Report on the State of Implementation of the Nitrates Directive in the United Kingdom (Northern Ireland)

2016-2019

(In accordance with Article 10 of the Nitrates Directive (91/676/EEC))

July 2020

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

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cafre College of Agriculture, Food & Rural Enterprise

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1. Water quality: monitoring, assessment and maps

The Department of Agriculture, Environment and Rural Affairs (DAERA) has responsibility for monitoring water quality which includes providing monitoring data collected from surface waters (rivers, lakes, transitional and coastal marine waters) and groundwaters across Northern Ireland. The ‘Nitrates Directive Development Guide for Member States’, updated and re-issued in 2020, indicates that for the purposes of reporting, data may be averaged over more than one year. Where data availability permits, an additional column has been added to the summary tables on water quality to introduce the data for the period 2008-2011, thus allowing a three period comparison for some assessments, as advised in the Development Guide (2020). For the purposes of this report DAERA will use 2012-2015 and 2008-2011 to represent the two previous reporting periods and 2016-2019 to represent the current reporting period. The Water Framework Directive (2000/60/EEC) (WFD) 2018 interim classification data for Northern Ireland will also be used to assess eutrophication in both rivers and lakes, and transitional and coastal marine waters.

Summary data tables for 2008-2011 reporting period were previously supplied via ReportNet to the Commission in 2012. Summary data tables for 2012-2015 reporting period were previously supplied via ReportNet to the Commission in 2016.

The surface freshwater monitoring network coverage in Northern Ireland aims to fulfil all monitoring obligations under multiple directives such as WFD and the Nitrates Directive (91/676/EEC) (ND). However, financial and resource constraints have led to multiple revisions of the surface freshwater monitoring network since 2010. A review of the surface freshwater monitoring programme was undertaken for the second cycle of the River Basin Management Plans (RBMP). As a result, changes were implemented in 2015 through better targeting and by adopting a risk based approach to monitoring. Any modifications to the monitoring network programme have taken into account the need to ensure long-term reporting of nitrate and phosphorus concentrations in surface waters in Northern Ireland. In 2019, the average number of monthly samples analysed for nutrients was 505.

In the period 2008-2011, NIEA monitored nitrate concentrations at 622 surface freshwater monitoring stations across Northern Ireland. In the period 2012-2015, NIEA monitored nitrate concentrations at 337 surface freshwater monitoring stations across Northern Ireland. In the current period 2016-2019, NIEA monitored nitrate concentrations at 534 surface freshwater monitoring stations across Northern Ireland.

Groundwater monitoring from 2016-2019 was carried out at 56 monitoring sites. The groundwater monitoring sites are the same as those sampled for the WFD groundwater monitoring network in order to meet the requirements of that Directive. Within the groundwater monitoring network the Northern Ireland Environment Agency (NIEA) depends largely on third party owned groundwater boreholes to collect samples from sites, as there is little public drinking water supplies sourced from groundwater.

Nutrient monitoring in Northern Ireland’s transitional and coastal waters has been primarily developed to fulfil the requirements of the Water Framework Directive (2000/60/EC) as well as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). Nutrient status is typically determined through the assessment of winter (November-February) dissolved inorganic nitrogen (DIN) concentrations and are reported at the water body level. In addition to surveillance nutrient monitoring, a number of investigative monitoring programmes in response to known pressures and specific areas of concern, have also been undertaken. For this assessment, nutrient (NO_3) data from a variety of monitoring programmes, including investigative monitoring, were collated to provide a comprehensive historical and contemporary dataset. In order to ensure a robust and realistic assessment, nitrate data in transitional and coastal waters only included winter samples and was analysed at the WFD water body level. Some 300 sampling sites were reviewed and collated into 24 transitional and coastal water bodies. The data were further allocated to three reporting periods: 2008-2011, 2012-2015, and 2016-2019. Results are reported at a representative site for each water body.

Structure of the water quality assessment chapter

The following sections in the water quality chapter present the assessment of water quality in Northern Ireland for all surface and groundwaters in accordance with the '*Nitrates Directive Development Guide for Member States*', 2020. The chapter is divided into seven parts as follows:-

1.1. Assessment and classification of nitrate in groundwaters;
1.2. Assessment and classification of nitrate in surface freshwaters;
1.3. Assessment and classification of nitrate in coastal and transitional marine waters
1.4. Overview of assessment of eutrophic indicators in rivers, lakes and transitional and coastal marine waters;
1.5. Current overall WFD assessment of trophic status of rivers
1.6. Assessment of eutrophic indicators in lakes; and
1.7. Assessment of eutrophic indicators in transitional and coastal marine waters.

1.1. Assessment and classification of nitrate in groundwater

1.1.1. Groundwater monitoring network

Northern Ireland, in comparison with most of the rest of the UK has a particularly diverse and complex geology. The nature of the rocks and their associated geological 'history' is such that associated groundwater flow is predominately through fractures, concentrated in the upper part of the aquifer and discharging locally. These factors produce generally small, compartmentalised aquifers with fast groundwater through-flow which have, for the most part, only limited to moderate productivity with respect to water abstraction. The bedrock aquifers in Northern Ireland can be locally confined by glacial deposits. Superficial aquifers are also found in Northern Ireland – mostly in the form of sand and gravel or alluvial deposits which are generally restricted in their extent.

Groundwater quality in Northern Ireland is assessed in accordance with NIEA's groundwater monitoring programme through the collection of groundwater water samples from boreholes, wells and springs that are mostly owned and operated by third parties. The public drinking water supply provider (Northern Ireland Water Ltd) does not currently utilise groundwater with the exception of Rathlin Island, a small island off the north coast of Northern Ireland. Hence, NIEA rely mostly on third party owned groundwater boreholes and the co-operation of land/property owners to continue sampling from their groundwater sources for chemical monitoring and analysis. This means that the groundwater monitoring network can change due to businesses closing or changing their groundwater usage and in addition datasets available for trend assessments can be small. The monitoring network consists mainly of industrial boreholes where groundwater is utilised for manufacturing or food/drinks production. A small number of boreholes installed by NIEA are also monitored. The selection of monitoring sites to date has been based on a pressure-pathway assessment of the groundwater bodies and the availability of potential monitoring sites.

In the previous Article 10 report (2016) Northern Ireland presented groundwater data from 2012-2015. As discussed in the previous section, access to groundwater monitoring sites can be lost when business requirements change. Therefore, the numbers of monitoring sites presented in this report differs from the numbers previously reported in 2016. As a result of the changes to the monitoring network there are 34 sites monitored in the 2016-2019 reporting period which were also monitored in the 2012-2015 reporting period (see Table 1.1). For the purposes of this report groundwater monitoring data from 2016-2019 is compared with data from the previous reporting period (2012-2015) as well as the initial reporting period 2008 - 2011.

Table 1.1: Numbers of groundwater monitoring sites for nitrate concentrations (NO_3 mg/l) in Northern Ireland

Number of groundwater monitoring points			
	2012-2015 reporting period	**2016-2019 reporting period**	**Common points**
Phreatic groundwater (0-5m)	2	2	2
Phreatic groundwater (5-15 m)	36	38	34
Phreatic groundwater deep (15-30 m)	0	0	0
Phreatic groundwater > 30m	7	7	7
Captive groundwater	5	4	4
Karstic groundwater	5	5	5
Overall Summary	55	56	52

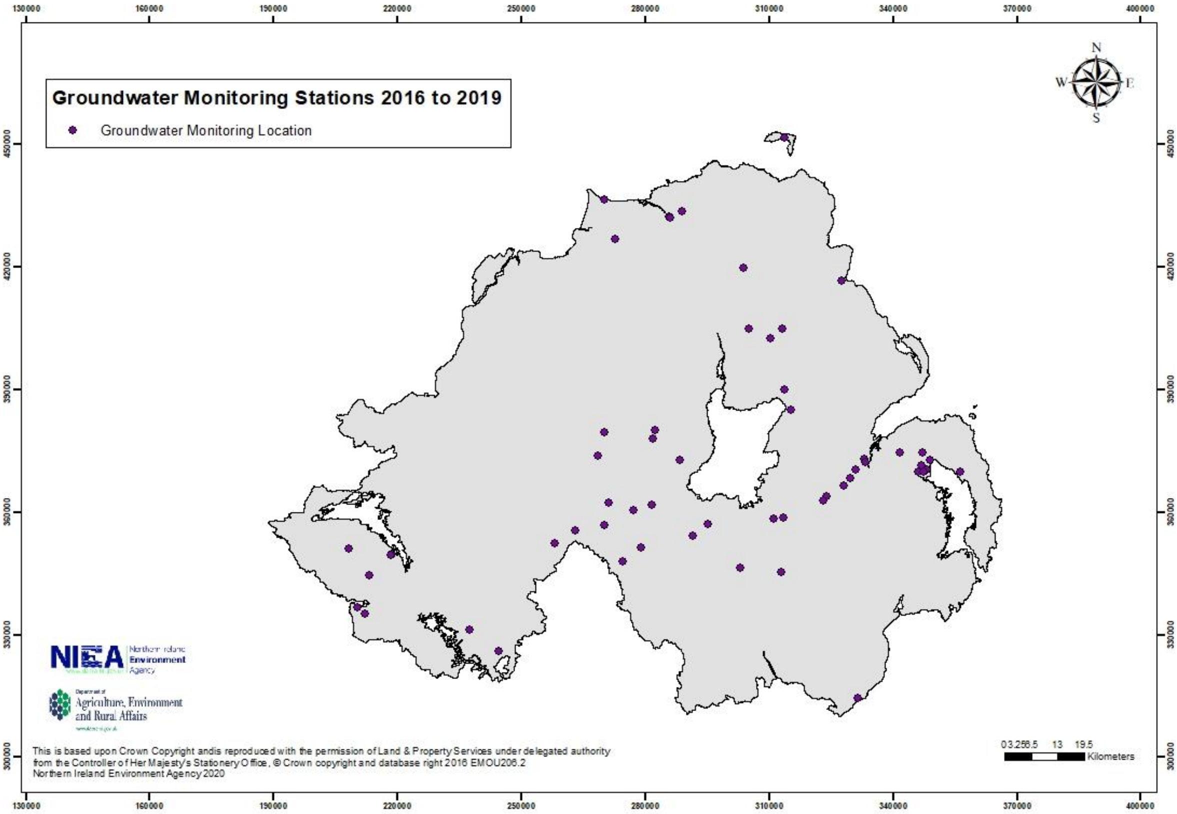

Figure 1.1: Location of groundwater monitoring sites: (2016-2019)

1.1.2. Evolution of nitrate concentrations (NO_3 mg/l) in groundwaters

During the reporting period 2016-19, NIEA collected data on groundwater nitrate concentrations from 56 groundwater monitoring sites across Northern Ireland. For the purposes of this report all available data collected in the period 2016-19 was included to calculate the average and maximum nitrate concentrations.

Table 1.2 shows the monitored average nitrate concentrations for the reporting period 2008-2011. This shows that no sites had an average nitrate concentration greater that 50 mg/l NO_3 for this period of time.

Table 1.3 shows that, monitored average nitrate concentrations for the previous reporting period 2012–2015 in groundwater in Northern Ireland were generally low. Results show that of the 56 sites, 55 had an annual average of less than 25 mg/l NO_3 and only 1 had greater than 50 mg/l NO_3.

Table 1.2 Average nitrate concentrations (NO_3 mg/l) in groundwater: 2008-2011 (% of monitoring sites)

Quality classes for average nitrate concentrations (mg NO3/L) in groundwater (% of sampling points) 2008-2011				
	0-24.99	**25-39.99**	**40-50**	**>50**
Groundwater annual average (NO_3 mg/l)	94.83	5.17	0	0

Table 1.3: Average nitrate concentrations (NO_3 mg/l) in groundwater: 2012-2015 (% of monitoring sites)

Quality classes for average nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2012-2015				
	% of points mg nitrate / L			
	< 25	25-39.99	40-49.99	≥50
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	100	0	0	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	80			20
Karstic groundwater	100	0	0	0
Overall Summary	98.2	0	0	1.8

Table 1.4: Average nitrate concentrations (NO_3 mg/l) in groundwater: 2016-2019 (% of monitoring sites)

Quality classes for average nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2016-2019				
	% of points mg nitrate / L			
	< 25	25-39.99	40-49.99	≥50
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	97.37	0	2.63	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	75		25	0
Karstic groundwater	100	0	0	0
Overall Summary	96.43	0	3.57	0

Table 1.4 shows that, monitored average nitrate concentrations for the current reporting period 2016–2019 in groundwater in Northern Ireland were also generally low. Results show that of the 56 sites, 54 had an annual average of less than 25 mg/l NO_3 and no sites had an annual average value greater than 50 mg/l NO_3. In the 2012 report the groundwater monitoring stations were not separated into different classes, and so only the overall summary can be compared.

The summary tables indicate that there has been a decrease in the quality of groundwater in terms of nitrates, however, it needs to be noted that the stations falling into the higher nitrate classes are sites that weren't monitored in the 2008-11 monitoring period. The two monitoring sites in the 40-49.99 mg/l NO3 band in the current period, one is a new monitoring point and the other is the location that was in the >50 mg/l NO3 in the 2016 report showing an improvement in quality.

The maximum values detected, show if there is any peak period where the nitrate concentrations show an extreme high. This could be due to a period of dry weather or in response to seasonal agricultural practices. This information is detailed in tables 1.6 – 1.8 that show these values in each of the reporting rounds 2008-2011, 2012-2015 and 2016-2019 respectively.

Table 1.5 Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2008-2011 (% of monitoring sites)

Quality classes for annual maximum nitrate concentrations (mg NO3/L) in groundwater (% of sampling points) 2008-2011				
	0-24.99	**25-39.99**	**40-50**	**>50**
Groundwater annual maximum (NO_3 mg/l)	84.48	8.62	5.17	1.72

Table 1.6 Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2012-2015 (% of monitoring sites)

Quality classes for maximum nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2012-2015				
	< 25	**25-39.99**	**40-49.99**	**≥50**
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	94.44	5.56	0	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	80	0	0	20
Karstic groundwater	100	0	0	0
Overall Summary	94.64	3.57	0	1.79

Table 1.7 Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2016-2019 (% of monitoring sites)

Quality classes for maximum nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2016-2019				
	< 25	**25-39.99**	**40-49.99**	**≥50**
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	94.74	2.63	0	2.63
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	75	0	0	25
Karstic groundwater	100	0	0	0
Overall Summary	94.64	1.79	0	3.57

Tables containing the summary data collected during 2016-19 displaying, for each borehole, the average nitrate concentration and the measured maximum nitrate concentration are available at ReportNet.

Nitrate concentrations are influenced by a range of factors including land use type, history and intensity, rainfall rates, soil types, the presence of glacial deposits providing some protection to the underlying water table and the small compartmentalised nature of the aquifers, as described in section 1.1.1. Northern Ireland is dominated by relatively poorly draining soils and low permeability glacial deposits which combine to reduce infiltration and offer opportunities for denitrification. Relatively high rainfall rates (mean annual rainfall 1,113 mm/yr; Betts, 1997) also act to reduce nitrate concentrations. Where nitrate concentrations are locally elevated this can coincide with superficial and bedrock aquifers which have some primary porosity potentially resulting in delayed release of nitrates to the water table via the unsaturated zone.

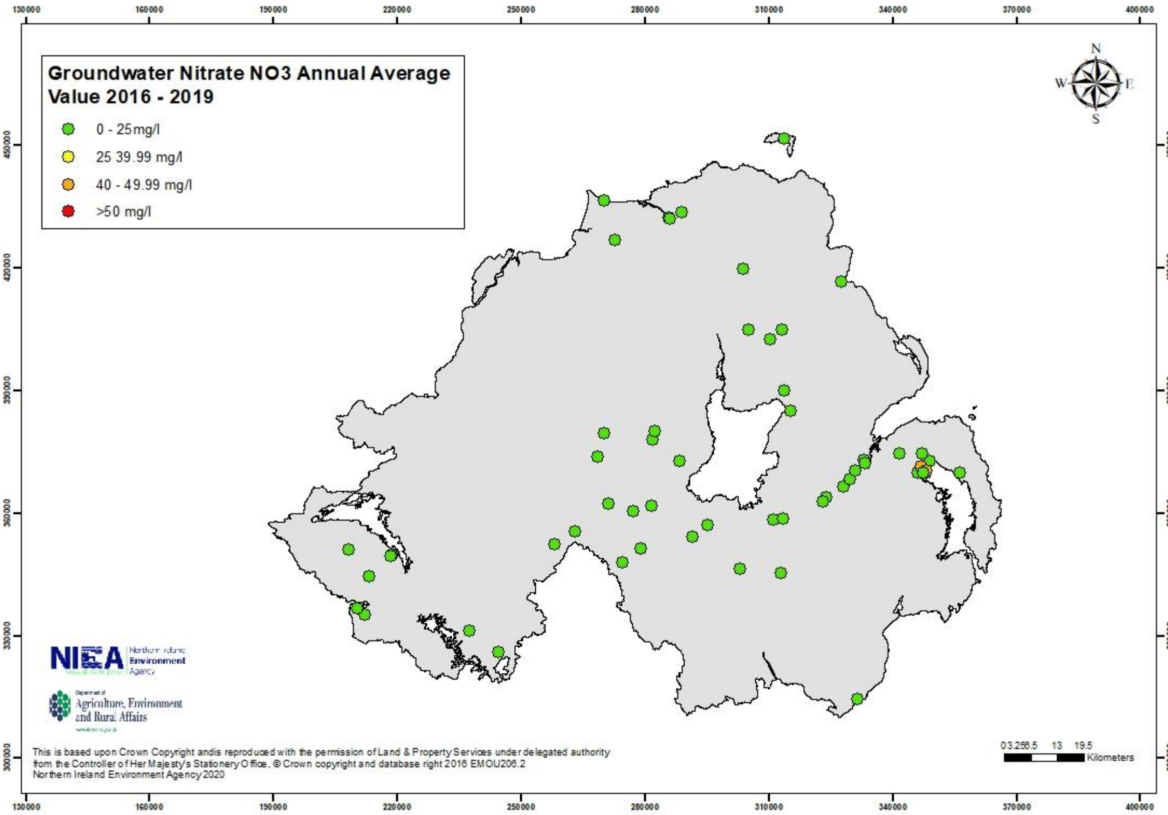

Figure 1.2: Annual average nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites: 2016-2019

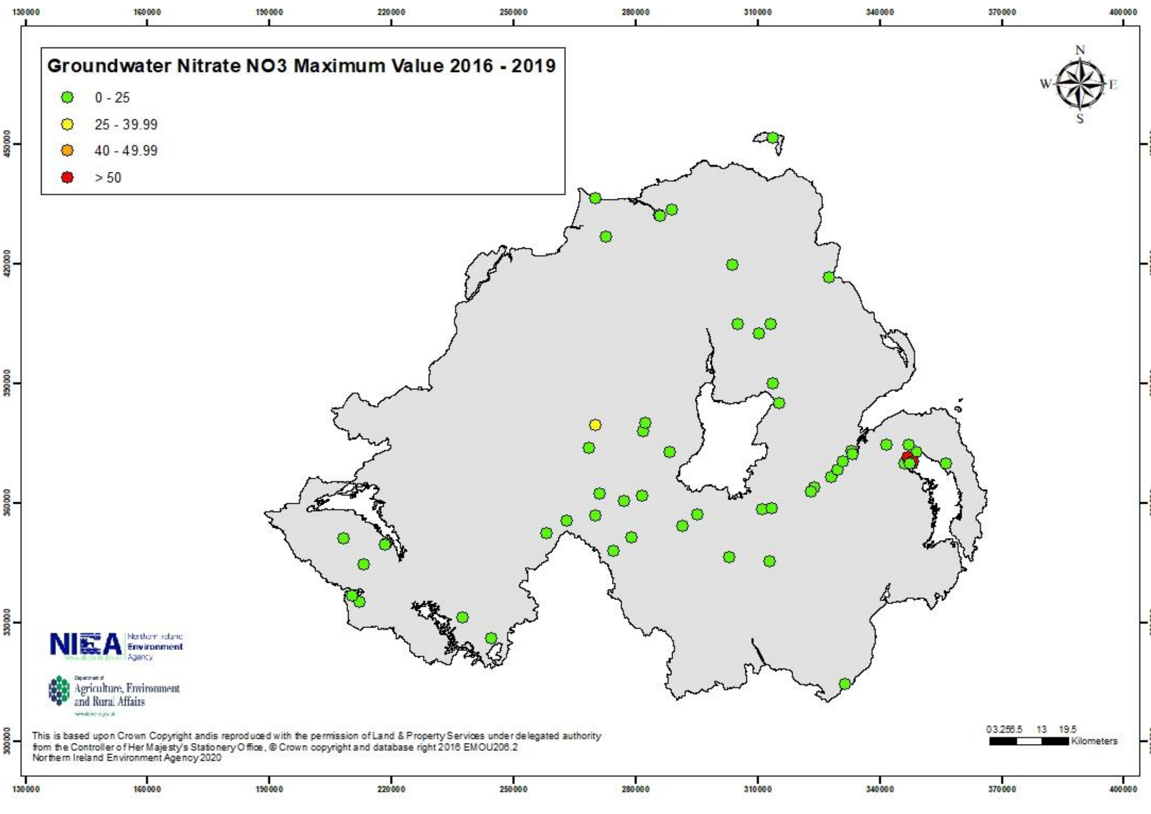

Figure 1.3: Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites: 2016-2019

1.1.3. Changes in nitrate concentrations between previous and current reporting periods

The data in Table 1.8 displays the change between the average nitrate concentrations for the common boreholes in the period 2015-2019 compared with concentrations in the period 2012-2015. Further details are available on ReportNet: http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/

Table 1.8: Changes in groundwater nitrate concentrations (NO_3 mg/l) based on annual average between 2012-2015 and 2016-2019 reporting periods (percentage of water monitoring sites)

	% of sampling points within each category nitrate (mg / L)				
	< - 5	>-1 and ≤ –5	≥– 1 and ≤ + 1	>+1 and ≤+5	> +5
Phreatic groundwater (0-5m)	0	50	50	0	0
Phreatic groundwater (5-15 m)	11.43	5.71	71.43	8.57	2.86
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	0	14.29	57.14	28.6	0
Captive groundwater	25	0	50	25	0
Karstic groundwater	0	25	75	0	0
Overall Summary	9.4	9.4	69.8	5.7	5.7

Table 1.9: Changes in groundwater nitrate concentrations (NO_3 mg/l) based on annual average between 2008-2011 and 2012-2015 reporting periods (percentage of water monitoring sites)

	% of sampling points within each category nitrate (mg / L)				
	< - 5	>-1 and ≤ –5	≥– 1 and ≤ + 1	>+1 and ≤+5	> +5
Phreatic groundwater (0-5m)	0	50	0	50	0
Phreatic groundwater (5-15 m)	4.8	28.6	57.1	9.5	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	0	14.29	57.14	28.6	0
Captive groundwater	N/A	N/A	N/A	N/A	N/A
Karstic groundwater	0	0	100	0	0
Overall Summary	2.9	22.9	60.0	14.3	0.0

For comparison table 1.9 displays the change between the annual average nitrate concentrations between the previous reporting periods 2008-2011 and 2012-2015. There is a much larger percentage of sites showing stable or an increasing trend in this reporting round 2016-2019 than there was in the previous 2012-2015 reporting round. However, there is a much larger number of sites showing decreasing concentrations of nitrates in groundwater, and the majority, (60%) of sites showing stable concentrations.

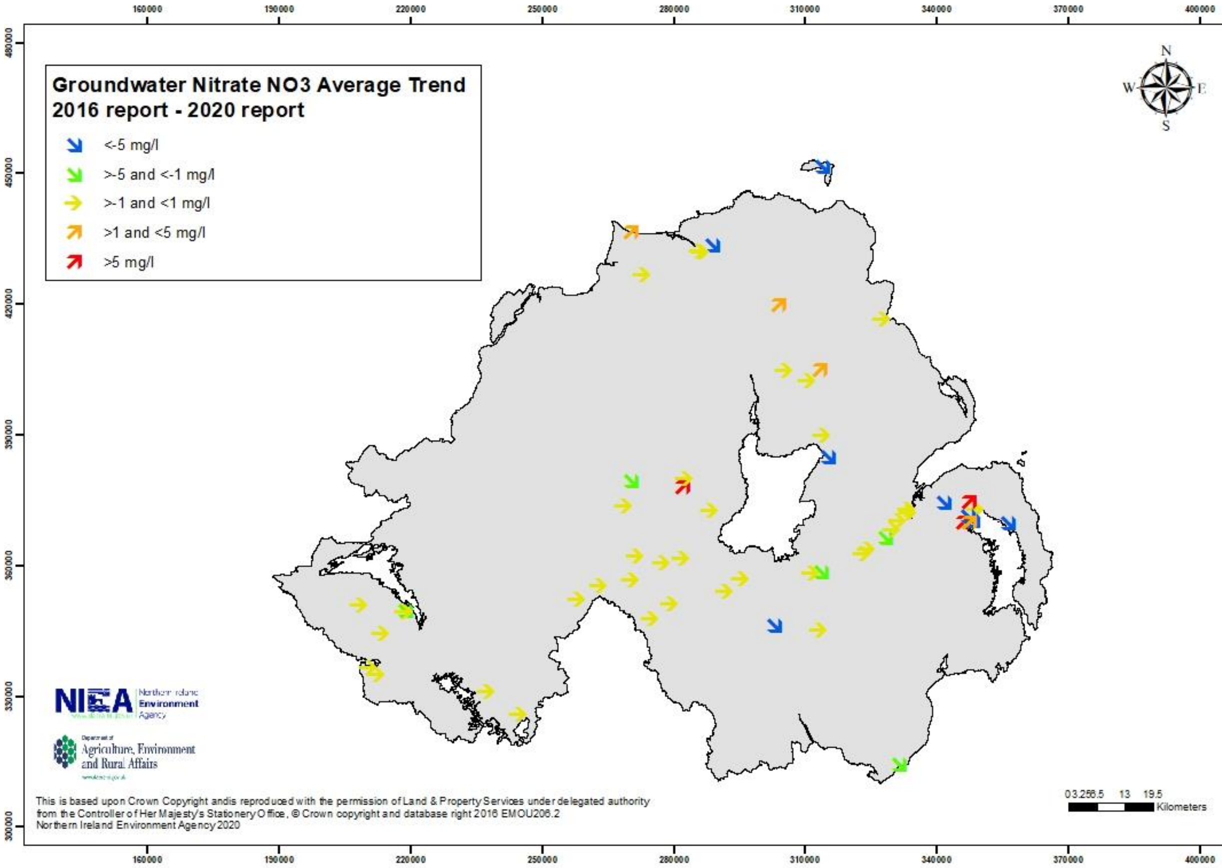

Figure 1.4: Change in annual average nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites between previous (2012-2015) and current (2016-2019) reporting period (negative values indicate a decrease).

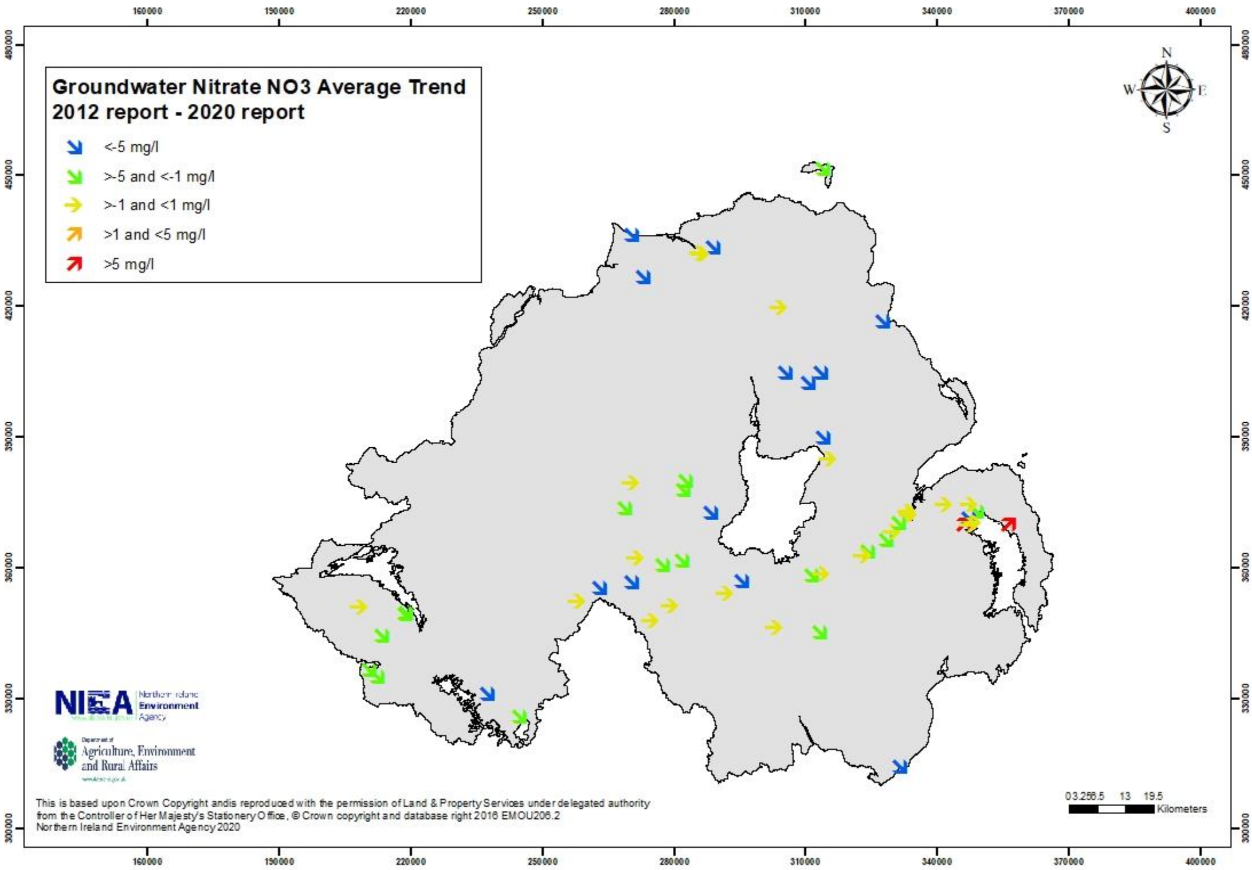

Figure 1.5: Change in annual average nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites between the first (2008-2011) and current (2016-2019) reporting periods (negative values indicate a decrease).

1.2. Assessment and classification of nitrate in surface freshwaters

1.2.1. Surface freshwater monitoring network

In the previous Article 10 report (2012-2015) submitted to the EU Commission in 2016, Northern Ireland presented data for surface waters averaged over the four-year periods 2008-2011 and 2012-2015. In this report Northern Ireland is presenting surface water data averaged over the four-year periods 2012-2015 and 2016-2019. Data from the period 2008-2011 is also presented in Tables 1.10 to 1.13 to allow a three period comparison. The number of monitoring sites presented will differ during each reporting period. Drinking water data was included as a separate category in the 2008-2011 reporting period but was unavailable in subsequent years as it was provided by an external water regulator. Reservoirs greater than 50 hectares that act as sources of drinking waters are subsumed in the lake/ reservoir station type as stated in the reporting guidance (2020) and are assessed by NIEA as part of the monitoring network,

Table 1.10: Numbers of surface freshwater monitoring sites for nitrate concentrations (NO_3 mg/l) in Northern Ireland, 2008-2019

	2008-2011	2012-2015	2016-2019	Common points between 2012-15 and 2016-2019
Rivers	567	316	472	304
Lakes	27	21	21	21
Drinking Waters	28	0	0	0
Total	622	337	493	325

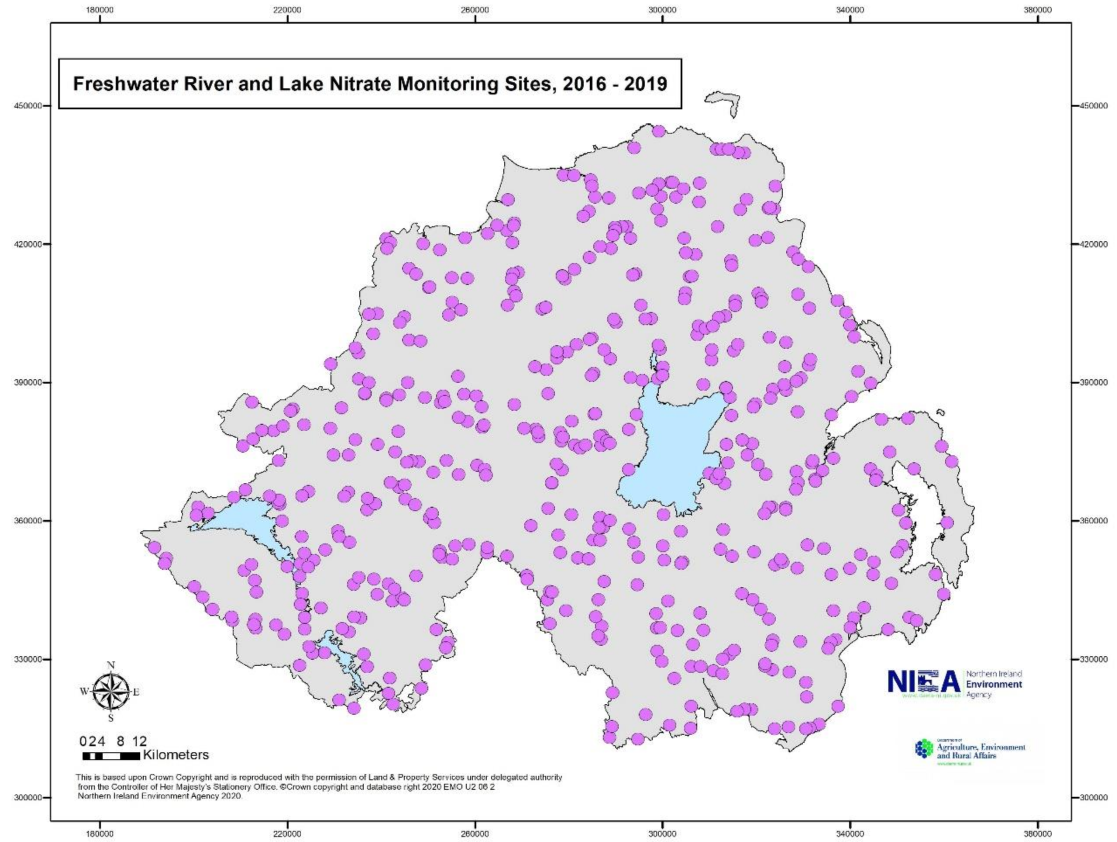

Figure 1.6: Surface freshwater (rivers and lakes) monitoring sites, current reporting period (2016–2019)

In the period 2008–2011 monitoring was carried out at 760 river and lake sites. Sufficient numbers of samples (i.e. >=20 samples for annual averages and >=10 samples for winter averages) over four years were available at 567 of the river sites, 27 lake sites and at 28 surface drinking water sites, giving a total of 622 sites. In the period 2012–2015 monitoring was carried out at 632 river and lake sites. Sufficient numbers of samples over four years were available at 316 of the rivers' sites and 21 lake sites, giving a total of 337 sites. In the current four-year reporting period (2016–2019) monitoring was carried out at 534 river and lake sites. Sufficient numbers of samples over four years were available at 472 of the rivers' sites and 21 lake sites, giving a total of 493 sites (Table 1.10 and Figure 1.6).

As part of the revised guidance issued in 2020, the Commission has requested that further information is provided for any monitoring station that has been supressed since the previous reporting period. The key information to be presented is the reason why the station was removed from the monitoring scheme (e.g. recorded nitrates values under 25 mg/l over the last reporting period or some other reason to be specified) and the identification of the alternative monitoring station(s) that ensure the continuity of monitoring of the pollution that the suppressed station identified, as well as the results of this station. None of the stations suppressed since the last reporting period had annual average values exceeding 25 mg/l but in the interests of full traceability the reason for closure has been identified. The tables can be found in the Appendix.

1.2.2. Evolution of nitrate concentrations (NO_3 mg/l) in surface waters: rivers, lakes and surface drinking waters

Annual average, winter average and the maximum nitrate concentrations for the two previous reporting periods and the current reporting period for river and lake sites are summarised in Tables 1.11, 1.12 and 1.13. Figures 1.7–1.9 illustrate the data from the current reporting period only (2016-2019).

Table 1.11: Rivers and lakes annual average, 2008-2019

	% of sites (NO_3 mg/l)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-49.99**	**>50**
2008-2011 *(n=622)*	29.1	60.3	10.5	0.2	0	0
2012-2015 *(n=337)*	24.9	64.4	10.7	0	0	0
2016-2019 *(n=493)*	23.1	62.9	14.0	0	0	0

Table 1.11 shows the rivers and lakes annual average concentration for the periods 2008-2011, 2012-2015 and 2016-2019. In the period 2008-2011, 99.8 % of surface water sites had an average nitrate concentration below 25 mg/l NO_3 with 89.4 % being below 10 mg/l NO_3. In the period 2012-2015, 100 % of surface water sites had an average nitrate concentration below 25 mg/l NO_3 with 89.3 % being below 10 mg/l NO_3. In the current reporting period 2016-2019, all surface water sites are still below 25 mg/l NO_3 with 86 % being below 10 mg/l NO_3.

Table 1.12: Rivers and lakes winter average, 2008-2019

	% of sites (NO_3 mg/l)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-49.99**	**>50**
2008-2011 *(n=622)*	23.1	62.3	14.5	0.2	0	0
2012-2015 *(n=337)*	21.1	65.9	12.7	0.3	0	0
2016-2019 *(n=493)*	22.1	59.0	18.3	0.6	0	0

Table 1.12 shows the rivers and lakes winter average concentrations over the three reporting periods 2008-2011, 2012-2015 and 2016-2019. In the period 2008-2011, the majority (99.8 %) of sites monitored over the winter period of October to March each year, had concentrations less than 25 mg/l NO_3. In the period 2012-2015, 99.7 % of sites monitored over the winter period had concentrations less than 25 mg/l NO_3. In the current period 2016–2019, the majority (99.4 %) of sites monitored over the winter period had concentrations less than 25 mg/l NO_3.

Table 1.13: Rivers and lakes maximum, 2008-2019

	% of sites (NO_3 mg/l)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-49.99**	**>50**
2008-2011 *(n=622)*	8.4	51.1	36.7	3.2	0.5	0.2
2012-2015 *(n=337)*	6.5	51.6	38.9	2.4	0.6	0
2016-2019 *(n=493)*	8.7	40.0	38.7	8.5	2.0	2.0

Table 1.13 shows river and lake maxima concentrations over the three reporting periods 2008-2011, 2012-2015 and 2016-2019. In the period 2008-2011, 96.2 % of sites had concentrations less than 25 mg/l NO_3 whilst in the period 2012-2015, 97 % of sites had concentrations less than 25 mg/l NO_3. In the current reporting period 2016–2019, when

maxima were considered, 87.4 % of sites had concentrations less than 25 mg/l NO_3. 2% (10 sites) had concentrations greater than 50 mg/l. These high levels of nitrate were all found in November 2018 monthly samples, which may be related to an extended dry period in summer and very wet late autumn. Burgess and Mellander (2019) noted that weather is also a significant factor impacting on the nutrient concentration of water. During the dry summer of 2018, grass was not growing due to drought stress. There was little or no uptake of either naturally occurring nitrogen or applied nitrate fertiliser. When the rain did arrive in the autumn, particularly the heavy precipitation in early November, much of this unused nitrate was washed through the dried out soil and reached the surface freshwaters, resulting in concentrations of nitrate that were higher than found in previous, drought free years.

