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**COMMISSION STAFF WORKING DOCUMENT**

***Accompanying the document***

**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}

# Pressure from Agriculture



Portugal's utilized agricultural area amounts to 3.6 Mha, representing 40% of the total land area. The major outputs of the agricultural industry excluding services include in a decreasing order fruit (19.3%), vegetables and horticultural plants (16.6%) and other crops (14.9%).

## Major land use statistics for Portugal

Table 1.Utilized agricultural area (abbreviated as UAA)

| Portugal | 2005 | 2007 | 2010 | 2013 | 2016 |
|---|---|---|---|---|---|
| Utilised agricultural area UAA (1000 ha) | NA | 3661 | 3654 | 3718 | 3636 |
| arable land (1000 ha) | NA | 1127 | 1129 | 1139 | 982 |
| permanent grass (1000 ha) | NA | 1782 | 1793 | 1817 | 1877 |
| permanent crops (1000 ha) | NA | 731 | 714 | 748 | 761 |
| kitchen gardens (1000 ha) | NA | 21 | 19 | 15 | 16 |

*Note:*
Eurostat (FSS)

Portugal's arable land has decreased from the last reporting period by 14%. Permanent grassland, crops and kitchen gardens remained stable.

## Animal distribution in Portugal

Portugal has seen an increase in all livestock numbers. Consequently, the livestock density index has increased by 8.9% since 2013. The livestock intensity index is lower than the EU average of 0.8.

Table 2. Livestock statistics

| Portugal | 2005 | 2007 | 2010 | 2013 | 2016 |
|---|---|---|---|---|---|
| Livestock index | 0.56 | 0.58 | 0.60 | 0.56 | 0.61 |
| dairy cows ($10^6$ heads) | 0.28 | 0.27 | 0.24 | 0.23 | 0.24 |
| live bovines ($10^6$ heads) | 1.50 | 1.49 | 1.50 | 1.47 | 1.64 |
| live pigs ($10^6$ heads) | 1.96 | 1.98 | 1.92 | 2.01 | 2.15 |
| live poultry ($10^6$ heads) | NA | NA | 35.35 | 28.61 | 36.05 |

*Note:*
Eurostat (FSS)

## Nitrogen and phosphorus fertilizers and surplus (kg/ha UAA)

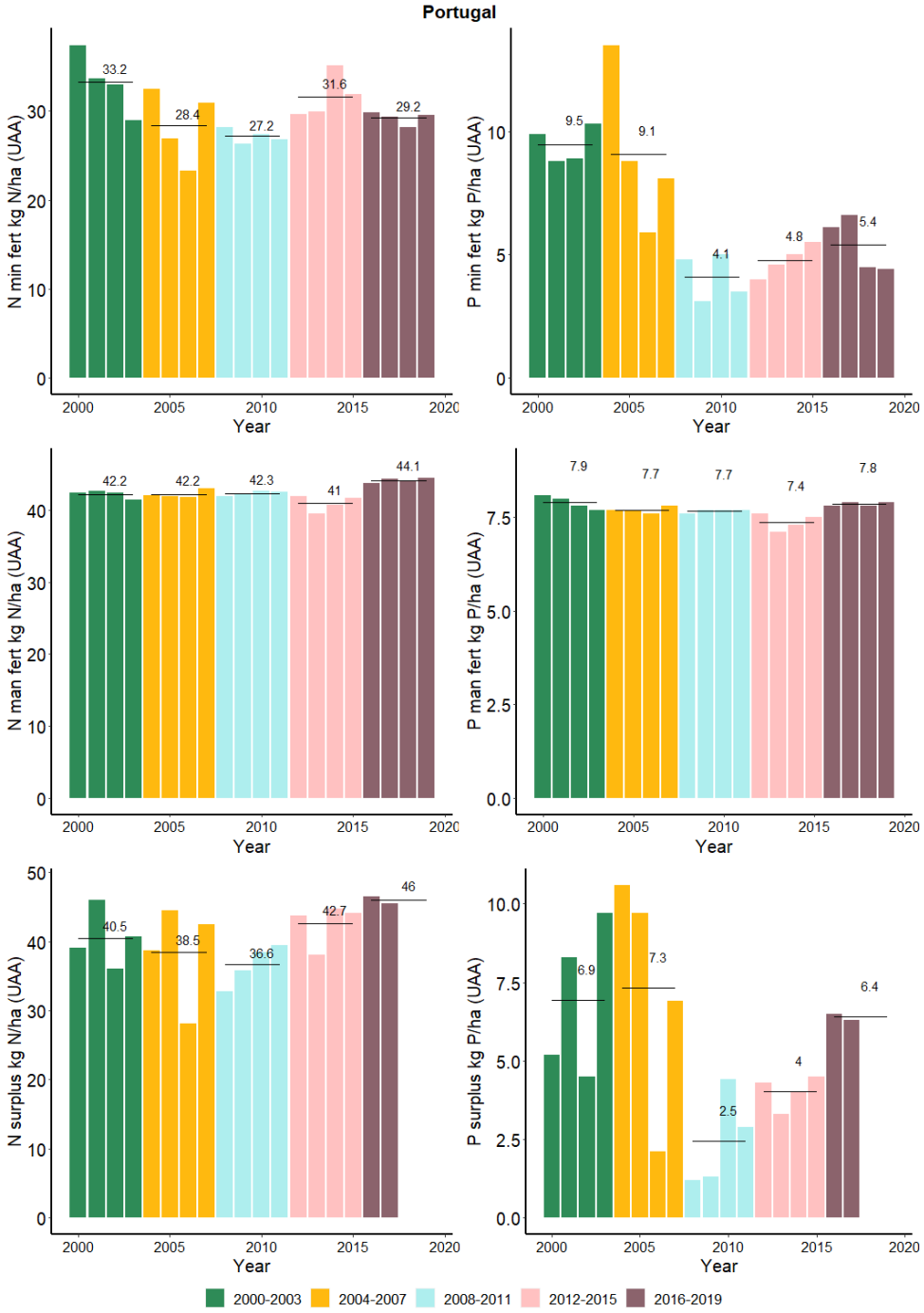



Figure 1. N and P fertilizers and gross surplus (kg/ha)

The N and P mineral fertilizer, manure and gross nitrogen (N) and phosphorus (P) surpluses originate from EUROSTAT data for the years 2000-2017, while for years 2018-2019 from the National Institute of Statistics (INE). The consumption of inorganic N during the last reporting period is lower than that of the previous. The consumption of inorganic P fertilizer has increased by 13%. Both N and P from manure have increased since the last reporting period. The N surplus continues to increase since 2010. The phosphorus surplus is higher than that of the previous reporting period. In the plots: N/P min and N/P man are respectively the N/P mineral fertilizers and N/P manure.

## Livestock unit - LSU /ha

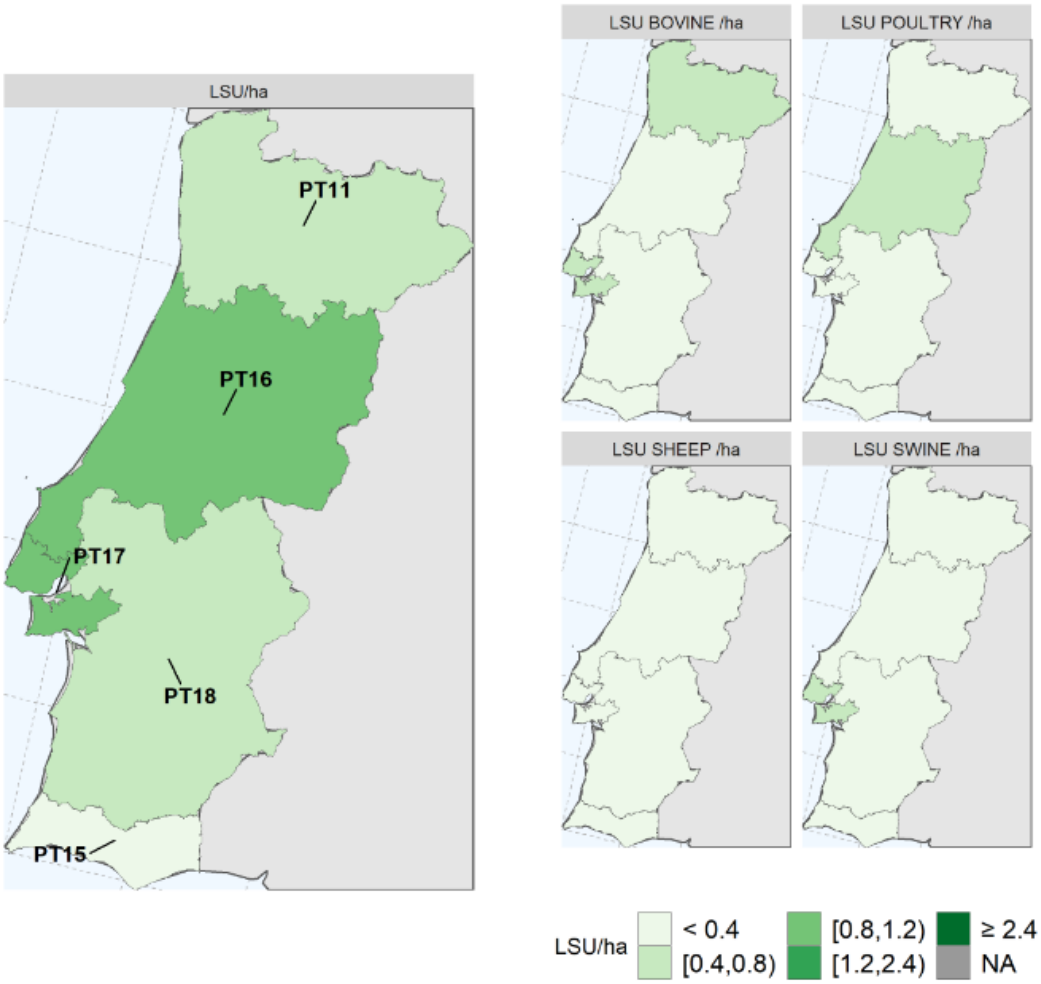



Figure 2. Map of livestock unit distribution in the Continent part, year 2016 (Source: Eurostat, February 2021)

