Ministry of Environment and Food of Denmark
Department

Derogation Report 2017

Danish Report
in accordance with the
Commission Decisions
2005/294/EC, 2008/664/EC,
2012/659/EU and 2017/847/EU

December 2017

Ministry of Environment and Food of Denmark
Department
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1. Introduction

With Commission Decisions 2005/294/EC, 2008/664/EC, 2012/659/EU and 2017/847/EU, Danish cattle holdings are allowed to derogate from the general rules in the Nitrates Directive (91/676/EEC).

The aim of the report is to present maps showing the percentage of farms and percentage of agricultural land encompassed by the derogation in each Danish municipality for the planning period 2015/2016. Furthermore, compliance control results for the Danish derogation farms are reported for 2014/2015 and for January-February 2017, and monitoring results for 2015/2016 are included. The planning period 2015/2016 is the last period covered by Commission Decision 2012/659/EU.

This report does not include monitoring results for farms applying the derogation in 2016/2017 according to derogation decision 2017/847/EU. Monitoring results for that period will be included in the next monitoring report.

Decision 2012/659/EU is the relevant decision for the data reported in this report. According to this decision, cattle holdings could apply for authorisation to apply livestock manure corresponding to up to 2.3 livestock units (LU[1]) per hectare per year (corresponding to 230 kg N/ha), if more than 70 per cent of the area available for manure application was cultivated with beets, grass or grass catch crops. With decision 2017/847/EU, this management requirement was changed from 70 to 80 per cent coverage with the same crops. Furthermore, derogation holdings have to comply with several other conditions laid down in the decision.

According to decision 2012/659/EU, the Danish authorities shall transmit the following information to the Commission for the derogation period 2015/2016:

- According to Article 7 (1) and 9 (a): maps, showing the percentage of cattle farms, percentage of livestock and percentage of agricultural land covered by the derogation for each municipality of Denmark.

- According to Article 9 (g), an evaluation of the implementation of the derogation conditions, on the basis of controls at farm level and information on non-compliant farms, based on the results of the administrative and field inspections.

- According to Article 9 (b, c, e), the results on ground and surface water monitoring as regards nitrate and phosphate, including information on water quality trend as well as the impact of derogation on water quality. Further results of model-based calculations from farms benefiting from an individual derogation.

- According to Article 9 (d and f), the results of the surveys on local land use, crop rotations and agricultural practices including tables showing the percentage of agricultural land under derogation covered by clover or alfalfa in grassland and by barley/pea, undersown with grass.

The latest derogation decision (2017/847/EU) requires according to article 12 (h), to include trends in livestock numbers and manure production for each livestock category in Denmark and in derogation farms. Based on register data, it is already now possible to provide the data and it is included in this report.

[1] One livestock unit is defined as 100 kg nitrogen in the livestock manure ex. storage.

Moreover, the latest derogation decision (2017/847/EU) requires according to Articles 10 (2) and 12 (b), reporting of water quality data from reinforced monitoring on sandy soils and in an area, where at least 3% of all derogation farms are located. A possible approach to meet these new conditions has been developed and the current status for this work is presented in this report. Actual monitoring data will be included in the coming reports, as soon as sufficient quality-assured data has been made available.

Various Danish authorities and institutions have contributed to this report, edited by the Ministry of Environment and Food of Denmark. The respective authors, and hence responsible institutions for the different chapters, can be found under the heading to the respective chapters.

2. Maps of cattle holdings, arable land and livestock units in 2016

Lars Paulsen and Lene Kragh Møller, The Danish Agricultural Agency, Ministry of Environment and Food of Denmark, December 2017

For the planning period 2015/2016 the Danish Agricultural Agency received 35,176 fertilizer accounts containing key figures on the use of nitrogen (commercial fertilizer and livestock manure). The accounts were registered and reviewed. The maps (Figure 2.1 - Figure 2.3) are based on the number of agricultural holdings, number of livestock units (LU) and arable land used by derogation farms in 2015/2016. The fertilizer accounting year runs from 1st of August to 31st of July. Accounts for 2015/2016 were to be submitted to the Danish Agricultural Agency no later than 31st of March 2017.

In the fertilizer account the farmer states, if the derogation is used. This means, that the individual farmer needs to apply for the use of derogation when the fertilization plan is reported (at the latest 21st of April each year). The application information is automatically transferred to the fertilizer accounting system. The maps of cattle holdings, arable land and livestock units are based on the data reported by the farmers.

2.1 Map of derogation holdings 2015/2016

The map (Figure 2.1) shows derogation holdings in percentage of the total number of agricultural holdings registered in each respective municipality.

In 2015/2016, 1,466 derogation holdings were encompassed by the derogation. This corresponds to 4.2 % of all registered fertilizer accounts. The applied amount of manure on these farms ranged from 170 to 230 kg N per hectare per year. If the production of manure on a derogation farm corresponds to more than 230 kg N per hectare, the farmer is obliged to deliver the excess manure to one or more contractual partner-farmers.

2.2 Map of arable land 2015/2016

The map (Figure 2.2) shows the percentage the arable land on derogation holdings of the total agricultural area in the respective municipality.

In 2015/2016 the arable land on cattle holding encompassed by the derogation was 210,061 hectare at national scale. This corresponded to 8.6 % of the registered area used for agriculture in Denmark.

2.3 Map of livestock units 2015/2016

The map (Figure 2.3) shows the number of livestock units on derogation holdings in percentage of the total number of livestock units in the respective municipality.

In 2015/2016, the number of livestock units on cattle holdings encompassed by the derogation was 443,134 LU in total. This corresponded to 19.4 % of all registered livestock units in Denmark.

2.4 Use of derogation

During the first three years where the derogation was used, i.e. 2002/2003, 2003/2004 and 2004/2005, an increase in the use of the derogation was registered both regarding the number of farms, the number of hectares and the number of livestock unit (Table 2.1). This tendency was broken between 2005/2006, where a decrease was observed for all three measured parameters and the decreasing trend continued until the period 2008/2009. Between 2009/2010 and 2015/2016 an overall increase in the agricultural area using the derogation, was observed, whereas the number of farms remained at a more constant level. The general trend of Danish farms becoming bigger is reflected in these numbers. Compared to the previous reporting period, there has been an increase in area and number of livestock units encompassed by the derogation.

Table 2.1 Development in use of the derogation for number of farms, agricultural area and livestock units (LU) from 2002/2003 until 2015/2016.

Year	Number of derogation farms	Share of total farms (%)	Area of derogation (ha)	Share of total Area (%)	Number of LUs	Share of total LUs (%)
2002/2003	1,845	4.0	123,068	5.0	213,617	10.6
2003/2004	1,927	4.0	128,523	5.0	225,586	10.6
2004/2005	2,331	5.0	134,780	5.0	277,330	12.9
2005/2006	1,779	3.4	115,336	4.2	220,839	10.3
2006/2007	1,610	3.2	111,845	4.0	211,765	9.5
2007/2008	1,296	2.8	92,282	3.9	186,313	8.3
2008/2009	1,115	2.4	90,647	3.6	176,588	8.2
2009/2010	1,507	3.3	134,698	6.1	276,765	11.9
2010/2011	1,607	3.9	164,353	7.4	341,781	14.1
2011/2012	1,652	4.0	175,783	7.1	365,887	15.5
2012/2013	1,481	3.7	162,176	6.7	334,508	14.5
2013/2014	1,482	3.8	189,495	7.7	397,014	17.1
2014/2015	1,500	4.0	205,165	8.2	425,102	18.6
2015/2016	1,466	4.2	210,061	8.6	443,134	19.4

The livestock density on derogation farms has remained at an approximately constant level, compared to the periods 2009/2010-2015/2016 (Table 2.2). The average number of livestock units per farm has increased over the years and this trend continued in 2015/2016.

For comparison, in total 11,823 Danish agricultural holdings had cattle as livestock in 2015/2016. These holdings housed in total 1,193,787 LU[2] and covered an agricultural area of 930,420 ha. This gave an average of 101.0 LU per cattle holding and an average livestock density of 1.28 LU/ha on all cattle Danish farms. Consequently, approximately 12.4 % of all cattle farms were derogation farms in 2015/2016, and the derogation (cattle) farms housed 37.1 % of all cattle-LU in Denmark and covered 22.6 % of the total Danish cattle farm area.

[2] Data from the fertilizer accounting system as of 10th of November 2017

Table 2.2 Average number of spread livestock units (LU) per holding and per hectare under the derogation.

Year	Average stocking size (LU/holding)	Average livestock density (LU/ha)
2002/2003	115.78	1.74
2003/2004	117.07	1.76
2004/2005	118.97	2.06
2005/2006	124.14	1.91
2006/2007	131.53	1.89
2007/2008	143.76	2.02
2008/2009	158.37	1.95
2009/2010	183.65	2.05
2010/2011	212.68	2.08
2011/2012	221.48	2.08
2012/2013	225.86	2.06
2013/2014	267.89	2.10
2014/2015	283.40	2.07
2015/2016	302.27	2.11

The maps (Figure 2.1 - Figure 2.3) illustrate that derogation cattle holdings are concentrated in the western parts of Jutland. A few holdings are located on Zealand and even fewer on Funen and the island of Bornholm. The one holding located in Copenhagen was taken over by a mortgage credit institution but has its production facilities in Jutland.

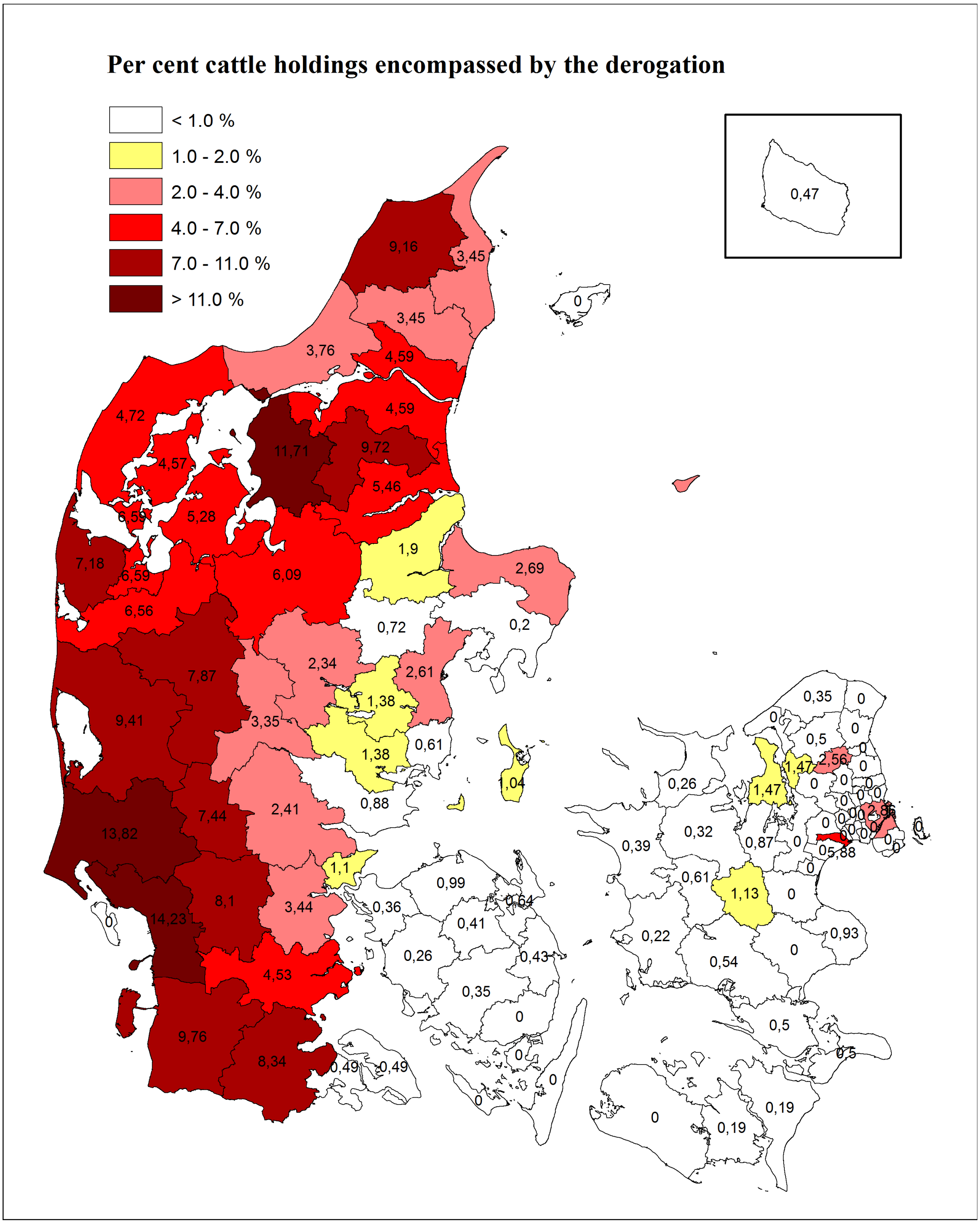

Figure 2.1 Derogation holdings in percent of total number of agricultural holdings in Denmark in 2015/2016. Location of holdings is determined by location of the owning company. One derogation holding is located in Copenhagen because it was taken over by a mortgage credit institute whereas its production facilities are in Jutland.

