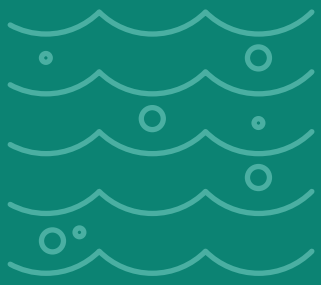
European Environment Agency

8th Environment Action Programme

Nitrate in groundwater



8TH EAP HEADLINE INDICATOR, 2023

European Environment Agency

Nitrate in groundwater

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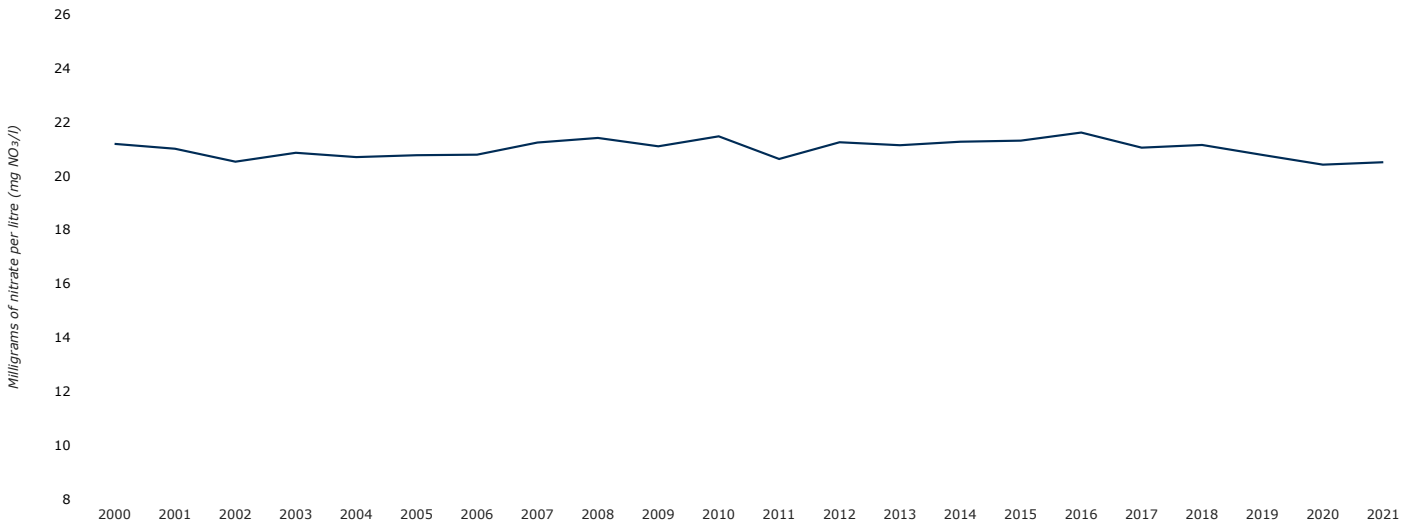
Despite legislation addressing nutrient pollution, the average nitrate concentration in EU groundwaters did not change significantly from 2000 to 2021. In addition, the number of groundwater monitoring stations with nitrate concentrations greater than 50mg/l, has not been reduced. Results from a high ambition model scenario show that potential nutrient load reductions are substantial, but still below the 2030 target. At this stage, it remains unlikely but uncertain whether the trend is sufficient to achieve EU obligations or the 50% nutrient loss reduction target.

Figure 1. Groundwater nitrate 2000-2021



Source: EEA.

Data used in the graph

Year	Concentration
2000	21.19
2001	21.01
2002	20.53
2003	20.86
2004	20.7
2005	20.77
2006	20.79
2007	21.24
2008	21.41
2009	21.1
2010	21.47
2011	20.63
2012	21.25
2013	21.14
2014	21.27
2015	21.31
2016	21.61
2017	21.05
2018	21.15
2019	20.78
2020	20.42
2021	20.51

Nutrients such as nitrogen, that are not taken up by plants, are lost to the environment and become pollutants when present in excessive amounts. This includes high levels of nitrate (NO_3) in groundwater, which pose a threat to the environment and to 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 the main sources of nitrate concentrations in EU groundwaters and an estimated 80% of the nitrogen discharge to the EU aquatic environment stems from agriculture. Around 30% of surface water and 80% of marine waters are eutrophic [1][2][3][4].

