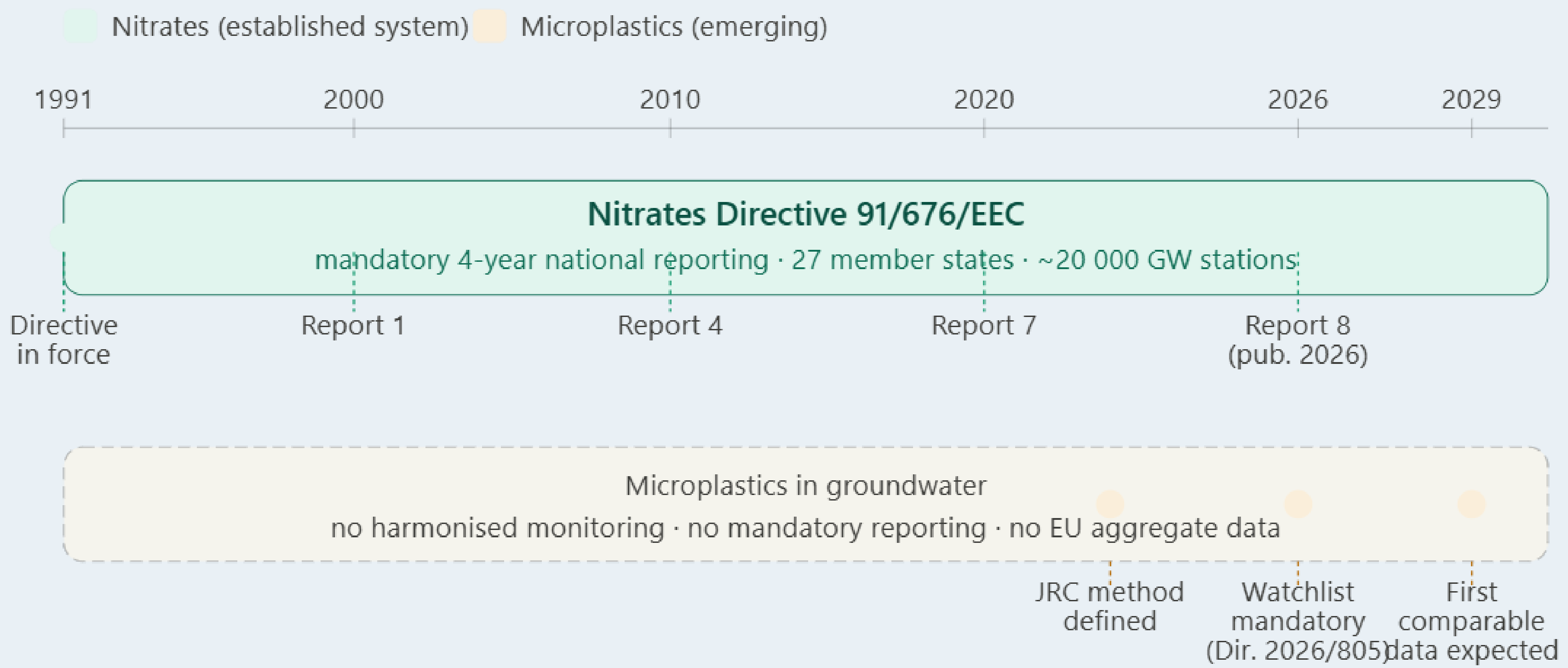
Nitrogen in ground water

- The **seven EU member** states with more than 15% of groundwater monitoring stations exceeding 50 mg/l are Belgium, Cyprus, Germany, Luxembourg, Malta, Portugal and Spain. (EEA, 2025)

- **In Spain**, municipalities with nitrate levels above the 50 mg/l limit increased 50% in one year (171 to 257), leaving at least 220,000 people without safe drinking water. (Ecologistas en Acción, 2024)

- **Only 8 of 26 EU countries** maintain national records of methemoglobinemia (blue baby syndrome). (EEA–WHO, **2004**) (https://www.europarl.europa.eu/doceo/document/E-5-2004-0562-ASW_EN.html?redirect)
- **University of Copenhagen** (2023), We can save lives and millions with less nitrate in drinking water. https://news.ku.dk/all_news/2023/11/we-can-save-lives-and-millions-with-less-nitrate-in-drinking-water/

Micro and Nano plastics Official Data



Key knowledge gap in EU water policy

For nitrates: a 35-year EU system with national data reported every 4 years.
For microplastics in groundwater: no equivalent framework yet exists.

Conclusion

- **For nitrates**, the EU has operated a mature, 35-year monitoring framework under Directive 91/676/EEC.
- The average **nitrate concentration** in EU **groundwater** did **not change** significantly between **2007** and **2023**, declining marginally from 19.3 to 18.1 mg/l — with wide variability across countries and regions. (*https://www.eea.europa.eu/en/analysis/indicators/nitrate-in-groundwater-8th-eap*)
- **No aggregate EU** data exist on nitrate-induced methemoglobinemia (**Baby Blue Syndrome**) deaths or hospitalisations. The only institutional reference — a 2004 European Commission statement — reports "hundreds of cases in Eastern Europe" with no breakdown by country, year, or outcome.
- The **primary acute health** effect of the Nitrates Directive is **not systematically monitored** at **EU** level.
- **For microplastics: No harmonised EU monitoring framework exists in groundwater**, and no national datasets are comparable. Methods were standardised only in 2024; mandatory monitoring started in 2026. Data expected post-2028.
- There is a **clear lack of official European data** to conduct a **risk assessment** of the hazards posed by microplastics in organic recycling manures (digestate, compost, and biosolids), as well as their contamination of groundwater and drinking water.

Conclusion

Safe Food Advocacy Europe

STRIVING FOR SAFER FOOD FOR EUROPEAN CONSUMERS

Recommendations

- **Standardised analytical methods** and epidemiological national and EU data for **Baby Blue Syndrome**
- EU standard method to determine microplastic in manure, digestate, compost, biosolid (2027?)
- **Routine monitoring** of organic waste-derived amendments especially for microplastic.
- Regulatory frameworks that explicitly recognise microplastics as **contaminants in the Nitrate Directive for the Nitrogen**.
- **No action** to reduce the environmental release of digestate, compost and biosolids **prior to** having the data necessary for a **risk assessment**.

Thank you for your attention!

Luigi Tozzi

SAFE – Safe Food Advocacy Europe

www.safefoodadvocacy.eu

Rue du Villaine XIIII 17,

1050 Ixelles, Belgium

tozzi@safefoodadvocacy.eu

safe
Safe Food Advocacy Europe
STRIVING FOR SAFER FOOD FOR EUROPEAN CONSUMERS