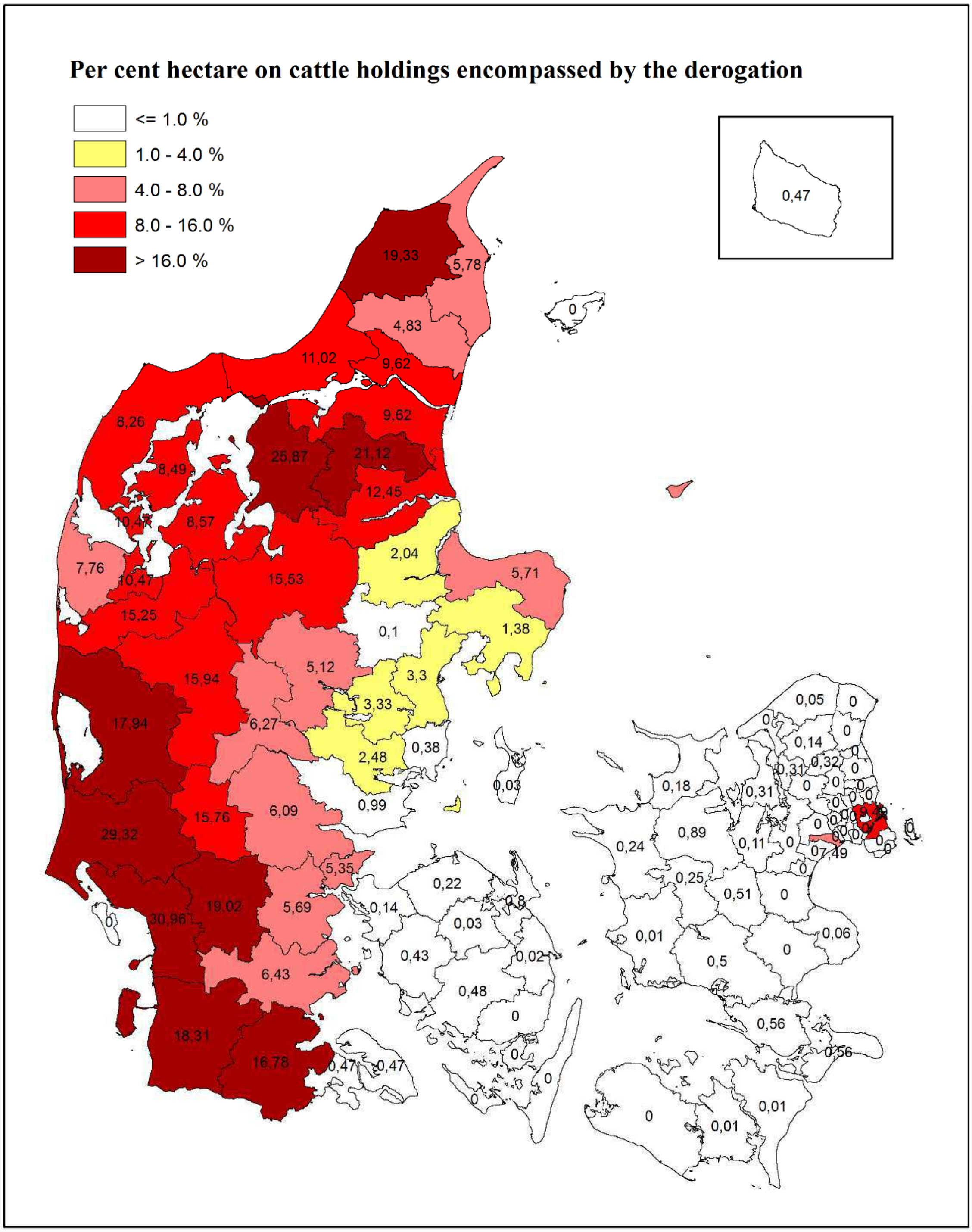

Figure 2.2 Agricultural land encompassed by the derogation in 2015/2016 in percent of the total agricultural area in Denmark. Location of holdings is determined by location of the owning company. One derogation holding is located in Copenhagen because it was taken over by a mortgage credit institute whereas its production facilities are in Jutland.

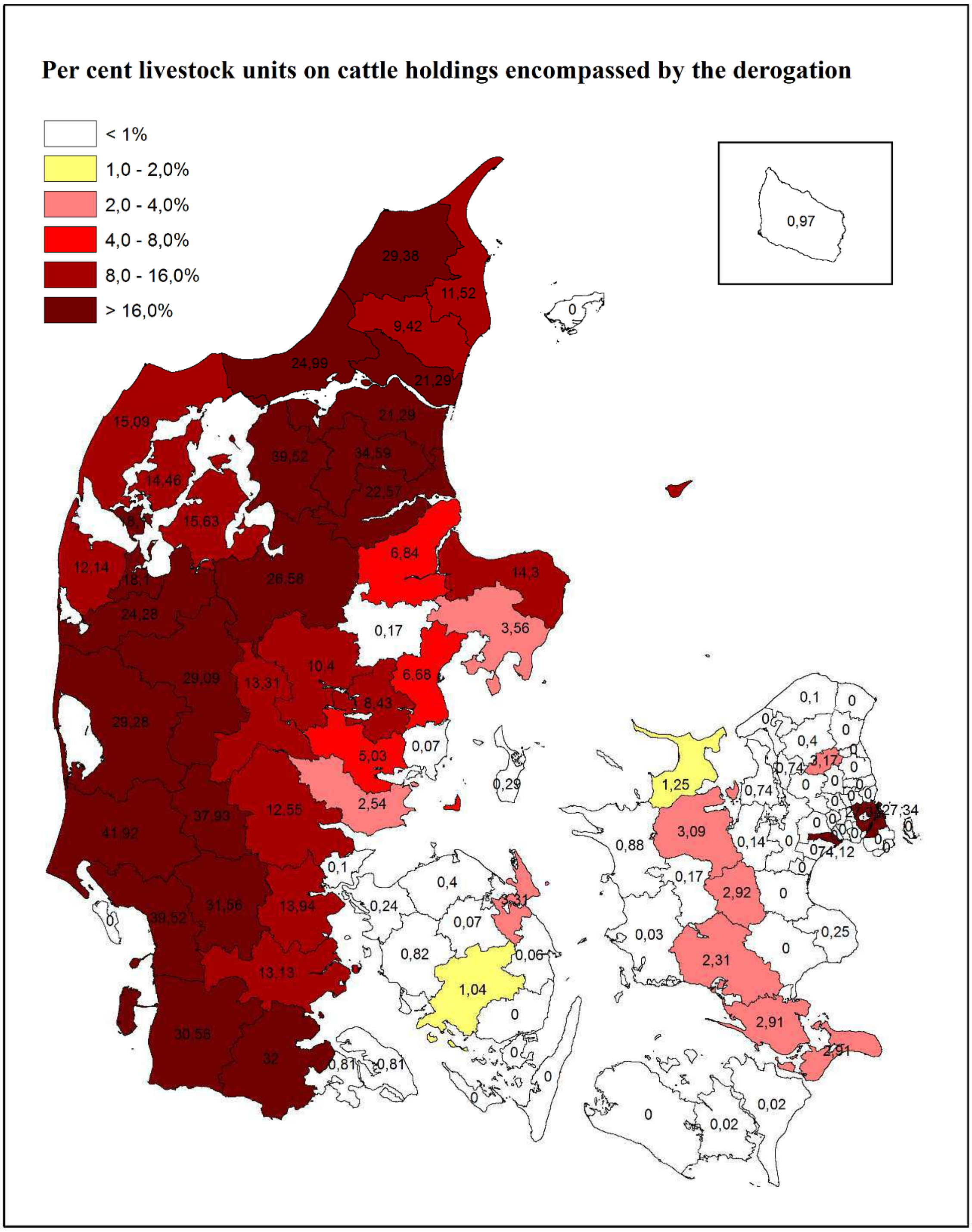

Figure 2.3 Livestock units spread on derogation farms in percent of total livestock units in 2015/2016 in Denmark. Location of holdings is determined by location of the owning company. One derogation holding is located in Copenhagen because it was taken over by a mortgage credit institute whereas its production facilities are in Jutland.

2.5 Trends in livestock

According to decision 2017/847/EU, the Danish authorities shall transmit information about trends in livestock numbers and manure production for each livestock category in Denmark and in derogation farms according to Article 12 (h). Even though the data, presented in this report, primarily have been generated, while the conditions of the previous derogation decision (2012/659/EU) were still applying, the register data are already available and are presented below. All numbers have been brought to a round number in order to have a clearer picture.

The trends in livestock numbers (i.e. number of herds[3]) and manure production (i.e. number of LUs[4]) for each livestock category and in derogation farms can be derived from the data shown in table 2.3. From the planning period 2014/2015 to 2015/2016, the number of herds and LUs are decreasing for each livestock category - except for cattle, where the number of LUs is increasing. The total number of livestock has been decreasing by ca. 0.4% in between the last two planning periods.

Table 2.3 Number of Danish herds of livestock and of LUs per livestock category, rounded to the closest unit of 100[5].

Year	**2014/2015**		**2015/2016**	
Livestock category	**Number of herds**	**Number of LUs**	**Number of herds**	**Number of LUs**
Cattle - total	12,300	1,164,700	11,800	1,193,400
Cattle - derogation[6]	1,500	425,100	1,500	443,100
Pigs	4,100	905,300	3,900	881,300
Fur and poultry	2,000	190,500	2,000	178,000
Sheep and goats	2,400	12,200	2,300	10,500
Others	6,100	19,100	5,800	18,800
Total	**26,900**	**2,291,800**	**25,800**	**2,282,000**

[3] The total number of herds does not coincide with total number of holdings in Denmark. A herd includes only one type of livestock and some holdings keep more than one herd, ex. cattle and pigs.

[4] One livestock unit is defined as 100 kg nitrogen in the livestock manure ex. storage.

[5] Data from fertilizer accounting system generated 27th of November 2017

[6] 2014/2015 data from "Derogation Report 2016". 2015/2016 data generated 10th of November 2017

3. Controls on farm level

Lars Paulsen and Lene Kragh Møller, The Danish Agricultural Agency, Ministry of Environment and Food of Denmark, December 2017

3.1 Control of compliance with the Danish derogation

According to Article 8 of Commission Decision 2012/659/EC, Denmark must submit a concise report on the evaluation practice, i.e. control at farm level to the Commission every year.

The control of compliance with the Commission Decision 2012/659/EC follows two strategies:

1. Inspection of compliance with farm management, which is carried out during the year the farmer uses the derogation. This can include field inspections, when necessary.
2. Control of the amount of livestock manure applied per hectare per year (control of compliance with the harmony rules), which is carried out after the derogation year has ended. This control is carried out in two ways: 1) as an inspection of all parameters of the production at the farm and 2) as an administrative control of submitted fertilizer accounts.

3.2 Summary of inspection results 2017

Compliance with management conditions:

- Inspection at the farm: 49 inspections were carried out. 42 farms complied with the derogation management conditions, 1 farm got a remark and 6 farms informed that they did not intend to make use of the derogation in 2017 anyway.

Compliance with the harmony rules for farms using the derogation:

- Inspection at the farm: 30 inspections were carried out. 29 farms complied with the specific rules for derogation farms, but 1 farm had not carried out the minimum required number of soil sample and analysis and could therefore only apply manure according to 1.7 LU/ha.
- Administrative control of the submitted fertilizer accounts: 62 inspections were carried out, out of which 30 farms complied with the rules. For 28 farms the investigation is still on-going. However, the extended investigation time does not equal an expectation of requirements not being met.

3.3 Inspection of compliance within the derogation year

The Danish Agricultural Agency inspected the fulfilment of Danish derogation conditions on derogation holdings from 2002/2003 until 2016/2017. The farmers are required to fulfil certain conditions in order to use the derogation. Some conditions have to be checked on site at the farm (physical inspection), for example certain ploughing conditions, which are checked in January and February.

During the inspection at the farm the inspector asks the following questions:

1. Do cattle make up at least 2/3 of the livestock units, i.e. is the farm mainly a cattle holding?
2. Has a plan been made for crops grown in the actual planning period?
3. Has the manager stated that the farm intends to comply with the 2.3 LU/ha derogation in the crop rotation plan?
4. Does the plan contain leguminous crops, e.g. red and white clover?
5. Has a declaration about (omitted) manure application been made?
6. Does the plan include ploughing grassland or grass catch crops in the planning period?
7. If the answer is “yes” in question 6: Have the fields already been ploughed by the time of inspection?

The inspection is based on 1) an interview with the farmer, 2) an inspection of the farms crop rotation plan for the previous and coming growing season and 3) a visual inspection of fields designated for ploughing.

At the inspection the inspector draws up a report, which includes answers to the above mentioned questions. At the end of the inspection the farmer is informed whether the holding is allowed to apply manure corresponding to 2.3 LU/ha, i.e. whether the derogation can be used or not. If the holding is not complying with the derogation conditions, the holding is only allowed to apply livestock manure up to 170 kg N/ha. In this case the farmer has to find other means of disposing the surplus manure produced on the farm.

If a farmer informs the inspector that the derogation will not be used, the field inspection is not carried out. An administrative control of the farm is carried out instead by the time the fertilizer account has been submitted. This control is carried out to secure that no more than 170 kg N/ha was applied.

The inspection report is submitted by the inspector to the headquarters of the Agricultural Agency for possible further administrative inspection where the data are verified. Additional remarks made by the inspector, if any, are examined. This includes a process where the parties of interest are allowed to make statements on the case if an infringement is discovered.

3.4 Results

From 1 January until 1 March 2017 the Agricultural Agency carried out 49 inspections on cattle holdings to inspect whether the conditions requirements were met. The control refers to the fertilizer accounts of the year 2016/2017. Table 3.1 shows the results of the inspection for the last 14 years. Only very few remarks have been given and in general a good compliance with the rules has been noted.

Table 3.1 Development of results of on-site inspection of compliance within the derogation years during winter.

Control year	Total number of inspections	Inspections without remarks	Inspections with remarks
2003	35	29	6
2004	46	46	0
2005	50	49	1
2006	50	49	1
2007	54	54	0
2008	47	46	1
2009	51	49	2
2010	50	50	0
2011	54	52	2
2012	49	49	0
2013	47	46	1
2014	49	49	0
2015	48	48	0
2016	49	48	1

3.5 General inspection of the harmony rules

Harmony rules

Control of the harmony rules (i.e. the amount of livestock manure applied per hectare per year) on derogation farms is carried out after the derogation year has ended. This control is carried out within the general inspection of the Danish harmony rules. The inspector visits the farm to inspect the production, based on various production and fertilizer account documents. Violation of the harmony rules is sanctioned. For minor violations the farmer is imposed a warning. For more severe violations the farmer is fined. Farmers that receive a warning or a fine are reported for not complying with the cross compliance criteria.

Concerning the year 2014/2015, 435 livestock holdings (including derogation farms) have been inspected for violation of the harmony rules. Holdings are automatically selected for inspection, based on a previously agreed set of “risk criteria”. The Agricultural Agency has therefore no direct influence on, how many derogation holdings are selected for “harmony rules inspection”. Of the selected holdings 6.9 % (30 holdings) were derogation holdings. Out of these derogation controls, 96.7 % (29 holdings) were closed without remarks. One holding (3.3%) is still under investigation (Table 3.2). The farmer had not taken any soil samples even though it was the fourth year in a row the farm used the derogation.

Table 3.2 Results of inspection of compliance with the harmony rules for farms using the derogation.

Control year	Total number of inspections	Inspections without remarks	Inspections with minor violations	Inspections with fines	Inspections still under investigation
2006/2007	65	59	0	5	1
2007/2008	27	22	2	2	1
2008/2009	32	26	1	5	0
2009/2010	27	24	1	2	0
2010/2011	37	35	0	0	2
2011/2012	52	50	0	2	0
2012/2013	43	40	0	3	0
2013/2014	29	27	0	1	1
2014/2015	30	29	0	0	1

Soil analysis
If the derogation is used for four consecutive years the farmer must provide a soil analysis where phosphorous and nitrogen levels in the soil are examined. One sample per five hectares must be provided.

In Denmark the soil analysis for phosphorus (the ”P-tal”) indicates the soil’s phosphorus status and hence approximates phosphorus in the soil available for uptake by the crop. Internationally the soil analysis is referred to as “Olsen-P”. Olsen-P is often expressed in mg P per kg soil. In Denmark however, the “P-tal” is expressed in mg P per 100 g soil. Olsen-P in Danish agricultural soil is in average around 40 mg P per kg soil (P-tal = 4.0). Only a part of the inorganic phosphorus available for the crop is extracted from the soil sample, when the phosphorus status is determined. This extractable part accounts for approximately 5 to 10 per cent of the total phosphorous content of the soil. A P-tal between 2 and 4 is generally accepted as a sufficient level for most crops and 2-2.5 is the lower critical soil P level. A P-tal above 6 is considered very high.

