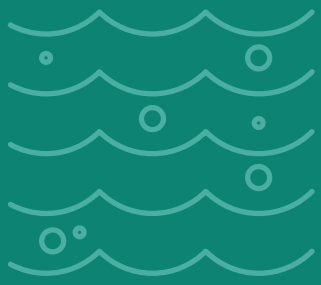
European Environment Agency

8th Environment Action Programme

Nitrate in groundwater



8TH EAP HEADLINE INDICATOR, 2025

European Environment Agency

Nitrate in groundwater in Europe

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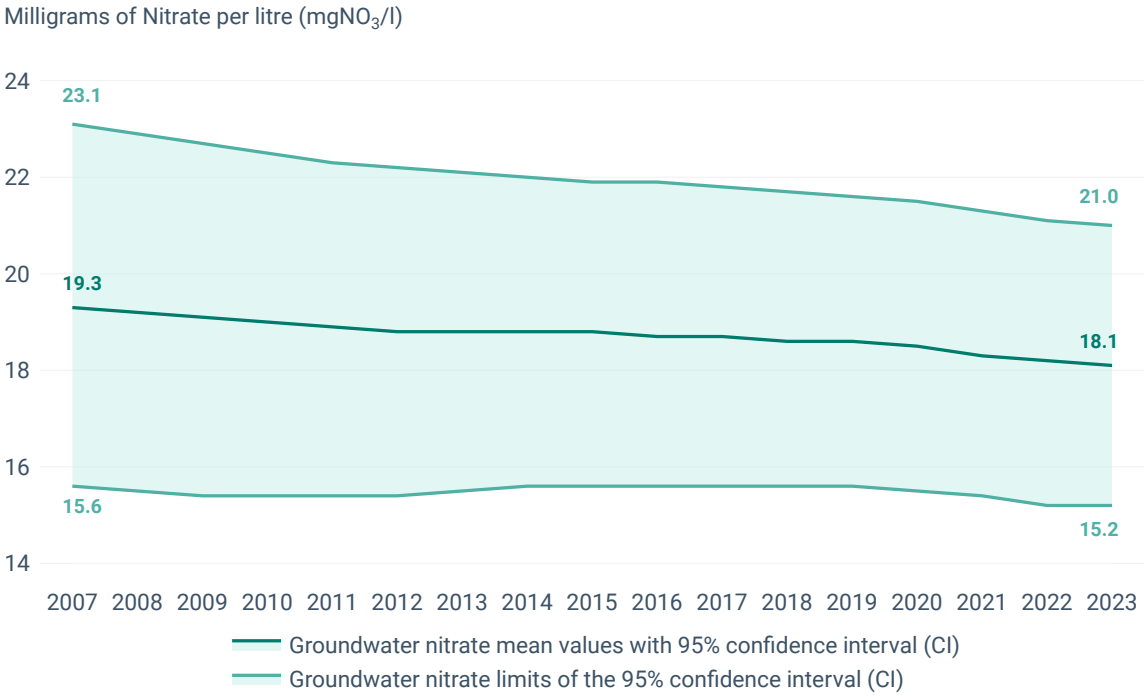
The average nitrate concentration in European Union groundwaters did not change significantly from 2007 to 2023. The number of groundwater monitoring stations in 2016-2019 with nitrate concentrations greater than 50mg/l also remains largely unchanged compared to the reference period 2012-2015. Further, results from a high ambition model scenario show that potential nutrient load reductions are substantial, but still below the 2030 target. Currently, it remains unlikely that the trend is sufficient to achieve EU obligations or the 50% nutrient loss reduction target.

Figure 1. Groundwater nitrate 2007-2023



Nutrients such as nitrogen and phosphorus, not absorbed by plants, are lost and become pollutants when present in excessive amounts. This includes high levels of nitrate (NO_3) in groundwater, which poses a **threat to the environment and human health**.

Reducing high levels of nitrate in groundwater has been a target of EU policy since the adoption of the Nitrates Directive. Mineral fertilisers and manure are **main sources** of nitrate concentrations in EU groundwaters and an estimated 80% of the nitrogen discharge to the EU aquatic environment stems from agriculture. A large part of nutrients lost to surface- and groundwaters reaches the sea. Around 30% of surface water and 80% of marine waters monitored under the Nitrates Directive are eutrophic[1][2][3][4].

Several directives address nitrogen losses to the environment[1][5][6][7][8] . The Groundwater Directive and Drinking Water Directive set the maximum **allowable concentration** for nitrate at 50mgNO_3/l in order to protect human health and the environment.

