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Sources and pathways of nutrients to the Baltic Sea

HELCOM PLC-6

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Preface

Eutrophication caused by oversupply of the Baltic Sea by nutrients remains the major environmental pressure on the marine ecosystem. In order to mitigate eutrophication, HELCOM countries have agreed on a joint effort to reduce nutrient load on the marine ecosystem, reflected in the HELCOM Baltic Sea Action Plan as a nutrient input reduction scheme. Compilations of pollution load data, designed to follow up on the implementation of the scheme, have been an integral part of the HELCOM assessment system since 1987. This assessment of major sources and pathways of nitrogen and phosphorus into the marine environment is a vital part of the HELCOM Pollution Load Compilation (PLC) and one of the main products of the HELCOM Sixth Pollution Load Compilation project (PLC-6). The product includes an assessment of three major pathways of nutrients – riverine, airborne and via direct sources – and more detailed assessment of sources of riverine load. The previous (PLC-5) assessment, published in 2013, was based on the data on nutrient inputs in 2006. Current assessment illustrates the contribution of various sources of nitrogen and phosphorus into total loads in 2014 (2012 for Germany and Poland). The assessment also illustrates changes in proportion of different pathways since 1995.

Contents

Changes in the main nitrogen sources and pathways

Changes in total nitrogen and phosphorus inputs into the Baltic Sea, as well as the proportion of the major pathways have been evaluated for the years 1995, 2000, 2006 and 2014. The reported major pathways include riverine loads, direct point-sources and, for nitrogen, atmospheric deposition. The results are illustrated as pie charts in Figures 1 to 34, where Figures 1 and 18 show the changes in nitrogen and phosphorus inputs to the entire Baltic Sea, respectively. Figures 2 to 8 and 19 to 25 show the nitrogen and phosphorus input changes to the different Baltic Sea basins, and Figures 9 to 17 and 26 to 34 show the nitrogen and phosphorus input changes attributed to the different HELCOM countries.

Changes in the main pathways of nitrogen input

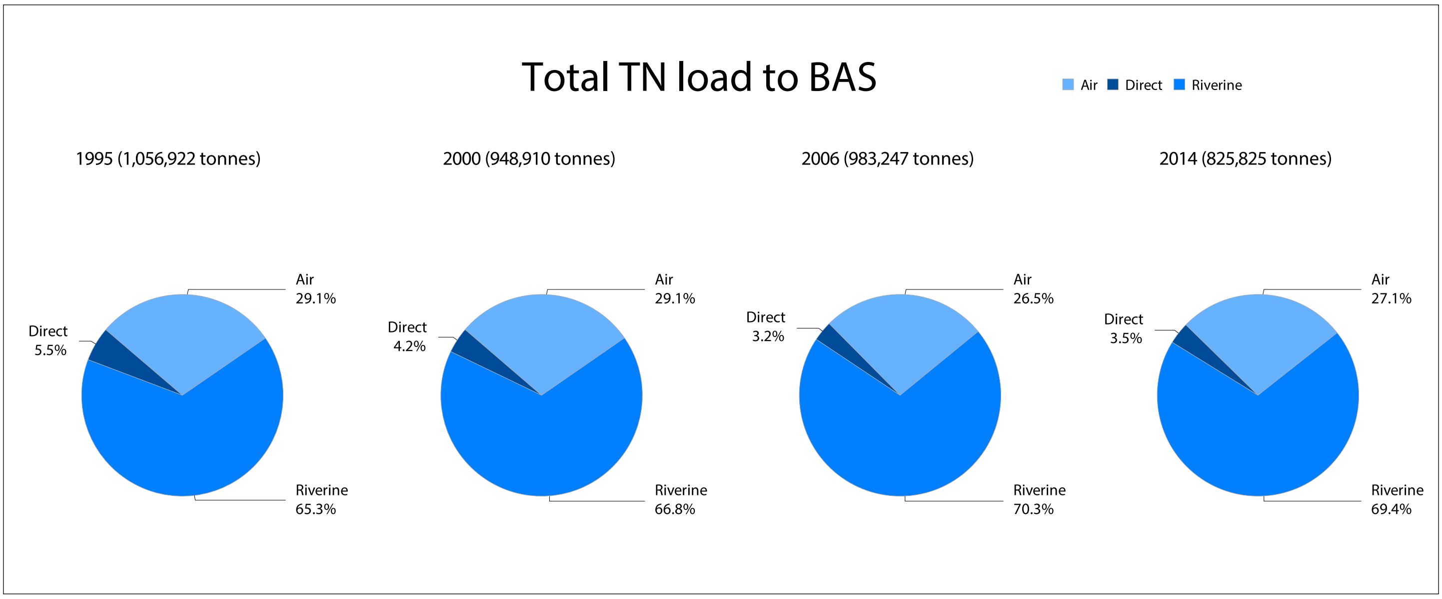
For the entire Baltic Sea, the total nitrogen inputs fall during the recorded period, with the share of direct point-sources experiencing greatest change (Figure 1).