Animal production is concentrated in the south-western part of the Portugal (total LSU and LSU by animal type were retrieved individually from EUROSTAT).
In this document, the NUTS-2013 version is used.
(https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts)

## Livestock unit - LSU /ha

## Acores and Madeira

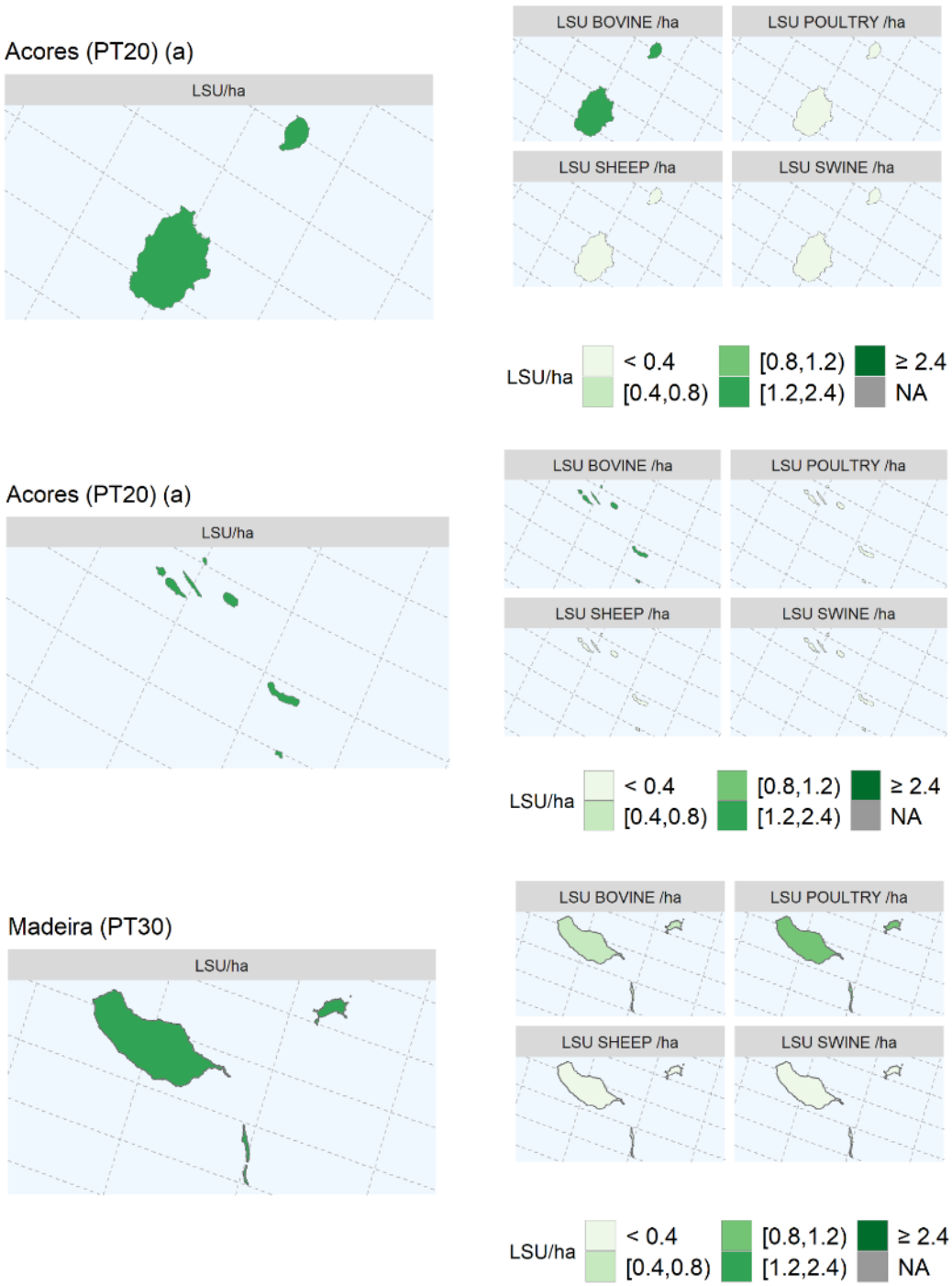



Figure 3. Map of livestock unit distribution in Acores and Madeira, year 2016 (Source: Eurostat, February 2021)

Bovine production is dominating in Acores while poultry is dominating in Madeira (total LSU and LSU by animal type were retrieved individually from EUROSTAT).

In this document, the NUTS-2013 version is used. (https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts)

# Water Quality Monitoring

The Regional Directorates of Water Resources and Spatial Planning including the Azores Regional Directorate are in charge of maintaining an up to date record of the results obtained from the region's monitoring programmes and provide it to the competent national authority, the Portuguese Environment Agency.

It is noteworthy that in some cases in the bar charts the total value can differ from 100% due to rounding errors.

## Groundwater quality monitoring network

Table 3. Number of GW stations with measurements and trends per type

| | | Number of stations with measurements | | | Number of stations with Trends | | |
|---|---|---|---|---|---|---|---|
| Station Type | Description | 2008-2011 | 2012-2015 | 2016-2019 | 2008-2011 | 2012-2015 | 2016-2019 |
| 0 | Phreatic groundwater (shallow): 0-5 m | 251 | 249 | 229 | 208 | 231 | 229 |
| 1a | Phreatic groundwater (deep) 5-15 m | 83 | 70 | 60 | 79 | 70 | 60 |
| 1b | Phreatic groundwater (deep) 15-30 m | 90 | 58 | 46 | 90 | 58 | 46 |
| 1c | Phreatic groundwater (deep) >30 m | 86 | 85 | 81 | 74 | 76 | 80 |
| 2 | Captive groundwater | 3 | 7 | 6 | 3 | 7 | 6 |
| 3 | Karstic groundwater | 144 | 111 | 98 | 132 | 111 | 98 |
| 9 | Not specified | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | **657** | **580** | **520** | **586** | **553** | **519** |

## Surface water quality monitoring network

Table 4. Number of SW stations with measurements, trends and trophic status per type

| | | Number of stations with measurements | | | Number of stations with Trends | | | Number of stations with Trophic status | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Station Type | Description | 2008-2011 | 2012-2015 | 2016-2019 | 2008-2011 | 2012-2015 | 2016-2019 | 2008-2011 | 2012-2015 | 2016-2019 |
| 4 | River water | 89 | 92 | 96 | 61 | 89 | 90 | 28 | 55 | 53 |
| 5 | Lake/reservoir water | 57 | 62 | 62 | 49 | 54 | 62 | 50 | 62 | 60 |
| 6 | Transitional water | 45 | 5 | 12 | 1 | 2 | 4 | 0 | 0 | 10 |
| 7 | Coastal water | 10 | 1 | 8 | 0 | 0 | 0 | 0 | 0 | 8 |
| 8 | Marine water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Not specified | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | **201** | **160** | **178** | **111** | **145** | **156** | **78** | **117** | **131** |

# Groundwater Quality

## Groundwater average annual nitrate concentration

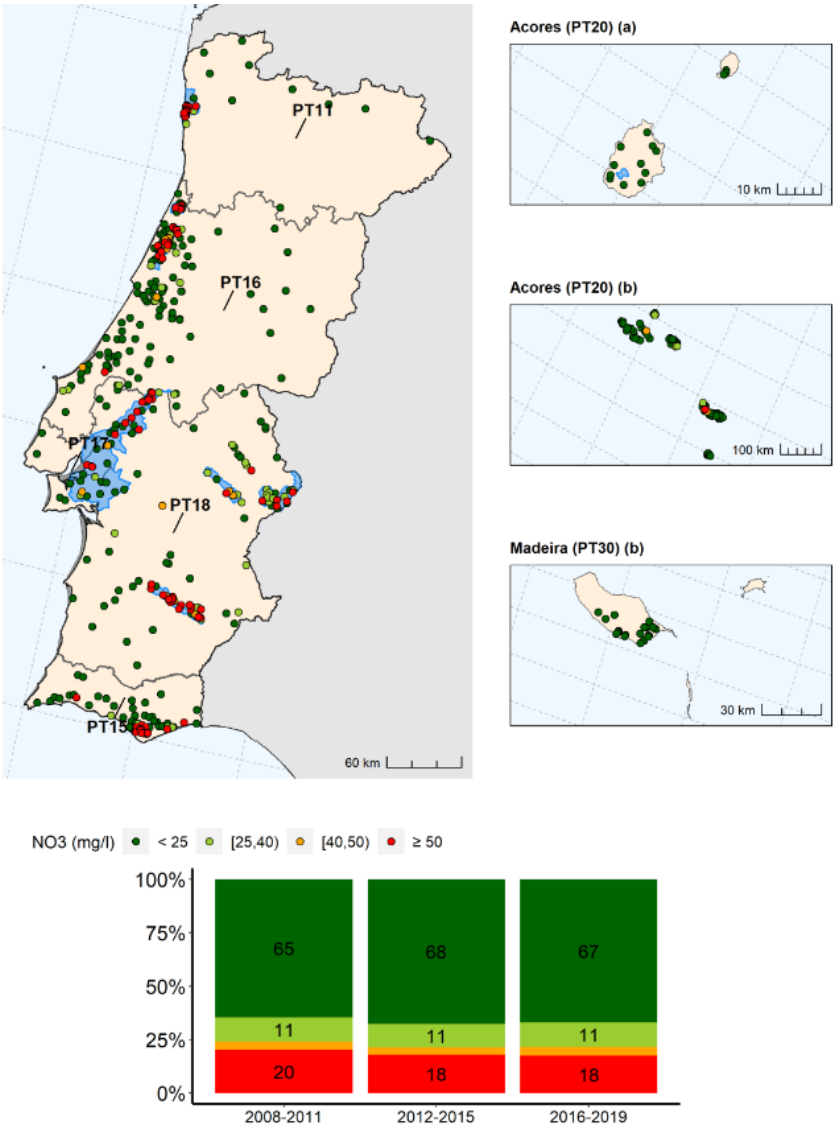



Figure 4. Spatial distribution of average NO3 annual concentration (map) and corresponding percentage of monitoring points per classes of concentration by reporting period (x axis). The percentages below 5% are not labelled, see the next plot for more information. In the map in blue the NVZ.