The N-total analysis is used to determine the amount of extra fertilizer to be added to meet the crop demand. The total soil N content describes the N pool in the soil which potentially is available to the crops as a result of slow mineralization. In Denmark, depending on the C/N ratio in the soil, the standard N-total is 0.13 %. The farmer cannot expect any N-supply from mineralization, if the level of 0.13 % N-total is found. . If the value is above 0.22 %, the level is high and expected mineralization is (accounted for with) 40 kg N in maize and cereals per hectare. The N-total standard for grass fields is 0.18-0.22 %, and if the value is above 0.22 %, the expected mineralization is (accounted for with) 10 kg N per hectare.

Results of soil analyses from derogation farms
The inspection of derogation farms for 2014/2015 showed that 73.3 % used the derogation for the fourth consecutive year. These 22 holdings were obliged to provide soil analysis. One holding got a remark regarding soil analysis and the case is still under investigation.

The sampling and analyses shall be carried out at least once every three years and from 2012/2013 at least once every four years. The results of the development of compliance with the requirement of soil analysis are shown in table 3.3.

Table 3.3 Development of results of inspection of compliance with the soil analysis requirement.

Control year	Number of inspections with need for soil analysis	Inspections without remarks	Inspections with remarks/still under investigation
2004/2005	74	71	3
2005/2006	18	16	2
2006/2007	39	34	5
2007/2008	16	12	4
2008/2009	22	18	4
2009/2010	11	9	2
2010/2011	14	13	1
2011/2012	35	35	0
2012/2013	30	27	3
2013/2014	15	14	1
2014/2015	22	21	1

The results of the soil analyses for phosphorus and nitrogen on derogation farms are shown in Table 3.4.

Table 3.4 Phosphorus ("P-tal" after Olsen-P-extraction) and nitrogen levels in soil analyses, given as average of all inspected holdings (n=23 for P and n=21 for N in 2014/2015) and with the lowest and highest average values at holding scale, respectively.

Year		2011/2012	2012/2013	2013/2014	2014/2015
P tal	**Average**	**4.36**	**4.60**	**4.33**	**4.60**
(mg P/100 g soil)	Minimum	2.00	2.90	2.90	2.87
	Maximum	6.40	6.10	8.40	6.08
N-total	**Average**	**0.60**	**0.33**	**0.25**	**0.25**
(%)	Minimum	0.11	0.12	0.15	0.13
	Maximum	2.39	1.71	0.41	0.58
N in grass	**Average**	**0.36**	**0.24**	**0.48**	**0.24**
(%)	Minimum	0.01	0.17	0.16	0.16
	Maximum	1.10	0.35	2.00	0.51

3.6 Control of fertilizer accounts

Each year the farmers submit a fertilizer account to the Danish Agricultural Agency. The accounts include key data on:

- total arable land on the farm
- arable land available for application of livestock manure
- data on catch crops
- type and number of livestock (LU)
- production of livestock manure (kg N)
- usage of livestock manure including manure from contractors
- usage of fertilizers and organic matter other than livestock manure
- the farm's nitrogen quota[7]
- information on whether the farmer has used the derogation or not

[7] In the planning period 2014/2015, the allowed nitrogen quota for the crops was set to a level at least 18 per cent lower than the economical optimal level.

For the year 2014/2015, 976 (2.8 %) of the submitted fertilizer accounts were subject to administrative inspection. 391 fertilizer accounts remains to be investigated. The data was verified and the parties of interest were allowed to comment their cases. The accounts were selected based on different risk criteria. In 2014/2015, 62 (6.4 %) derogation holdings were selected for more thorough control. The holdings were asked to submit their crop rotation plan and to state their manure application. It was checked, whether the crop rotation plan included at least 70 % crops with a high N demand, a long growing season and whether or not leguminous plants were included. If the derogation was used for four consecutive years, the farmer further had to submit the results of the soil analysis. Also the share of cattle- and other animal-LU on the farm was controlled.

Results
Out of the 62 harmony controls, 30 holdings (48.4 %) were closed without remarks. Four holdings (6.5 %) got remarks and 28 (45.2 %) inspections are still under investigation (Table 3.5). The comparatively high number of cases still being investigated for the season 2014/15 does not equal any expectation of requirements not being met. The Agricultural Agency expects to complete the investigation of the remaining cases by 2018. Table 3.5 will be updated accordingly in the next derogation report.

Table 3.5 Results of administrative inspection of compliance with the harmony rules of farms using the derogation.

Control year	Number of inspections	Inspections without remarks	Inspections with remarks	Inspections still under investigation
2009/2010	38	34	0	-
2010/2011	68	68	0	-
2011/2012	40	39	1	-
2012/2013	62	58	1	3
2013/2014	34	24	4	6
2014/2015	62	30	4	28

4. Water quality

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According to Article 7(2) and Article 7(3) of Commission Decision 2012/7182/EC, Denmark shall deliver maps at municipality level, showing the percentage of farms with derogation, their number of livestock and crop cover. A survey providing data on local land use, crop rotations and practices on cattle holdings as well as continuous analysis for level and trends in nitrate and phosphorus concentrations shall be carried out in the national monitoring programme on sandy and loamy soils. These data can be used for model-based calculations of the magnitude of nitrate leaching from fields, where up to 230 kg nitrogen in livestock manure are applied per hectare.

According to Article 7(2), a network of stations for sampling of soil water, water in streams and in shallow groundwater, established in agricultural catchments under the national monitoring programme, shall be maintained to provide data on the state of nitrate and phosphorus content in water leaving the root zone and entering the groundwater system in order to document that the derogation will not jeopardise the objective of the national Nitrates Action Programme and the Nitrates Directive.

According to Article 9, maps at municipality level showing the percentage of farms with derogation, their number of livestock and crop cover and the results of the monitoring shall be submitted every year to the Commission with a concise report on water quality trends (based on monitoring of root zone leaching and surface/groundwater quality and model-based N-leaching calculations).

As data in this chapter is from the year 2016, the Commission Decision 2012 covers this period.

4.1 Introduction

Since the late 1980s, Denmark has yielded a comprehensive and efficient effort to improve the environmental state of groundwater and surface water by lowering nitrate concentrations, especially through reductions in nitrate leaching from agricultural sources. The first Action Plan on the Aquatic Environment was adopted in 1987 and has since then been followed by subsequent action programmes to ensure that sufficient efforts are being made to reduce the loss of nitrogen and phosphorus to the aquatic environment.

In 1998, Action Plan for the Aquatic Environment (APAE) II was accepted by the EU Commission as the Danish Nitrate Action Plan implementing the Nitrate Directive (1998-2003). In 2003, a final evaluation of Action Plan II was performed. It showed a reduction of 48% of the nitrate leaching from the agricultural sector, thus fulfilling the reduction target set in 1987. In the five-year period 2001-2005, the total flow-normalized nitrogen load to marine waters was in the interval 62,000 to 70,000 t N.

Further mitigation measures in the subsequent action plans, including the Green Growth Agreement from 2009 and the first and the second River Basin Management Plan from 2014 and 2016, respectively, as well as the Food and Agricultural Agreement in December 2015, suggest measures and reduction targets for the N load to marine areas in order to fulfil the targets in the Water Framework Directive.

In 2015, Denmark implemented the EU Greening component under CAP direct payments (REG EU 1307/2013), implying that at least 5% of the arable land of farm holdings is appointed as an ecological focus area with a greening element, for instance set-aside, catch crops etc.

Establishment of an obligatory buffer zone app. 10 m from the edge of open streams and lakes larger than 100 m^2 was implemented in 2014. In the buffer zones, application of fertilizer is prohibited and soil cultivation must not take place. The area with buffer zones was adjusted from 50,000 ha to 25,000 ha in 2014, and from the beginning of 2016 buffer zones are no longer mandatory.

The political Agreement on Food and Agricultural Package from December 2015 includes a diverse package of measures aimed to change the environmental regulation of the agricultural sector. The first part of this political agreement was implemented as from 2016.

In 2016, farmers were allowed to use more fertilizer. From the agreement in APAE II farmers were restricted in the application of fertilizer to under economical optimum. The measure in APAE II was set to reduce the fertilizer application of nitrogen to 10 pct. below the economic optimum. This rule was regulated so that the total national nitrogen quota was set to a fixed level but with the possibility of an adjustment relative to changes in crop cover. This adjustment made sense as crops having a high application standard also have a higher nitrogen uptake. If crops such as grass increase in cover, then the fertilizer application and N quota will increase as well. However, due to the suspension of set-aside in 2008, higher yields and increases in prices of cereals and proteins, the gap between the economic optimum and the national N quota increased, especially after 2008, amounting to 18% in 2015.

According to the Agreement on Food and Agricultural Package, agreed that in 2016 extra fertilizer amounted to 2/3 of the gap between the economic optimum and the reduced N quota, and in 2017 farmers are allowed to apply nitrogen up to the economic optimum level. Corrected for organic farming, i.e. farming without use of inorganic fertilizer, the potential extra consumption was estimated to 48,200 t N and 73,000 t N in 2016 and 2017, respectively (Jensen et al., 2015). Additional cover of catch crops and the greening element, for instance further catch crops and set-aside, were, among other measures, suggested to counteract the potential increase in leaching due to the extra application of fertilizer in 2016.

The second River Basin Management Plans (RBMPII) were adopted in June 2016, in which plans for mitigation measures, e.g. re-established riparian areas and constructed wetlands, set-aside of organic soils, afforestation, and adjustment of elements in the Greening is planned to give an annual reduction in the marine N load of 6,900 t N in the period 2015-2021. Decision on measures to yield an annual reduction of 6,200 t N was postponed to after 2021.

The N load to marine waters has stepwise been reduced as planned measures for point sources and agriculture were implemented successfully. Approximately half of the Danish land area lies within catchments equipped with stream water gauging stations, where the N load to marine areas is regularly measured (Kronvang et al., 2008). Nitrogen load for the ungauged catchments has been modelled using an empirical model (Windolf et al., 2011). The annual load to marine waters varies between 55,000 and 59,000 t N, yielding an average of 57,000 t N for the five years (2010-2014) and was used as the reference level in the RBMPII (SVANA, 2016).

The regulation and effects described in this chapter cover the period until and including 2016.

The remaining part of this chapter consists of three parts:
Firstly, the general development in agricultural practices at national level is presented for the period 2005-2016. This analysis is based on national register datasets from the Ministry of Environment and Food (previously partly Ministry of Agriculture), i.e. the single payment register and the fertilizer accounts.

Secondly, modelled nitrate leaching, including crop distribution and the nitrogen balances, is presented for various farm types and geographical areas, and the impact of derogation farms is analysed. This analysis is based on a dataset derived by linking data from the single payment register, including data on the crops on each field of the holdings, and the fertilizer accounts. Both datasets cover agriculture in the year 2016.

Thirdly, measurements of water quality from the National Monitoring Programme are presented for the period 1990/91-2015/16, with particular reference to the Agricultural Catchment Monitoring Programme (Blicher-Mathiesen et al., 2017, in prep.). This section includes:

- Modelling of nitrate leaching in the monitoring catchments
- Measurements of nitrate in water leaving the root zone, including fields receiving more than 170 kg N ha^{-1} in organic manure
- Nitrogen in surface water, draining from agricultural catchments.

Modelling of nitrate leaching in this report is carried out by means of the latest version of the empirical model N-LES (version 4) from 2008 (Kristensen et al., 2008). This model is partly based on data from the Agricultural Catchment Monitoring Programme. The model requires input data for agricultural practises (N fertilization, cropping system), soil data and water percolation from the root zone. Percolation is calculated using the Daisy model and a standard climate from a 10 km grid net (Danish Meteorological Institute), representing weather measurements from 1990-2010. The climate dataset contains dynamic correction factors for rainfall (Refsgaard et al., 2011). Thus, modelled nitrate leaching represents the leaching in a standardised climate (water percolation). In contrast, all measurements from the Agricultural Catchment Monitoring represent nitrate leaching under actual climatic conditions.

4.2 Development in agricultural practices at the national level from 2005 to 2016

The development in crop distribution for 2005-2016 was analysed on the basis of the single payment registration. Figure 4.1 presents the results for cash crops, fodder crops and non-cultivated areas. The year 2005 was the first year with the single payment and it is anticipated that the reporting of areas was overestimated. Hereafter, the total reported agricultural area, including set-aside, has decreased from approximately 2,757,000 ha in 2006 to 2,647,000 ha in 2016.

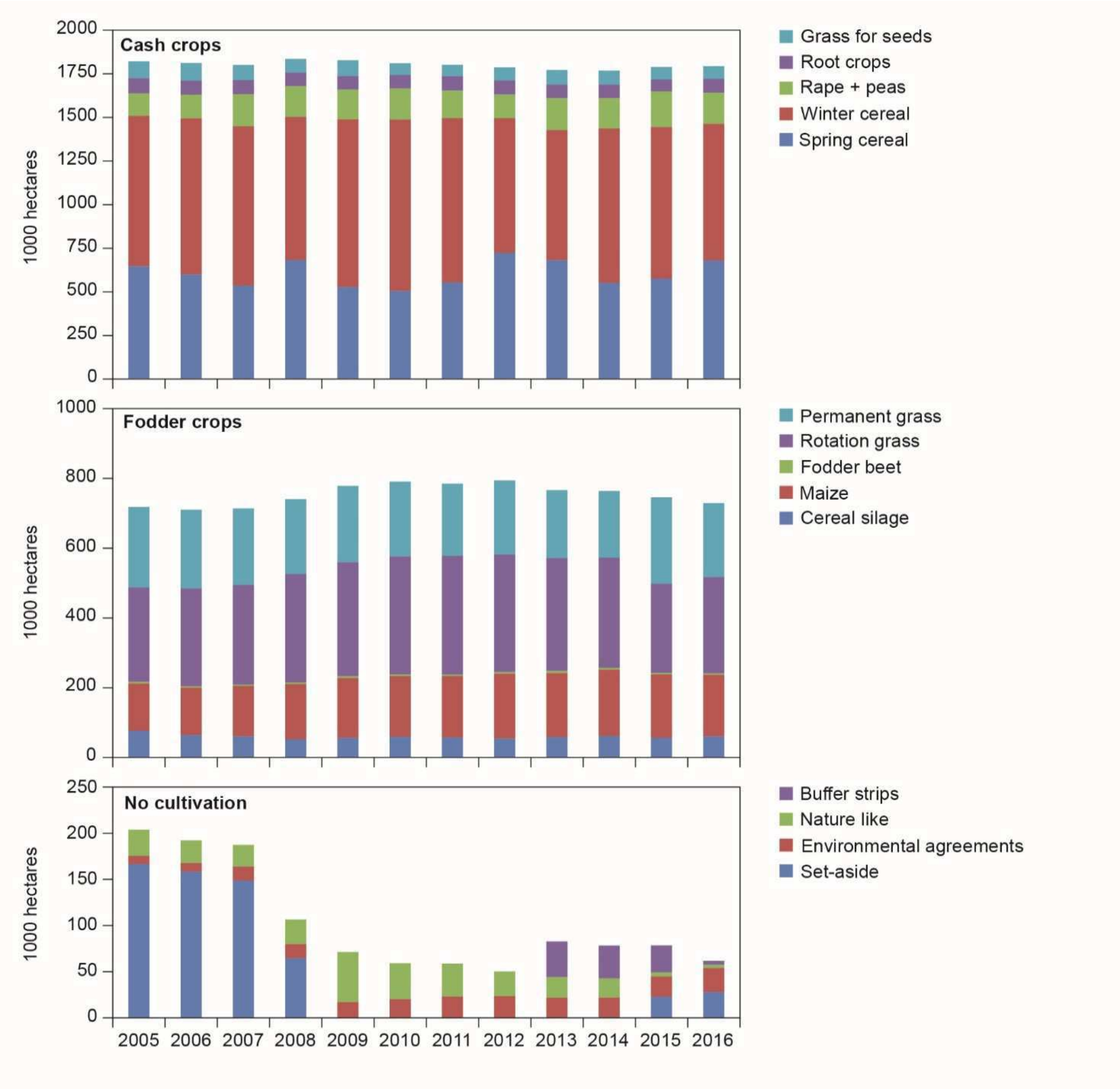

Figure 4.1 Development in crop distribution at the national level from 2005 to 2016, data from the single payment register.