The tables containing the summary data collected monthly from the surface water monitoring network during 2016-2019 including, for each sampling site, the average nitrate concentration, the measured maximum nitrate concentration and the winter average nitrate concentrations in rivers and lakes are available on ReportNet.

http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate_Directive_NI_Final._NiD_SW_Conc.xml; and

http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate_Directive_NI_Final._NiD_SW_AnnConc.xml

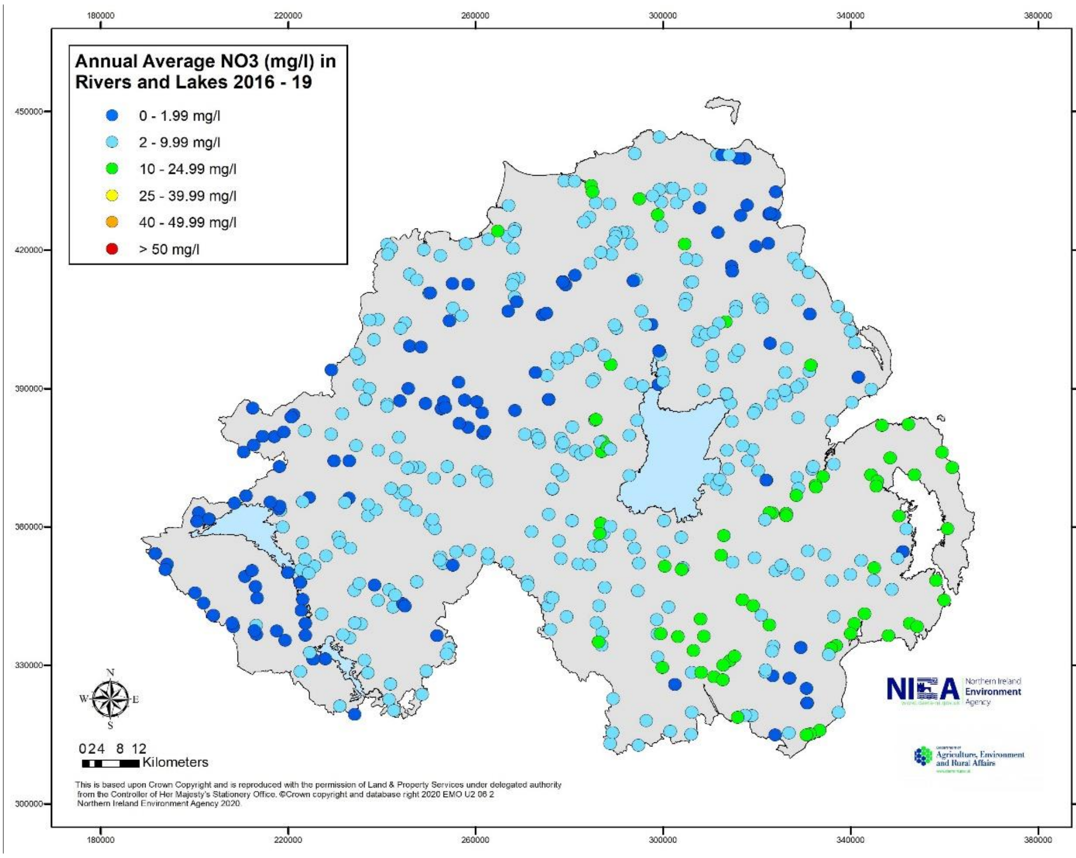

Figure 1.7: Annual average nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2016–2019

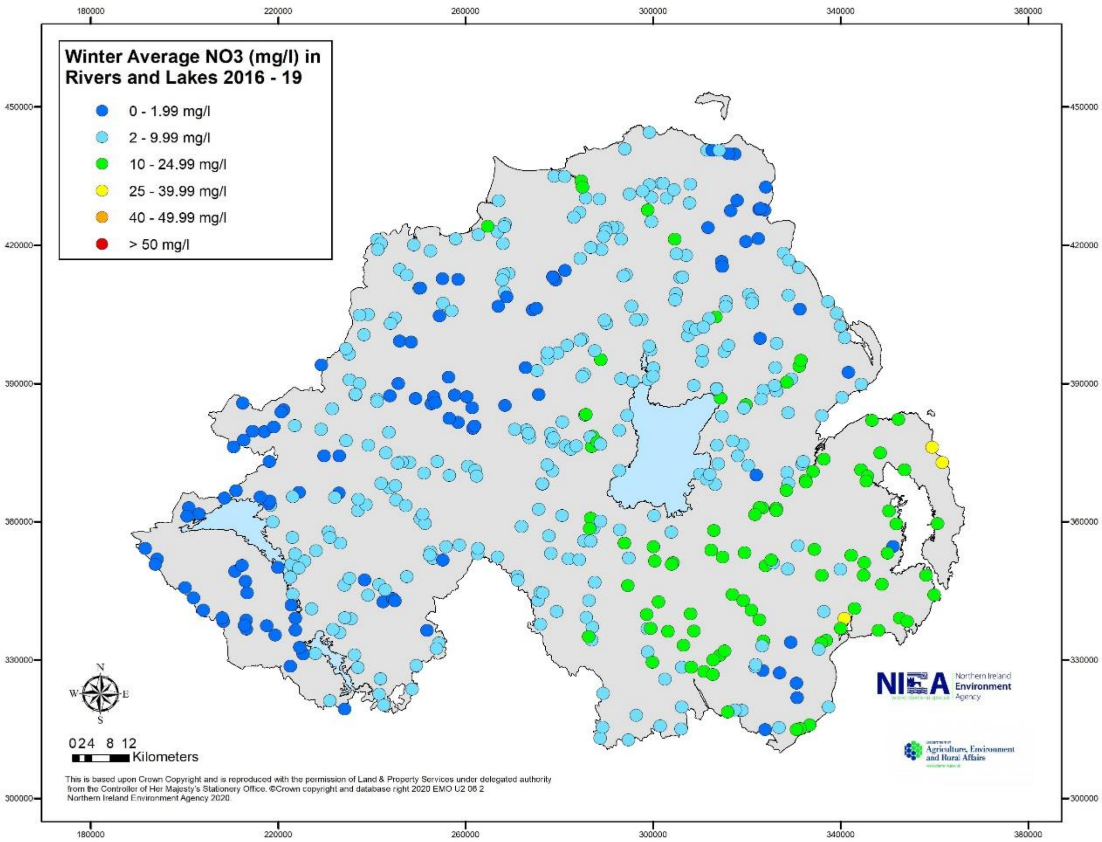

Figure 1.8: Annual winter nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2016–2019

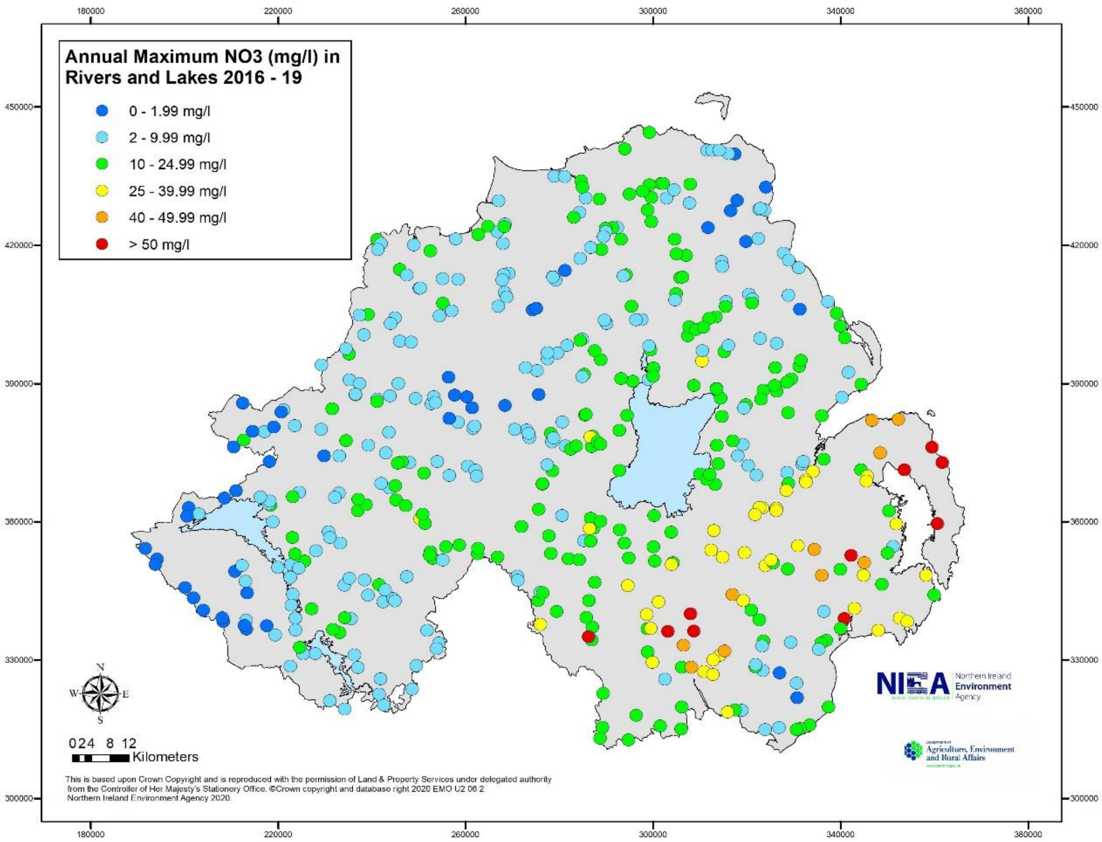

Figure 1.9: Annual maximum nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2016–2019

1.2.3. Changes between previous and current reporting periods

The nitrate concentrations for 2016-2019 are compared against results from the previous reporting period (2012-2015) for the river and lake sites that are common to both reporting periods. A total of 325 sites are common between both reporting periods. Table 1.14 and Figures 1.10–1.12 show the evolution of annual average, maximum and winter average nitrate concentrations at these river and lake sites between the two reporting periods.

The changes between the average concentration in the previous reporting period, 2012-2015 and the current reporting period, 2016-2019 for the rivers and lakes common sites are available on ReportNet.

http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate_Directive_NI_Final._NiD_SW_Conc.xml

Table 1.14: Changes in surface water nitrate concentrations (NO_3 mg/l) based on annual average, winter average and maximum values for the previous and current reporting periods (% of sites)

	% of sites (n= 325)				
	Strong decrease	**Weak decrease**	**Stable**	**Weak increase**	**Strong increase**
Rivers and lakes annual average	0	1.8	75.4	21.8	0.9
Rivers and lakes winter average	0	2.2	72.0	21.5	4.3
Rivers and lakes maximum	2.8	8.0	34.8	27.7	26.8

Based on mg/l difference - Strong Decrease = < -5; Weak Decrease = ≥ -5 to < -1; Stable = ≥ -1 to ≤ +1; Weak Increase = > +1 to ≤+5; Strong Increase = > +5

Table 1.14 and Figure 1.10 show that the annual average nitrate concentrations in rivers and lakes were stable or decreasing (77.2 % of sites) between the two reporting periods. For comparison, 98.1% of sites were stable or decreasing as noted in the previous report (2016) when changes in the annual average nitrate concentrations between the reporting periods of 2008-11 and 2012-15 were assessed. Results also show a similar pattern in winter average nitrate concentrations where 74.2 % of sites were decreasing or stable between the two reporting periods. (Table 1.14 and Figure 1.11). For comparison, 98.7% of sites were stable or decreasing as noted in the previous report (2016) when changes in the winter average nitrate concentrations between the reporting periods of 2008-11 and 2012-15 were assessed. However, when maxima were considered, only 45.6 % of sites remained stable or showed a decrease whilst 54.5 % of sites showed an increase, which may be related to an extended dry period in summer and very wet late autumn in 2018. Of these, 26.8 % (87 sites) (Table 1.14 and Figure 1.12) show a strong increase in maximum concentrations but it should be noted that of these 87 sites, 40 sites exhibit a maximum concentration <25 mg/l NO_3. For comparison, 81% of sites were stable or decreasing as noted in the previous report (2016) when changes in the maximum nitrate concentrations between the reporting periods of 2008-11 and 2012-15 were assessed. Further investigations and actions will be implemented in these catchments. This will include engagement with sewerage regulators, home owners and farmers in local areas.

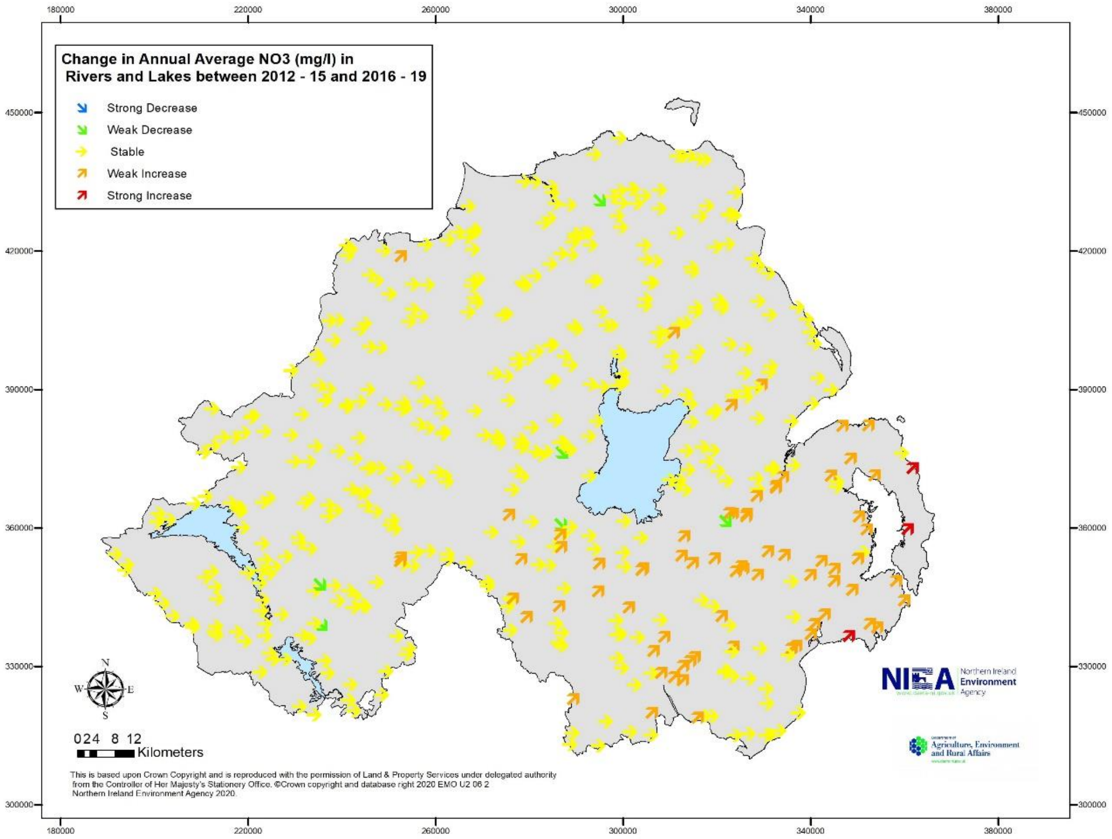

Figure 1.10: Change in annual average nitrate concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods

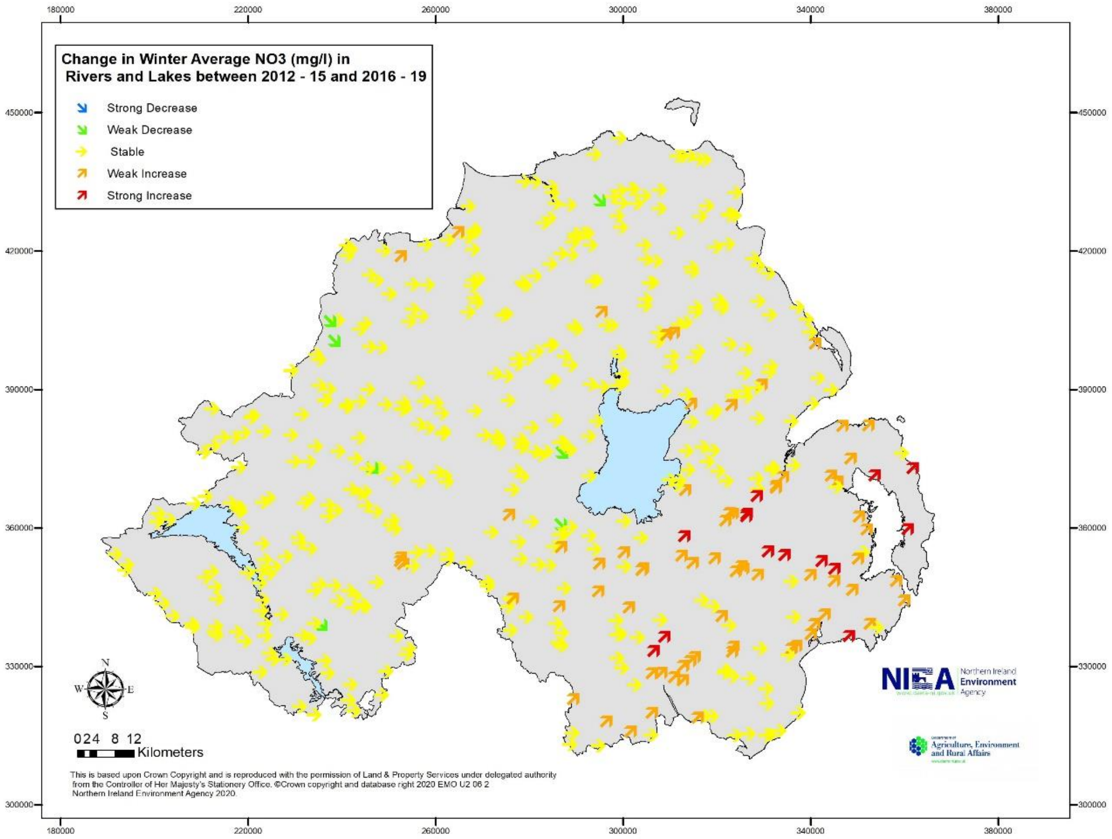

Figure 1.11: Change in winter average concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods

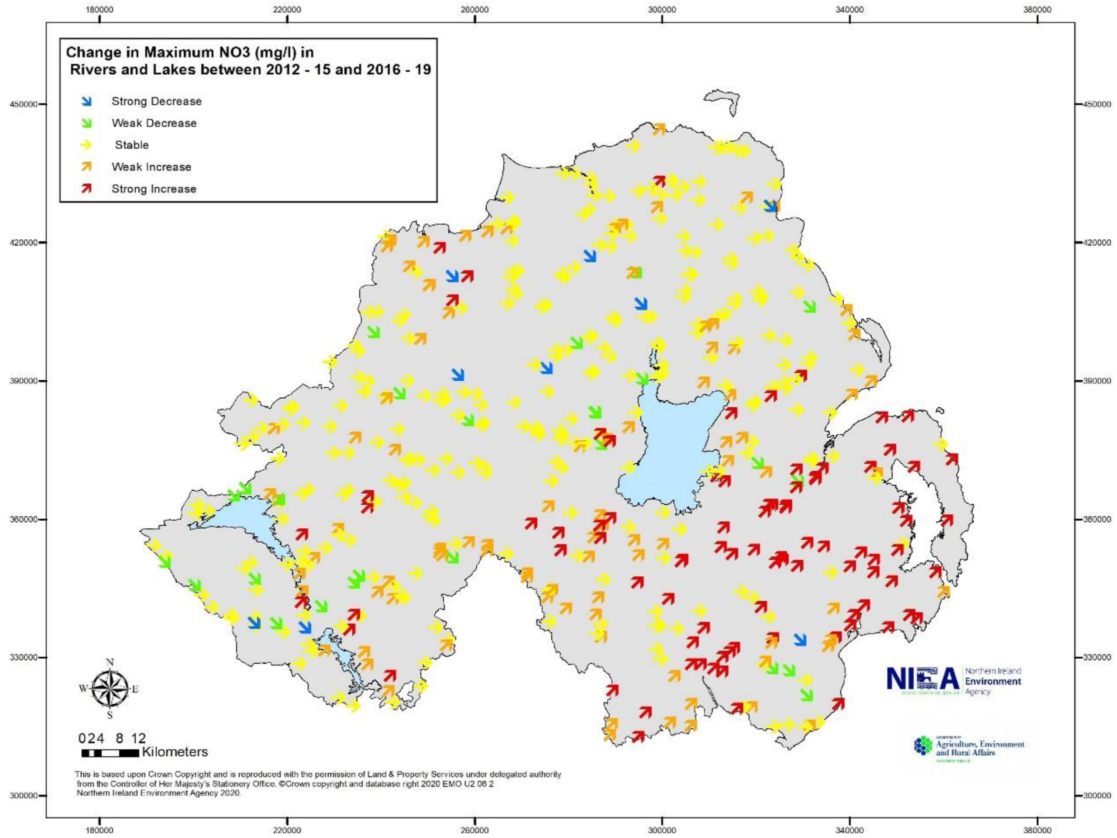

Figure 1.12: Change in maximum nitrate concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods

1.2.4. Long-term trend analysis of nitrate concentration

To fulfil the obligations of reporting as outlined in the *'Nitrates Directive Development Guidance Notes for Member States'* 2020, NIEA carried out a statistical analysis to enable an assessment of long-term temporal trends of measured nitrate concentrations in monitored surface waters in Northern Ireland between January 1992 and December 2019. A total of 689 monitoring sites (minimum >6 years data as recommended by UKTAG) were analysed and of these, 214 sites passed secondary quality validation screening (Stuart, 2012). The non-parametric Seasonal Mann-Kendall Tau (SMK) test (Hirsch *et al.,* 1982) was used along with Theil-Sen test to determine trends and provided a measure of the overall trend for each of the individual 214 monitoring sites. Seasonal trend analysis showed that the monthly trends in average nitrate concentrations in 193 rivers in Northern Ireland were decreasing or stable over the 28-year period, 1992-2019 (90.19 % of sites). Twenty-one sites (9.81 % of sites) showed a significant increasing trend (Tables 1.14 and Figure 1.13). Figure 1.14 shows the distribution of long-term nitrate trends across Northern Ireland at individual sites.

For the Northern Ireland dataset as a whole, the mean monthly nitrate concentrations of the 689 rivers sites (>6 years data) were calculated from the 28-year data set (Figure 1.15). The SMK and Sen tests indicated a significant decreasing slope for this combined dataset.

It is recognised that climatic factors may have a significant impact on trends in Northern Ireland's rivers (DOE-DARD, 2002). In a large proportion of rivers, peaks in nitrate concentrations since the 1970s have occurred quite regularly at intervals of approximately six years following exceptionally dry summers. This series may reflect a climatic signal in low summer rainfall detected at Armagh Observatory and extending back to 1840 (Butler *et al.,* 1998).

A strong contributing factor to the decreasing long term trend in Fig 1.15 is the initial high nitrate levels in the early 1990s, from which there has been a gradual decrease. However the long term trend data does not indicate changing trends within an extended time period; it cannot go in two directions. As such a recent switch from decreasing to increasing, as shown in Figures 1.10-1.12 would be masked by the overall downward trend. Any gradual increases in the long term trends would initially be identified in a stabilisation of the trend before showing increases. The exception to this would be significant nitrate rises above previous concentrations. A high concentration spike is shown in Fig 1.15 post 2018. To help evaluate this spike we can compare the long term trend analysis from the 2016 report against the 2020 data in table 1.15. This comparison shows the percentage of water bodies decreasing went from 58% in 2016 to 64.49% in 2020 following the expected long term trend. Stabilising waterbodies decreased from 37% in 2016 to 25.7% in 2020. Worryingly however the percentage of waterbodies showing an increasing long term trend went from 4.6% in 2016 to 9.8% in 2020.

Table 1.15: Summary of numbers of monitoring sites showing overall, increases or stable trends of nitrate (NO_3) between 1992 and 2019

Time Period	**NO_3 (n=214): 1992-2019**		
	Decrease (p=<0.05)*	**Stable (NS)***	**Increase (p=<0.05)***
Overall	***138 (64.49 %)***	***55 (25.70 %)***	***21 (9.81 %)***

**(Significance levels determined by the Seasonal Mann-Kendall were where z-statistic = <-1.94 = significant (p=<0.05); z-statistic = >1.94 to <= +1.94 = NS; z-statistic = > +1.94 = significant (p=0.05))*

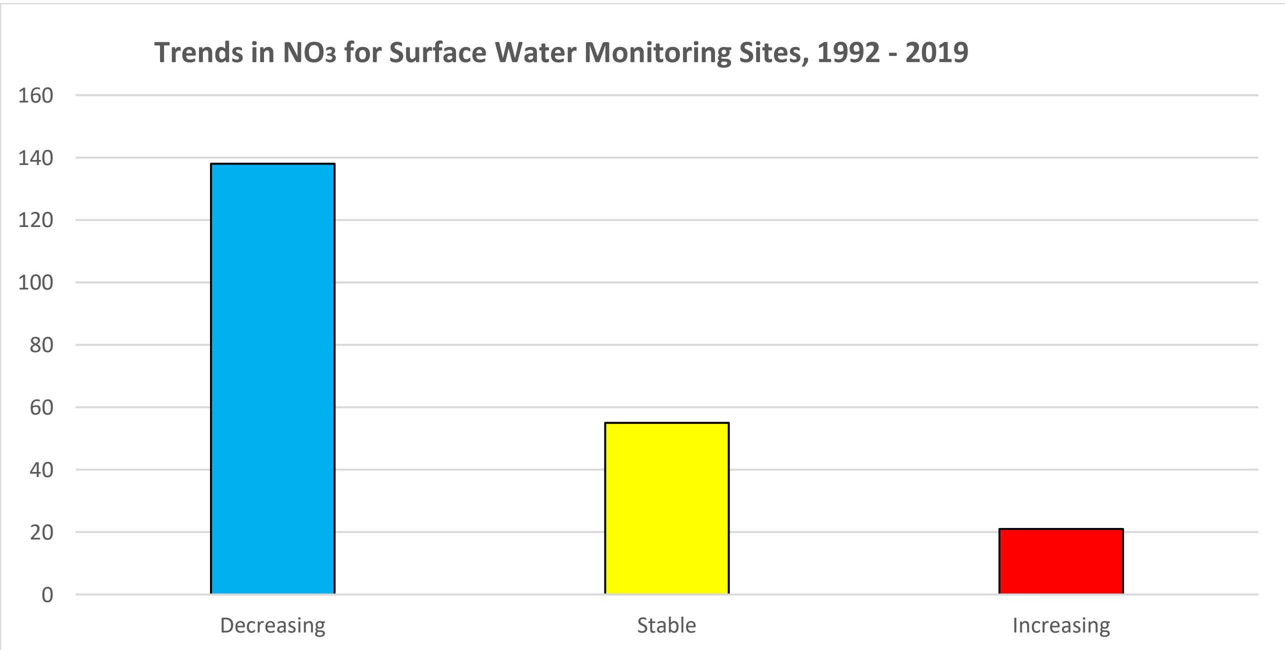

Figure 1.13: Numbers of monitoring sites showing increases, decreases or remaining stable, 1992-2019

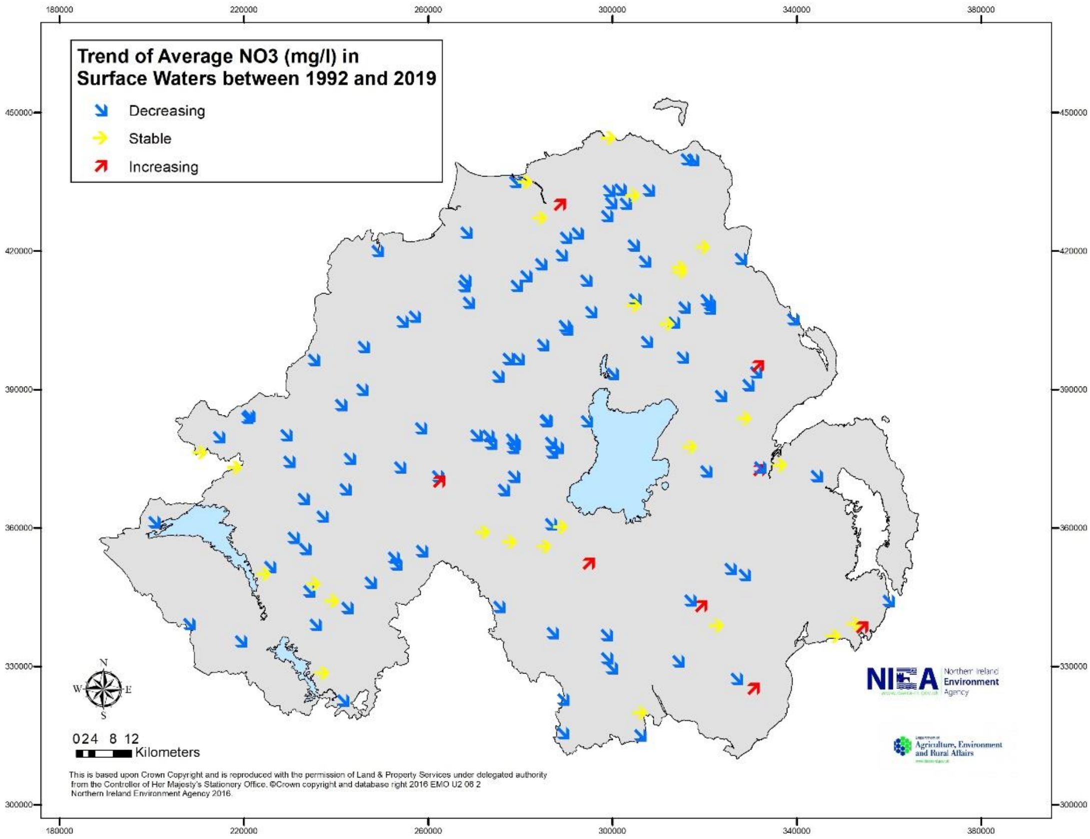

Figure 1.14: Overall trend of average nitrate (NO_3 mg/l) in surface waters across Northern Ireland in the period January 1992 to December 2019

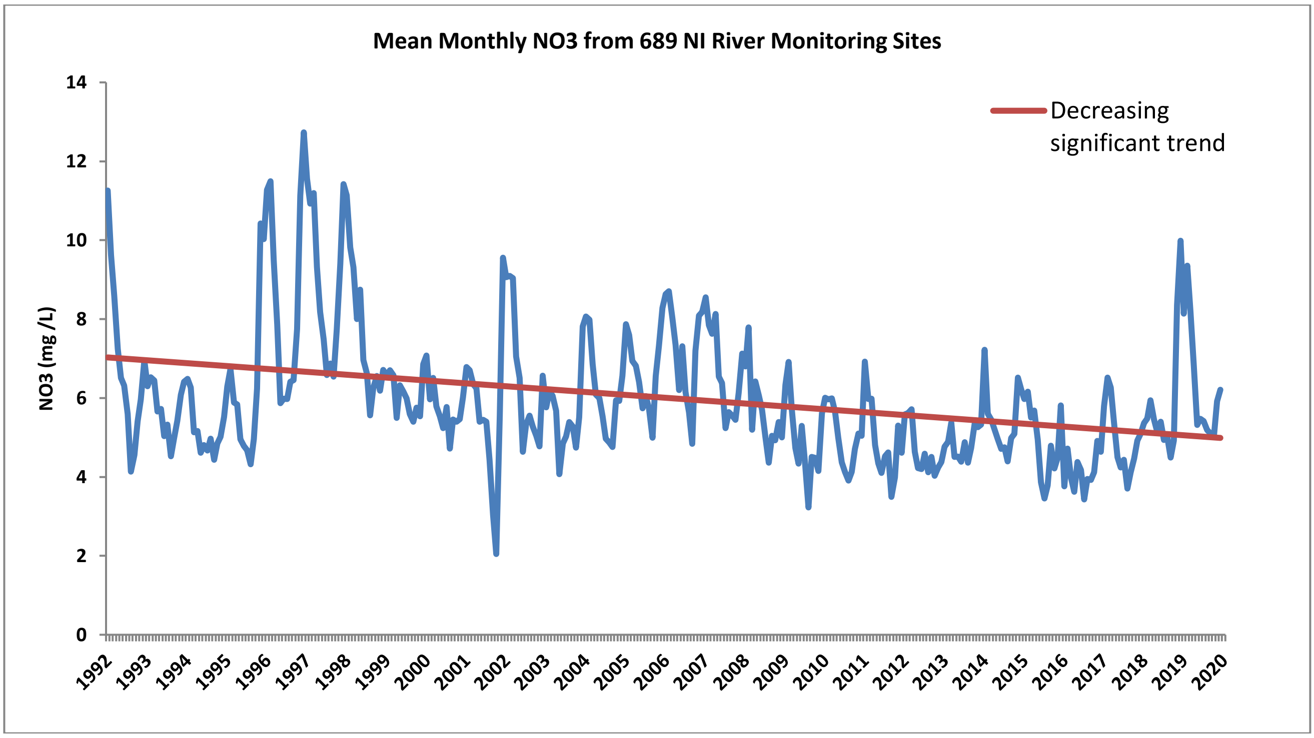

Figure 1.15: Nitrate (NO_3) concentrations in 689 river monitoring sites summarized by month into annual mean values of the site population, 1992-2019

In summary for section 1.2 on nitrates in freshwaters. In recent years there has been an increase in the number of sites showing increasing levels of nitrate in freshwaters, particularly in the south and east of the region, which is a cause for concern. Over the long term, since 1992, levels continue to decline. Further analysis will be undertaken to establish the causative factors and any geospatial differences in the recent changes reported.

1.3 Assessment and classification of nitrate in coastal and transitional marine waters

1.3.1 *Transitional and coastal monitoring network*

This assessment is based on a review and collation of all available records in transitional and coastal waters. Nutrient (NO_3) data from a variety of historical and current monitoring programmes, including investigative monitoring programmes, were collated to provide a comprehensive historical and contemporary dataset. Assessments of transitional and coastal waters, particularly under the Water Framework Directive, are undertaken at the water body level, which provides an integrated measure of environmental conditions. All data collected at each monitoring site were assessed in terms of quantity and frequency; although some sites had good long-term data, the data for many sites, particularly those in offshore coastal waters was somewhat limited. This is due to the complex and challenging nature of site-specific marine monitoring schemes. In order to ensure a robust and comprehensive analysis, the assessment of nitrate in transitional and coastal waters was undertaken at the water body level. Some 300 sampling sites were reviewed and collated into the 25 transitional and coastal water bodies identified under the Water Framework Directive (Figure 1.16).

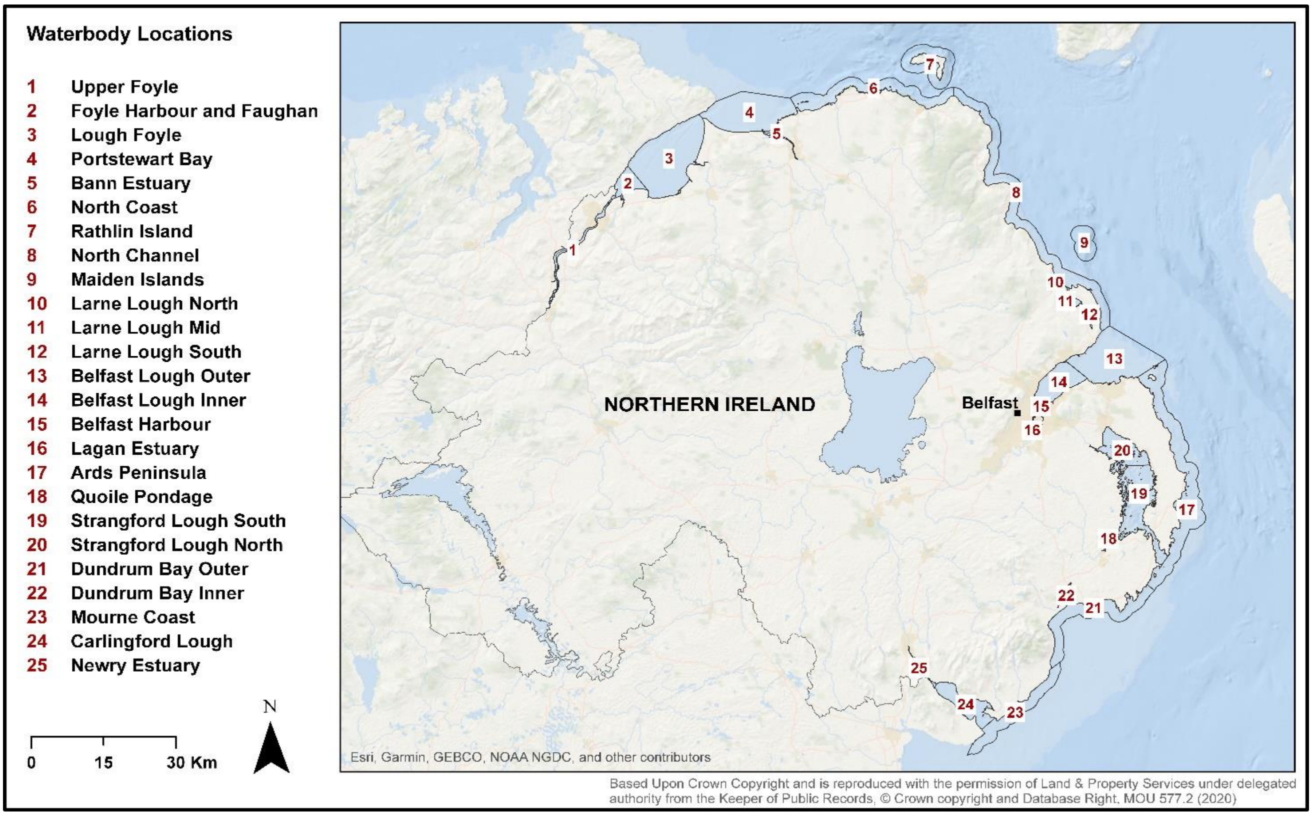

Figure 1.16: Transitional and coastal water bodies identified in Northern Ireland.

Sufficient data were available for 24 water bodies. The Quoile Pondage transitional water is a heavily modified water body that has been transformed from a tidal estuarine system into a freshwater-dominated impoundment through the construction of a barrage at the mouth. Most marine monitoring and assessment methods cannot be applied to this system; it will, however, form part of a dedicated monitoring programme in future. For the 24 water bodies included in this assessment, the data were further allocated to three reporting periods: 2008-2011, 2012-2015, and 2016-2019. For reporting purposes, the results are presented at a representative site for each water body (Figure 1.17).

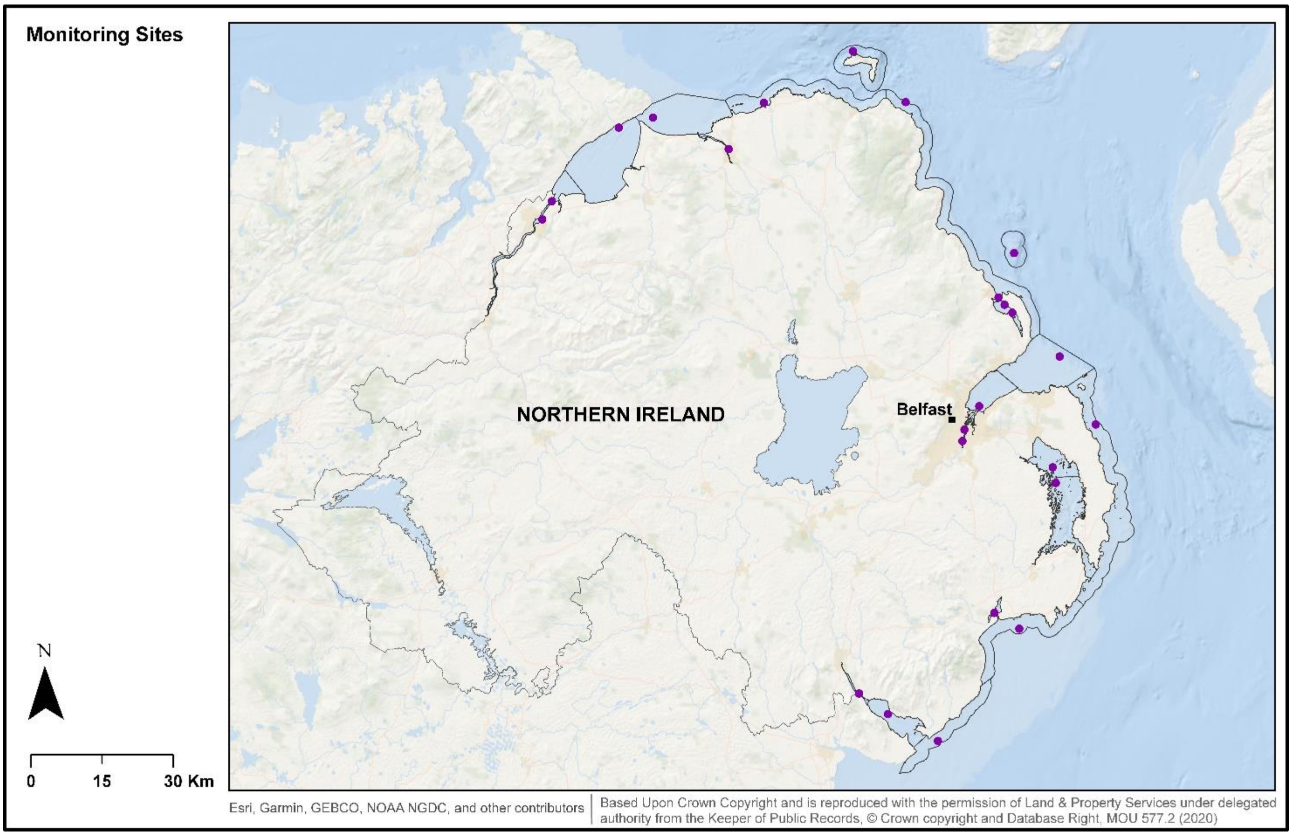

Figure 1.17: Transitional and coastal monitoring sites in Northern Ireland.