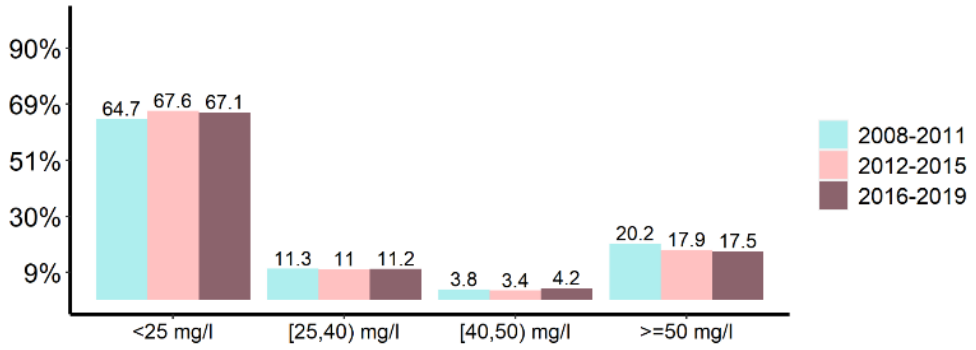
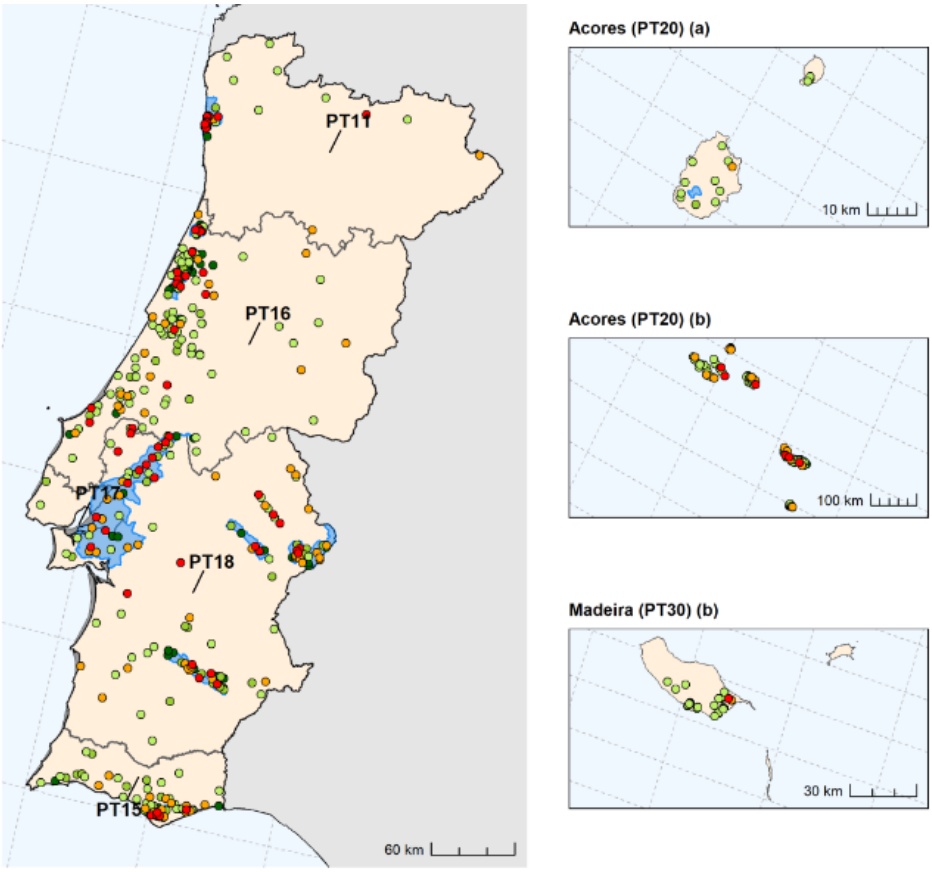



Figure 5. Comparison of percentage of monitoring points in the three reporting periods by classes of average NO3 annual concentration (x axis)

# Groundwater average annual nitrate concentration trend



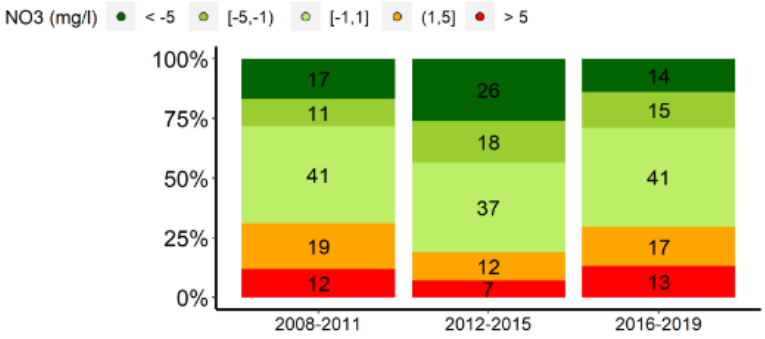




Figure 6. Spatial distribution of average NO3 annual trends (map) and corresponding percentage of monitoring points per classes of trends by reporting period (x axis). In the map in blue the NVZ.

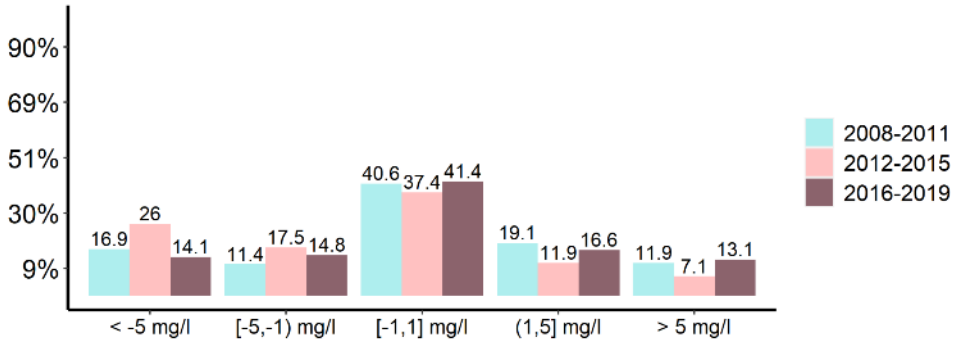
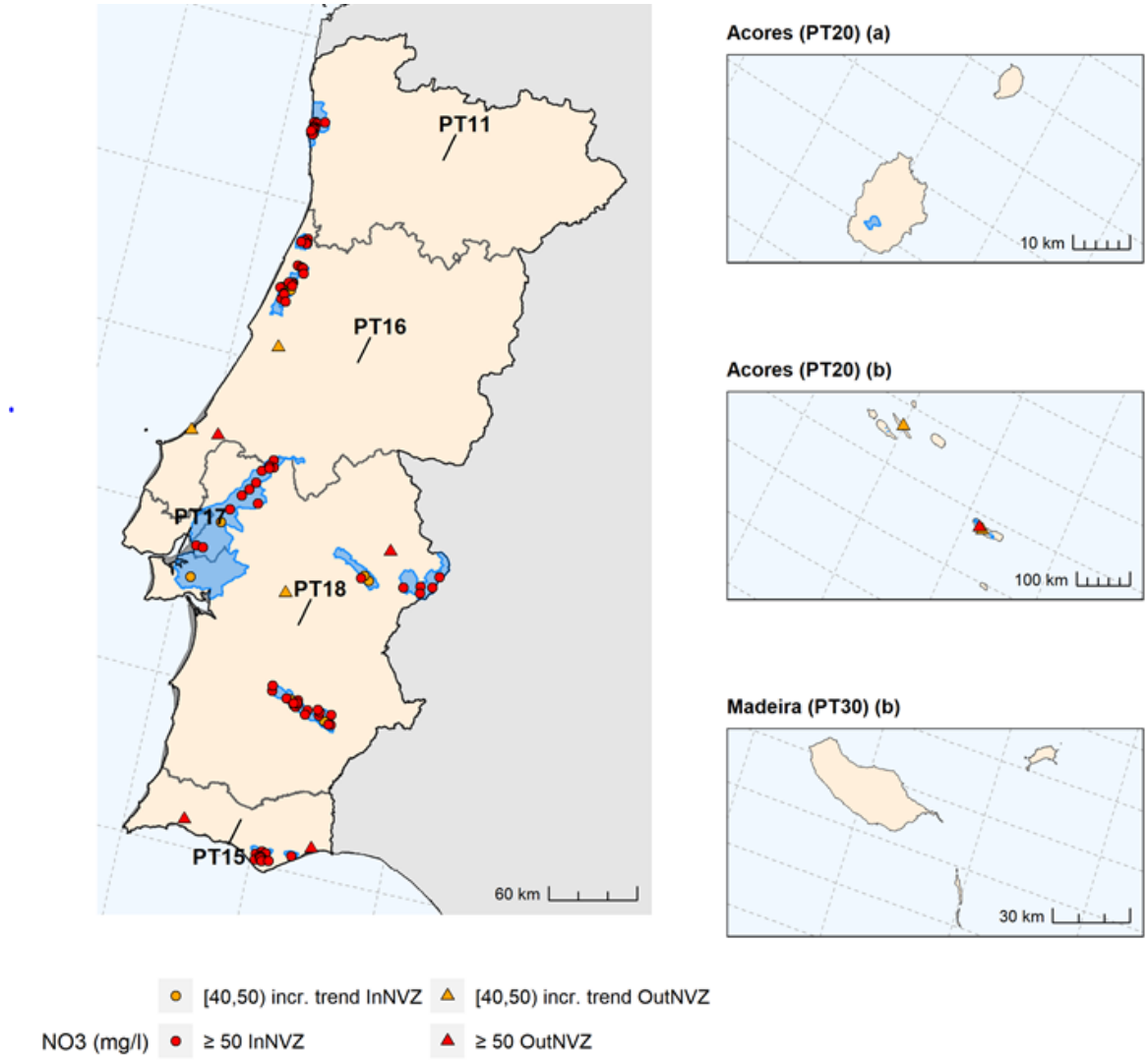