The decrease in agricultural area of about 10,500 ha per year is due to road construction, afforestation, urbanisation etc. During the years 2006-07, set-aside comprised about 160,000 ha. As from 2008 the set-aside obligation was suspended, and in 2008 and 2009 set-aside areas were converted to cash crop, fodder crops and nature-like areas. This has resulted in an increase in the area with fodder crops (about 80,000 ha), particularly rotation grass and maize, as well as an increase in nature-like areas (about 25,000 ha) from 2007 to 2010. Set-aside covered approx. 23,000 and 28,000 ha in 2015 and 2016, respectively as set-aside is an element in the Danish implementation of the EU Greening. The area with cash crops and fodder crops has decreased slightly since 2012.

In Action Plan III, the requirement for growing catch crops was carried over from the former Action Plan, stipulating that farmers in 2005-2009 should grow catch crops on at least 6% of the potential catch crop area, if applying less than 80 kg organic manure N ha^{-1}, and on 10% of the area, if applying more than 80 kg organic manure N ha^{-1}. From 2010, an additional catch crop area, equivalent to 4%, was implemented, summing up to a total requirement of 10% or 14%, respectively. In 2008, the requirement for growing catch crops was raised to counterbalance the effects of the set-aside suspension. During this period (2005-2010), farmers growing winter crops (wheat, rye, oilseed rape), implying that catch crop requirements could not be fulfilled, were granted a reduction in the required catch crop area. From 2011, this possibility ceased, implying that some farmers had to alter their crop rotation from winter to spring crops. At the same time, voluntary alternatives to catch crops were introduced such as:

- reduction in the farm nitrogen quota
- growing of special crops between harvest and sowing of winter crops
- growing catch crops on other farms
- establishment of energy crops
- separation and treatment (biogas and burning) of animal manure
- from 2015: substitution of one hectare of catch crop by four hectare of set-aside near riparian areas and located next to agricultural areas in rotation
- from 2014: substitution of one hectare of catch crop by five hectares of winter wheat, if sown earlier than September 7.

Data from the fertilizer accounts show that establishment of catch crops and catch crop alternatives has increased from about 118,600-138,000 ha in 2005/06-2007/08 to about 389,200 ha of catch crop equivalents in 2016/17 (Table 4.1). The introduction and use of catch crop alternatives were equivalent to the effect of 13,900-44,000 ha catch crops in the period 2011/12- 2016/17. The area with catch crops in the latest year 2016 is the planned area, while the actual area is recorded later. Therefore the catch crop area for 2015 is now adjusted to the recorded data, which is app. 20,000 lower than the planned area for this year.

Table 4.1 Area with catch crops and catch crop alternatives (1,000 hectares of catch crops equivalents) reported by the farmers in the annual fertilizer account in the period 2005/06-2016/17.

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Catch crops	138.0	118.6	127.2	196.6	183.0	211.0	211.0	224.0	295.7	321.1	390.0	353.1
Catch crop alternatives	0	0	0	0	0	0	28.6	44.0	13.9	43.3	37.6	36.1

Data on the use of nitrogen in animal manure is based on calculations of fodder utilisation per livestock and the number of livestock (Statistics Denmark), whereas the annual use of inorganic fertilizers is obtained from the fertilizer accounts (Table 4.2).

The analysis shows that the use of animal manure was almost constant throughout the years 2005-2016, with some year-to-year variations, though. The use of inorganic fertilizers amounted to about 181,000-202,000 t N $year^{-1}$ in 2005-2007 and increased to 205,000 and 209,300 t N $year^{-1}$ in 2008 and 2009, probably due to the cultivation of previous set-aside areas. This was expected to be a temporary effect, as the procedure for setting the crop nitrogen standards implies that an increase in agricultural area with fertilizer requirements must be followed by an equivalent reduction in nitrogen standards. Administratively, however, this reduction is based on statistical data for the cultivated area, resulting in a delay of two years. Thus, in 2010-2014 the use of inorganic fertilizers decreased again, reaching the same level as in 2005-2007. The use of inorganic fertilizer increased slightly in the year 2015 to 210,000 t N and in year 2016 to 243,000 t N.

Table 4.2 Development in use of inorganic nitrogen fertilizer as reported by the farmers in the annual fertilizer status accounts and the use of nitrogen in animal manure as stated in the national statistics for the period 2005-2016 (1,000 t N a^{-1}).

	05	06	07	08	09	10	11	12	13	14	15	16
Fertilizer	191	181	202	205	209	198	203	198	199	203	210	243
Animal manure	227	219	237	230	226	224	228	227	222	223	222	224

4.3 Modelled nitrate leaching for farm types and geographical areas and the impact of derogation farms at the national level, 2016 data

Modelled nitrate leaching demonstrates the effect of crop distribution, nitrogen input, soil type, and water percolation through the soil. This section includes a presentation of all these parameters. The analyses are based on the national datasets from the single payment register and the fertilizer accounts. However, before data can be used for this purpose, a detailed data compilation of the two datasets must be undertaken (Børgesen et al., 2009). The single payment register contains information on crops at field-block level, and the fertilizer accounts contain information on the use of nitrogen (inorganic fertilizer and organic manure) at farm level. The two datasets are linked by means of the common farm identity number, and the reported amount of fertilizer and the manure from the individual accounts are divided between the fields of each farm according to the crop nitrogen standards. Hereby, we obtain a dataset with coherent data for crops and nitrogen application at field level. We have no information on grass-ley from either dataset. Therefore, we estimate this parameter based on the area with rotation grass, assuming a conversion rate of three years. If there is not enough space in the crop rotation, the area with grass-ley is reduced accordingly. Data on catch crops are derived from the fertilizer accounts.

The field-blocks are geographically mapped, implying that each field can be linked to soil maps and to the meteorological grid net. Having established the soil type for each field-block, the standard harvest yield may be estimated. Furthermore, nitrogen fixation is included using standard values for each crop. This final dataset now contains all necessary information for geographically distributed computation of crop coverage and field nitrogen balances and for modelling nitrate leaching.

Farm type

The data are divided into three main groups of farm type – arable farming, pig farms and cattle farms. A pig farm is defined as a farm, where more than 2/3 of the livestock units (LU) originate from pigs, and a cattle farm is defined as a farm, where at least 2/3 of the LU originates from cattle. An arable farm is a farm with less than 2 LU, but the farm may import animal manure, which will appear in the fertilizer account and is therefore included in this analysis. Other farm types are not included in this analysis.

Figure 4.2 shows that arable farms and pig farms grow cereals, and particularly winter wheat, on the majority of the agricultural area (64-77%) in 2016. Other cash crops, i.e. oilseed rape, peas, root crops (potatoes and sugar beet) and grass for seeds, are also major crops (17-21%). Cereal silage, grass and maize take up a minor part of the area (5-13%). Catch crops are grown on 12-15% and grass-ley on 2-3% of the agricultural area on arable and pig farms.

Cattle farms have a different crop rotation. Cereals and other cash crops are grown on only 35% of the area, whereas cereal silage, grass and maize are grown on 58% of the area. Fodder beet is grown on 1.1% of the area. In addition, grass-ley is found on 10% and catch crops on 14% of the area.

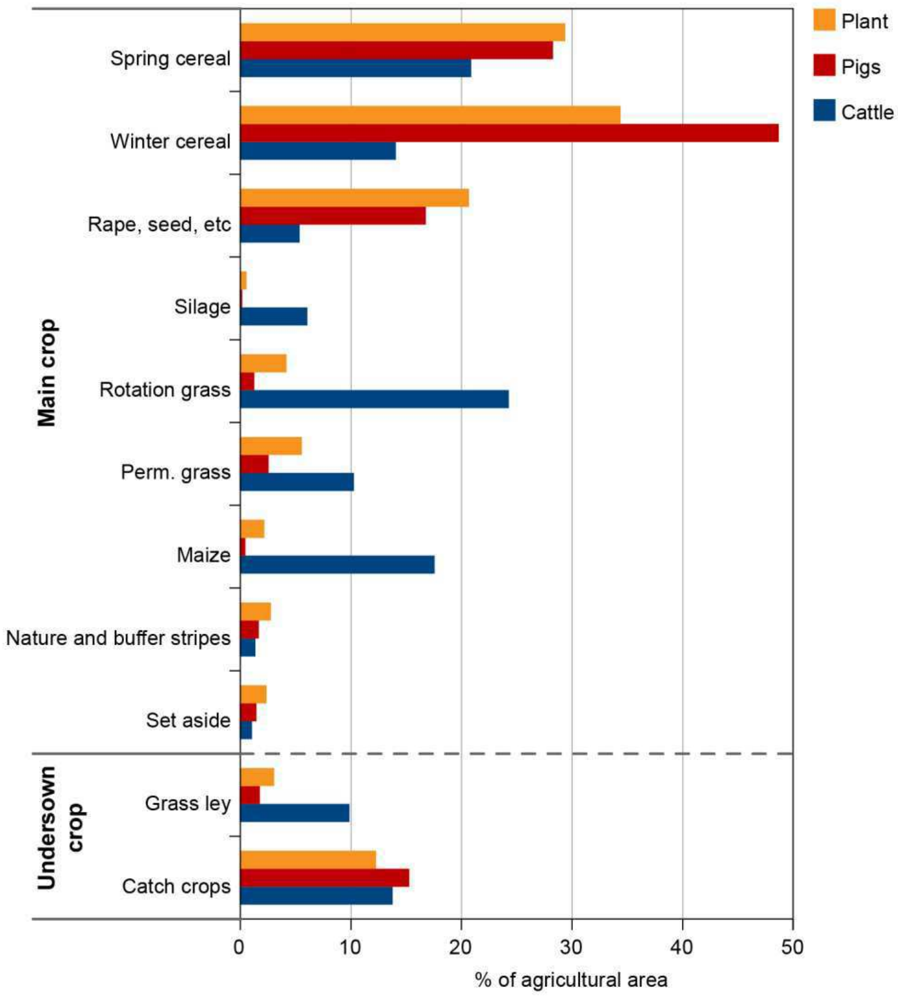

Figure 4.2 Crop distribution for three main farm types in 2016, combined data set from the single payment register and the fertilizer status accounts.

On arable farms, an average amount of about 46 kg N ha-1 from animal manure is applied. For pig and cattle farms the amounts are, respectively, 99 kg N ha-1 and 128 kg N ha-1 (Table 4.3).

Table 4.3 N inputs, N balances and nitrate leaching and nitrate concentration at bottom of the root zone for three main farm types in 2016, combined data set.

	N balance									Root zone water		
	Comm. Fertilizer	Animal manure	Other org.	N fix.	N depos.	Seeds	Total input	Har-vest	N balance	Percol.	Nitrate leaching	NO_3^- conc.
	(kg N ha-1 a-1)									(mm a-1)	(kg N ha-1)	(mg l-1)
Arable	110	46	5.4	8,2	13	1.9	185	107	77	339	58	75
Pigs	90	99	1.1	4,8	13	2.0	211	111	100	381	68	80
Cattle	75	128	1.3	29	14	1.4	248	143	104	413	68	73

The use of inorganic fertilizers decreases with increasing application of animal manure. Total inputs of nitrogen from inorganic fertilizer, manure, other organic sources, N fixation and atmospheric deposition add up to 185, 211 and 248 kg N ha-1 for arable farms, pig farms and cattle farms, respectively. N balances, calculated as the difference between total input of nitrogen and removal by harvested crops, are 77, 100 and 104 kg N ha^{-1} for arable farms, pig farms and cattle farms, respectively. As expected, modelled nitrate leaching is lower from arable farms (on average 58 kg N ha^{-1}) than from animal husbandry farms (on average 68 kg N ha^{-1}). N leaching is on average similar for pig and cattle farms despite a larger N input and N balances for cattle farms than for pig farms. The reason is that cattle farms grow a high proportion of fodder crops having a long growing season and therefore a larger N uptake.

On arable farms, the modelled nitrate leaching amounts to 75 % of the N balance, which is high relative to 68 and 65 % for the other two farm types, pig and cattle farms respectively. An explanation may be that leaching on these soils with low input of organic manure is affected by mineralisation of the organic pool, i.e. a depletion of the total soil N content. However, the high leaching fraction may also be caused by the uncertainties associated with the two separate calculations of the N leaching and N balance.

The water percolation through the soils is considerably higher on cattle farms than on arable and pig farms. However, this is not due to differences in farm type, but due to the fact that the cattle farms are located mainly in the western part of the country with more sandy soil and higher rainfall and a consequently higher percolation. The higher percolation on cattle farms leads to a dilution of the nitrate concentration in the soil water. Thus, the modelled average nitrate concentrations in soil water are 75-80 mg NO_3 l^{-1} on arable and pig farms, respectively, and 73 mg NO_3 l^{-1} on cattle farms for the year 2016.

Geographical areas
Farm types are not evenly distributed throughout the country because of variations in farming conditions. The country has therefore been divided into five farming regions (Figure 4.3).