Winter mean and winter maximum nitrate concentrations (NO_3 mgl^{-1}) were calculated for each water body for the reporting periods 2008-2011, 2012-2015, and 2016-2019.

1.3.2 Nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters

Mean winter nitrate concentrations over the 2016-2019 reporting period ranged between 1.6 and 50.3 mgl^{-1}. Overall, 92% of transitional and coastal water bodies had nitrate concentrations of less than 25 mgl^{-1}. The remaining 8% of sites exceeded 25 mgl^{-1} with 4% exceeding 50 mgl^{-1} (Table 1.16). Maximum winter nitrate concentrations measured between 2.0 and 141.3 mgl^{-1}. Over 83% of transitional and coastal water bodies had maximum winter nitrate values of less than 25 mgl^{-1} with 17% exceeding 50 mgl^{-1}.

Table 1.16: Classification of mean and maximum winter nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters 2016-2019 (% of sites).

	% of sites (NO_3 mgl^{-1})					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-50**	**>50**
Transitional and coastal winter mean	33.3	37.5	20.8	4.2	0.0	4.2
Transitional and coastal winter maximum	0.0	66.7	16.7	0.0	0.0	16.7

Water bodies that exceeded 25 mgl^{-1} were either transitional waters (e.g. Lagan estuary) or inshore coastal sea loughs (e.g. Belfast Harbour and Dundrum Bay Inner) (Figures 1.18 and 1.19). All offshore coastal waters had mean or maximum winter nitrate values below 10 mgl^{-1}.

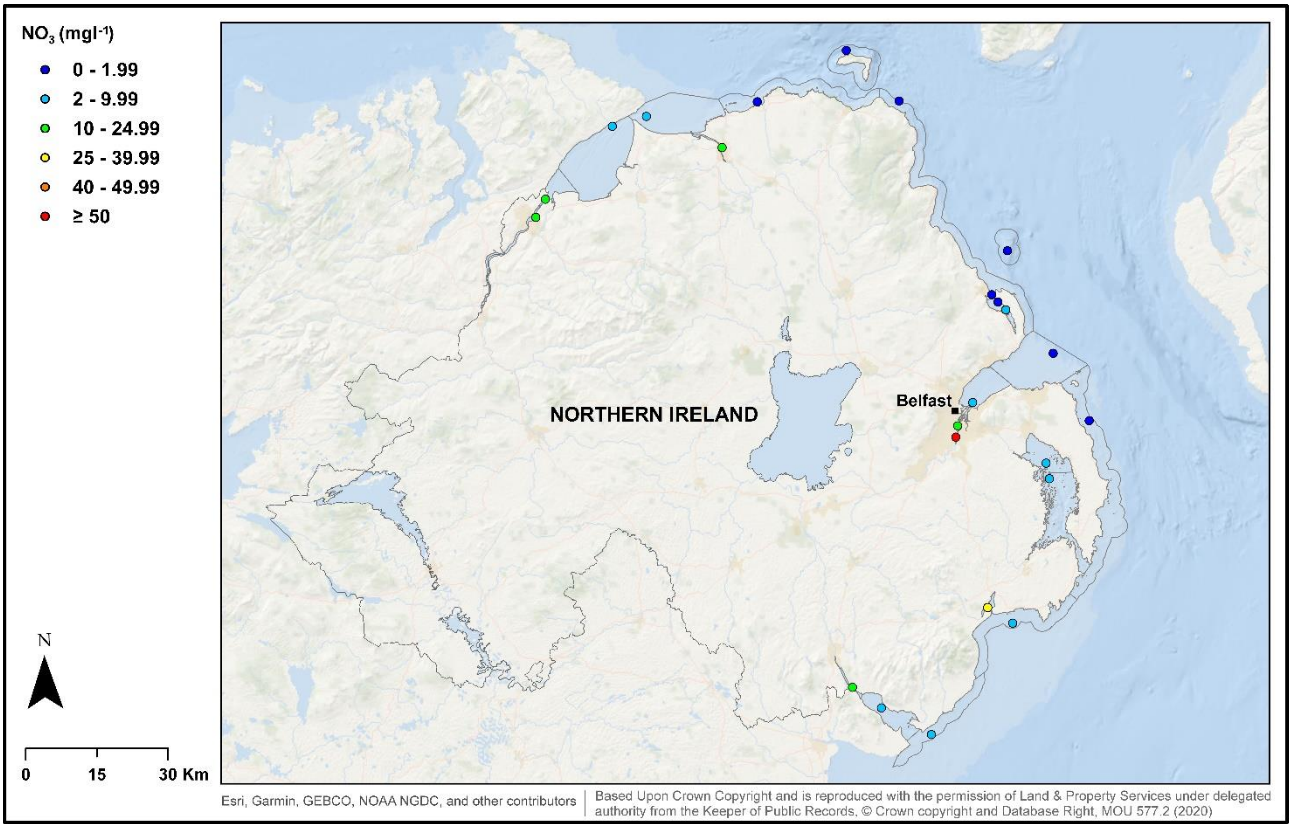

Figure 1.18: Mean winter nitrate concentrations in transitional and coastal water bodies, 2016-2019.

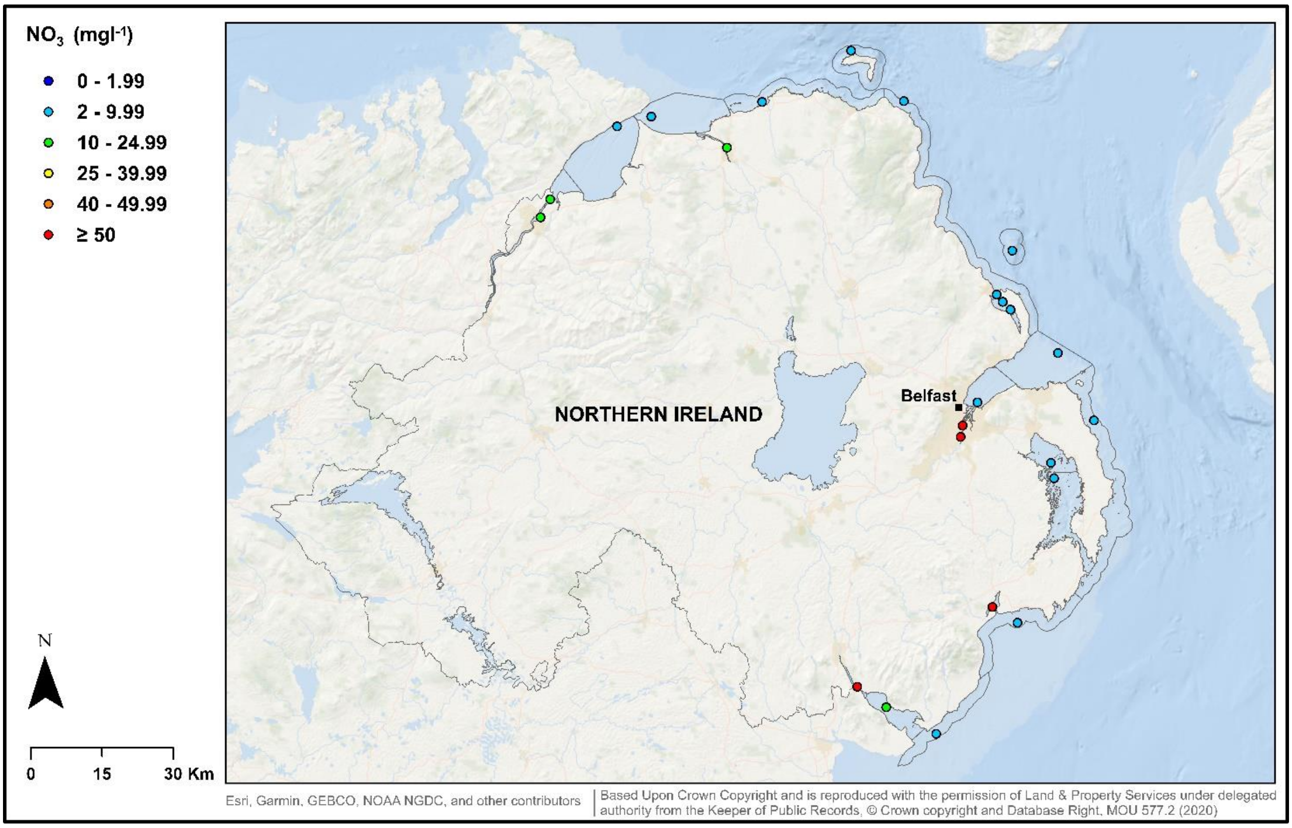

Figure 1.19: Maximum winter nitrate concentrations in transitional and coastal water bodies, 2016-2019.

1.3.3 *Changes between previous and current reporting periods*

Nitrate concentrations in transitional and coastal waters for the current (2016-2019) reporting period were compared with concentrations recorded during the previous two reporting cycles (2012-2015 and 2008-2011). A comparison between the 2016-2019 and 2012-2015 reporting periods showed that approximately 71% of water bodies were considered stable based on winter mean values while 33% were stable based on winter maximum values (Table 1.17, Figures 1.20 and 1.21). Twenty-five percent of water bodies exhibited a weak to strong increase based on winter mean values while 38% exhibited an increase based on maximum values. Maximum nitrate values also showed that 29% of water bodies a weak to strong decrease between the two reporting cycles.

Table 1.17: Changes in mean winter nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters between 2016-2019 and 2012-2015.

	% of sites (based on mgl^{-1} difference)				
	≤- 5 - Strong decrease	>-5 to ≤ -1 Weak decrease	>-1 to ≤ + 1 Stable	>+1 to ≤ +5 Weak increase	> +5 Strong increase
Transitional and coastal winter mean (n=24)	0.0	4.2	70.8	12.5	12.5
Transitional and coastal winter maximum (n=24)	12.5	16.7	33.3	12.5	25.0

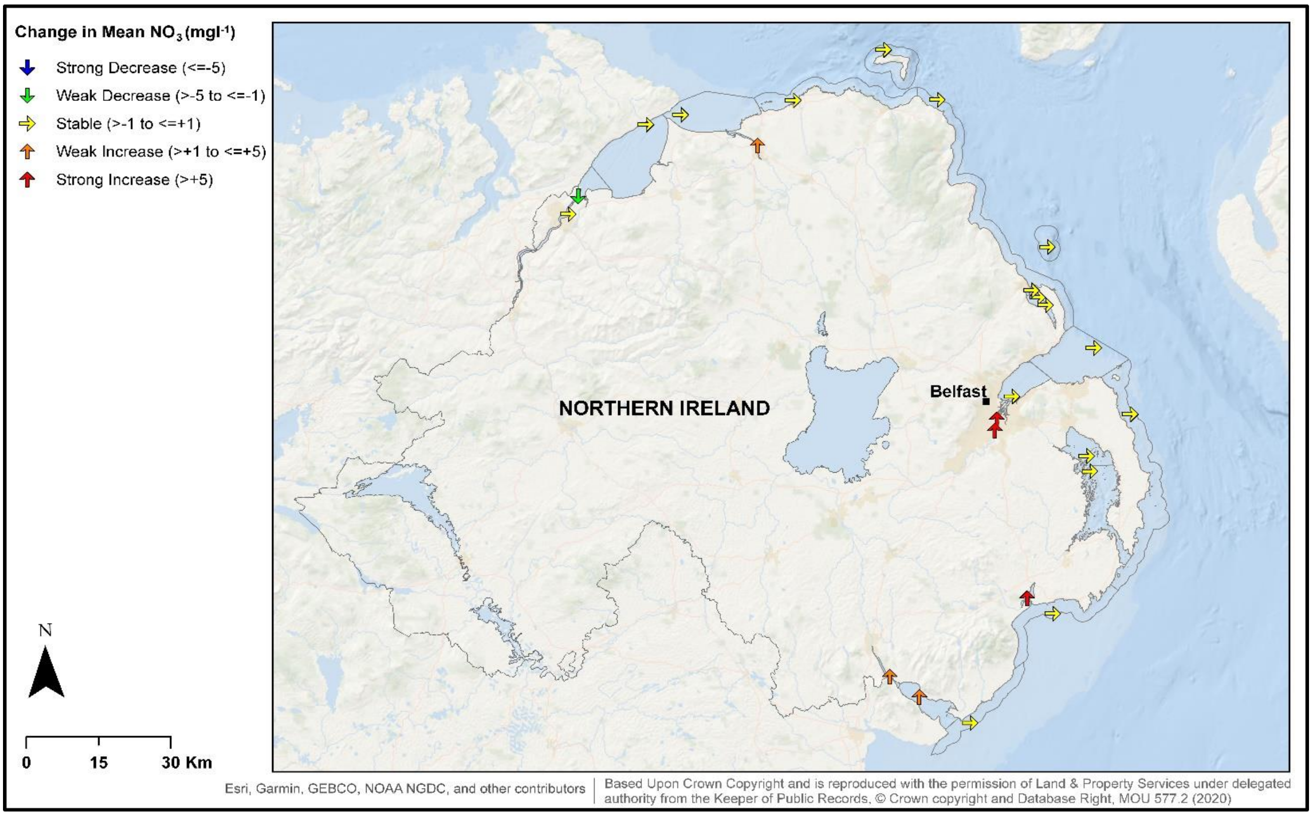

Figure 1.20: Change in mean winter nitrate concentrations in transitional and coastal water bodies between 2016-2019 and 2012-2015 reporting periods.

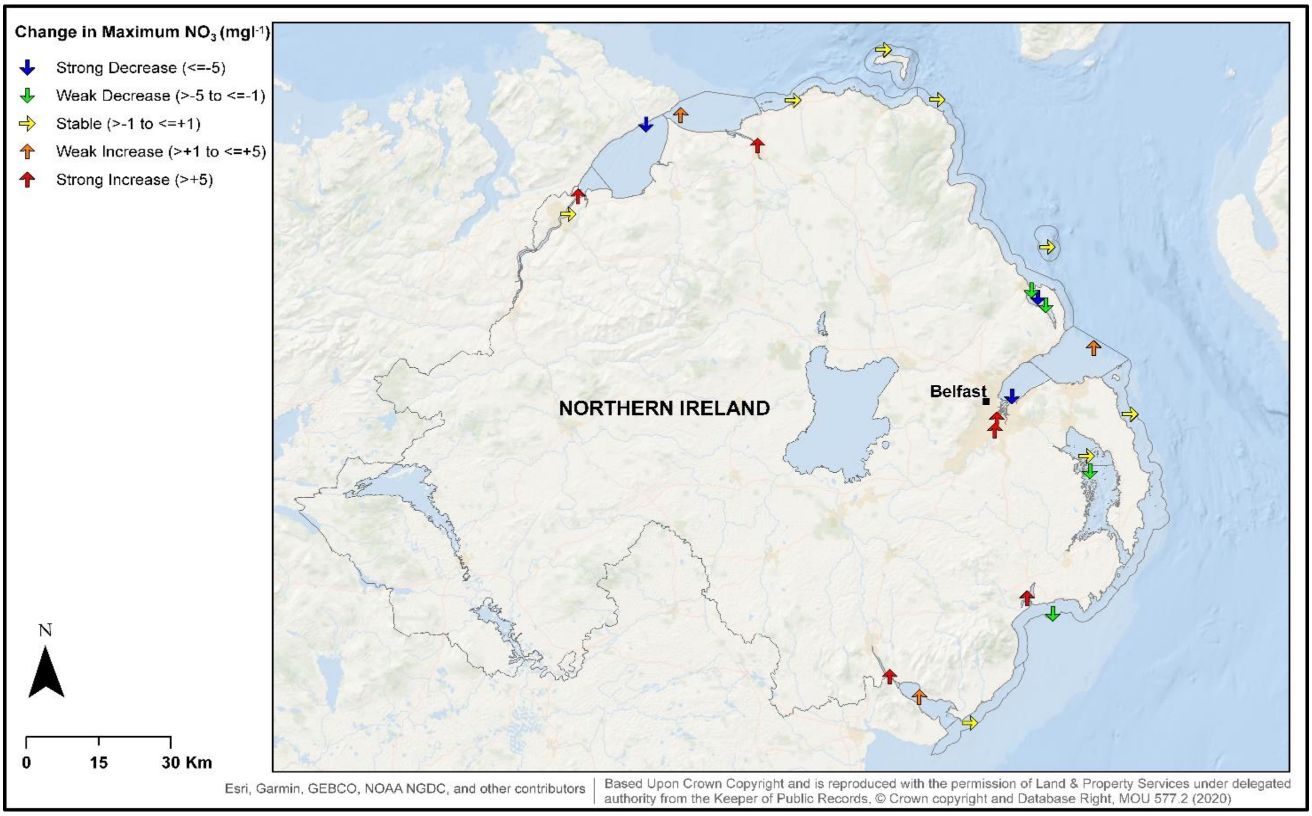

Figure 1.21: Change in maximum winter nitrate concentrations in transitional and coastal water bodies between 2016-2019 and 2012-2015 reporting periods.

Data for 23 water bodies were used to compare nitrate values between the 2016-2019 and the 2008-2011 reporting periods. Based on winter mean values, approximately 70% of water bodies were considered stable (Table 1.18, Figure 1.22). Some 17% of water bodies exhibited a weak decrease while the remaining 13% showed a weak to strong increase in nitrate concentrations. Winter maximum values showed that 48% of transitional and coastal water bodies were stable, 22% exhibited a decrease, and 30% showed a weak to strong increase (Table 1.18, Figure 1.23).

Table 1.18: Changes in mean winter nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters between 2012-2019 and 2008-2011.

	% of sites (based on mgl^{-1} difference)				
	≤- 5 - Strong decrease	**>-5 to ≤ -1 Weak decrease**	**>-1 to ≤ + 1 Stable**	**>+1 to ≤ +5 Weak increase**	**> +5 Strong increase**
Transitional and coastal winter mean (n=23)	0.0	17.4	69.6	4.4	8.7
Transitional and coastal winter maximum (n=23)	8.7	13.0	47.8	8.7	21.7

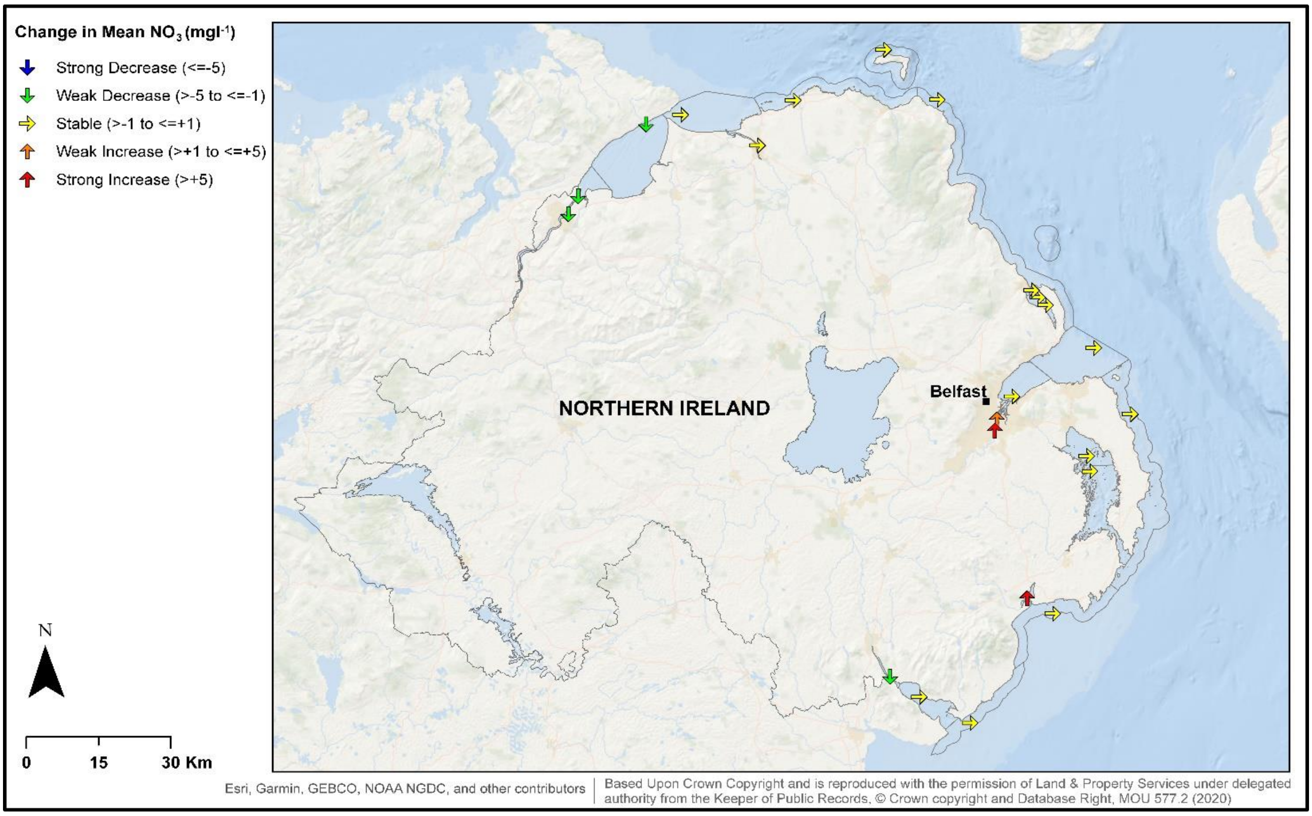

Figure 1.22: Change in mean winter nitrate concentrations in transitional and coastal water bodies between 2016-2019 and 2008-2011 reporting periods.

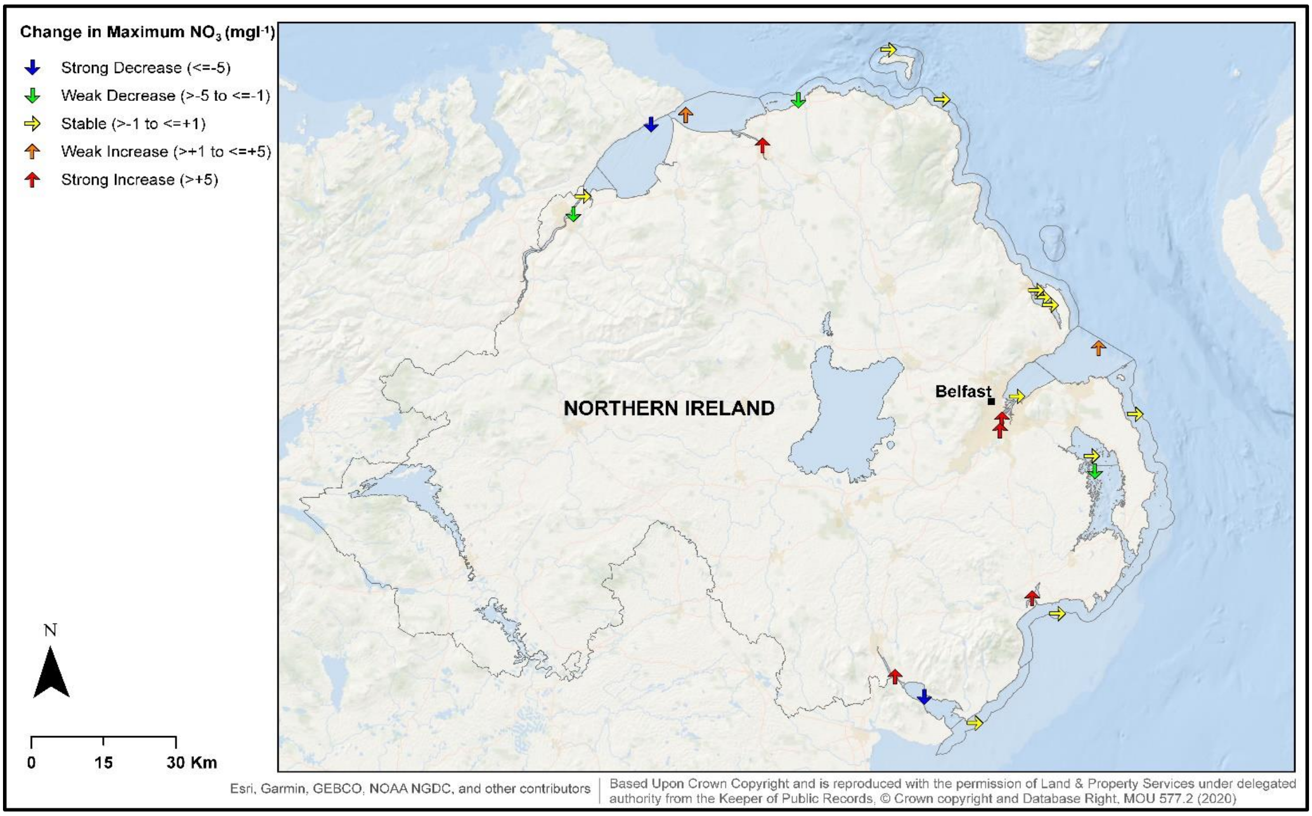

Figure 1.23: Change in maximum winter nitrate concentrations in transitional and coastal water bodies between 2016-2019 and 2008-2011 reporting periods.

1.3.4 *Long-term trend analysis of nitrate concentration*

A long-term trend analysis was undertaken on individual water bodies. Data extending to the year 2000 was collated for each transitional and coastal water and those that contained at least six years historical data selected. The non-parametric Mann-Kendall test was applied to the mean annual nitrate values calculated for each water body. No statistically significant ($p>0.05$) trend was detected in 12 water bodies (50%). Nine water bodies (38%) exhibited a significant ($p<0.05$) decrease while three water bodies (13%) exhibited a significant ($p<0.05$) increase (Table 1.19).

Table 1.19: Summary results of the Mann-Kendall trend analysis of mean annual winter nitrate (NO_3) values in transitional and coastal water bodies over at least the last six years.

	Trend		
	Decrease ($p<0.05$)	**Stable (NS)**	**Increase ($p<0.05$)**
Number of water bodies	***9 (37.5%)***	***12 (50.0 %)***	***3 (12.5 %)***

All the water bodies that exhibited a downward trend were either coastal sea loughs or transitional waters. Although an upward trend was observed for the Mourne Coast coastal water, nitrate values in this water body were typically low (< 3.6 mgl^{-1}). Carlingford Lough also exhibited a significant increasing trend; annual mean nitrate values in this system did not exceed 8.3 mgl^{-1}. Dundrum Bay Inner was the other water body that exhibited an increasing trend. Eutrophication has been identified as a potential issue in this system and an integrated catchment management plan and monitoring programme has been initiated.

1.4 Overview of assessment of eutrophic indicators in rivers, lakes and transitional and coastal marine waters

1.4.1 Eutrophication parameters

DAERA's NIEA, and Environment, Marine and Fisheries Division monitor a number of quality elements and parameters when considering eutrophication pressures for WFD in all water body types, as outlined in Table 1.20. Eutrophic waters are identified using WFD nutrient standards and Biological Quality Element (BQE) classification tools which are known to be sensitive to nutrient enrichment. For each water body type (rivers, lakes and transitional and coastal marine waters) the overall trophic status, using a combination of nutrients and responsive biological parameters is discussed in general. This is followed in each case by a more detailed discussion of each of the nutrient parameters.

Table 1.20: WFD quality elements and parameters relevant to eutrophication in 2016-2019*****

QUALITY ELEMENT	RIVERS	FRESHWATER LAKES	TRANSITIONAL WATERS	COASTAL WATERS
GENERAL CONDITIONS	Soluble Reactive Phosphorus	Total Phosphorus (TP)	Dissolved Inorganic Nitrogen Dissolved Oxygen	Dissolved Inorganic Nitrogen Dissolved Oxygen
PHYTOPLANKTON	-	Chlorophyll-α % Cyanobacteria Phytoplankton	Chlorophyll-α	Chlorophyll-α
MACROPHYTES & PHYTOBENTHOS	Diatoms Macrophytes	Diatoms Macrophytes	-	-
MACROALGAE & ANGIOSPERMS	N/A	N/A	Macroalgae: (Blooming Tool) (Rsl)**	Macroalgae: (Blooming Tool) (Rsl)**

***** *Standards (*elements and parameters) *used in Table 1.20 are those current in 2019. Revised standards may be included in the future*

Information collected on the above indicators is assessed against the three elements of 'eutrophication' as set out in guidance issued by the EU Commission closely aligning with the OSPAR Common Assessment Criteria for Eutrophication, under ND, UWWTD and WFD (see Figure 1.15). Assessment of the indicators is used to determine whether a water body is eutrophic or may become eutrophic in the near future if protective action is not taken. The three elements are:

- if the water body is enriched by nitrogen and/or phosphorus;
- this enrichment causes accelerated growth of algae and higher forms of plant life; and
- the accelerated growth produces an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned.

In the previous report, each of the WFD classes were evaluated against the earlier classification used in Nitrate Directive reporting (Ultra-Oligotrophic, Oligotrophic, Mesotrophic, Eutrophic and Hypertrophic). According to the European guidance updated and re-issued in 2020, High and Good status under WFD correspond with 'non-eutrophic' status under the Nitrates Directive; Poor and Bad status under WFD correspond with 'eutrophic', relating to situations where undesirable disturbances are common or severe. Moderate status can be thought of as a transitional zone between good status, where the probability of 'undesirable disturbances' occurring is zero, and Poor/Bad status where they are increasingly common and severe. Moderate status may lead to a classification of 'eutrophic' if the previous trophic status was Moderate, Poor or Bad under WFD. However, if the previous classification was High or Good under WFD, the trophic status should be ‘may become eutrophic’. This corresponds to a negative eutrophication trend between the previous and current reporting periods. This is not applicable to a negative trend between High and Good status (Table 1.21).

Table 1.21: WFD status in relation to trophic status

WFD Status	Trophic Status
High	Non- eutrophic
Good	Non- eutrophic
Moderate	Eutrophic or May become eutrophic
Poor	Eutrophic
Bad	Eutrophic

In 2019, DAERA carried out an assessment of the trophic status of surface freshwaters and transitional and coastal marine waters under the UWWTD Sensitive Area Review using all the trophic parameters (i.e. chemical and biological) outlined in Table 1.20. The review used WFD 2018 classification data and focussed on areas previously identified as Sensitive (Eutrophic) under the UWWT Directive in Northern Ireland and considered if the remaining catchments not previously identified as sensitive should now be designated. The existing Sensitive Area (Eutrophic) designations were supported and no new Sensitive Area (Eutrophic) identifications were recommended. Further biological monitoring of surface freshwaters and transitional and coastal marine waters is required to continue to assess trends in eutrophic water quality, improve confidence in class and provide evidence for the next review period. The total existing area of land draining to water bodies which are sensitive to eutrophication is approximately 86 % of the Northern Ireland land area. The next SAR under the UWWTD will be carried out in 2023.

1.5 Current overall WFD assessment of trophic status of rivers

River water bodies can contain more than one river and more than one monitoring station (monitoring site). There are rules governing how water bodies with one monitoring station are classified but commonly they are averaged. A water body with one monitoring station is classified by that station and a water body with no monitoring stations is classified by an adjacent water body either upstream or downstream. Not all monitoring sites are monitored for both biology and chemistry elements, therefore, different monitoring stations may be used to classify a water body for different quality elements.

For eutrophic pressures, macrophytes, diatoms and soluble reactive phosphorus (SRP) are considered. WFD assessment of trophic status is based on 2018 WFD classification data. NIEA monitored phosphorus concentrations at 491 surface freshwater sites across Northern Ireland over the period 2015-2017. Macrophyte surveys were carried out on a catchment basis at 510 river sites over the period 2009-2017 and benthic diatoms samples were collected at 501 selected river sites over the period 2010-2018 to inform 2018 WFD classification. Each of the parameters was assessed using the WFD classification system. The results of each assessment were then combined to give an overall WFD Trophic class for a river water body using the WFD criterion of defaulting to the lowest class

Northern Ireland has identified 450 water bodies for WFD classification and one overall class is given to each water body. Each trophic parameter is also assessed for each monitoring site (584 were used in 2018 WFD classification) within all of the water bodies. *Note that these trophic status classifications do not include the full suite of WFD classification elements at all locations.*

Table 1.22: Overall WFD 2015 and 2018 classifications of the trophic indicator quality elements for river water bodies and monitoring sites in Northern Ireland (based on SRP, macrophytes and diatoms)

	WFD Class (% of sites)					
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**	**NO DATA**
% of Sites 2015 (n=559)	16.1	41.1	35.8	7.0	0	0
% of Sites 2018 (n=584)	14.7	39.7	37.8	7.7	0	0
% of Water Bodies 2015 (n=450)	13.1	41.3	34.4	6.2	0.2	4.7
% of Water Bodies 2018 (n=450)	10.7	37.6	39.6	8.2	0.2	3.8

The distribution of WFD 2018 classes for sites and water bodies across Northern Ireland is shown in Table 1.22 and Figure 1.24. Data from the previous reporting period using WFD 2015 classification data is also presented in Table 1.22 to allow comparison. The number of monitoring sites presented will differ during each reporting period.

The WFD 2015 trophic classifications show that 57.2 % of river sites across Northern Ireland were considered to be of High/Good trophic status. No river sites were considered to be of Bad trophic status. However, 42.8 % of river sites were classed as Moderate or Poor status. The WFD 2015 trophic classifications show that 54.4 % of river water bodies across Northern Ireland were considered to be of High/Good trophic status. 40.6 % of river water bodies were classed as Moderate or Poor status. 0.2 % of river water bodies (Lough Neagh peripherals which was classified using Lough Neagh lake data) are considered to be of Bad trophic status. Data was not available for 4.7 % of river water bodies (Table 1.22) in 2015.

The WFD 2018 trophic classifications show that 54.5 % of river sites across Northern Ireland are considered to be of High/Good trophic status. No river sites are considered to be of Bad trophic status. However, 45.5 % of river sites are classed as Moderate/Poor status which is indicative of eutrophic conditions (Table 1.22 and Figure 1.24). 48.2 % of river water bodies across Northern Ireland are considered to be of High/Good trophic status. 48.0 % of river water bodies are classed as Moderate or worse status which is indicative of eutrophic conditions. Of these, 0.2 % of river water bodies (Lough Neagh peripherals which are classified using Lough Neagh lake data) are considered to be of Bad. Data was not available for 3.8 % of river water bodies in 2018 (Table 1.22 and Figure 1.24).

Note that for the purposes of this report 'Eutrophic State' reported in ReportNet tables is based solely on classification of SRP.

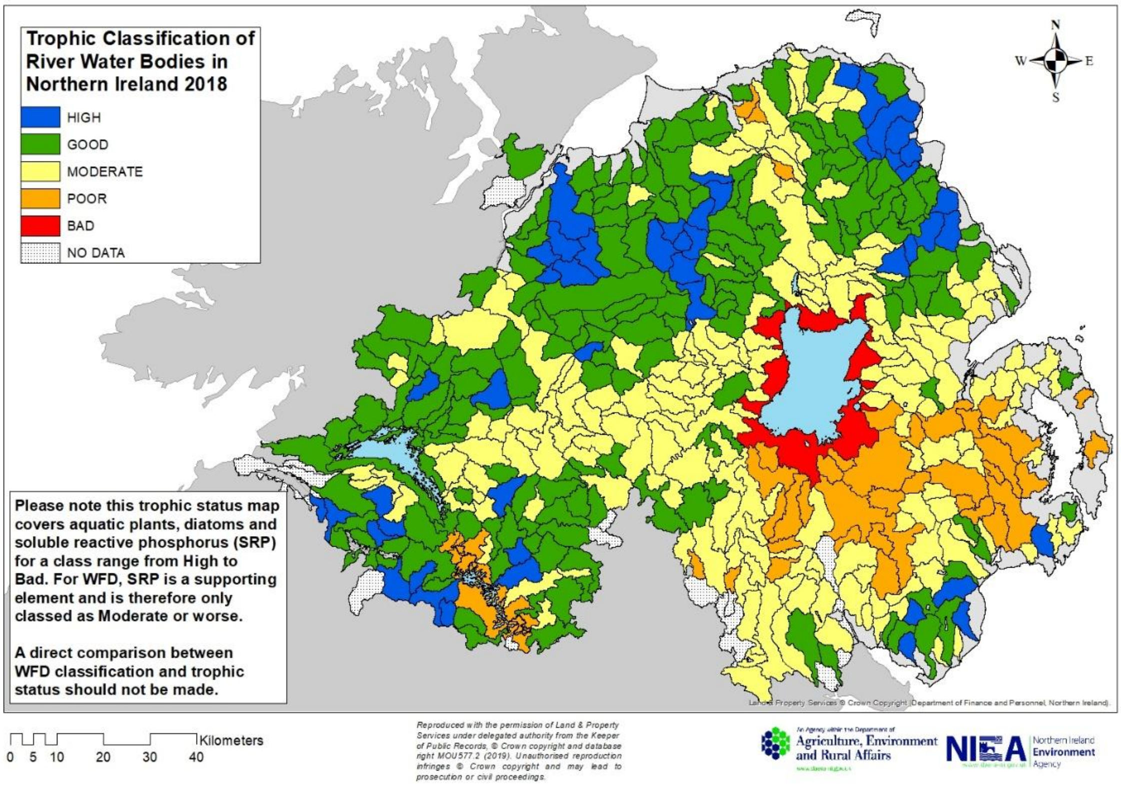

Figure 1.24: Distribution of overall 2018 WFD trophic classes across Northern Ireland's 450 river water bodies

The WFD 2018 trophic water body classifications were assessed against the corresponding trophic state according to the guidance updated and reissued in 2020 as described in Table 1.21. This has been compared against results from the previous reporting period where WFD 2015 water body classification data was used to report trophic status. The previous report interpreted Moderate WFD status as 'indicative of eutrophic conditions'. It was not possible to determine if the Moderate status for the WFD 2015 trophic classifications were corresponding to a negative eutrophication trend as the data preceding the 2016 report was not available for comparison. Table 1.23 shows the quality classes on the trophic state of water bodies in Northern Ireland for the current reporting period.

Table 1.23: Quality classes on the trophic state for river water bodies based on WFD 2018 classifications of the trophic indicator quality elements

	% of Water Bodies			
	Non-Eutrophic	May Become Eutrophic	Eutrophic	No Data
WFD 2018	48.2	9.8	38.2	3.8

Table 1.23 shows that 48.2 % of river water bodies across Northern Ireland are considered to be in a non-eutrophic state. 9.8% of the river water bodies may become eutrophic, i.e. the trophic class was Moderate according to WFD 2018 classification and was High or Good in the previous reporting period (WFD 2015). 38.2% of the river water bodies are considered to be eutrophic. Data was not available for 3.8% of the river water bodies.

1.5.1 Soluble Reactive Phosphorus (SRP)

The importance of phosphorus is recognised by the inclusion of SRP in WFD classification. Increasing nutrient concentrations are capable of changing the biomass and composition of biological communities with the most obvious primary impact being enhanced plant and algal production. Secondary impacts can include reduced dissolved oxygen levels caused by the overnight respiration of higher aquatic plants or macrophytes which can have a negative impact on fish. Elevated nutrient levels can also cause toxic blooms of blue-green algae leading to potential negative impacts on livestock and other animals as well as overgrowth of other species. Classification provides a way of comparing waters and a way of looking at changes over time, therefore, where the trend of phosphorus deteriorates from good status to moderate status the water body would be considered to be 'may become eutrophic'.

Northern Ireland has assessed annual average data from 2008-2011, 2012-2015 and 2016-2019 using the latest version of the SRP standards calculator (recommended by UKTAG) to obtain a SRP classification for each site. Further information on the application of the WFD standards for phosphorus is at:
www.wfduk.org/sites/default/files/Media/UKTAG %20Phosphorus %20Standards %20for %20Rivers_Final %20130906_0.pdf

NIEA monitored SRP concentrations at 568 surface freshwater stations across Northern Ireland in 2008-2011 and at 391 surface freshwater stations in 2012-2015 During the 2016-2019 reporting period 534 sites were monitored. Sufficient numbers of samples (i.e. >=12 samples) over four years were available at 471 sites. Of these sites, 362 are common with those sites monitored in the previous period.