Figure 7. Comparison of percentage of monitoring points in the three reporting periods by classes of average NO3 annual trends (x axis)

## Groundwater hotspot

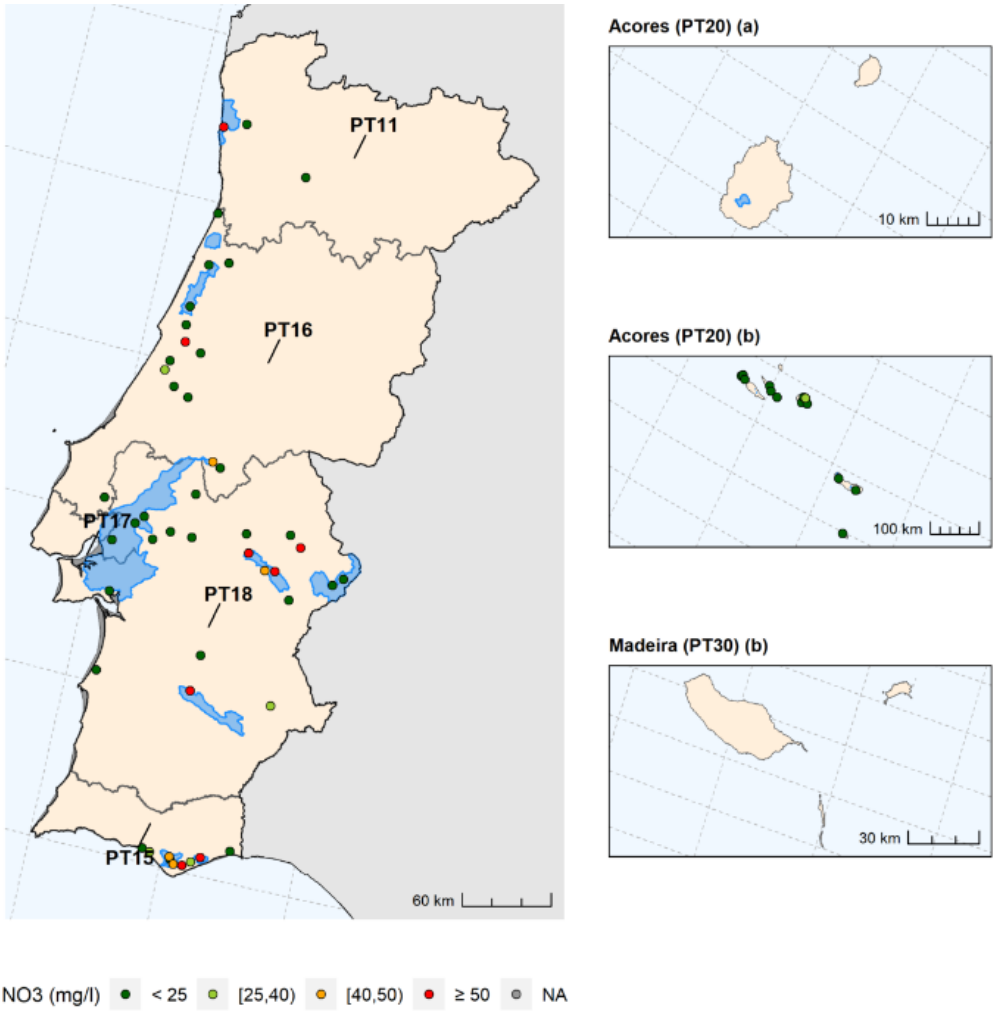



| | | >=40 and < 50 mg/l incr.trend | | >=50 mg/l | |
|---|---|---|---|---|---|
| NUTS ID | NUTS NAME | InNVZ | OutNVZ | InNVZ | OutNVZ |
| PT11 | Norte | 1 | 0 | 15 | 0 |
| PT15 | Algarve | 1 | 0 | 16 | 2 |
| PT16 | Centro (PT) | 2 | 2 | 20 | 1 |
| PT17 | Área Metropolitana de Lisboa | 1 | 0 | 0 | 0 |
| PT18 | Alentejo | 6 | 1 | 35 | 1 |
| PT20 | Região Autónoma dos Açores | 0 | 2 | 0 | 1 |
| | **Total** | **11** | **5** | **86** | **5** |

Figure 8. GW hotspot analysis map (top graph) and distribution by NUTS2 (lower graph) of average NO3 annual concentration greater than 40 mg/l. In the map in blue the NVZ.

The hotspot analysis identifies all the GW monitoring stations that have NO3 concentration in the range of 40-50 mg/l with increasing trends or are above 50 mg/l. The map shows the spatial distribution of these points, and the table reports the number of stations by NUTS inside and outside NVZ. Only the NUTS of interest are reported.

## Groundwater stations removed




| Station Type | Description | Number of removed stations | | |
|---|---|---|---|---|
| | | total removed | with measurements | with trends |
| 0 | Phreatic groundwater (shallow): 0-5 m | 20 | 20 | 20 |
| 1a | Phreatic groundwater (deep) 5-15 m | 10 | 10 | 10 |
| 1b | Phreatic groundwater (deep) 15-30 m | 13 | 13 | 13 |
| 1c | Phreatic groundwater (deep) >30 m | 4 | 4 | 4 |
| 2 | Captive groundwater | 1 | 1 | 1 |
| 3 | Karstic groundwater | 13 | 13 | 13 |
| 9 | Not specified | 0 | 0 | 0 |
| | **Total** | **61** | **61** | **61** |

Figure 9. GW removed stations map (top graph) and distribution by groundwater type (lower graph). In the map in blue the NVZ.

The removed stations analysis identifies all the GW monitoring stations that were removed in the current reporting period. The map shows the spatial distribution of these points with the concentrations of the previous reporting period, and the table reports the number of stations with measurements and trends per type.

# Surface Water Quality

## Surface water average annual nitrate concentration

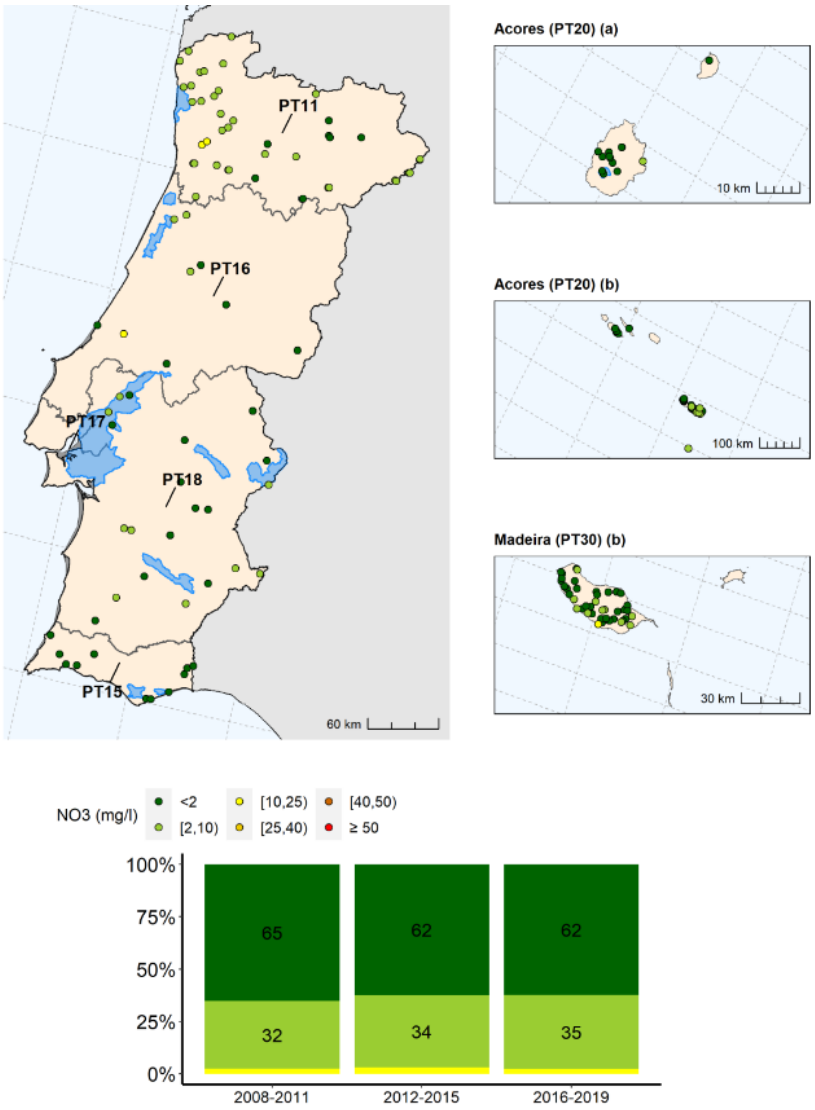



Figure 10. Spatial distribution of average NO3 annual concentration (map) and corresponding percentage of monitoring points per classes of concentration by reporting period (x axis). The percentages below 5% are not labelled, see the next plot for more information. In the map in blue the NVZ.