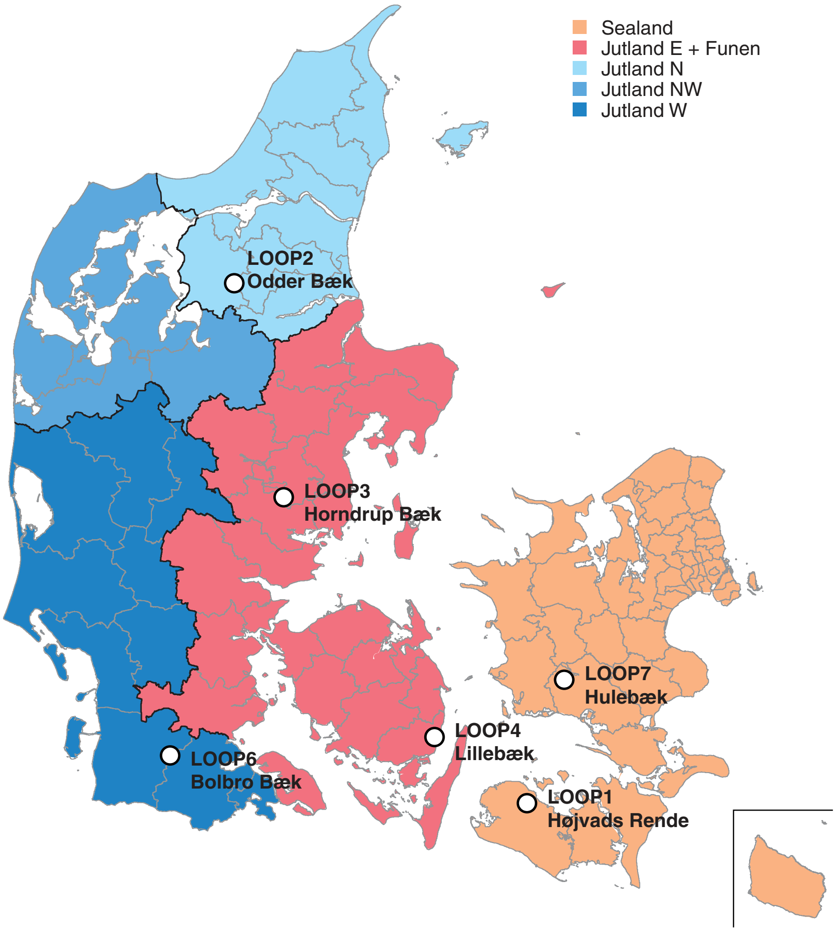

Figure 4.3 Farming regions in Denmark with different soil types, farming practices and rainfall and the position of the six monitored agricultural catchments.

Table 4.44 shows that Zealand is dominated by arable farming, whereas Eastern (E) Jutland and Funen are dominated by arable farming and pig production. Finally, North (N), North-west (NW) and West (W) Jutland have the highest density of cattle farming. Thus, arable and pig farms are located mainly in the eastern part of Denmark on the loamy soils and with low rainfall, whereas cattle farms are located mainly in the northern and western parts on sandy soils and with higher rainfall, the rainfall increasing from north to south.

Table 4.4 Distribution of farm types and soil types and water percolation through the soils in Denmark divided into five main geographical areas, 2016.

	Arable	Pig	Cattle	Other	Sand	Loam	Organic soils	Percol.
	% of agricultural area				% of agricultural area			mm/year
Zealand	63	13	16	8	5	92	3	200
Jutland E+ Funen	42	26	25	8	26	70	4	336
Jutland N	35	17	37	11	80	10	10	365
Jutland NW	28	23	40	10	62	33	5	450
Jutland W	31	15	45	9	76	18	6	543

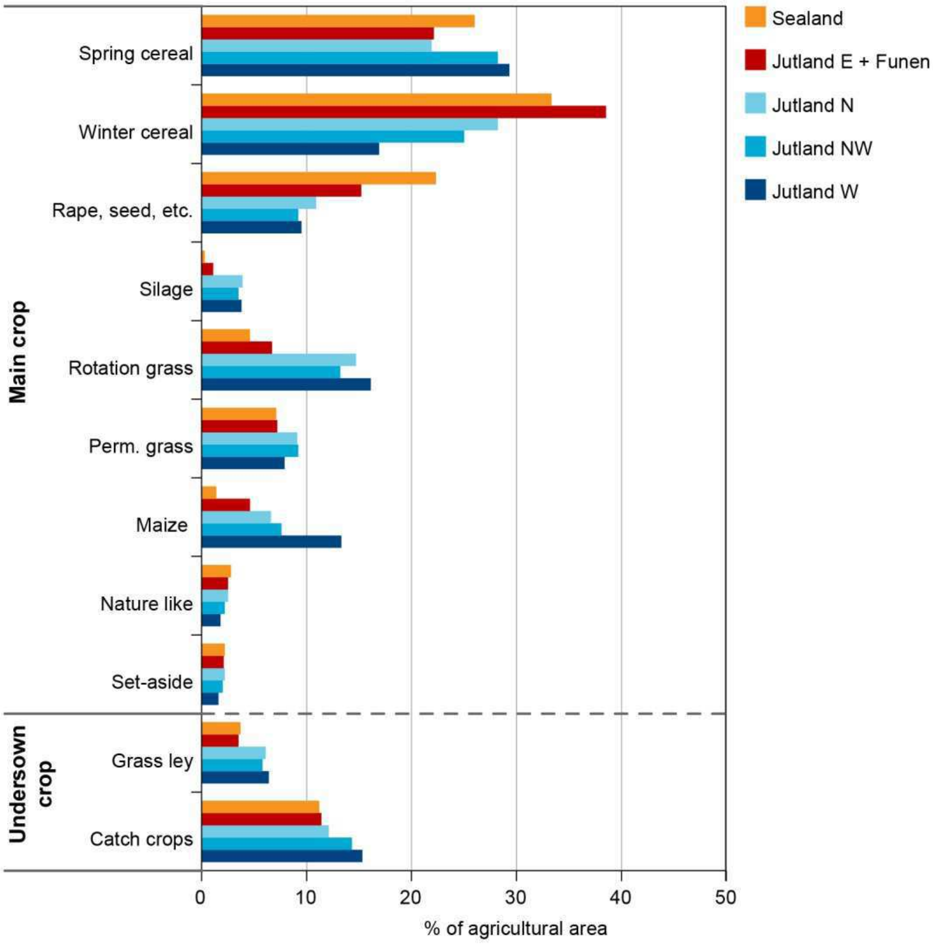

Figure 4.4 Crop distribution for five farming regions in Denmark in 2016, combined data set from the single payment register and the fertilizer accounts.

The crop distribution within the five farming regions of Denmark follows the same pattern traced for farm types, i.e. mainly cereals and other cash crops on the islands and in Eastern Jutland and cereals and fodder crops in West and North Jutland (Figure 4.4).

The input of nitrogen with animal manure, the total nitrogen input and the field nitrogen balances are lowest on Zealand, higher in E Jutland and on Funen and highest in W, NW and N Jutland (Table 4.5). In the latter three areas, the nitrogen inputs vary between 211 and 227 kg N ha^{-1}. The modelled nitrate leaching generally increases from east to west due to increases in nitrogen input and percolation. Within the three western and northern parts of Jutland, the nitrate leaching increases from the northern to the southern Jutland, mainly due to increased water percolation through the root zone. Higher water percolation leads to dilution of the nitrate concentrations of the soil water, resulting in a an average concentration in soil water of 85, 77-78 and 67-71 mg NO_3 l^{-1} on Zealand, Funen + E and N Jutland, and NW and W Jutland, respectively.

Table 4.5 N inputs, N balances, and nitrate leaching and nitrate concentration at the bottom of the root zone calculated for five geographical areas in Denmark in 2016. Combined data set from the single payment register and the fertilizer accounts

	N balance									Root zone water		
	Comm. fertilizer	Animal manure	Other org. N	N-fix.	N-depos.	Seeds	Total input	Har-vest	N balance	Percol.	Nitrate leaching	NO_3^- conc
	kg N ha^{-1} yr^{-1}									mm a^{-1}	kg N ha^{-1}	mg l^{-1}
Zealand	121	35	4.6	8.8	12	1.7	183	114	69	200	38	85
Jutl. E +Funen	99	74	2.6	11	13	1.8	202	115	87	336	58	77
Jutland N	77	100	2.1	19	12	1.5	211	118	93	365	64	78
Jutland NW	72	109	0.6	18	13	1.6	214	120	93	450	72	71
Jutland W	73	113	3.5	20	16	1.7	227	127	100	543	82	67

Derogation farms

Derogation farms are mainly located in N, NW and W Jutland, where cattle farming is dominant (see chapter 2). The effect of the derogation is evaluated for these three geographical areas. The cattle farms are grouped into four livestock density groups: 0-1.0, 1.0-1.4, 1.4-1.7 LU ha^{-1} and derogation farms (1.7-2.3 LU ha^{-1}).

The crop distributions for the three geographical areas are almost identical (Figure 4.5). There is a clear trend indicating a decrease in areas with cereals and other cash crops with increasing livestock density and, in turn, that the area with fodder crops increases with increasing livestock density. The area with roughage amounts to 51, 72 and 71 % for the three groups, 0-1.0, 1.0-1.4, 1.4-1.7 LU ha^{-1}, respectively, whereas derogation farms grow roughage on average 86 % of the area.

The effect of derogation on nitrate leaching is evaluated for the three geographical areas separately. The nitrogen input as well as the field nitrogen balances increase with increasing livestock density (Table 4.6). Modelled nitrate leaching is a combined effect of two opposing mechanisms – an increase in leaching due to increased nitrogen input and a decrease in leaching due to an increased area with roughage. Table 4.6 shows that modelled nitrate leaching generally increases with increasing livestock density and hence with increasing nitrogen input. Thus, there are differences in modelled annual nitrogen leaching of 0, 3 and 8 kg N ha^{-1}, respectively, between derogation farms and farms using 140-170 kg N ha^{-1} of organic N in the three Jutland regions. Similarly, nitrate concentrations in the soil water leaving the root zone of derogations farms are respectively 4, 6 and 6 mg NO_3 l^{-1} higher than for cattle farms using 140-170 kg organic N ha^{-1} in the three regions.

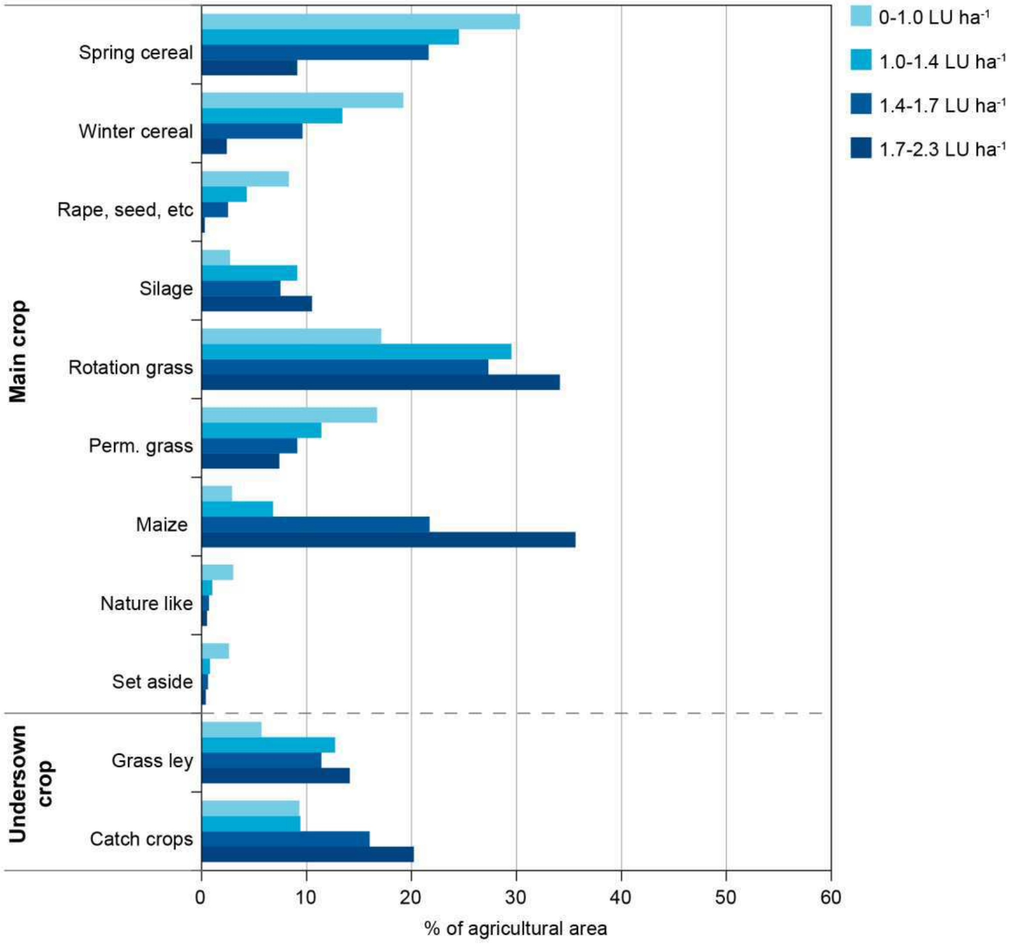

Figure 4.5 Average crop distribution for four groups of livestock density in N, NW and W Jutland in 2016, combined data set from the single payment register and the fertilizer accounts.

The use of legumes (clover, alfalfa, peas) in grass and cereal silage is shown in Table 4.7. The general trend is that derogation farms grow legumes to a slightly lower extent than non-derogation farms for permanent grass and grass in rotation and slightly higher for cereal silage (Table 4.7). Thus, clover or alfalfa (max. 50% share) in rotation grass is used on 76 % of the grass area for derogation farms and on 79-92 % for non-derogation farms. For permanent grass, the equivalent values are 23 % for derogation farms and 21-35 % for non-derogation farms. Cereal silage with peas amounts to 23 % of the silage area for derogation farms and 17-21 % for non-derogation farms.

Table 4.6 N inputs, N balances and nitrate leaching and nitrate concentration at the bottom of the root zone, calculated for four groups of livestock density at cattle farms and in three geographical areas in Jutland, Denmark in 2016, combined data set from the single payment register and the fertilizer accounts.

Region	Live-Stock density	N balance									Root zone water		
		Comm. fertiliser	Animal manure	Other org.N	N fix.	N depos.	Seeds	Total input	Harvest	Balance	Percol.	Nitrate leaching	NO_3-conc
	LU/ha	kg N ha⁻¹ a⁻¹									mm a⁻¹	kg N ha⁻¹	mg l⁻¹
Jutland N	0-1.0	84	55	1.9	20	12	1.1	174	101	72	359	55	68
	1.0-1.4	49	123	0.7	44	12	1.0	230	135	95	357	57	71
	1.4-1.7	78	152	0.4	36	12	1.3	279	154	125	360	69	85
	1.7-2.3	69	202	0.0	40	12	1.3	325	179	146	347	69	89
Jutland NW	0-1.0	82	62	1.6	18	13	1.2	177	101	76	433	61	55
	1.0-1.4	53	121	0.1	37	13	1.1	225	128	97	450	65	57
	1.4-1.7	74	151	0.0	33	13	1.4	272	155	117	448	77	72
	1.7-2.3	61	198	0.1	38	13	1.4	311	173	138	435	80	78
Jutland W	0-1.0	76	58	5.7	22	16	1.4	179	111	68	527	65	55
	1.0-1.4	40	126	1.7	46	16	1.1	231	138	93	542	70	57
	1.4-1.7	76	152	1.4	30	16	1.5	277	154	123	546	89	72
	1.7-2.3	73	204	0.6	29	16	1.6	324	181	143	550	97	78

Table 4.7 Use of legumes in grass and cereal silage at cattle farms for derogation and non-derogation farms, 2016.