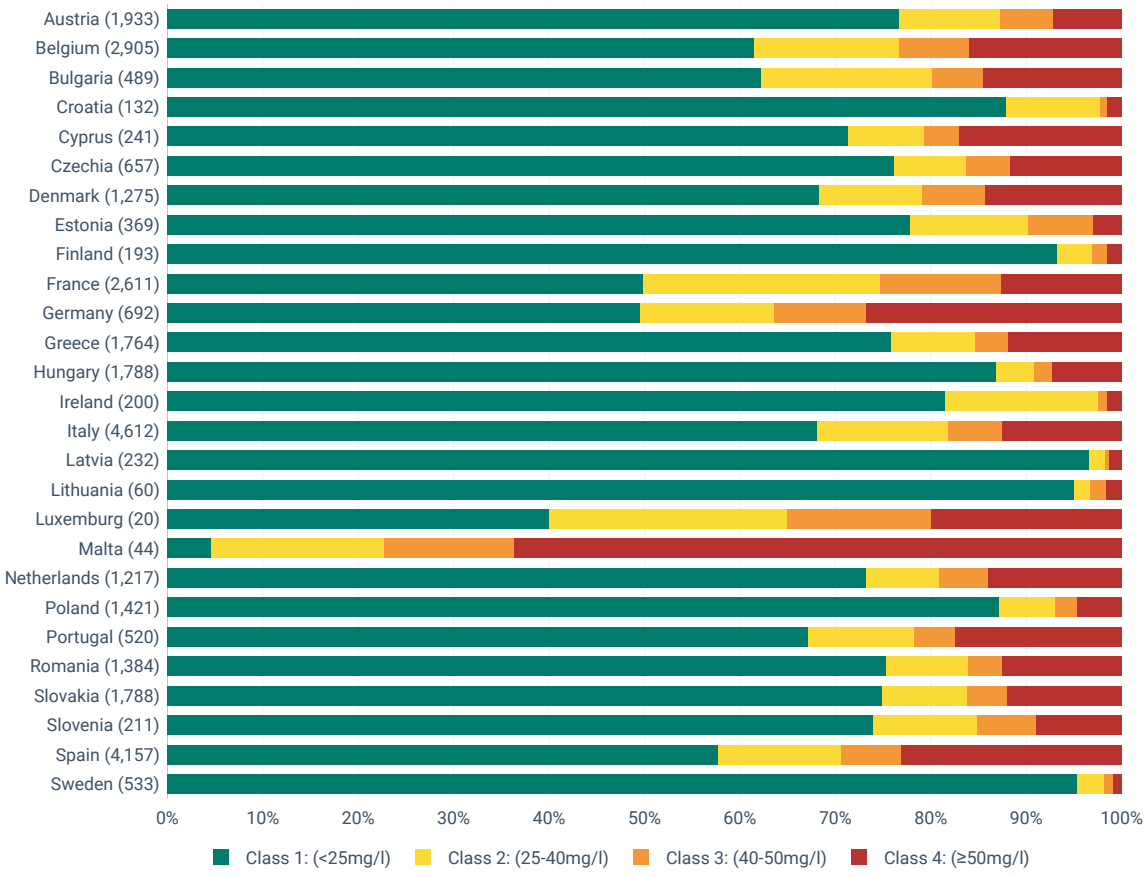
The Zero Pollution Action Plan, Biodiversity strategy and Farm to Fork strategy are initiatives of the European Green Deal, which aims to **reduce nutrient losses** to the environment by 50% in the EU, by 2030. The reduction could lower groundwater nitrate concentrations and decrease the number of monitoring stations with nitrate concentrations above 50mg/l, compared to the

reference period 2012-2015[9][10].

Despite legislation addressing nutrient pollution, the average nitrate (NO_3) concentration in monitored EU groundwaters did not change significantly from 2007 to 2023, **decreasing** from 19.3 to 18.1mgNO_3/l but with a large variability as shown by the confidence interval in Figure 1. The Nitrates Directive reporting data over the period 2016-2019 shows 14.1% of groundwater monitoring stations **exceeded** the maximum allowable concentration of 50mgNO_3/l. This is slightly higher than the observed 13.2% from the reporting period of 2012-2015.

An analysis from the Joint Research Centre modelled impacts in a high ambition scenario of improvements in domestic wastewater treatment and reduction of nutrient emissions to air. It used measures under the CAP 2023-2027, needed to achieve the Biodiversity and Farm to Fork strategy targets. The measures, where CAP measures are relevant for groundwater, could together reduce the nutrient load in European seas by 30% for nitrogen and 20% for phosphorus by 2030[11]. While these potential reductions would be substantial, they still fall **below the target** of 50% reduction overall in nutrient losses.

Figure 2. Nitrate in Groundwater - Nitrates Directive reporting period 7 (2016-2019)



EU Member States report groundwater nitrate concentrations under the Nitrates Directive. At country level, nitrate concentrations in groundwater monitoring stations for the period 2016-2019 are distributed into **four classes** (Figure 2). Class 1 represents monitoring stations where concentrations are below 25mg/l. At the other end of the scale, Class 4 shows the share of stations that exceed the 50mgNO_3/l maximum allowable concentration.