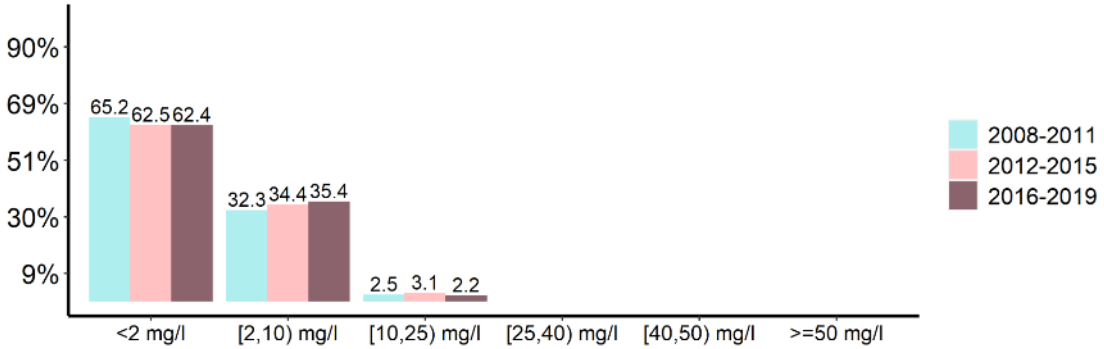



Figure 11. Comparison of percentage of monitoring points between the three reporting periods by classes of NO3 concentration (x axis)

# Surface water average annual nitrate concentration trend

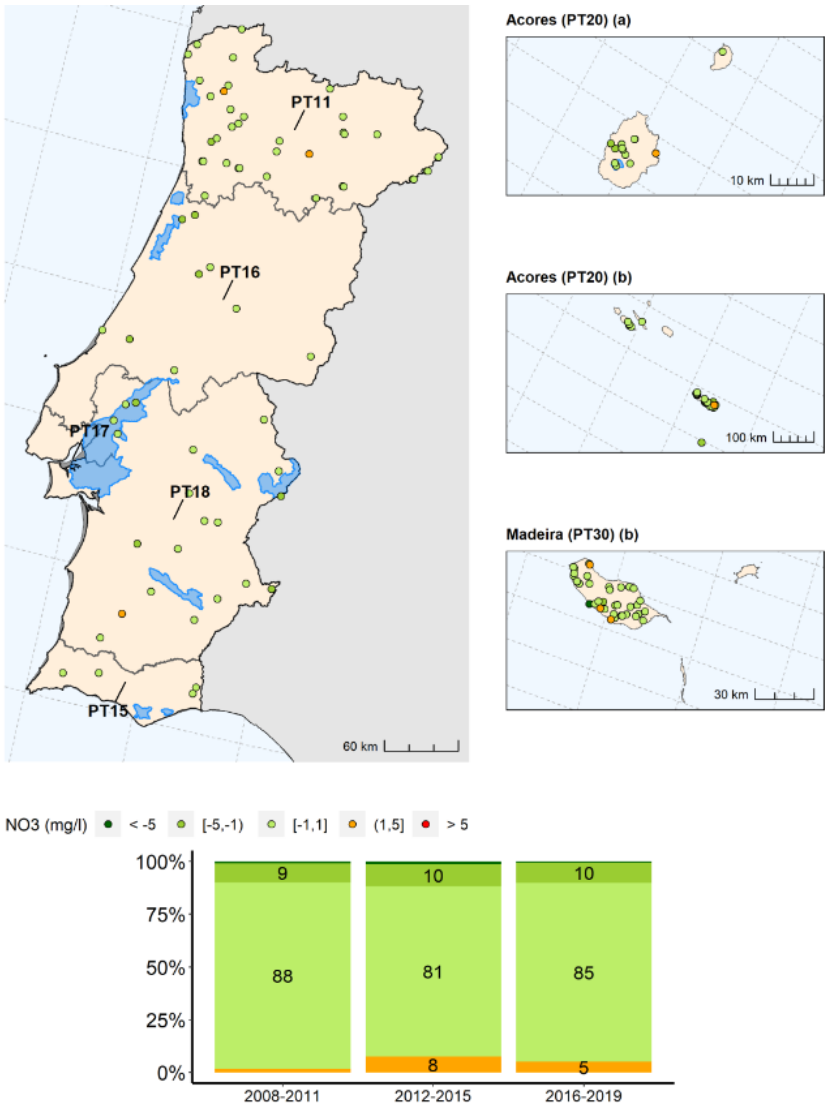



Figure 12. Spatial distribution of average NO3 annual trends (map) and corresponding percentage of monitoring points per classes of trends by reporting period (x axis). The percentages below 5% are not labelled, see the next plot for more information. In the map in blue the NVZ.

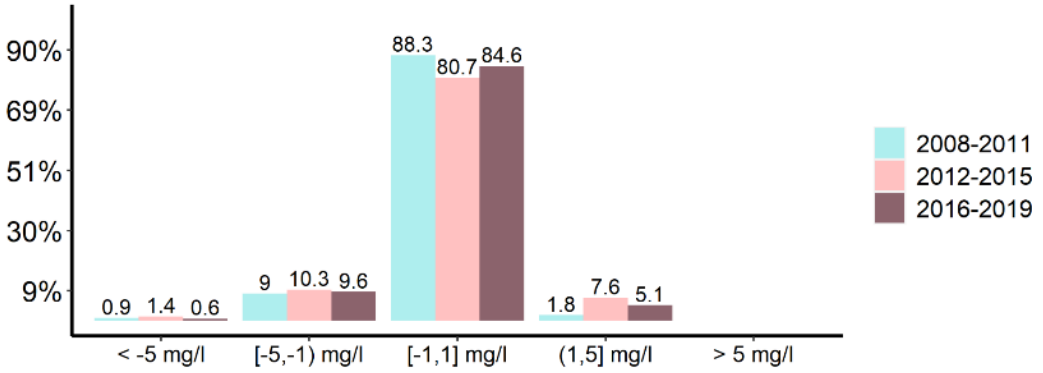



Figure 13. Comparison of percentage of monitoring points in the three reporting periods by classes of average NO3 annual trends (x axis)

# Surface Water Eutrophication

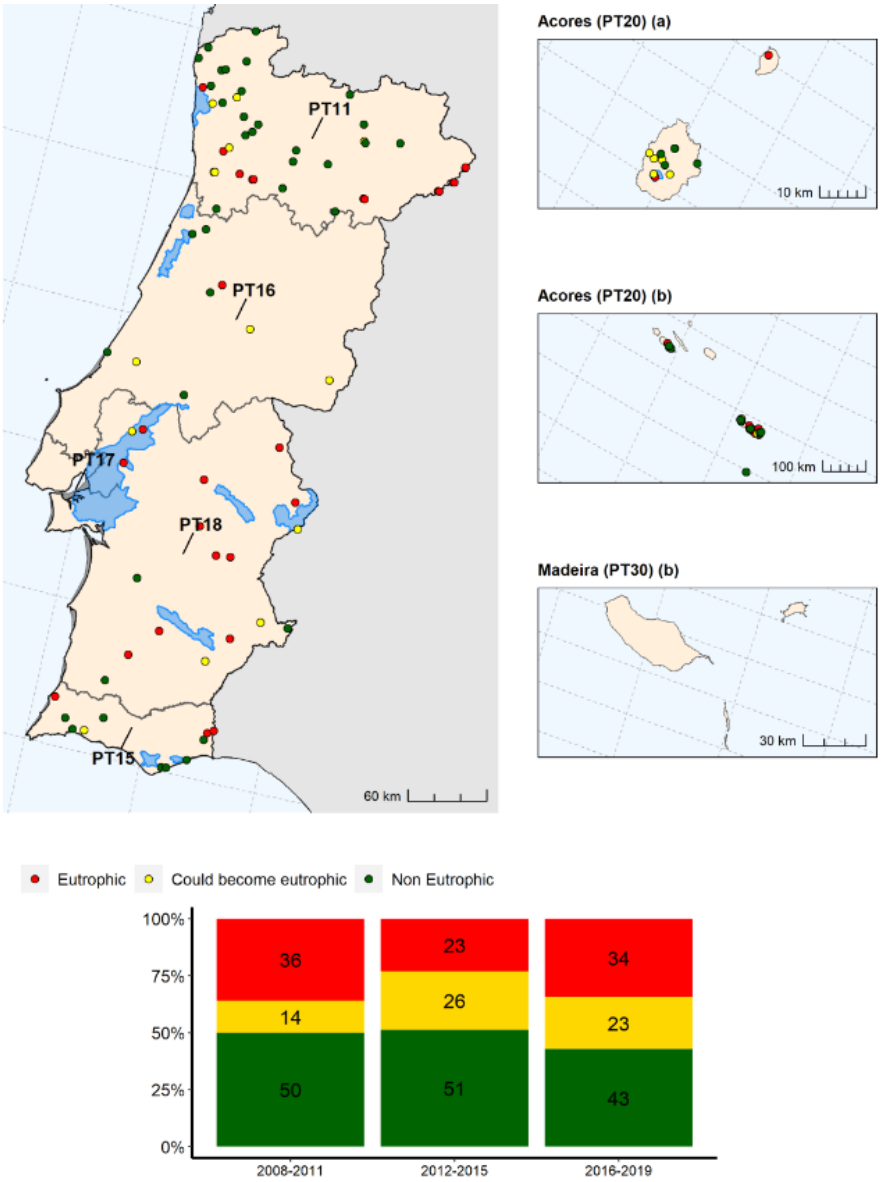



Figure 14. Spatial distribution of eutrophic status (map) and corresponding percentage of monitoring points per classes of status by reporting period (x axis). In the map in blue the NVZ.