	Livestock density (LU ha⁻¹)			
	0-1.0	**1.0-1.4**	**1.4-1.7**	**1.7-2.3**
			share of agricultural area (%)	
Rotation grass	10.6	26.8	24.4	32.5
			share of rotation grass (%)	
No clover/alfalfa	19	7	15	24
< 50% clover/alfalfa	79	92	84	76
> 50% clover/alfalfa	2	1	0	0
			share of agricultural area (%)	
Permanent grass	14.7	10.7	8.1	6.6
			share of permanent grass (%)	
No clover/alfalfa	65	73	79	77
< 50% clover/alfalfa	35	27	21	23
> 50% clover/alfalfa	0	0	0	0
			share of agricultural area (%)	
Cereal silage	1.6	7.9	6.2	6.6
			share of cereal silage (%)	
No legumes	75	48	66	77
< 50% legumes	17	21	21	23
100% legumes	8	31	13	0

4.4 Development in modelled nitrate leaching in the Agricultural Catchment Monitoring Programme, 1990-2016

This section deals with the general development in nitrate leaching from 1990 to 2016. Information on agricultural practises is derived from the Agricultural Catchment Monitoring Programme. This programme includes six small agricultural catchments situated in various parts of the country in order to cover the variation in soil type and rainfall and hence in agricultural practises (Figure 4.3). The farmers are interviewed every year about livestock, crops and fertilization and cultivation practises. Nitrate leaching is modelled for every field in the catchments, based on the information on agricultural practises and standard percolation values, calculated on the basis of the climate for 1990-2010.

In 2016, 115 farmers participated in the investigation. Of all the investigated farms, 22 were cattle holdings, and of these six were registered as derogation farms. These derogation farms covered 15 % of the total area in the Agricultural Monitoring catchments in 2015/16. This is considerably higher than the share of derogation farm area at national level in 2015/16, which amounted to 8.6 % of the agricultural area.

The modelled nitrogen leaching from the agricultural area in the catchments from 1990 to 2016 (representing the hydrological years 1990/91 to 2016/17) is shown in Figure 4.6 as an average for sandy and loamy catchments, respectively.

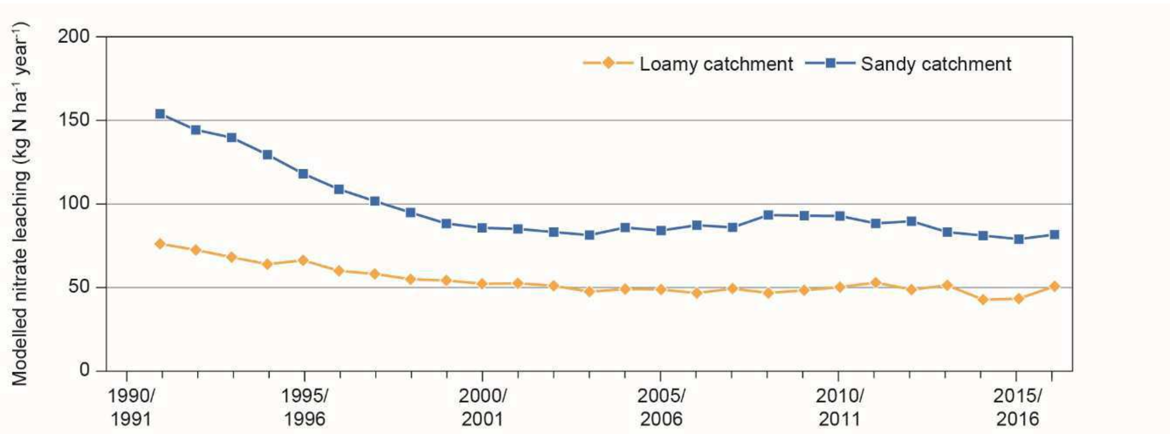

Figure 4.6 Modelled nitrate leaching in a standard climate for the fields of the Agricultural Catchment Monitoring Programme, 1990/91-2016/17.

When weighed in accordance with the distribution of the main soil types in Denmark, it was found that modelled nitrate leaching was reduced by 43% during the period 1991 to 2003 due to the general improvement in agriculture and fertilization practises (Action Plan I+II). After 2008, there was a small increase in nitrate leaching, particularly on sandy soils, probably caused by suspension of the set-aside obligation. At the national level, about 120,000 hectares of set-aside were cultivated in 2008 and 2009, leading to a change in crop rotation towards a higher leaching potential and a temporary increase in fertilizer application. After 2011, the modelled nitrate leaching for the sandy catchments again decreased and reached the same level as before 2008.

For the loamy catchments, modelled annual nitrate leaching was less affected by the change in set-aside. The nitrate leaching was quite stable around 50 kg N ha^{-1} during 2003-2013, decreasing with app. 6 kg N ha^{-1} in 2014 and 2015 and increasing again to the level of 2003-2013 in 2016

For the sandy catchments the annual leaching during 2014-2016 is about 8 kg N ha^{-1} lower than the average leaching of 80 kg N ha^{-1} for the period 2003-2013. The lower leaching for these three years are mainly due to a higher share of catch crops after cereals and in maize. The calculated effect of catch crops in maize and cereals is identical in the model, as no measurements of the catch crops effect in maize were available, when the empirical model was developed. During the last four to five years farmers and researchers have increased focus on management and the effect of catch crops in maize (Blicher-Mathiesen et al., 2016). If maize was cropped without catch crops the average modelled annual leaching for the sandy catchments would be approx. 5 kg N ha^{-1} higher in 2014/15 - 2016/17.

The purpose of the root zone modelling is to show the effect of measures introduced to mitigate nutrient losses from agriculture. The modelling is therefore carried out for normalised growth conditions, i.e. averaging the model output for a 20 years period: The model is run for each year in the 20 years period and model outputs are then averaged for the period. The climatic data used cover the period 1990-2010. Actual measurements of nitrate leaching will show higher annual variations than the climatic average for modelled values, as the measurements depend on the actual climate.
Certain forms of soil cultivation and ploughing of grass fields in the autumn were prohibited as from the autumn of 2011. This is not included in the leaching model due to lack of actual measurements that could be used for the model development. It is estimated that postponed soil tillage will reduce root zone leaching by 2,400 t N at the national level corresponding to an average effect of about 1 kg N ha^{-1} (Børgesen et al., 2013).

4.5 Measurements of nitrate in water leaving the root zone
In five of the six Agricultural Monitoring Catchments, water samples are collected regularly at 30 sites. One of the sites is covered by forest and is therefore not included in the data for nitrate concentration measured on agricultural area. Measurement on one sandy sites stopped in 2011 as the farmers did not want to participate in the Monitoring. Two sites on a loamy catchment are placed very close to the edge of the field and tractor transport in and out of the fields give unusual damage on crop, uneven fertilizer application and very high values of measured nitrate leaching. Out of the remaining 27 sites on agriculture areas, the 14 sites a located on loamy soils and 13 sites are located on sandy soils. And those data rated as valid for the trend analysis of the loamy and sandy catchments. The samples represent the root zone water (approx. 1 m depth – 30 samples per year) and the upper oxic groundwater (1.5-5 m depth – 6 samples per year). The measured concentrations are shown as annual average values for loamy and sandy soils, respectively, for the period 1990/91-2015/16 (Figure 4.7).

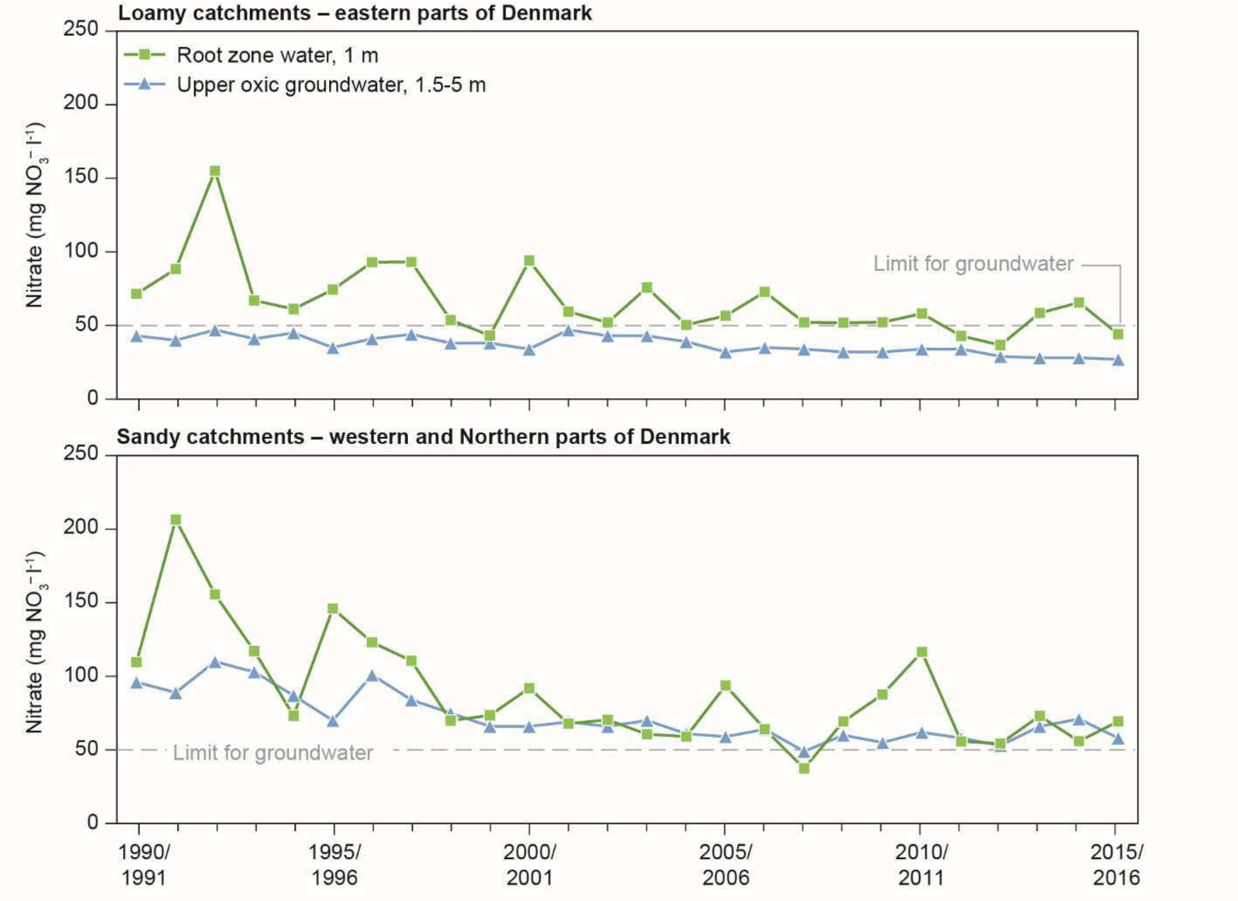

Figure 4.7 Annual flow-weighted nitrate concentrations measured in root zone water and annual average nitrate concentrations measured in upper oxic groundwater, the Agricultural Catchment Monitoring Programme 1990/91-2015/16.

Generally, measured data for nitrate leaching from the root zone on only 27 sites cannot be used as an estimate for all agricultural area as the effect of a single variable such as fertilizer or manure input because of the high variability in yield, crops cover and climate between the monitoring fields and measured years.

However, the data are used for the development of the nitrate leaching model, N-LES4. This model is then used for calculating the leaching from all the fields in the catchment based on the agricultural practises (Figure 4.6). The measurements are also used for calculating statistical trends for the monitoring period.

General trend for nitrate concentrations in water leaving the root zone

There is strong inter-annual variation in measured nitrate concentrations due to variations in rainfall and temperature. Therefore, a long time series and a large number of measuring points are needed to detect any statistically significant trend. Such data series are available from the Danish Monitoring Programme. A statistical trend analysis, a Mann-Kendall test, which incorporated the annual variations in the mean annual flow-weighted nitrate concentrations for water leaving the root zone, showed that concentrations significantly decreased by 1.2 and 2.6 mg NO_3 l^{-1} a^{-1} for the measured sites on loamy and sandy soils, respectively and calculated for the monitored period of 26 years, 1990/91-2015/16.

On loamy catchments the measured nitrate concentration in root zone water decrease from 61-155 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 37-66 mg NO_3 l^{-1} in the five year period 2011/12-2015/16. On sandy catchments the nitrate concentration decreased from 73-207 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 54-73 mg NO_3 l^{-1} in the five year period 2011/12-2015/16 (Figure 4.7).

After 2003/04 (Action Plan III + Green Growth), no statistically significant change in measured nitrate concentrations in soil water leaving the root zone has been recorded. However, before 2011/12, high concentrations have been observed temporarily for sandy soils. This is most likely a coincidence of crops with high leaching potential on these fields, such as turn-over of grassland, followed by cereals with no catch crops the following years, growing of maize and winter rape etc.

It should be noted that the measurements of nitrate leaching originate from a small number of samplings stations (27 stations). Furthermore, the measurements are affected by high crop yields in particular in 2009 and effects of crop rotation, especially of grass in rotation. These conditions give higher inter-annual variations than seen in the modelled nitrate leaching that cover a larger area from approx. 114 farms (Figure 4.6).

In the upper groundwater (1.5-5.0 m), nitrate concentrations are lower than in the root zone water, indicating nitrate reduction in the aquifer sediment between the bottom of the root zone and the uppermost groundwater (Figure 4.7).

On loamy catchments the measured nitrate concentration in the upper oxic groundwater decreases from 40-47 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 27-34 mg NO_3 l^{-1} in the five year period 2011/12-2015/16. On sandy catchments the nitrate concentration decreases form 87-110 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 53-71 mg NO_3 l^{-1} in the five year period 2011/12-2015/16.

The general conclusions to be drawn from the Agricultural Catchment Monitoring Programme are that:

- Nitrate concentrations in root zone soil water (1.0 m below soil surface) have decreased steadily from 1990 to 2016. On loamy catchments the measured nitrate concentration decreased from 61-155 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 37-66 mg NO_3 l^{-1} in the five year period 2011/12-2015/16. On sandy catchments the nitrate concentration was 73-207 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 and decreased to 54-73 mg NO_3 l^{-1} in the five year period 2011/12-2015/16.
- Nitrate concentrations in the upper oxic groundwater (1.5-5.0 m below soil surface) decreased to a level well below the limit of 50 mg NO_3 l^{-1} for loamy catchments and to a level between 53 and 71 mg NO3 l^{-1} for the two sandy catchments in the period 2011/12-2015/16.

