Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Federal Ministry of Food, Acriculture and Consumer Protection

Nitrates Report 2008

Joint report by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Ministry of Food, Agriculture and Consumer Protection

Imprint

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1. Preliminary remarks

In accordance with Article 10 of Council Directive 91/676/EEC (Nitrates Directive) Member States submit a report to the Commission at the end of each four-year action programme. This report must provide information on the implementation of the Nitrates Directive in Germany and in particular on the water monitoring results, codes of good agricultural practice and measures adopted in the context of the action programmes.

The 2008 Nitrates Report presented here summarises the information and data provided by Germany's regional states (*Länder*). Three thematic areas are addressed in particular:

- the development of nitrate pollution of surface waters (including coastal waters) and groundwater,
- the expected development of nitrate pollution of waters over the coming years,
- the implementation of the measures of the Nitrates Directive in the *Länder* including special water protection measures going beyond good agricultural practice.

Short summary of the main results

- With the revision of both the federal ordinance on the use of fertilisers (*Düngeverordnung,* hereinafter referred to as Fertiliser Ordinance) and the regional states' rules for manure storage systems, the Nitrates Directive has presently been fully transposed into national law.

- Nitrate pollution of surface waters and coastal waters is showing a slight downward trend.

- Similarly, nitrate concentrations in groundwater show a predominantly downward trend, especially at sampling points with previously very high nitrate concentrations. However, there are still monitoring stations at which nitrate concentrations continue to rise.

- Despite these successes, the objectives of the Nitrates Directive and the Water Framework Directive have yet to be met in many areas.

- On the basis of trend calculations and modelling it can be expected that nitrate pollution will continue to decline over the coming years.

2. Results of water monitoring

2.1 Surface waters

2.1.1 Development of nitrate pollution

Nitrate pollution of inland surface waters is subject to regular measuring at monitoring stations as part of the *Länder* network of monitoring stations. Representative summary data provided by the *Länder* were used for the evaluation. This does not preclude the possibility that regionally, and especially in smaller surface waters, loads may differ substantially and might require more far-reaching measures. However, this does not call the overall development into question. The representative selection of these monitoring stations on the basis of uniform nationwide criteria includes 153 monitoring stations (LAWA network of monitoring stations, see Appendix II). At these monitoring stations sampling is carried out at least 12 times per year and in most instances 26 times per year. The following status descriptions are based on these measurements.

In the Federal Republic of Germany, the assessment of the chemo-physical quality of waters uses a seven-level classification system to describe water quality. The chemical water quality classification (LAWA 1998) uses the following rating for nitrates:

Table 2.1: Classification of water quality with respect to nitrate-N content in mg/l

Name of substance	**Substance-related chemical water quality class**						
	I	**I - II**	**II**	**II - III**	**III**	**III - IV**	**IV**
Nitrate-N [mg/l N] [1)]	≤ 1	≤ 1.5	≤ 2.5	≤ 5	≤ 10	≤ 20	> 20
Corresponds to: Nitrate [mg/l NO_3]	*≤ 4.4*	*≤ 6.6*	*≤ 11.1*	*≤ 22.1*	*≤ 44.3*	*≤ 88.6*	*> 88.6*

The water quality map for nitrate (Fig. 2.1) gives an overview of the development of nitrate pollution of watercourses between 1997 and 2006. It shows the quality classes as established at the monitoring stations of the LAWA network. Annual characteristic values are used to assign the stations to classes; the control value is the 90th percentile (*i.e.* 90% of the readings taken in a year are lower than this value).

[2)] For surface waters it is necessary to convert to N in order to alllow for the comparison of the different nitrogen components which are subject to transformation in the ecosystem, primarily nitrate, nitrite (NO_2), ammonium (NH_4) and organic nitrogen.

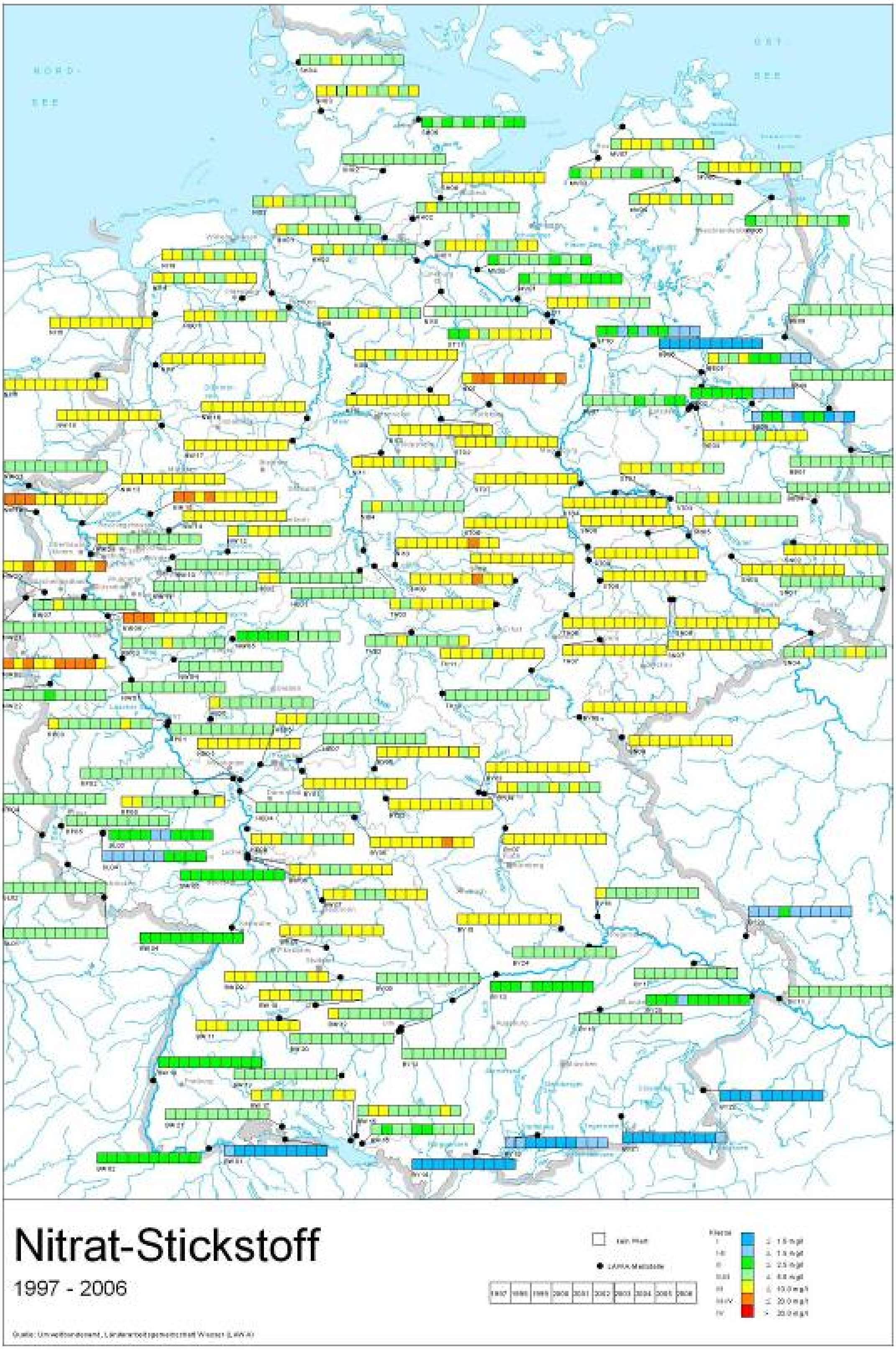


Figure 2.1: Water quality map for nitrate 1997 – 2006

Nitrat-Stickstoff = Nitrate-nitrogen

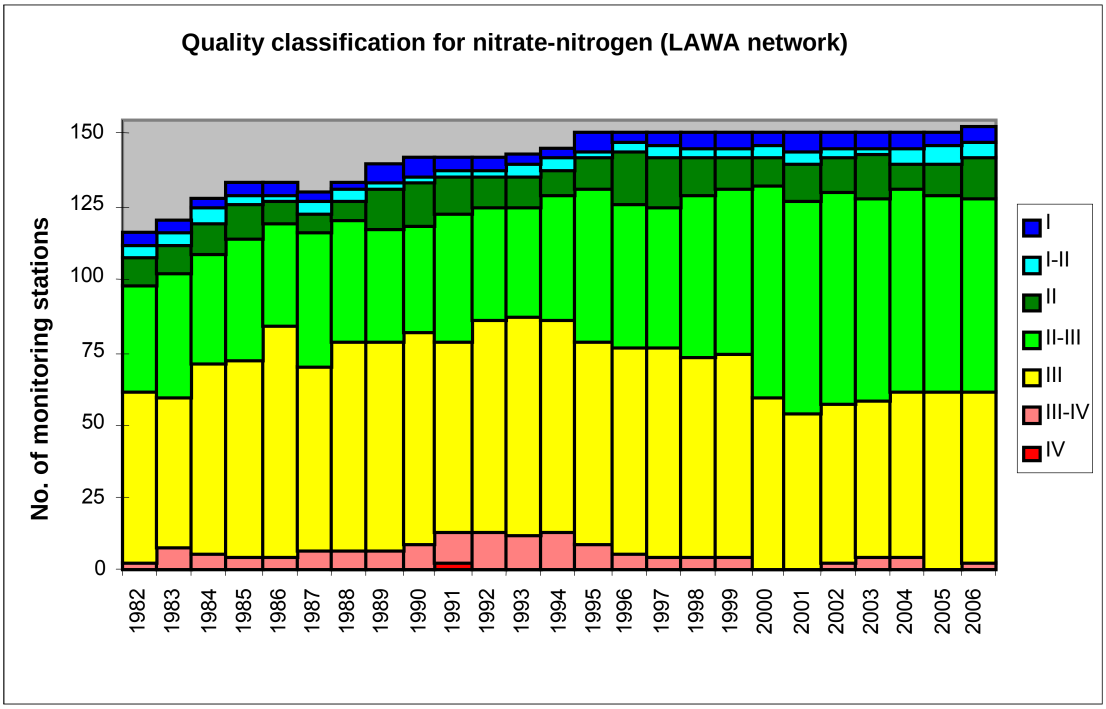


Figure 2.2: Distribution of monitoring stations by quality classes in the period 1982-2006

Figure 2.2 shows that in 2006 16% of the monitoring stations had a 90th-percentile value for nitrate-N below 2.5 mg/l N, 44% had values between 2.5 and 5 mg/l N, 39% had values between 5 and 10 mg/l N, and 2 stations had values between 10 and 20 mg/l N. Since 1994 none of the monitoring stations had 90th-percentile values of more than 20 mg/l N. The number of stations showing very high (IV) to elevated (III) levels of contamination has declined significantly since the mid-1990s. In contrast, the number of stations exhibiting moderately elevated (II-III) levels of contamination has increased significantly. The number of stations exhibiting moderate (II) to very low (I) levels of contamination has remained steady.

The Nitrates Directive's quality objective of 50 mg/l NO_3 has been met during the 2003-2006 reporting period at all monitoring stations shown. The annual mean was used as the control value.

2.1.2 Trend estimate

A trend estimate for the 153 monitoring stations is also made on the basis of the 90th-percentiles. Under the climatic and hydrological conditions in Germany higher nitrate concentrations occur during winter. Therefore, this approach is consistent with the proposal in the development guide to use winter averages.
In order to minimise the influence of fluctuations of nitrate concentrations due to runoff, the 90th-percentiles of the years 1991-1994 and 2003-2006 respectively were averaged. The averages in the two reporting periods were compared and the results grouped by percentage deviation from the 1991-1994 reporting period.
For nine monitoring stations the underlying data for the 1991-1994 reporting period were insufficient. Therefore, for these nine monitoring stations, and divergent from all other monitoring stations, the comparison was made using the average of the 90th-percentiles of the years 1995-1998. The results of the evaluation are given in Figure 2.3 and Tables 2.2-2.7 (see Appendix). The tables also contain the 2006 90th-percentiles depicted in the colour of the associated quality class.

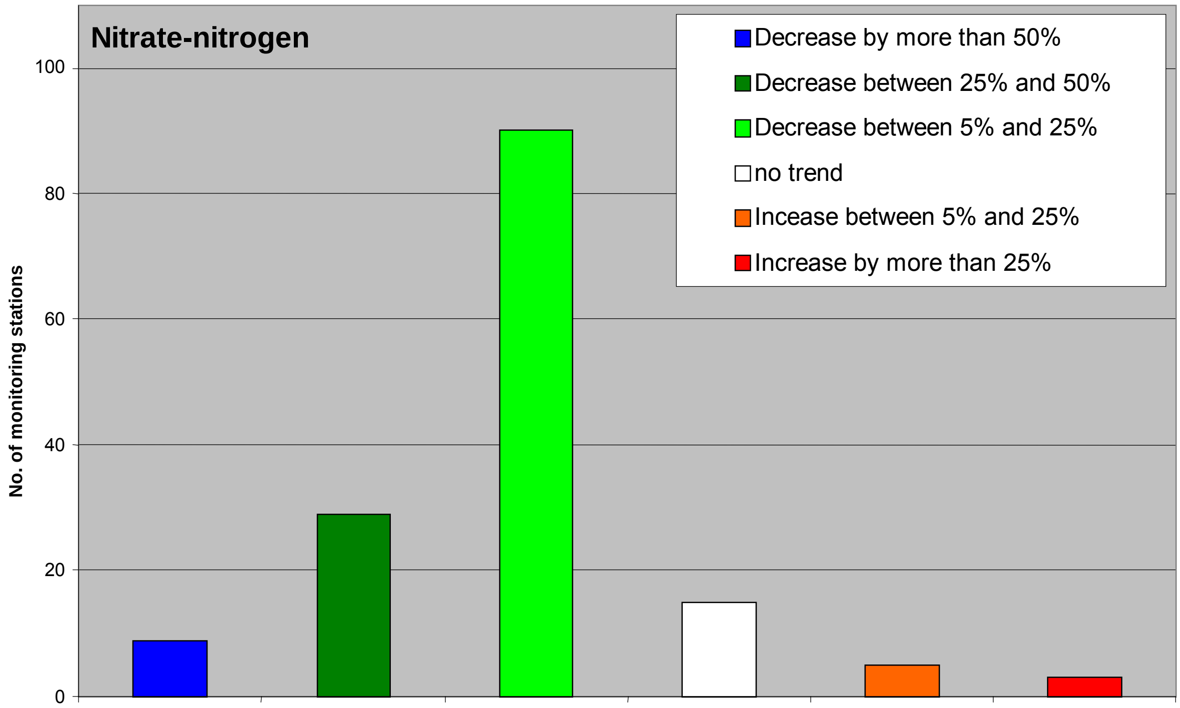


Figure 2.3: Changes in nitrate concentrations in surface waters in Germany 2003-2006 compared to 1991-94 (Basis: LAWA network of monitoring stations; averages of 90th-percentiles of the years)

Figure 2.3 and Tables 2.2-2.6 show a slight or clear reduction of contamination at the majority of monitoring stations: Approximately 85% of monitoring stations of the LAWA network show a downward trend while at approx. 10% of monitoring stations the nitrate load has remained steady and at 5% of the stations there has been a greater or lesser increase (see also Tables 2.11 and 2.12).
The causes of the reduction in contamination have already been explored in detail in the notification submitted at the end of the First Action Programme (see November 2000 report, Section 2.1.3 and Appendix I). Analyses of both pollution loads (*ibid.* Appendix I, Part A1) and emissions (*ibid.* Appendix I, Part A2) showed independently of each other that the reductions are predominantly due to measures implementing Council Directive 91/271/EEC concerning urban wastewater treatment. Newer emission analyses also confirm this result for the current reporting period (see Chapter 2.1.3).
Amongst the five monitoring stations where there has been an increase in contamination of between 5% and 25% there are two reference monitoring stations (Altbach/ Nonnweiler, Prims/ Nonnweiler). Similarly amongst the three monitoring stations where there has been an increase in contamination of more than 25% there are two reference monitoring stations (Große Ohe/ Taferlruck, Sieg/ Netphen). The increase in nitrate concentrations at the reference monitoring stations comes, in part, from a very low previous level (see also Appendix II). The catchment areas of the reference monitoring stations contain a high proportion of forestry without any direct municipal or industrial inputs. Therefore the anthropogenic input of nitrogen is solely due to aerial deposition and precipitation. In Germany, emissions of reactive nitrogen compounds are due to agriculture (50% at present, remaining constant) and combustion processes in energy generation, transport and traffic (50% at present, declining; Source: UBA, Data on the Environment 2000).

The remaining monitoring stations which show an increase in nitrate contamination are in part located in the “new” *Länder* of the former German Democratic Republic. The cause of the increases is likely due to the expansion of biological treatment in sewage treatment plants. Previously insufficiently treated wastewater contained higher levels of ammonium, which are now discharged as nitrates or to a lesser extent denitrified to gaseous nitrogen.

2.1.3 Analysis of nitrogen sources

Detailed emission estimates are available for the periods of 1983-87, 1993-97, 1998-2002 and 2002-2005 for the eight most important input pathways into surface waters in 165 catchment areas in Germany (see Figure 2.4 and Table 2.8). According to these data, approximately 75% of the nitrogen load entered surface waters through pathways supplied mostly by agricultural lands, *i.e.* groundwater, drainage water, particle runoff and erosion. The groundwater pathway was the most important one, providing more than 50 % of the load. The total emissions had declined continuously, more than 40 % compared to the mid-1980s and by about 15 % compared to the last reporting period. The decline was particularly evident with regard to point-sources. The slight increase in groundwater-borne loads in the 1998-2000 period compared to 1993-1997 was due to higher flow rates.

The declines in nitrogen discharges and nitrate concentrations in watercourses are thus roughly in agreement.

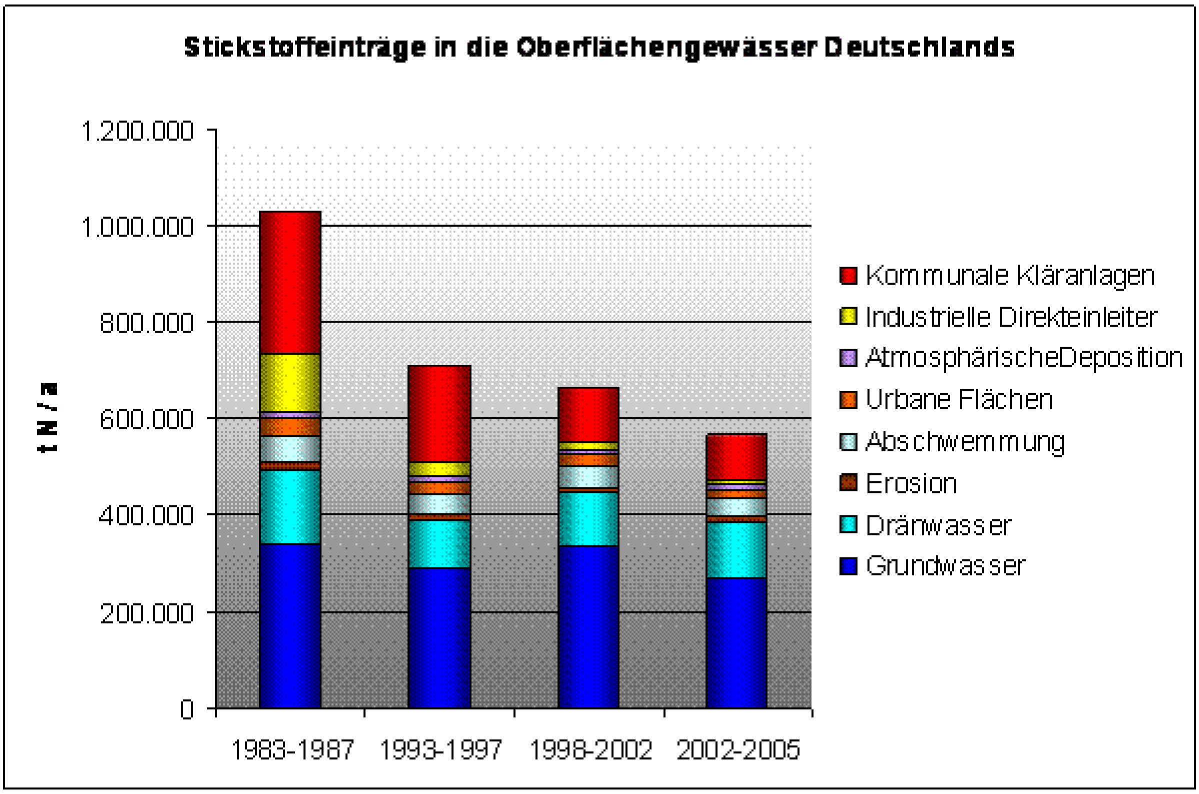


Figure 2.4: Nitrogen discharges to surface waters in Germany 1983-2005 (Source: Umweltbundesamt, Behrendt et al. (IGB Berlin))

Stickstoffeinträge in ..= Nitrogen emissions to surface waters in Germany
Kommunale K …= Municipal sewage treatment plants
Industrielle D… = Industrial direct discharge
Atmosphärische D… = Atmospheric deposition
Urbane F… = Urban areas
Abschwemmung = Particle runoff
Erosion = Erosion
Dränwasser = Drainage water
Grundwasser = Groundwater

Table 2.8: Nitrogen discharges to surface waters in Germany 1975-2005

NITROGEN DISCHARGES TO WATERCOURSES		1983-1987	1993-1997	1998-2002	2002-2005
		in t/a	in t/a	in t/a	in t/a
Diffuse discharges (incl. background load)	Groundwater	340,560	287,250	334,430	268,620
	Drainage water	156,130	103,300	111,610	118,610
	Erosion	11,900	11,220	11,580	10,430
	Particle runoff	53,430	40,960	44,560	37,280
	Natural background load	32,090	29,330	32,410	27,010
	Agriculture	429,840	328,100	370,790	335,770
	Urban areas	39,650	26,730	21,850	16,520
	Atmospheric deposition	14,840	12,270	12,490	11,780
Total diffuse discharges		616,510	481,730	536,520	463,240
Discharges from point sources	Industrial direct discharge	119,620	29,140	13,920	9,650
	Municipal sewage treatment plants	294,990	196,730	114,450	91,890
Total discharges from point sources		414,610	225,870	128,370	101,540
Totals		1,031,120	707,600	664,890	564,780

2.1.4 Chlorophyll

Monitoring of chlorophyll concentrations aims to identify algal growth caused by eutrophication and document the effects of countermeasures (*e.g.* reduction in nutrients).

Algal growth in German inland waters is primarily limited by phosphate concentrations. In highly supplied or turbid waters further limits are imposed by temporary or constant lack of light. Nitrogen becomes a limiting factor only temporarily in some waters during midsummer. However, these conditions often lead to blooms of blue-green algae which take up nitrogen from the air. Algal growth is also influenced by weather conditions while ecosystem effects (*e.g.* change of species) and other as yet unexplained causal factors vary strongly from year to year.

There is thus only a weak and uncertain connection between chlorophyll and nitrogen concentrations in the form of nitrates and ammonium in inland waters. Therefore, chlorophyll concentrations are not suited to assessing the impacts of action programmes under the Nitrates Directive. Hence the authors have abstained from detailing and analysing the data in this report.

2.2 Coastal waters

The competent federal German authorities and the *Länder* jointly carry out monitoring programmes in estuaries, coastal waters and offshore areas (Joint Federal/Länder North Sea Monitoring Programme, Joint Federal/Länder Baltic Sea Monitoring Programme). These programmes are undertaken in fulfilment of commitments the Federal Republic of Germany has taken on in the context of international marine environmental protection conventions (OSPARCOM, HELCOM) including reporting obligations under relevant EU Directives (*e.g.* Nitrates Directive, 91/676/EEC).

2.2.1 Selection of the monitoring stations and observation period in coastal waters

The monitoring stations selected for the Joint Federal/Länder Monitoring Programme cover the estuaries of the major and minor rivers (Weser, Elbe, Eider, Jade) including the Wadden Sea, the inner German Bight (Helgoland-Reede station) and the outer coastal areas of the North Sea. In the German Baltic Sea area both coastal and marine areas are represented (see Figures below).