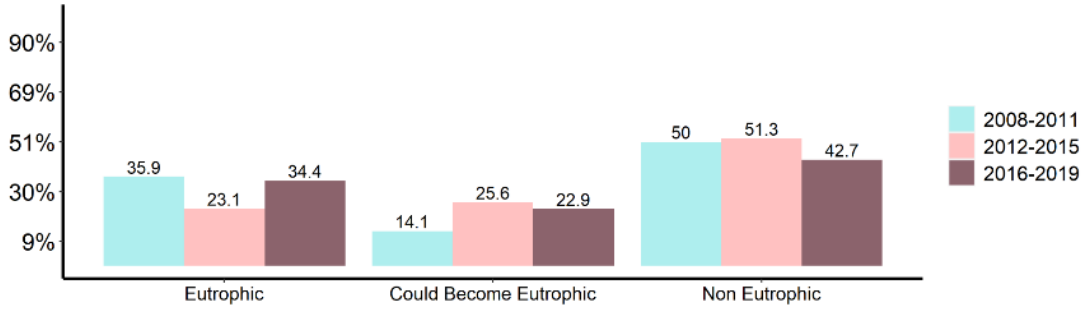
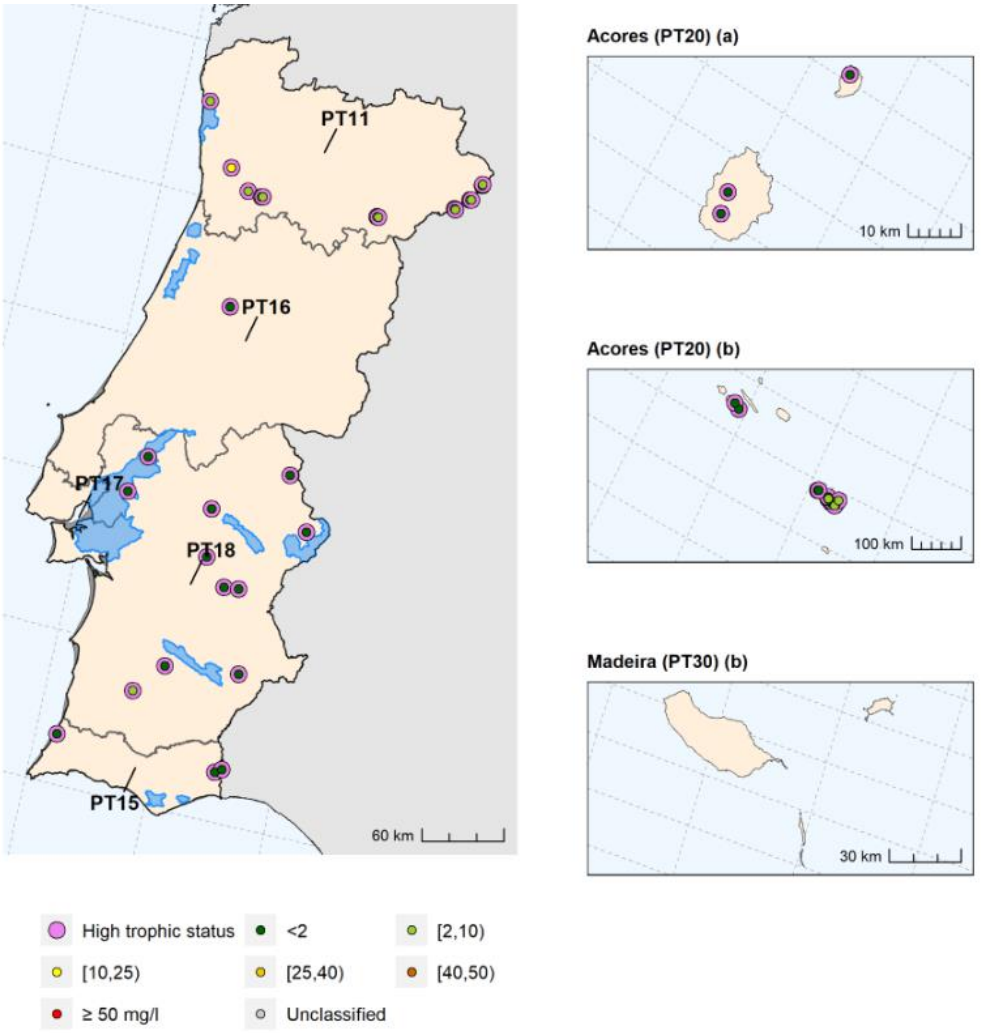



Figure 15. Comparison of percentage of monitoring points in the three reporting periods by classes of status (x axis)

## The Eutrophic status vs average NO3 annual concentration




| | | | Number of stations by classes of concentration | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NUTS ID | NUTS NAME | High trophic status | <2 mg/l | [2,10) mg/l | [10,25) mg/l | [25,40) mg/l | [40,50) mg/l | >=50 mg/l | Unclassified |
| NO_NUTS | SALINE | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| PT11 | Norte | 12 | 0 | 11 | 1 | 0 | 0 | 0 | 0 |
| PT15 | Algarve | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| PT16 | Centro (PT) | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| PT18 | Alentejo | 11 | 10 | 1 | 0 | 0 | 0 | 0 | 0 |
| PT20 | Região Autónoma dos Açores | 17 | 13 | 4 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | **45** | **27** | **17** | **1** | **0** | **0** | **0** | **0** |

Figure 16. The SW monitoring stations with eutrophic status versus the average NO3 annual concentration. In the map in blue the NVZ.

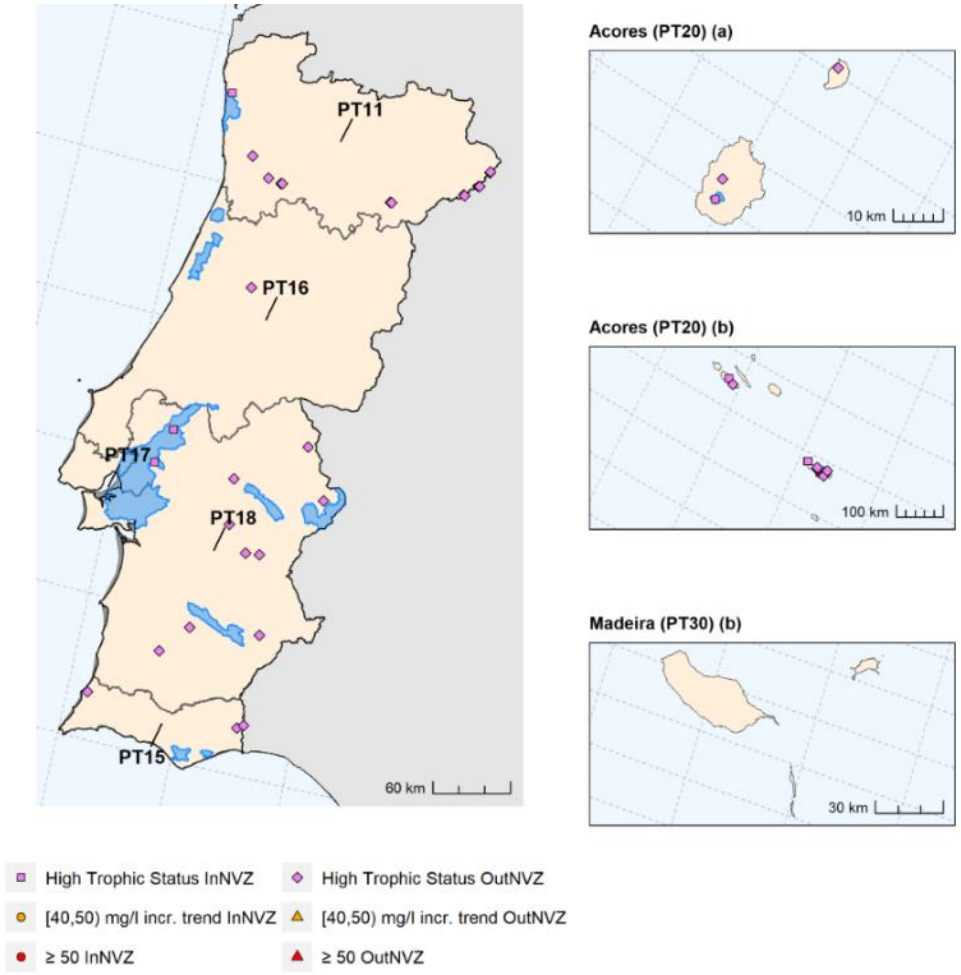
The analysis shows all the SW monitoring stations with the higher trophic status and the corresponding value of NO3 concentration. The map shows the spatial distribution of these points, and the table reports the number of stations with measurements with highest trophic status and the corresponding stations by classes of NO3 concentration. Only the NUTS of interest are reported.