Nitrate concentrations in water leaving the root zone for cattle holdings

Two to three of the monitoring sites belong to cattle holdings that on average use between 130 and 170 kg organic manure N ha^{-1} in the period 2000/01-2015/16 and four to five sites belong to holdings that on average use more than 170 kg organic manure N ha^{-1} on the measuring site. Measurements of nitrate in water, leaving the root zone, are shown annually for each site for the period 2000/01-2015/16. On one of the sites, station "st 604", the manure input changed from a high annual input, above 170 kg N ha^{-1} until 2008 (data shown in Figure 4.8 bottom) to a lower input, below 170 kg N ha^{-1} in the following years (data shown in Figure 4.8 top). Suction cups on site "st 203" were re-established in 2012, giving no measurements for this site in the two years 2012/13 and 2013/14. The annual manure input on site "st 202" changed to a much lower level of 78 and 178 kg N ha^{-1} for 2012 and 2013 respectively, and nitrate concentration in the root zone water is therefore not shown for these two years.

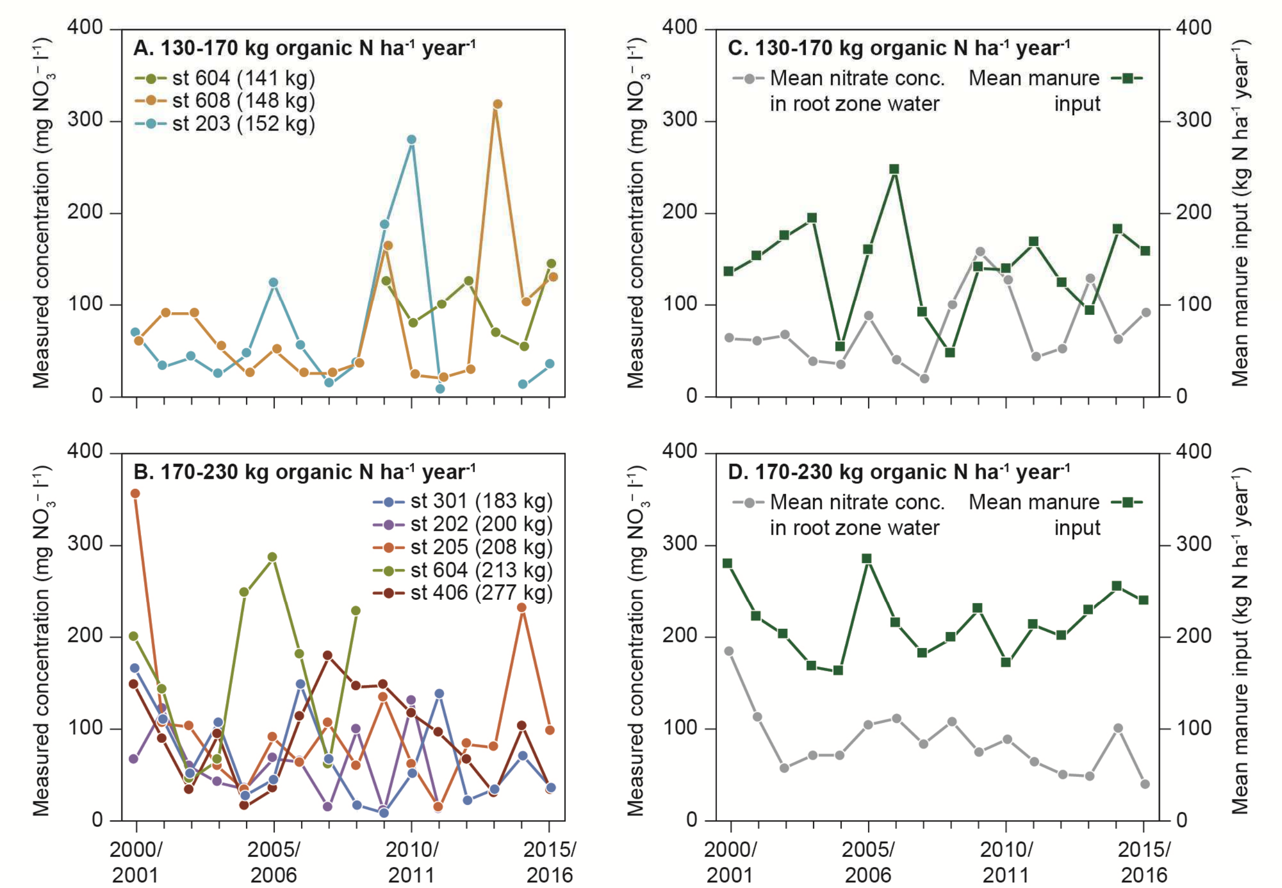

Figure 4.8 Measured nitrate concentrations in root zone water (1 m depth) with average application of 130-170 (A) and more than 170 kg organic N per hectare (B) at the sites (average application of organic manure N is shown in brackets). Figures for annual averages for the measured stations, average application of 130-170 (C) and more than 170 kg organic N per hectare (D). All data is shown for the period 2000/01-2015/16.

Annual variations in measured concentrations at these single monitoring stations are expected, partly due to crop rotation, yield and variations in meteorological conditions.

The sites that annually receive on average 130-170 kg N in manure ha^{-1} for the period 2000/01-2015/16 do have high average nitrate concentration for the six years 2005/06, 2008/09-2010/11, 2013/14 and 2015/16 (Figure 4.8 top left). The sites that annually receive more than 170 kg N in manure ha^{-1} on average in the same period do also have very high nitrate concentrations for some sites e.g. "st 604" in five out of six years between 2004/05 and 2009/10. However other sites, receiving high manure input, show relatively lower soil water concentration (Figure 4.8 bottom). High nitrate concentrations are more likely resulting from crop rotation, especially turn-over of clover grass in rotation, followed by cereals without catch crops or high N input to maize and hence cannot be linked to the level of manure input alone.

Phosphorus concentrations in the water leaving the root zone are shown in Figure 4.9. Generally, the concentrations vary between 0.005 and 0.050 mg PO_4-P l[-1], irrespective of the use of organic manure. However, on one field receiving an average of 148 kg organic N ha[-1] (st 608), P concentrations are much more variable. The soil texture on this field is coarse sand and it is located in an area with high rainfall.

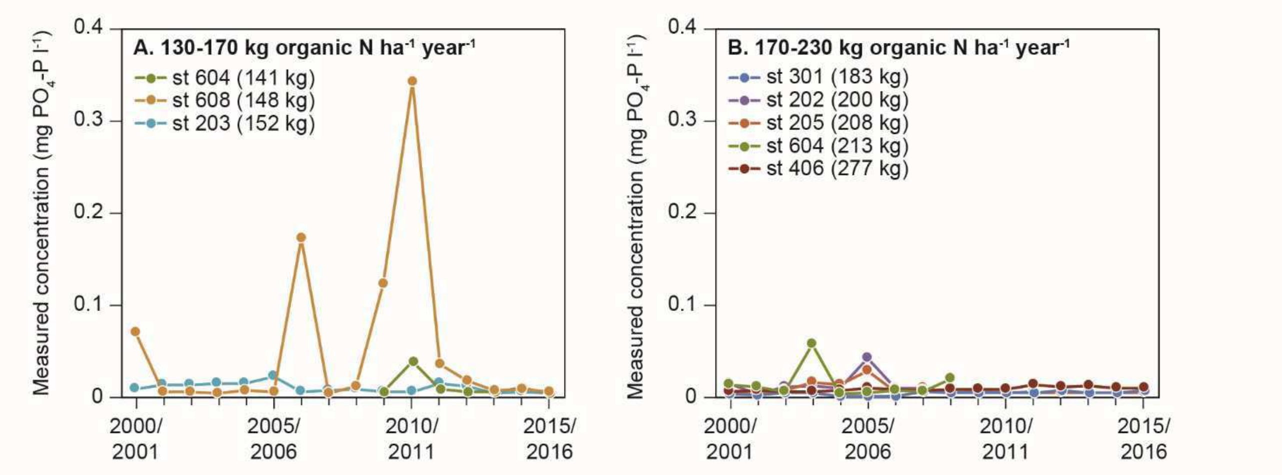

Figure 4.9 Measured phosphorus concentrations as dissolved orthophosphate (PO4-P) at soil water stations (1 m depth) with average application of 130-170 (A) and more than 170 kg organic N per hectare (B) at the sites (average application of organic manure N is shown in brackets). All data are shown for the period 2000/01-2015/16.

4.6 The nitrogen flow to surface water in agricultural catchments

When percolating water leaves the root zone, it divides into one component, which discharges to surface water, and another component, which discharges to groundwater, from where it will eventually – often some years later – drain into the streams. The pathways for water and nutrients in agricultural catchments are analysed in the Agricultural Catchment Monitoring Programme. Nitrate concentrations are measured in soil water, in water from tile drains includes three loamy catchments and two sandy catchments.

The monitoring programme does not allow an evaluation of the effect of derogation farms specifically on the nitrate transport in the stream since measurements at the catchment outlet integrates the effects of all activities in the catchment. However, the monitoring programme will provide an overview of the general trend for surface water, including the effect of any derogation farms in the catchment.

This chapter gives an overview of the nitrogen pathways in the hydrological cycle and describes the trends for nitrate in water for the period 1990-2016. Continued monitoring within the framework of the Agricultural Catchment Programme and the Stream Programme will provide indicators for the future development.

The hydrological pathways

An analysis of the water flow in the streams of the five agricultural catchments has shown that it can be conceptually divided into three components with rapid, intermediate and slow response to precipitation, respectively (Table 4.8). These components may be regarded as flow from the upper soil layers (including tile drainage), from the upper oxic groundwater and from deep groundwater.

In loamy catchments, the flow path is characterised by rapidly responding water (from upper soil layers), whereas there is a larger proportion of slowly responding water (from deeper groundwater) in sandy catchments.

Table 4.8 Partitioning of water flow in streams into three components – rapid, intermediate and slow responding water. The analysis included three loamy catchments and two sandy catchments (1989/90-2002/03)

	Flow response		
	Rapid	**Intermediate**	**Slow**
Loamy catchments	41 %	16 %	43 %
Sandy catchments	20 %	23 %	57 %

This flow pattern is outlined in Figure 4.10. Measurements of nitrate concentrations in soil root zone water (mg NO_3 l-1), upper oxic groundwater (1.5-5 m) and in streams are also shown. When water percolates from the root zone to the upper groundwater denitrification processes take place. Thus, nitrate concentrations in the upper groundwater are lower than in the root zone water. When the water passes through the deeper aquifers, it will usually reach the redox cline where the remaining nitrate will be removed by biological and geo-chemical reduction processes.

As sandy catchments are characterised by groundwater flow, the water discharging to the streams has been exposed to reduction processes. Thus, nitrate concentrations in the stream water are relatively low. In loamy catchments, the discharging water has mainly passed through the upper soil layers and through drainage system, where less nitrate reduction takes place. Hence nitrate concentrations in the streams are higher than in sandy catchments.

In this context, it should be noted that cattle farms, and hence the derogations farms, are mainly located in the western and northern parts of Jutland, with sandy soils and deep groundwater flow, leading to high nitrate removal and low nitrogen concentrations in the streams.

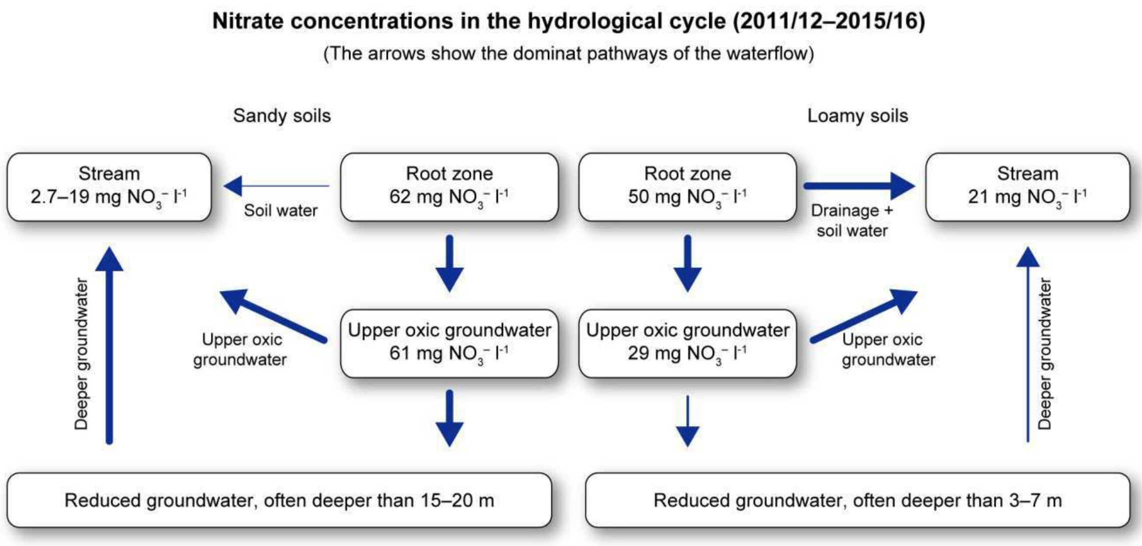

Figure 4.10 Measured nitrate concentrations in the hydrological cycle in three loamy catchment and two sandy catchments in the Agricultural Catchment Monitoring Programme. Values are calculated as an annual means for the period 2011/12-2015/16.

Trends in nitrate concentrations in the hydrological cycle

The development in nitrate concentrations in root zone water, upper oxic groundwater and stream water is shown in Figure 4.11. Statistical analyses incorporating the annual variations showed that the nitrate concentration in water leaving the root zone significantly decreased by 1.2 and 2.6 mg NO_3 l^{-1} a^{-1} for the measured sites on loamy and sandy soils, respectively and calculated for the monitored period of 26 years, 1990/91-2015/16 (see section 4.5). In the Stream Monitoring Programme the development is analysed for a larger number of streams. This programme showed during the period 1989-2011 an average reduction of 48% in total nitrogen transport for 63 agricultural catchments representing both loamy and sandy soils (Wiberg-Larsen et al., 2012).