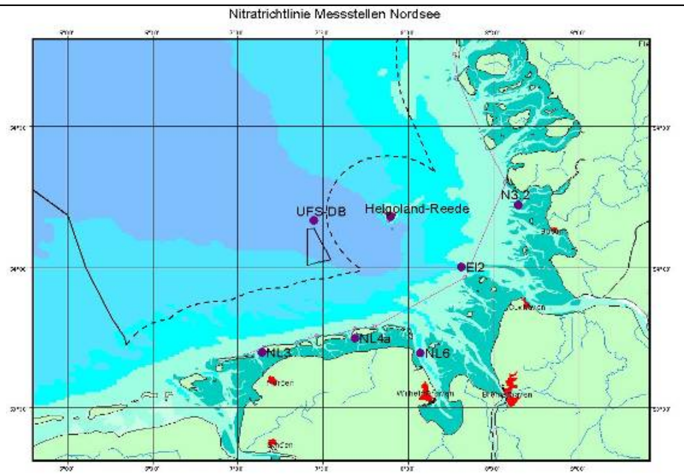


Figure 2.5: Nitrate monitoring stations in German coastal waters of the North Sea

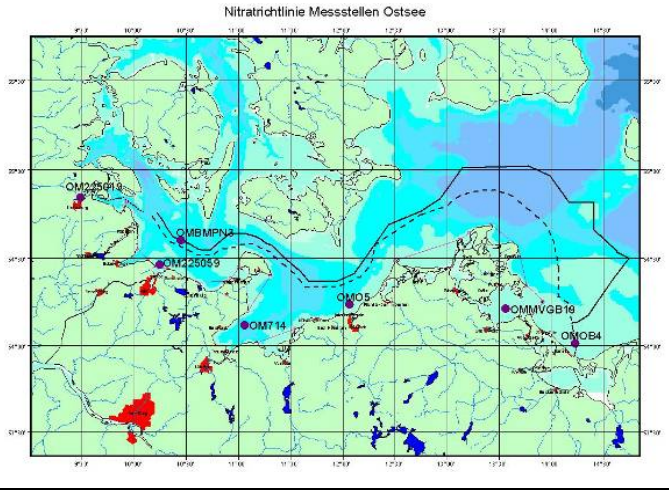


Figure 2.6: Nitrate monitoring stations in German coastal waters of the Baltic Sea

2.2.2 Current reporting period 2003-2006

Figures 2.7 and 2.8 depict nitrate concentrations (mg/l) at the selected monitoring stations.

The annual course of nitrate concentrations in estuaries and the Wadden Sea is of a different order of magnitude than that of the offshore areas. Estuaries are primarily influenced by freshwater flows. They are characterised by the transition from freshwater to saltwater and by substance transport due to water movement. As the estuaries receive continuous nutrient inputs from the confluent rivers, they often exhibit high nitrogen concentrations during the summer. In the areas well away from the estuaries however, the nitrogen is almost entirely consumed during the growing season. Nitrate concentrations in the outer coastal areas are mostly controlled by phytoplankton activity while in the Wadden Sea the nutrients of coastal waters as well as sediments and benthos are also significant factors. Nitrate concentrations generally show a distinct annual course with a winter maximum and a summer minimum.
Monitoring data are evaluated on the basis of background and orientation values for nitrates as set out in Part B of the "*Rahmenkonzeption Monitoring*" (Monitoring framework strategy) published by LAWA (Joint Working Group of the Federal Government and the Länder on Water). The background values which are used as reference values for evaluation purposes were defined on a scientific basis for all types of waters in transitional and coastal waters in accordance with the specifications set out in the Water Framework Directive (WFD). The orientation values which are consulted in order to assess the effectiveness of reduction measures were developed on the basis of the procedures provided for under OSPAR and HELCOM, *i.e.* 50% is added to the respective background values. This addition reflects the tolerable deviation from the reference value as well as natural variability which can be very high in estuaries and coastal areas. Nutrient values that are between background and orientation values should be indicative of a good ecological status in accordance with the WFD.

2.2.3 North Sea

Nitrate concentrations at the German North Sea coast

An evaluation of the data on the basis of the reference and orientation values derived for the WFD shows that nitrate orientation values at North Sea stations were in most cases clearly exceeded during the 2003-06 reporting period (Figure 2.7). The readings from the Buoy 15 station in the Northern Friesian Wadden Sea "*Nordfriesisches Wattenmeer Eider, Tonne 15*" (BLMP N3.2) are particularly striking, with winter values for 2006 exceeding the orientation value fourfold.
Nitrate concentrations decline with increasing distance from the coastline as inputs are derived mainly from land areas and become progressively more diluted in a seaward direction.

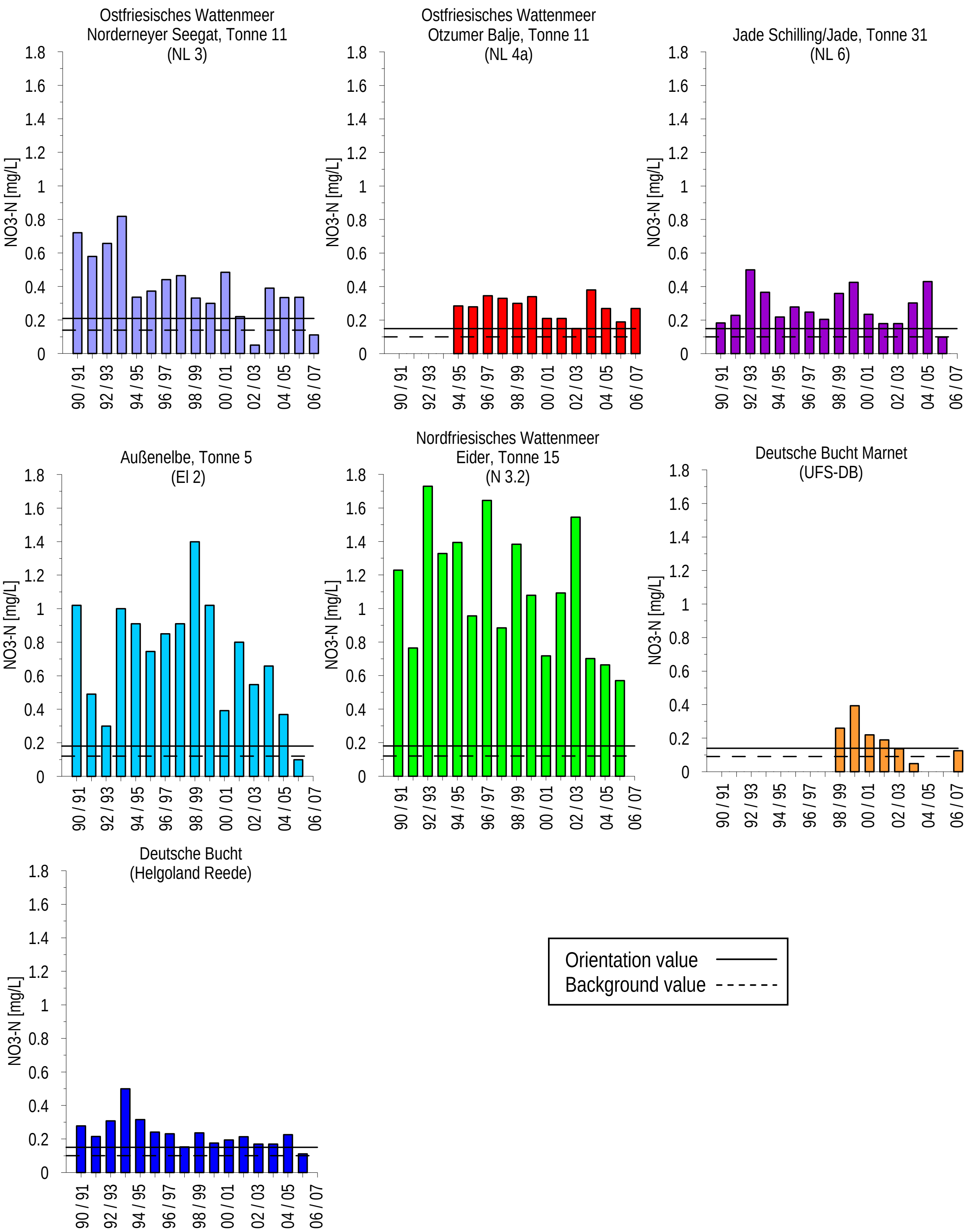


Figure 2.7: Nitrate-N winter values (mg N/l) taken at a depth of mostly 0.5-1.0 metres in 1991 to 2006 (across the turn of the year from 1 Nov. to 28 Feb.; January and February values are assigned to the previous year) for monitoring stations at the North Sea coast. Background values and orientation values refer to the relevant classification of coastal waters in accordance with the Water Framework Directive.

Assessment of eutrophication in the German Bight

The national report on the eutrophication status of the German coastal region prepared in the context of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) has identified the entire inner German Bight as a problem area with regard to eutrophication. Apart from nutrient and oxygen concentrations this comprehensive assessment for the 2001-2005 period primarily considered biological parameters.

Similarly, the quality assessment report for the Wadden Sea (Wadden Sea Quality Status Report, QSR 2004) concludes that the Wadden Sea must continue to be classified as a problem area with regard to eutrophication. The nutrient contents assessed for the Wadden Sea QSR 2004 were three to five times higher than the background values.
The results of the eutrophication assessment for the German Bight including the Wadden Sea are also mirrored in the results of the inventory carried out in accordance with Art. 5 of the WFD which show that the majority of German North Sea coastal waters are not expected to attain “good ecological status” by 2015 as they are eutrophicated. It has become evident that, apart from the biological quality elements of the WFD, the quality element “nutrient conditions” is of key importance to German transitional and coastal waters, for example with regard to determining nutrient reduction measures.

2.2.4 Baltic Sea

Nitrate concentrations at the German Baltic Sea coast

As would be expected, nitrate concentrations at the Baltic Sea monitoring stations are much lower compared to the North Sea. The assessment of nitrate concentrations in accordance with the WFD shows that in the years 2003-06 nitrate orientation values at the “Flensburg Inner Förde” (OM225019) and “Pomeranian Bay” (OMOB4) stations were often exceeded. However, at the “Kiel Outer Förde” (OM225059) and “Mecklenburg Bay” (OMO5) stations, nitrate concentrations have consistently been below the orientation value in the past four years. WFD implementation does not require the assessment of waters at the offshore stations “Kiel Bay“ (OMBMPN3), “Lübeck Bay“ (OM714)”, “Mecklenburg Bay” (OMO5) and “Pomeranian Bay” (OMOB4) as these are located outside of the 1 nm zone; only the chemical condition needs to be assessed based on concentrations of priority substances. Nevertheless, for the purposes of this report the offshore stations were assessed. As they correspond best to water types B3/B4, the background and orientation values for these types were used. Figure 2.8 shows that the orientation values for these three stations were only exceeded in the 1990s. A weakness of this pragmatic approach can be seen in that the readings taken over the past few years were in part below the background values. However, if one considers that at the selected Baltic stations nitrogen is also being fixed by way of phytoplankton biomass production during the winter, the nitrogen concentrations measured would theoretically need to be increased. To this end, the chlorophyll concentrations measured during the winter could be converted into nitrogen equivalents and added to the nitrate concentrations. In such test calculations for the selected Baltic Sea stations background and orientation values for nitrates were exceeded throughout.

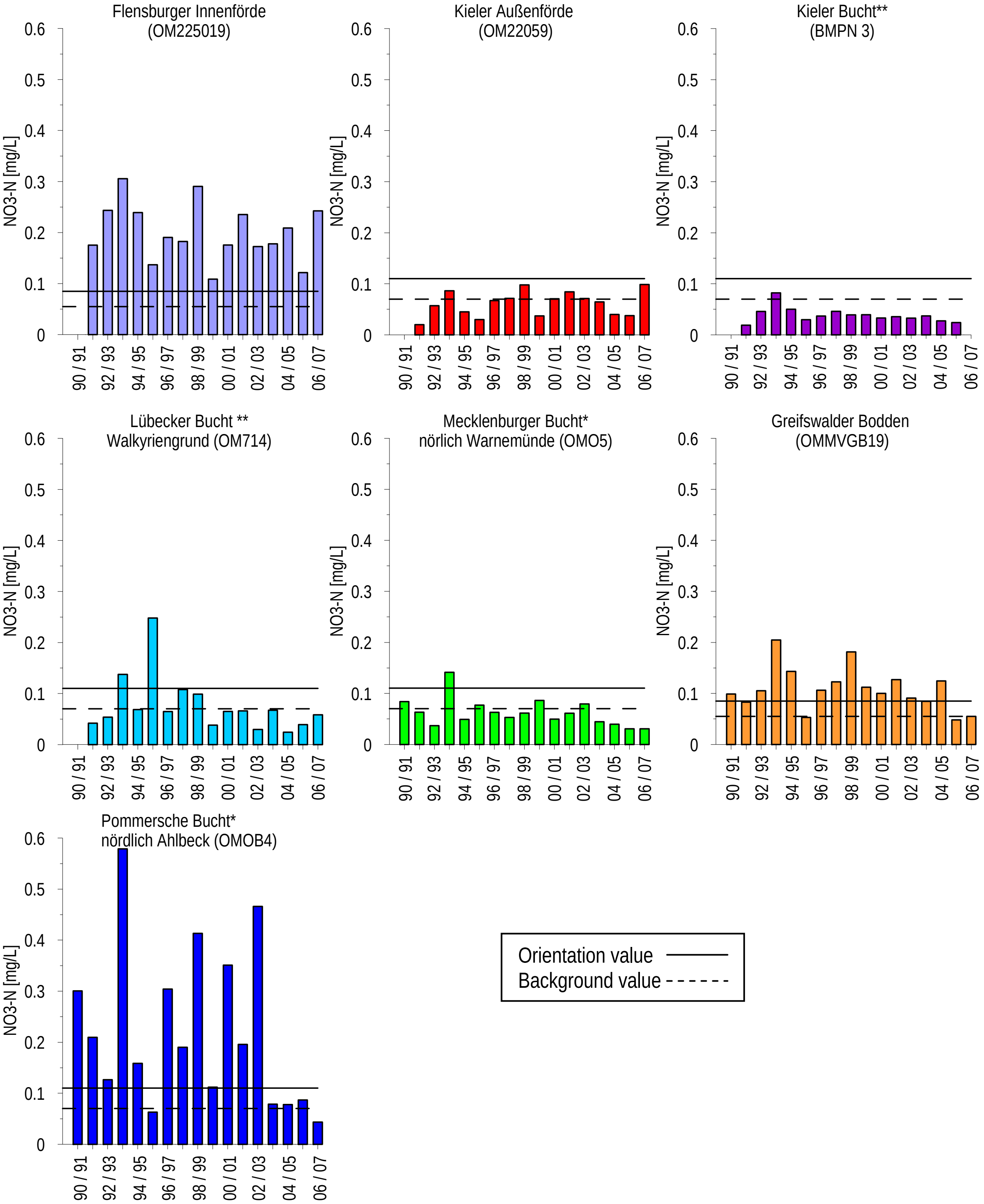


Figure 2.8: Nitrate-N winter values (mg N/l) taken at a depth of 0.5-1.0 metres in 1991 to 2006 (1 Nov. – 28 Feb.) for monitoring stations at the Baltic Sea Coast. Background values and orientation values refer to the relevant classification of coastal waters in accordance with the Water Framework Directive. For the "Flensburg Förde" and "Greifswald Bodden" stations the respective higher background and orientation values are shown.
*, ** Chemical assessment only in accordance with WFD, correspond most closely to water types B3* and B4**

Assessment of eutrophication at the German Baltic Sea coast

A thematic assessment of eutrophication in the Baltic Sea is currently being carried out under the Helsinki Convention. The joint assessment method (HELCOM Eutrophication Assessment Tool; HEAT) closely follows the OSPAR method. It can reasonably be assumed that the bulk of the German Baltic Sea inner coastal waters will be found to be eutrophicated.

2.2.5 Comparison of nitrate concentrations in the periods 1991-1994 and 2003-2006

At the majority of stations nitrate concentrations show a slight decrease or have remained stable. A comprehensive assessment of monitoring results with a view to trend estimates is constrained by low sampling frequencies for the entire 1991-2006 period.
As nitrates are mostly derived from diffuse sources, the nitrate concentrations are closely correlated with annual rainfall patterns and the associated discharge. A potential reduction at source is therefore not clearly traceable and in turn it is difficult to identify a general trend. Nevertheless, between the first reporting period (1991-1994) and the current reporting period (2003-2006) a decline in nitrate concentrations could be detected in German coastal waters and thus a slight approximation of orientation and background values.

At the monitoring stations located in German North Sea coastal waters with estuarine influence a decline of >30% in nitrate concentrations compared to the first reporting period was reported at the "Norderney Tidal Channel, Buoy 11", "Outer Elbe, Buoy 5", "Eider, Buoy 15" and "Helgoland Roadstead" stations. However, at the "Otzum Tidal Creek, Buoy 11" and "Jade Estuary Schillig, Buoy 31" stations nitrate concentrations have remained merely stable in the current reporting period compared to the first reporting period.
Nitrate inputs are subject to strong hydrodynamics-based fluctuations. As the nutrients mostly enter coastal waters with the river-derived freshwater and are progressively diluted by the salty water of the North Sea, correlations with salt contents can be used to calculate station-specific mean nitrate concentrations which can be compared to the monitoring values. From such an analysis it can be seen that at all reported stations there has been a declining trend since 1991. This type of analysis is not suited to the Baltic Sea due its low saline gradient.

For Baltic Sea coastal waters in Schleswig-Holstein the nitrate-N winter concentrations at the "Flensburg Inner Förde" and „Lübeck Bay" stations were considerably lower (>25%) in the current reporting period (2003-2006) than in the early to mid-1990s. At the "Kiel Outer Förde" and "Kiel Bay" stations, outside of the 1 nm zone, slight increases and decreases of nitrate-N concentrations below the orientation values were observed. At the coast of Mecklenburg-Western Pomerania considerable decreases of nitrate-N readings (between 36% and 66%) have also been observed. One of the three stations ("Pomeranian Bay") in this *Land* is situated outside of the 1nm zone.

Table 2.9: Mean values of nitrate-N concentrations (in mg N/l) for the periods of Nov. 1990 to Feb. 1995 and Nov. 2002 to Feb. 2007 (1.11-28.2) and percentage increase or decrease between the two monitoring periods. Mean values were calculated from individual monitoring values.
Background and orientation values for nitrate-N (in mg N/l) are assigned by water body type.
*,** These stations are situated outside of the 1 nm zone. They are not characterised as a particular water body type but correspond most closely to water types B3* and B4** respectively.

Region (WFD type)	**Monitoring station**	**Mean winter values NO_3 [mg N/l]**		**Increase / decrease in %**	**Background values**	**Orientation values**
		Nov.1991-Feb.1995	**Nov.2003-Feb.2007**		**NO_3 [mg N/l] winter**	
NORTH SEA						
East Friesian Wadden Sea (Type N4)	NorderneyTidal Channel, Buoy 11	0.51	0.27	-48	0.14	0.21
East Friesian Wadden Sea (Type N2)	Otzum Tidal Creek, Buoy 11	0.28	0.28	0	0.10	0.15
Jade (Type N2)	Schillig / Jade, Buoy 31	0.30	0.29	-5	0.10	0.15
Elbe (Type N3)	Outer Elbe Buoy 5	0.67	0.42	-38	0.12	0.18
North Friesian Wadden Sea (Type N3)	Eider, Buoy 15	1.38	0.65	-53	0.12	0.18
German Bight	German Bight MARNET		0.09		0.09	0.14
German Bight (Type N5)	Helgoland Roadstead	0.37	0.18	-51	0.10	0.15
BALTIC SEA						
Flensburg Inner Förde (Type B2)	Southern Ochseninsel	0.25	0.18	-27	0.04–0.07	0.06–0.11
Kiel Outer Förde (Type B4)	Buoy Kleverberg East	0.05	0.06	19	0.07	0.11
Kiel Bay** (Type B4)	Kiel Bay	0.05	0.04	-14	0.07	0.11
Lübeck Bay** (Type B4)	Walkyriengrund	0.08	0.05	-33	0.07	0.11
Mecklenburg Bay (Type B3)*	North of Warnemünde	0.06	0.04	-37	0.07	0.11
Greifswald Bodden (Type B2)	Buoy Ariadne	0.14	0.09	-36	0.04–0.07	0.06–0.11
Pomeranian Bay (Type B3)*	North of Ahlbeck	0.23	0.08	-66	0.07*	0.11*

2.3 Groundwater

2.3.1 Operative monitoring network for monitoring nitrate concentrations

With a view to reporting pursuant to Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC) the *Länder* established 186 groundwater monitoring stations in 1995.

The following criteria were used in selecting the monitoring stations:

- Monitoring stations in near-surface aquifers (uppermost aquifer, aquifer unconfined by aquitard);
- Monitoring stations which already showed clearly elevated nitrate concentrations prior to 1995;
- Monitoring stations with a clear connection to agriculturally used lands;
- Significance for as large as possible a catchment.

This monitoring network – hereinafter referred to as **operative monitoring network** – is a polluter monitoring network for nitrate inputs originating from agricultural sources into groundwater. An operative monitoring network can provide evidence as to the efficacy of measures taken (see Chapter 3.4) with a view to improving the nitrates situation in groundwater.

Individual monitoring stations emerged over time as being unsuited for reporting or have been decommissioned. They have been removed from the network and have largely been replaced by equivalent monitoring stations. Sampling at the monitoring stations takes place at least once a year. Sampling and analysis are carried out based on comparable criteria.

The current report closely follows the previous three reports and takes guidance from the "Development guide for Member States' reports" as revised in 2008 by the European Commission Directorate-General for Environment. For the assessment of the development of nitrate concentrations from the commencement of the First Action Programme ("zero point") to the present ("end of the Third Action Programme"), a total of 170 common monitoring stations ("common points") could be availed of. For these monitoring stations nitrate readings are available for all four monitoring periods (1992-1994; 1996-1998; 2000-2002; 2004-2006).

2.3.2 Current nitrate contamination

The frequency distribution of nitrate concentrations at the 170 common points of the operative monitoring network during the 2004-2006 monitoring period is given in Figure 2.9.

The fact that monitoring stations with high nitrate concentrations feature strongly demonstrates the immediate link with agriculture as established with the operative monitoring network. Mean values for nitrate concentrations are below 25 mg/l at less than 12% of the monitoring stations.