The classification criteria implemented under the WFD were considered as the basis to assess the trophic status of both rivers and reservoirs. Two geographical zones were considered for the classification in which both nitrate and total phosphorus concentrations were used. For the northern rivers the lowest limits for eutrophication were 25 mg NO3/l and 0.2 mg P/L for nitrate and total phosphorus, respectively. For southern rivers the lowest criteria for total phosphorus is 0.23 mgP/L while the criteria of nitrate is identical to that of northern rivers. For reservoirs, chlorophyll-a is considered in addition to the nitrate and total phosphorus criteria. Again, two zones are used to determine the trophic classes boundaries. For reservoirs, the nitrate limit for eutrophication is the same as for rivers. For total phosphorus the concentrations limits are 0.05 and 0.08 mgP/L for northern and southern reservoirs, respectively. The chlorophyll-a limits for eutrophication are 7.9 and 9.66 mg/L for northern and southern reservoirs, respectively. Nitrate, phosphate and chlorophyll-a parameters were considered pertinent in the trophic status classification system of coastal and transitional water, using as a basis the reference values defined in the implementation of the WFD for the different types of water bodies and classes of salinity. While most rivers are classified as non-eutrophic the large majority of lakes are eutrophic. There are no eutrophic coastal waters while transitional waters had almost the same distribution for the eutrophic, non-eutrophic and could become eutrophic classes.

Table 5. Summary of SW stations by classes of trophic status and type.

| | | Number of stations with Trophic status | | |
|---|---|---|---|---|
| Station Type | Description | Eutrophic | Could become eutrophic | Non Eutrophic |
| 4 | River water | 8 | 13 | 32 |
| 5 | Lake/reservoir water | 34 | 12 | 14 |
| 6 | Transitional water | 3 | 3 | 4 |
| 7 | Coastal water | 0 | 2 | 6 |
| 8 | Marine water | 0 | 0 | 0 |
| 9 | Not specified | 0 | 0 | 0 |
| | **Total** | **45** | **30** | **56** |

## Surface Water quality hotspot



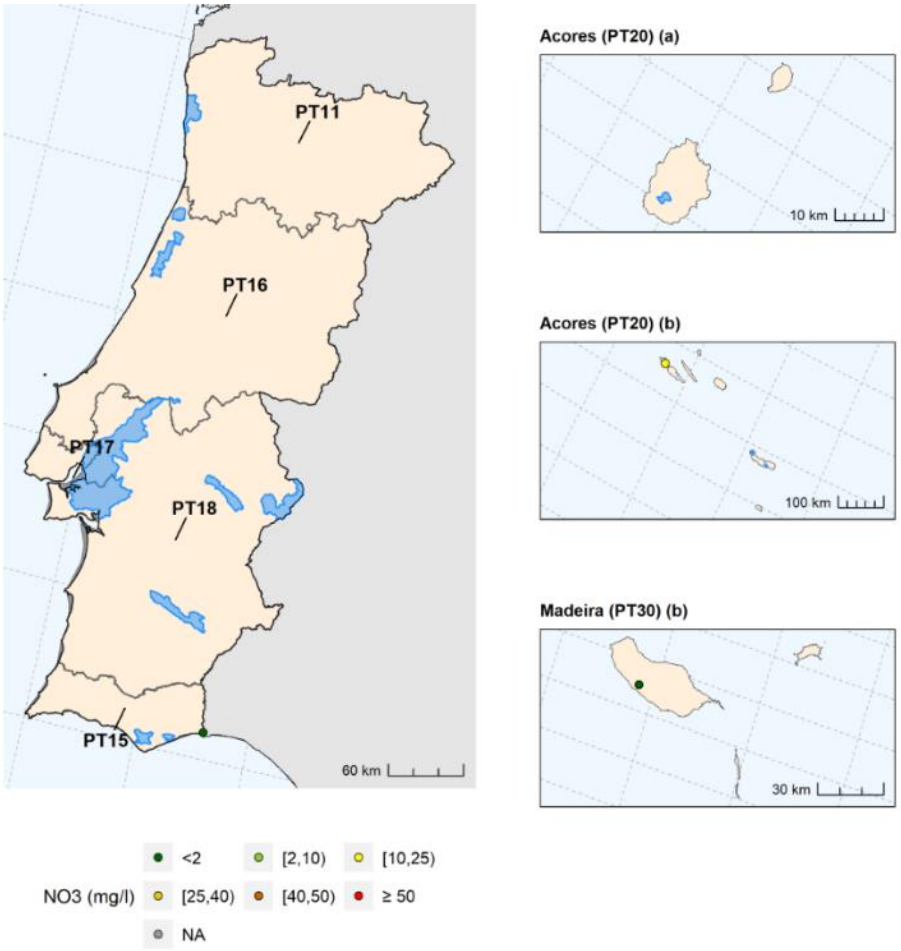

| | | High trophic status | | >=40 and < 50 mg/l incr.trend | | >=50 mg/l | |
|---|---|---|---|---|---|---|---|
| NUTS ID | NUTS NAME | InNVZ | OutNVZ | InNVZ | OutNVZ | InNVZ | OutNVZ |
| NO_NUTS | SALINE | 1 | 2 | 0 | 0 | 0 | 0 |
| PT11 | Norte | 0 | 12 | 0 | 0 | 0 | 0 |
| PT15 | Algarve | 0 | 1 | 0 | 0 | 0 | 0 |
| PT16 | Centro (PT) | 0 | 1 | 0 | 0 | 0 | 0 |
| PT18 | Alentejo | 2 | 9 | 0 | 0 | 0 | 0 |
| PT20 | Região Autónoma dos Açores | 7 | 10 | 0 | 0 | 0 | 0 |
| | **Total** | **10** | **35** | **0** | **0** | **0** | **0** |

Figure 17. SW hotspot analysis map (top graph) and distribution by NUTS2 (lower graph) of average NO3 annual concentration greater than 40 mg/l and trophic status. In the map in blue the NVZ.

The hotspot analysis identifies all the SW monitoring stations that have high trophic status, NO3 concentration in the range of 40-50 mg/l with increasing trends or are above 50 mg/l. The map shows the spatial distribution of these points, and the table reports the number of stations by NUTS inside and outside NVZ.

Only the NUTS of interest are reported.

## Surface Water Stations Removed




| Station Type | Description | Number of removed stations | | | |
|---|---|---|---|---|---|
| | | total removed | with measurements | with trends | with trophic status |
| 4 | River water | 2 | 2 | 2 | 1 |
| 5 | Lake/reservoir water | 0 | 0 | 0 | 0 |
| 6 | Transitional water | 1 | 1 | 0 | 0 |
| 7 | Coastal water | 1 | 1 | 0 | 0 |
| 8 | Marine water | 0 | 0 | 0 | 0 |
| 9 | Not specified | 0 | 0 | 0 | 0 |
| | **Total** | **4** | **4** | **2** | **1** |

Figure 18. SW removed stations map (top graph) and distribution by surface water type (lower graph). In the map in blue the NVZ.

The removed stations analysis identifies all the SW monitoring stations that were removed in the current reporting period. The map shows the spatial distribution of these points with the concentrations of the previous reporting period, and the table reports the number of stations with measurements and trends per type.

# Measures in the Action Programme

The first Code of Good Agricultural Practice was drawn up on 23/11/1997, revised in 2016 and approved in 2018. The new version of CGAP contains updates with regard to:

- Periods in which the application of fertiliser is inappropriate
- Application of fertiliser on steep slopes
- Fertiliser application on water-saturated, flooded, frozen or snow-covered soil
- Conditions for fertiliser application on land adjacent to watercourses
- The capacity and the construction of manure storage tanks, including measures to prevent water pollution by run-off and seepage into the groundwater and surface water of liquids containing livestock manures and effluents from stored plant materials such as silage
- Fertiliser application methods, including dosage and uniformity of spreading, of both chemical fertiliser and livestock manure in order to maintain nutrient losses to water at an acceptable level
- Land use management, including crop rotation systems and the relative proportion between the area devoted to permanent crops and annual crops
- Maintaining a minimum level of vegetation cover during (rainy) periods that will absorb soil nitrogen that otherwise could cause water pollution by nitrates
- Establishment of fertiliser plans at farm level and maintaining a record of the application of fertilisers
- Prevention of water pollution caused by drainage or by infiltration beyond the roots of the plants in irrigation systems

Portuguese authorities have pointed out that they assume that the voluntary implementation of CGAP by farmers and livestock producers located outside NVZs has grown since it was first published in 1997, due to the evolution seen in the agricultural and livestock sector.

The Action Programme (AP) was published for the first time in 1998 and was revised in 2001 for NVZ: Esposende Villa do Conde, Aveiro, Faro. In 2003 Mira was included. During the four-year period of 2008-2011 the following NVZ were included: Tagus, Beja, Elvas-Villa Boim, Luz-Tavira. Revisions of NVZ areas were also made in this period. Recently, a single Action Programme was drawn up for all NVZs on mainland Portugal, while in Azores three different Action Programmes are available for different NVZ.

The Action Programme was drawn up taking into account crop requirements during their growth cycle and the maximum quantities of nitrogen to be applied. It also limits the amount of organic fertilisers which can be used and considers the need to draw

up fertilisation plans and balances. It further prohibits the application of fertilisers in specific seasons, in soils which are flooded or susceptible to flooding, in snow-covered or frozen soils and on land adjacent to watercourses, groundwater wells, reservoirs, lakes (buffer strips). The AP also sets out the requirement for the sustainable management of livestock manure and slurry and the correct management of irrigation while also making compulsory certain agricultural practices on sloping land. It also sets out procedures for monitoring and controlling nitrates in waters and on agricultural land parcels.