Results in Table 1.24 show that in the 2008–2011 reporting period, 71 % of river sites were classified as High or Good for SRP status. The remaining 29.1 % of river sites had a WFD SRP classification of less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 5.5 % were classified as Poor status for SRP, indicative of nutrient enrichment. No sites were classified as Bad status.

Table 1.24 and Figure 1.25 show that in the 2012–2015 reporting period, 66.3 % of river sites were classified as High or Good for SRP status. The remaining 33.7% of river sites had a WFD SRP classification of less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 5.6 % were classified as Poor status for SRP, indicative of nutrient enrichment. No sites were classified as Bad status.

Table 1.24 and Figure 1.26 show that in the current reporting period 2016–2019, 57.1 % of river sites were classified as High or Good for SRP status. Compared with the previous reporting period this was a decrease in the number of sites that were classified as High or Good. 42.9 % of river sites had a WFD SRP classification of less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 8.1 % were classified as Poor status for SRP. No sites were classified as Bad status.

Table 1.24: WFD Soluble reactive phosphorus classification in rivers: 2008-2011, 2012-2015 and 2016-2019 (number and % of sites)

Rivers SRP WFD classification	Number and % of sites				
	High	**Good**	**Moderate**	**Poor**	**Bad**
2008-2011 (n=568)	213	190	134	31	0
	37.5 %	33.5 %	23.6 %	5.5 %	0
2012-2015 (n=391)	127	132	110	22	0
	32.5 %	33.8 %	28.1 %	5.6 %	0
2016-2019 (n=471)	92	177	164	38	0
	19.5 %	37.6 %	34.8 %	8.1 %	0

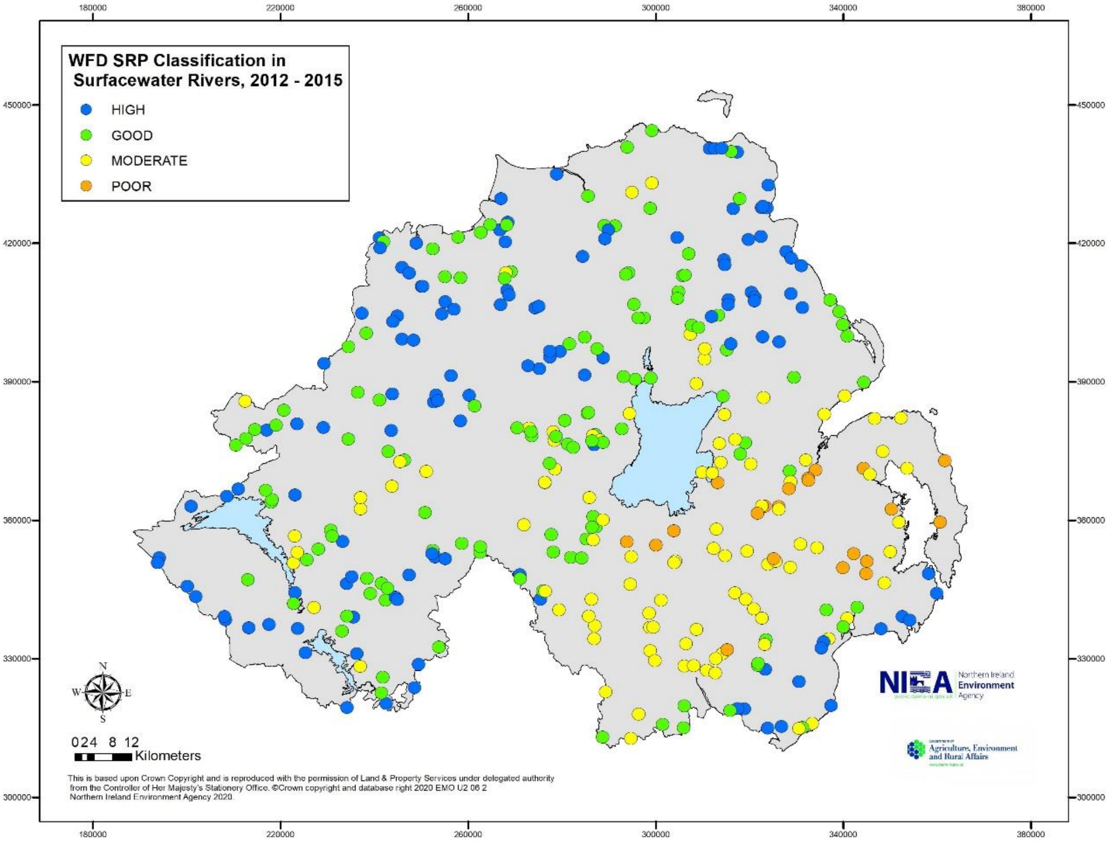

Figure 1.25: WFD soluble reactive phosphorus classification in river monitoring sites, 2012–2015

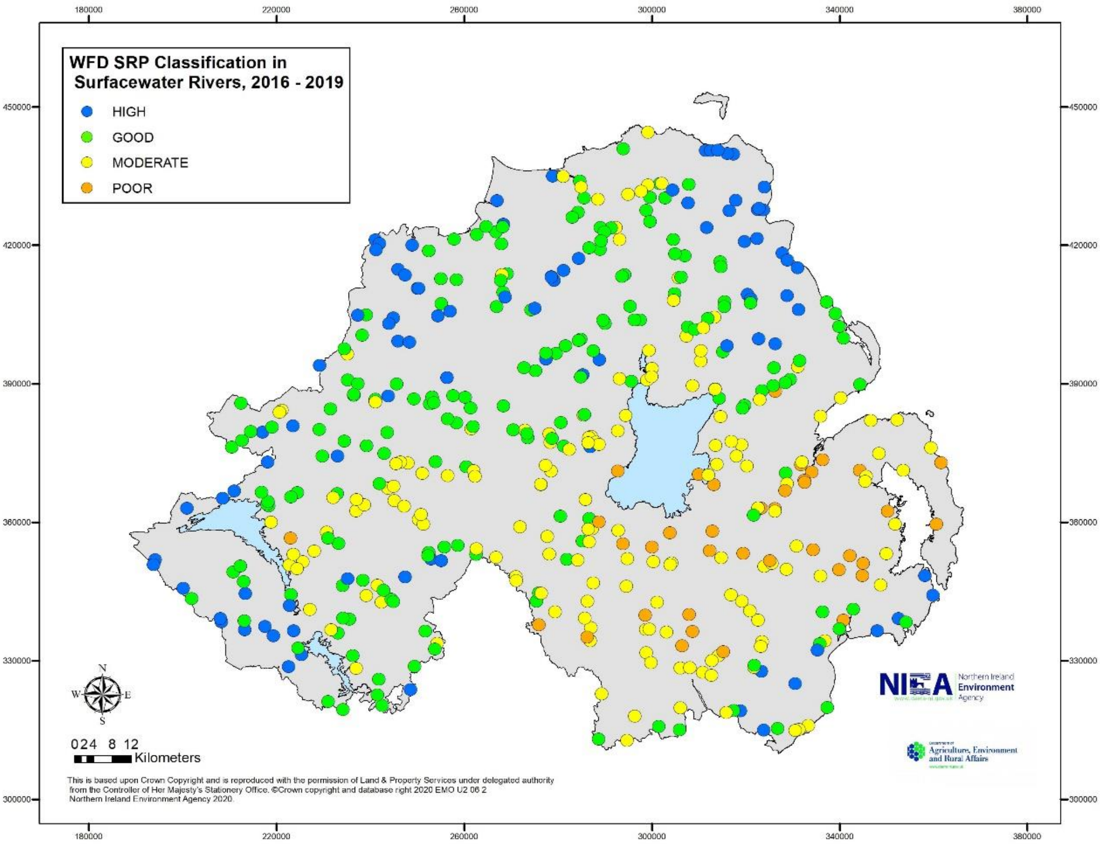

Figure 1.26: WFD soluble reactive phosphorus classification in river monitoring sites, 2016–2019

Overall changes in Table 1.25 indicate that the majority (73.8 %) of river sites experienced a decrease or stabilisation in WFD SRP classification status between the previous and current reporting periods. 26 % of sites exhibited a weak increase in SRP between the two reporting periods as they deteriorated by one class. One site (Crilly Feeder at Dunmacmay) exhibited a strong increase in SRP between the two reporting periods as it deteriorated by 2 classes from High to Moderate (Figure 1.27). All sites showing an increasing trend in SRP WFD status will be subject to further investigations and actions as part of the relevant River Basin District (RBD) programme of targeted catchment projects under WFD. This will include engagement with sewerage regulators, home owners and farmers in local areas to follow up actions arising from reported pollution incidents and improve water protection.

Table 1.25: Changes in river SRP WFD classification between former and current reporting periods (number and percentage of river sites)

	Number and % of sites				
	Strong decrease[1]	**Weak decrease[2]**	**Stable[3]**	**Weak increase[4]**	**Strong increase[5]**
Rivers WFD SRP classification (n=362)	1	5	261	94	1
	0.3 %	1.4 %	72.1 %	26.0 %	0.3 %

[1] Strong Decrease = ≥2 improvements in class; [2] Weak Decrease = 1 improvement in class; [3] Stable = No change in class; [4] Weak Increase = 1 deterioration in class; [5] Strong Increase = ≥2 deteriorations in class

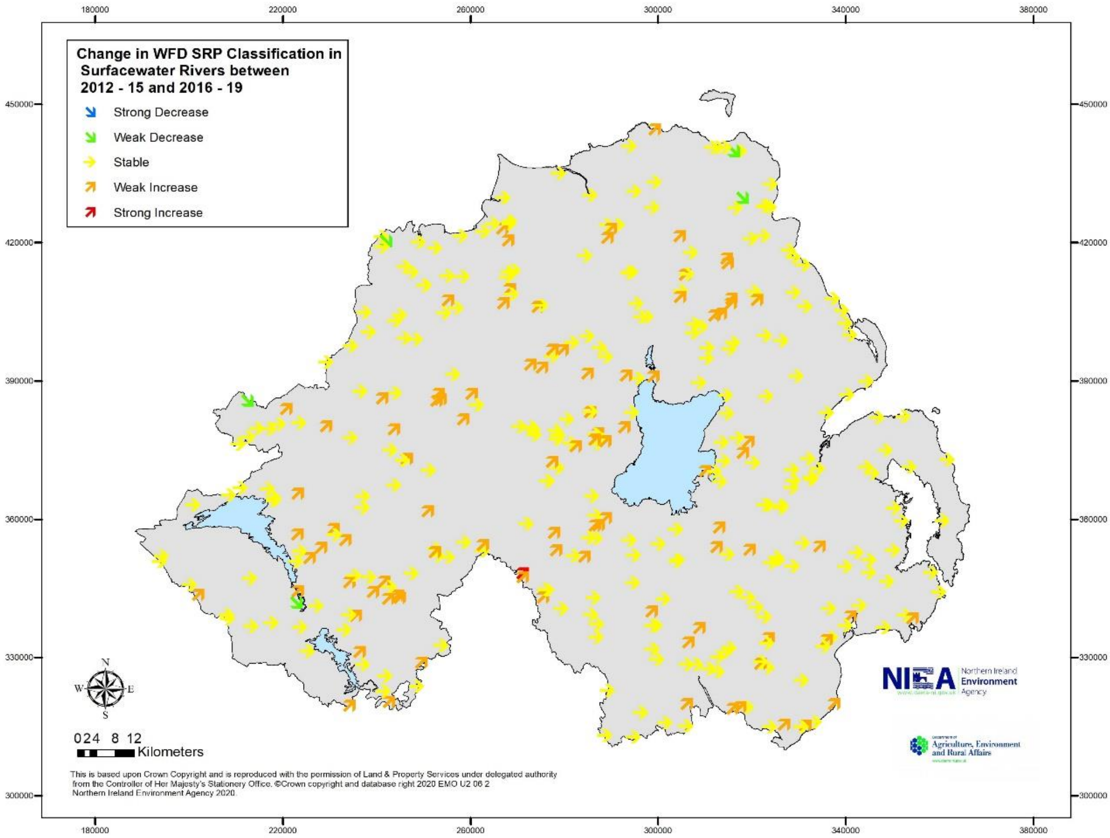

Figure: 1.27: Change in WFD soluble reactive phosphorus classification in river monitoring sites between previous and current reporting period, 2012-2015 and 2016-2019

The SRP status for the current reporting period 2016–2019 were assessed against the corresponding trophic state according to the guidance updated and reissued in 2020 as described in Table 1.21. This has been compared against results from the previous reporting period 2012-2015. In turn, the 2012-2015 results were compared against the 2008-2011 SRP status to determine trophic state for the previous reporting period. Table 1.26 show the quality classes on the trophic state of SRP in Northern Ireland in the two reporting periods, 2012-2015 and 2016-2019.

Table 1.26: Quality classes on the trophic state of soluble reactive phosphorus classification in rivers: 2016-2019 (number and % of sites)

	Number and % of sites		
	Non-Eutrophic	**May Become Eutrophic**	**Eutrophic**
2012-2015 (n=374)	248	16	110
	66.3 %	4.3 %	29.4 %
2016-2019 (n = 362)	207	38	117
	57.2 %	10.5%	32.3%

Table 1.26 shows that in the period 2012-2015, 66.3 % of river water bodies across Northern Ireland were considered to be in a non-eutrophic state when assessed for SRP classification. 4.3 % of the river water bodies were assessed as may become eutrophic, i.e. the trophic class was Moderate according to WFD SRP classification and was High or Good in the previous reporting period (2008-2011). 29.4 % of the river water bodies were considered to be eutrophic. In the current reporting period 2016-2019, there was a decrease

in the number of river water bodies across Northern Ireland considered to be in a non-eutrophic state when assessed for SRP classification (57.2 %). There was an increase to 10.5 % of the percentage of river water bodies that may become eutrophic, i.e. the trophic class was Moderate according to WFD SRP classification and was High or Good in the previous reporting period (2012-2015). The percentage of the river water bodies considered to be eutrophic increased to 32.3 % in the current reporting period.

1.5.2 Long-term trend analysis of Soluble Reactive Phosphorus concentration

As discussed in Section 1.2.4, NIEA carried out a statistical analysis to enable an assessment of long-term temporal trend of measured nitrate concentration concentrations in monitored rivers and streams in Northern Ireland between January 1992 and December 2019. The SRP data-set is for a shorter time period (1998-2015) due to a change in the laboratory limit of detection for SRP from 0.05 to 0.01 mg/l in 1998, as some sites would have previously had values less than the limit of detection.

A total of 650 monitoring sites (minimum >6 years data as recommended by UKTAG) were analysed and of these, 88 sites passed secondary quality validation screening (Stuart, 2012). The non-parametric Seasonal Mann-Kendall Tau (SMK) test (Hirsch *et al.,* 1982) was used along with Theil-Sen test to determine trends and provided a measure of the overall trend for each of the 88 individual monitoring sites. Seasonal trend analysis showed that the monthly trends in average phosphorus concentrations in 81 rivers in Northern Ireland were decreasing or stable over the 21-year period, 1998-2019 (92.05 % of sites). Only 7 sites (7.95% of sites) showed a significant increasing trend (Tables 1.27 and Figure 1.28). Figure 1.29 shows the distribution of long-term phosphorus trends across Northern Ireland at individual sites.

For the Northern Ireland dataset as a whole, the mean monthly phosphorus concentrations of the 650 rivers sites were calculated from the 21-year data set (Figure 1.30). Peak values tended to occur in the summer months. The SMK and Sen tests indicated a significant decreasing slope for this combined dataset.

Table 1.27: Summary of numbers of monitoring sites showing overall and seasonal significant decreases, increases or stable trends of phosphorus between 1998 and 2019

Time Period	SRP (n=88): 1998-2019		
	Decrease (p=<0.05)*	Stable (NS)*	Increase (p=<0.05)*
Overall	***31 (35.23 %)***	***50 (56.82 %)***	***7(7.95 %)***

**(Significance levels determined by the SMK were where z-statistic = <-1.94 = significant (p=<0.05); z-statistic = >1.94 to <= +1.94 = NS; z-statistic = > +1.94 = significant (p=0.05))*

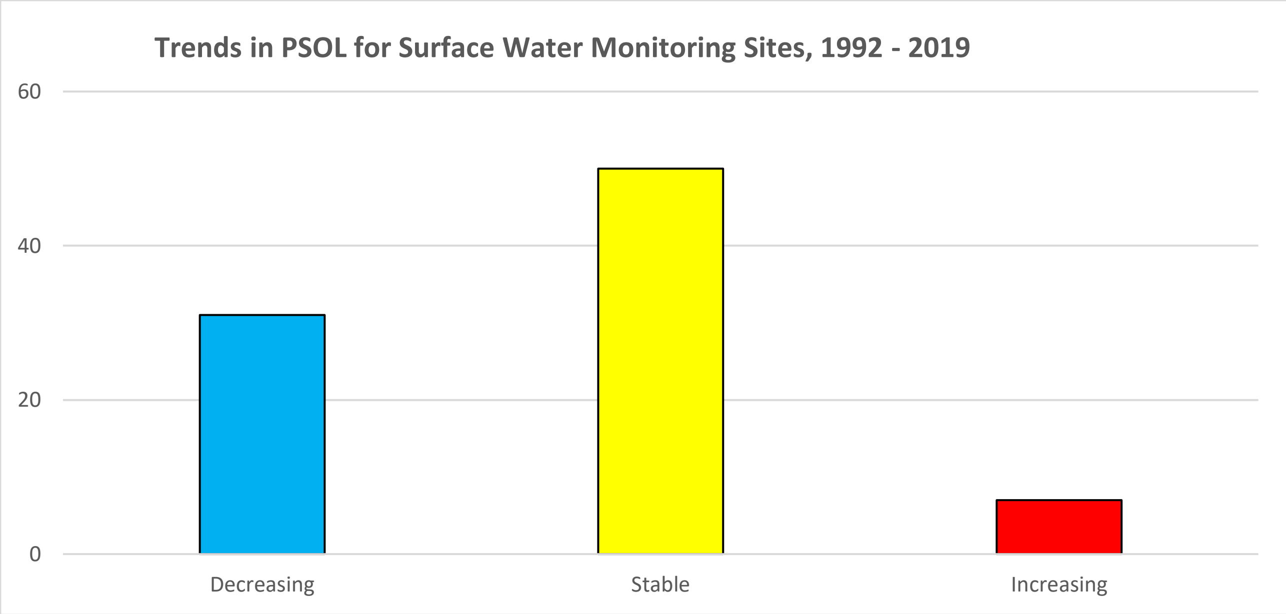

Figure 1.28: Numbers of monitoring sites showing increases, decreases or stability for soluble reactive phosphorus concentrations, 1998-2019

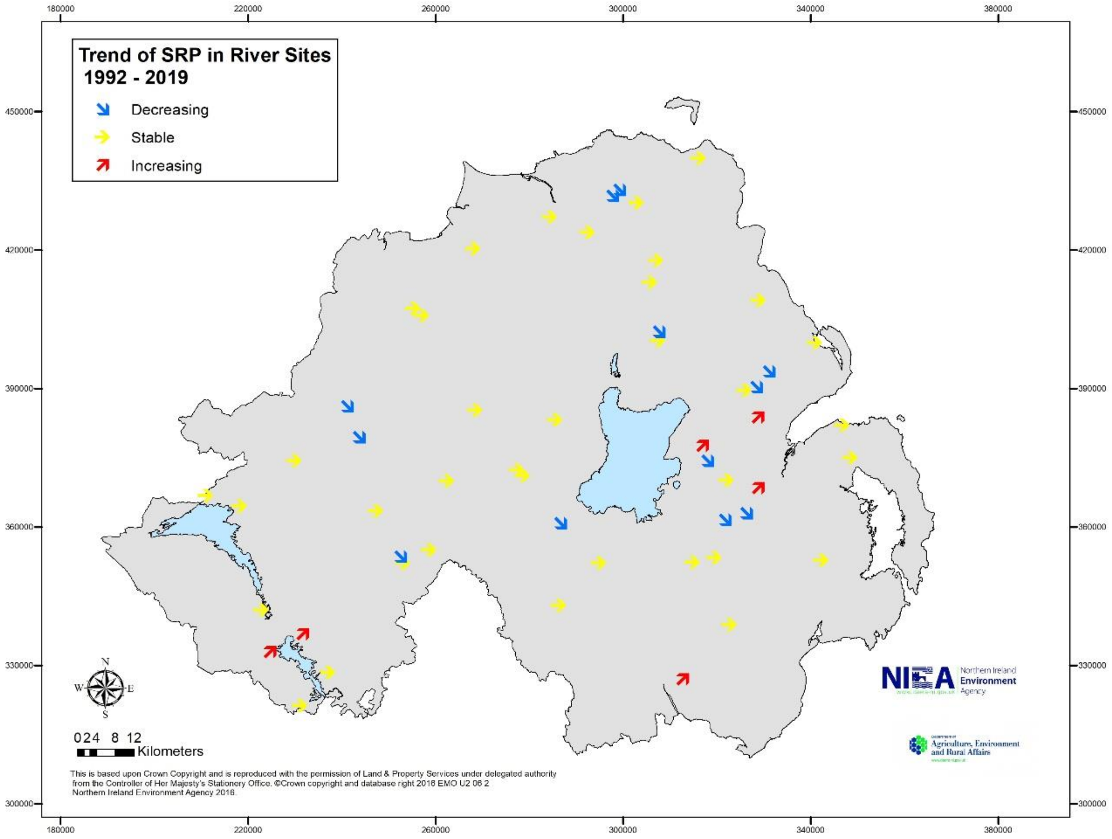

Figure 1.29: Trend of average soluble reactive phosphorus (SRP mg /l) in rivers across Northern Ireland: 1998–2019

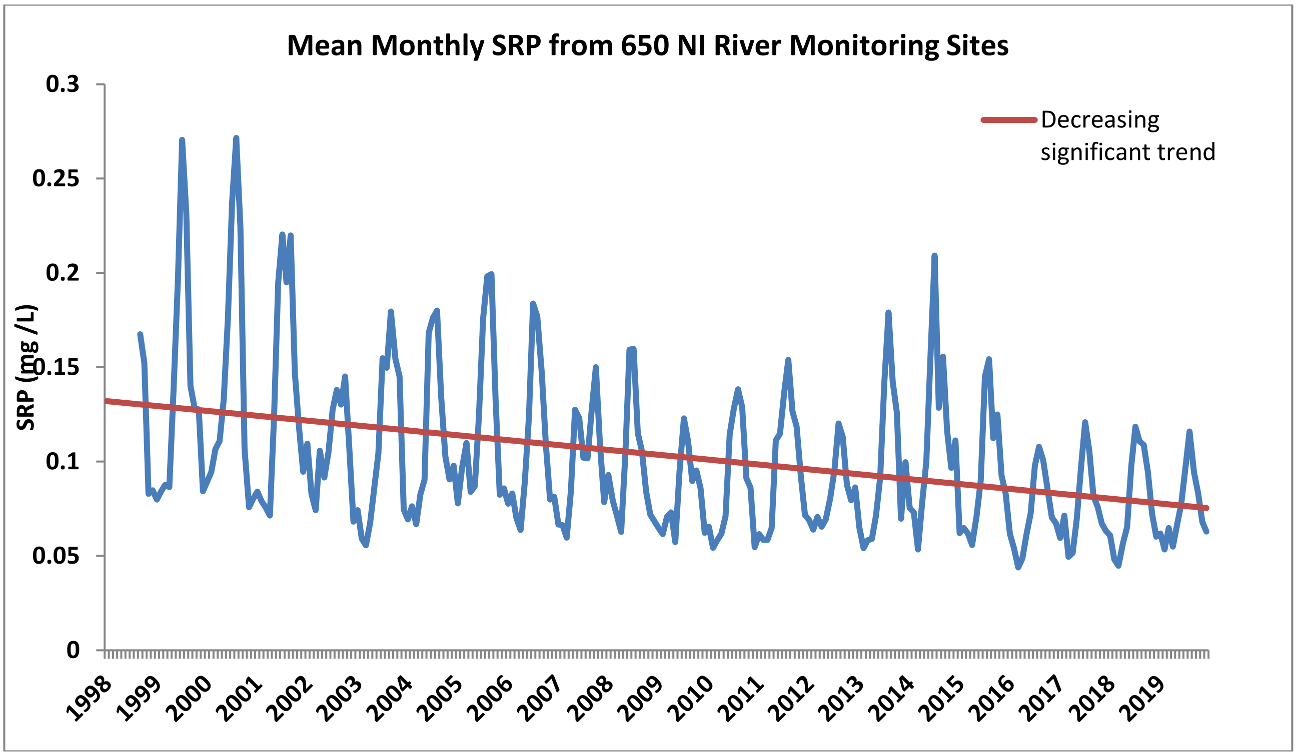

Figure 1.30: Soluble reactive phosphorus concentrations (SRP mg /l) in 650 river monitoring sites summarized by month into annual mean values of the site population, 1998-2019

In summary for section 1.5.1 on phosphorus in freshwaters. In recent years there has been an increase in the number of sites showing increasing levels of phosphorus in freshwaters, across Northern Ireland. In particular the period 2014-2016 had shown rates of increase that were a cause for concern. Over the long term, since 1992, levels continue to decline. Further analysis will be undertaken to establish the causative factors and any geospatial differences in the recent changes reported.

1.6 Current WFD assessment of trophic status of lakes

Lakes over 50 hectares (ha) in size are water bodies in themselves, but lakes less than 50 ha are subsumed under river water bodies. The WFD has an implicit requirement to assess eutrophication when classifying the status of water bodies where nutrient enrichment affects biological and physiochemical quality elements (Table 1.20). Similar to rivers classification, this provides a way of comparing the trophic status of lakes and a way of looking at changes over time. According to the European guidance updated and re-issued in 2020, lakes which are not considered to be eutrophic are classed as High or Good. Poor and Bad status under WFD correspond with ‘eutrophic’, relating to situations where undesirable disturbances are common or severe. Moderate status may lead to a classification of ‘eutrophic’ if the previous trophic status was Moderate, Poor or Bad under WFD. However, if the previous classification was High or Good under WFD, the trophic status should be ‘may become eutrophic’. This corresponds to a negative eutrophication trend between the previous and current reporting periods. This is not applicable to a negative trend between High and Good status (Table 1.21).

In the WFD classification periods 2012-2014 (WFD 2015) and 2015-2017 (WFD 2018), NIEA monitored total phosphorus (TP), phytoplankton, macrophytes and benthic diatoms at 21 lakes across Northern Ireland. Lakes with a surface area greater than 50 ha are known as surveillance lakes. Lower Lough Erne is divided into two water bodies and it should also be noted that the monitoring station located at Lower Bann at Toome Bridge is representative of the Lough Neagh water body and thus will be included in the assessment of water quality of Lough Neagh in the two reporting periods.

Macrophytes and benthic diatoms were generally surveyed at each lake on a three-year rolling basis. Samples for TP analysis were collected at monthly intervals, giving a maximum of 12 samples per year. Phytoplankton samples are collected in July, August and September for three consecutive years to give a total of nine samples.

The results of each parameter were then combined to give an overall trophic classification for each water body using the WFD criterion of defaulting to the lowest class in each case. However, the UK Technical Guidance (2008) recommends that macrophytes are not used for classification where lakes are classed as Heavily Modified Water Bodies (HMWB) unless they are known to be ecologically sensitive. It will be assumed that if a lake HMWB passes its lake level standards (hydrology class) this indicates that the habitat should be favourable for macrophyte colonisation and that macrophytes should be included in trophic status assessments. If a lake fails the hydrology standards then macrophytes will not be included in trophic status assessments. There are currently eleven HMWB lake designations in Northern Ireland: Lower Lough Erne at Kesh, Lower Lough Erne at Devenish, Upper Lough Erne, Lough Neagh, Stoneyford Reservoir, Cam Lough, Lough Fea, Lough Island Reavy, Lough Mourne, Silent Valley Reservoir and Spelga Dam. Of these, the first five named pass their hydrology standard and macrophytes are included in trophic assessment. The remaining six fail their hydrology and macrophytes are not used in trophic assessment.

In this report WFD trophic assessments will be made using data from the current reporting period, as well as data from the previous reporting period (WFD 2015) to allow comparison. Section 1.6.1 and 1.6.2 will investigate the evolution of trophic status using TP and chlorophyll-α data thereby providing a comparative eutrophic assessment between the three reporting periods 2009-2011, 2012-2014 and 2015-2017.

For the purposes of this report, data which describes eutrophic state reported in the ReportNet tables is based solely on classification of total phosphorus (TP) and chlorophyll-α. These are discussed in the following paragraphs separately without the supporting biological parameters.

The status for the trophic elements and overall trophic status for each lake in WFD 2015 is shown in Table 1.28.

Table 1.28: WFD 2015 status for *Total Phosphorus (TP), phytoplankton, macrophytes, diatoms and overall trophic class for each surveillance lake*

Lake Name	Phytoplankton	Diatoms	Macrophytes	TP Class	Trophic Class
Lough Beg	Moderate	Poor	Moderate	Poor	Poor
Cam Lough	Poor	Good		Poor	Poor
Castlehume Lough	High	High	Good	High	Good
Clea Lakes	Moderate		Moderate	Poor	Poor
Lower Lough Erne at Kesh	Good	Moderate	Moderate	Good	Moderate
Lower Lough Erne at Devenish	Good	Moderate	Moderate	Moderate	Moderate
Upper Lough Erne	High	Moderate	Moderate	Moderate	Moderate
Lough Fea	High	High		High	High
Lough Gullion	Good	Moderate	Bad	Poor	Bad
Lough Island Reavy	Good	High		Moderate	Moderate
Lower MacNean	High	Good	Bad	Good	Bad
Upper MacNean	Good	Good	Moderate	Good	Moderate
Lough Melvin	Good	High	Moderate	Good	Moderate
Lough Mourne	Moderate	Good		Poor	Poor
Lough Neagh	Poor	Poor	Bad	Bad	Bad
Portmore Lough	Poor	Poor	Bad	Bad	Bad
Lough Ross	Moderate	Moderate	Moderate	Poor	Poor
Lough Scolban	Good	High	Good	High	Good
Silent Valley	High	High		High	High
Spelga Dam	Good	High		High	Good
Stoneyford	Moderate	Moderate	Poor	Poor	Poor

The status for the trophic elements and overall trophic status for each lake in WFD 2018 is shown in Table 1.29

Table 1.29: WFD 2018 status for *Total Phosphorus (TP), phytoplankton, macrophytes, diatoms and overall trophic class for each surveillance lake*

Lake Name	Phytoplankton	Diatoms	Macrophytes	TP Class	Trophic Class
Lough Beg	Moderate	Poor	Moderate	Poor	Poor
Cam Lough	Poor	Moderate		Poor	Poor
Castlehume Lough	High	Good	Good	Good	Good
Clea Lakes	Moderate	Moderate		Moderate	Moderate
Lower Lough Erne at Kesh	Good	Poor	Moderate	Moderate	Poor
Lower Lough Erne at Devenish	Good	Moderate	Moderate	Moderate	Moderate
Upper Lough Erne	High	Poor	Moderate	Moderate	Poor
Lough Fea	High	High		High	High
Lough Gullion	Good	Poor	Bad	Poor	Bad
Lough Island Reavy	Moderate	High		Moderate	Moderate
Lower MacNean	High	Moderate	Poor	Good	Poor
Upper MacNean	Moderate	Good	Poor	Good	Poor
Lough Melvin	High	Good	Moderate	Moderate	Moderate
Lough Mourne	Moderate	Moderate		Poor	Poor
Lough Neagh	Poor	Poor	Poor	Bad	Bad
Portmore Lough	Poor	Moderate	Bad	Bad	Bad
Lough Ross	Moderate	Moderate	Moderate	Moderate	Moderate
Lough Scolban	Good	High	High	High	Good
Silent Valley	High	High		High	High
Spelga Dam	High	High		High	High
Stoneyford	Moderate	Poor	Good	Poor	Poor

The distribution of WFD 2015 and WFD 2018 classes for lake water bodies in Northern Ireland is shown in Table 1.30 and Figure 1.31.

Table 1.28 and Table 1.30 show that five of the 21 lake water bodies were classed as High/Good overall trophic status in 2012-2014 whilst the other 16 lakes were classed as Moderate, Poor or Bad trophic status which is indicative of eutrophic conditions. Further detail can be obtained from the previous report published in 2016.

Table 1.29 and Table 1.30 show that the same five lake water bodies were classed as High/Good overall trophic status in 2015-2017. The other 16 lakes were classed as Moderate, Poor or Bad trophic status which is indicative of eutrophic conditions. This is the same distribution as the previous reporting period, however the apportionment of the lakes in each WFD status has changed at an element level for some lakes. Overall the trophic status remained unchanged at 14 lakes. Three lakes deteriorated from Moderate trophic status in the previous reporting period to Poor trophic status in WFD 2018 due to a decline in the diatom or macrophyte classification. Four lakes improved by one status class.

All lakes exhibiting eutrophic conditions will be subject to further investigations and actions as part of the relevant River Basin Management programme of targeted catchment projects under WFD. This will include engagement with sewerage regulators, home owners and farmers in local areas to follow up actions arising from reported pollution incidents and improve water protection.

Table 1.30: Overall WFD 2015 and WFD 2018 classification of trophic indicator quality elements for 21 lakes in Northern Ireland *(based on Total Phosphorus (TP), phytoplankton, macrophytes and diatoms)*

	WFD Class (n=21)				
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**
Number of Lakes 2015	2	3	6	6	4
Number of Lakes 2018	3	2	5	8	3
% of Lakes 2015	10 %	14 %	29 %	29%	19%
% of Lakes 2018	14 %	10 %	24 %	38 %	14 %

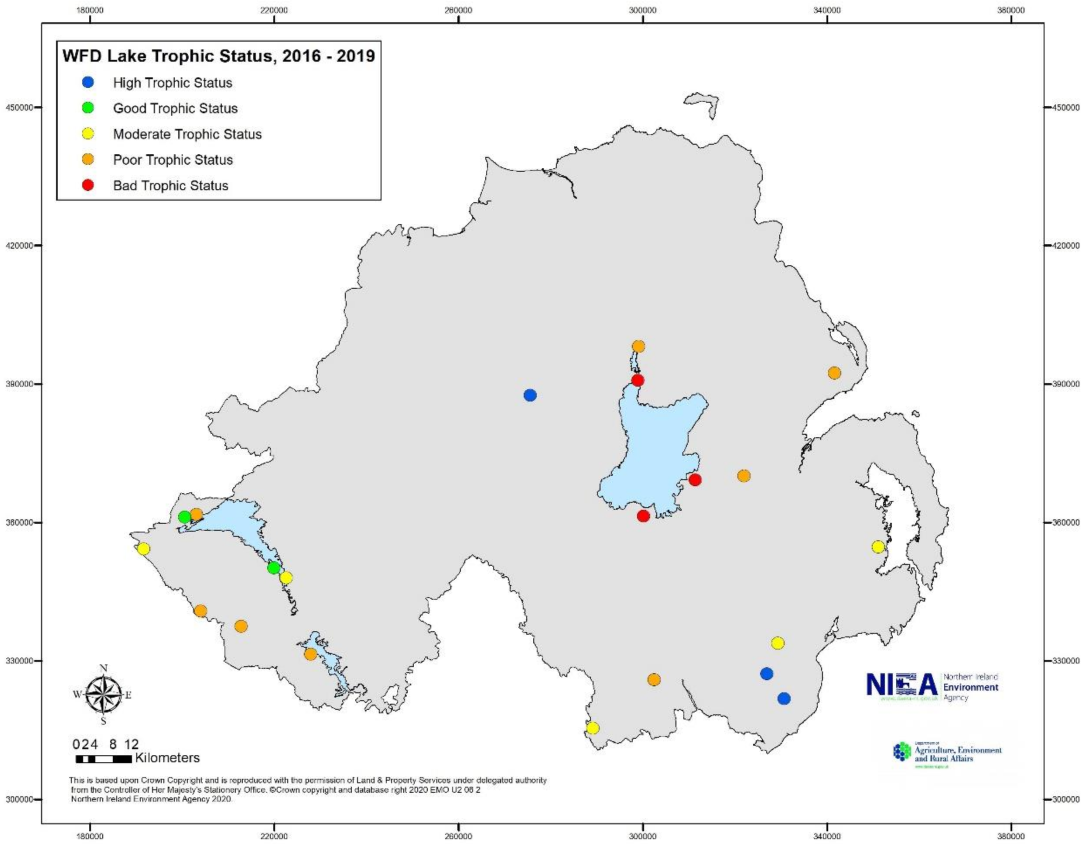

Figure 1.31: Overall WFD trophic classes across Northern Ireland 21 lake monitoring stations in the period 2015-2017 *(based on TP, phytoplankton, macrophytes and diatoms)*

The WFD 2018 trophic lake classifications were compared against the results from WFD 2015 according to the guidance updated and reissued in 2020 as described in Table 1.21.

Table 1.31 shows that 5 lakes in Northern Ireland were considered to be in a non-eutrophic state and 16 lakes were assessed as Eutrophic. As no lake water bodies had declined from High or Good to Moderate over the reporting period, no lakes are assessed as May become Eutrophic. It was not possible to determine if the Moderate status for the WFD 2015 trophic classifications were corresponding to a negative eutrophication trend as the data preceding the 2016 report was not available for comparison. Table 1.31 shows the quality classes on the trophic state of water bodies in Northern Ireland for the current reporting period.

Table 1.31: Quality classes on the trophic state of lakes based on WFD 2015 and 2018 classifications of the trophic indicator quality elements

	Number of Water Bodies		
	Non-Eutrophic	May Become Eutrophic	Eutrophic
WFD 2018	5	0	16

1.6.1 Total phosphorus

Northern Ireland has assessed data from 2015-2017 using the latest version of the WFD Lake TP reference boundary calculator (v4) to obtain a TP classification. The data from 2009-11 which was presented in the previous report is shown in Table 1.32 below, thus allowing a three period comparison. This review is based on 2012, 2015 and 2018 WFD lake TP classifications. Twenty-one lakes in Northern Ireland were routinely monitored on a monthly basis for TP for all classification periods. The same 21 lakes were monitored during all reporting periods.

Table 1.32: Total Phosphorus, classification in Northern Ireland, 2009-2011, 2012-2014 and 2015-2017

Reporting Period (n=21)	High	Good	Moderate	Poor	Bad
2009-2011	6	2	4	7	2
2012-2014	5	4	3	7	2
2015-2017	4	3	7	5	2

Table 1.32 shows that of the 21 lakes monitored for TP in the reporting period 2009-2011, eight lakes were classed as High or Good status. Thirteen lakes had TP classifications less than Good which is indicative of nutrient enrichment or considered to be eutrophic. Lough Neagh and Portmore Lough were classified as Bad status for TP classification.

In the reporting period 2012-2014, nine lakes were classed as High/Good. Twelve lakes had TP classifications less than Good. Of these, seven lakes were classified as Poor status for TP, which are considered to be eutrophic. Lough Neagh and Portmore Lough remained classified as Bad status for TP classification (Figure 1.32).

In the reporting period 2015-2017, seven lakes were classed as High/Good. This is a slight deterioration from the previous reporting period as Lower Lough Erne at Kesh and Lough Melvin both deteriorated from Good to Moderate TP status. Fourteen lakes had TP classifications less than Good which is indicative of nutrient enrichment or considered to be eutrophic. Of these, five lakes were classified as Poor status for TP, which are considered to be eutrophic. Lough Neagh and Portmore Lough were classified as Bad status for TP classification (the same lakes as the in the previous reporting periods) (Figure 1.33).