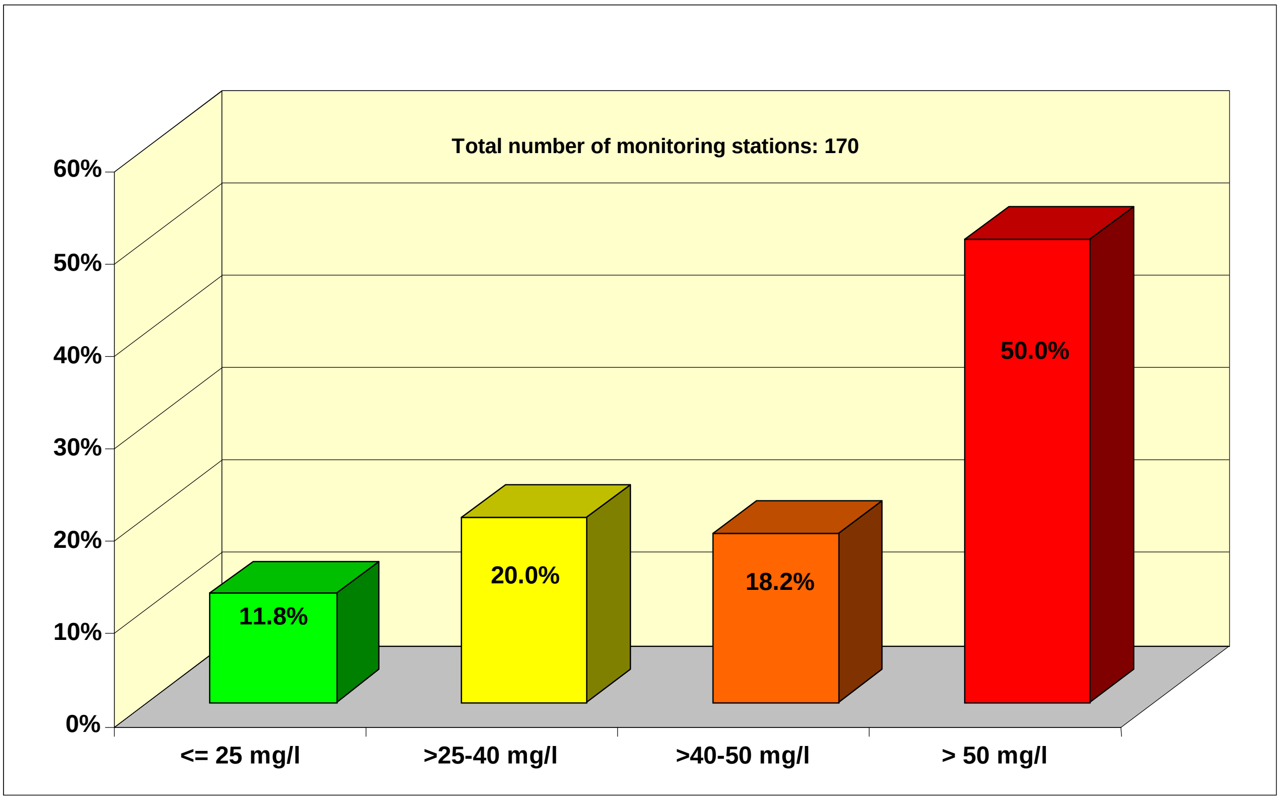


Fig. 2.9: Frequency distribution of mean nitrate concentrations during the 2004-2006 monitoring period

2.3.3 Comparison of nitrate concentrations with the 1992-1994, 1996-1998 and 2000-2002 monitoring periods

For the purpose of comparing the current situation with groundwater nitrate contamination prior to the First Action Programme (1992-1994 monitoring period) and in the second (1996-1998) and third (2000-2002) monitoring periods, Figures 2.10-2.12 show the frequency distributions of mean nitrate concentrations for each period in the operative monitoring network. In order to make the charts comparable, the charts for the past monitoring period (data for three years each) were adapted to only show the remaining 170 common monitoring stations. However, this does not lead to any significant changes from the corresponding charts published in the previous reports (see also Table 2.13).

The comparison of the current situation with the previous monitoring periods shows that the number of monitoring stations with medium nitrate concentrations of more than 50 mg/l has gradually declined by 10% between 1992/94 and 2004/06. At the same time the number of monitoring stations in the lowest concentration class of <25 mg/l increased from 5.3% to 11.8% (see Figures 2.9-2.12).

It can thus be established that the groundwater nitrate concentrations measured in the operative monitoring network show a slight downward trend since measures under Articles 4 and 5 have commenced. The easing situation which can be seen at the margins of the frequency distribution must not however obscure the fact that changes in groundwater nitrate concentrations are slow and occur gradually. Therefore the stronger decrease in the number of monitoring stations in the highest concentration class will first lead to an increase in the number of stations in the medium classes before there can be a considerable increase in the number of stations falling into the lowest class (< 25 mg/l).

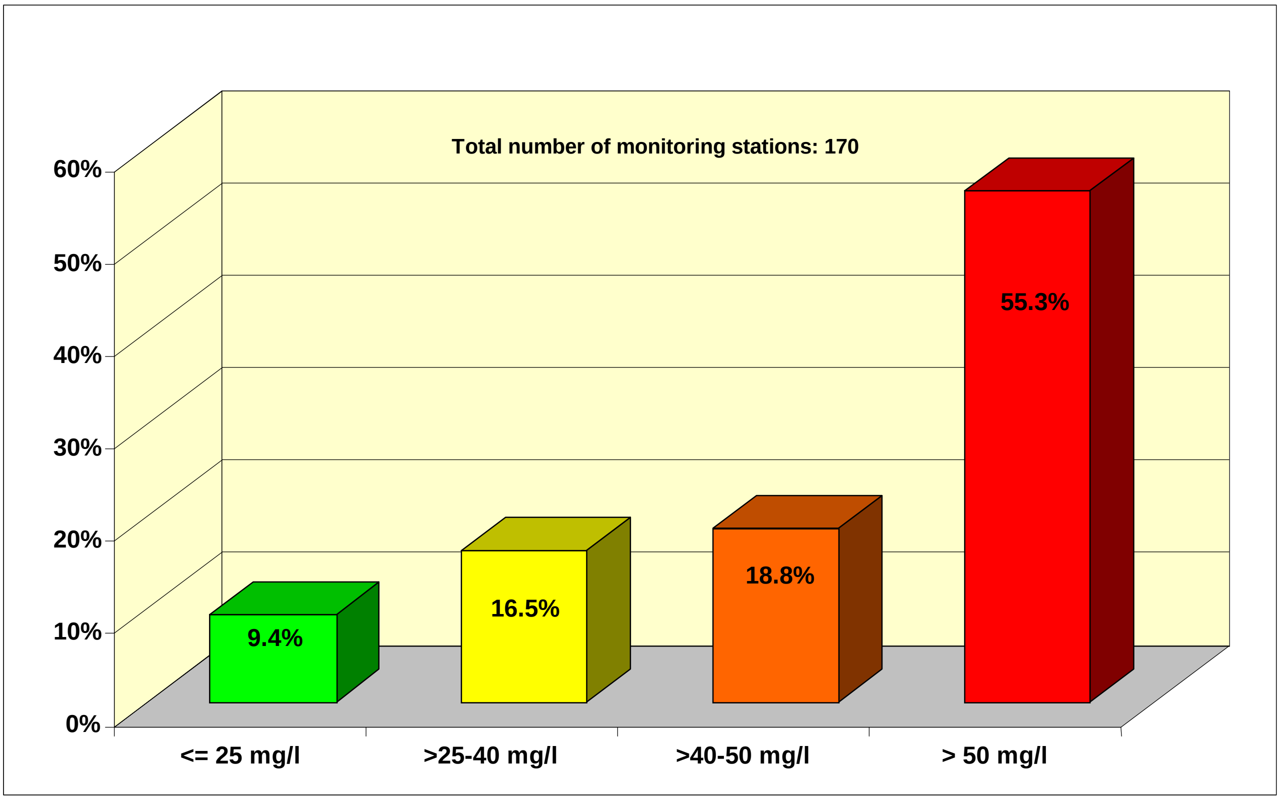


Fig. 2.10: Frequency distribution of mean nitrate concentrations during the 2000-2002 monitoring period

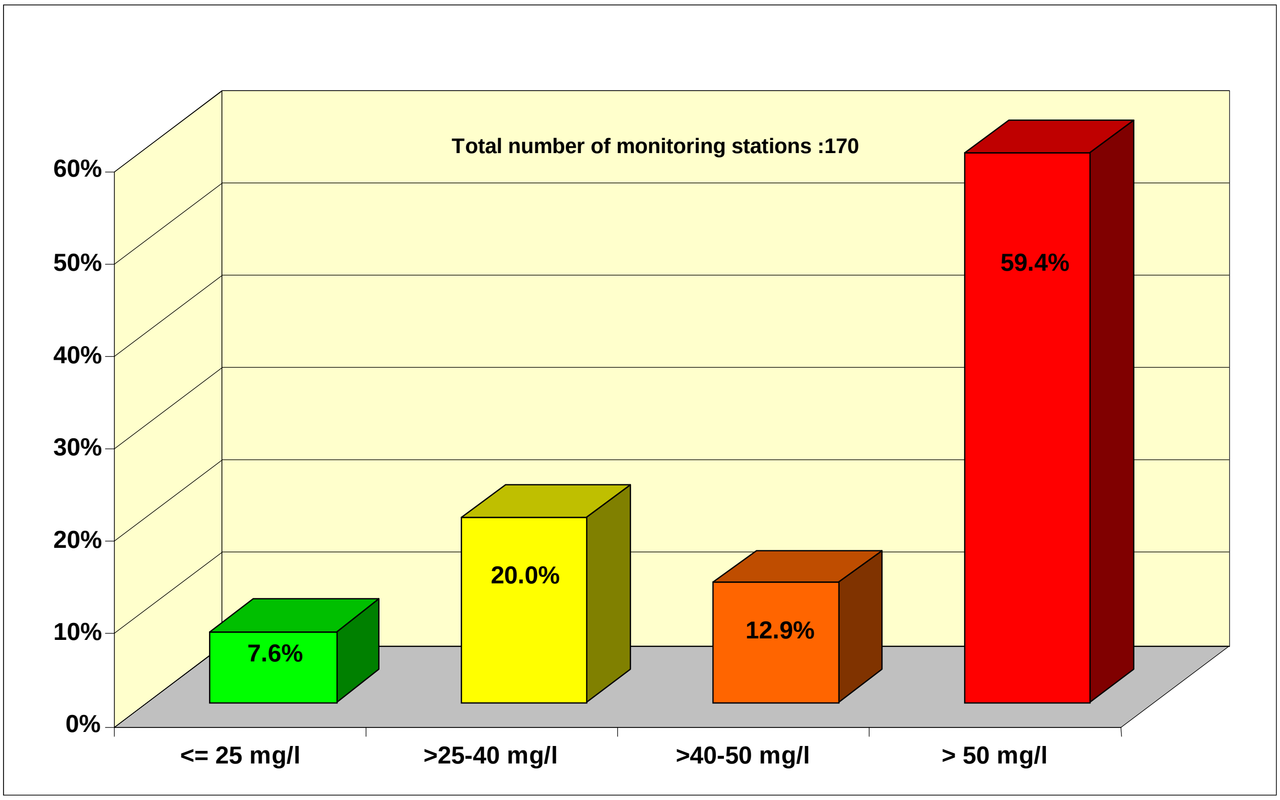


Fig. 2.11: Frequency distribution of mean nitrate concentrations during the 1996-1998 monitoring period

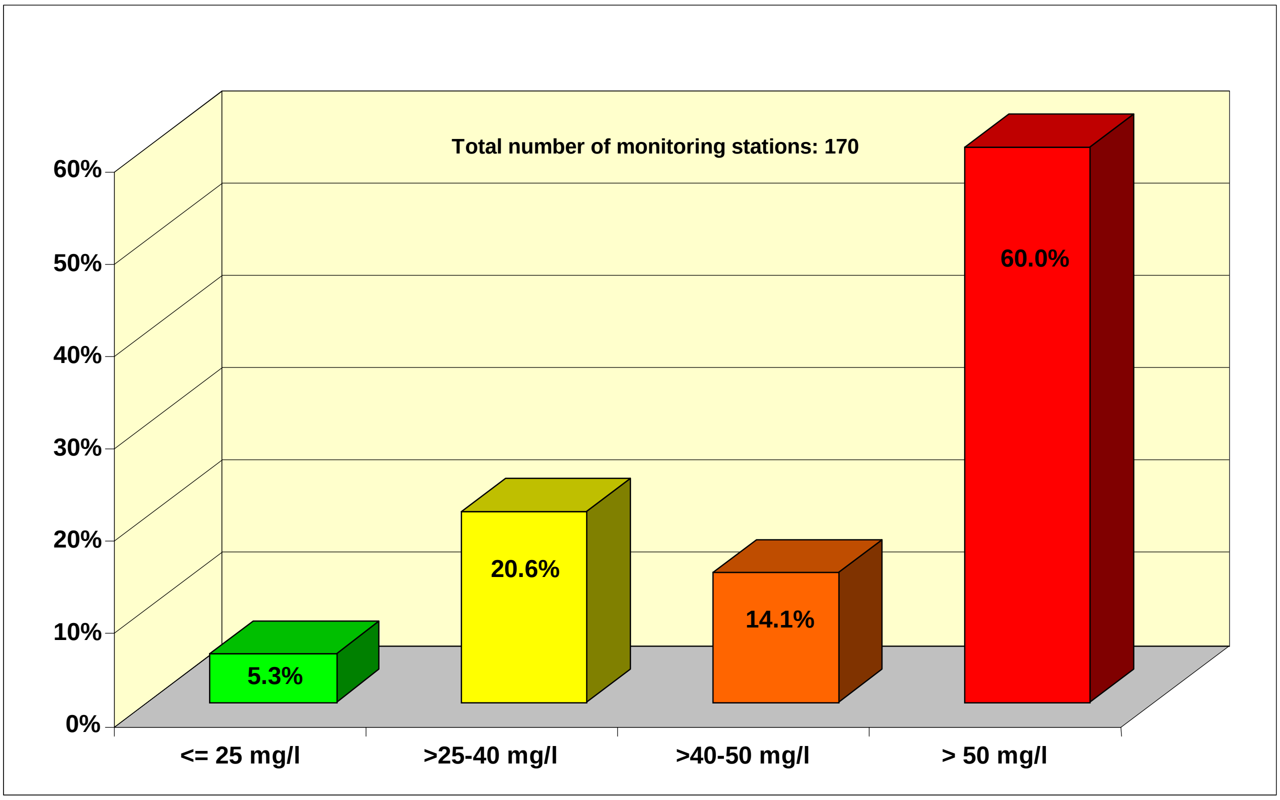


Fig. 2.12: Frequency distribution of mean nitrate concentrations during the 1992-1994 monitoring period *)

*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

2.3.4 Changes in nitrate concentrations between the monitoring periods

In addition to the current contamination situation at the monitoring stations, the development over time (increase or reduction of nitrogen concentrations at each individual monitoring station; hereinafter referred to as “trend”) from the commencement of monitoring to the current monitoring period is also of particular interest. Figures 2.13 and 2.15 show the frequency distributions of changes in nitrate concentrations, calculated by subtraction, between the latest monitoring period (2004-2006) and the 2000-2002 and 1992-1994 monitoring periods respectively. The trend classification follows the specifications set out in the Development Guide. To allow for a comparison between the 2004-2006 period and the first monitoring period, the class limits had to be adapted accordingly.

The fact that compared to both the 2000-2002 and the 1992-1994 reference periods almost one third of the monitoring stations (32.4% and 30% respectively) show a strong downward trend can be regarded as a positive development. At 21.2% and 28.2% of monitoring stations respectively, nitrate concentrations show at least a weak reduction. However, compared to the 2000-2003 period there is evidence of an increasing trend (weak or strong increase) at about a third of the monitoring stations, while compared to the first monitoring period about a quarter of the monitoring stations show an increase in nitrate concentrations.

The number of monitoring stations showing a decreasing trend (weak reduction or strong reduction) predominates in both comparisons, compared to the number of monitoring stations showing an increasing trend (strong increase or weak increase). In Figure 2.13 the ratio between monitoring stations with decreasing vs. increasing nitrate concentrations is somewhat wider at 3:2 (91:58 monitoring stations). The assessment of the comparison between the latest monitoring period and the first monitoring period (Fig. 2.14) is even more positive, with a ratio of 2:1 (99:42 monitoring stations).

Figure 2.15 shows the spatial distribution of mean nitrate concentrations in the 2004-2006 period and the changes compared to the 2000-2002 means at the 170 monitoring stations. Similarly, Figure 2.16 compares the values obtained during the first reporting period (1992-1994) with the current situation.

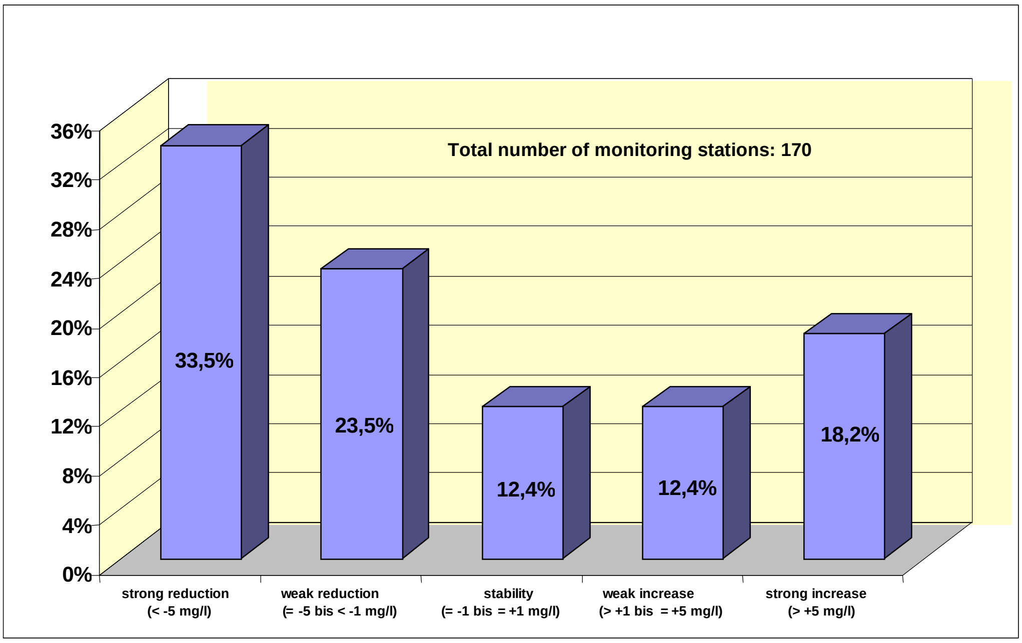


Fig. 2.13: Frequency distribution of changes in mean nitrate concentrations between the 2000-2002 reporting period and the 2004-2006 reporting period

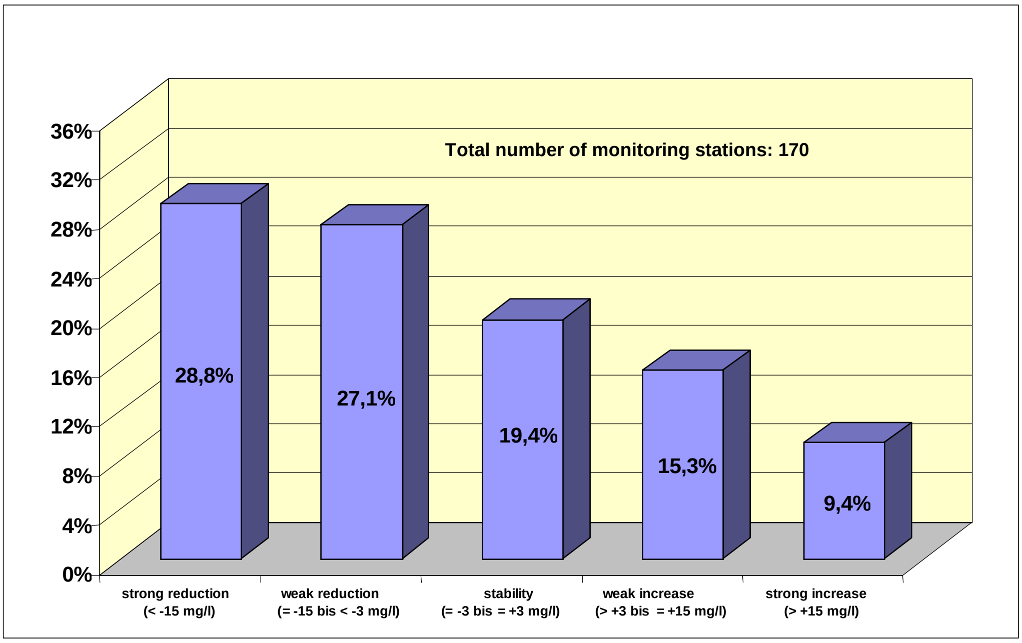


Fig. 2.14: Frequency distribution of changes in mean nitrate concentrations between the 1992-1994*) reporting period and the 2004-2006 reporting period

*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

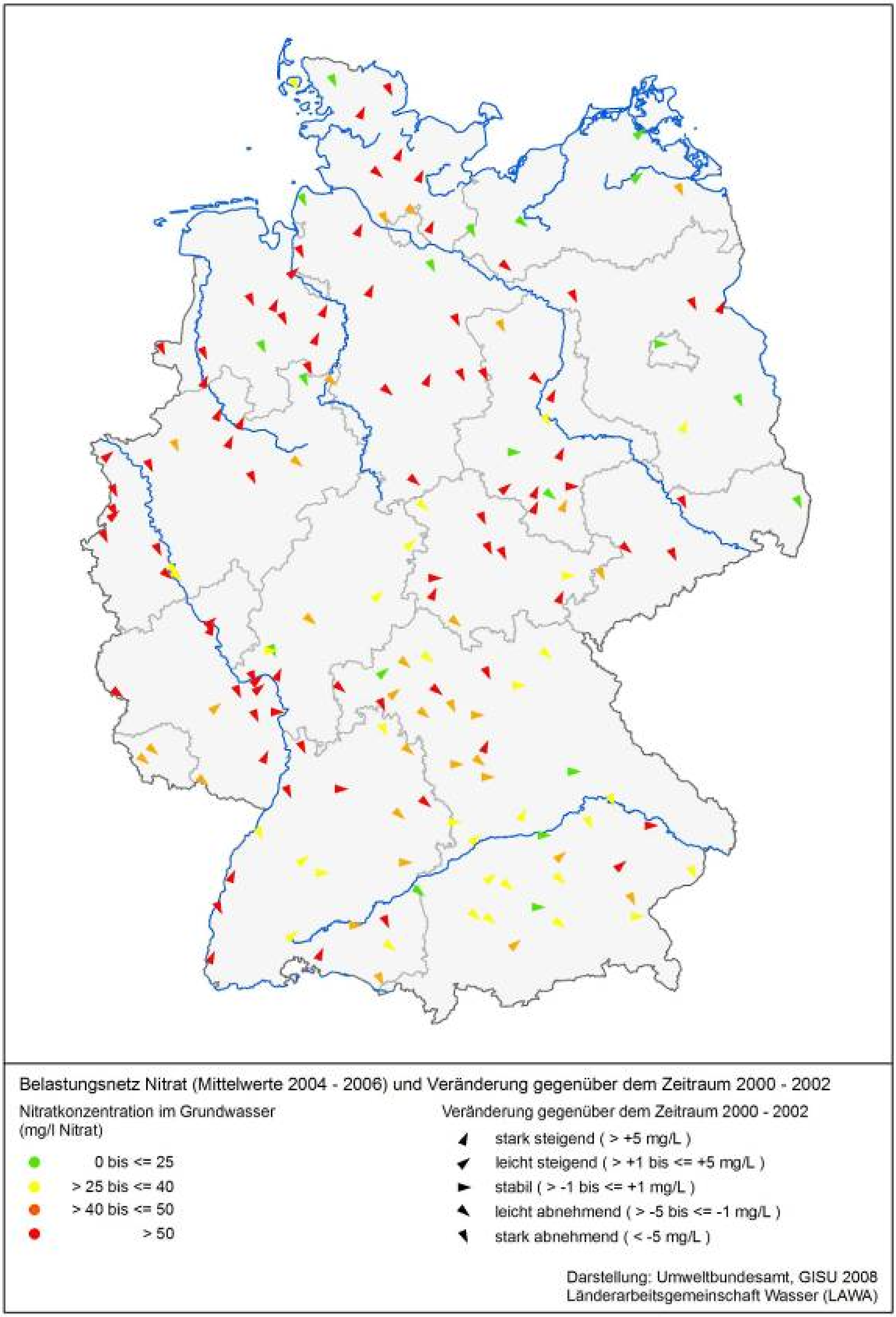


Fig. 2.15: Operative monitoring network for nitrates (mean values for 2004-2006) and changes compared to the 2000-2002 period at 170 common monitoring stations