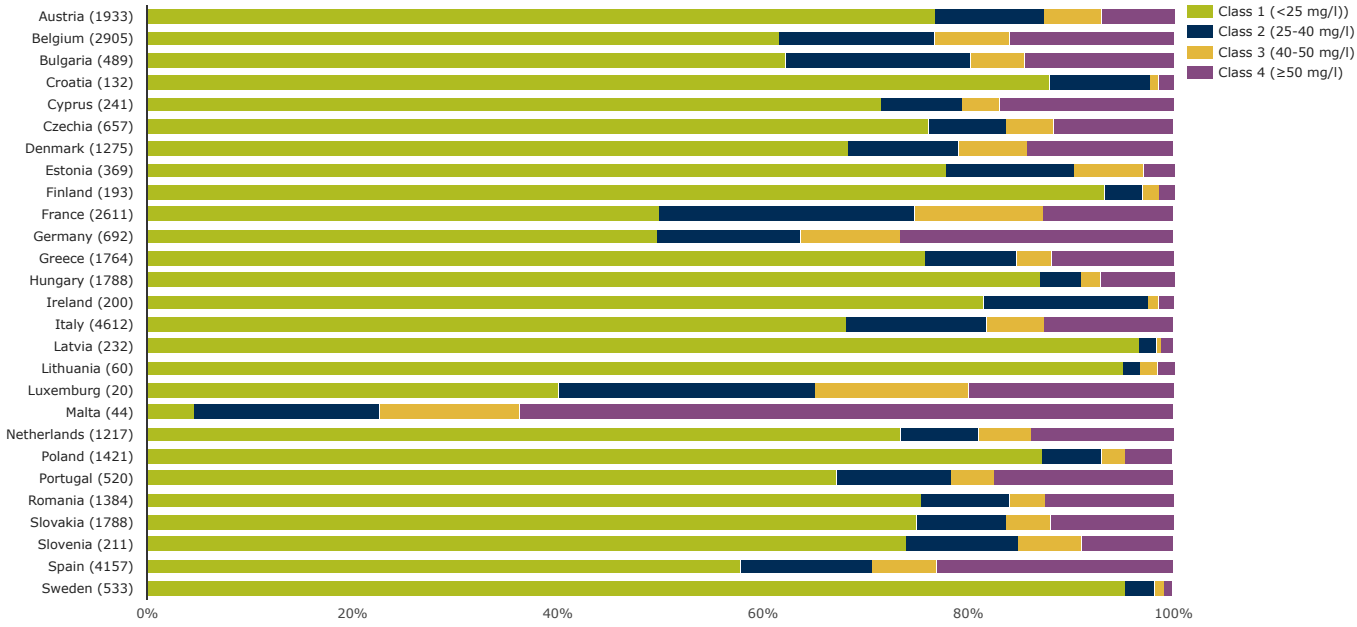
Several Directives address nitrogen losses to the environment[5][4][6][7][8]. The Groundwater Directive [9] and the Drinking Water Directive [10] set the maximum allowable concentration for nitrate at 50mg NO_3/l in order to protect human health and water resources.

The European Green Deal[11] with its initiatives of the Zero pollution action plan [12], and the Biodiversity and Farm to Fork strategies [13][14], set a goal for the EU to reduce nutrient losses to the environment by 50%, by 2030. Such a reduction should result in lower groundwater nitrate concentrations and a reduced number of groundwater monitoring stations with nitrate concentration greater than 50mg/l, compared to the reference period 2012-2015 [15][16].

Despite legislation addressing nutrient pollution, the average nitrate (NO_3) concentration in EU groundwaters did not change significantly from 2000 to 2021 - oscillating around 21mg NO_3/l. In addition, data reported under the Nitrates Directive covering the period 2016-2019 shows, 14.1% of groundwater stations exceeded the maximum allowable concentration of 50mg NO_3/l, which is comparable to 13.2% that was observed in the previous reporting period 2012-2015 [3].

An analysis, from the JRC (Joint Research Centre), modelled impacts in a high ambition scenario of improvements in domestic wastewater treatment, reduction of nutrient emissions to air, and with measures under the CAP 2023-2027 needed to achieve the Biodiversity Strategy and Farm to Fork targets. These measures, where especially the CAP measures are relevant for groundwater, could in combination reduce the nutrient load in European seas by 30% for nitrogen and 20% for phosphorous by 2030 (EC 2022). While these projected reductions are substantial, they are still below the target of 50% reduction overall in nutrient losses.

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



Source: Joint Research Centre.

Data used in the graph

Country	Class 1 (<25 mg/l))	Class 2 (25-40 mg/l)	Class 3 (40-50 mg/l)	Class 4 (≥50 mg/l)
Sweden (533)	95.3	2.8	0.9	0.9
Spain (4157)	57.7	12.9	6.3	23.1
Slovenia (211)	73.9	10.9	6.2	9
Slovakia (1788)	74.9	8.8	4.3	12
Romania (1384)	75.3	8.7	3.5	12.6
Portugal (520)	67.1	11.2	4.2	17.5
Poland (1421)	87.1	5.8	2.4	4.6
Netherlands (1217)	73.3	7.6	5.2	14
Malta (44)	4.5	18.2	13.6	63.6
Luxemburg (20)	40	25	15	20
Lithuania (60)	95	1.7	1.7	1.7
Latvia (232)	96.6	1.7	0.4	1.3
Italy (4612)	68.1	13.7	5.6	12.6
Ireland (200)	81.5	16	1	1.5
Hungary (1788)	86.9	4	1.9	7.3
Greece (1764)	75.8	8.9	3.4	11.9
Germany (692)	49.6	14	9.7	26.7
France (2611)	49.8	24.9	12.6	12.7
Finland (193)	93.3	3.6	1.6	1.6
Estonia (369)	77.8	12.5	6.8	3
Denmark (1275)	68.3	10.7	6.7	14.3
Czechia (657)	76.1	7.6	4.6	11.7
Cyprus (241)	71.4	7.9	3.7	17