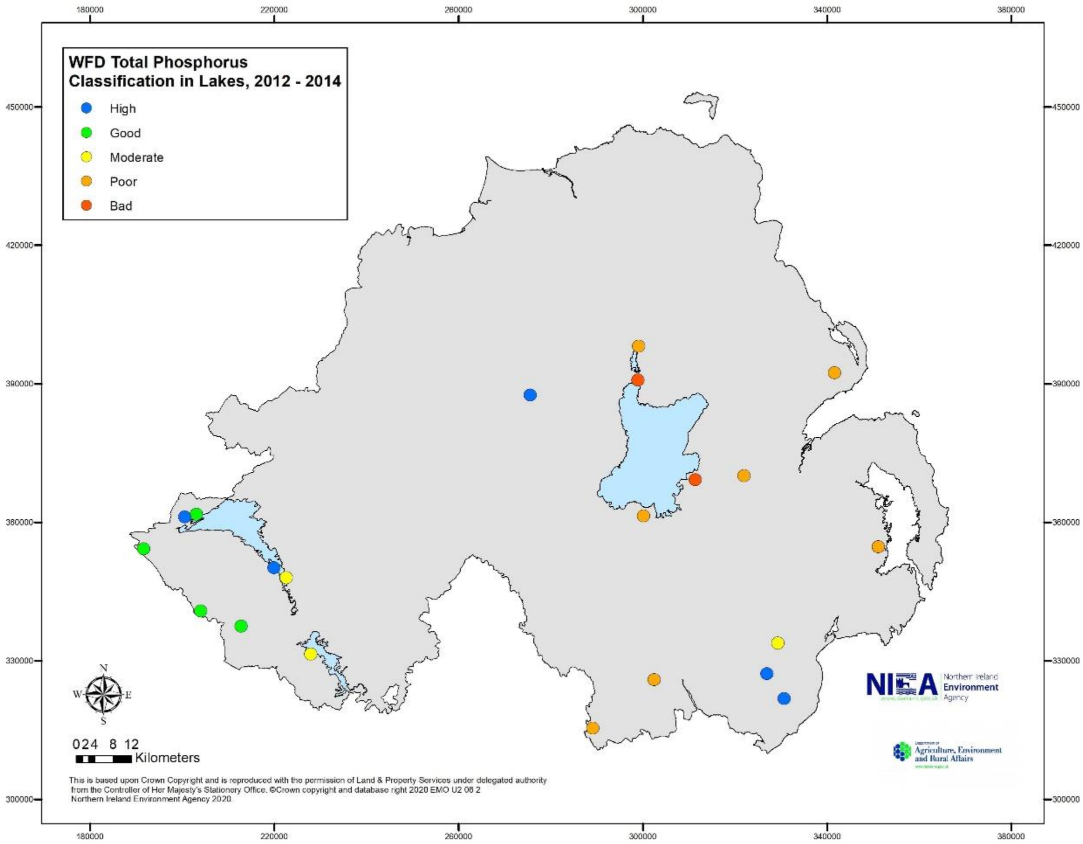

Figure 1.32: WFD Total Phosphorus classification in lakes, 2012–2014

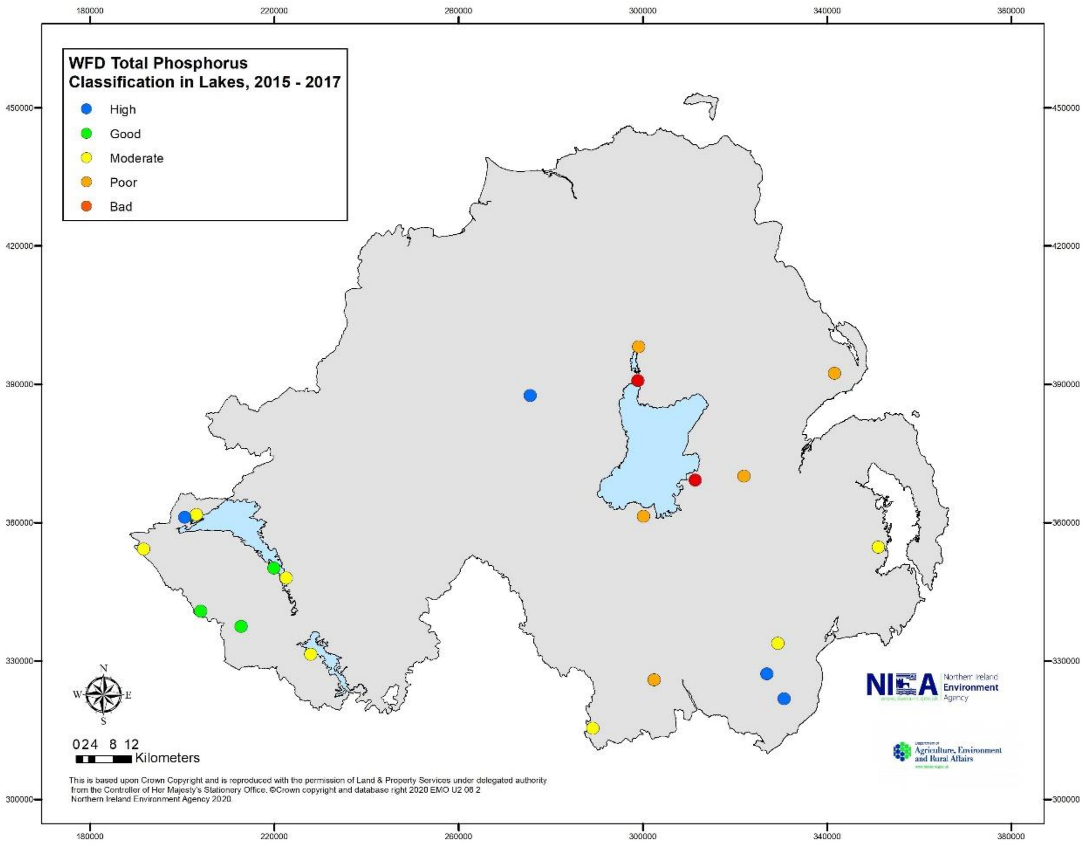

Figure 1.33: WFD Total Phosphorus classification in lakes, 2015-2017

Overall changes shown in Table 1.33 indicate that for the 21 common lake monitoring sites, two lakes, Lough Ross and Clea Lakes have shown improvement in WFD TP classification between the reporting periods, improving from Poor to Moderate status. However, it should be noted that the humic condition of these lakes changed from clear to humic, thus impacting the calculation of TP class between the reporting periods. Although an improvement in class was noted due to type change, the actual geometric means for TP were consistent between reporting periods and did not show any signs of real improvement. Sixteen lakes remained stable between the reporting periods 2012-2014 and 2015-2017 (Figure 1.34).

Table 1.33: Changes in WFD Total Phosphorus classification in lakes between former and current reporting periods (numbers and % of lake sampling points)

	Number and % of points				
	Strong decrease[1]	**Weak decrease[2]**	**Stable[3]**	**Weak increase[4]**	**Strong increase[5]**
Lakes WFD TP classification (n=21)	0	2	16	3	0
	0 %	9.5 %	76.2 %	14.3 %	0 %

[1] Strong Decrease = ≥2 improvements in class; [2] Weak Decrease = 1 improvement in class; [3] Stable = No change in class; [4] Weak Increase = 1 deterioration in class; 5 Strong Increase = ≥2 deteriorations in class

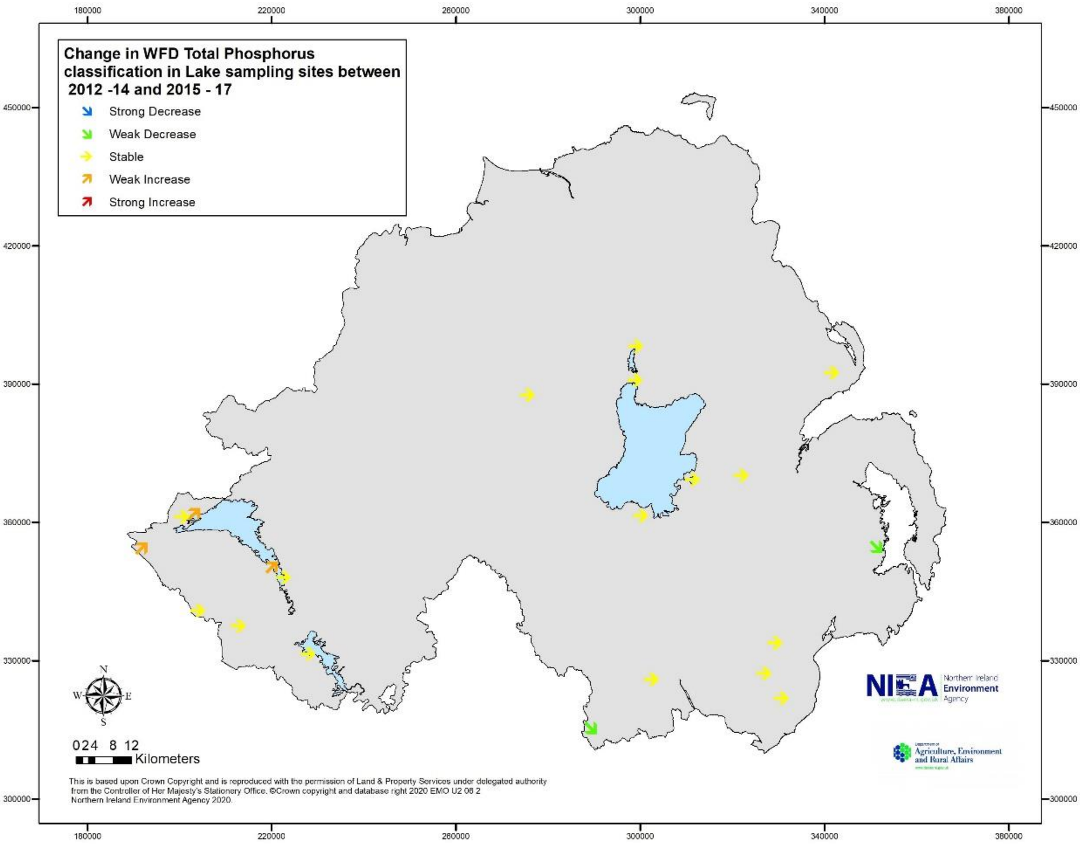

Figure 1.34: Change in WFD Total Phosphorus classification in lake sampling sites between previous and current reporting period, 2012-2014 and 2015-2017.

The TP status for the current reporting period 2015–2017 were assessed against the corresponding trophic state according to the guidance updated and reissued in 2020 as described in Table 1.21. This has been compared against results from the previous reporting period 2012-2014. In turn, the 2012-2014 results were compared against the 2009-2011 TP status to determine trophic state for the previous reporting period. The data is based on 21 lakes common to all reporting periods. Table 1.34 show the quality classes of the trophic state of TP in Northern Ireland in the two reporting periods.

Table 1.34: Quality classes on the trophic state of TP classification in lakes: 2012-2014 and 2015-2017 (number and % of sites)

	Number and % of sites (n=21)		
	Non-Eutrophic	**May Become Eutrophic**	**Eutrophic**
2012-2014	9	0	12
	42.9 %	0 %	57.1 %
2015-2017	7	2	12
	33.3 %	9.5 %	57.1 %

Table 1.34 shows that in the period 2012-2014, 42.9 % of lakes in Northern Ireland were considered to be in a non-eutrophic state when assessed for TP classification. None of the lakes were classed as 'may become eutrophic', i.e. where the trophic class was Moderate according to WFD TP classification and was High or Good in the previous reporting period (2009-2011). 57.1 % of the lakes were considered to be eutrophic. In the current reporting period 2015-2017, there was a decrease in the number of lakes in Northern Ireland considered to be in a non-eutrophic state when assessed for TP classification (33.3 %). There was an increase to 9.5 % of the percentage of lakes that may become eutrophic, i.e. where the trophic class was Moderate according to WFD TP classification and was High or Good in the previous reporting period (2012-2014). The percentage of lakes considered to be eutrophic remained the same in the current reporting period (57.1 %).

Although not considered further in this report it is worth noting that annual updates are made to Lake TP classification. Over the period 2016-2018 fifteen lakes remained stable for TP status. Of these, six remained at High or Good status, seven remained Moderate status and two remained Bad status. Six lakes deteriorated but as four deteriorated from High to Good TP status they would remain being assessed as Non Eutrophic. The other two deteriorations were one from Good to Moderate and is therefore assessed as May become Eutrophic and one from Poor to Bad which therefore remains Eutrophic. With the inclusion of 2019 data three lakes deteriorated from Good to Moderate and are therefore likely to become eutrophic and one lake deteriorated from Moderate to Poor and therefore remains eutrophic. The status of the other 17 lakes remains unchanged.

1.6.2 Chlorophyll-α

Northern Ireland has assessed data from 2012-2015 and 2016-2019 using the latest version of the WFD PLUTO Single Site Calculator (V4h). The data from 2008-11 which was presented in the previous report is shown in Table 1.35 below, thus allowing a three period comparison. Only the chlorophyll-α component of the PLUTO classification tool will be considered in this section of the report, without the supporting biological data and only summer data is included (April to October). Twenty-one lakes in Northern Ireland were routinely monitored on a monthly basis for chlorophyll-α for all classification periods. The same 21 lakes were monitored during all reporting periods.

Table 1.35: WFD chlorophyll-α classification in Northern Ireland, 2008-2011, 2012-2015 and 2016-2019

Reporting Period (n=21)	High	Good	Moderate	Poor	Bad
2008-2011	6	8	4	3	0
2012-2015	5	8	4	4	0
2016-2019	5	5	6	5	0

Table 1.35 shows that of the 21 lakes monitored for chlorophyll-α in the 2008-2011, reporting period, 14 lakes were classed as High/Good. Seven lakes had chlorophyll-α classifications less than Good which is indicative of nutrient enrichment. Of these, three (Lough Neagh, Lough Ross and Cam Lough) were classified as Poor chlorophyll *α,* and are considered to be eutrophic. No lakes were classified as Bad status for chlorophyll-α.

In the reporting period 2012-2015, 13 lakes were classed as High/ Good. Eight lakes had chlorophyll-α classifications less than Good with four lakes at Moderate status and for at Poor status. No lakes were classified as Bad status for chlorophyll-α (Figure 1.35).

In the current reporting period (2016-2019), 10 lakes were classed as High/ Good. Six lakes were classed as Moderate status and five lakes were classed as Poor status for chlorophyll-α. No lakes were classified as Bad status for chlorophyll-α in the current reporting period (Figure 1.36).

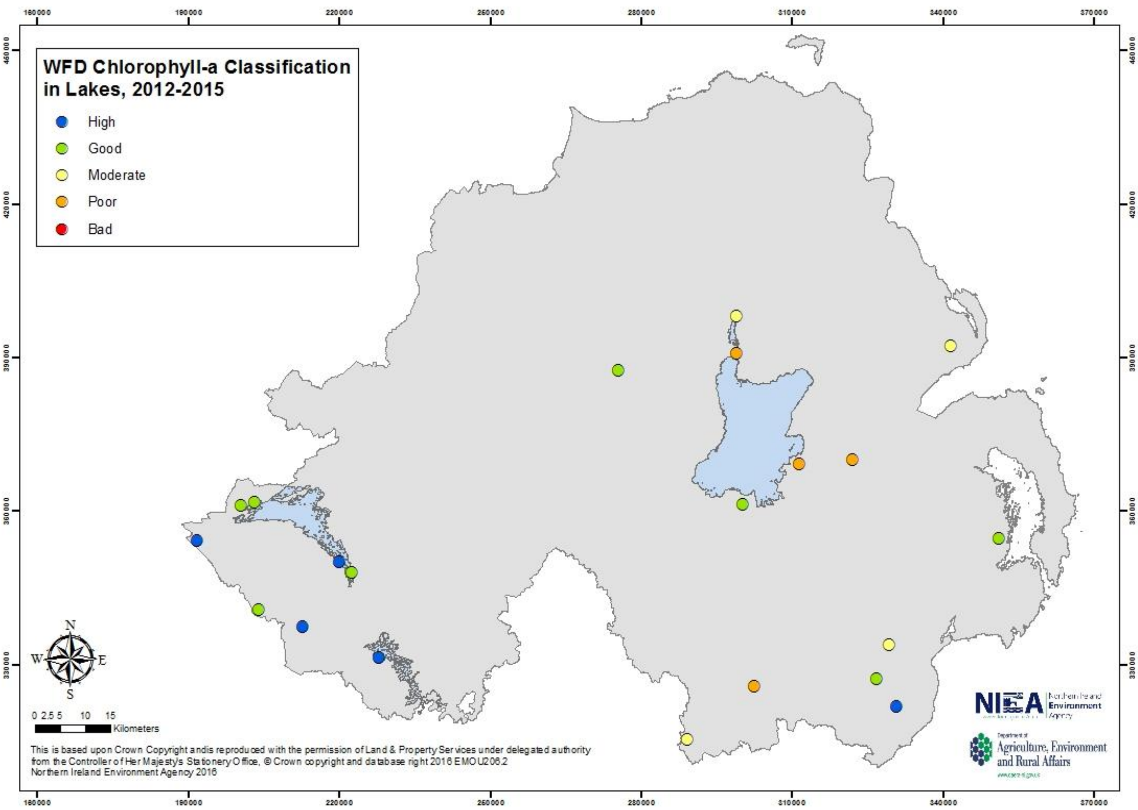

Figure 1.35: WFD chlorophyll-α classification in lakes, 2012-2015

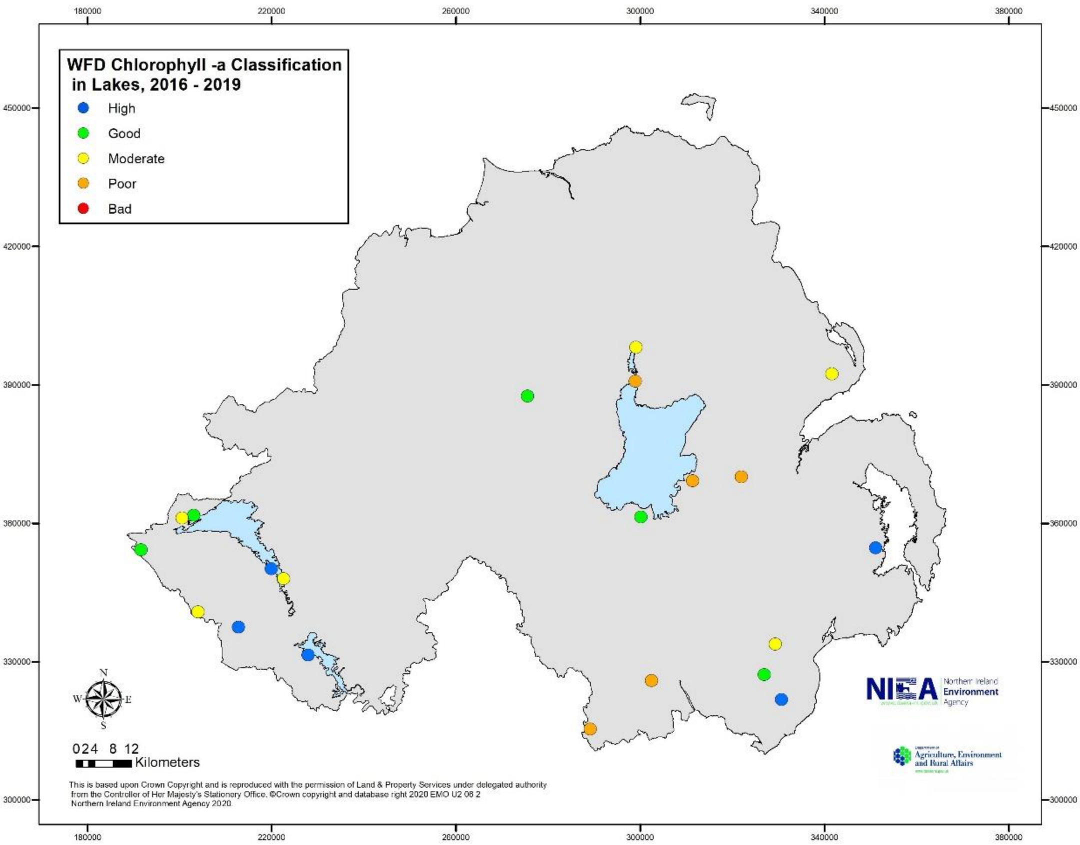

Figure 1.36: WFD chlorophyll-α classification in lakes, 2016–2019

Changes in lake WFD chlorophyll-α classification shown in Table 1.36 and Figure 1.37 indicate that overall, for the majority (15) of the 21 lakes monitored in Northern Ireland, the trophic status has remained stable between the reporting periods. One lake (Clea Lakes) has shown improvement in chlorophyll-α WFD classification between the reporting periods from Good to High status. However, it should be noted that the humic condition of this lake changed from clear to humic, thus impacting the calculation of Chla class between the reporting periods. Five lakes deteriorated by one class. Further investigation of these lakes is planned as part of the second cycle River Basin Management Plans (RBMPs).

Table 1.36: Changes in lake WFD chlorophyll-α classification between 2012-2015 and 2016-2019 periods (numbers and % of lake sites)

	Number and % of sites (n=21)				
	Strong decrease[1]	**Weak decrease[2]**	**Stable[3]**	**Weak increase[4]**	**Strong increase[5]**
Lakes WFD chlorophyll-α classification	0	1	15	5	0
	0 %	4.8 %	71.4 %	23.8 %	0 %

[1] Strong Decrease = ≥2 improvements in class; [2] Weak Decrease = 1 improvement in class; [3] Stable = No change in class; [4] Weak Increase = 1 deterioration in class; [5] Strong Increase = ≥2 deteriorations in class

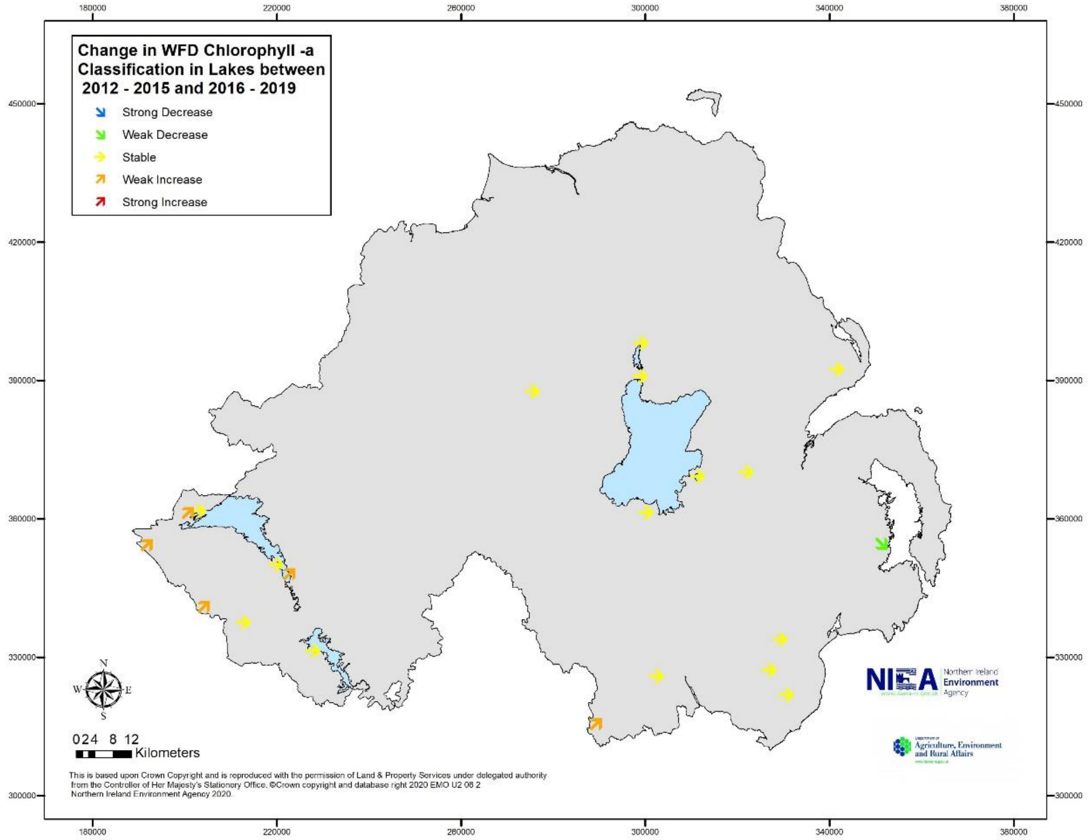

Figure 1.37: Change in WFD chlorophyll-α classification in lakes sites between previous and current reporting period.

The chlorophyll-α status for the current reporting period 2016–2019 were assessed against the corresponding trophic state according to the guidance updated and reissued in 2020 as described in Table 1.21. This was compared against results from the previous reporting period 2012-2015. In turn, the 2012-2015 results were compared against the 2008-2011 chlorophyll-α status to determine trophic state for the previous reporting period. The data is based on 21 lakes common to all reporting periods. Table 1.35 show the quality classes on the trophic state of chlorophyll-α in Northern Ireland in the two reporting periods.

Table 1.37: Quality classes on the trophic state of chlorophyll-α classification in lakes: 2012-2015 and 2016-2019 (number and % of sites)

	Number and % of sites (n=21)		
	Non-Eutrophic	**May Become Eutrophic**	**Eutrophic**
2012-2015	13	1	7
	61.9 %	4.8 %	33.3 %
2016-2019	10	3	8
	47.6 %	14.3 %	38.1 %

Table 1.37 shows that in the period 2012-2015, 61.9 % of lakes in Northern Ireland were considered to be in a non-eutrophic state when assessed for chlorophyll-α classification. 4.8 % (one lake, namely Lough Island Reavy) was classed as 'may become eutrophic', i.e. the trophic class was Moderate according to the WFD chlorophyll-α classification and was High or Good in the previous reporting period (2008-2011). 33.3 % of the lakes were considered to be eutrophic.

In the current reporting period 2016-2019, there was a decrease in the number of lakes in Northern Ireland considered to be in a non-eutrophic state when assessed for chlorophyll-α classification (47.6 %). Three lakes (14.3 %) were classed as 'may become eutrophic', i.e. the trophic class was Moderate according to WFD chlorophyll-α classification and was Good in the previous reporting period (2012-2015). The percentage of lakes considered to be eutrophic increased to 38.1 % in the current reporting period. Lough Island Reavy, which was previously classed as 'may become eutrophic' is now considered as eutrophic as it maintained Moderate status between the two reporting periods.

Overall the monitoring of lakes indicates continuing nutrient pressures, with more lakes moving towards a eutrophic state.

1.7 Current Water Framework Directive (2000/60/EEC) assessment of trophic status of transitional and coastal marine waters

Eutrophication in transitional, coastal, and marine waters is assessed following the Common Procedure for the Identification of the Eutrophication Status of the Maritime Area of the OSPAR Convention (OSPAR 97/15/1, Annex 24) and selected quality elements monitored under the WFD. The OSPAR Common Procedure also provides the framework for assessing eutrophication under the MSFD. The Common Procedure comprises two steps. The first step is a Screening ("broad brush") Procedure to identify areas which, in practical terms, are likely to be non-problem areas with regard to eutrophication. The second step is the Comprehensive (iterative) Procedure which enables the classification of the maritime area in terms of problem areas, potential problem areas and non-problem areas with regard to eutrophication. Following application of the Screening Procedure, the Western Irish Sea and the offshore marine areas to the north of Northern Ireland (Minch-Malin) were not considered to be eutrophic, leaving only the inshore coastal and transitional water bodies described in the WFD to be assessed via the Comprehensive Procedure.

The OSPAR Comprehensive Procedure includes a set of assessment parameters relating to nutrient enrichment (e.g. dissolved inorganic nitrogen), direct effects of nutrient enrichment (e.g. chlorophyll-a, phytoplankton, macroalgae), indirect effects of nutrient enrichment (e.g. oxygen depletion) and other effects of nutrient enrichment (e.g. algal toxins). The OSPAR Comprehensive Procedure is also designed to support harmonisation with the WFD. Although the WFD does not specifically define eutrophication, many of the parameters under the OSPAR Comprehensive Procedure are included as quality elements within the WFD.

The trophic status of transitional and coastal waters was assessed using the results of the 2018 WFD interim water body classification. This assessment was restricted only to the appropriate eutrophication quality elements. These included dissolved inorganic nitrogen (DIN), phytoplankton (including chlorophyll-a), macroalgae, angiosperms, and dissolved oxygen. It is important to note that the trophic status classification does not include all WFD quality elements and is restricted only to those that reflect trophic status.

Based on the results of the 2018 WFD classification results, the trophic status of transitional and coastal waters indicated that 58% of water bodies were high or good status, 25% were moderate status, and 17% were either poor or bad status (Table 1.38).

Table 1.38: Overall Water Framework Directive classification of eutrophication for transitional and coastal waters *(based on Dissolved Inorganic Nitrogen (DIN), phytoplankton, macroalgae, macrophytes and dissolved oxygen)*

WFD CLASS	2018 Classification	
	Number of water bodies (n=24)	%
HIGH	7	29.2%
GOOD	7	29.2%
MODERATE	6	25.0%
POOR	2	8.3%
BAD	2	8.3%

The assessment also showed that eutrophication did not appear to be an issue in coastal waters; all coastal water bodies were either good or high status (Figure 1.38). All water bodies that were classified as moderate or worse were either transitional (estuarine) waters or nearshore sea loughs such as Larne Lough South, Belfast Harbour, Belfast Lough Inner, Dundrum Bay Inner, and Carlingford Lough.

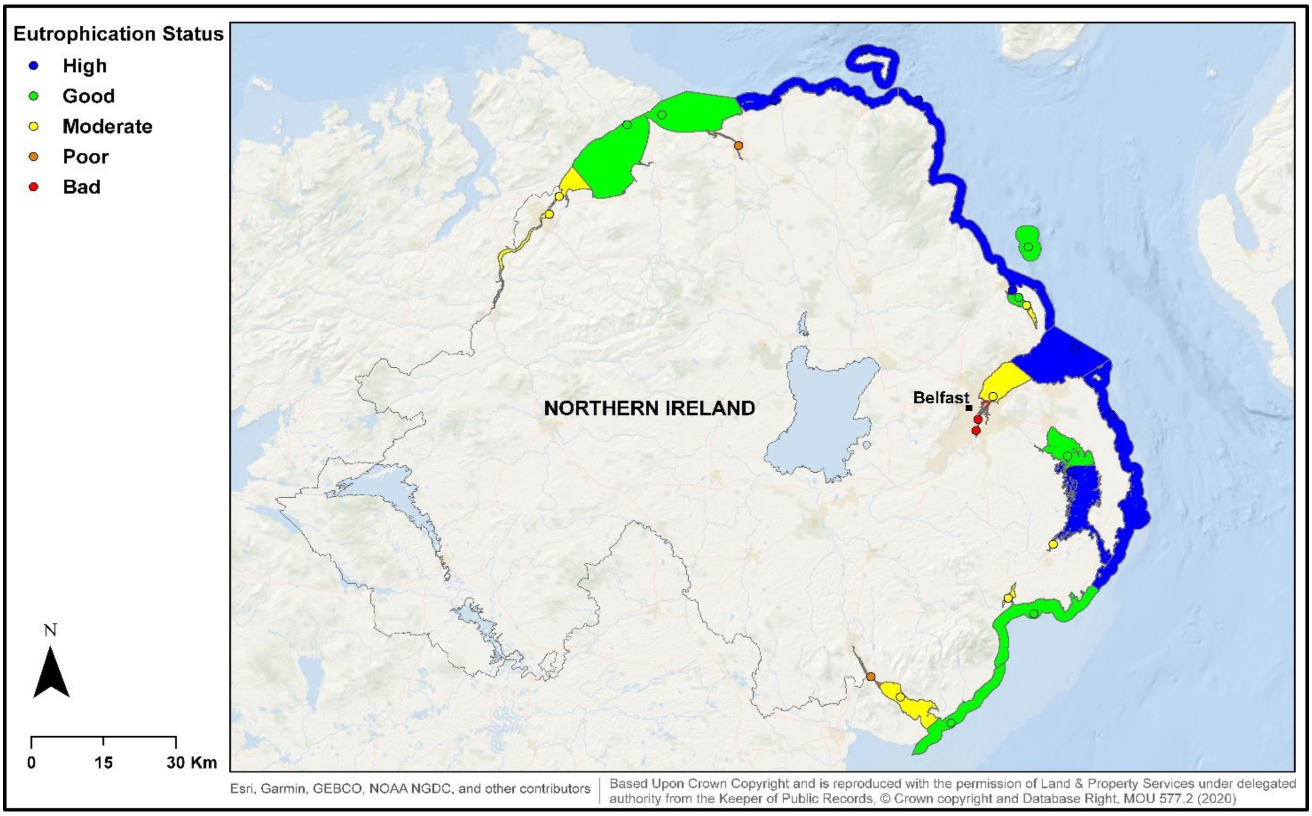

Figure 1.38: Northern Ireland water body classification based on the combination of all relevant direct and indirect eutrophication related parameters

2. Action programmes 2015-2018 and 2019-2022

The Nitrates Action Programme (NAP) is required to be reviewed and, where necessary, revised, at least every four years. There have been three NAPs implemented in Northern Ireland since 2006. Following a scientific review, public consultation and discussion with the Commission, a fourth NAP for the period 2019-2022 came into effect on 11 April 2019 through the Nutrient Action Programme Regulations (Northern Ireland) 2019 (the 2019 NAP Regulations).

This renaming from the Nitrates Action Programme to the Nutrients Action Programme is to reflect the fact that the previous stand-alone Phosphorus Regulations 2015 – 2018 are now incorporated as part of the overall Action Programme. The new name aims to increase farmer awareness on the need to also manage phosphorus inputs and the additional phosphorus controls in the new 2019-2022 NAP.

A Nitrates Derogation for Northern Ireland for the period 2019-2022 was also approved in Commission Decision EU 2019/1325 following a positive Member State vote at the Nitrates Regulatory Committee meeting in March 2019. This is the fourth derogation decision approved for Northern Ireland. Therefore the 2019 NAP Regulations were amended to include measures to allow derogation from the 170 kg/ha/year N limit up to a limit of 250 kg/ha/year N for intensive grassland farms which meet certain criteria. A summary of the measures contained in the 2019 NAP Regulations is provided at section 4.2.

3 Development, promotion and implementation of the code of good practice

3.1. The status of agriculture in Northern Ireland

Agriculture plays an important role in the Northern Ireland economy. In 2018 it accounted for approximately 1.4 % of Gross Value Added (GVA) and supports 2.8 % of civil employment in Northern Ireland. It is, therefore, proportionately almost three times as important to the local economy compared to agriculture in the overall UK economy. When food processing is included, the shares of GVA and employment in Northern Ireland rise to 3.7 % and 4.6 % respectively.

There are currently 24,827 farm businesses in Northern Ireland in 2019, of which approximately 23 % are regarded as large enough to provide full-time employment for one or more persons (based on a standardised labour requirement). Farm numbers declined steadily from 1981 until 2010 and have been relatively stable over the past 10 years (Figure 3.1). However, farm numbers increased in the years 2013, 2015 and 2017. It is estimated that 49,400 people were engaged in some form of agricultural activity in 2019, although the majority do so on a casual or part-time basis. The size of the agricultural labour force has been increasing at an annual average rate of 0.29 % over the last 10 years. There has been a stabilisation in changes to farm numbers and agricultural labour force in recent years.

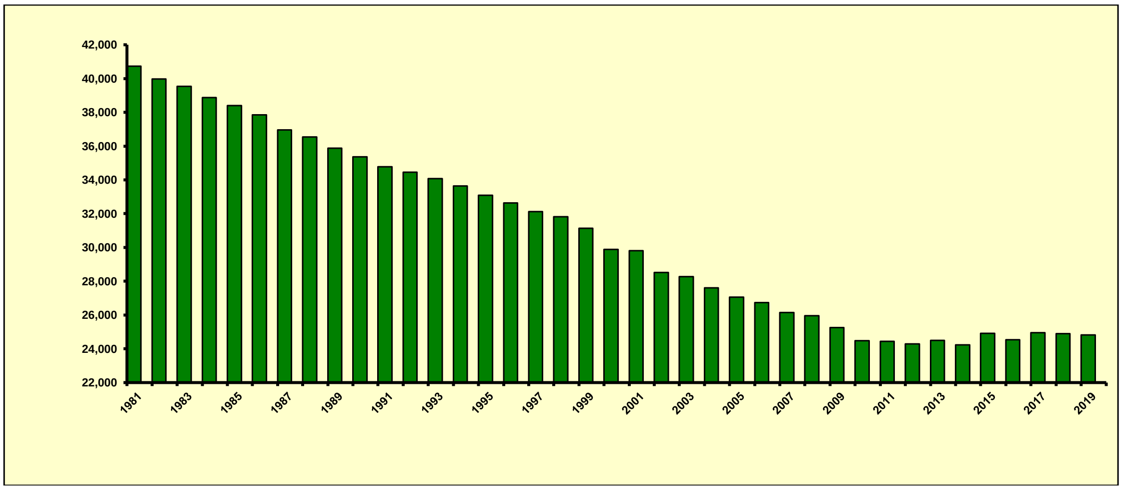

Figure 3.1 Trend in farm numbers in Northern Ireland (1981-2019)

Farms in Northern Ireland are almost entirely owner-occupied and are small by UK standards but the average area of farm businesses of 41.2 ha in 2019 is just over 2.5 times larger than the average size of EU-27 countries of 16.2 ha in 2013. Since 1990 average farm size has increased by just over 10 ha and there has been a modest reduction in the total area farmed in Northern Ireland. Although the quantity of land sold annually on the open market is small, annual leasing of land is common and facilitates both farm business expansion and contraction.

Farming in Northern Ireland is dominated by cattle and sheep production with some 89 % of farms designated as mainly dairy, beef cattle or sheep using EU farm classification typology (Table 3.1). The dominant land use is grassland. Managed or permanent grassland accounted for 79 % of the agricultural area from 2016-2019. By comparison, arable crops accounted for only 5 % of the agricultural area. The other main component of agricultural land is rough grazing, which mostly consists of upland areas of moorland and mountains with low agricultural potential. From 2016-2019 rough grazing represented 14 % of the agricultural area but would not normally be expected to receive any application of chemical fertiliser or applications of manure in the form of slurry or farm yard manure. The land areas available for such applications are taken to be the sum of the permanent grass and arable crops.

Table 3.1: Agricultural census/land use data for Northern Ireland.

	Reporting Period			
	2008-2011	**2012-2015**	**2016-2019**	**Units**
Total land area	13,600			km^2
Agricultural land	10,027	9,959	10,196	km^2
Agricultural land available for application of manure	8,409	8,395	8,516	km^2
Arable crops	565	504	461	km^2
Permanent grass	7,843	7,890	8,055	km^2
Perennial crops[a]	15	15	15	km^2
Agricultural land under Agri-environment Scheme[b]	4,545	3,780	518	km^2
Annual use of organic N from livestock manure	96,666	97,864	102,862	tonnes N per year
Annual use of organic N other than livestock manure	273	91	90	tonnes N per year
Annual use of mineral N	68,276	71,042	77,733	tonnes N per year
Number of farms[c]	24,436	24,907	24,827	
Number of farms with livestock[c]	23,516	23,817	23,646	
Cattle[d]	1,590	1,609	1,612	Thousand
Sheep	1,886	1,990	1,987	Thousand
Pigs	421	570	675	Thousand
Poultry	19,623	21,246	24,780	Thousand
Other[e]	15	14	12	Thousand

[a] *Perennial crops are orchards plus small fruit. They exclude forestry.*
[b] *Area given is a mean value for the four year period*
[c] *Numbers of farms refer to years 2011, 2015 and 2019.*
[d] *Livestock numbers include adults and young stock. There are based on the results of the annual agricultural census undertaken by the Department of Agriculture, Environment & Rural Affairs (DAERA) and available in the Statistical Review of Northern Ireland Agriculture. This is published annually by DAERA (www.daera-ni.gov.uk/publications/statistical-review-ni-agriculture-2007-onward).*
[e] *Horses (9,000) and goats (4,000).*

3.2. Nitrogen discharges to the environment

Table 3.2 summarises estimates of discharges of nitrate from land to the aquatic environment in Northern Ireland for the periods 2004-07, 2008-11, 2012-15 and 2016-19. Estimates of the diffuse losses of nitrate from agriculture were based on mean annual nitrate-N export coefficients derived using NIEA river monitoring data as explained in Section 6.3, with allowance made for changes in annual fertiliser-N and cattle excreta-N usage (50% of the latter has been assumed to be available for leaching). Human population data were taken from the Northern Ireland Statistics and Research Agency (NISRA) website to estimate the average annual domestic sewage discharge of nitrate-N for both periods. Data provided in Section 4 provide a more detailed breakdown of the amount of nitrogen applied to land and, in particular, the residue of nitrogen that is unaccounted for by the difference between inputs via fertiliser and imported feedstuffs and outputs removed in agricultural product. Agriculture is computed to be the largest source of nitrogen discharges to surface waters. This reflects the large proportion of the land area of Northern Ireland devoted to agriculture (75%) and the current level of animal production within agriculture which can lead to loss rates in the region of 20 kg N ha^{-1} $year^{-1}$ or 2 tonnes N km^{-2} $year^{-1}$. By comparison, the average human population density in the period 2016-2019 is approximately 139 persons km^{-2} which, on the basis of a per capita nitrogen loading of 2.45 kg N $person^{-1}$ $year^{-1}$ (6.7 g N $person^{-1}$ day^{-1}; Smith, 1976; Jordan & Smith, 2005), equates to an area-weighted loss of nitrogen from the human population of 0.341 tonnes N km^{-2} $year^{-1}$. There was an overall increase of 5% in the combined total nitrogen discharged resulting from a 6% increase in the agricultural component and a 2% increase in the domestic sewage (human population) component of the total.