Translations on page 24

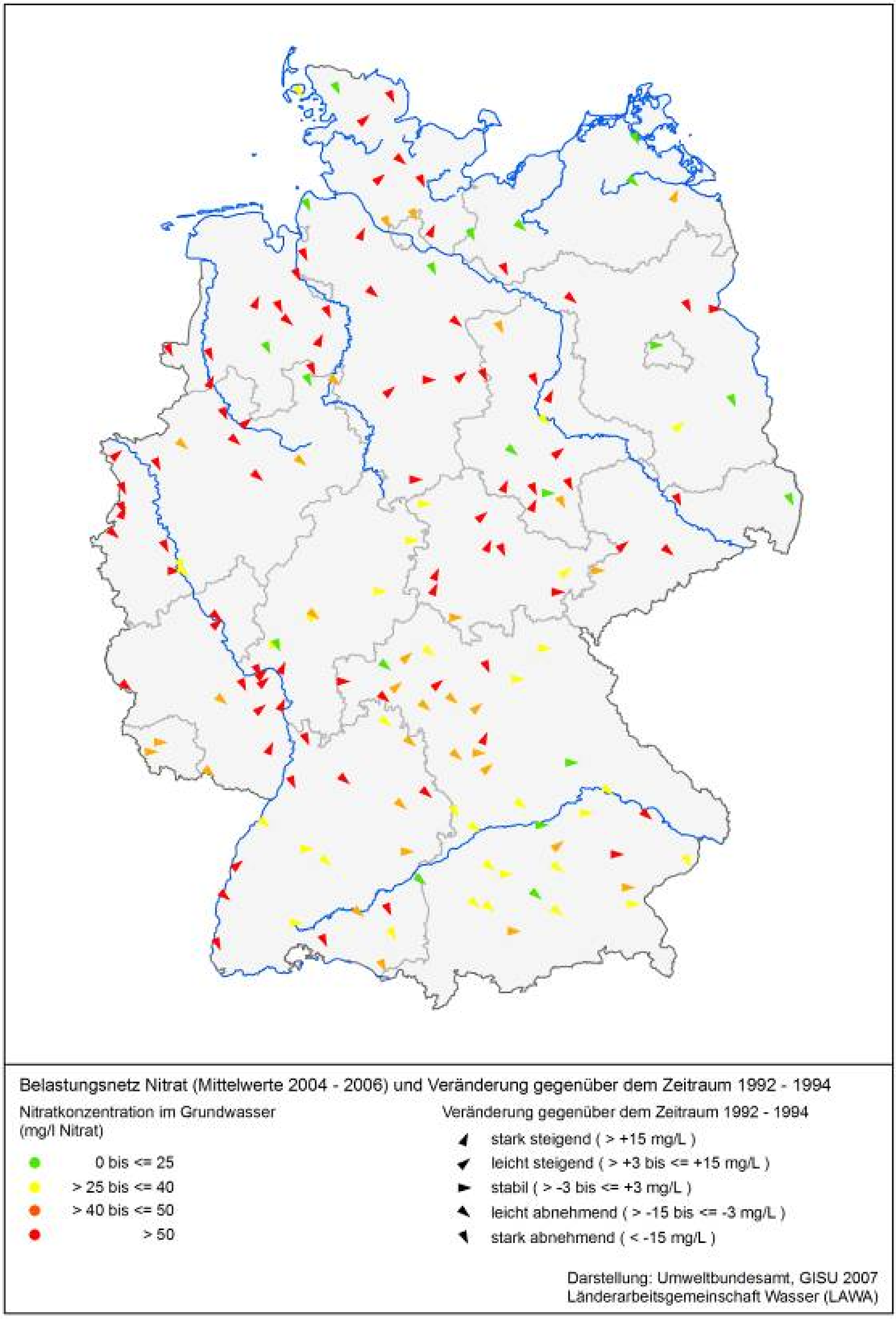


Fig. 2.16: Operative monitoring network for nitrates (mean values for 2004-2006) and changes compared to the 1992-1994 period at 170 common monitoring stations

Belastungsnetz Nitrat … = Operative monitoring network for nitrates (mean values for 2004-2006) and changes compared to the 1992-1994 period
Nitratkonzentration im Grundwasser… = Groundwater nitrate concentration (mg/l nitrate)
0 bis <=25 = 0 to <25
> 25 bis <=40 = > 25 to <=40
> 40 bis <=50 = > 40 to <=50
> 50 = >50

Veränderungen gegenüber … = Changes compared to the 1992-1994 period
stark steigend …. = strong increase (> +15 mg/l)
leicht steigend …… = weak increase (> +3 to <= +15 mg/l)
stabil …. = stability
leicht abnehmend … = weak decrease (> -15 to <= -3 mg/l)
stark abnehmend … = strong decrease (< -15 mg/l)

Darstellung … = Graphic: German Federal Environment Ministry, GISU 2007, Joint Working Group of the Federal Government and the Länder on Water (LAWA)

2.3.5 Statistical summary in accordance with the Development Guide

	1992-1994	1996-1998	2000-2002	2004-2006	of which common monitoring stations
Number of monitoring stations	186	181	190	181	170

Table 2.13: Comparison between monitoring periods of the percentage of common monitoring stations exceeding certain nitrate levels

Nitrate concentrations in reference periods:		1992-1994	1996-1998	2000-2002	2004-2006
> 50 mg/l	Max. NO_3 content	71.8	67.1	68.8	62.4
	Mean NO_3 content	60.0	59.4	55.3	50.0
> 40 mg/l	Max. NO_3 content	85.9	81.2	79.4	74.1
	Mean NO_3 content	74.1	72.4	74.1	68.2

Table 2.14: Trend between the third (2000-2002) and fourth (2004-2006) monitoring periods as a percentage of the 170 common monitoring stations

Trend:	Maximum values	Mean values
strong increase (> + 5 mg/l NO_3)	17.1	18.2
weak increase (> +1 to 5 mg/l NO_3)	15.9	12.4
stability (≥ -1 to +1 mg/l NO_3)	8.2	12.4
weak decrease (≥ -5 to -1 mg/l NO_3)	25.3	23.5
strong decrease (< -5 mg/l NO_3)	33.5	33.5

Table 2.15: Trend between the first (2000-2002) and fourth (2004-2006) monitoring periods as a percentage of the 170 common monitoring stations

Trend:	Maximum values	Mean values
strong increase (> + 15 mg/l NO_3)	11.8	9.4
weak increase (> +3 to 15 mg/l NO_3)	12.4	15.3
stability (≥ -3 to +3 mg/l NO_3)	17.6	19.4
weak decrease (≥ -15 to -3 mg/l NO_3)	24.7	27.1
strong decrease (< -15 mg/l NO_3)	33.5	28.8

2.3.6 Overall situation

The monitoring stations of the operative monitoring network were selected in a targeted manner and are not suited to providing a general overview of nitrate contamination in Germany's near-surface groundwater. For a more balanced overview the *Länder* have selected 782 representative monitoring stations as depicted in Figure 2.17. The data from this monitoring network are used for reporting to the European Environmental Agency (EEA Monitoring Network) on the current situation regarding contamination of near-surface groundwater with nitrates. It is evident that groundwater contamination with nitrates is a problem across the whole of the federal territory which can not be limited to a small number of areas or regions which could be designated. The quality standard for nitrates in groundwater is being exceeded at 13.6% of the EEA monitoring stations shown.

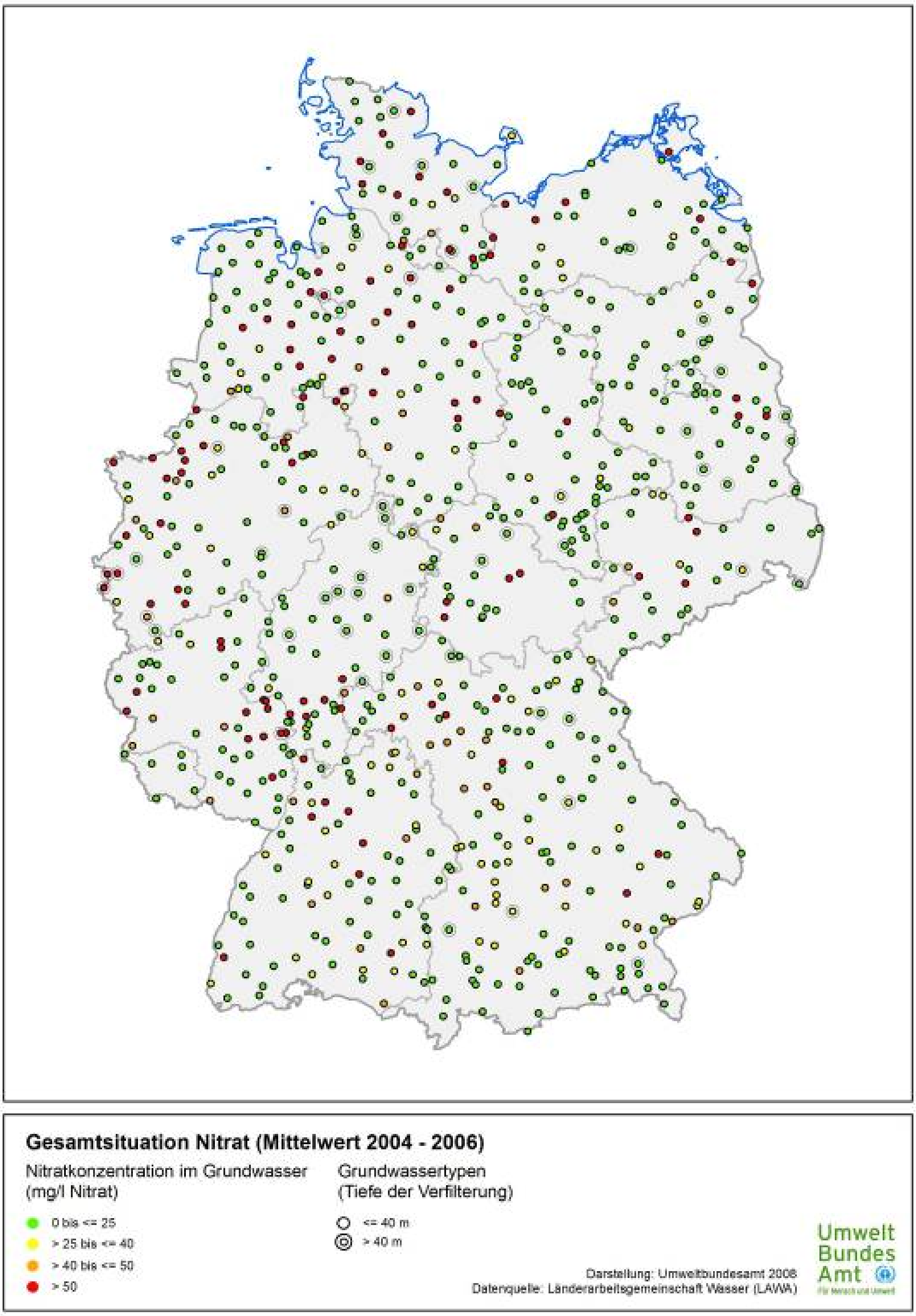


Fig. 2.17: Overall nitrates situation (2004-2006 mean values) at 782 selected groundwater monitoring stations as part of the EEA Monitoring Network

Gesamtsituation Nitrat … = Overall nitrates situation (2004-2006 mean values) at 782 selected groundwater monitoring stations as part of the EEA Monitoring Network
Nitratkonzentration im Grundwasser… = Groundwater nitrate concentration (mg/l nitrate)
0 bis <=25 = 0 to <25
> 25 bis <=40 = > 25 to <=40
> 40 bis <=50 = > 40 to <=50
> 50 = >50
Grundwassertypen … = Groundwater types (filtering depth)
[Symbole und Zahlen bleiben]

Darstellung … = Graphic: German Federal Environment Ministry 2006, Source of data: Joint Working Group of the Federal Government and the Länder on Water (LAWA)

2.3.7 Summary and assessment

As diffuse nitrate loads entering groundwater predominantly arise from agricultural land use, such areas must be considered separately. This is being achieved with the operative monitoring network. The data from the operative monitoring network therefore do not describe the general nationwide nitrates situation in groundwater but specifically describe the development over time of the pollution of groundwater influenced by agricultural land use.

The frequency distributions shown in Figures 2.9 - 2.12 demonstrate that nitrate concentrations at near-surface groundwater monitoring stations influenced by agricultural land use have decreased since the first monitoring period. This development can be backed up statistically with a prognosis which is first presented in this report, *i.e.* the linear regression as a basis for the trend assessment. The analysis of changes at the individual monitoring stations between monitoring periods, as presented in Figures 2.13 and 2.14, also shows a surplus of monitoring stations with a decreasing trend in nitrate concentrations.

It is apparent that especially the very high nitrate concentrations (>50 mg/l) have decreased in recent years. A comparison of the statistical summaries of maximum and mean nitrate concentrations found in the various monitoring periods (see Chapter 2.3.5) shows that the measures taken to reduce nitrate contamination in groundwater initially lead to a capping of peak concentrations at the individual monitoring stations. A clear and abrupt reduction of groundwater contamination in agriculturally used catchments has so far not taken place. However, due to the, in part, long retention times of water in soils, this is not to be expected.

It must also be pointed out that nitrate concentrations have continued to increase at a considerable number of monitoring stations, especially compared to the previous reporting period (Fig. 2.13). This may be partly due to the dry year of 2003. Results from the regional (*Länder*) monitoring networks have shown that the low crop yields in 2003 ensuing from the drought have led to increased soil nitrogen and a time-lagged increase in groundwater nitrate concentrations from 2005 onwards at some stations.

As data series from the monitoring stations are relatively short and the changes observed since the commencement of measures are in part rather minor, the possibility that, for example, short-term hydrological impacts have characterised groundwater nitrate concentrations at individual monitoring stations can not be excluded. Furthermore, crop rotations and changes in soil cultivation have a significant impact on the development of nitrate concentrations in soils and seepage water and thus also on groundwater.

Moreover, it must be noted that the observation of nitrate concentrations does not entail the observation of actual nitrate loads entering the groundwater. An assessment of nitrate loads (actual quantity of leached nitrates) can only be undertaken if the effective groundwater recharge for the year in question is considered. The annual groundwater recharge rate can have a significant impact on nitrate concentrations measured, especially in near-surface groundwater.

3. Good agricultural practice: Development, support and implementation

3.1 Data for the total area of the Federal Republic of Germany

The following data were obtained as part of Germany's official statistics. Some of the surveys follow a multi-annual cycle and hence data are not in all cases available for 2002 and 2006 respectively. The data presented below refer to the reference years 2002 and 2006 unless stated otherwise.

	2002	2006
Number of agricultural holdings	420,697 (2003)	396,581 (2005)
… of which keep livestock	327,696 (2003)	280,975 (2005)
Total area 357 000 km²		
Agricultural area (AA in 1 000 ha)	16,974	16,951
= Arable land	11,791 (69.5%)	11,866 (70.0%)
= Grassland	4,970 (29.3%)	4,882 (28.8%)
= Permanent crops (fruit, vegetables, wine)	213 (1.2%)	204 (1.2%)

It can be assumed that generally the entire agricultural area (AA) minus set-aside is available for landspreading of livestock farm wastes.

N applications from bought-in fertilisers, excl. fallow lands

2002/03 111.3 kg N/ha
2004/05 109.4 kg N/ha
2006/07 98.0 kg N/ha (preliminary)

N applications from livestock farm wastes 1997/98 approx. 83 kg N/ha
2004/05 approx. 76 kg N/ha

Livestock units (LU) per 100 ha 1990 112 LU
2001 85 LU
2005 79 LU

N balance per ha AA

Nitrogen balances provide information on nitrogen management and are thus a good indicator for the effectiveness of the action programme under the Nitrates Directive and other measures going beyond the Directive's requirements. While water quality monitoring stations may only indicate the success or otherwise of management measures with several years' delay, N balances provide immediate information on relevant input and output quantities. Especially the developments over a longer period of time allow for conclusions on nitrogen management on agricultural holdings, as the impacts of extreme events on the annual nitrogen balance, such as failed harvests due to drought, are levelled out. A number of changes have been made to the calculation of nitrogen balances since the previous nitrates report. As a result, the data of today's balances may diverge from those calculated four years ago. With regard to input data the main changes have been as follows: Consideration of 15% nitrogen loss in grassland harvests; Consideration of herbage quantities from alpine pastures and common grazing lands (and similarly consideration of 15% N loss); Consideration of harvested yields of beet tops and vegetables. In addition to gaseous N losses from farm wastes the calculation of the net N balance per unit area in Germany now also considers losses from mineral fertilisers as well as other N losses (applications of sewage sludge, cultivation of organic soils, legume production, crop residues and changes in soil N stocks in accordance with cross-compliance provisions).

Since German reunification, the average net N balance surplus on agricultural land in Germany decreased from 98 kg N/ha in 1990 to approx. 54 kg N/ha in 2006 (see Table 3.1). The main reason for this reduction is the increased removal of nutrients with crops from agricultural lands as a result of yield increases. This increase in nutrient removal was also evident during the previous action programme, with the exception of 2003 where extreme weather conditions entailed yield reductions strongly diverging from the mean which in turn led to an increased N surplus.

Table 3.1 shows further that the average use of mineral fertilisers per unit area in Germany decreased strongly between 1990 and 1994. Harvest yields stagnated during that time. This was followed by a temporary increase in mineral fertiliser use which was due to a re-intensification of production in the new *Länder*. The strong increase in yields since that time and the ensuing nitrogen removal from farmland are indicative of this. During the last action programme mineral fertiliser use has remained more or less constant. Fluctuations must be interpreted against the background of the fact that the statistics record fertiliser sales but not possible changes in stock-keeping, fertiliser purchases in other countries, or the use of fertilisers abroad which were purchased in Germany.

The application of farm wastes showed a considerable decline until the mid-1990s and has been continuously declining since, in line with reductions in the national herd and flock.

Table 3.1: Development of nitrogen inputs and outputs (nitrogen balance) in Germany 1990-2006

	1990[1]	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**[4]
	kg*ha^{-1} AA																
Fertiliser	124	113	104	102	96	106	105	104	106	114	121	111	109	108	110	107	108
Mineral fertiliser	121	110	101	99	93	103	102	101	103	111	118	108	106	105	107	104	105
Secondary raw material fertiliser	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Livestock farm waste	98	90	88	86	85	84	84	83	82	81	81	81	79	78	77	76	76
Other N inputs	40	39	38	38	38	38	38	38	38	38	37	38	37	37	37	37	37
Atmospheric deposition	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Biological N fixation	16	15	14	14	14	14	14	14	14	14	13	14	13	13	13	13	13
Seeds and planting material	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total N inputs	262	242	230	226	219	228	227	225	226	233	239	230	225	223	224	220	221
Total N outputs	115	118	110	117	113	116	118	124	126	126	128	132	125	106	136	132	124
Gross N balance	**147**	**124**	**120**	**109**	**106**	**112**	**109**	**101**	**100**	**107**	**111**	**98**	**100**	**117**	**88**	**88**	**97**
Gaseous N losses	49	46	45	42	40	42	42	42	42	45	45	44	44	45	44	43	43
Farm waste	23	21	21	20	20	20	20	20	20	20	19	19	19	19	19	19	19
Mineral fertiliser [2]	18	17	17	16	14	16	15	15	15	16	17	18	17	17	17	16	16
Other N losses[2; 3]	8	8	7	6	6	6	7	7	6	8	8	8	8	9	8	8	8
Net N balance	**98**	**78**	**75**	**67**	**66**	**70**	**67**	**59**	**58**	**62**	**66**	**54**	**56**	**72**	**44**	**45**	**54**

[1] 1990 data base for new *Länder* in parts uncertain

[2] Figures calculated after: Dämmgen U (Ed.) (2007) Emissionen aus der deutschen Landwirtschaft - Nationaler Inventarbericht (NIR) 2007 für 2005 Tabellen, Landbauforschung Völkenrode, Sonderheft 304 A, 347 pp.

[3] Figures calculated after: Körschens et al. (2004) Humusbilanzierung – Methode zur Beurteilung und Bemessung der Humusversorgung von Ackerland, VDLUFA-Standpunkt, 12 pp.

[4] 2006 preliminary figures

In Table 3.2 below the N balances were regionalised by calculating the N balance surpluses for the individual *Länder* based on a uniform methodology for the agricultural lands of the Federal Republic of Germany and the former GDR.
Mineral fertiliser use in the *Länder* is calculated on the basis of the national efficiency of nitrogen use in agriculture (OECD Guideline) taking account of gaseous N losses from farm wastes. In contrast to the N balance for Germany as a whole, gaseous N losses from mineral fertilisers and other N losses (applications of sewage sludge, cultivation of organic soils, legume production, crop residues and changes in soil N stocks in accordance with cross-compliance provisions) are not taken into account at the *Länder* level.

Table 3.2: N balance surpluses in Germany by *Land* for selected years between 1990 and 2005

	1990	**1995**	**2000**	**2005**
	kg*ha^{-1} AA			
Baden-Wuerttemberg	116	98	95	76
Bavaria	129	108	108	83
Hesse	99	79	79	61
Lower Saxony	124	106	108	85
North-Rhine/Westphalia	131	111	112	91
Rhineland-Palatinate	86	73	72	55
Saarland	100	85	83	65
Schleswig-Holstein	125	107	106	86
Brandenburg	Allocation	66	67	53
Mecklenburg-Western Pomerania	of data to	56	56	38
Saxony	new	77	75	53
Saxony-Anhalt	*Länder*	56	57	41
Thuringia	uncertain	70	69	51
Germany (Gross gaseous N losses from farm wastes)[5]	125	92	92	71

[5] Information on gaseous N losses from farm wastes and other N losses are not available at *Länder* level. For this reason there are discrepancies between Tables 3.1 and 3.2.

Use of mineral fertiliser in *Land* = N output in *Land* / N efficiency in Germany

N efficiency in Germany = N output in Germany / Mineral N fertiliser in Germany

Developments in the new and old *Länder* have differed since 1990. While in the old *Länder* there has been a slow but continuous and enduring decrease in N balance surpluses, the situation in the new *Länder* is characterised by a sharp drop in 1990 followed by a resurgence. Since 1990 the balance surplus in the old *Länder* has decreased from well over 100 kg/ha AA to a level of approx. 75 kg/ha AA (2005). Following reunification, there was an initial sharp drop in the new *Länder* down to approx. 20 kg/ha AA but over subsequent years the balance surplus increased again, reaching approx. 50 kg/ha AA in 2005.

There are strong regional differences between the *Länder*. The highest N surpluses (between 85 and approx. 90 kg N/ha AA) have been calculated for North-Rhine/Westphalia, Lower Saxony, Bavaria and Schleswig-Holstein. This is due to more intensive livestock production in these *Länder* which inevitably entails higher N surpluses. Rhineland-Palatinate, Hesse and Saarland have consistently had considerably lower N surpluses than the other *Länder.*

Comparing the years 1995 and 2005 it can be seen that in this ten year period there has been an average reduction of N surpluses in the order of approx. 20 kg/ha AA in both the old and new *Länder*.

The figures attest to an overall clearly positive development in N surpluses and point to the effectiveness of the measures taken in Germany.

3.2 Nitrogen discharges into the natural environment (cf. Chapter 2.1.3)

Table 3.3: Nitrogen discharges to surface waters in Germany
1975 to 2005 (see Table 2.8 in Chapter 2.1.3)

NITROGEN DISCHARGES TO WATERCOURSES		1983-1987	1993-1997	1998-2002	2002-2005
		in t/a	in t/a	in t/a	in t/a
Diffuse discharges (incl. background load)	Groundwater	340,560	287,250	334,430	268,620
	Drainage water	156,130	103,300	111,610	118,610
	Erosion	11,900	11,220	11,580	10,430
	Particle runoff	53,430	40,960	44,560	37,280
	Natural background load	32,090	29,330	32,410	27,010
	Agriculture	429,840	328,100	370,790	335,770
	Urban areas	39,650	26,730	21,850	16,520
	Atmospheric deposition	14,840	12,270	12,490	11,780
Total diffuse discharges		616,510	481,730	536,520	463,240
Discharges from point sources	Industrial direct discharge	119,620	29,140	13,920	9,650
	Municipal sewage treatment plants	294,990	196,730	114,450	91,890
Total discharges from point sources		414,610	225,870	128,370	101,540
Totals		1,031,120	707,600	664,890	564,780

3.3 Code of good farming practice (GFP) and measures under the Action Programme

In Germany, GFP rules on fertiliser use and the measures under the action programme are set out in detail and made compulsory in the Federal Fertiliser Ordinance and the *Länder* ordinances on the storage of slurry, liquid manure, farmyard manure and silage effluent (*JGS-Anlagenverordnungen*). As both the code of good farming practice and the measures of the action programme are mandatory in the entire territory, the GFP rules are largely identical to the measures of the action programme. Therefore, these will be jointly addressed in this Chapter.