Country	Class 1 (<25 mg/l))	Class 2 (25-40 mg/l)	Class 3 (40-50 mg/l)	Class 4 (≥50 mg/l)
Croatia (132)	87.9	9.8	0.8	1.5
Bulgaria (489)	62.2	18	5.3	14.5
Belgium (2905)	61.5	15.2	7.3	16
Austria (1933)	76.7	10.7	5.5	7.2

EU Member States report groundwater nitrate concentrations under the Nitrates Directive. At country level, nitrate concentrations in groundwater for the period 2016-2019 are distributed into four classes (Figure 2). Class one represents groundwaters where concentrations are below 25mg/l, and at the other end of the scale, class four shows the share of stations that exceed the 50mg NO_3/l maximum allowable concentration. In this reporting period, all EU-27 countries had some groundwaters with reported nitrate concentrations above the maximum allowable concentration of 50mg NO_3/l (class four). The seven countries reporting more than 15% of their groundwaters exceeding this maximum level were Belgium, Cyprus, Germany, Luxemburg, Malta, Portugal, and Spain. In contrast, the seven countries with more than 80% of groundwaters below 25mg/l in class one 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, annual mean concentrations 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. Automatic quality control procedures are applied both to the disaggregated and aggregated data, excluding data failing the tests from further analysis. In addition, a semi-manual

procedure is applied, focusing on suspicious values having a major impact on the country time series and on the most recently reported data. This comprises:

- Outliers
- Consecutive values deviating strongly from the rest of the time series
- Whole time series deviating strongly in level compared to other time series for that country and determinant
- Where values for a specific year are consistently much higher or lower than the remaining values for that country and determinant.

Such values are removed from the analysis and checked with the country. For time series analyses, only complete series after inter/extrapolation are used. This is to ensure that the aggregated time series are consistent, i.e. include the same sites throughout.

Inter/extrapolations of gaps up to three years are allowed, i.e. to increase the number of available time series. At the beginning or end of the data series, missing values are replaced by the first or last value of the original data series, respectively. In the middle of the data series, missing values are linearly interpolated. The selected time series are aggregated to country and European level by averaging across all sites for each year.

For analysis of the present state on country level (figure 2), data reported under the Nitrates Directive 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.

Policy/environmental relevance

The quality of freshwater, with respect to nutrient concentrations, is an objective of several directives: The Nitrates Directive (91/676/EEC), aimed at reducing nitrate pollution from agricultural land; the Urban Waste Water Treatment Directive (91/271/EEC), aimed at reducing pollution from sewage treatment works and certain industries; the Industrial Emissions Directive (2010/75/EU), aimed at reducing emissions from industry; the Water Framework Directive (2000/60/EC), which requires the achievement of good ecological status; the Groundwater Directive (2006/118/EC) 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 (2020/2184), the Nitrates Directive and the Groundwater Directive under the Water Framework Directive, set the maximum allowable concentration for nitrate at 50mg NO_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 (WHO 2003).

Reducing nutrient losses by 50% by 2030 is an important aspect of the European Green Deal initiatives: 'Farm to Fork' Strategy; Biodiversity strategy; Zero pollution action plan. The Common

Agricultural Policy (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 [16] and is evaluated in the context of the Zero Pollution Monitoring Assessment published on 8 December 2022.

The 8th Environment Action Programme supports the objectives of the European Green Deal 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 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), Joint Research Centre (JRC)
- Waterbase - Water Quality ICM, 2022, European Environment Agency (EEA)

Metadata

DPSIR

State

Topics

 # Water # Agriculture and food

Tags

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

Temporal coverage

2000-2021

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

Clean water and sanitation

Unit of measure

FIG1: the concentration of nitrate in groundwater is expressed as milligrams of nitrate per litre (mg NO_3/l)

FIG2: percentage

Frequency of dissemination

Once a year

Contact

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References and footnotes

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a b
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9. 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
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10. 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 (recast) (Text with EEA relevance, OJ L 435, 23.12.2020, p. 1–62 (BG, ES, CS, DA, DE, ET, EL, EN, FR, GA, HR, IT, LV, LT, HU, MT, NL, PL, PT, RO, SK, SL, FI, SV).
↲

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