Table 3.2: Annual mean discharges of nitrate-N to the aquatic environment by sector

	2004-07	2008-11	2012-15	2016-19	Units
Agricultural NO_3N	19199	16177	17148	18116	tonnes N per year
Domestic sewage NO_3N	4240	4386	4496	4599	tonnes N per year
Total	23439	20563	21644	22715	tonnes N per year

3.3. Code of Good Agricutural Practice (COGAP)

Table 3.3: Summary data on codes of good agricultural practice

Date of first publication – COGAP for the Prevention of Pollution of Water, Air and Soil	1999
Dates of revision	2002
	2008
Date of first publication – COGAP for Reducing Ammonia Emissions	2019

In Northern Ireland, the Code of Good Agricultural Practice (COGAP) for the Prevention of Pollution of Water, Air and Soil was developed prior to the first designation of Nitrate Vulnerable Zones in 1999. It outlined management practices for preventing pollution of water, air and soil. It was first revised and updated in 2002, comprising two booklets, one of which applied specifically to water. DARD (now DAERA) issued this to all farmers in Northern Ireland in 2003.

Following extensive consultation within Government and a 12-week public consultation period in 2007, the COGAP for the Prevention of Pollution of Water, Air and Soil was fully revised and updated to take account of the NAP Regulations and other legislation changes at the time. The most recent version was published in 2008 and outlines legislative requirements at that time for farmers regarding water, air and soil. It combines these with practical advice on management practices designed to reduce any negative impact from agricultural activities on the environment. It is reader friendly in that it is activity-based rather than guidance for a specific piece of legislation.

A further update of the COGAP for the Prevention of Pollution of Water, Air and Soil is scheduled in coming years to accommodate changes to the 2019 NAP Regulations and other relevant legislation. In the meantime, DAERA ensures that farmers are kept updated about any changes to the NAP requirements through updated NAP Guidance documents, stakeholder events, press articles, and via the DAERA website.

In addition to the COGAP for the Prevention of Pollution of Water, Air and Soil, the COGAP for Reducing Ammonia Emissions was published by DAERA in May 2019. Produced in collaboration with the farming industry, it provides farmers with a range of practical steps they can take to minimise emissions of this air pollutant. In particular, it outlines the legislative requirements of NAP in relation to the storage of organic manures, and how to apply organic manures effectively and efficiently through the use of Low Emission Slurry Spreading Equipment (LESSE).

3.4. Compliance with Code of Good Agricutural Practice

As a consequence of the total territory approach in Northern Ireland, the sections of the COGAP for the Prevention of Pollution of Water, Air and Soil relevant to livestock manure storage and nitrogen fertiliser application are incorporated into the 2019 NAP Regulations and compliance is a legal requirement for all farm businesses in Northern Ireland. In addition, the COGAP for the Reducing Ammonia Emissions section on spreading organic manure using LESSE is compulsory for farms which meet certain criteria. All NAP information literature will be reviewed, updated and re-published in 2020. Discussion on compliance with the NAP Regulations is set out in Section 5 and summarised in Table 5.2.

3.5. Factors affecting uptake of environmental measures

In the period 2016 to 2019, the DAERA College of Agriculture, Food and Rural Enterprise (CAFRE) held training workshops covering Nitrates Information, Nitrates Derogation and Nutrient Management Planning.

Successive research among agri-environment participants indicate that a significant majority of farmers value agri-environment schemes and are very willing to participate in them.

DAERA's current agri-environment climate scheme under the Northern Ireland Rural Development Programme 2014-2020 is the Environmental Farming Scheme (EFS). It was launched in 2017 and provides a range of voluntary options aimed at improving water quality, biodiversity, habitat condition and sequestering carbon.

A key feature of EFS development has been the close engagement between colleagues across the Department for Agriculture, the Environment and Rural Affairs (DAERA) (the Department) (previously two Government Departments – Department of Agriculture and Rural Affairs (DARD) and Department for the Environment (DOE) – which from the 9 May 2016 have combined to form DAERA. Information from both the original Departments has been combined spatially and has enabled much more accurate targeting of measures impacting on water quality.

EFS has two main elements. EFS (Higher) aims to improve habitat condition and biodiversity with an outcome target of 60,000 ha of environmentally designated land and priority habitat under favourable management. EFS (Wider) aims to improve biodiversity and water quality, and sequester carbon, across the wider countryside with an outcome target of creating 7,400 ha of green infrastructure.

A Sustainable Agricultural Land Management Strategy (SALMS) for Northern Ireland was produced in 2016, by an independent Expert Working Group on Sustainable Land Management. The group's aim was to outline how the ambition for a strategic land management policy could be achieved in a way which improves farm incomes and environmental performance simultaneously.

SALMS identified a series of issues in the way agricultural land is managed;
• Grass utilisation is significantly below optimal levels
• Less than 10% of farmland has an up-to-date soil analysis
• 64% of soils are not at optimum pH
• Almost 30% of agricultural land is let in Conacre, a short term arrangement which denies tenants security in their land tenure and therefore impedes long term planning

The strategy also highlighted that too many farmers associate the environment with regulation and penalties leading to a culture of fear. Instead of recognising that so much of what is good for the environment is also good for farm businesses and that the environment can be a profit centre and not just a cost centre.

In early 2018, as part of the EU Exceptional Adjustment Aid (EAA) Package. DAERA implemented a Soil Sampling and Analysis Scheme for livestock farmers in NI. The scheme provided participating farmers with free soil sampling and analysis on a field by field basis. The scheme was delivered in two components, with two sample populations:
Component A "Open Scheme" – livestock farmers across all of Northern Ireland;
Component B "Catchment Scheme" – livestock farmers within selected Sub-catchments of the Upper Bann Catchment.

A further Soil Testing and Training Initiative for farmers within targeted sub-catchments of the Colebrooke and Strule water bodies has been implemented by DAERA in 2019. The Initiative was an extension of EU Exceptional Adjustment Aid (EAA) Soil Sampling and Analysis Scheme. This was a pilot programme to help inform the potential roll-out of the Sustainable Agriculture Land Management Strategy (SALMS) recommendation for a publicly funded soil sampling and analysis survey of all agricultural land in Northern Ireland. Agri-Food and Biosciences Institute (AFBI) managed and delivered the initiative on behalf of DAERA, which provided participants with free soil sampling and analysis in order to apply nutrients in line with crop requirements. By applying organic and inorganic fertilisers as efficiently as possible, farmers can optimise crop yields and increase farm profitability, while also improving environmental performance and water quality in particular.

3.6. Other activities to reduce diffuse water pollution from agriculture

A number of other activities are carried out by public bodies, the agricultural industry and environmental non-governmental organisations to reduce diffuse water pollution from agriculture. The most substantial of these are outlined below.

3.6.1. Activities by the Department

Awareness raising- Agriculture

DAERA has produced numerous advisory articles to raise awareness of the Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil water quality issues. This publicity is ongoing and the articles coincide with seasonal activities such as slurry spreading and silage cutting to maximise their impact on protecting water quality.

DAERA Countryside Management Branch and College of Agriculture, Food and Rural Enterprise (CAFRE) published a wide range of press articles dealing with farm nutrient and waste management during the period. Using various methods of communication including local farming press, radio, DAERA & CAFRE websites and various social media platforms.

The DAERA Farm Advisory System Newsletter 'FAS News' published triannually, is an important means for the department to communicate key information on the CAP Pillar 1 (land payments) and Pillar II (Rural Development Programme) schemes to farmers. The newsletter focuses on key advisory messages, including Water Framework Directive measures and is delivered to all farm businesses applying to the Basic Payment Scheme.

Advice

From 2012 DAERA Countryside Management Delivery Branch has provided farm nutrient management and pollution control advice to farm businesses.

In April 2018 DAERA launched its new single advisory service aimed at supporting Northern Ireland's farm and food businesses. The Knowledge Advisory Service (KAS) brings together existing advisory functions provided by CAFRE along with agri-environment advisory functions formerly provided by the Department's Countryside Management Unit (CMU).

The primary role of the Knowledge Advisory Service is the holistic development of farm and food businesses, where economic and environmental performance are inextricably linked. This ensures that the productivity, environmental sustainability and resilience agendas are the primary focus. From an environmental perspective, the new service represents an opportunity for DAERA to better integrate environmental advice into its support to the agri-food sector.

The service has been enhanced by the formation of a new Sustainable Land Management Branch, based at Greenmount Campus. This environmental branch delivers Knowledge and Technology Transfer (KTT) across the key areas of air quality, biodiversity, land management and water quality. Central to this branch is the CAFRE Farm, which remains vital to the delivery of education, training and knowledge transfer to our farming industry.

Following engagement with key stakeholders, the new service encourages a partnership approach with external bodies. As the Knowledge Advisory Service develops, DAERA believes it will drive business practices and behaviours that will lead to improved productivity and profitability as well as enhanced environmental performance.

Guidance and training

In the period 2016 to 2019 CAFRE held training workshops that included coverage of Cross Compliance, Nitrates and Nutrient Management Planning.
Other training related to the NAP that took place in 2016-2019 included:

- Updates for CAFRE Development Advisers on NAP and Nitrates Derogation.
- Training for the Agricultural Consultants Association of N.I. on Nitrates Derogation and the online tools developed by NIEA for submission of manure exports, fertilisation account and derogation application forms
- Through the Family Farm Key Skills (FFKS) initiative and working in conjunction with Ai Services, CAFRE provided Nutrient Management Planning & Understanding your Soil Analysis training to farm business within the Upper Bann and Strule & Colebrook Catchments targeted under the European Area Aid Soil Sampling and Analysis Scheme.
- CAFRE Development Advisers delivered nitrates and nutrient management to almost 3000 farmers in Business Development Groups.

In addition, CAFRE Advisers and the Agri-Environment Team successfully dealt with numerous enquiries from farmers, Advisers and Consultants on nitrates related issues including the closed period, manure exports (online record submission) and nitrates derogation (online record submission).

Although not part of the EU Exceptional Adjustment Aid (EAA) Soil Sampling and Analysis Scheme, training on nutrient management planning and how to understand soil analyses was essential to ensure farmers use organic and inorganic fertilisers as efficiently as possible, to optimise crop yields and increase farm profitability, while also improving water quality in particular.

Training facilitated by CAFRE was provided under the remit of Family Farm Key Skills (FFKS) and delivered by AI Services. It was offered to all scheme participants within the Upper Bann Catchment and the Open Component of the scheme. In total 583 participants attended the 40 training courses between 5 Feb and 19 April 2018. Similarly in the Strule and Colebrooke Catchments 38 workshops were delivered between 16th January and 28th March 2019. Across the two catchment areas, 344 individual farmers attending.

Training and support for Nutrient Management and Land Management is being delivered to farmers on a sectorial basis through the Business Development Group (BDG) Programme. Approximately 3,000 farmers are participating in BDG's since their initiation in 2016. In 2019/20 the BDG sectoral approach is to be extended to include Environmental Farming BDG's, under Tranche 5 of the BDG programme. This will result in the initiation of approximately 20 additional Environmental Farming BDG's, focusing specifically on environmental issues including water quality.

Agri-environment schemes

Under the Northern Ireland Rural Development Programme (NIRDP) 2014-2020, the Environmental Farming Scheme (EFS) opened in 2017 and three intake tranches have been processed. EFS is a totally new scheme when compared with its predecessor, the Northern Ireland Countryside Management Scheme (NICMS), and earlier schemes. It is more targeted and aims to put measures in place where most environmental benefit can be delivered. The overall objectives are to protect and enhance biodiversity and water quality, and sequester carbon.

EFS has a Higher level and a Wider level. The Higher level aims to protect and enhance environmentally designated land and priority habitat by supporting farmers to implement site specific management measures. The Wider level supports farmers to create 'green infrastructure' outside of these areas, such as riparian margins, new hedgerows, native woodland and winter feed crop for wild birds.

In addition, a range of Group pilot projects support a co-ordinated approach among farmers in EFS to deliver environmental benefit on a landscape scale, for example, on environmentally designated land and within water catchments.

The water quality measures available to EFS participants in the first three tranches included 'Riparian Margins' (RM) and 'Watercourse Stabilisation with Fencing' (WSF), which aim to protect and enhance water quality, help local agriculture to meet the requirements of the WFD and support riverbank biodiversity.

Four RM options are available, incorporating 2m or 10m buffers, either with or without planted trees.

There are currently some 4,900 EFS Agreements in place after three tranches, covering approximately 49,000 hectares of land. After three tranches, 76% of EFS Wider Level agreements include at least one water quality measure, and some 186km of RMs and 2,912km of WSF have been implemented through EFS.

A fourth intake tranche of EFS will be progressed in 2020, and DAERA plans to open two more tranches in the coming years, subject to the necessary approvals.

To encourage increased uptake of the RM options, the WSF option is not available from Tranche 4 onwards.

The EFS is a voluntary scheme and successful applicants are offered a five year agreement to deliver a range of environmental measures. One of the requirements of the scheme is that all applicants must undertake training for each of the Options and Capital Items that form part of their agreement.

Catchment initiatives
Several initiatives focusing on a catchment or water body scale have been undertaken in a multi-agency approach. Input has ranged from public meetings, a planned awareness raising campaign and individual, business specific, advice to surrounding landowners.

In the first cycle of the Water Framework Directive (2009-2015) the focus was looking at the Local Management Areas (LMA) working on a catchment scale. This process worked through all the LMAs in Northern Ireland within the first WFD cycle, focusing on each LMA for a year. For that year the farms within the LMA where given an additional weighting for cross compliance visit; industries where provided with additional pollution prevention advice. Additional survey work was under taken to identify and address key pressures.

In the second cycle of the Water Framework Directive (2015-2021) efforts have been focused at a water body level. In the first half of the cycles 2015-2018 the focus was on water bodies failing to reach their WFD objective status by one element. The measures applied to these water bodies where bespoke to the failing element. Water bodies failing from nutrient related issues had an increase weighting for cross compliance visits. Additional sampling and survey work identified areas of increased nutrient loading. Where the additional loading was from farming practices this resulted in cross compliance visits to farm businesses known to be impacting on water quality. Where appropriate the catchments or sub catchments where highlighted for agri-environmental training and guidance. The catchments were also prioritized in the EFS.

Additional catchment initiatives have been delivered through the Environment Fund. This fund delivers projects within Northern Ireland aligned with the NIEA's objectives. There is one such project being delivered on the Ballinderry catchment, which is designated as a Special Area of Conservation, primarily for the Freshwater Pearl Mussel population. A key aspect of this project is to deliver agri-environment improvements within the catchment, above and beyond the measures available in the EFS. Things they would consider within these measures would be biobeds and pesticide handling areas, water gates, and means to intercept overland flow from farm yards, lanes etc.

The Trust works with farmers within the Ballinderry catchment providing advice and support drafting farm Water Environment Management Plans (WEMPs) which ensure water, slurry and farm waste are managed better, with no impact upon the Upper Ballinderry SAC.

The project will also see the SAC conservation management plan complete; two focused water body improvement efforts; an invasive control plan created and implemented within the catchment; along with a breeding and re-introduction programme for the Freshwater Pearl Mussel.

Interreg Va is delivering a number of projects that will see improvements in water quality. Catchment Care is seeking improvement is WFD status on the Blackwater, Finn and Arney catchment. This project includes looking at farm nutrient management practices within these catchments, agronomic field trials and a comparison of the Olsen P v Morgan P soil index systems in use on either side of the border. The Source to Tap project seeks to improve the raw water quality on the river Erne and Derg catchments with farms offered assistance in developing Water Environment Management Plans (WEMPS).

Other grant schemes

Through the Manure Efficiency Technology Scheme (METS), the Department provided capital grant support to farmers to encourage uptake of advanced slurry spreading equipment such as the trailing shoe system. There were three tranches of the Scheme between 2009 and 2014. In total, METS funded over 300 machines. This represents a total investment of over £7 million in advanced slurry spreading technology.

The increased nutrient efficiency from using these spreading systems results in reduced chemical fertiliser costs, lower greenhouse gas emissions and reduced risk of phosphorus run-off. They also deliver a range of other practical and environmental benefits, including flexibility in timing of slurry spreading and reduced odour.

Since 2016 DAERA has continued to provide financial support for Low Emission Slurry Spreading Equipment (LESSE) through the Farm Business Improvement Scheme (FBIS). Some £882,000 grant aid for 152 LESS systems has been provided to date under Tier 1 of the FBIS – Capital, to support the change to LESSE.

Research

The Department funds an extensive programme of research at the Northern Ireland Agri-food and Biosciences Institute (AFBI). A significant portion of this is focussed on issues related to the effect of agricultural practices on water quality. For example, there is an on-going long-term project the '*UK Environmental Change Network: Freshwater'*. In addition a number of new projects have been commissioned including: 'Factors affecting the ecological recovery of Northern Irish Fresh-waters' (costing £628,782); 'Targeted agri-environmental landscape interventions exploiting SRC willow to mitigate the negative effects of sustainable intensification on water quality, energy use and the land-use nexus' (costing £278,600); 'Decision support systems to support the management of nutrient on Northern Irish farms' (costing £242,733); and 'Monitoring and modelling of nutrient losses to water in agricultural catchments to evaluate the effectiveness of the Nutrient Action Programme (NAP) and the Environmental Farming Scheme (EFS)' (costing £4,027,407).

Awareness raising - Water Framework Directive (2000/60/EEC) (WFD)

Within Northern Ireland the strategic implementation of WFD is overseen and co-ordinated by an Inter-departmental Board. The Board had established an Implementation Working Group to co-ordinate the activities of government departments and agencies that deliver the requirements of the Directive. The implementation of the first cycle River Basin Management Plans (RBMP) 2009-2015 was taken forward through the development and implementation of 26 Local Management Area action plans over a three year rolling programme over the period 2010/2011 to 2012/2013.

Stakeholder engagement on the implementation of the RBMPs took place through a WFD Stakeholder Forum, linked to a network of nine Catchment Stakeholder Groups, which were set up by the NIEA. The Groups covered all of Northern Ireland and were open to anyone who had an interest in the water environment and were publicised through local media and email communication to key stakeholders. The Groups met twice each year in spring and autumn and representatives from agricultural organisations, as well as individual farmers, attended.

For the second cycle RBMPs (2015-2021) the stakeholder engagement was developed further. With workshops for each River Basin District looking at specific themes, coupled with an biennial conference to build capacity and inform stakeholders.

NIEA funded a part time Rivers Trust Development Officer post to promote the development of River Trusts in Northern Ireland. River Trusts deliver practical river improvements in water quality and help to raise awareness and educate the wider public on river issues. There are now six Rivers Trusts in Northern Ireland (Ballinderry, Erne, Six Mile, Lagan, Strule, and Blackwater).

Water quality improvement schemes
NIEA continues to work with stakeholders through a dedicated competitive grant scheme which was used to allocate funds to voluntary 'not for profit' bodies and local councils to support their operational work in the delivery of agreed water focused environmental objectives identified. The scheme focused on improving water quality and an understanding of water quality issue. A total of £150,000 was awarded for projects in 2012/2013 and 2013/2014. The scheme has since been integrated to a broader Environmental Challenge Fund in 2014/2015, which will relaunch again in 2020/21.

3.6.2. Activities by the agricultural industry

Voluntary agreement on phosphate reduction in livestock feed
There is a voluntary agreement with the local feed industry in Northern Ireland to lower Phosphourus (P) in livestock diets; particularly dairy and pig diets. The target for the Northern Ireland Grain Trade Association (NIGTA) was to achieve an average P level in dairy compound feed of 0.58 %. Analysis of samples by the Department indicates that the average P level in dairy compound feed is now 0.51 %.

The Voluntary Initiative to promote responsible pesticide use
The Voluntary Initiative (VI) was set up in 2001 as an industry-led partnership that works with government, regulators and stakeholders to promote the responsible use of agricultural and horticultural pesticides. Through its national groups the VI provides a UK wide framework for promoting best practice at the local level.

The VI established a National Sprayer Testing Scheme (NSTS) and a National Register of Sprayer Operators (NRoSO) to encourage adoption of best practice in pesticide handling and application. NRoSO membership is now included in the audit procedures of the major assurance schemes.

The VI works closely with other industry-led initiatives to ensure that the best possible advice is provided to farmers and sprayer operators.

3.6.3. Activities by environmental NGOs

For second cycle River Basin Management Plans (RBMPs) a new targeted approach to operational delivery will be implemented through the formation of NIEA Water Management

Unit River Basin District Groups delivering in partnership with other government agencies and stakeholders.

Environmental farming schemes will provide options for mitigating the effects of diffuse pollution to supplement regulatory controls through NAP and cross compliance. This will be faciltated by groups such as local Rivers Trusts identified in 3.6.1, and proposed cross border projects supported through INTERREG programmes.

4. Principal Measures applied in the Action Programmes

4.1 Agricultural activities, development and nitrogen assessment

This section presents a summary of trends in both the quantities of manure nitrogen (N) produced on farms in Northern Ireland and the land areas that have been available for manure applications in Northern Ireland. The basic period of comparison is the current reporting period 2016-2019 with the previous reporting period 2012-2015. For further comparison data for the period 2008-2011 are also given.

4.1.1. Livestock manure N

Between the current (2016-2019) and the previous reporting period (2012-2015), the total amount of manure N produced on farms in Northern Ireland has remained virtually unchanged, only increasing by 3.8%

Table 4.1: Livestock manure nitrogen production in Northern Ireland from cattle, sheep, pigs and poultry for 1996-1999, 2000-2003, 2004-2007, 2008–2011, 2012-2015 and 2016-2019.

	Period					
Animal category	**1996-1999**	**2000-2003**	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**
	kg N ha^{-1}					
Cattle	94.9	91.6	95.4	87.4	87.1	88.3
Sheep	21.7	18.5	16.4	15.1	15.5	15.8
Pigs	6.1	4.0	2.0	2.2	2.5	3.1
Poultry	8.4	8.2	9.0	9.5	10.6	12.9
Total manure N	**131.1**	**122.3**	**122.8**	**114.2**	**115.7**	**120.1**

Manure production has continued to be dominated by cattle with the cattle component accounting for more than 70 % of the total manure N production since 1996-1999. While N produced from sheep has stabilised, excretions from pigs and poultry have increased since the last reporting period.

Cattle and sheep are only housed for part of the year, so that only manure N produced during housing will be actively managed for crop production either as slurry or farmyard manure applications. Assuming that cattle are housed for five months of the year and sheep for one month (typically close to lambing), then the quantity of manure-N collected from housed animals, including pigs and poultry and applied to land which in 1996-1999 was 56 kg/(ha/year) N and declined to 49 kg/(ha/year) N in 2008-2011, has gradually increased again to 54 kg/(ha/year) in 2016-2019.

4.1.2 Land use

Table 4.2 illustrates that, total agricultural area, which decreased between 2008 and 2011 and 2012-2015, has since increased (by 2.4 %) in 2016-2019, and that agricultural land use continues to be dominated by managed grassland (accounting for 79 % in 2016-2019).

The area of grass under five years old has marginally increased by 4,175 ha since the last reporting period, and likewise the area of older grass (5+ years) (12,325 ha increase), whereas that under arable cropping have decreased by 4,425 ha. As a result, 8,600 ha of older grassland plus some arable land have been re-seeded with grass since the last reporting period.

This is an encouraging trend as it suggests an increased commitment by farmers to systems of livestock production relying on grass rather than on N and phosphorus (P)-containing concentrate feeds, which inflate farm N and P surpluses.

Table 4.2: Composition of agricultural land area within Northern Ireland land for 2000-2003, 2004-2007, 2008 – 2011, 2012-2015 and 2016-2019

	Period				
Land use	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2012-2015 vs. 2016-2019**
	Area (ha)				% change
Grass <5 years old	131,509	121,537	142,300	146,475	2.93
Grass 5+ years old	680,390	662,804	646,750	659,075	1.91
Grass (total)	811,899	784,341	789,025	805,525	2.09
Arable crops and horticulture	51,595	56,514	50,450	46,025	-8.77
Rough grazing	149,408	142,589	137,525	141,100	2.60
Other land*	20,941	19,246	18,862	26,825	-1.93
Total agricultural area	**1,033,843**	**1,002,690**	**995,887**	**1,019,500**	**2.37**

** For a breakdown of Other land category see Table 4.3*

Table 4.2 also illustrates that there has been small increase (12,075 ha) in the total area of crops and grass available for manure N applications. The area of land reported as rough grazing, which is typically unenclosed upland moor and mountains, also increased by 2.6 %. This category of land would not be expected to receive any fertiliser and indeed is capable of sustaining only low animal stocking rates. The components showing slight increases were the total grass and rough grazing categories. These areas increased by 2.09 % and 2.6 % respectively. A breakdown of components of the *Other land* category in Table 4.3 show a substantial 46.8% increase in woodland area which is an important and needed change and in keeping with the need to enhance biodiversity and reduce the carbon footprint of agriculture.

Table 4.3: Components of the *Other land* category of reported agricultural land within Northern Ireland land for 2004-2007, 2008-2011, 2012-2015 and 2016-2019

	Period				
Land use	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2012-2015 vs. 2016-2019**
	Area (ha)				% change
Set-aside	2,496	400	0	0	0
Woodland	9,100	10,273	10,883	15,975	+46.8
Other (e.g. buildings, roads, ponds)	9,345	8,572	7,979	10,850	+36.0
Total other land	**20,941**	**19,246**	**18,862**	**26,825**	**+42.2**

It is not entirely clear why previously a trend of lower agricultural land area was evident between the 2008-2011 and 2012-2015 reporting periods as there was no evidence of significant land abandonment or compensating expansion in land use for non-agricultural purposes. The decline in reported agricultural area observed in 2012 may have been a consequence of changes in the way that some land owners reported these short-term leasing relationships and linked to conditions associated with the operation of the Single Payment Systems which was introduced in 2005. Stabilisation in the total agricultural land area in the 2016-2019 period supports this theory.

4.2 Action programme measures

The action programme measures contained in the 2010 and 2014 NAP Regulations were detailed in the previous Article 10 report (2012-2015). As referred to in section 2.1, a revised action programme, applying to all farmers across Northern Ireland, came into operation on 11 April 2019. The 2019 NAP Regulations measures are summarised in the following subsections.

4.2.1 Closed spreading periods

- Chemical N and P fertiliser must not be applied to grassland from midnight 15 September to midnight 31 January.
- All types of chemical fertiliser must not be applied to arable land from midnight 15 September to midnight 31 January unless there is a demonstrable crop requirement.
- Organic manures, including slurry, poultry litter, digestate, sewage sludge and abattoir waste, must not be applied from midnight 15 October to midnight 31 January.
- Farmyard manure (FYM) must not be applied from midnight 31 October to midnight 31 January.
- There is no closed spreading period for dirty water.

4.2.2 Land application restrictions

Land application restrictions listed below apply to spreading of all fertilisers, including dirty water.

- All fertilisers, chemical and organic and including dirty water, must not be applied:-
  - On waterlogged soils, flooded land or land liable to flood;
  - On frozen ground or snow covered ground;
  - If heavy rain is falling or forecast in the next 48 hours;
  - On steep slopes (with an average incline of 20% or more on grassland 15% or more on all other land) where other significant risks of water pollution exist. The risk factors to be considered include the proximity to waterways/lakes, type and amount of fertiliser to be applied, soil conditions, weather forecast and time to incorporation if applied to arable land.
  - On all other land (with an incline of less than 20% for grassland or less than 15% for all other land) where significant risks of water pollution exist. The risk factors to be considered include the proximity to waterways/lakes, amount to be applied, soil conditions, weather forecast and time to incorporation if applied to arable land.
- Prevent entry of fertilisers to waters and ensure application is accurate, uniform and not in a location or manner likely to cause entry to waters.
- All types of chemical fertiliser must not be applied within 2m of any waterway.
- Organic manures including dirty water must not be applied within:-
  - 20m of lakes;
  - 50m of a borehole, spring or well;
  - 250m of a borehole used for a public water supply;
  - 15m of exposed cavernous or karstified limestone features;
  - 10m of a waterway other than lakes; this distance may be reduced to 3m where slope is less than 10% towards the waterway and where organic manures are spread by bandspreaders, trailing shoe, trailing hose or soil injection OR where adjoining area is less than 1 ha in size OR not more than 50m in width and less than 15m3 in a single application.

- Application rates:-
  - no more than 50 m^3/ha (4,500 gal/ac) or 50 tonnes/ha (20 t/ac) of organic manures to be applied at one time, with a minimum of three weeks between applications; or
  - no more than 50 m^3/ha (4,500 gal/ac) of dirty water to be applied at one time, with a minimum of two weeks between applications.
- From midnight 30 September - 15 October and during February:
  - The buffer zones for spreading slurry are increased:
    - from 10m to 15m of any waterway
    - from 20m to 30m for lakes
  - The maximum slurry application rate is reduced from 50m3 per ha (4500gal per ac) to 30m3 per ha (2700 gal per ac).
- Slurry can only be spread by inverted splashplate, bandspreaders, trailing shoe, trailing hose or soil injection.
- Dirty water to be spread by same methods as slurry and by irrigation.
- Sludgigators and upward facing splash plates must not be used.
- Low Emission Slurry Spreading Equipment (LESSE) includes bandspreading, dribble bar, trailing hose, trailing shoe, soil incorporation or soil injection methods. LESSE must be used: from 1 February 2020 for spreading anaerobic digestate, from 1 February 2021 by slurry contractors and from 1 February 2022 on cattle farms with 200 or more cattle livestock units and pig farms with a total annual livestock manure nitrogen production of 20,000 kg or more from pigs.
- Where it is not practical to spread on a field using LESSE due to slope, slurry can be spread using an inverted splash plate on that field. A record of the field number and the reason for spreading using a splash plate must be kept for inspection.

4.2.3 Livestock manure nitrogen limits

- Loading limited to 170 kg/ha/year N livestock. Farms with at least 80 % grassland may apply annually for a derogation to permit application of up to 250 kg/ha/year N from grazing livestock manure subject to certain additional criteria and conditions.

4.2.4 Nitrogen and Phosphorus Excretion Rates

- From 11 April 2019 revised nitrogen and phosphorus excretion rates for poultry production systems must be used.
- From 1 January 2020 revised nitrogen and phosphorus excretion rates for cattle must be used.

4.2.5 Nitrogen fertiliser application limits

- Maximum kg/ha/year N on grassland (apart from N in livestock manure):-
  Dairy farms* 272 ($8^1/4$ bags/ac)**
  Other farms 222 ($6^3/4$ bags/ac)**
  *More than 50 % of N in livestock manure comes from dairy cattle.
  ** Approximate number of 50 kg bags of a 27 % N type fertiliser
- When applying chemical nitrogen fertiliser, N from organic manures other than livestock manure and anaerobic digestate containing digested livestock manure must be subtracted.
- For non-grassland crops, maximum N applied (from all types of fertiliser, including livestock manure) must not exceed crop requirement, and for certain arable crops an N-Max limit applies to the total crop area.

4.2.6 High phosphorus manures

- From 1 January 2017, organic manure with more than 0.25 kg of total phosphorus (TP) per 1 kg of total N (e.g. some anaerobic digestates) can only be applied where soil analysis shows there is a crop requirement for P.

4.2.7 Phosphate Fertiliser Application Limits

- From 1 January 2020 new maximum phosphate fertiliser application rates (kg P2 O5 per ha) for extensively managed grassland (receiving under 60kg chemical N/ha/year or under 120kg manure N per ha per year loading) will apply.

4.2.8 Livestock manure and Silage effluent storage requirements

- Manure storage for pig and poultry enterprises limited to 26 weeks.
- Storage for other enterprises limited to 22 weeks.
- When certain criteria are met there are allowances for out-wintering, animals on bedded accommodation, separated cattle slurry, renting additional tanks, poultry litter and anaerobic digestate fibre stored in a midden or field heap and exporting manure to approved outlets. Livestock manure and silage effluent storage must be maintained and managed to prevent seepage or run-off.
- Silage and slurry stores constructed or substantially modified after 1 December 2003 must comply with certain construction standards (set out in the 2014 NAP Regulations) and be notified at least 28 days before they are brought into use.
- Silage bales must be stored at least 10 m from any waterway and stored and managed in such a way as to prevent seepage into the waterway.
- FYM, poultry litter and anaerobic digestate fibre:
  - May be stored in middens with adequate effluent collection facilities.
  - May be stored in a field heap where they are to be applied, for a maximum of 120 days
  - Field storage of poultry litter and anaerobic digestate fibre must be notified to NIEA prior to placement in the field.
- FYM, poultry litter and anaerobic digestate fibre field heaps must not be stored:-
  - In the same location of the field year after year;
  - Within 50m of a borehole, spring or well;
  - Within 250m of a borehole used for a public water supply;
  - Within 50m of exposed cavernous or karstified limestone features;
  - On land that is waterlogged, flooded or likely to flood.
- FYM field heaps must not be stored within 20m of any waterway and 50m of lakes.
- Poultry litter and anaerobic digestate fibre field heaps must not be stored within 100m of lakes and 40m of any waterway.
- Poultry litter and anaerobic digestate fibre field heaps must be covered with an impermeable membrane as soon as possible and within 24 hours of placement in the field.
- Provide storage for dirty water during periods when conditions for land application are unsuitable.
- From 1 January 2020 new above ground slurry stores must be sited at least 50m from waterway and fitted with a cover.

4.2.9 Land management

- From harvest of a crop other than grass until 15 January of the following year, the controller must manage the land to ensure minimum soil cover and to minimise soil erosion and nutrient run off. Residues of crops harvested late must be left undisturbed until just before sowing the following spring.

- From 1 January 2020 supplementary feeding sites must be a minimum of 20m from any waterway where there could be a significant risk of pollution occurring from their use.
- From 1 January 2022 supplementary livestock drinking points must be a minimum of 10m from any waterway where there could be a significant risk of pollution occurring from their use.

4.2.10 Additional Measures relating to derogated farms

- Annual application is required to the controlling authority for derogation.
- Annual fertilisation plan must be completed by 1 March, and kept on farm for inspection.
- Where the fertilisation plan indicates a proposal to disturb soil as part of grass cultivation, for example ploughing, there must be no application to that parcel of land of any organic manures, including FYM and dirty water, from midnight 15 October in any year to midnight 31 January of the following year.
- At least every four years, soil testing over every four hectares for must be carried out across the agricultural area of the holding under the same cropping regime and soil type.
- When available, soil analysis results must be produced during inspection.
- Annual fertilisation account must be completed and submitted to controlling authority.
- 250 kg/ha/year N limit from grazing livestock manure, 170 kg/ha/year N limit from all other livestock.
- At least 80 % of controlled agricultural area must be grassland.
- Temporary grassland is only permitted to be ploughed in spring.
- Ploughed grass is followed immediately by a crop with a high N demand.
- Crop rotation must not include leguminous or other plants fixing N except for grassland with less than 50 % clover and to areas with cereals and peas undersown with grass.
- There must not be an exceedance of a surplus of 10 kg P/ha/year on a derogated holding.
- At least 50% of slurry produced on the holding must be applied by 15th June.
- After 15th June, slurry must be applied using Low Emission Slurry Spreading Equipment (LESSE).

4.2.11 Record Keeping Requirements

Following records must be kept:-

- Agricultural area, field size and location.
- Cropping regimes and areas, Soil Nitrogen Supply (SNS) index for crops other than grassland.
- Livestock numbers, type, species and time kept.
- Organic and chemical fertiliser details including imports and exports.
- Evidence of a crop phosphate requirement from soil analysis if chemical phosphate fertiliser is applied.
- From 1 January 2017, evidence of crop P requirement from soil analysis if organic manure with over 0.25 kg TP per 1 kg total nitrogen is applied.
- From 1 January 2020 a fertilisation plan must be prepared and kept up to date by all grassland farms using chemical phosphorus fertiliser, and all farms using phosphorus rich manure e.g. some poultry manures, pig FYMs and anaerobic digestate. A soil analysis is required.
- From 1 January 2020 farms importing anaerobic digestate will require a nutrient content analysis.
- Storage capacity and, where applicable, details of rental agreements, authorisation to store poultry litter and or anaerobic digestate in field heaps and associated evidence to support allowances to reduce capacity.

- Records relating to export of organic manure to be submitted annually by 31 January of the following year and by 1 March for derogated holdings.

Records must be available for inspection by 30 June of the following calendar year and must be retained for a period of five years.

4.2.12 Cross-Compliance

The measures controlling the application of chemical phosphorus fertiliser to land are now a Cross-Compliance requirement.

4.3 Additional measures

Given that eutrophication of Northern Ireland's surface waters occurs primarily in freshwaters where P is the main contributor, the Phosphorus (Use in Agriculture) Regulations (Northern Ireland) 2006 (The Phosphorus Regulations) came into operation on 1 January 2007.

The Regulations limited the application of chemical P fertiliser to crop requirement, based upon a soil analysis, and introduced land application restrictions similar to those for N fertilisers. They also set values for P recommendations for grassland and P availabilities for organic manures. Following a review of the NAP 2015-2018, the decision was made to bring the Phosphorus Regulations under Cross Compliance to encourage farmers to make better use of P from organic manures generated on farm and only using chemical fertiliser containing P where there is a demonstrable agronomic need. Therefore the Phosphorus Regulations were incorporated into the 2019–2022 Action Programme, and it was renamed from the 'Nitrates Action Programme' to the 'Nutrients Action Programme' to better reflect the nutrient management measures both on nitrogen and phosphorus, and its objectives.

4.4 Guidance and training

To help farmers understand the requirements of the action programme and to continue to promote best working practice, DAERA has produced and are continuing to produce updated guidance information for the 2019 NAP Regulations.

The guidance documents include:-

Produced to date:

- Summary of the changes to the Nutrients Action Programme 2019-2022

In production:

- NAP 2019-2022 Guidance Booklet
- NAP 2019-2022 Workbook
- NAP Derogation Guidance Booklet 2019 – 2022
- NAP Derogation fertilisation plan
- NAP Derogation fertilisation account

These will be published on the DAERA website when available.

DAERA also continues to provide press articles, workshops and other outreach and training events to assist farmers in complying with the action programme, as well as outline tools for record keeping and fertiliser application and manure production calculations.

5. Evaluation of the implementation of the action programme measures

5.1. Statistics on farm inspections

Inspection and enforcement of the 2014 NAP Regulations and the Nutrient Action Programme Regulations (Northern Ireland) 2019 are carried out by NIEA which is also responsible for the enforcement of a range of other environmental regulations on farms. From 1 January 2007, Northern Ireland adopted a total territory approach to implementation of the ND and all farm businesses are required to comply with the NAP Regulations.

From 2005, NIEA has been the Competent Control Authority in Northern Ireland for Cross Compliance inspections for the Statutory Management Requirements (SMRs) relating to the Birds Directive (2009/147/EC), Habitats Directive (92/43/EEC), Groundwater Directive (2006/118/EC), UWWTD and ND in Northern Ireland. For each Statutory Management Requirement (SMR), NIEA selects 1 % of farm businesses claiming direct aid for annual inspection using a risk based approach. In addition, 5 % of the farm businesses operating under the NAP Regulations derogation are also inspected. Around 300 farm businesses are now selected for inspection each year.

Tables 5.1 and 5.2 present data on compliance with the NAP Regulations from the annual programme of scheduled inspections. For the current reporting period, additional data from reactive inspections made in response to referrals from other agencies, complaints from members of the public, etc., are also included. Table 5.1 shows the number of inspections, including referrals. The total number of inspections peaked in 2014 with 679 farms and was lowest in 2018 with 330 inspections being carried out as reflected respectively in the 2.1% and 1.4% inspection rates. In this reporting period 2016-2019 the total number of inspections leveled out with an annual average of 346 equating to 1.4%. The annual number of referral inspections conducted in this reporting period was 72, ranging from 91 in 2016 to 59 in 2018. All such referral reports are investigated by NIEA and enforcement action is taken when a breach of the NAP Regulations is confirmed. The great majority of these reports are substantiated, accounting for the higher rate of non-compliance reported from reactive inspections as shown in Table 5.2. All substantiated breaches (from both scheduled and reactive inspections) are also reported to DAERA, who are responsible for applying any reductions in direct aid claims under Cross Compliance.