Date of first publication of the Action Programme: 26 January 1996
Revisions adopted on 10 January 2006 and 27 January 2007

1. Period during which the application of fertilisers to land is prohibited
Arable land: 1 November to 31 January
Grassland: 15 November to 31 January

2. Distances to surface waterbodies and watercourses
Minimum distance of 3 metres, or 1 metre if a precision fertiliser spreader is used. There must be no direct input and no runoff of nutrients into the watercourse or waterbody. Terrain and soil conditions must be given adequate consideration. Additional water-rights-related distance and management regulations must be observed.

3. Fertiliser applications on steep slopes
A minimum distance of 3 metres with no exceptions applies to steeply sloped arable land (ground which has an incline of 10% or more within the first 20 metres from the top of the bank). Fertilisers must be incorporated immediately; for top dressings crop development must be at an adequate stage.

4. Fertiliser application on waterlogged, frozen or snow-covered ground
Fertilisers with significant nutrient contents must not be applied to waterlogged, frozen or snow-covered ground.

5. Appropriate fertiliser applications (incl. nitrogen balance, soil analysis, analysis of farm wastes, incorporation into soils)
In order to achieve a balance between the plants' expected nutrient demand and supply, the crop requirement in relation to the application of fertilisers must be established prior to fertiliser applications, having regard to the site's crop yield level, site conditions (climate, soil texture and type), lime content and organic matter content. Soil analysis for phosphorus is mandatory, while for nitrogen calculation methods and methods of estimation or analysis of comparable sites as well as recommendations issued by the authorities with responsibility for agricultural advisory services in accordance with *Land* law are used. Total nitrogen content and phosphorus content must be determined for fertilisers and farm wastes; for liquid manure, slurry and other liquid fertilisers as well as poultry manure ammonium-N must also be determined.

6. Incorporation of fertilisers
Liquid manure, slurry and other liquid fertilisers as well as poultry manure must immediately be incorporated into the soil on uncultivated arable land in order to prevent ammonia volatilisation.

7. Land spreading methods and equipment
Fertiliser spreaders must be conformant with acknowledged rules of technology. From 1 January 2010 certain machinery (as set out in Annex 4 of the Fertiliser Ordinance) will no longer be permitted.

8. Limits on the amount of livestock manure to be applied
The amount of livestock manure applied in any year to agriculturally used land on a holding, together with that deposited to land by livestock, must not exceed 170 kg of nitrogen per hectare. The amount of nitrogen produced by livestock and the nitrogen content of livestock manure is to be calculated in accordance with Annex 5 of the Fertiliser Ordinance. On arable land, following the harvest of the main crop, a maximum of 40kg ammonia-N/ha or 80kg total N/ha from liquid manure, slurry or other liquid organic or organic-mineral fertiliser or poultry manure may be applied to meet the nitrogen demand of subsequent crops or as compensatory fertilisation to accelerate straw decomposition.

9. Keeping of records

For nitrogen and phosphorus, nutrient input/output budgets must be drawn up at farm level. Nutrient inputs are compared to nutrients removed from the system. The difference (nutrient balance) must be established per plot or area.
The following data must be recorded:

- Soil nitrogen content and method of determination
- Soil analysis results for phosphorus
- Total nitrogen and total phosphorus contents of fertilisers and method of determination; also the ammonium-N content in the case of slurry, liquid manure, other liquid organic or fertilisers and poultry manure
- Baseline data and results of input/output budgets.

10. Regulations regarding manure storage

Statutory instruments issued by the *Länder* generally prescribe a minimum storage period of 26 weeks for slurry/liquid manure and storage facilities must be of sound construction. The 26-week minimum storage period applies to facilities constructed since the statutory instruments came into force. Older facilities must be brought up to standard by the end of 2008.

11. Maximum N and P surpluses

In addition to the requirements set out in Annexes II and III of the Nitrates Directive, maximum permitted surpluses at farm level have been set for nitrogen and phosphorus. The N balance, calculated as the average of the three preceding fertiliser years, must not exceed the following values:

- ❖ 90 kg/ha in the fertiliser years 2006 to 2008
- ❖ 80 kg/ha in the fertiliser years 2007 to 2009
- ❖ 70 kg/ha in the fertiliser years 2008 to 2010
- ❖ 60 kg/ha in the fertiliser years 2009 to 2011 and thereafter

For phosphorus, calculated as the average of the six preceding fertiliser years, the maximum excess permitted is 20 kg/ha/year.

The *Länder* have introduced codes of good farming practice which go beyond these legally binding provisions of the Fertiliser Ordinance and which farmers implement on a voluntary basis. These codes deal with *i.a.*:

- Design of the agricultural landscape
- Soil management
- Cropping and utilisation of land (incl. design of crop rotations)
- Fertiliser use
- Plant protection
- Livestock management
- Field storage clamps for ensiled feeds and field storage of farmyard manure and manure compost
- Irrigation.

The provisions of the Fertiliser Ordinance are binding for all farm holdings. It can therefore be assumed that all farmers are familiar with the provisions of the Fertiliser Ordinance and the *Länder* provisions regarding manure storage and that they comply with these provisions. In particular, the comprehensive training, education and information measures established by the *Länder* as well technical support contribute to implementation. Breaches of the provisions of the Fertiliser Ordinance have decreased considerably in recent years. This is also clearly evident from the farm inspections carried out over recent years in the context of cross-compliance provisions.

3.4 Evaluation of the implementation and impact of the action programme

3.4.1 General notes on the implementation of the action programme and on results available to date

In Germany, the *Länder* are responsible for education, training and advisory services. In order to fulfil this role, the *Länder* have established an agricultural extension system as part of the agricultural administration which provides agricultural training, advisory and information programmes supported by a more or less comprehensive system of field research and taking account of regional conditions. The extension system increasingly also involves the support of private consultancies which provide advisory services, *e.g.* in the area of special advice on the protection of watercourses or on the implementation of cross-compliance requirements.

The general point should be made that with the entry into force and further development of the Fertiliser Ordinance as a Nitrates Action Programme covering the whole territory, the implementation of good practice in fertiliser use is given the highest priority in all *Länder*. In this context the focus is on preventative measures (*e.g.* advisory and education measures, development of forecasting systems). To support this work the competent *Länder* authorities have developed a variety of booklets and information leaflets dealing with the proper use of fertilisers in a manner that protects water. They are widely used in training measures and advisory services. The following key technical areas during the past action period can be highlighted:

- Advice for farmers with regard to record keeping and in compiling the nutrient input/output budgets prescribed by the Fertiliser Ordinance. This is to allow for an analysis of nutrient management on the holdings and to find weak points. Especially on holdings keeping livestock the aim is to reduce nutrient surpluses and to improve nutrient efficiency.

- Generation and provision of data relevant to fertiliser management which protects water quality to as many farmers as possible. To this end, representative areas are sampled, targeted field trials carried out and weather data collected. The data thus obtained are disseminated through special technical meetings, circulars, specialist publications and increasingly through the Internet.

- Increased activities (advice and financial support) in the area of extending required storage facilities for slurry and farmyard manure in order to enable the farmers to adapt to the required minimum storage capacity for a 26 week period which from January 2009 also applies to installations in existence prior to the coming into force of the legislation. Other support measures include storage covers and environmentally-friendly landspreading techniques.

- Extension of agri-environmental measures with a focus on water protection with a view to establishing stronger measures going beyond good farming practice, especially in problem zones.

- Establishment of a systematic control system which meets the requirements of the Council Regulation establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers (Reg.

(EC) No 1782/2003). Additionally, the *Länder* carry out technical random checks, especially speculative inspections, where charges have been brought, or so-called *Anlasskontrollen, i.e.* inspections where there are reasons to think that irregularities have been committed. The results of the inspections are shown in Table 3.4.

The data situation regarding impacts on agricultural practices varies strongly between the *Länder*. The necessary date for the indicators listed in the Development Guide were not available in all cases. However, the *Länder* all report clear improvements in farm management with a view to the prevention of water pollution. This is not only due to measures taken under the Fertiliser Ordinance, but also to a changing general agri-policy framework resulting from the reform of the Common Agricultural Policy including support for water-related agri-environmental measures.

Table 3.4 Monitoring measures regarding fertiliser legislation in the 2004-2006 period

Monitoring of compliance with the Fertiliser Ordinance		Total **Inspections**[1)] - No. -	Total **Infringe-ments**[2)] - No. -	Total **Fines imposed**[3) 4)] - No. -
1.	Avoidance of direct deposition and no prevention of runoff of fertiliser into surface waters	**6,645 (744)**	**109**	**47**
2.	Landspreading of nitrogen-containing fertilisers with disregard for absorptive capacity of soils	**6,754 (744)**	**336**	**201**
3.	Immediate incorporation into the soil of slurry, liquid manure, poultry manure and nitrogen-containing secondary raw material fertiliser on unploughed arable land	**9,450 (28,020)**	**431**	**266**
4.	Exceeding the total allowable nitrogen quantity when landspreading slurry, liquid manure, poultry manure or nitrogen-containing secondary raw material fertiliser in the autumn	**5,338 (744)**	**44**	**20**
5.	Unlicensed landspreading of slurry, liquid manure, poultry manure or nitrogen-containing secondary raw material fertiliser during the period in which applications are prohibited	**6,939 (744)**	**131**	**73**
6.	Limited application of livestock farm waste on soils with very high phosphorus (P) or potassium (K) contents	**10,579**	**17**	**8**
7.	Limit to the total amount of nitrogen derived from livestock farm waste which may be applied to land on the holding on average	**15,467 (2,249)**	**369**	**203**
8.	Regular and correct (as per regulation) determination of - available nitrogen - content of P, K and Ca in the soils.	**24,613 (29,808)**	**4 464**	**2,013**
9.	Correct (as per regulation) determination of N, P and K contents of farm wastes to be landspread	**15,129 (2 096)**	**189**	**40**
10.	Record keeping for the purposes of determining the amount of fertiliser required and for nutrient input/output budgeting	**22,901 (29,464)**	**1 659**	**829**
11.	Compliance with retention period for records	**19,083 (5,207)**	**334**	**148**
12.	Compliance with provisions regarding construction and capacity of storage facilities for livestock manure	**5,959 (2,108)**	**178**	**14**

1) Number of cases investigated by the competent authority. Includes cases where *Anlasskontrollen* (*i.e.* inspections where there are reasons to think that irregularities have been committed) were carried out to follow up on non-compliance cases discovered during IACS inspections. The number of IACS inspections are given in brackets. Data regarding IACS inspections were only available for 6 *Länder* (Bavaria, Hesse, Mecklenburg-Western Pomerania, Lower Saxony, North-Rhine/Westphalia, Saxony-Anhalt).

[2] Number of infringements, independent of the nature of proceedings taken (caution, cautionary fine, order, administrative fine).
[3] Evaluation of completed and legally effective fines imposed during the reporting period.
[4] 326 fine proceedings instituted in Hesse can not be assigned to individual infringements and are therefore not included in the table.

3.5 Cost-benefit analysis for individual water protection measures which go beyond good practice

The table below lists some of the familiar measures taken to reduce nitrogen discharges into ground and surface water from the point of view of costs vs. effectiveness. The costs are largely based on the relevant guidelines for the provision of funding for agri-environmental measures during the 2006 support period. Both costs and effectiveness of measures can vary significantly depending on local conditions. The table only shows average figures. Account must be taken of the fact that the agri-environmental measures mentioned not only achieve reductions in N emissions but also entail other positive impacts on the environment, such as reduction of soil erosion, improved soil fertility, reduction of pollution from plant protection products, or enhancement of biodiversity. These effects are not included in the cost-benefit analysis. Therefore a monetary comparison of individual measures is incomplete and is not suited as a the sole criterion for decision-making with regard to possible support measures.

Measure	**Cost**	**Reduction of N emissions**	**Average cost-effectiveness**
Springtime N_{min} analysis to support fertiliser planning	20 - 80 €/plot	0 - 30 kg N/ha	6 €/kg N
Unfertilised riparian zone	800 €/ha	only effective in special cases	-
Use of stabilised mineral fertiliser nitrogen on winter cereal and potato crops	25 - 35 €/ha	0 - 20 kg N/ha	3 €/kg N
Conversion of arable land into extensive grassland	400 - 600 €/ha	30 - 70 kg N/ha	8 €/kg N
Organic farming	80 - 200 €/ha	0 - 50 kg	8.5 €/kg N
Intercropping with late ploughing	40 - 120 €/ha	25 - 50 kg	2.6 €/kg N
Reduced mineral fertiliser nitrogen applications (arable land), to achieve an N target value minus 10-20%; max. 80kg N/ha per application, no late applications for cereals	50 - 300 €/ha	0 - 10 kg	16 €/kg N

Source: Osterburg B., Rühling I., Runge T., Schmidt T.G., Seidel K. (FAL), Antony F., Gödecke B., Witt-Altfelder P.: Kosteneffiziente Maßnahmenkombinationen nach Wasserrahmenrichtlinie zur Nitratreduktion in der Landwirtschaft

4. Forecast

4.1 Forecast for groundwater

Based on the results presented here from the 170 common monitoring stations of the operative monitoring network, a forecast of the possible future development of groundwater quality is given for the first time. The next report to be submitted, *i.e.* the 5th report for the years 2008-2011 was chosen as the forecasting horizon. Due to the special importance of the year 2015 with regard to the EU Water Framework Directive the forecast also includes the future 6th report which will be based on monitoring results from 2012-2015. Forecasts extending further into the future were not attempted.

The estimated future development of nitrate concentrations in groundwater at the 170 common monitoring stations of the operative monitoring network is based on changes in frequency distributions of the concentration classes. The method used is linear regression. The four value pairs consist of the respective report periods (x-axis = abscissa) and the affiliated percentage share of common monitoring stations with reference to a concentration limit (y-axis = ordinate). The calculated trend line was tested for statistical significance. A probability of 90% ($\alpha = 0.05$, two-tailed test) was chosen as significance level. The methodology used corresponds precisely to the algorithm developed as a valid method for trend calculations based on groundwater quality monitoring results in the context of the European Water Framework Directive.

The regression was carried out with concentrations of 50 mg/l, 40 mg/l and 25 mg/l which delimit the four predefined concentration classes. Table 4.1 shows the baseline data and the forecast based thereon for the 50 mg/l concentration limit which is of principal interest and also corresponds to the quality standard for nitrates in groundwater pursuant to the EU Water Framework Directive. For the first reporting period, the share of common monitoring stations showing nitrate concentrations ≤ 50 mg/l is comprised of the sum of shares of the three lower concentration classes (5.3% + 20.6% + 14.1%), amounting to 40.0% (*cf.* Fig. 2.12). The same process was used for the following three reporting periods (Figures 2. 9 -2. 11).

Table 4.1: Forecast for the development of the share of common monitoring stations with a nitrate concentration below the quantification limit of ≤ 50 mg/l

Monitoring periods	**1992-1994***	**1996-1998**	**2000-2002**	**2004-2006**	2008-2011	2012-2015
EU Nitrate Reports (x-axis)	**1**	**2**	**3**	**4**	5	6
Share of common monitoring stations ≤ 50 mg/l [%]	**40.0**	**40.5**	**44.7**	**50.0**	---	---
Regression line: y = f(x) = 3.42 x + 35.3						
Linear regression [%]	**38.7**	**42.1**	**45.5**	**48.9**	---	---
Forecast [%]:					52.4	55.8

*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

The four value pairs in Table 4.1 already demonstrate that the percentage share of common monitoring stations with an average nitrate concentration at or below the quality standard of 50 mg/l increases continuously. The slope of the calculated regression line shows an increase of 3.42% per reporting period. The regression line slope shows a significant trend, indicating an increase of the share to 53.4% and 55.8% respectively for the fifth and sixth reporting periods. Consequently, the share of monitoring stations in the concentration class >50mg/l will therefore decrease.

The calculations for the concentration limit of 40 mg/l, using the same procedure as above, are given in Table 4.2 (also see Figures 2.9-2.12). In this case the baseline data do not show a continuous percentage increase. While the calculated regression line shows a slope of 1.60% per reporting period, this does not represent a significant trend. Therefore, the calculated regression line can not be extrapolated to provide a forecast.

Table 4.2: Forecast for the development of the share of common monitoring stations with a nitrate concentration below the quantification limit of ≤ 40 mg/l

Monitoring periods	**1992-1994***	**1996-1998**	**2000-2002**	**2004-2006**	2008-2011	2012-2015
EU Nitrate Reports (x-axis)	**1**	**2**	**3**	**4**	5	6
Share of common monitoring stations ≤ 40 mg/l [%]	**25.9**	**27.6**	**25.9**	**31.8**	---	---
Regression line: y = f(x) = 1.60 x + 23.8						
Linear regression [%]	**25.4**	**27.0**	**28.6**	**30.2**	---	---
Forecast [%]:					Trend not significant	

*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

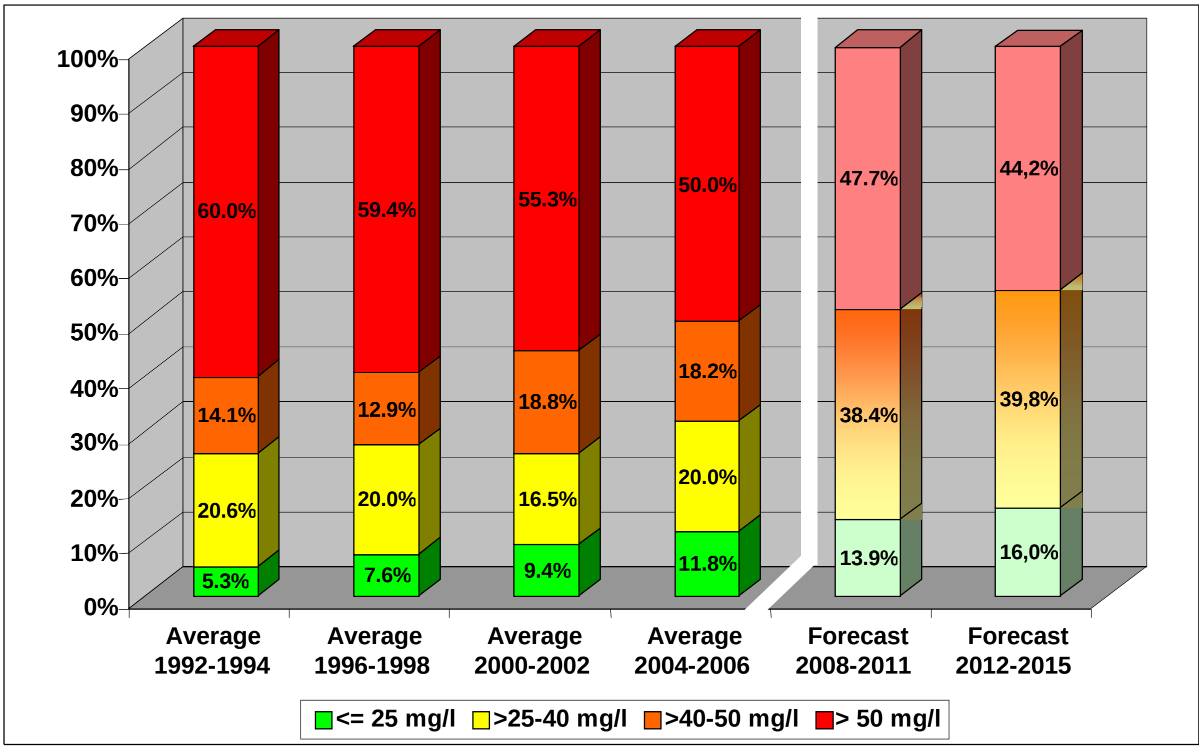
Table 4.3 gives a summary of the results for the 25 mg/l concentration class. This data set also shows a continuous increase in the percentage share of common monitoring stations with an average nitrate concentration at or below 25 mg/l. The regression line slope of 2.13% per reporting period represents a significant trend and allows for a forecast of 13.9% and 16.0% respectively for the two future reporting periods.

Table 4.3: Forecast for the development of the share of common monitoring stations with a nitrate concentration below the quantification limit of ≤ 25 mg/l

Monitoring periods	**1992-1994***	**1996-1998**	**2000-2002**	**2004-2006**	2008-2011	2012-2015
EU Nitrate Reports (x-axis)	**1**	**2**	**3**	**4**	5	6
Share of common monitoring stations ≤ 25 mg/l [%]	**5.3**	**7.7**	**9.4**	**11.8**	---	---
Regression line: y = f(x) = 2.13 x + 3.2						
Linear regression	**5.4**	**7.5**	**9.6**	**11.7**	---	---
Forecast [%]:					13.9	16.0

*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

Figure 4.1 summarises the results given in Tables 4.1-4.3 in graphic form. Basically these are Figures 2.10-2.13 presented as stacked columns per reporting period and with the addition of the two forecasts for future reporting periods. The decrease in the >50 mg/l concentration class is clearly evident, starting at 60% and dropping to a forecast 44.2% (Table 4.1). The increase in the percentage share of common monitoring stations with an average nitrate concentration at or below 25 mg/l is similarly prominent, starting at 5.3% and rising to an expected 16% by 2015 (Table 4.3). Due to the non-significant trend for the 40 mg/l concentration limit (Table 4.2) the two medium concentration classes of >25 to ≤ 40 mg/l and >40 to ≤ 50 mg/l can not be differentiated further. Their joint share increases slightly from 34.7% at the outset to a forecast 39.8% by 2015.

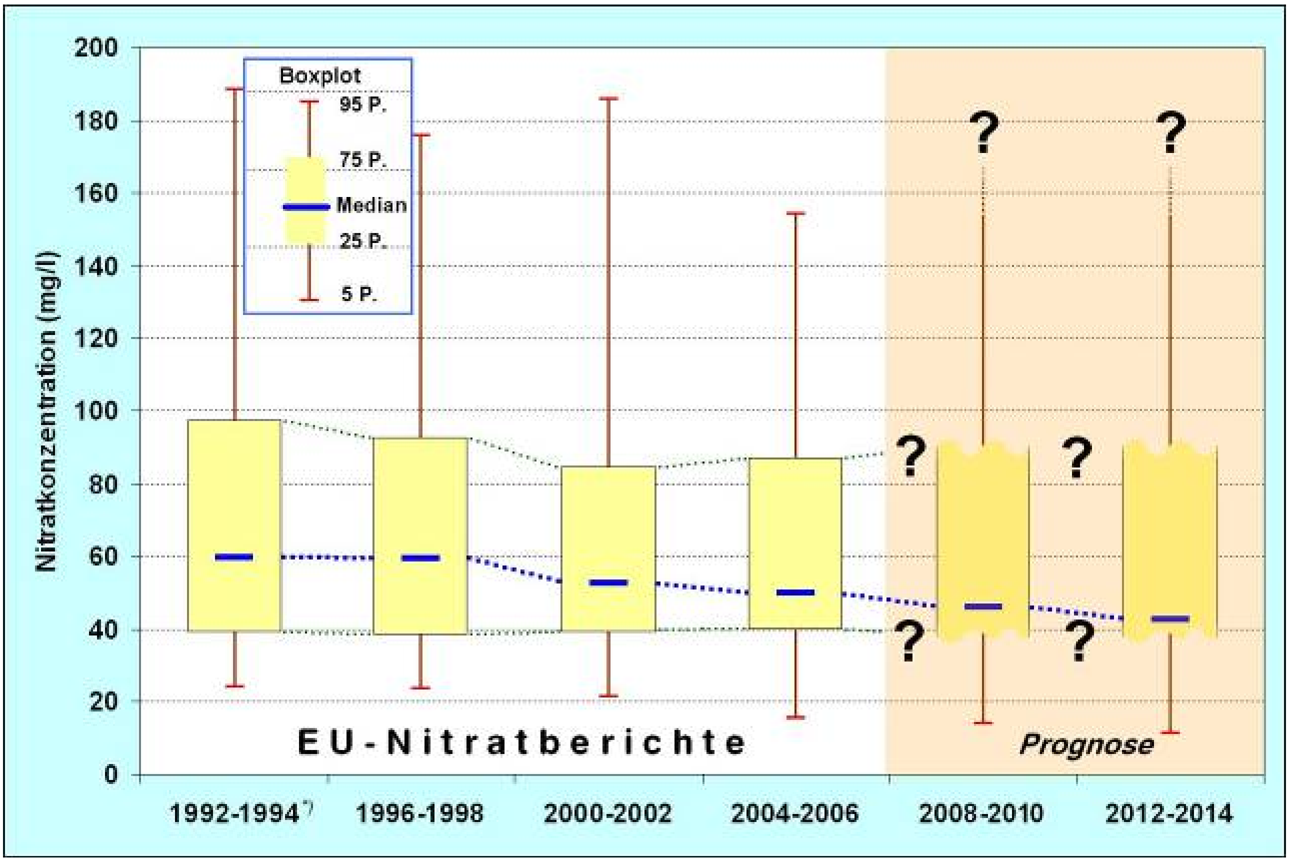


*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

Fig. 4.1: Forecast for the development of nitrate concentrations, based on frequency distributions of the average nitrate concentrations at the 170 common monitoring stations of the EU operative monitoring network in the four completed reporting periods.