All 27 EU Member States had some groundwaters with **reported** nitrate concentrations above the maximum allowable concentration of 50mgNO_3/l (class 4). The seven countries with more than 15% of their groundwater monitoring stations exceeding this maximum level were Belgium, Cyprus, Germany, Luxemburg, Malta, Portugal, and Spain. In contrast, the seven countries with more than 80% of groundwater monitoring stations below 25mg/l (class 1) were Croatia, Finland, Hungary, Ireland, Latvia, Poland and Sweden.

Supporting information

Definition

This indicator shows concentrations of nitrate in groundwater bodies. The indicator can be used to illustrate geographical variations in current concentrations and temporal trends. Large inputs of nitrogen to water bodies from urban areas, industry, and agricultural areas, can have negative impacts on the use of water for human consumption and other purposes.

Methodology

This indicator uses data reported under two different obligations. For the time series of average concentrations in figure 1 data from WISE SoE - Water quality (WISE-6) reporting obligation are used used (published in Waterbase – Water Quality ICM). For the country level assessment in figure 2 data from the Nitrates Directive reporting obligation are used.

For the time series in Figure 1 a detailed methodology document "Methodology, oxygen consuming substances and nutrients indicators" is provided on WISE Freshwater. The methodology described in the document is used for more multiple indicators. A brief summary is provided here as well:

Annual mean concentrations per monitoring site are used as a basis in the analyses. Unless the country reports aggregated data, the aggregation to annual mean concentrations is done by the EEA. The data undergo automatic and manual quality checks to remove errors and outliers. Monitoring site time series from the same water body are combined and gap filled before further analysis. Gap filling is necessary to ensure that the average European time series represents the same water bodies every year. Water body time series are only included in the analysis if they have data within the first and last five years of the time range and data from at least 40% of the years in the time range.

Data are aggregated from site to water body level and gap-filled using generalized additive models (GAM) in the free software R, using the mgcv package. For water bodies with more than one site, a GAM model with concentration as response variable, year as fixed effect and site as random effect is used to estimate annual concentrations per site. Annual values for the water body are subsequently estimated by averaging the annual site predictions. For water bodies with only one site, or where the random effect for site is non-significant, a GAM without a random site effect is used to estimate annual values and for gap filling. The gap-filled water body time series are averaged by country and a weighted average of the country time series (weighting by the total area of groundwater in the country) is calculated to give the time series for Europe. A 95% confidence interval for the weighted average is calculated using of the formula for standard error of a weighted mean recommended in Gatz and Smith (1995).

For analysis of the present state on country level (figure 2), data reported under the Nitrates Directive[1] for reporting period 2016-2019 are used, where data on monitoring station level are collected for each reporting period (four year period) and include characteristics on the water monitoring stations and values for the concentrations of NO_3 for each station. The data is summarised by country and by concentration classes. This information can also be viewed in the JRC exploratory dashboard for reporting period seven. While 2016-2019 is the last period for which there are consolidated data published, Member States have completed their reporting for 2020-2023 and it will be published in 2026.

Policy/environmental relevance

The quality of freshwater, with respect to nutrient concentrations, is an objective of several directives: The Nitrates Directive[1], aimed at reducing nitrate pollution from agricultural land; the Urban Waste Water Treatment Directive[5], aimed at reducing pollution from sewage treatment works and certain industries; the Industrial Emissions Directive[6], aimed at reducing emissions from industry; the Water Framework Directive[7], which requires the achievement of good ecological status; the Groundwater Directive[12] on the protection of groundwater against pollution and deterioration. The Water Framework Directive also requires the reversal of significant and sustained upward trends in the concentrations of pollutants. Based on the Drinking Water Directive[13], the Nitrates Directive and the Groundwater Directive under the Water Framework Directive, set the maximum allowable concentration for nitrate at 50mgNO_3/l. This is to eliminate the need for expensive water treatment because it has been shown that drinking water in excess of the nitrate limit can result in adverse health effects [3].

Reducing nutrient losses by 50% by 2030 is an important aspect of the European Green Deal[14] initiatives: 'Farm to Fork' Strategy; Biodiversity strategy; Zero pollution action plan[15][16][17]. The Common Agricultural Policy[18][19] (CAP) is a key tool in this respect. The assessment of the 50% target is set out in the Annex to the Recommendations for the CAP Strategic Plans[10] and is evaluated in the context of the Zero Pollution Monitoring Assessment[20] published on 8 December 2022.

The 8th Environment Action Programme[9] supports the objectives of the European Green Deal[14] and forms the basis for the EU to achieve the Sustainable Development Goals of the United Nations.