Table 5.1: Number of farm inspections

Reporting period	2008 – 2011 All inspections	2012 – 2015 All inspections	2016 – 2019 Scheduled inspections	2016 – 2019 All inspections
Number of farm businesses visited	2008 – 466 2009 – 453 2010 – 483 2011 – 648	2012 – 605 2013 – 598 2014 – 679 2015 – 402	2016 – 274 2017 – 266 2018 – 271 2019 – 284	2016 – 365 2017 – 336 2018 – 330 2019 – 352
Percentage of relevant farm businesses visited each year	2008 – 1.2 % 2009 – 1.2 % 2010 – 1.2 % 2011 – 1.7 %	2012 – 1.5 % 2013 – 1.6 % 2014 – 2.1 % 2015 – 1.3 %	2016 – 1.1% 2017 – 1.1% 2018 – 1.1% 2019 – 1.2%	2016 – 1.4% 2017 – 1.3% 2018 – 1.4% 2019 – 1.4%

Data are the percentage of farms inspected out of the total number of claimants of direct agricultural support payments in Northern Ireland

Under the NAP Regulations farm records do not have to be available for inspection until 30 June of the following calendar year. It is, therefore, not possible to check against certain measures in year x until records are available in year x+1. It should also be noted that non-compliances are reported relating to the year of detection which is not necessarily the year of occurrence.

Table 5.2: Percentage of the inspected farm businesses compliant with the NAP Regulations

Reporting period	Compliance from all inspections: 2008 - 2011	Compliance from all inspections: 2012 - 2015	Compliance from scheduled inspections: 2016 - 2019	Compliance from all inspections: 2016 - 2019
Closed spreading periods for chemical fertiliser	2008 – 100 % 2009 – 100 % 2010 – 100 % 2011 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %	2016 – 100% 2017 – 100% 2018 – 100% 2019 – 100%	2016 – 100% 2017 – 100% 2018 – 100% 2019 – 100%
Closed spreading periods for organic manures	2008 – 100 % 2009 – 98.5 % 2010 – 100 % 2011 – 100 %	2012 – 94.5 % 2013 – 99.5 % 2014 – 100 % 2015 – 99 %	2016 – 100% 2017 – 100% 2018 – 95.6% 2019 – 98.9%	2016 – 100% 2017 – 99.4% 2018 – 96.4% 2019 – 99.1%
Land Application Restrictions	2008 – 86 % 2009 – 90.5 % 2010 – 90 % 2011 – 90 %	2012 – 97 % 2013 – 95 % 2014 – 97 % 2015 – 94 %	2016 –100% 2017 – 100% 2018 – 90.4% 2019 – 98.6%	2016 – 91% 2017 – 95.2% 2018 – 84.8% 2019 – 96.6%
Nitrogen fertilizer entering a waterway or water contained in underground strata	2008 – 89 % 2009 – 83 % 2010 – 80 % 2011 – 60 %	2012 – 75 % 2013 – 80 % 2014 – 72 % 2015 – 88 %	2016 – 97.1% 2017 – 96.2% 2018 – 91.1% 2019 – 94.4%	2016 – 78.6% 2017 – 83.9% 2018 – 79.7% 2019 – 77.8%
Nitrogen fertiliser crop requirement limits	2008 – 99.5 % 2009 – 98 % 2010 – 99 % 2011 – 98 %	2012 – 99 % 2013 – 99 % 2014 – 99 % 2015 – 99.5 %	2016 – 100% 2017 – 99.6% 2018 – 100% 2019 – 100%	2016 – 99.5% 2017 – 99.4% 2018 – 99.4% 2019 – 100%
Livestock manure nitrogen limits	2008 – 99 % 2009 – 89 % 2010 – 98 % 2011 – 97 %	2012 – 90 % 2013 – 95 % 2014 – 96 % 2015 – 97.5 %	2016 – 95.3% 2017 – 97% 2018 – 90.8% 2019 – 90.1%	2016 – 95.1% 2017 – 96.4% 2018 – 91.8% 2019 – 92%
Livestock manure storage requirements	2008 – 84 % 2009 – 84.5 % 2010 – 80.5 % 2011 – 62 %	2012 – 83 % 2013 – 82.5 % 2014 – 75 % 2015 – 87.5 %	2016 – 95.3% 2017 – 95.1% 2018 – 88.2% 2019 – 90.1%	2016 – 78.4% 2017 – 81% 2018 – 80% 2019 – 77%
Land management	2008 – 100 % 2009 – 100 % 2010 – 100 % 2011 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %	2016 – 100% 2017 – 100% 2018 – 100% 2019 – 100%	2016 – 100% 2017 – 100% 2018 – 100% 2019 – 100%
Record keeping	2008 – 92.5 % 2009 – 82 % 2010 – 93 % 2011 – 88.5 %	2012 – 91.5 % 2013 – 95.5 % 2014 – 97.5 % 2015 – 96.5 %	2016 – 99.6% 2017 – 94.4% 2018 – 93.7% 2019 – 95.8%	2016 – 98.1% 2017 – 92.6% 2018 – 94.8% 2019 – 96.6%

5.2. Commentary on points of difficulty regarding compliance

Table 5.2 shows the percentage of the inspected farm businesses compliant with NAP Regulations. Overall, compliance in most areas was good. With 100% compliance recorded for both Closed spreading periods for chemical fertiliser and land management in this and previous reporting periods. Compliance with Nitrogen fertiliser crop requirement limits was also very high averaging 99.57% in this period.

The most frequent areas of non-compliance related to water pollution, often associated with poorly managed or inadequate manure storage facilities, and exceeding livestock manure limits. Nitrogen fertiliser entering a waterway or water contained in underground strata, resulting in pollution is the most common non-compliance issue found in referral inspections.

In 2018 an increase in non-compliance relating to closed period spreading and land applications was evident which may have been due in part to a very wet late autumn. Compliance in 2018 was 84.8% compared to 95.2% and 96.6% in the year previous and following years respectively

Pollution impacts arising from discharges of farm effluents containing nitrogen were recorded on a number of referral visits, pollution signs such as fungal growths being reported by members of the public. Lower compliance rates align with wetter years, and particularly with intense rainfall coinciding with critical periods of the farming year such as silage harvesting and when storage capacity is under pressure. The opposite was true of years with low rainfall levels, resulting in improved compliance in these areas. However, pollution risk remains, and NIEA is concentrating inspection effort on priority water bodies where agricultural pressures have been identified as adversely impacting on water quality.

5.3. Measurable criteria for assessing the impact of the Nitrates Action Programme on practices in the field

A key aspect of the NAP is to improve the efficiency by which farms utilise the nutrients, particularly nitrogen, present in organic manures. By substituting nitrogen in imported chemical fertilisers with manure nitrogen, the surplus of nitrogen on farms can be lowered. As the surplus represents nutrients not exported from farms in agricultural product it can be potentially lost to the environment. The only other fate is for it to accumulate in the soil.

As part of NAP the maximum allowable chemical fertiliser/other organic manure application rate for nitrogen has been lowered from the economic optimum, to take into account the livestock manure nitrogen that is produced on farms. Therefore, by reducing the maximum rates of chemical fertiliser/other organic manure nitrogen, NAP endeavours to ensure that the full crop response potential to nitrogen in livestock manures is taken into account when planning fertiliser applications. For nitrogen, this can be achieved by optimising the timing of manures applications to avoid periods when crop response is low, and also the use of application methods that minimise losses of nitrogen to the atmosphere.

The degree by which the nitrogen surplus is being lowered can, therefore, be used as an indicator for evaluating the effectiveness of the 2019 NAP Regulations in achieving the aims of the Nitrates Directive in Northern Ireland. A secondary and related indicator is the change in nitrogen efficiency on farms. In Section 5.4, changes in the nitrogen surplus and nitrogen efficiency are presented. Given the importance of phosphorus in the eutrophication process, the effectiveness of control measures can also be assessed on a broad scale by the scale of reductions in the phosphorus surplus on farms; trends in phosphorus surplus or balance are, therefore, also presented.

The nitrogen and phosphorus balances were determined using the methodology set out by Foy, R.H., Bailey, J.S. and Lennox, S.D (2002). The balances are based on the difference between inputs of nutrients to farms in chemical fertilisers and imported feedstuffs less outputs of agricultural product that are exported from farms. In all calculations, the protein content of feedstuffs (concentrates) has been assumed to be 17 %. Inevitably the balances are positive i.e. the balance is always in surplus.

The data used are sourced from the Statistical Review of Northern Ireland Agriculture which is published each year by DAERA (www.daera-ni.gov.uk/publications/statistical-review-ni-agriculture-2007-onward). This summarises the agricultural census undertaken by the previous agricultural Department in Northern Ireland, DARD, in June of each year. In addition to data on land use and stock numbers, the Review provides statistics on inputs of fertilisers and imported feedstuffs to agriculture together with measures of agricultural outputs such as milk, meat and crops. The basic period of comparison is the current reporting period 2016-2019 with the previous reporting period 2012-2015. For further comparison data for 2000-2003, 2004-2007, and 2008-2011 are also given to highlight how nitrogen efficiency has generally improved in recent years.

5.4. Difference between input and output of nitrogen (mineral & organic)

For agriculture in Northern Ireland, time series of nitrogen inputs and outputs are plotted in Figure 5.1. Following a pronounced decline in the use of chemical nitrogen (N) fertiliser between 2003 and 2009, fertiliser N inputs have fluctuated up and down, and currently (2019) are 85 kg/(ha/year) N, 7 kg/(ha/year) N greater than in 2015..

Over the recent reporting period, the amount of nitrogen imported in feedstuffs has also marginally increased. As a consequence, the total amount of nitrogen entering the system has increased from 162 kg/(ha/year) N in 2015 to 178 kg/(ha/year) N in 2019, i.e. a 10 % increase.

However, alongside the increased nitrogen inputs, outputs of nitrogen from agriculture, which are dominated by exports of meat and milk, also increased from 41 kg/(ha/year) N in 2015 to 43 kg/(ha/year) N in 2019, and hence nitrogen efficiency within agriculture remained stable at 23 %.

The data presented in Figure 5.1 are summarised in Tables 5.3 and 5.4. Table 5.3 gives the gross amounts in tonnes nitrogen per year for N utilised and exported from agriculture in Northern Ireland as well as the N balance. The gross inputs of nitrogen to agriculture increased by 9.0 % in the current reporting period compared to the previous period causing an 8.8 % increase in the N balance, which was driven by increases in fertiliser and feedstuff N inputs. However, outputs of nitrogen also increased by 10 % and as a result N efficiency remained stable at 23 %.

The data for nitrogen inputs and outputs are also summarised in Table 5.4 but normalised to the area of crops and grass in Northern Ireland, thus giving slightly different percentage changes for the nitrogen input, output and balance compared to those in Table 5.3. The nitrogen balance increased by 7.2 % compared to the previous period, i.e. from about 130 to 139 kg/(ha/year), as a result of increase in fertiliser and feedstuff N inputs. However, it should be noted that this balance still remains substantially lower than previous peak N balances during the mid1990s which exceeded 165 kg/ha/year N.

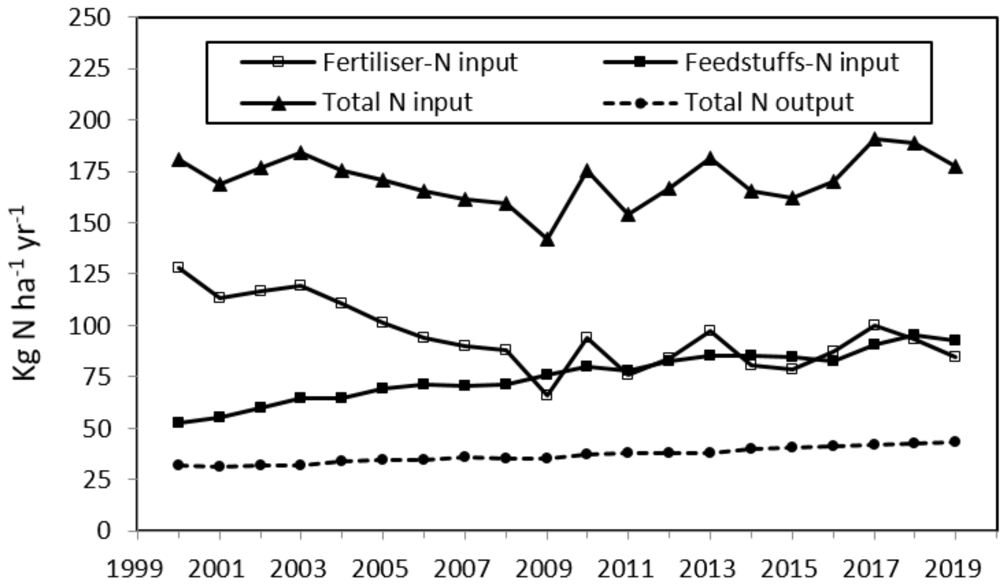

Figure 5.1 Time series of nitrogen (N) inputs and outputs for agriculture in Northern Ireland for the years 2000 to 2019

Table 5.3 Nitrogen input, output, balance and efficiency for agriculture in Northern Ireland (Inputs are purchases of N in chemical fertilisers and imported feeds while N exports are in agricultural outputs leaving farms. The balance is the difference between inputs and outputs and the efficiency is expressed as the ratio of outputs/inputs).

Period	**2000-2003**	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2016-19 vs. 2012-15**
	(tonnes N year^{-1})					(% change)
Input N						
Fertiliser N	107161	85827	68276	71042	77733	9.4
Feed N	52136	59486	64284	70813	76960	8.7
Total N inputs	159297	145313	132560	141855	154693	9.0
N outputs	28378	30074	30539	32830	36124	10.0
N balance	130919	115239	102021	109026	118569	8.8
N effic' (%)	17.8	20.7	23.1	23.2	23.4	0.9

(Inputs are purchases of N in chemical fertilisers and imported feeds while N exports are in agricultural outputs leaving farms. The balance is the difference between inputs and outputs and the efficiency is expressed as the ratio of outputs/inputs).

Table 5.4 Nitrogen (N) input, output, balance and efficiency data normalised to the area of crops and grass

Period	2000-2003	2004-2007	2008-2011	2012-2015	2016-2019	2016-19 vs. 2012-15
	(kg N ha^{-1} year-1)					(% change)
Input N						
Fertiliser N	119.5	99.1	81.2	85.1	91.3	7.3
Feed N	58.1	68.9	76.5	84.4	90.4	7.2
Total N inputs	177.6	168.0	157.7	169.0	181.6	7.5
N outputs	31.6	34.8	36.3	39.1	42.4	8.4
N balance	146.0	133.2	121.4	129.9	139.2	7.2
N efficiency (%)	17.8	20.8	23.1	23.2	23.4	1.1

Although nitrogen inputs have increased in recent years and caused dips in N efficiency in 2013 and 2017, as already noted, in the last couple of years, N inputs have begun to decline again (Figure 5.1), and N efficiency is currently 23.4 %, i.e. its highest level since 2015 (Figure 5.2).

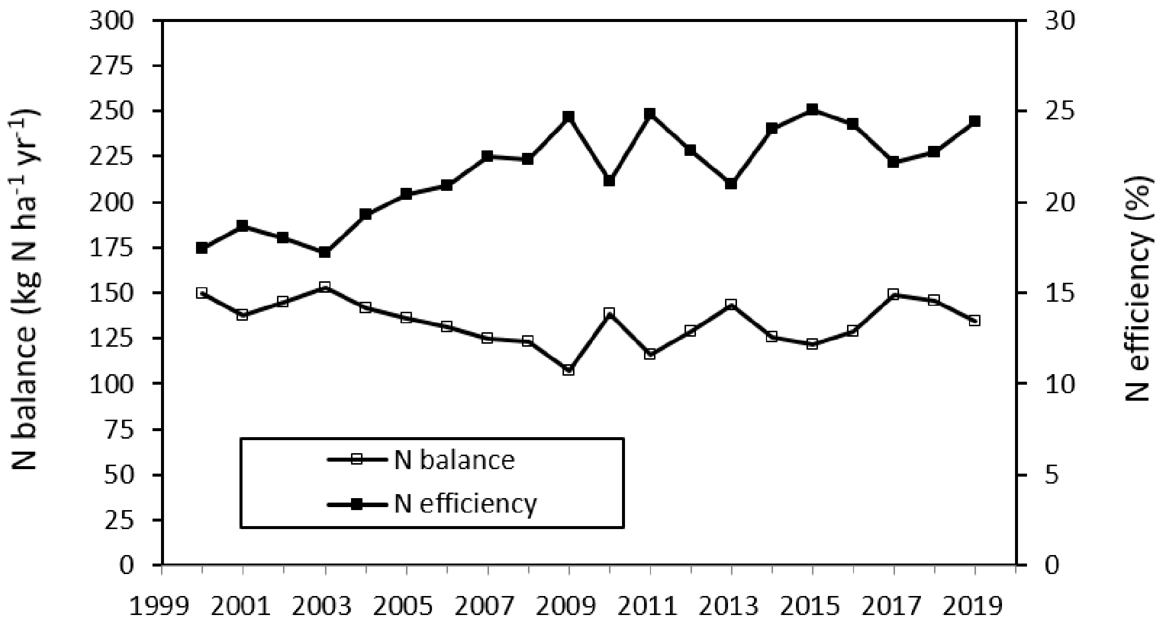

Figure 5.2 Time series of nitrogen (N) balance and efficiency for agriculture in Northern Ireland for the years 2000 to 2019. (Data normalised to the area of crops and grass)

Currently, for environmental and economic reasons, the intensive dairy and beef sectors are being encouraged to increase the amounts of meat and milk produced from grass and forage, and reduce the amounts produced from purchased concentrate feeds as means of lowering P inputs to farms. While this strategy may lead to some increases in fertiliser N inputs, i.e. to produce more grass and forage of higher protein and energy content, it should largely be offset by the concomitant reductions in feedstuff N inputs.

The need to control phosphorus (P) as well as nitrogen has also been a key message of advice, workshops and the consultative process, and is now being given greater emphasis to try to counteract a trend in increased feedstuff and fertiliser P inputs over the last few years. In autumn 2015, a major stakeholder workshop was held with farming industry representatives and various stakeholders including the supply trade to discuss and agree options for reducing farm P surpluses.

Following this workshop, a Phosphorus Working Group comprising scientists, advisors and technical experts, environmental regulators and policy makers, was established and tasked with preparing a strategy for tackling high P surpluses and high P soils. In July 2016 the group produced its draft report outlining the actions that the farming industry and the supply trade should take to correct the problems.

Figure 5.3 shows the time series of inputs and outputs of P to Northern Ireland Agriculture from 2000 until 2019. Chemical fertiliser inputs declined dramatically from 2003 and reached its lowest level since records began (ninety years ago) in 2009 (2.5 kg/(ha/year) P), but then increased again before levelling off between 4.0 and 5.0 kg/(ha/year) P in 2014-2015 and 2016-2019 (Figure 5.3). Feedstuffs P inputs which declined between 2006 and 2008 have been increasing since then, and are currently at 17 kg/(ha/year) P in 2016-2019. As a result, total P inputs are currently about 22 kg/(ha/year) P.

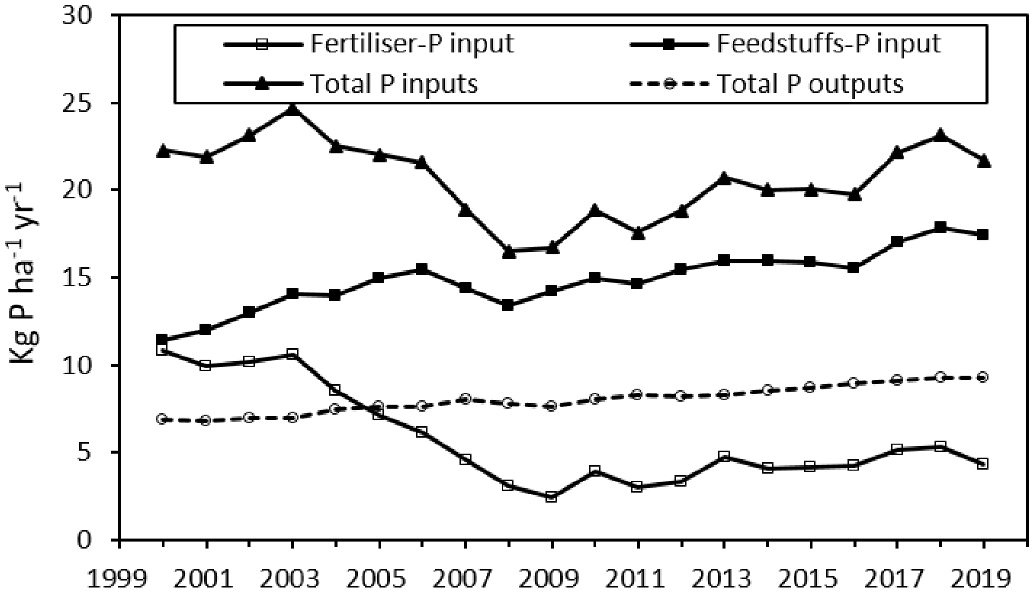

Figure 5.3 Time series of phosphorus inputs and outputs for agriculture in Northern Ireland for the years 2000 to 2019. (Data normalised to the area of crops and grass)

From 2003 to 2011, the net P balance or surplus declined from 17.7 kg/(ha/year) P in 2003 to 9.5 kg/(ha/year) P in 2011 (Figure 5.4). This decline reflects both declining inputs and small increases in outputs. As a consequence, the P efficiency for agriculture in Northern Ireland showed a very marked increase from 28 % in 2003 to 46 % in 2011. After 2011, owing to the increases in chemical fertiliser P and feedstuffs P, the P balance increased and the P efficiency is now 43% in 2019, which is still considerably better than it was just 12 years ago (Figure 5.4). However, there is still scope for improvement in P efficiency and for reductions in the agricultural P surplus or balance.

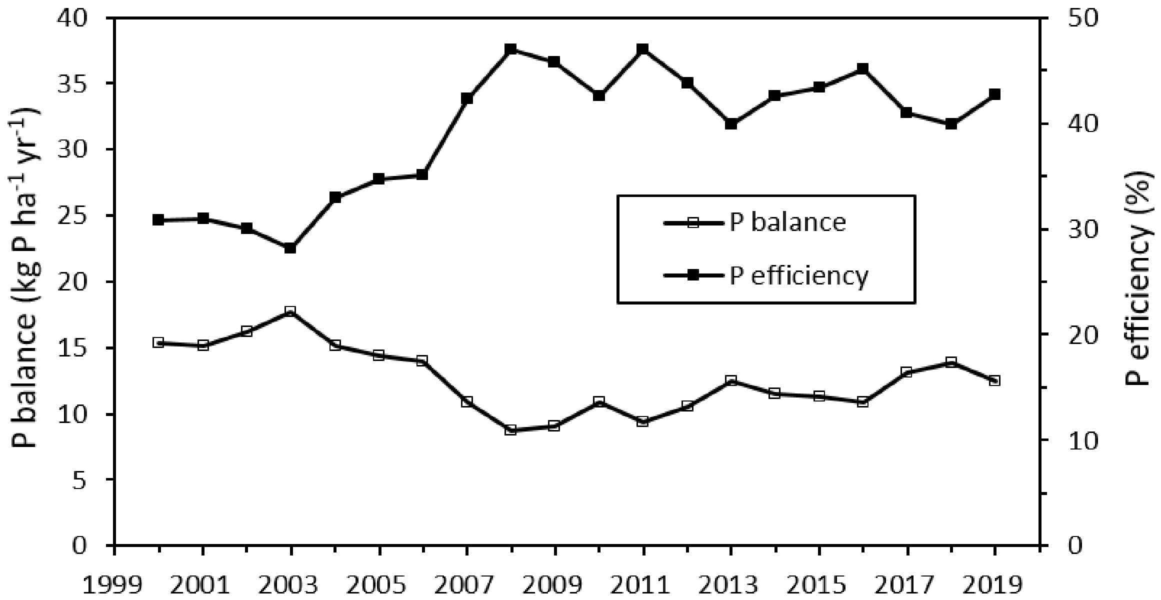

Figure 5.4 Time series of phosphorus balance and efficiency for agriculture in Northern Ireland for the years 2000 to 2019

5.5 Individual cost effectiveness studies

Some measures in the 2019 NAP Regulations go beyond the measures set out in Article 4(1) (a) and Annex III of the ND, such as the mandatory requirement for the use of Low Emission Slurry Spreading Equipment (LESSE) for farms that meet certain criteria. Therefore studies on cost effectiveness of measures under Article 5(5) of the ND are part of the 2019 Regulatory Impact Assessment (RIA) listed below.

As part of the development of the 2019 NAP Regulations, a Regulatory Impact Assessment (RIA) was carried out. This examined different options for revisions to the 2019 NAP Regulations and included analysis of costs of the different options to both the agricultural industry and the regulator and identification of qualitative and economic benefits. The finalised RIA is available at:-
http://www.legislation.gov.uk/ukia/2019/121/pdfs/ukia_20190121_en.pdf

In addition, the Northern Ireland 2019 NAP Regulations are one of the basic measures for agriculture under the Water Framework Directive (2000/60/EEC) (WFD) River Basin Management Plans (RBMP) programmes of measures. Under WFD, for the agriculture sector, additional (supplementary) measures are targeted at further reducing phosphorus levels, improving nutrient management and mechanisms to identify and target diffuse pollution in general from agricultural sources.

For the development of the second cycle of river basin management plans under WFD, the proposed additional measures were subject to an economic analysis to assist in identifying the potential costs, impacts and the benefits they might bring. The economic analysis paper is available on the DAERA website at:-
www.daera-ni.gov.uk/publications/economic-analysis-paper-programme-measures-river-basin-management-plans-2015

6. Forecasting future water quality

The ND requires Member States to extrapolate to estimate future water quality beyond the current reporting period. For this purpose a range of methods are suggested, including extrapolation of measured trends derived from current monitoring, use of data modelling integrating pressures and nitrogen flux data, and use of data from experiments, similar catchments or other sources.

6.1. Methodology for forecasting future water quality

Northern Ireland continues to develop methods to enable forecasting of water quality and estimation of recovery times. These rely on:-

- economic modelling to predict future livestock and cropping production levels;
- forecast of diffuse nitrogen loss from agricultural land; and
- forecast of water quality using statistical trend analysis.

Estimates are given in Section 6.2 of projected land use and nitrogen excretion for 2022. The latter depend on estimates of livestock numbers for 2022 which in turn are based on extrapolation of recent observed trends, adjusted to reflect the possible impact of anticipated economic and structural conditions. As a result these projections are uncertain and must be viewed as only indicative of possible outcomes for 2022.

6.2. Forecast of future agricultural land use and nitrogen (N) loading from livestock manure

In the previous 2016 Article 10 Report, the total area of agricultural land in Northern Ireland was predicted to increase by 99 km^2 between 2015 and 2019 increasing the area available for manure application by this amount. In reality, the agricultural area increased by 255 km^2, but the area available for manure application only increased by 55 km^2, since much of the increase in the agricultural area was due to expansions in rough grazing (+125 km^2), and woodland (+46 km^2) areas (Table 6.1; based on data for 2015 and 2019 taken from the DARD (now DAERA) Statistical Review of Northern Ireland Agriculture 2019). Since 2011, the total agricultural area has experienced growth, and it is likely that the 2010 and 2015 CAP reforms contributed much to this expansion. However, these reforms are unlikely to be a driver going forward, with farm gate prices more volatile than in the past and the value of subsidies reduced in real terms by inflation.

In the previous Article 10 Report, it was predicted that total Nitrogen (N) excretion by animals would only decrease by 0.4 % by 2019, whereas in reality it decreased by 1.9 %, with decreases occurring in all the main livestock sectors, the biggest decreases in the pig (11 %) and poultry (5.5 %) sectors, and the smallest decrease in the cattle sector (1.1 %).

Looking forward to 2022, results from the Food and Agricultural Policy Research Institute (FAPRI) UK model are projecting modest declines in sheep, beef and dairy cow numbers, so it is likely, that neither the total agricultural area nor the area of land available for manure application will increase above 2019 values (and may indeed decline because of Brexit). It is predicted that the total area of permanent grass, will remain relatively unchanged by 2022, but that the arable area will decline by 6% to 418 km^2.

Given that livestock numbers in bovine, sheep, pig and poultry sectors are expected to decline between 2019 and 2022, total manure N from all sectors is predicted to reach its lowest level in more than a decade, at just 96,632 tonne N per year, i.e. a 1.8% reduction on the 2019 value. So with no change expected in the area of land for spreading manure predicted, this reduction in manure N production should help to lower the risk of nitrate loss from land to water.

Currently fertiliser N usage is at a low level compared to that in the 1990s, and may need to increase if more livestock products are to be produced from grass and less from imported N and P-containing feedstuffs. Nitrate losses from land to water are directly correlated with agricultural N surpluses. Reducing feedstuff N inputs, and increasing the use of grass and forage in ruminant diets, would reduce farm N surpluses, and the amount of N excreted by animals, and thereby the risk of nitrate loss from land to water.

Table 6.1: Prediction of agricultural activities in 2023

	2015	2019	2023	Units
Total land area		13,600		km^2
Agricultural area	9,977	10,232	10,492	km^2
Agricultural area available for manure application	8,477	8,536	8,598	km^2
Change in farming practices				
Permanent pasture	8,003	8,087	8,172	km^2
Arable crops	473	449	426	km^2
N excretion by animals				
Cattle	71,132	70,383	69,215	tonnes $year^{-1}$
Sheep	17,874	17,542	17,027	tonnes $year^{-1}$
Pigs	3,499	3,107	2,968	tonnes $year^{-1}$
Poultry	7,259	6,858	6,888	tonnes $year^{-1}$
Horses + Ponies	484	504	504	tonnes $year^{-1}$
Goats	35	30	30	tonnes $year^{-1}$
Total	99,983	98,424	96,632	tonnes $year^{-1}$

6.3. Forecast of diffuse nutrient loss from agricultural land

Due to their contribution to freshwater and marine eutrophication, losses of nutrients (nitrate and phosphate) via drainage and surface runoff from agricultural sources potentially have a major detrimental impact on water quality within Northern Ireland.

Increasing efforts are being made to control nutrient losses from agriculture and the 2019 Nutrient Action Programme Regulations 2019 apply to all farms across Northern Ireland. These Regulations seek to increase efficiency of nitrogen and phosphorus use on farms and so reduce the surplus that is available for loss to water as nutrients. Under the ND, Member States are required to estimate and report the time for stabilisation or recovery of waters polluted or threatened by nitrogen pollution and eutrophication which lie wholly within their territory.

Previously, spatial data sets developed by AFBI on soil type, land cover and farming intensity were linked with 2003-2005 and 2006-2008 NIEA water quality data sets to determine seasonality in concentrations and compliance with ND standards associated with land-use in river catchments. Geo-statistical modelling techniques have developed extensively in the last 10 years or so, and analysis has been undertaken to explore changes in Nutrient Export Coefficients in recent years. This modelling now includes assessment of losses of soluble reactive phosphorus as well as nitrate.

Nutrient Export Coefficients

An analysis of regional time-series of nutrient export intensity was conducted with respect to efficacy of Nitrates Directive (ND) measures. The aims of the analysis were to:

1. Determine regional scale trends in nutrient loads and export (load per area) over the period of ND implementation
2. Determine which specific land uses are associated with changes in nutrient export, if any, and what is the magnitude of change.

Methodology

Nutrient exports from 84 river catchments were calculated by applying regression equations that relate land use to nutrient loadings using export coefficients (load per area). Different regression equations were derived for (1) Nitrate and (2) Soluble Reactive P (SRP). The CORINE land use data was used for the calculations. Two different time periods were analysed, the first from 2005-2010 and the second from 2010-2016. The breakpoint of 2010 corresponded to the implementation of stricter ND measures so it was expected that the export over the two time periods would be slightly different, with the effect of the ND measures reducing the export in the second period.

To estimate the export coefficients the multiple regression technique was used in the R statistical package where the y data corresponded to the nutrient loads from ca. 55 catchments covering the whole of the region, that had a high quality dataset comprising daily stream-flows and monthly (or more frequent) nutrient concentrations. The x data (or predictor variables) corresponded to the areas of different land uses in the catchments. The analysis aggregated the loads over the time period being considered using the flow weighted mean concentrations multiplied by the mean streamflow over the sampling interval. The form of the equations is thus:

$$L(p) = a_0 + a_1\,ALU_1 + a_2\,ALU_2 + a_3\,ALU_3 \ldots\ldots\; a_n\,ALU_n + \varepsilon$$

Where there are n land uses in the CORINE database that are considered to be important for the calculations, L(p) is the catchment nutrient load for period p (1 or 2), ALUi is the area of land use i (i=1,n) in the catchment. The coefficients a_i are unknown and are determined by the method of least squares. ε is a residual error term that reflects the component of L(p) that cannot be estimated from regression. The first term is a constant that would be expected to take the value of zero when considering nutrient export as a function of land use. A set of equations was developed for each catchments and then the equations solved together to determine the values of the coefficients (a).

Results

Table 6.2 (generated from the R statistical package) shows the Export Coefficients derived for the two time periods for nitrate and SRP. The format of the equations means that the size of the coefficient broadly indicates the intensity of the export from the area of the associated land use in the catchment, so as expected arable tended to generate the highest nitrate loads and native vegetation the lowest. Nitrate export coefficients for improved pasture fell slightly in Period 2 which may indicate that the ND was producing the desired effect of reducing export from pasture

Table 6.2: Nutrient Export Coefficients for from both Periods and the percentage changes

NO_3 Coefficients (kg N ha^{-1} yr^{-1})

Land Use	Period 1	Period 2	% Change
Arable	16.14	20.74	28.5
Improved Pasture	10.78	8.42	-21.9
Unimproved Pasture	-	5.58	-
Native Vegetation	5.46	2.75	-49.6

SRP Coefficients (kg P ha^{-1} yr^{-1})

Land Use	Period 1	Period 2	Change
Conifer	0.62	0.37	-40.3
Arable	0.74	0.75	1.4
Improved Pasture	0.47	0.56	19.1
Unimproved Pasture	0.22	0.23	4.6

For SRP arable land again had the highest export coefficient associated with it, however the export coefficient for coniferous woodland was also quite high for Period 1 but lower in Period 2. Export coefficients for Improved and Unimproved pasture also showed an increase from Period 1 to Period 2 which is interesting as the effect of the ND was intended to reduce nutrient export from pasture. Arable export coefficients for both Periods were very similar.

The equations were then used to calculate nitrate and SRP exports from each of the 84 catchments individually and the results are shown below in Table 6.3.

Table 6.3: Predicted Nutrient Exports from both Periods and changes

	Nutrient Export (tonnes)		Change in Nutrient Export from Period 1 to Period 2		
	Period 1	Period 2	(tonnes)	(kg ha^{-1})	%
Nitrate	10656	11183	527	0.31	5
SRP	556	604	48	0.03	9

The pair of maps shown in Figure 6.1, indicate that between Period 1 (2006-2010) and Period 2 (2010-2016) there was a noticeable increase in nitrate export from the south eastern catchments in Co. Down. These catchments have a higher than typical percentage of arable land, and the 25% increase in the export coefficient associated with this land use has led to this increase. Nitrate export in the other areas remained broadly the same as in Period 1 and decreased for catchments where improved pasture was the dominant land use, although the decrease was too small to be clearly detectable on the scale shown on these maps. Some examples where there was a decrease in nitrate export were the Flurry and Upper Erne catchments.

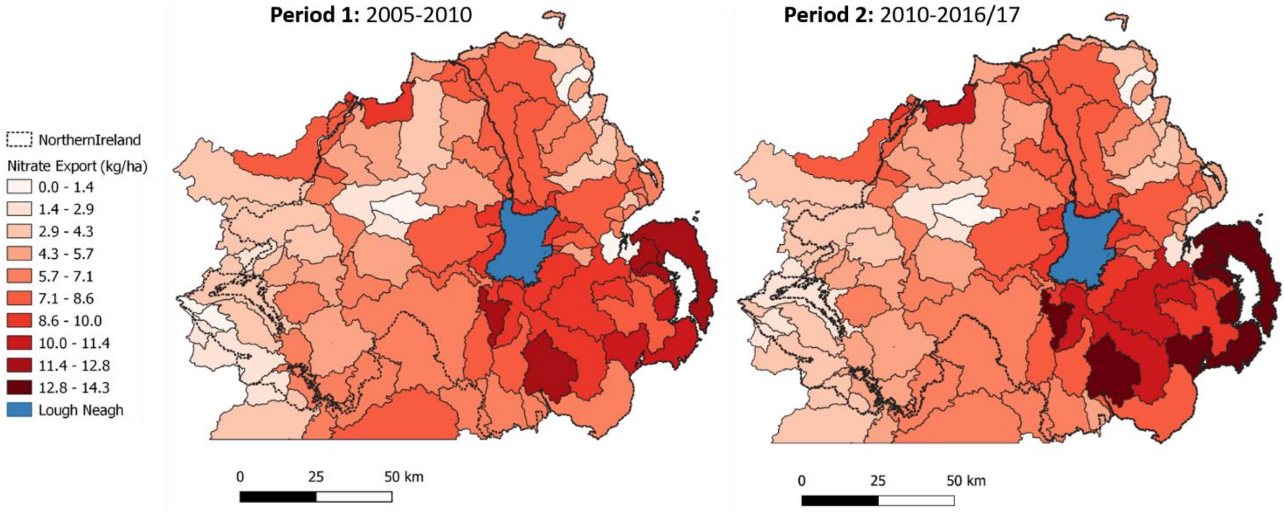

Figure 6.1 Maps showing nitrate export in 84 river catchments in NI, over two consecutive periods – Period 1 (2005-2010) and Period 2 (2010-2016).

The pair of maps shown in Figure 6.2 indicate that between Period 1 (2006-2010) and Period 2 (2010-2016) there was a noticeable increase in SRP export from most areas of NI. The increase was greatest from the south eastern catchments in Co. Down due to the fact that there is a greater percentage of arable land in these catchments than in other catchments across the region. There was also some noticeable increases in SRP export from catchments draining into Lough Neagh and the Lower Bann. The SRP export rates from the far western and trans-border catchments were relatively constant in both time periods and in a few catchments (Arney and Sillees) even decreased slightly in Period 2.

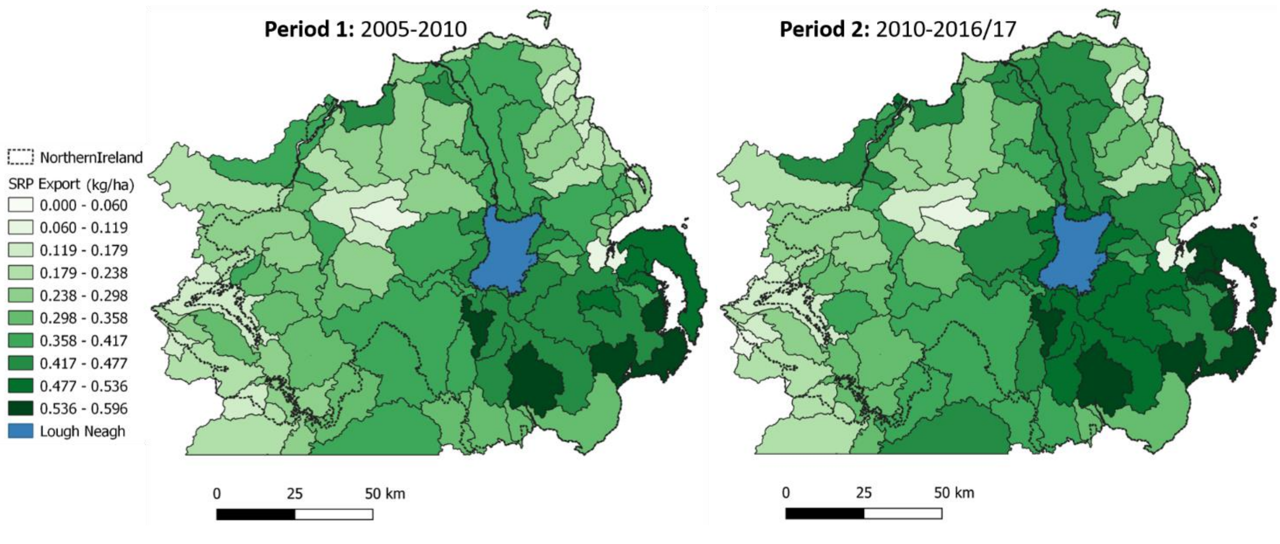

Figure 6.2 Maps showing soluble reactive phosphorus (SRP) export in 84 river catchments in NI, over two consecutive periods – Period 1 (2005-2010) and Period 2 (2010-2016).