An alternative graphic depiction of a forecast based on the 170 common groundwater monitoring stations of the EU operative monitoring network is given in Fig. 4.2. The boxplots are described by the 5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles. The calculation of a regression line, including the test for significance, is carried out separately for each of the five selected percentiles. A significant trend and thus a conjectural estimate for the two future reporting periods is only possible for the 5^{th} percentile and the median. The median decreases from 60 mg/l at the outset to 50 mg/l in the current reporting period. From this trend, an expected value of 45 mg/l can be estimated for the sixth report.

In contrast, the 25^{th}, 75^{th} and 95^{th} percentiles do not allow for a forecast by extrapolation of a regression line recognised as a trend. On the basis of just four value pairs, fluctuations in baseline data, as are particularly evident for the 95^{th} percentile, can quickly lead to a trend for a regression line to be rejected despite the fact that there is at least an indication of a decrease in concentrations in the 95^{th} percentile over the four reporting periods. The graph shows clearly that the change in nitrate concentrations for the subset of monitoring stations with average readings of > approx. 50 mg/l can not be demonstrated with sufficient significance on the basis of the dataset available for this report. However, these are the groundwater monitoring stations at which the development of nitrate concentrations is of particular interest.



*) Monitoring stations at which the first nitrate sampling data were gathered in 1995 are included in the 1992-1994 monitoring period

Fig. 4.2: Forecast of the development of nitrate concentrations. Boxplot presentation of the average nitrate concentrations at the 170 common monitoring stations of the EU operative monitoring network in the four completed reporting periods, extended by two time periods for forecasting purposes.

Nitratkonzentration … = Nitrate concentration (mg/l)
EU- Nitrat… = EU Nitrate Reports
Prognose = Forecast

Even though this report can not answer all questions as to estimates of the development of nitrate concentrations at the majority of highly contaminated groundwater monitoring stations, it can be established that generally a lower degree of contamination of groundwater with nitrates compared to the initial reporting period is discernible. Provided current conditions remain unaltered or are slightly enhanced by optimised measures (*e.g.* action programme), it can reasonably be expected that the trend in groundwater quality will continue. This assumption is also supported by the results of model calculations of which an example is given in Chapter 4.2, dealing with the Weser River hydrographical district at the regional level. Considering numerous additional factors, which are only documented as past summary readings or past average readings at monitoring stations in the context of this chapter, these model calculations document that under the conditions assumed, a development towards generally slightly decreasing nitrate concentrations in groundwater continues to be a realistic assumption for the nearest future.

4.2 Forecast of the development of the quality of waters using computer-based models

To a great extent, the future development of the pollution of waters with nitrates is dependent on the agricultural and environmental policy framework for agricultural production. Due to the complexity of causal relationships in this field, the force and direction of the policy impacts on regional nutrient losses from farming and thus on water quality are very hard to determine. To this end, long established computer-based models were combined into an interdisciplinary model network and applied to the Weser river hydrographical district. The models are RAUMIS (Kreins et al., 2007) for agriculture, developed at the Johann Heinrich von Thünen-Institute (vTI-Braunschweig), GROWA/WEKU (Wendland et al., 2004) for nutrient discharges into groundwater and surface waters, developed at the Jülich Research Centre, and MONERIS (Behrendt et al., 1999), an emission model developed at the Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin. This combination of models allows for estimates to be made regarding the expected regional developments in the farming sector and the resulting impacts on groundwater and surface waters. The study area around the Weser river is heterogeneous both in agricultural terms and in terms of natural site conditions and mirrors a wide range of conditions as can be found in other parts of Germany. Therefore the conclusions drawn from the results of the combination of models would be transferable to the country as a whole.

4.2.1 Development of excess nutrients in farming

With a view to the development of future nutrient balance surpluses in Germany the following parameters were taken into account in the model analyses:

- extrapolation of technical progress;
- further development of the EU Common Agricultural Policy (CAP) including the decoupling of direct payments from plant and livestock production, the suspension of compulsory set-aside, the reform of the market organisation for sugar, the introduction of nationwide trade in milk quotas, and changes in agri-environmental programmes in the 2007-2013 funding period;
- support for the production of energy crops resulting from the amendment of the Renewable Energy Sources Act in 2004;
- amendment of the Fertiliser Ordinance in 2006.

Regarding price trends, a sustained increase for agricultural products, as has been evident since 2007, was implied in keeping with projections issued by international research institutes. It was not possible to consider the implementation of supplementary measures to achieve the objectives of the Water Framework Directive since the relevant programmes have not yet been finalised by the *Länder*.

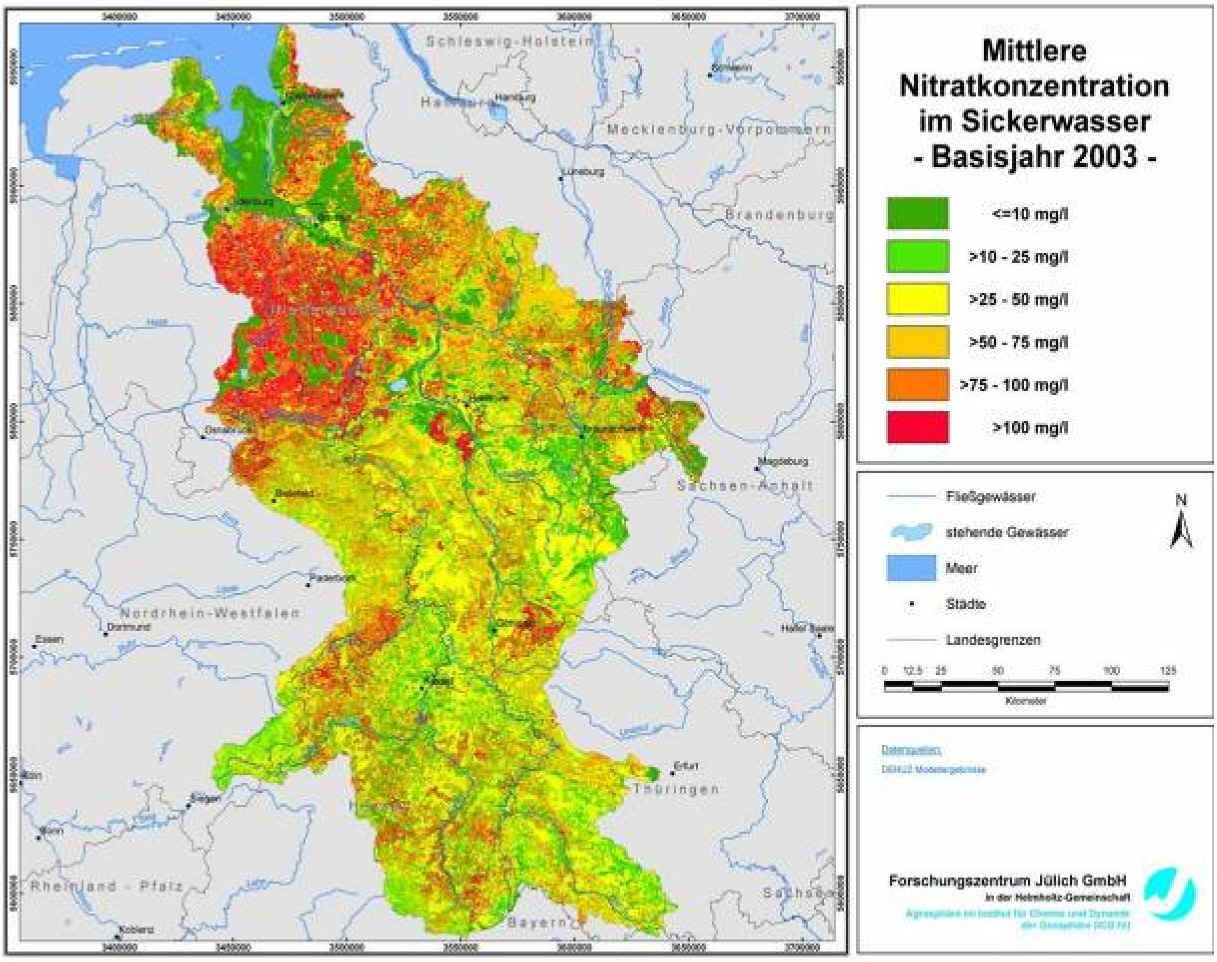
It can reasonably be expected that current developments in agricultural and agri-environmental policy will entail further reductions in pollution from diffuse sources but the regional manifestation as well as the force and direction of impacts may vary widely. While increased production due to the forecast price increase for agricultural commodities, the suspension of set-aside and an increase in the production of maize as an energy crop are likely to lead to an increased nutrient balance surplus, the reduction in cattle numbers due to the decoupling of livestock premia and the expected efficiency increases in the use of farm wastes resulting from the implementation of the Fertiliser Ordinance should lead to a reduction in nutrient balance surpluses. Therefore, it is expected that by 2015 nutrient surpluses should decrease by approximately 10-15 kg N/ha AA overall. In regions with high livestock densities whose baseline situation has been characterised by above average nutrient balance surpluses, a relatively high decrease in nitrogen budget surpluses is predicted. Nonetheless these regions will continue to show the highest nutrient balance surpluses.

4.2.2 Groundwater

In consultation with the Weser River Basin Commission and the *Länder* bordering the river, a concentration of 50 mg nitrate/l in seepage water was agreed as a target value for groundwater. In order to determine the nitrate concentrations in seepage water for the entire catchment area of the Weser river, the nitrogen budget surpluses calculated by the RAUMIS model were combined with seepage rates calculated by the GROWA model. The following figures show the results of the modelled average nitrate concentrations in seepage water for 2003 (Fig. 4.3), the expected average nitrate concentrations in seepage water in 2015 considering all the above-named factors (Fig. 4.4) and the change between 2003 and 2015 (Fig. 4.5).

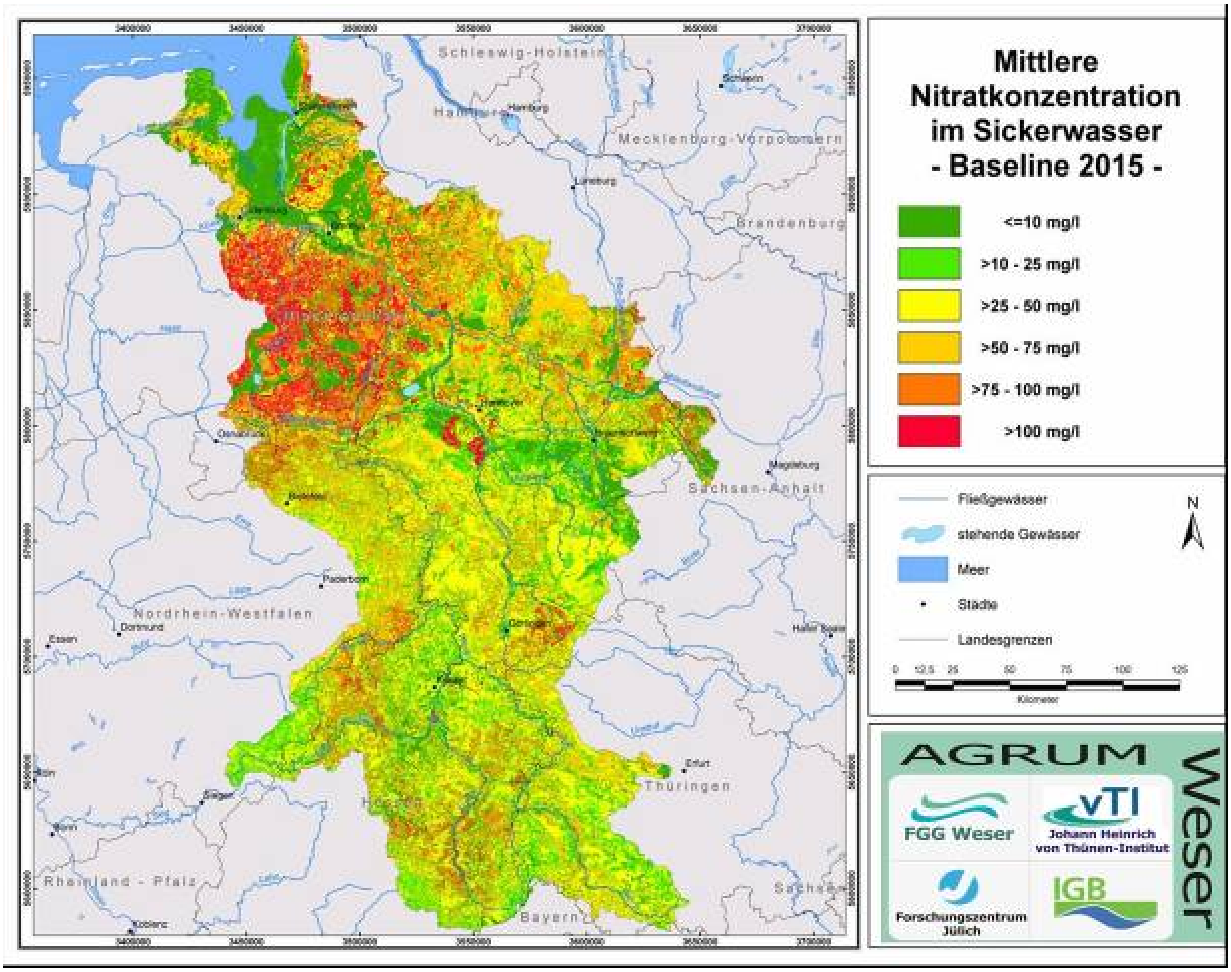
It is evident that nitrate concentrations in seepage water modelled for the baseline year of 2003 are higher than 50 mg nitrate/l in many regions. The measures implemented by 2015 will lead to a reduction of nitrate concentrations in seepage water in almost all regions of the Weser river catchment. Especially in the regions with high livestock densities, which are located in the northwest of the study area, the reduction can be 50 mg/l or more. Nevertheless it must be assumed that additional measures will be required in the “hotspot” regions for the environmental quality target of 50 mg/l to be achieved by 2015.

Figure 4.3: Average nitrate concentrations in seepage water in 2003



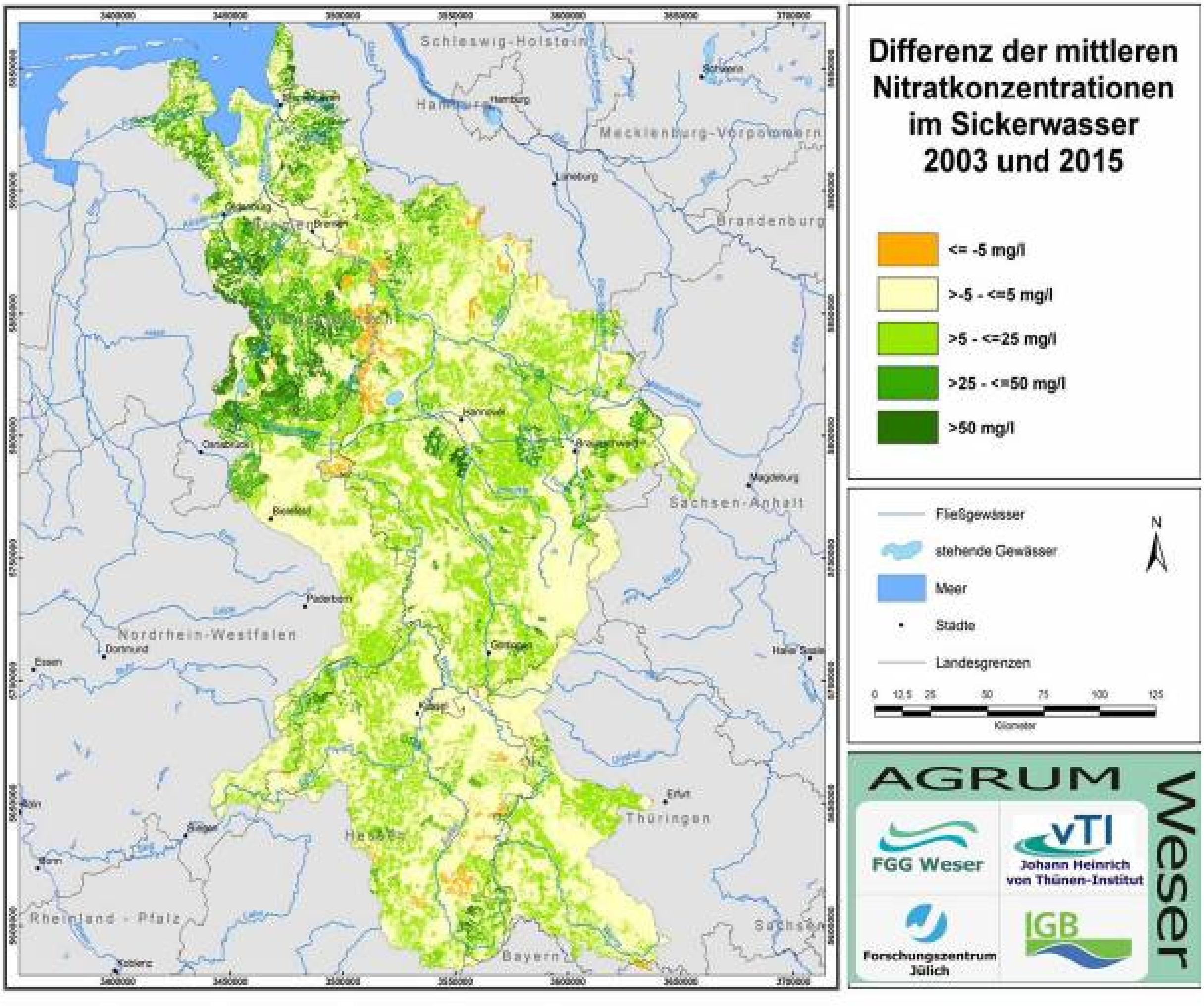
Mittlere Nitrat … = Average nitrate concentrations in seepage water – Baseline year 2003 –
Fließgewässer = Rivers and streams
Stehende Gewässer = Stagnant waters
Meer = Sea
Städte = Towns and cities
Landesgrenzen = *Land* borders

Figure 4.4: Average nitrate concentrations in seepage water in 2015



Mittlere Nitrat … = Average nitrate concentrations in seepage water – Baseline year 2015 –
Fließgewässer = Rivers and streams
Stehende Gewässer = Stagnant waters
Meer = Sea
Städte = Towns and cities
Landesgrenzen = *Land* borders

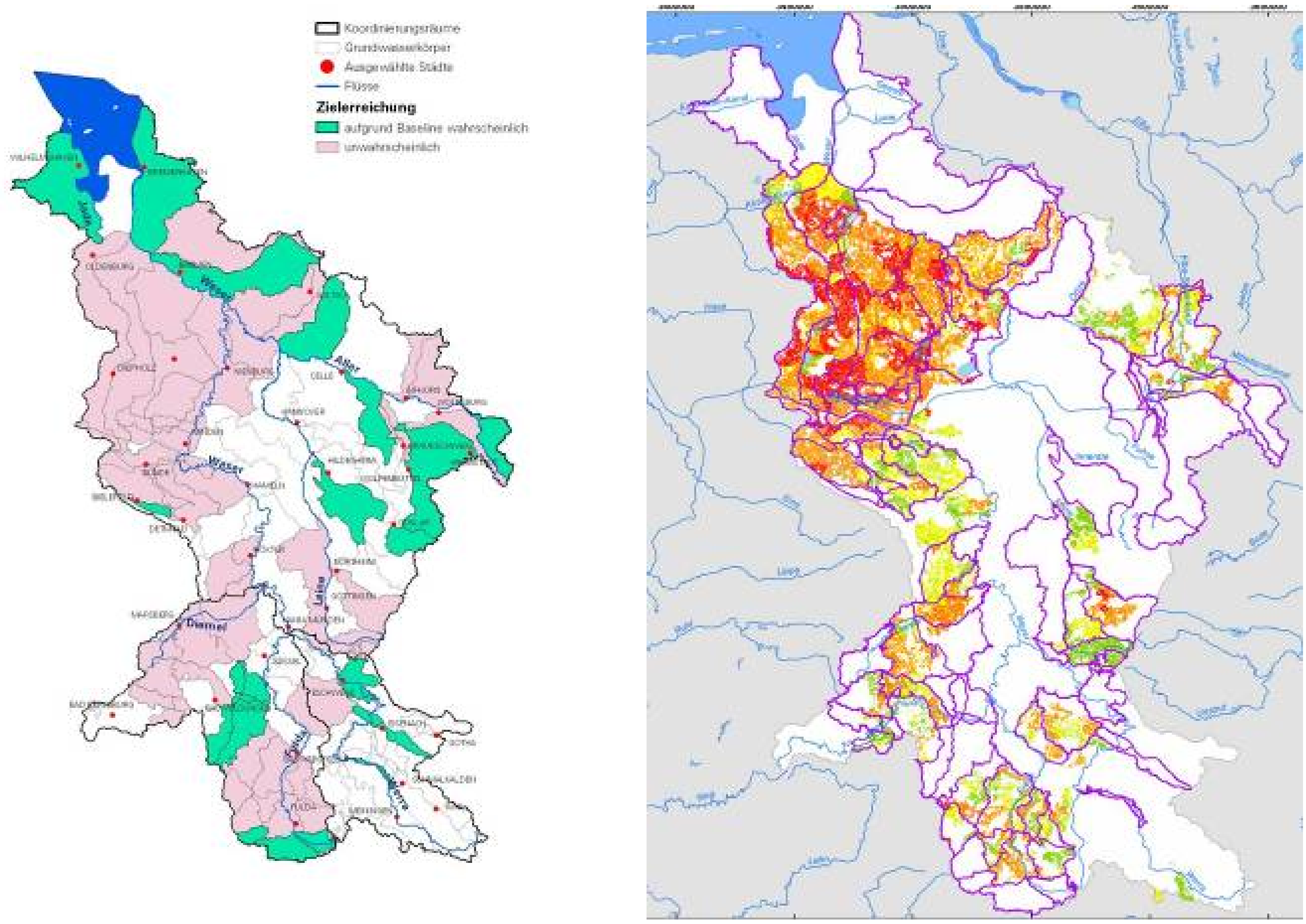
Figure 4.5: Difference between average nitrate concentrations in seepage water in 2003 and 2015