For each NVZ, measurable criteria for assessing impact of the programmes on practices in the field have been reported, as well as the percentage of farmers respecting the rules.

No cost effectiveness was reported.

# Controls

Portugal reported by NVZ regions the controls performed to assess the implementation of the Action Programme. The percentage of farms visited in each zone varied from 0 to 25% of the farmers concerned. The percentage of non-compliance varies widely between the regions and ranges from 0% to 20% of non-compliance. The most frequent reason of non-compliance deals with the need of a balanced fertilization.

# Designation of NVZ

Portugal has made no adjustment to the nitrate vulnerable zones designated in the previous report. So, Portugal designated 4,047 $km^2$ as NVZ, which represents 4.4% of the national territory.

# Forecast of Water Quality

A groundwater model was used to simulate the nine vulnerable zones designated in mainland Portugal. The groundwater model was calibrated against actual measurements of piezometric levels and nitrate concentration. Then it was assumed that no additional nitrate input occurred in the groundwater and the model was used to estimate nitrate concentrations in 2040. Six aquifers out of 9 have nitrate concentrations above 50mg/l. Calculated concentrations of nitrate above 50mg/L covered from 1.5 to 6.7% of the area of the remaining aquifers.

# Summary

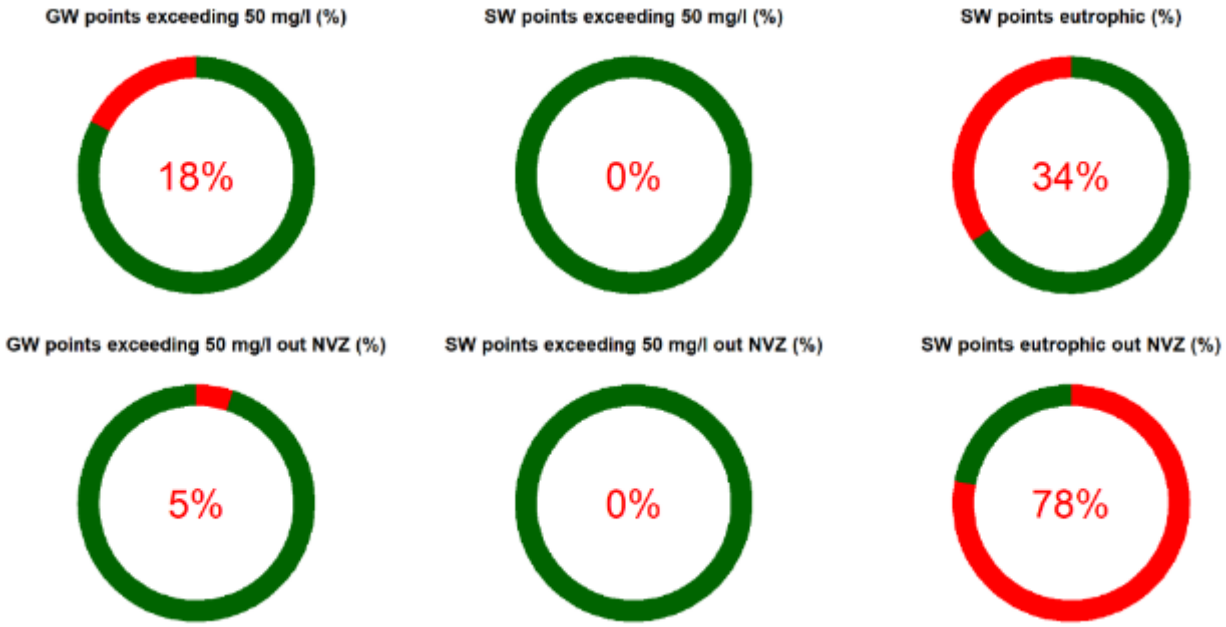



Figure 19. The summary plot for the period 2016-2019

This plot provides in the first row the percentage of stations exceeding 50 mg/l with respect to the total stations with measures and the percentage of eutrophic SW stations with respect to the total for which the trophic status is reported. In the second row, the percentage of stations exceeding 50 mg/l that are outside NVZ with respect to the total of stations exceeding 50 mg/, and the percentage of SW eutrophic stations that are outside NVZ with respect to the total that are eutrophic.

# Long term analysis

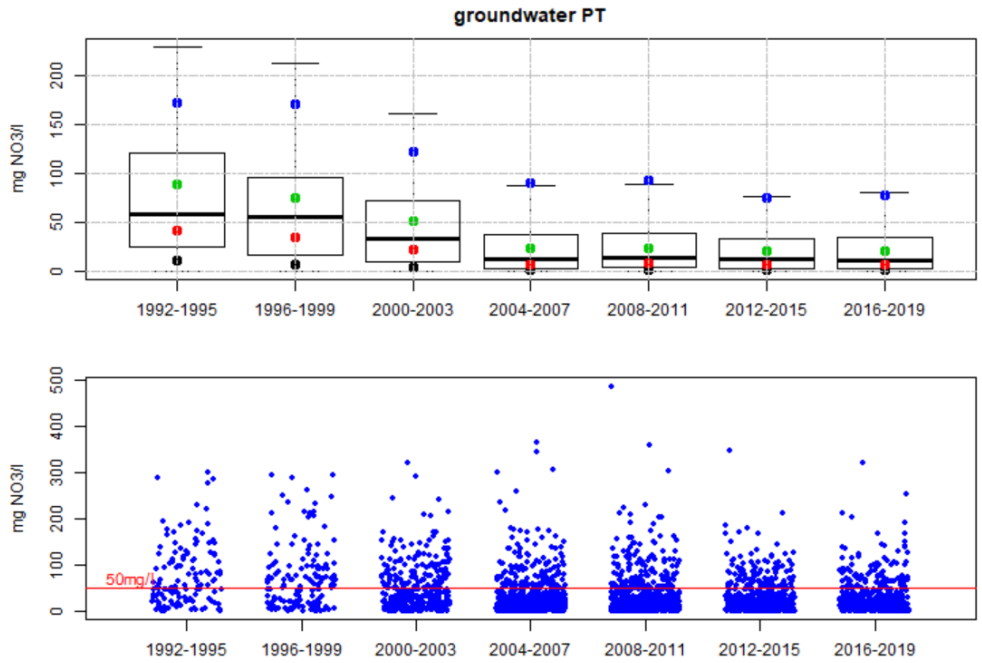



Figure 20. Time series of box whisker plots along with the distribution of the average NO3 annual concentrations for each reporting period, for groundwater stations. The blue, red, green and black dots represent the mean of the fourth third, second and first quartiles, respectively.

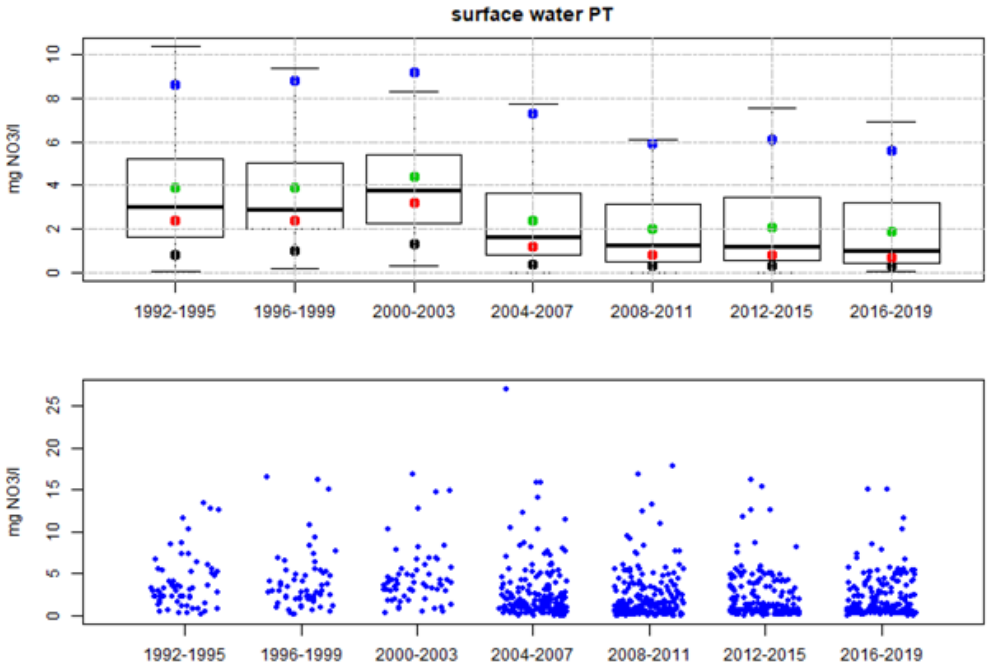



Figure 21. Time series of box whisker plots along with the distribution of the average NO3 annual concentrations for each reporting period, for surface water stations. The blue, red, green and black dots represent the mean of the fourth third, second and first quartiles, respectively.

# Conclusions and recommendations

The livestock density close to the EU average and a nitrogen and phosphorus surplus which is slightly lower than the EU average.

The network of monitoring stations is concentrated in NVZ but there are also station outside NVZ to follow the development of the possible nitrates pollution. There is a high number of groundwater hotspots showing nitrates concentration above 50 mg/l in NVZ, also a high number of stations show an increasing trend. A high number of surface waters are affected by eutrophication of which very high number is outside NVZ.

The action programmes was revised in 2012.

The Commission recommends that Portugal revises and reinforces its action programme to tackle the groundwater pollution in hot spots and revises NVZ designation to address eutrophication of surface waters where agriculture pressure is significant.