To summarise, the implementation of the ND in NI has clearly had more effect on reducing nitrate export from the bulk of the catchments where pasture is the dominant land use than from catchments containing a significant percentage of arable land use. The picture for SRP is less encouraging as there has been an increase of around 9% in SRP loads going from Period 1 to Period 2 and this trend applied to most of the agricultural catchments.

6.4. Forecast of water quality

6.4.1. Forecast response for nitrate and phosphorus in surface freshwaters

Nitrate (NO_3 mg/l)

To enable a forecast of the future trend of nitrates in surface waters, NIEA carried out a statistical trend analysis using non-parametric Seasonal Mann-Kendall test and Theil-Sen test to predict the concentrations of nitrate of surface waters in Northern Ireland for 2023 and 2027 using long term averages from 214 and 206 monitoring sites respectively between 1992 and 2019. The methodology describing how raw surface water monitoring data was analysed to predict the concentrations of nitrate in 2023 and 2027 is shown in the Technical Annex.

Table 6.4: Nitrate concentrations (NO_3 mg/l) in surface waters: Forecast for 2023 and 2027

	% of points (NO_3 mg/l)				
	0 – 9.99	**10 – 24.99**	**25 – 39.99**	**40 – 49.99**	**> 50**
Surface water annual average in 2023 (n=214)	86.9	10.7	2.3	0	0
Surface water annual average in 2027 (n=206)	88.3	8.7	2.9	0	0

Results from trend analysis shown in Table 6.4 indicate that in 2023 97.7% and in 2027, 97.1% of average nitrate concentrations are predicted to be below 25 mg/l NO_3.

Table 6.5: Predicted trends in annual average surface water Nitrate concentrations (NO_3 mg/l) in rivers (change between 2016-2019 and 2023 and 2027).

	% of points (based on mg/l difference)				
	Strong decrease	**Weak decrease**	**Stable**	**Weak increase**	**Strong increase**
Surface water annual average in 2023 (n=210)	5.7	9.5	44.8	33.8	6.2
Surface water annual average in 2027 (n=202)	6.9	9.4	31.7	43.1	8.9

Based on mg/l difference - Strong Decrease = < -5; Weak Decrease = ≥ -5 to < -1; Stable = ≥ -1 to ≤ +1; Weak Increase = > +1 to ≤+5; Strong Increase = > +5

Information on the trend of average concentrations in rivers between 2016-2019 and 2023 and 2027 (Table 6.5 and Figures 6.3 and 6.4) indicates that there will be a 15.2 % decrease and 44.8 % stabilisation across all sites in the next four years to 2023. Predictions of trend of nitrate concentrations for 2027 indicate that 48 % of sites will show a decrease or remain stable.

It should be noted that experimental investigations have shown that short term variation in nitrate concentration in Northern Ireland reflect climatic influences on nitrate leaching, as high leaching occurs after dry summers (Watson et al., 2000a). Longer term trends have shown that peaks in nitrate concentrations occur at quite regular intervals of approximately six years and this series may reflect a climatic signal in low summer rainfall extending back to 1840. The climatic influence on river nitrate concentrations in Northern Ireland is recognised as a consideration for a long-term monitoring programme to assess the effectiveness of the action programme measures.

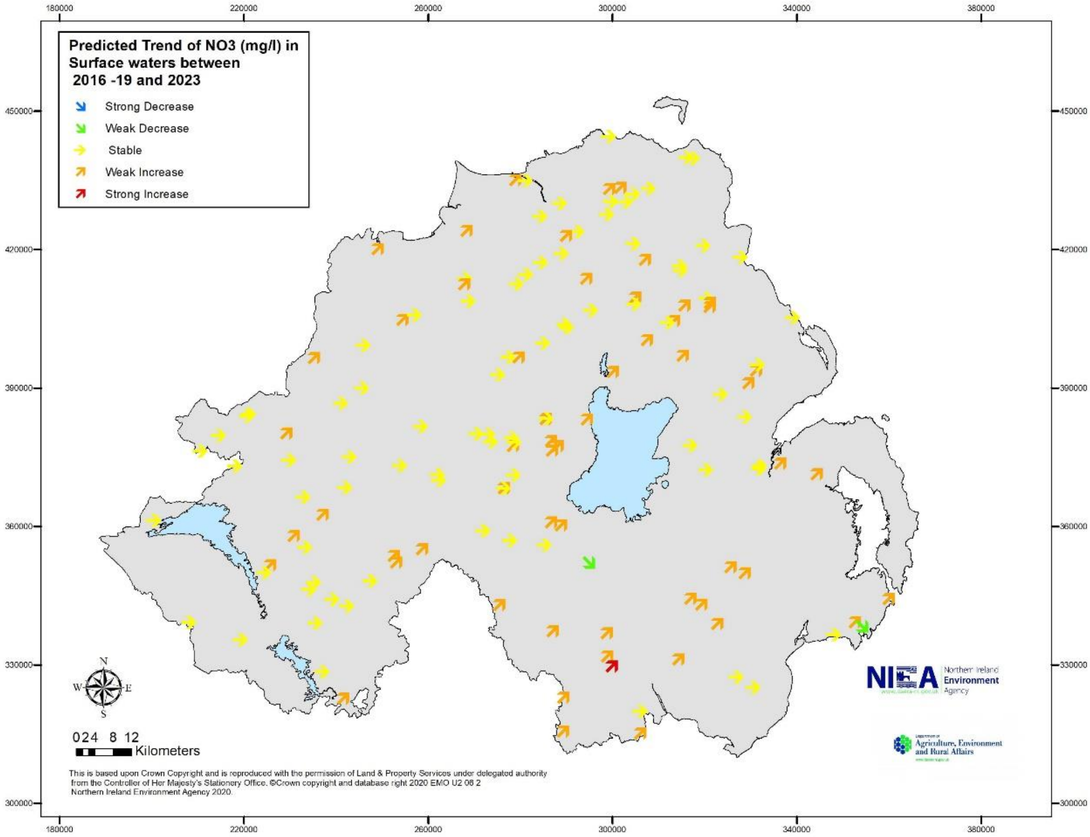

Figure 6.3: Trends of predicted Nitrate concentrations (NO_3 mg/l) in rivers between 2016-2019 and 2023

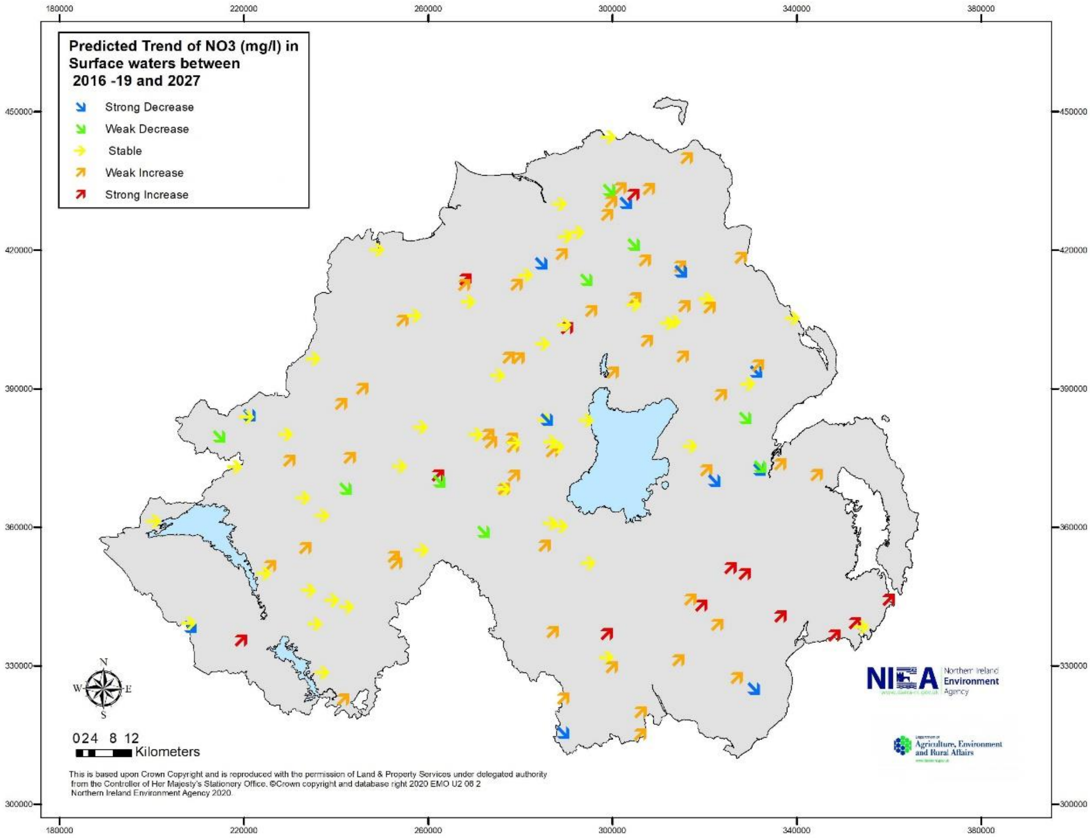

Figure 6.4: Trends of predicted Nitrate concentrations (NO_3 mg/l) in rivers between 2016-2019 and 2027

Soluble reactive phosphorus (SRP mg/l)

NIEA carried out similar statistical trend analysis using non-parametric Seasonal Mann-Kendall test and Theil-Sen test to predict the concentrations of phosphorus of rivers in Northern Ireland for 2023 and 2027 using long term averages between 1998 and 2019. Predictions for 2023 are presented for 62 monitoring stations and of these, 49 are common with the 2016-2019 reporting period. Predictions for 2027 are presented for 53 monitoring stations. Of these, 46 are common with the 2016-2019 reporting period. The methodology describing how raw surface water monitoring data was analysed to predict the concentrations of phosphorus in 2023 and 2027 is shown in the Technical Annex.

Table 6.6: WFD phosphorus classification in rivers: Forecast for 2023 and 2027

	% of points				
	High	**Good**	**Moderate**	**Poor**	**Bad**
Rivers SRP WFD classification 2023 (n=62)	27.4	29.0	38.7	4.8	0
Rivers SRP WFD classification 2027 (n=53)	24.5	26.4	41.5	7.5	0

Results from predicted trend analysis shown in Table 6.6 indicate that 56.5 % of river sites are predicted to be High or Good status for SRP classification in 2023 and 50.9 % in 2027. 43.5 % of river sites are predicted to be less than Good status for SRP classification in 2023 and 49 % in 2027.

Table 6.7: Predicted trends in WFD phosphorus classifications in rivers (change between 2016-2019 and 2023 and 2027)

	% of points				
	Strong decrease[1]	**Weak decrease**[2]	**Stable**[3]	**Weak increase**[4]	**Strong increase**[5]
Rivers SRP WFD classification 2023 (n=49)	2.0	22.4	71.4	4.1	0
Rivers SRP WFD classification 2027 (n=46)	2.2	21.7	67.4	8.7	0

[1] Strong Decrease = ≥2 improvements in class; [2] Weak Decrease = 1 improvement in class; [3] Stable = No change in class; [4] Weak Increase = 1 deterioration in class; [5] Strong Increase = ≥2 deteriorations in class

The trend of WFD phosphorus classification in rivers between the current reporting period, 2016-2019 and 2023 and 2027 (Table 6.7 and Figures 6.5 and 6.6) indicates in the next four years to 2023, there will be a 24.4 % decrease and 71.4 % stabilisation across all sites. 4.1 % of sites are expected to deteriorate by one class. Predictions of trend of phosphorus concentrations for 2027 indicate that that there will be a 23.9 % decrease and

67.4 % stabilisation across all sites. 8.7 % of sites are expected to deteriorate by one class.

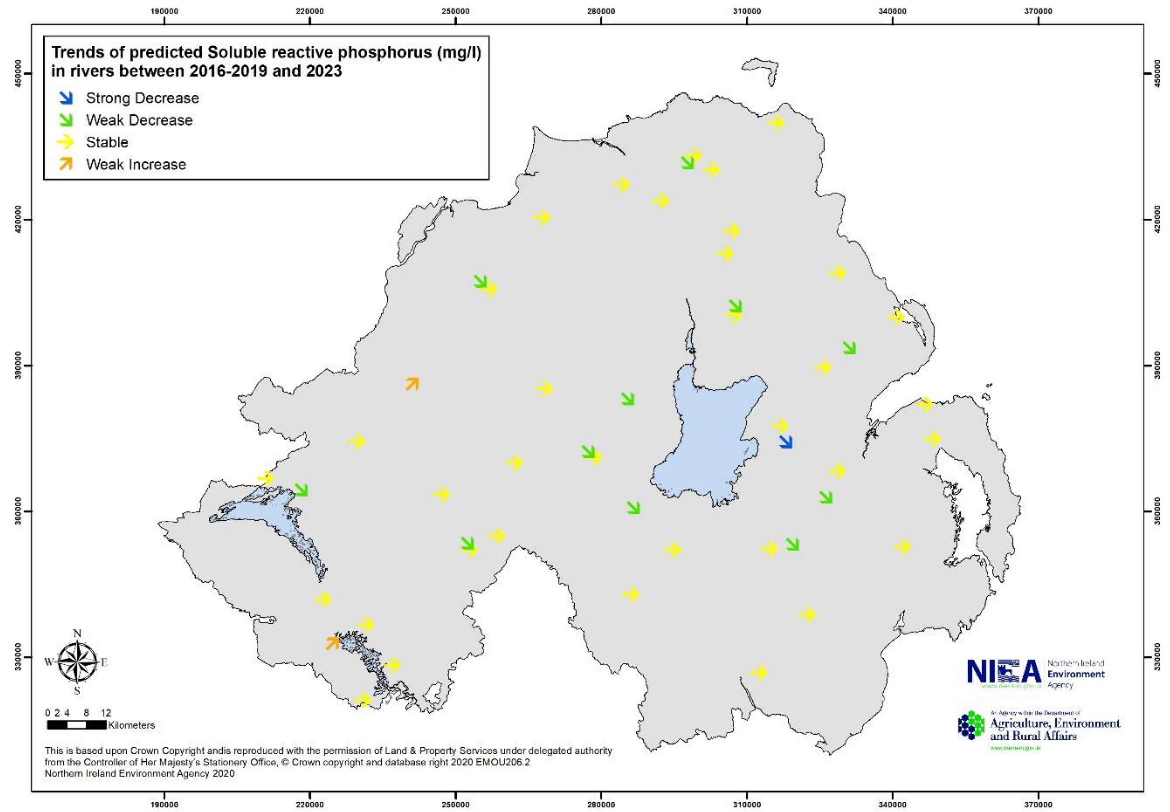

Figure 6.5: Trends of predicted Soluble Reactive Phosphorus (mg/l) in rivers between 2016-2019 and 2023

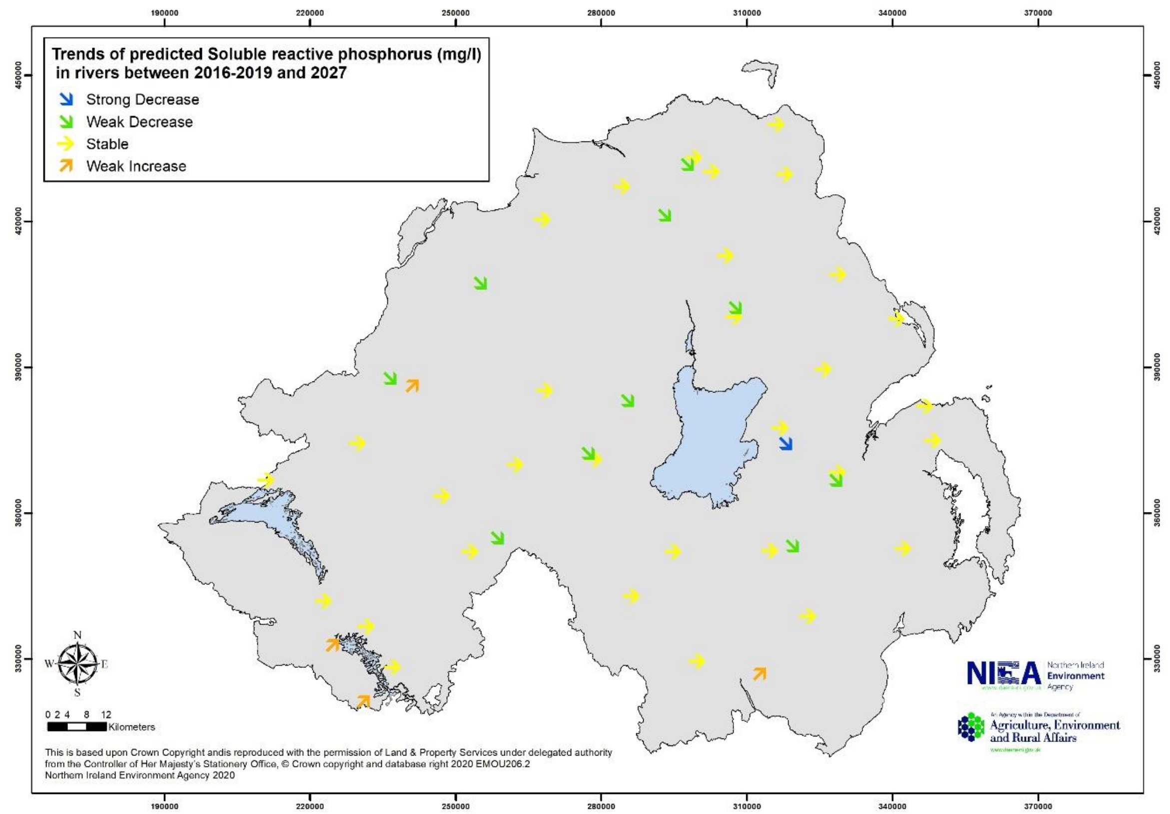

Figure 6.6: Trends of predicted Soluble Reactive Phosphorus (mg/l) in rivers between 2016-2019 and 2027

6.4.2. Forecast response for groundwaters

Forecasting of response in groundwater nitrate concentrations to changes in land use is particularly difficult in Northern Ireland given the dominance of locally discharging, shallow flow groundwater systems with relatively limited groundwater residence times. The extensive and variable cover of glacially-derived deposits, which strongly influences the vertical migration of nitrates from near surface to the underlying groundwater body, also complicates predictions.

Groundwater monitoring and results analysis to date has indicated that measured groundwater concentrations are, for the most part, below concentrations of significance (for 2014-2019 period 98 % of monitored boreholes with annual average < 25 mg/l NO_3).

To enable a forecast of the future trend nitrates in groundwater average groundwater nitrates concentrations were assessed using the Aquachem software. The software was used to establish whether the time series exhibit statistically significant trends of nitrate concentrations. The method used is described in the technical annex.

Analysis showed that the groundwater monitoring sites that were determined to have a statistically significant trend all have average and maximum nitrate concentrations below the 25 mg/l standard for the period 2014-2019. The predicted concentrations for 2020/2021 are expected to remain below the 25 mg/l value with the following exceptions:

- UKGBNIGWNE27-C Scrabo
- UKGBNIGWNE54-C Ballyhenry
- UKGBNIGWNB52-C Braeside Farm

Nitrate levels in the samples from the Scrabo source exhibit a relatively large variability with respect to their average value (which exceeds the 25 mg/l threshold by some margin). Samples from this source in the immediate future may reasonably be expected to pass the standard in their own right but will not be sufficient to reverse the currently predicted upward trend.

Nitrate levels in the samples taken from the Ballyhenry source have been increasing in a more incremental manner. Having already exceeded the standard once during 2018 it would not be reasonable to expect samples taken from this source after 2022 to be below the standard.

Recent Nitrate levels in the samples taken at Braeside farm generally exceed the standard however the overall trend as indicated by the Sen slope is slightly down. Conservatively this source may be expected to narrowly fail its next investigation but it would pass subsequent tests.

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APPENDIX – Modified Groundwater and Surface Water Monitoring Stations

Removed station	
National station code (NationalStationCode)	UKGBNIGWNB53-C
Station Type (StationType)	1a
National station name (NationalStationName)	Musgrave
Longitude	-5.9725
Latitude	54.5647
Last annual average nitrate concentrations	2012 - Annual Average Concentration = 1.062 NO3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[1]	No
Other (please specify)	No longer access for sampling
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	UKGBNIGWNE15-C
Station Type (StationType)	1a
National station name (NationalStationName)	1a
Longitude	-6.7392
Latitude	Balmoral BH1
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 0.7746 NO_3/L

[1] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	UKGBNIGWNB53-C
Station Type **(StationType)**	1a
National station name **(NationalStationName)**	Camden Glass
Longitude	-6.7832
Latitude	54.4049
Last annual average nitrate concentrations	2016 Annual Average Concentration = 0.88536 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[2]	No
Other (please specify)	No longer access for sampling
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	UKGBNIGWNB17-C
Station Type **(StationType)**	1a
National station name **(NationalStationName)**	Moypark Coolhill BH1
Longitude	-6.7392
Latitude	54.4969
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 0.7746 NO_3/L

[2] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	UKGBNIGWNW05-C
Station Type **(StationType)**	3
National station name **(NationalStationName)**	LEGLAND SPRING
Longitude	-7.8517
Latitude	54.3975
Last annual average nitrate concentrations	2012 - Annual Average Concentration = 4.869 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[3]	No
Other (please specify)	No longer access for sampling
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	UKGBNIGWNW06-C
Station Type **(StationType)**	3
National station name **(NationalStationName)**	BOHO RISING
Longitude	-7.7978
Latitude	54.3489
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 - Annual Average Concentration = 0.7636 mg NO_3/L

[3] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	UKGBNIGWNB04-C
Station Type (StationType)	1a
National station name (NationalStationName)	GLARRYFORD
Longitude	-6.3561
Latitude	54.9603
Last annual average nitrate concentrations	2012 - Annual Average Concentration = 19.744 NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[4]	No
Other (please specify)	No longer access for sampling
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type (StationType)	N/A
National station name (NationalStationName)	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[4] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10138
Station Type **(StationType)**	4
National station name **(NationalStationName)**	PARK TRIBUTARY AT PARK
Longitude	-7.0832
Latitude	54.8669
Last annual average nitrate concentrations	2013 Annual Average Concentration = 1.33 mg NO_3/L 2014 Annual Average Concentration = 2.10 mg NO_3/L 2015 Annual Average Concentration = 1.98 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[5]	Yes - Please note - This was not the reason for closure. The monitoring station was used for the Intercalibration Project and was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[5] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10210
Station Type **(StationType)**	4
National station name **(NationalStationName)**	DEERFIN BURN AT HARRYVILLE
Longitude	-6.2769
Latitude	54.8554
Last annual average nitrate concentrations	2012 Annual Average Concentration = 6.09 mg NO_3/L 2013 Annual Average Concentration = 5.11 mg NO_3/L 2014 Annual Average Concentration = 6.62 mg NO_3/L 2015 Annual Average Concentration = 6.57 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[6]	Yes - Please note - This was not the reason for closure. The monitoring station was closed and replaced by monitoring station F11472 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11472
Station Type **(StationType)**	4
National station name **(NationalStationName)**	DEERFIN BURN AT FOOTBRIDGE IN MEMORIAL PARK
Longitude	-6.2724695
Latitude	54.854492
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 5.48 mg NO_3/L 2017 Annual Average Concentration = 5.78 mg NO_3/L 2018 Annual Average Concentration = 7.63 mg NO_3/L 2019 Annual Average Concentration = 8.23 mg NO_3/L

[6] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10269
Station Type **(StationType)**	4
National station name **(NationalStationName)**	UPPER BANN BELOW MOTORWAY BRIDGE
Longitude	-6.4327
Latitude	54.4698
Last annual average nitrate concentrations	2012 Annual Average Concentration = 7.31 mg NO_3/L 2013 Annual Average Concentration = 6.56 mg NO_3/L 2014 Annual Average Concentration = 7.00 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[7]	Yes - Please note - This was not the reason for closure. The monitoring station closed in 2014 due to redelineation of river waterbodies for WFD second cycle. The monitoring station not replaced - but F10271 was redesignated the surveillance site for the new river waterbody
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[7] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10270
Station Type **(StationType)**	4
National station name **(NationalStationName)**	UPPER BANN AT SHILLINGTON BRIDGE
Longitude	-6.4404
Latitude	54.4274
Last annual average nitrate concentrations	2012 Annual Average Concentration = 7.35 mg NO_3/L 2013 Annual Average Concentration = 6.67 mg NO_3/L 2014 Annual Average Concentration = 6.98 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[8]	Yes - Please note - This was not the reason for closure. The monitoring station was Closed 2014 due to redelineation of river waterbodies for WFD second cycle. The monitoring station not replaced - but F10271 was redesignated the surveillance site for the new river waterbody.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[8] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10315
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TORRENT RIVER AT CASTLECAULFIELD
Longitude	-6.8342
Latitude	54.5072
Last annual average nitrate concentrations	2012 Annual Average Concentration = 3.35 mg NO_3/L 2013 Annual Average Concentration = 4.06 mg NO_3/L 2014 Annual Average Concentration = 4.68 mg NO_3/L 2015 Annual Average Concentration = 4.11 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[9]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to Health and Safety concerns (Giant Hogweed). It was replaced by monitoring station F11450 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11450
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TORRENT RIVER AT THE MOOR BRIDGE
Longitude	-6.6744876
Latitude	54.525596
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 8.27 mg NO_3/L 2017 Annual Average Concentration = 7.81 mg NO_3/L 2018 Annual Average Concentration = 10.13 mg NO_3/L 2019 Annual Average Concentration = 9.50 mg NO_3/L

[9] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10335
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TORRENT RIVER AT NEW BRIDGE, ANNAGHBEG
Longitude	-6.6379
Latitude	54.5063
Last annual average nitrate concentrations	2012 Annual Average Concentration = 8.66 mg NO_3/L 2013 Annual Average Concentration = 4.76 mg NO_3/L 2014 Annual Average Concentration = 6.03 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[10]	Yes - Please note - This was not the reason for closure. The monitoring station was closed 2014 due to redelineation of river waterbodies for WFD second cycle. The monitoring station was replaced by new station F11450.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11450
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TORRENT RIVER AT THE MOOR BRIDGE
Longitude	-6.6744876
Latitude	54.525596
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 8.27 mg NO_3/L 2017 Annual Average Concentration = 7.81 mg NO_3/L 2018 Annual Average Concentration = 10.13 mg NO_3/L 2019 Annual Average Concentration = 9.50 mg NO_3/L

[10] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10336
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TORRENT RIVER AT NEWMILLS BRIDGE
Longitude	-6.7404
Latitude	54.5513
Last annual average nitrate concentrations	2012 Annual Average Concentration = 7.87 mg NO_3/L 2013 Annual Average Concentration = 8.52 mg NO_3/L 2014 Annual Average Concentration = 9.14 mg NO_3/L 2015 Annual Average Concentration = 8.17 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[11]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to Health and Safety concerns (Giant Hogweed). It was replaced by monitoring station F11450 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11450
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TORRENT RIVER AT THE MOOR BRIDGE
Longitude	-6.6744876
Latitude	54.525596
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 8.27 mg NO_3/L 2017 Annual Average Concentration = 7.81 mg NO_3/L 2018 Annual Average Concentration = 10.13 mg NO_3/L 2019 Annual Average Concentration = 9.50 mg NO_3/L

[11] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10362
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BALLINDERRY RIVER AT DOORLESS NEW BRIDGE
Longitude	-6.7069
Latitude	54.6293
Last annual average nitrate concentrations	2013 Annual Average Concentration = 8.81 mg NO_3/L 2014 Annual Average Concentration = 7.91 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[12]	Yes - Please note - This was not the reason for closure. The monitoring station was moved for Health and Safety considerations (better access to site). It was replaced by monitoring station F11451 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11451
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BALLINDERRY RIVER AT ARDTREA BRIDGE
Longitude	-6.7067625
Latitude	54.629471
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 7.15 mg NO_3/L 2017 Annual Average Concentration = 7.54 mg NO_3/L 2018 Annual Average Concentration = 8.86 mg NO_3/L 2019 Annual Average Concentration = 9.50 mg NO_3/L

[12] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10447
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BURN GUSHET RIVER AT BALLYBOGY
Longitude	-6.5552
Latitude	55.1304
Last annual average nitrate concentrations	2012 Annual Average Concentration = 20.92 mg NO_3/L 2013 Annual Average Concentration = 18.73 mg NO_3/L 2014 Annual Average Concentration = 17.52 mg NO_3/L 2015 Annual Average Concentration = 19.61 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[13]	Yes - Please note - This was not the reason for closure. The monitoring station was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[13] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10661
Station Type **(StationType)**	4
National station name **(NationalStationName)**	ERNE RIVER AT ROSSCOR VIADUCT
Longitude	-8.0215
Latitude	54.476
Last annual average nitrate concentrations	2012 Annual Average Concentration = 2.14 mg NO_3/L 2013 Annual Average Concentration = 2.00 mg NO_3/L 2014 Annual Average Concentration = 2.16 mg NO_3/L 2015 Annual Average Concentration = 2.24 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[14]	Yes - Please note - This was not the reason for closure. The river monitoring station was lake influenced by Lower Lough Erne.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[14] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10681
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BANNAGH RIVER AT BANNAGH BRIDGE
Longitude	-7.7504
Latitude	54.5366
Last annual average nitrate concentrations	2012 Annual Average Concentration = 0.74 mg NO_3/L 2013 Annual Average Concentration = 0.96 mg NO_3/L 2014 Annual Average Concentration = 1.41 mg NO_3/L 2015 Annual Average Concentration = 1.45 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[15]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to Health and Safety concerns. It was replaced by monitoring station F11505 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11505
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BANNAGH RIVER AT DRUMCURREN BRIDGE
Longitude	-7.7408633
Latitude	54.546696
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 1.03 mg NO_3/L 2017 Annual Average Concentration = 0.84 mg NO_3/L 2018 Annual Average Concentration = 1.06 mg NO_3/L 2019 Annual Average Concentration = 1.20 mg NO_3/L

[15] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10712
Station Type **(StationType)**	4
National station name **(NationalStationName)**	LISNABANE BURN AT LISNABANE BRIDGE
Longitude	-7.418
Latitude	54.3493
Last annual average nitrate concentrations	2013 Annual Average Concentration = 3.64 mg NO_3/L 2014 Annual Average Concentration = 3.26 mg NO_3/L 2015 Annual Average Concentration = 2.68 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[16]	Yes - Please note - This was not the reason for closure. The monitoring station was used for the Intercalibration Project and was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[16] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10739
Station Type **(StationType)**	5
National station name **(NationalStationName)**	LOWER LOUGH MACNEAN AT CUSHRUSHEEN
Longitude	-7.8042
Latitude	54.2861
Last annual average nitrate concentrations	2012 Annual Average Concentration = 0.42 mg NO_3/L 2013 Annual Average Concentration = 2.39 mg NO_3/L 2014 Annual Average Concentration = 0.91 mg NO_3/L 2015 Annual Average Concentration = 0.43 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[17]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to Health and Safety concerns. It was replaced by monitoring station F11490 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11490
Station Type **(StationType)**	5
National station name **(NationalStationName)**	LOWER LOUGH MACNEAN AT GORTATOLE JETTY
Longitude	-7.8332845
Latitude	54.283558
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 0.42 mg NO_3/L 2017 Annual Average Concentration = 0.51 mg NO_3/L 2018 Annual Average Concentration = 0.46 mg NO_3/L 2019 Annual Average Concentration = 0.63 mg NO_3/L

[17] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10746
Station Type **(StationType)**	4
National station name **(NationalStationName)**	SILLEES RIVER AT DRUMKEEN NEW BRIDGE
Longitude	-7.6471
Latitude	54.3198
Last annual average nitrate concentrations	2012 Annual Average Concentration = 1.29 mg NO_3/L 2013 Annual Average Concentration = 1.87 mg NO_3/L 2014 Annual Average Concentration = 1.51 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[18]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to impact from effluent.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[18] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10909
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BURNFOOT TRIBUTARY AT BALLYSPALLAN
Longitude	-7.0041
Latitude	55.0544
Last annual average nitrate concentrations	2012 Annual Average Concentration = 22.31 mg NO_3/L 2013 Annual Average Concentration = 23.51 mg NO_3/L 2014 Annual Average Concentration = 23.52 mg NO_3/L 2015 Annual Average Concentration = 22.18 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[19]	Yes - Please note - This was not the reason for closure. The monitoring station was not in a >10km² river water body.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[19] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10913
Station Type **(StationType)**	4
National station name **(NationalStationName)**	AGIVEY RIVER AT BRICKHILL BRIDGE
Longitude	-6.6029
Latitude	55.0363
Last annual average nitrate concentrations	2012 Annual Average Concentration = 4.18 mg NO_3/L 2013 Annual Average Concentration = 3.30 mg NO_3/L 2014 Annual Average Concentration = 3.93 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[20]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to a review of the monitoring network. It was replaced by monitoring station F11456 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	F11456
Station Type **(StationType)**	4
National station name **(NationalStationName)**	AGIVEY RIVER AT CULLYCAPPLE BRIDGE
Longitude	-6.6067262
Latitude	55.028229
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 3.03 mg NO_3/L 2017 Annual Average Concentration = 3.88 mg NO_3/L 2018 Annual Average Concentration = 3.86 mg NO_3/L 2019 Annual Average Concentration = 4.31 mg NO_3/L

[20] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F11295
Station Type **(StationType)**	4
National station name **(NationalStationName)**	MULLYRODDAN RIVER AT MULLYRODDAN
Longitude	-6.8745
Latitude	54.4647
Last annual average nitrate concentrations	2013 Annual Average Concentration = 2.90 mg NO_3/L 2014 Annual Average Concentration = 3.57 mg NO_3/L 2015 Annual Average Concentration = 2.51 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[21]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to a review of the monitoring network and was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[21] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F11326
Station Type **(StationType)**	4
National station name **(NationalStationName)**	CALLAN RIVER AT MOY ROAD
Longitude	-6.6719
Latitude	54.3621
Last annual average nitrate concentrations	2013 Annual Average Concentration = 5.34 mg NO_3/L 2014 Annual Average Concentration = 5.61 mg NO_3/L 2015 Annual Average Concentration = 6.05 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[22]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to a review of the monitoring network and was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[22] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	ROE2
Station Type (StationType)	6
National station name (NationalStationName)	ROE ESTUARY
Longitude	-6.9865
Latitude	55.1055
Last annual average nitrate concentrations	2013 Annual Average Concentration = 2.47 mg NO_3/L 2014 Annual Average Concentration = 1.99 mg NO_3/L 2015 Annual Average Concentration = 2.94 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[23]	Yes - Please note - This was not the reason for closure. The monitoring station was closed due to a review of the WFD monitoring network. This water body was subsumed into an adjacent water body.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2012-2015 period)	
National station code (NationalStationCode)	LF3
Station Type (StationType)	6
National station name (NationalStationName)	Foyle Harbour & Faughan
Longitude	-7.2575
Latitude	55.0467
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2016 Annual Average Concentration = 11.87 mg NO_3/L

[23] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

TECHNICAL ANNEX - Water Quality Datasets

All tables of water quality information for Northern Ireland for the current reporting period 2016-2019 are presented through ReportNet and use the Excel templates downloaded from the Data Dictionary. All entries are formatted according to the Annex to the European Guidance – '*Reporting templates and formats for Geographical Information and summary tables on water quality'* and the data dictionary *'Definition of Evaluation of water quality under the Nitrates Directive (February 2012)'.*

1. Groundwater nitrates
Northern Ireland groundwater monitoring stations 2016-2019
ReportNet Location –
http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/ Nitrate_Directive_NI_Final._NiD_GW_Stat.xml

Nitrate concentrations in Northern Ireland groundwater 2008-2011
ReportNet Location –
http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/ Nitrate_Directive_NI_Final._NiD_GW_Conc.xml
and
http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate_Directive_NI_Final._NiD_GW_AnnConc.xml

This table contains the national station codes, the beginning and end dates for data sampling, the units of measurement, number of samples, annual average nitrate concentrations, maximum nitrate concentrations and the trend of average Nitrate (NO_3) based on mg/l differences between the current and previous reporting periods. Trends are only calculated for monitoring stations common to both the current and previous reporting periods and a minus symbol indicates a decrease or negative trend. Prior to calculation of summary values, raw data values which are less than the Limit of Detection (LoD) have been reported as half the LoD.

2. Surface water nitrates (rivers, lakes, drinking waters and transitional and coastal marine waters)
Northern Ireland Surface Water Monitoring Stations 2016-2019
ReportNet Location - ***http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate Directive NI Final. NiD_SW_Stat.xlm***

Nitrate concentrations in Northern Ireland surface waters 2016-2019
ReportNet Location - ***http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate Directive NI Final. NiD_SW_Conc.xlm***
and
http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate Directive NI Final. NiD_SW_AnnConc.xlm

This table contains the national station codes, the beginning and end dates for data sampling, the units of measurement, number of samples, annual average nitrate concentrations, maximum nitrate concentrations and winter average concentrations. Winter average data are based on all freshwater monitoring data collected in each year between 1 October 2016 and 31 March 2019. Winter average data are based on all marine water monitoring data collected in each year between 1 January and 31 March. The table also contains the trend of average NO_3 based on mg/l differences between the current and previous reporting periods. Trends are only calculated for monitoring stations common to both the current and previous reporting periods and a minus symbol indicates a decrease or negative trend. Prior to calculation of summary values, raw data values which are less than the LoD have been reported as half the LoD.

3. Surface waters eutrophication parameters

Eutrophication parameter concentrations in Northern Ireland surface waters 2016-2019

ReportNet Location - ***http://cdr.eionet.europa.eu/gb/eu/nid/envxsojfg/Nitrate Directive NI Final. NiD_SW_EutroMeas.xlm***

These tables contain the national station codes, the beginning and end dates for data sampling, the parameters, units of measurement, number of samples, annual average soluble reactive phosphorus (SRP), total phosphorus concentrations and summer chlorophyll-α concentrations. Summer average data are based on all monitoring data collected in each year between 1 April and 30 September. Prior to calculation of summary values, raw data values which are less than the LoD have been reported as half the LoD.

4. Datasets supporting forecasting of water quality

Surface water data 1992-2019

Trend analysis was applied to this dataset for the purposes of extrapolating water quality (nitrate and phosphorus) derived from the current surface water monitoring network identifying those surface waters which could exceed the 50mg/l NO_3 or deteriorate from High or Good Water Framework Directive (2000/60/EC) status for Soluble reactive phosphorus (SRP) if protective action is not taken. The forecasting data file contains the summary data for 689 nitrate and 650 surface water sites for the years January 1992 – December 2019.

The trend analysis was carried out using the software package “AquaChem” which provided a Seasonal Mann-Kendall derived output of trend significance and direction, a Theil-Sen test of slope with intercept along with confidence intervals and a Linear regression.

Sites were screened to ensure that a minimum of six years and 10 samples were available and that less than 80 % of values were at the limit of detection. Secondary screening of the analysis data checked that Theil-Sen and Linear regression slopes agreed within 10 %, predictive values agreed to within 10 % and Linear r squared was better than 50 % (0.5). An added check was done on the Sen’s Test predictions to ensure readings did not exceed the expected max (NO3 set to 100mg/L and SRP set to 1mg/L)

Sites were crossed checked against the Seasonal Mann-Kendall trend to confirm trend significance and direction.

Groundwater data 2014-2019

Monitoring data for all 56 stations were imported into the Aquachem software in order to establish whether the data exhibit a statistically significant upward or downward trend. Where available data were included from 2014 to 2019, but data records for some monitoring boreholes can be shorter.

The trend analysis was carried out using the software package “AquaChem” which provided a Mann-Kendall derived output of trend significance and direction, a Theil-Sen test of slope along with confidence intervals and a Linear regression. No minimum record length or sampling period was set and any result returned by Aquachem was recorded and examined.

As the fitted trend is a linear function a time to stabilisation of the present pollution cannot be calculated. The software only assesses if there is a statistically significant trend, but not if concentrations are constant or almost constant. The return ‘no trend’ applies to datasets that are too scattered to establish a trend as well as to constant datasets.