Mittlere Nitrat … = Average nitrate concentrations in seepage water – Baseline year 2003 –
Fließgewässer = Rivers and streams
Stehende Gewässer = Stagnant waters
Meer = Sea
Städte = Towns and cities
Landesgrenzen = *Land* borders

In order to assess whether the measures implemented by 2015 will suffice to achieve the environmental quality target of 50 mg/l in seepage water in the bodies of groundwater which were classified as “achievement of objective unlikely” in the baseline inventory, the target situation was compared to the evaluation of the baseline inventory (see Figure 4.6):

Figure 4.6



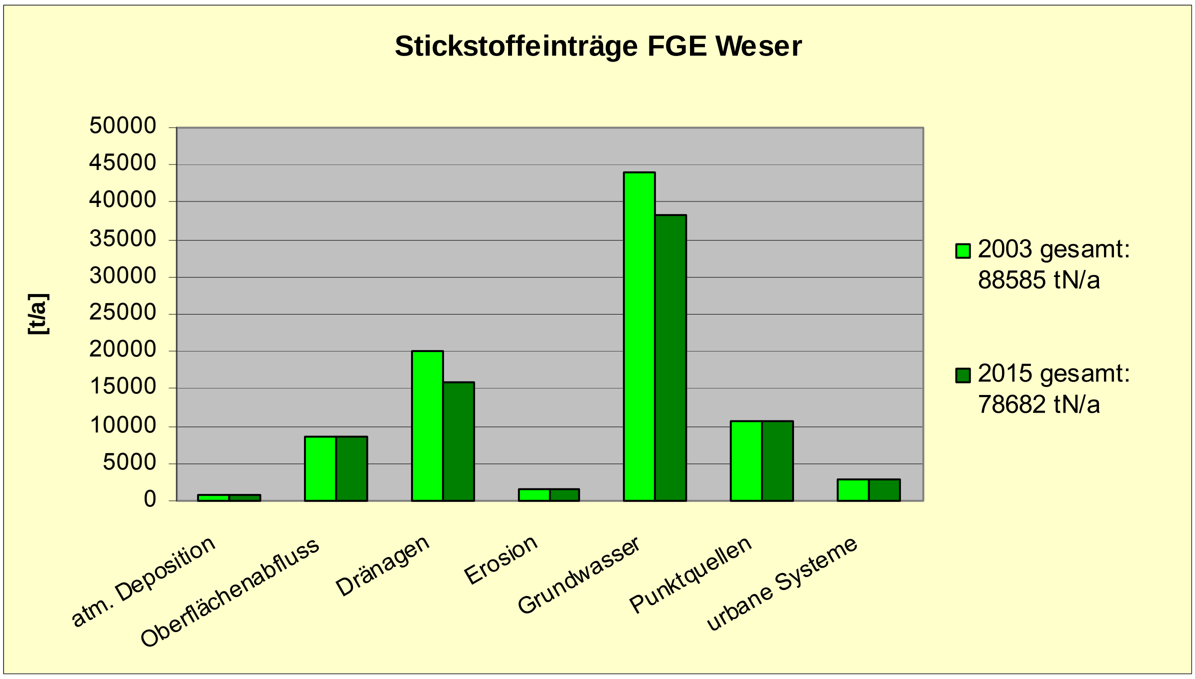
Koordinierungsräume = Coordination areas
Grundwasserkörper = Bodies of groundwater
Ausgewählte Städte = Selected towns
Flüsse = Rivers
Zielerreichung = Achievement of objective
aufgrund Baseline wahrscheinlich = likely under baseline scenario
unwahrscheinlich = unlikely

Figure 4.6 (map on left) depicts the bodies of groundwater in green and pink which were classified as “achievement of objective uncertain” or “achievement of objective unlikely” respectively in the baseline inventory under the WFD. Green areas depict bodies of groundwater which will achieve the objective solely with the basic measures (especially the Nitrates Action Programme) – described here as the baseline scenario. These are 22 bodies of groundwater representing 20% of the total Weser River Basin Commission area. They are equivalent to the white areas in Figure 4.6 (map on right). In the remaining 56 bodies of groundwater shown in pink (42% of the total Weser River Basin Commission area) the target is not expected to be achieved by 2015. Currently additional measures are being assessed in these areas which are to be implemented in the context of the programmes of measures under the Water Framework Directive. However, due to the in part long residence times of water in the soil it would be unrealistic to expect that the objectives will be achieved in all bodies of groundwater by 2015.

4.2.3 Surface waters

With the aid of the MONERIS model nutrient inputs were calculated based on the nutrient balance surpluses determined by the Johann Heinrich von Thünen-Institute (vTI Braunschweig). Under average hydrological conditions the calculated nitrogen discharges amount to 88,585 tons in 2003 and 78,682 tons in 2015. For 2015 the nitrogen discharges can be broken down by pathways as follows:

Figure 4.7 Nitrogen discharges into the Weser river



Stickstoffeinträge FGE…= Nitrogen discharges river basin district Weser
atmos.Deposition = deposition
Oberflächenabfluß = Surface runoff
Dränagen = Drainage
Erosion = Erosion
Grundwasser = Groundwater
Punktquellen = Point sources
urbane Systeme = Urban systems

In addition to the changes shown in Figure 4.7 a reduction of point source pollution can be expected in the territories of the new *Länder* which are part of the Weser River Basin Commission area as most likely both the treatment phases available at sewage treatment plants and sewer connection rates of settlements will increase. The reduction of inputs through drainage is not due to dismantling of drains but to the reduction of agricultural N budget surpluses. Nitrogen discharges from atmospheric deposition, which contribute significantly to N discharges from agricultural lands and are included in the “surface runoff”, “drainage” and “groundwater/interflow” input paths of the above graphic, will decline due to decreasing cattle numbers. Forecasts on this matter are not yet available. Overall, an 11% reduction in loads is expected in the Weser River Basin Commission area.

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Appendix I

Implementation of the Action Programme and results from the *Länder*

***Land*: Brandenburg (BB)**

Activity	Extent of measures, impacts
Training and information measures on improved application of Good Farming Practice	25 presentations in the districts, at agricultural colleges, at private agricultural extension facilities and at the Brandenburg State Academy. Specialist conferences and field visits. Publications on soil analysis results in the media and on the Internet. Further training of advisors.
Soil analysis, official fertiliser recommendation, analysis of slurry	N monitoring on 350 representative areas, regularly sampled in spring and autumn. Publication of N_{min} values and specification of reference values for first N application.
Storage capacity for farm wastes	Investment support for slurry and farmyard manure storage Cross compliance inspections in 2005 to 2007
Agri-environmental measures	The KULAP 2000 cultural landscape programme in BB supported measures which reduce erosion, are less damaging to soils and widen crop rotations. 2004 – 15,510 ha 2005 – 15,510 ha 2006 – 5,392 ha 2007 – figures not yet available
Evaluation of N balances	Inspection of nutrient balances of holdings 2004 – 225 holdings 2005 – 220 holdings 2006 – 40 holdings (selected based on risk assessment) 2007 – 20 holdings
Erosion control	Winter green cover over the past few years was as follows: 2003/2004 – 670,700 ha 2004/2005 – 687,400 ha 2005/2006 – 721,000 ha 2006/2007 – 765,515 ha
Measures going beyond good agricultural practice (e.g. in water protection areas)	

Land: Baden-Württemberg (BW)

Activity	Extent of measures, impacts
Training and information measures on improved application of Good Farming Practice	Training and information measures aimed at conveying the precise nature of good agricultural practice in fertiliser use were consistently continued in Baden-Württemberg during the third action period. The emphasis was on nutrient balancing and the assessment of nutrient input/output budgets.
Soil analysis, official fertiliser recommendation, analysis of slurry	40,000 soil analyses for nitrate-N annually in 2004 to 2006, including N fertiliser recommendations for each plot. Fertiliser recommendations are given for all enterprises (tillage, grassland, fruit production, wine production, horticulture). As part of MEKA, more than 2,000 holdings regularly analyse their slurry for nutrient content.
Storage capacity for farm wastes	According to official statistics (2003 and 2005 censuses) the storage capacity for slurry has increased by 6% to just under 11 m^3 per LU during that period in Baden-Württemberg overall.
Agri-environmental measures: Scheme for the re-alignment of production with the market capacity and for the protection of cultural landscapes (MEKA)	Support for the use of modern (close to the surface) slurry application technology on more than 80,000 ha (just under 10% of lands to which slurry is applied). Green cover was sown following the harvest of the main crop on approx. 150,000 ha or 18% of tillage ground during the reporting period.
Evaluation of N balances	According to evaluations of long-term records from farm holdings by the University of Hohenheim, the N balance surplus (“farm gate balance”) continued to decrease during the reporting period down to 76 kg N/ha in 2005/06. In 2000/01 the surplus was 92 kg N/ha.
Erosion control	As part of the MEKA agri-environmental programme mulch seeding was practiced on more than 120,000 ha AA or 15% of tillage ground during the reporting period.
Other	As part of the state’s Protected Areas Compensation Ordinance (*Schutzgebiets- und Ausgleichs-Verordnung – SchALVO*) soils are monitored for N_{min} at approx. 20,000 sites annually at the end of the growing season.
Measures going beyond good agricultural practice (e.g. in water protection areas)	Baden-Württemberg’s water protection areas (approx. 25% of the state’s area) are, in their entirety, subject to the SchALVO (Protected Areas Compensation Ordinance). With the amendment of the ordinance in 2001, additional measures were focused on areas with higher nitrate concentrations (problem areas and rehabilitation areas). These comprise approximately 5% of the state’s area. The additional measures going beyond good agricultural practice, such as limitations on the spreading of farm wastes, specifications on the timing and manner of soil cultivation etc., are inspected on about 20% of the lands.

Land: Bavaria (Bayern) (BY)

Activity	Extent of measures, impacts [1]
Training and information measures on improved application of Good Farming Practice	3,927 information activities with approximately 150,000 participants; 744 training measures with approximately 22,000 participants
Soil analysis, official fertiliser recommendation, analysis of slurry	N fertiliser recommendations for 167,170 plots based on N_{min} soil analysis or EUF.
Storage capacity for farm wastes	Support for 664.879 m³ slurry storage capacity
Agri-environmental measures	As part of the Cultural Landscape Programme Part A premia were paid between 2004 to 2006 on 1,263,751 ha of land in connection with nitrogen discharges to waters (multiple listing of sites is possible). Under the conservation management agreement programme premia were paid on an average of 1,922 ha in 2005 and 2006.
Evaluation of N balances	8,697 nutrient balances (evaluated at the authorities with responsibility for farming and forestry as part of their advisory service); in 2007 9,253 holdings used the input/output accounting programme developed by the state agency for agriculture; for viniculture and horticulture this work is done by the Franken vintners' association and the numbers are not included here.
Erosion control	Investment support for the purchasing of 169 mulch seeders (Funding: € 869,083); Advise disseminated through circulars to producers.
Other	Numerous circulars and press releases Investment support for the purchasing of 132 slurry spreaders applying slurry at soil level, injector slurry spreaders and precision spreaders for farmyard manure (Funding: € 681,311)
Measures going beyond good agricultural practice (e.g. in water protection areas)	The following are examples of measures taken: CULTAN project (Controlled Uptake Long Term Ammonium Nutrition) of the *AK Marktfrucht* (working group on market crops) Bad Kissingen Participation in various water protection strategies (*e.g.* Simseeschutzkonzept, Eixendorfer Stausee, Drachensee, Projekt Vilstal, Projekt Unterer Main, Projekt Waginger-Tachinger See) The following topics were or are the subjects of applied research: - Necessity of autumn N applications on winter grazing land - Autumn N applications on straw of grain maize - N applications using the N Sensor system - Necessary N applications in biogas crop rotations - Impact of organic fertilisers on plant production

[1] The measures listed here are those implemented in 2004 to 2007 unless stated otherwise.

Land: Hesse (Hessen) (HE)

Activity	Extent of measures, impacts
Training and information measures on improved application of Good Farming Practice	Approx. 250 information events on questions relating to fertiliser use. Development of a guide to the implementation of the new Fertiliser Ordinance – 2,000 copies; also available on the Internet with approx. 3,000 downloads per annum.
Soil analysis, official fertiliser recommendation, analysis of slurry	Approx. 6,500 N_{min} analyses carried out at the state laboratory *Landesbetrieb Hessisches Landeslabor (LHL)* and fertiliser recommendations issued. 100 analyses for winter barley test site programme 700 analyses for reference site programme (development of fertiliser recommendations by the LHL)
Storage capacity for farm wastes	No information
Agri-environmental measures	Lands supported under AEP: - Organic farming 43,359 ha - Intercropping 1,905 ha - Flower-rich plots on set-aside/ conservation headlands 95 ha - Mulch seeding and direct sowing methods 38,019 ha - Grassland extensification 105,097 ha
Evaluation of N balances	Evaluation of appr. 800 N balances by the state laboratory *Landesbetrieb Hessisches Landeslabor (LHL)* and special advisers in water protection areas
Erosion control	Annual soil conservation field days. Focus: Reducing discharge of nutrients into watercourses
Other	Pilot project on evaluation of different types of land use with a view to their groundwater pollution potential at the *Lange Schneise Nord* water purification plant.
Measures going beyond good agricultural practice (e.g. in water protection areas)	Soil conservation field days (focus on reducing discharge of nutrients into watercourses); annual event. Three-year pilot project on reducing discharge of nutrients into a flood detention basin (Antrift River Project) Approx. 73 cooperations incl. initial financing for the provision of additional advisory services in water protection; the cooperations were subject to an evaluation in 2004-2006. At 2/3 of holdings there was a significant decline in N budget surpluses.

***Land*: Mecklenburg-Western Pomerania (Mecklenburg-Vorpommern) (MV)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	Annual measures in 2004, 2005, 2006, 2007 - 100 training sessions annually by the agricultural authority (*Landwirtschaftliche Fachbehörde*, LFB) and other competent authorities with approx. 1500-2500 participants (*i.a.* fertiliser seminar, specialist conferences, farmers' meetings), - 15-20 publications annually by the LFB on topical issues (*i.a.* storage of farmyard manure, N balances, soil analysis), - 20 publications annually in specialist magazines or journals (*i.a. Bauernzeitung* / nutrient balance, storage of silage effluent), - Working group on fertiliser use under the aegis of the LFB with participation by practitioners, scientists and public authorities, - Leaflet on fertiliser use published by LFB in 2004 and 2007, - 2007, leaflet on implementation of the Fertiliser Ordinance in MV for farmers and advisors, - annual mailshot to all applicants regarding support for commitments under cross-compliance standards in accordance with Annex III and IV in printed form and as an electronic file together with the application forms, - Internet presence of LFB with all topical information on fertiliser use (leaflet on fertiliser use, law, N balance, specialist information, fertiliser recommendations, N_{min}, soil condition).
Soil analysis, official fertiliser recommendation, analysis of slurry	- Annual evaluation regarding nutrient supply of soils (*i.a.* MV Agricultural Report, specialist conferences); - annual information on N_{min} and N_{min} for organic farmers (226 plots) for farmers, advisors, public authorities; - annual information on soil condition (soil water saturation) for farmers and public authorities; - annual up-to-date fertiliser recommendations by crop as material for advisors and also on the Internet
Storage capacity for farm wastes	The *Anlagenverordnung* MV (Ordinance on installations handling water-polluting substances) was amended in 2005 and prescribes a storage capacity of at least 26 weeks. The programme for support for slurry tanks ended in 2004. Support for slurry tanks and dungsteads is provided as part of investments in agricultural holdings.
Agri-environmental measures	In MV the following agri-environmental programmes are available: - Organic farming; - Integrated fruit and vegetable production; - Extensive grassland farming; - Bird staging areas along migration routes - Hedgerow verges

	During the reporting period 2,400 applicants out of a total of 4,800 farmers participated in the programmes. All programmes include measures regarding fertiliser use which go beyond good agricultural practice.
Evaluation of N balances	Evaluation of 100,000 ha of market crop land; average balance is approx. 60 kg N/ha/a.
Erosion control	Inspections for erosion control are part of a complex on-site check in conjunction with inspections regarding nitrates, groundwater, Habitats Directive, protection of birds, and sewage sludge under cross-compliance. Mapping of sites at risk of erosion is planned. This is to provide a baseline for advisory services, measures undertaken by farm holdings, and checks by the authorities. At present an administrational guideline on erosion control is in preparation which is to be offered as an additional agri-environmental programme from 15.05.09.
Other	Change of distances to watercourses from a global 7 m in the state water management law to the distances specified in the Fertiliser Ordinance. In order to support inspections regarding fertiliser use and to inform farmers, a project to map sites with a slope of >10% has been commissioned. Peatland protection programme in the context of support for sustainable development of watercourses and wetlands. Between 2007 and 2013 approximately € 31 million are available for this objective, which also includes aspects of the WFD.
Measures going beyond good agricultural practice (e.g. in water protection areas)	Measures in water protection areas: Prototype catalogue for water protection areas with minimum prescriptions for the individual zones in accordance with the Fertiliser Ordinance; contains measures such as: extended period in which fertiliser applications are prohibited, lower maximum quantities of N (120 kg/ha) from farm wastes. Alliance for agriculture and the environment: Working group on diffuse nutrient discharges

***Land*: Lower Saxony (Niedersachsen) (NI)**

Activity	Extent of measures, impacts
Training and information measures on improved application of Good Farming Practice	Publication of professional articles on the amendment of the Fertiliser Ordinance in print media and on the Internet. State-wide information events on the amendment of the Fertiliser Ordinance; approx. 100 events in the winter of 2006/07. Training courses on compliance with cross-compliance criteria within the scope of the EU Nitrates Directive 91/676/EEC. Impact: improved application of good farming practice as regards fertiliser use. Improved nutrient efficiency and minimisation of nutrient losses in individual cases.
Soil analysis, official fertiliser recommendation, analysis of slurry	Approx. 40,000 N_{min} samples (0-30 cm) per year; trend stable in terms of numbers. Approx. 4,000 slurry analysis per year; trend increasing (2004: 3,183; 2007: 5,460 slurry samples). Continuous calibration of fertiliser recommendations against field trials. Publication of fertiliser recommendations in print media and on the website of the Lower Saxony Chamber of Agriculture. Impact: Improved nutrient efficiency and minimisation of nutrient losses
Storage capacity for farm wastes	Compilation of advisory material on the implementation of regulations regarding the construction and capacity of storage facilities for manure. Support for minimum storage capacities in the context of planning permissions. Check of existing storage capacities to bridge the period in which applications are prohibited in accordance with the Fertiliser Ordinance as part of cross-compliance checks. Impact: Improved nutrient efficiency and minimisation of nutrient losses
Agri-environmental measures	See under “Erosion control”. Application of liquid farm wastes on arable land or grassland using environmentally-friendly technology; approx.1,100 ongoing contracts covering an area of 115,000 ha. Impact: Improved nutrient efficiency and minimisation of nutrient losses.
Evaluation of N balances	Evaluation of approx. 3,000 N balances in accordance with the Fertiliser Ordinance. Calculation of N emissions on the basis of the N surpluses determined. Impact: Consideration of the evaluations as part of the baseline inventory in accordance with the Water Framework Directive. Implementation of management measures with a view to groundwater protection in the wider landscape.
Erosion control	Application of mulch seeding or direct sowing and mulch planting methods in tillage farming; approx. 1,600 ongoing contracts with a supported area of approx. 47,000 ha as part of the Lower Saxony agri-environmental programmes Impact: Minimisation of soil erosion and nutrient discharges into surface waters
Other	Pilot projects on erosion control and on improving nutrient efficiency

Measures going beyond good agricultural practice (e.g. in water protection areas)	Comprehensive research on land management with a view to groundwater protection. Approx. 120 information events on water protection issues.

***Land*: North-Rhine/Westphalia (Nordrhein-Westfalen) (NW)**

<table>
<tr><th>Activity</th><th>Extent of measures, impacts</th></tr>
<tr><td>Training and information measures on improved application of Good Farming Practice</td><td>Up to 50 specialist events per year with a variety of thematic priorities;
Fax information service by the Chamber of Agriculture (LWK)
Publications in weekly farming magazines and professional journals; annually updated booklet published by the Chamber of Agriculture (Guide on plant production and plant protection, approx. 490 pp; 8,000 copies).</td></tr>
<tr><td>Soil analysis, official fertiliser recommendation, analysis of slurry</td><td>LWK nitrates service, state-wide sampling network of 58 sites, monthly N_{min} measurement, evaluation and interpretation of data on the Internet, Internet portal “http://www.Nmin.de” (N_{min} reference values and fertiliser recommendations by plot, unlimited access)
Development of a fertiliser planning programme (cooperation between LWK and the company YARA: use of fertiliser recommendations is obligatory, programme is distributed by LWK free of charge and usage is free)
Development and application of the Excel-based nutrient input/output budgeting programme “Programm Nährstoffvergleich NRW" (implementation of the Fertiliser Ordinance, compilation and interpretation of nutrient input/output budgets, evaluation of N surplus)
N_{min} analyses/year (only by LUFA – Agricultural Investigation and Research Institution)
2004: 52,236, 2005: 51,276, 2006: 54,122, 2007: 55,326</td></tr>
<tr><td>Storage capacity for farm wastes</td><td>Support under the “Initiative ökologische und nachhaltige Wasserwirtschaft” (initiative for ecological and sustainable water management) until early 2006. Since 1999: 581 cases supported with a total of approx. € 5.7 million. Since 1989 new facilities constructed must have a minimum 26 week storage capacity.</td></tr>
<tr><td>Agri-environmental measures</td><td>Between 2004 and 2007 the following agri-environmental measures with regard to water protection / N discharges have received support:
<table>
<tr><th></th><th>total €
2004-07</th><th>max. eligible
area (ha)</th></tr>
<tr><td>Conservation headlands</td><td>1,752,408</td><td>852</td></tr>
<tr><td>Grassland extensification</td><td>56,859,147</td><td>92,734</td></tr>
<tr><td>Organic farming</td><td>44,276,870</td><td>49,484</td></tr>
<tr><td>Set-aside</td><td>3,325,405</td><td>2,084</td></tr>
<tr><td>Riparian zones</td><td>12,256,760</td><td>4,486</td></tr>
<tr><td>Conservation management agreements</td><td>40,810,227</td><td>37,343</td></tr>
</table></td></tr>
<tr><td>Evaluation of N balances</td><td>Approx. 1000 nutrient budgets per year requested and evaluated by the competent authority incl. plausibility checks; selection of farms for on-site inspection. Between 2004 and 2007 a total of 3467 nutrient budgets were checked.</td></tr>
</table>

Erosion control	Supported in the context of agri-environmental measures on approx. 90,543 ha in 2006; various research projects, *e.g.* determination of C-factors (Universal Soil Loss Equation) specific to NRW for erosion control advice.
Other	Development of enforcement advice on the amended Fertiliser Ordinance in 2006; continuous adaptation of programmes, training and advice. In 2007 commencement of projects on the application of 230 kg N/ha from farm wastes on grassland on farm holdings under the derogation: application, repercussions for soil nitrogen dynamics, nitrate leaching etc.