The 'nitrate in groundwater indicator' is a headline indicator for monitoring progress towards the 8th Environment Action Programme (8th EAP). It mainly contributes to monitoring aspects of the 8th EAP priority objective Article 2.2.d that shall be met by 2030: 'pursuing zero pollution, including in relation to harmful chemicals, in order to achieve a toxic-free environment, including for air, water and soil, as well as in relation to light and noise pollution, and protecting the health and wellbeing of people, animals and ecosystems from environment-related risks and negative impacts'. The European Commission's Communication on the 8th EAP monitoring framework[9] specifies that this indicator should monitor progress towards reducing nutrient losses by at least 50% in safe groundwater resources by 2030.

Accuracy and uncertainties

The indicator is meant to give a representative overview of nitrate conditions in the groundwaters of the European Union. This means it should reflect the variability in conditions over space and time. Countries are asked to provide data on groundwater bodies according to specified criteria.

The Waterbase - Water Quality ICM data for groundwater include almost all countries within the EU, while the Nitrates Directive data includes all EU countries. It is assumed that the data from each country represents the variability in space in their country. Likewise, it is assumed that the sampling frequency is sufficiently high to reflect variability in time. In practice, for Waterbase data, the representativeness will vary between countries, while for the Nitrates Directive data the coverage is more complete but reported at lower frequency.

Annual updates of Waterbase - Water Quality ICM data means that, due to changes in the database, the derived results of the assessment may vary in comparison to previous assessments. Database changes include changes in the QC procedure that excludes or re-includes individual sites or samples and retroactive reporting of data for past periods - which may re-introduce lost time series that were not used in the recent indicator assessments. Through communication with the reporting countries, the quality of the database can be, and incrementally is, further improved.

Data sources and providers

- Nitrates Directive reporting period 7 (2016-2019)(direct link to the dataset is not available), European Environment Agency (EEA)
- Waterbase - Water Quality ICM, European Environment Agency (EEA)
- WISE Statistics, European Environment Agency (EEA)

Metadata

DPSIR

State

Topics

Water # Agriculture and food

Tags

8th EAP # WAT004 # Freshwater quality # Groundwater # Nitrates

Temporal coverage

2007-2023

Geographic coverage

Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden

Typology

Descriptive indicator (Type A - What is happening to the environment and to humans?)

UN SDGs

SDG6: Clean water and sanitation

Unit of measure

FIG1: the concentration of nitrate in groundwater is expressed as milligrams of nitrate per litre ($mgNO_3/l$)

FIG2: percentage

Frequency of dissemination

Once a year

References and footnotes

1. EU, 1991, Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, OJ L 375, 31.12.1991, p. 1-8.
a b c d
2. EEA, 2022, 'Europe's groundwater — a key resource under pressure', European Environment Agency", *Briefing, European Environment Agency* (https://www.eea.europa.eu/publications/europes-groundwater).
↵
3. WHO, 2003, 'Nitrate and nitrite in drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality (WHO/SDE/WSH/04.03/56)', (https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/who-sde-wsh-04-03-56-eng.pdf?sfvrsn=e2fe0837_4).
a b
4. EC, 2021, *REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period 2016–2019*, COM/2021/1000 final, European Commission.

5. EC, 1991, Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment
a b
6. EU, 2010, Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJ L 334, 17.12.2010, p. 17-119.
a b
7. EC, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, 2000/60., 2000/60
a b
8. EU, 2001, Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309, 27.11.2001, p. 22-30.
9. EC, 2022, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the monitoring framework for the 8th Environment Action Programme: Measuring progress towards the attainment of the Programme's 2030 and 2050 priority objectives - COM/2022/357 final
a b c
10. EC, 2020, *ANNEXES to the COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - Recommendations to the Member States as regards their strategic plan for the Common Agricultural Policy*, COM(2020) 846 final, European Commission.
a b
11. European Commission. Joint Research Centre., 2022, *Zero pollution :outlook 2022.*, EUR 31248 EN, Publications Office, LU.
12. EC, 2014, Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration
13. EU, 2020, Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption, OJ L 435, 23.12.2020, p. 1-62.
14. EC, 2019, *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions 'The European Green Deal'*, COM(2019) 640 final,
a b
15. EC, 2020, 'COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system (COM(2020) 381 final)', (https://eur-lex.europa.eu/resource.html?uri=cellar:ea0f9f73-9ab2-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF).
16. EC, 2020, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - EU Biodiversity Strategy for 2030 Bringing nature back into our lives*,
17. EC, 2021, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil' COM/2021/400 final, 2021/400.
18. EU, 2021, Regulation (EU) 2021/2116 of the European Parliament and of the Council of 2 December 2021 on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013, OJ L 435, 6.12.2021, p. 187.
19. Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) No 1307/2013, 2021, OJ L.
20. EEA, 2022, *Zero pollution monitoring assessment*, EEA Web Report, 03/2022, European Environment Agency.