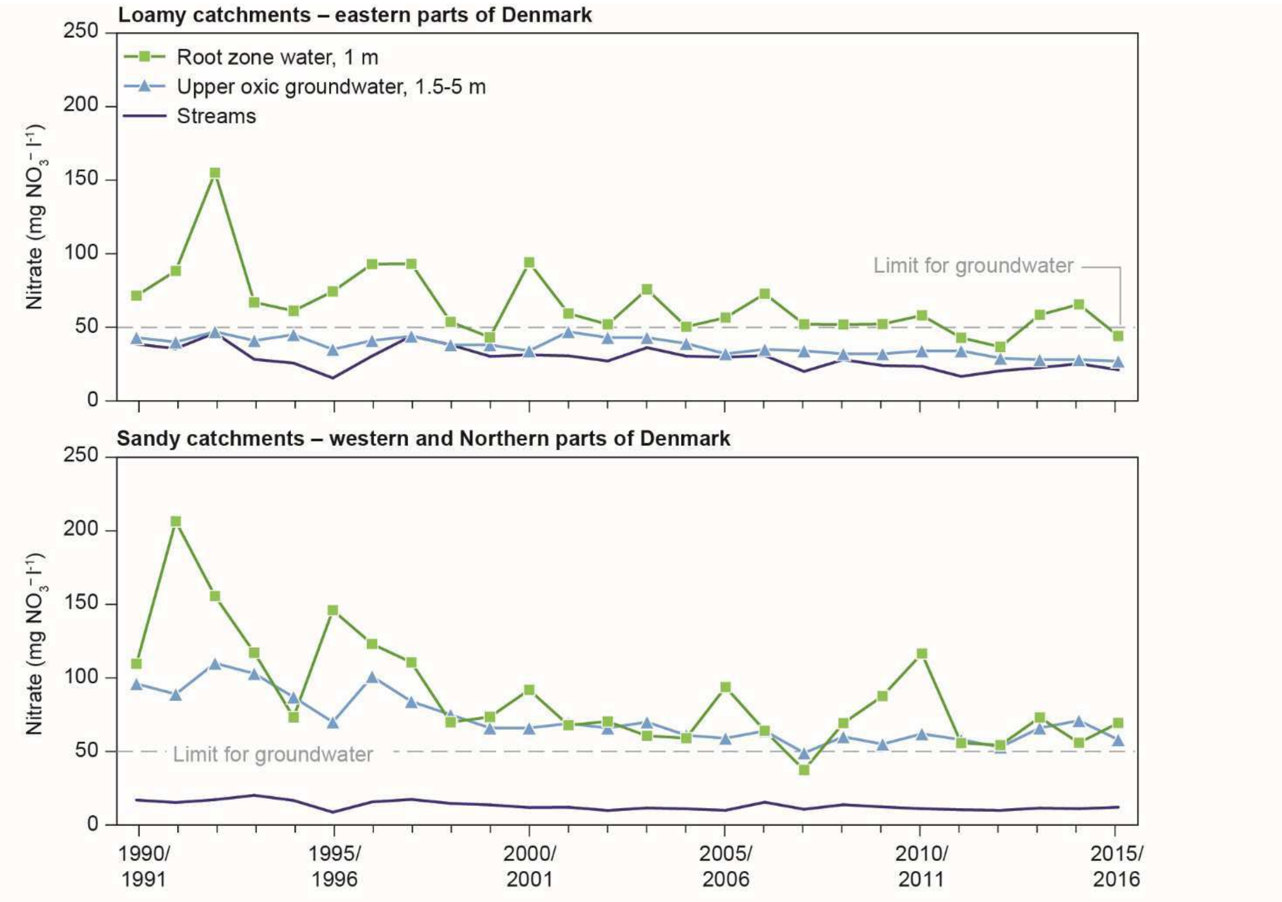

Figure 4.11 Nitrate concentration in root zone water, upper groundwater and in streams for three loamy catchments and two sandy catchments, the Agricultural Catchment Monitoring Programme, 1990/91-2015/16.

5. Reinforced monitoring in areas characterized by sandy soils

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The latest derogation decision (2017/847/EU) requires, according to Articles 10 (2) and 12 (b), reporting of water quality from reinforced monitoring on sandy soils and in an area, where at least 3% of all derogation farms are located.

More specifically the latest derogation decision states in Article 10 (2), in addition to the monitoring obligations in the previous derogation decision: "[...] *Reinforced monitoring shall be conducted in agricultural catchments on sandy soils. In addition, nitrates concentrations in surface and groundwater shall be monitored in at least 3 % of all farms, benefitting from authorisations*." According to Article 12 (b) the annual derogation report to the Commission has to contain "*the results of ground and surface water monitoring, as regards nitrates and phosphorus concentrations, including information on water quality trends, both under derogation and non-derogation conditions, as well as the impact of derogation on water quality, as referred to in Article 10 (2)*".

The overall approach to meet these new requirements has been developed and the current status of this work is presented below. Actual monitoring data will be included in the coming reports, as soon as sufficient quality-assured data is available.

So far, the derogation report with respect to data on water quality has been based on data from the national agricultural catchment monitoring programme. This very detailed monitoring programme takes detailed information on both agricultural practice and crop rotation on the one hand and data on water quality in rootzone water, uppermost groundwater and small local streams on the other hand into account. Full monitoring takes place in five agricultural catchments throughout the country, of which three catchments are located in parts of Denmark, which are characterized by loamy soils, and two catchments in the more western part, where sandy soils predominate. The latest results have been reported in chapter 4 of this report.

Due to the limited size of the area, which is monitored intensively within the national agricultural catchment monitoring programme, only very few farms, making use of the derogation are located in these five catchments. The majority of derogation farms can be found in the western part of Denmark, especially in the western part of middle and southern Jutland, as also presented on the maps in chapter 2 of this report. This part of Denmark is also characterized by predominantly sandy soils.

Consequently, the focus has been on the southwestern part of Denmark, when developing the approach on how to meet the reinforced monitoring obligations. Apart from the national agricultural catchment monitoring programme, Danish authorities are collecting data within the framework of a number of other national monitoring programmes. As part of the programme for "national monitoring of water and nature" (NOVANA), data from more than 200 water quality stations in streams and rivers are being collected on a regular basis with the primary purpose to determine nutrient loads to the sensitive recipients, i.e. coastal waters and lakes. The catchment area to the respective monitoring stations has been identified, which enables a coupling of agricultural-structural characteristics of the catchment, as e.g. location of derogation farms, as well as information on local soil types to the water monitoring station.

Together with colleagues from the Danish Environmental Protection Agency and based on a preliminary set of objectively defined criteria, a number of catchments, and hence monitoring stations, within the national stream monitoring network have already been identified, which could meet the reinforced monitoring obligations. Examples for criteria, which have been used to select relevant catchments, are the following:

- Location in the southwestern part of Denmark (georegion 1-3)
- A high average livestock density (min. 1.1 LU/ha)

- A minimum size of the agricultural area within the catchment (min. 1000 ha)
- Predominance of sandy soils (min. 70% of soils, categorized as JB1-4 according to Danish soil classification)
- The share of the agricultural area belonging to derogation farms

Based on the share of agricultural area, which belongs to derogation farms, the identified catchments have been divided into two groups:

1) Catchments with a high share (min. 35%) of the agricultural area belonging to derogation farms.
2) Catchments with a low share (max. 10%) of the agricultural area belonging to derogation farms.

As stated above, it was the intention to keep the other criteria, e.g. soil type, livestock density, etc. as similar as possible. Based on these preliminary general criteria, eight catchments could be identified to be potentially suitable. For three out of these eight catchments, a closer evaluation has shown that monitoring data from the stream stations are not suitable for the purpose of the reinforced monitoring, as one station is located downstream of a lake and another one downstream of a wetland, which both affect nutrient load in the stream due to e.g. retention of nutrients. The third monitoring station is located further upstream than another one, which has been identified. The downstream station has been selected to cover the whole catchment including the catchment of the more upstream station.

The map below (Figure 5.1) shows the location of all eight catchments, where the five stream monitoring stations, which so far has been identified to be suitable, are shown with the green dots.

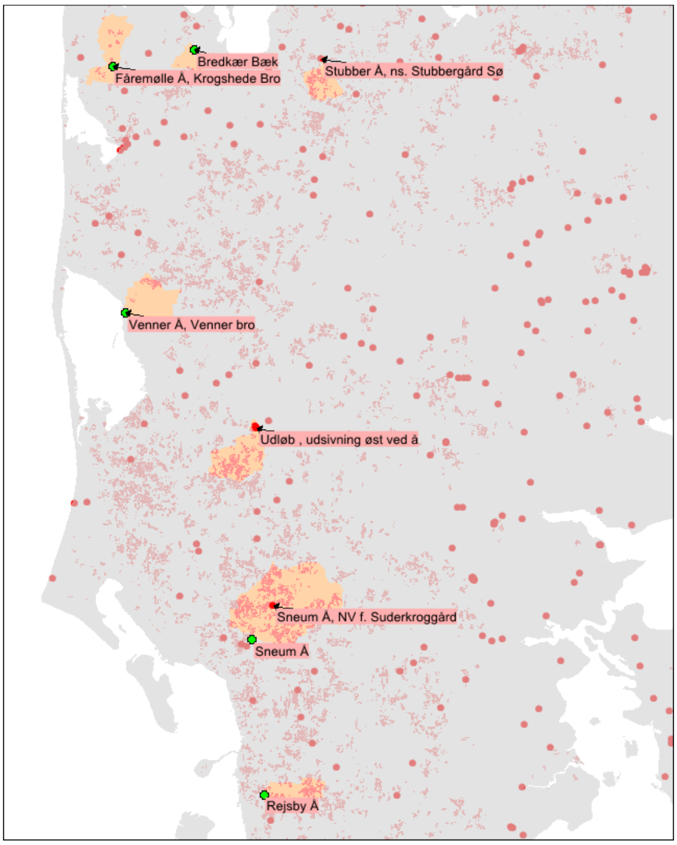

Figure 5.1 Map of the southwestern part of Denmark (part of Jutland). The eight potentially suitable catchments are shown as orange areas while pink areas indicate agricultural area belonging to derogation farms. Stream monitoring stations are shown as dots: the five green ones have so far been identified to be suitable for the purpose of the reinforced monitoring. The two most-southern stations belong to the catchments in group 1, the three stations further in the North belong to catchments in group 2.

Thus, five agricultural catchments and respective stream monitoring stations have so far been identified to be suitable. Two of them are categorized in group 1, i.e. having a high share of agricultural land, belonging to derogation farms and three of them are categorized in group 2 with a lower share. Based on register data, agricultural areas of more than 3% of all derogation farms can be found within these catchments in total.

As two out these five stream monitoring stations only have been established in spring 2017, quality-assured data from a whole hydrological season cannot be provided yet. It is currently being investigated, whether it is possible to provide data from groundwater monitoring within the identified catchments as well.

It is important to highlight that the above described possible approach for the reinforced monitoring does not provide sufficient data to examine the effect of the use of the derogation alone on water quality, as a long number of other factors influence nutrient concentrations in the aquatic environment. Nevertheless, the data basis for reporting according to the derogation conditions will be enlarged considerably and thereby supplement the water quality results, as shown in chapter 4, with more water quality data from sandy agricultural catchments.

In future reports to the Commission, a more detailed description of monitoring, including the finally identified catchments as well as actual monitoring data will be included, as soon as sufficient, quality-assured data has been made available.

7. Conclusions

In 1998 the Action Plan for the Aquatic Environment (APAE) II was accepted by the EU Commission as the Danish Nitrate Action Plan implementing the Nitrate Directive (1998-2003). In 2003, a final evaluation of Action Plan II was performed, showing a reduction of 48% of the nitrate leaching from the agricultural sector, fulfilling the reduction target set in 1987.

Further mitigation measures in the following Action Plans, APAE III from 2008 were implemented to reduce N leaching from the root zone and the Green Growth Agreement from 2009, the first and second River Basin Management Plan from 2014 and 2016, respectively as well as the Food and Agricultural Agreement in December 2015 suggests measures or reductions target for N load to marine areas in order to fulfil the targets in the Water Framework Directive.

Modelling of the nitrate leaching from the root zone at the national level showed an average concentration of 78-89 mg NO_3 l^{-1} for cattle holdings using 170-230 kg organic manure N in 2016.

Measured average flow-weighted nitrate concentration in root zone water at three to four specific sites that on average received 183-277 kg organic manure N per hectare varied between 49-102 mg NO_3 l^{-1} for the hydrologic years in the period 2011/12-2015/16.

In the upper oxic groundwater (1.5-5.0 m), nitrate concentrations are lower than in the root zone water, indicating that nitrate reduction occurs in the aquifer sediment between the bottom of the root zone and the uppermost groundwater. In loamy catchments the measured nitrate concentration in the upper oxic groundwater decreased from 40-47 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 27-34 mg NO_3 l^{-1} in the five year period 2011/12-2015/16. On sandy catchments the nitrate concentration decreased from 88-110 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 53-71 mg NO_3 l^{-1} in the five year period 2011/12-2015/16.

The general conclusion to be drawn from the Agricultural Catchment Monitoring Programme is that:

- Nitrate concentrations in root zone soil water (1.0 m below soil surface) have decreased steadily from 1990 to 2016, however with annual variations. In loamy catchments the measured the nitrate concentration decreased from 61-155 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 to 37-66 mg NO_3 l^{-1} in the five year period 2011/12-2015/16. In sandy catchments the nitrate concentration was 73-207 mg NO_3 l^{-1} in the five year period 1990/91-1994/95 and decreased to 54-73 mg NO_3 l^{-1} in the five year period 2011/12-2015/16.
- Nitrate concentrations in the upper oxic groundwater (1.5-5.0 m below soil surface) decreased to a level well below the limit of 50 mg NO_3 l^{-1} in loamy catchments and to a level between 53 and 71 mg NO3 l^{-1} for the two sandy catchments in the period 2011/12-2015/16.

In 2015/2016 a total of 1,466 cattle holdings made use of the derogation. This corresponds to 4.2 % of the total number of agricultural holdings in Denmark. The number of livestock units on these derogation cattle holdings was 443,134 LU corresponding to 19.4 % of the total number of livestock units. The arable land encompassed by the derogation in year 2015/2016 was 210,061 hectares corresponding to around 8.6 % of the total arable area. Whereas the number of holdings can be regarded as constant, an increase in the agricultural area and the number of livestock units, encompassed by the derogation, has been observed. This development illustrates the general trend of the average size of Danish holdings getting bigger.

In January – February 2017, 49 inspections of compliance with the derogation management conditions were carried out. 48 inspections were closed without remarks and one inspection is closed with a remark.

For the year 2014/2015 435 inspections (1.2 % of all Danish holdings) taking place at the farm were made concerning compliance with the harmony rules (amount of livestock manure applied per hectare). 30 of the inspected farms use the derogation. 29 of these inspections were closed without remarks and one farm is still under investigation.

All 37,135 fertilizer accounts submitted in 2014/2015 (100 %) were automatically screened by the IT-system according to normal procedure. Of these, 976 (2.6 %) were subject to further administrative control combined with physical inspection. In all, 62 of these holdings used the derogation. Of the inspections of derogation farms, 30 (48.4 %) were closed without remarks, 4 (6.5 %) were closed with remarks and 28 (45.2 %) are still under investigation.

In total approximately 9.6 % of the derogation farms (49 + 30 + 62 out of in total 1,466) were subject to control. As holdings are automatically selected - based on a previously agreed set of “risk criteria” - for both physical inspection and administrative control, the Agricultural Agency has no direct influence on the share of holdings, using the derogation, being inspected each year. Therefore, the share of derogation farms, which have in some way been subject to control, varies from year to year.