Measures going beyond good agricultural practice (e.g. in water protection areas)	As of 2007:
	• 119 cooperations
	• almost 9,000 members
	• 54 advisers
	• all 390 water protection areas covered
	• Approx. 3,840 km^2 (approx. 11,2% of the state's territory)
	Study on methodology for the evaluation of cooperations using the example of 21 water protection areas (40,000 ha):
	Results of the study:
	▪ Effectiveness/efficiency of individual measures not quantifiable; qualitative statements possible
	▪ Evidence of significant developments towards decline in nitrate concentrations in groundwater and untreated water, *i.a.* where nitrate concentrations are high or medium high
	▪ Deduction of essential basic data as they apply to cooperations with a view to intensity of impact on groundwater/untreated water (indirect evaluation criteria)
	    ▪ N_{min} timelines
	    ▪ Nutrient input/output budgets for individual holdings

***Land*: Rhineland-Palatinate (Rheinland-Pfalz) (RP)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	Agriculture: 731 events with approx. 32,000 participants; Fruit & vegetable production / viniculture: 103 presentations, 114 field visits, 160 visits to vineyards with a total of approx. 6,350 participants. Up-to-date information via hazard warning service, weather fax and Internet services. Approx. 20 fertiliser trials as part of agricultural research by the state of Rhineland-Palatinate
Soil analysis, official fertiliser recommendation, analysis of slurry	Agriculture: approx. 1,320 N_{min} tests incl. evaluation and fertiliser recommendation; Fruit & vegetable production / viniculture: approx. 13,500 N_{min} tests and P/K/Mg with fertiliser recommendations; Agricultural research: Testing for N_{min} and organic matter content, determination of leaf stalk NO_3, leaf analyses
Storage capacity for farm wastes	51 investment projects, including 40 slurry tanks. Between 2004 and 2007 40,322 m^3 new storage capacity was created (2000-2007: 187,924 m^3). Applications for derogations from the period in which land applications of fertilisers are prohibited continued to decline (2002-2004: 867, 2004-2006: 261), since 2007 extensions only on a few holdings
Agri-environmental measures	Support and technical advice as required, programmes FUL (Support Programme for Environmentally Sound Land Management) and PAULa (Programme Agriculture-Environment-Landscape)
Evaluation of N balances	Evaluation of 3,900 “farm gate” and “field to stable” nutrient budgets
Erosion control	Own series of experiments on erosion control. Numerous advisory sessions, demonstrations of seed drilling and sowing techniques. Mulch seeding programme: approx. 130 participants, 6,100 ha and numbers rising Increase in intercropping. Vegetative ground-cover in vineyards: 75% with grasses, the remainder use intercropping or apply straw mulch.
Other	Development of a catalogue of measures to reduce nitrate losses in vineyard soils
Measures going beyond good agricultural practice (e.g. in water protection areas)	Establishment of riparian zones at sensitive sites; Support and advice for four cooperations in water protection areas; Establishment of working groups in a few problem areas

***Land*: Schleswig-Holstein (SH)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	Various presentations and training events, especially with regard to nitrogen fertiliser use
Soil analysis, official fertiliser recommendation, analysis of slurry	"*Richtwerte der Düngung*" nutrient advice issued by the Chamber of Agriculture as the official fertiliser recommendations; Soil analyses estimated at approx. 45,000-50,000 p.a.; Slurry analyses approx. 500-800 p.a.
Storage capacity for farm wastes	Support in the context of investment in agricultural holdings. Following the end of the transition period at the end of 2008 all holdings must have a minimum storage capacity of 26 weeks.
Agri-environmental measures	▪ Winter green cover: 1,753 holdings, approx. 31,000 ha; ▪ Low emission slurry application methods: 1,060 holdings, approx. 52.000 ha ▪ Extensive grassland management: 290 holdings, approx. 2,500 ha ▪ Organic farming: 470 holdings, approx. 30.000 ha
Evaluation of N balances	Targeted weak-point analysis through analysis of nutrient budgets, planning of fertiliser use, advice throughout the growing season, and results monitoring (*e.g.* decreasing N_{min} concentrations in the autumn). The evaluation of N budgets on 38 holdings in a water protection area showed that there has been a reduction of N surpluses of between 10 and 20 kg N/ha since 2002.
Erosion control	Agri-environmental measures: Mulch seeding and direct sowing on approx. 36.000 ha land on 948 holdings.
Other	**Difficulties in the implementation of the Action Programme:** ▪ High cost of extending storage capacity, especially for "growing" holdings; ▪ Outdated landspreading techniques which are however still permitted under the Fertiliser Ordinance; ▪ Application of N fertilisers, especially livestock farm wastes, in the late autumn
Measures going beyond good agricultural practice (e.g. in water protection areas)	Provision of advice in 20 water protection areas: group advice, in some cases also advice for individual holdings on N fertiliser use which is considerate of groundwater resources incl. targeted weak-point analysis of N budget. $N\text{-}_{min}$ sampling in the autumn on approx. 150 representative sites.

***Land*: Saarland (SL)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	Several presentations given at tillage round tables held by the seed producer association, at producer groups for quality cereals and at the agricultural college incl. the master farmer's course.
Soil analysis, official fertiliser recommendation, analysis of slurry	Establishment of the nitrate sampling network (72 sites with spring sampling). Publication of the results incl. fertiliser recommendations in specialist publications and on the Internet.
Storage capacity for farm wastes	Support programme by the state for construction of slurry storage facilities.
Agri-environmental measures	Support for environmentally friendly slurry and farmyard manure application programmes. Support for extensive methods in tillage and grassland farming. Mulch seeding and direct sowing methods. Intercropping
Evaluation of N balances	Compilation of appr. 1100 farm nutrient budgets. The evaluation of 20 sample holdings showed a 10kg/ha N surplus in 2005, 15kg/ha N surplus in 2006, and 11kg/ha N surplus in 2007.
Erosion control	Support for mulch seeding systems; Support for intercropping; Machinery presentation of mulch seeding methods.
Other	Development of information leaflets on the following topics: Storage of farmyard manure, liquid manure, slurry, silage effluent, fertiliser use and protection of waters. The leaflets were made available to all farmers.
Measures going beyond good agricultural practice (e.g. in water protection areas)	Near-natural management and design of riparian zones - mineral fertiliser use within 5 metres of the riverbank is prohibited - the use of substances hazardous to water resources, including slurry and liquid manure, within 10 metres of the riverbank is prohibited

***Land*: Saxony (Sachsen) (SN)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	239 specialist events regarding the new Fertiliser Ordinance and cross-compliance with a total of 8,002 participants. 8 specialist conferences on fertiliser use in keeping with requirements with a total of approx. 885 participants. Various information leaflets regarding fertilisers and their usage. Up-to-date information on N_{min} results from representative test sites. Official fertiliser recommendations on the basis of computer-based advisory programme. Coverage: 44% of lands. Booklet entitled "*Umsetzung der Düngeverordnung – Hinweise und Richtwerte für die Praxis*" (Implementation of the Fertiliser Ordinance – Notes and reference values for the practitioner)
Soil analysis, official fertiliser recommendation, analysis of slurry	Evaluation of approx. 36,000 representative N_{min} samples taken in spring and approx. 1000 permanent sampling sites sampled in the autumn. Sampling results are strongly dependent on weather conditions. Seasonal fluctuations are increasing. On average a decrease in values is evident.
Storage capacity for farm wastes	Between 2004 and 2007 a total of 68 applications for support were received. 296,426 m^3 new storage capacity was created. 60 applications for support for environmentally friendly landspreading technology were approved. As continuous support is available in Saxony, predominantly low-emission methods are in use in the state.
Agri-environmental measures	Agri-environmental measures have the following priorities: - environmentally benign tillage farming (decrease of N fertiliser use by 20%) - extensive grassland farming (max. 120 kg total N/ha/a) - Intercropping and undersowing of crops - conservation tillage practices The measures have contributed to a demonstrable reduction of N concentrations
Evaluation of N balances	Evaluation of nutrient budgets by plot for 73 reference holdings. No significant changes since 1995 are evident. N budgets vary dependent on enterprises and level of intensity between 86 and 96 kg/ha on average for 1995-2005.
Erosion control	Conservation tillage methods (mulch seeding) practiced on approx. 1/3 of arable land (245,000 ha) (approx. 175,000 ha in 2002). Intercropping/undersown crops on approx. 35,500 ha (approx. 32,700 ha in 2002).
Other	
Measures going beyond good agricultural practice (e.g. in water protection areas)	Measures in water protection areas (7% of state territory) based on the Protected Areas Compensation Ordinance for Saxony (*Sächsische Schutz- und Ausgleichsverordnung – SächSchAVO*) Cooperation agreements in these areas.

***Land*: Saxony-Anhalt (Sachsen-Anhalt) (ST)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	Training and information events had the following priorities (total number of participants 2233): new Fertiliser Ordinance, improving N efficiency, reduction of N losses. Publication of N_{min} reference values via the Internet. Detailed booklet with guide values for planning fertiliser use.
Soil analysis, official fertiliser recommendation, analysis of slurry	4,306 N_{min} soil samples for farm holdings by 2005. N_{min} sampling network with 450 test sites since 2005. Appr. 4,500 N_{min} samples annually for computer-based fertiliser recommendations (*SBA-System*, a system to establish nitrogen requirements)
Storage capacity for farm wastes	Inspections have not found a shortfall with regard to the minimum 26 week storage period. In the case of investments into extensions or construction of new facilities, the required storage capacities also receive support. Between 2004 and 2007 133.639 m^3 of new storage capacity was created. In 11 cases the purchasing of low-emission slurry application technology was supported.
Agri-environmental measures	Support for various measures incl. restrictions on total N fertiliser use and on livestock manure. Also included is a mulch seeding programme under which approx. 15-20% of arable lands (195,889 ha in 2007) are managed.
Evaluation of N balances	Appr. 200-250 N budgets for individual holdings in accordance with the Fertiliser Ordinance have been evaluated. Between 2001 and 2007 the average state-wide N surplus was 41 kg N/ha. A long-term trend is not evident.
Erosion control	Support for mulch seeding and direct sowing as well as for mulch planting methods. Erosion control measures have been a focus of education, training and advanced training events.
Other	Field trials with the objective to increase N efficiency and decrease N discharges. Field trials on returning straw and beet tops as fertiliser, soil management and cultivation techniques, soil management and N dynamics. Project: Working group of farm holdings practising integrated agriculture in the Altmark region Demonstration project on the implementation of managing methods which are less damaging to soils Project: Planning of measures by plot to reduce soil erosion and sediment deposition in the catchment area of the "*Süßer See*" lake.
Measures going beyond good agricultural practice (e.g. in water protection areas)	See notes under "agri-environmental measures", "erosion control" and "other". Additional requirements regarding fertiliser use apply in water protection areas: Fertiliser use is prohibited in Zone II, it is limited to 120 kg N/ha in Zone III and must not exceed 80 kg N/ha where confining layers above the aquifer are permeable.

***Land*: Thuringia (Thüringen) (TH)**

Activity	**Extent of measures, impacts**
Training and information measures on improved application of Good Farming Practice	Annually: Thuringian Fertiliser Seminar in November with approx. 350 participants. In 2006: 10 training courses organised by the state agricultural office with approx. 750 farmers participating.
Soil analysis, official fertiliser recommendation, analysis of slurry	In Thuringia, soil analyses are carried out in government-approved private laboratories. All laboratories use the state advisory model (*SBA-System*, a system to establish nitrogen requirements) to establish fertiliser recommendations for the practitioners. The number of soil analyses with attached fertiliser recommendations increases continuously: 2004 17,670 samples 2005 18,450 samples 2006 19,760 samples 2007 20,790 samples Slurry analyses were carried out for approx. 60 holdings which present long-term nutrient input/output budgets and for approx. 70 holdings which have biogas installations.
Storage capacity for farm wastes	Support for 273 slurry storage facilities (capacity extended by 235,800 m^3) and farmyard manure (capacity extended by 21,500 $m^{3)}$. Funding volume: € 9.9 million. Support for environmentally-friendly slurry application technology; Funding volume: € 4.7 million.
Agri-environmental measures	Between 2004 and 2007 the following measures were approved in Thuringia with the aim of reducing nitrogen usage (annual averages): 1. Organic farming (A1) 170 holdings 21,250 ha € 3.8 million 1. Certified integrated tillage production (A7) 75 holdings 27,450 ha € 3.0 million. 2. Grazing of habitats (C3) 500 holdings 26,490 ha € 8.2 million. 3. Conditions for timing of cuts on grassland habitats 415 Holdings 6,932 ha €2.6 million.
Evaluation of N balances	Since 1997, the nutrient budgets of a total of 120 holdings per year have been inspected (of which 60 holdings can provide long-term results). Annual evaluation in conjunction with the water management authorities and the Thuringian farmers' association.

Erosion control	
Other	
Measures going beyond good agricultural practice (e.g. in water protection areas)	Cooperation models in water protection areas, *e.g.* at the Weida-Zeulenroda-Lössau dam. Cooperation between the water utility and 78 farm holdings; total area: 15,000 ha of which 12,000 are arable land and 3,000 ha grassland.

Appendix II

Table 2.2: Monitoring stations showing a reduction of more than 50%

LAWA No.	Name of watercourse	Monitoring station	90th-percentile 2006 in mg N/l	Catchment area in km²	Change in %
BB06	Havel	Hennigsdorf	0.58	3232	-53.0
BE02	Havel	Krughorn	1.21	14555	-54.1
NW12	Möhne	Völlinghausen	4.25	299	-58.4
HE04	Schwarzbach	Trebur-Astheim	5.00	445	-63.9
NW041	Sieg	Au	3.19	1257	-51.8
BB05	Spree	Neuzittau	0.74	6401	-53.4
NW08	Swist	Weilerswist	9.13	284	-52.7
HE08	Weschnitz	Biblis-Wattenheim	5.08	402	-57.1
NW06	Wupper	Leverkusen-Rheindorf	5.56	827	-53.2

Table 2.3: Monitoring stations showing a reduction of more than 25 % and up to 50 %

LAWA No.	Name of watercourse	Monitoring station	90th-percentile 2006 in mg N/l	Catchment area in km²	Change in %
HH02	Alster	Haselknick	4.30	306.5	-38.1
SH01	Bille	Reinbek	5.02	335	-32.0
SN051	Elbe	Dommitzsch	4.75	55655	-26.6
ST01	Elbe	Wittenberg	4.69	61879	-34.9
NI01	Elbe	Schnackenburg	4.49	125482	-27.9
MV01	Elde	Dömitz	2.11	2990	-38.7
NW181	Ems	Rheine	7.13	3749	-32.5
HE02	Fulda	Wahnhausen	4.09	6933	-27.1
BB07	Havel	Potsdam	2.26	15610	-31.3
ST10	Havel	Toppel	1.49	24297	-32.3
HE06	Lahn	Limburg-Staffel	4.06	4875	-35.6
HE011	Main	Bischofsheim	5.76	27140	-26.0
RP06	Nahe	Grolsheim	5.05	4013	-30.4
BW09	Neckar	Deizisau	5.09	3995	-25.4
BW08	Neckar	Poppenweiler	5.29	4982	-28.6
BW07	Neckar	Kochendorf	5.39	8510	-26.4
HE05	Nidda	Frankfurt-Nied	4.29	1941	-39.0
NW19	Niers	Goch	7.40	1203	-25.5
MV05	Peene	Anklam	3.79	5110	-30.2
MV07	Recknitz	Ribnitz	3.54	669	-34.3
NW09	Ruhr	Duisburg-Ruhrort	4.24	4485	-25.9
SN02	Schwarze Elster	Senftenberger See oh.	4.10	1066	-27.0
NW03	Sieg	Bergheim	4.07	2862	-28.5
BE01	Spree	Spandau	1.21	10104	-49.8
NW15	Stever	Olfen	9.69	567	-35.4
SH02	Stör	Willenscharen	3.85	476	-29.4
MV04	Tollense	Demmin	3.03	1809	-37.6
MV06	Uecker	Ueckermünde	2.35	2401	-31.1
MV03	Warnow	Kessin	2.78	2982	-48.0

Table 2.4: Monitoring stations showing a reduction of more than 5 % and up to 25 %

LAWA No.	Name of watercourse	Monitoring station	90th-percentile 2006 in mg N/l	Catchment area in km²	Change in %
NI07	Aller	Grafhorst	12.9	520	-18.5
NI08	Aller	Langlingen	6.03	3288	-7.3
NI09	Aller	Verden	4.29	15220	-14.0
BY151	Altmühl	Dietfurt	6.72	2504	-18.5
BY18	Amper	Moosburg	3.89	3088	-13.6
SH04	Bongsiel. Kanal	Schlüttsiel	3.27	723	-12.7
BW131	Donau	Hundersingen	4.00	2629	-14.8
BW12	Donau	Ulm	4.08	7578	-14.4
BY09	Donau	Dillingen	4.50	11315	-11.8
BY24	Donau	Kelheim	4.19	22950	-15.0
BY11	Donau	Jochenstein	3.19	77086	-13.4
SN04	Elbe	Schmilka	4.70	51391	-8.6
ST02	Elbe	Magdeburg	5.33	94942	-18.2
HH03	Elbe	Zollenspieker	4.39	139000	-17.6
HH011	Elbe	Seemannshöft	4.20	139900	-16.5
NI03	Elbe	Grauerort	4.19	141327	-24.3
NI15	Ems	Herbrum	6.48	9207	-19.0
NW07	Erft	Neuss	3.45	1828	-24.6
BY06	Fränk. Saale	Gemünden	5.02	2141	-15.9
SN06	Freib. Mulde	Erlln	6.23	2983	-15.9
SN03	Große Röder	Gröditz uh. Kläranlage	7.23	803	-22.0
NI17	Hase	Bokeloh	5.29	2968	-13.3
NI14	Hunte	Reithörne	5.00	2344	-18.7
BY12	Iller	Wiblingen	3.24	2115	-12.1
NI18	Ilmenau	Rote Schleuse	3.18	1545	-16.3
BY21	Inn	Kirchdorf	1.00	9905	-5.5
BY17	Isar	Plattling	3.60	8839	-13.5
HE07	Kinzig	Hanau	3.59	925	-19.3
SN01	Lausitzer Neiße	Görlitz oh.	3.74	1621	-8.9
BY14	Lech	Füssen	0.64	1417	-17.7
BY13	Lech	Feldheim	2.40	3926	-16.8
NI10	Leine	Reckershausen	8.79	321	-7.4
NI12	Leine	Neustadt	6.41	6043	-7.4
NW11	Lenne	Hohenlimburg	3.28	1316	-17.3
NW14	Lippe	Lünen	6.67	2834	-13.4
NW13	Lippe	Wesel	6.86	4886	-21.6
BY19	Loisach	Schlehdorf	1.19	640	-8.5
BY04	Main	Hallstadt	4.73	4399	-16.6
BY03	Main	Viereth	6.01	11956	-16.9
BY02	Main	Erlabrunn	5.70	14244	-21.1
BY01	Main	Kahl a. Main	5.69	23152	-17.9
RP03	Mosel	Koblenz	4.92	28100	-22.8
ST04	Mulde	Dessau	5.80	7399	-15.6
BY16	Naab	Heitzenhofen	4.22	5426	-20.6
BW11 *)	Neckar	Starzach-Börstingen	5.62	1512	-5.47

*) Comparison with the average of 90th-percentile values in the years 1995-1998

BW101	Neckar	Kirchentellinsfurt	5.25	2321	-18.6
BW06	Neckar	Mannheim/Neckar	5.58	13957	-23.6
BB01	Neiße	Ratzdorf	3.45	4460	-23.5
BB08	Oder	Frankfurt	4.10	53580	-22.5
BB09	Oder	Hohenwutzen	3.95	109519	-20.7
NI13	Oker	Groß Schwülper	6.27	1734	-10.9
BW21	Radolfz.-Aach	Rielasingen	3.47	263	-17.0
BY07	Regnitz	Hausen	7.21	4472	-24.3
BW01	Rhein	Öhningen	1.00	11514	-10.5
BW02	Rhein	Dogern	2.00	33987	-9.3
BW19	Rhein	Vogelgrün	2.20	44139	-10.1
BW041	Rhein	Karlsruhe	2.20	50196	-5.2
BW05	Rhein	Mannheim/Rhein	2.30	54029	-7.3
RP02	Rhein	Mainz	3.50	98206	-14.5
RP01	Rhein	Koblenz	3.40	110131	-23.4
NW01	Rhein	Bad Honnef	3.57	140756	-18.2
NW02	Rhein	Kleve-Bimmen	3.52	159127	-24.6
NW10	Ruhr	Villigst	3.79	1988	-17.9
NW22	Rur	Einruhr	3.33	198	-6.04
NW21	Rur	End-Steinkirchen	3.60	2135	-20.8
TH06	Saale	Camburg-Stöben	6.01	3977	-24.7
ST05	Saale	Bad Dürrenberg	5.72	12076	-10.8
ST07	Saale	Groß Rosenburg	5.92	23718	-9.3
SL01	Saar	Saarbrücken-Güdingen	4.05	3809.03	-6.4
RP05	Saar	Kanzem	4.77	7389	-12.7
BW15	Schussen	Meckenbeuren-Gerbertshaus	4.87	790	-21.5
NW20	Schwalm	Neumühle	10.9	83	-18.2
SH05	Schwentine	Kiel	2.47	714	-9.8
MV02	Sude	Bandekow	2.10	2253	-17.4
BY05	Tauber	Waldenhausen	9.24	1798	-13.2
SH06	Trave	Sehmsdorf	6.90	726	-19.9
TH09 *)	Unstrut	Oldisleben	5.47	4174	-6.7
NI16	Vechte	Laar	8.21	1762	-18.1
SN08	Vereinig. Mulde	Bad Düben	6.07	5995	-24.8
SN09	Weiße Elster	Bad Elster	5.46	47.7	-23.6
TH07	Weiße Elster	Gera unterhalb	7.20	2186	-7.8
TH10 *)	Werra	Meiningen	3.76	1170	-14.6
TH02	Werra	Gerstungen	6.61	3039	-5.4
HE03	Werra	Letzter Heller	4.31	5487	-16.9
NW17	Werre	Rehme	6.32	1482	-21.8
NI04	Weser	Hemeln	4.39	12550	-15.0
NW161	Weser	Petershagen	5.50	19347	-13.6
HB01	Weser	Bremen	4.89	38415	-21.8
NI19 *)	Weser	Farge	4.77	41730	-8.2
SN07	Zwick. Mulde	Sermuth	5.97	2361	-12.0

*) Comparison with the average of 90th-percentile values in the years 1995-1998

Table 2. 5: Monitoring stations not showing any trend

LAWA No.	Name of watercourse	Monitoring station	90th-percentile 2006 in mg N/l	Catchment area in km²	Change in %
ST11	Aland	Wanzer	5.57	1820	-1.6
BW20 *)	Donau	Ulm-Wiblingen	4.90	5384	-4.9
BY20	Inn	Passau-Ingling	1.90	26049	4.7
NI11	Leine	Poppenburg	6.56	3463	2.9
RP04	Mosel	Palzem	4.09	11623	-3.9
BW17	Rotach	Friedrichshafen	5.11	397	1.0
TH11 *)	Saale	Rudolstadt	5.67	2679	-1.6
ST06	Saale	Trotha	6.04	17979	-3.5
SL02	Saar	Fremersdorf	4.29	6983.3	-3.6
BY08	Sächs. Saale	Joditz	7.50	644	-4.9
BY22	Salzach	Laufen	0.91	6113	-2.2
BB04	Spree	Cottbus	2.70	2269	1.8
SH03	Treene	Friedrichstadt	6.23	797	-3.5
ST08	Unstrut	Freyburg	5.18	6327	-2.0
ST09	Weiße Elster	Ammendorf	6.55	5384	-1.0

Table 2. 6: Monitoring stations showing an increase of more than 5 % and up to 25 %

LAWA No.	Name of watercourse	Monitoring station	90th-percentile 2006 in mg N/l	Catchment area in km²	Change in %
SL04 *)	Altbach	Nonnweiler	1.86	15.63	19.8
SL03 *)	Prims	Nonnweiler	2.26	18.28	7.9
ST03	Schwarze Elster	Gorsdorf	3.39	5453	15.1
BE03 *)	Teltowkanal	Kohlhasenbrück	6.09	145	6.2
TH03	Unstrut	Straußfurt	5.70	2049	11.8

Table 2. 7: Monitoring stations showing an increase of more than 25 %

LAWA No.	Name of watercourse	Monitoring station	90th-percentile 2006 in mg N/l	Catchment area in km²	Change in %
BW16	Argen	Tettnang-Gießen	3.37	625	30.4
BY23	Große Ohe	Taferlruck	1.30	19	31.0
NW05	Sieg	Netphen	3.30	0.04	59.7

*) Comparison with the average of 90th-percentile values in the years 1995-1998