This pattern of nitrogen inputs reduction is in common for all basins in the Southern part of the Baltic Sea, (the Baltic Proper, Danish Straits, and Kattegat) (Figures 6-8) and correlates with falling inputs from Denmark, Germany, Poland and Sweden; the countries that dominate nitrogen input to these basins (Figures 9, 12, 15, and 17).

A similar tendency is indicated for nitrogen inputs to the Gulf of Finland (Figure 4), and corresponds with falling nitrogen input from Finland and Russia; the two countries responsible for the majority of input to the Gulf of Finland (Figures 11 and 16). However large total input in 2006 partly obscures this trend.

Total nitrogen inputs to the Gulf of Riga decrease over time (Figure 5), but in this case the countries that discharge into the Gulf - Estonia and Latvia - possess variable total inputs for the evaluated period (Figures 10 and 13). However, there is a tendency for the share of the direct point-sources to decrease over time.

Lithuania, discharging into the Baltic Proper, displays variable nitrogen inputs over time (Figure 14). For the two remaining basins, Bothnian Bay and Bothnian Sea, the total inputs do not show any strong tendencies, although the inputs in 2014 appear to be lower than in earlier years (Figures 2-3). Since the inter-annual variability appears to be substantial, it is hard to detect any trends in the share of different nitrogen pathways.



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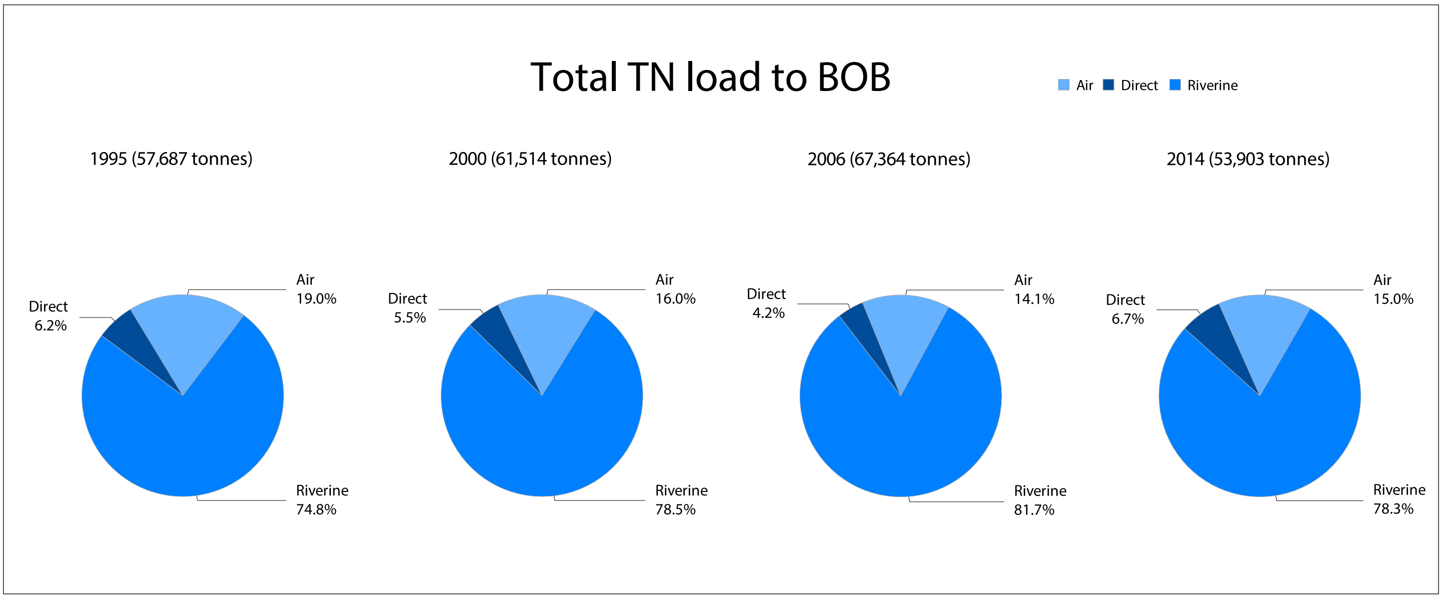

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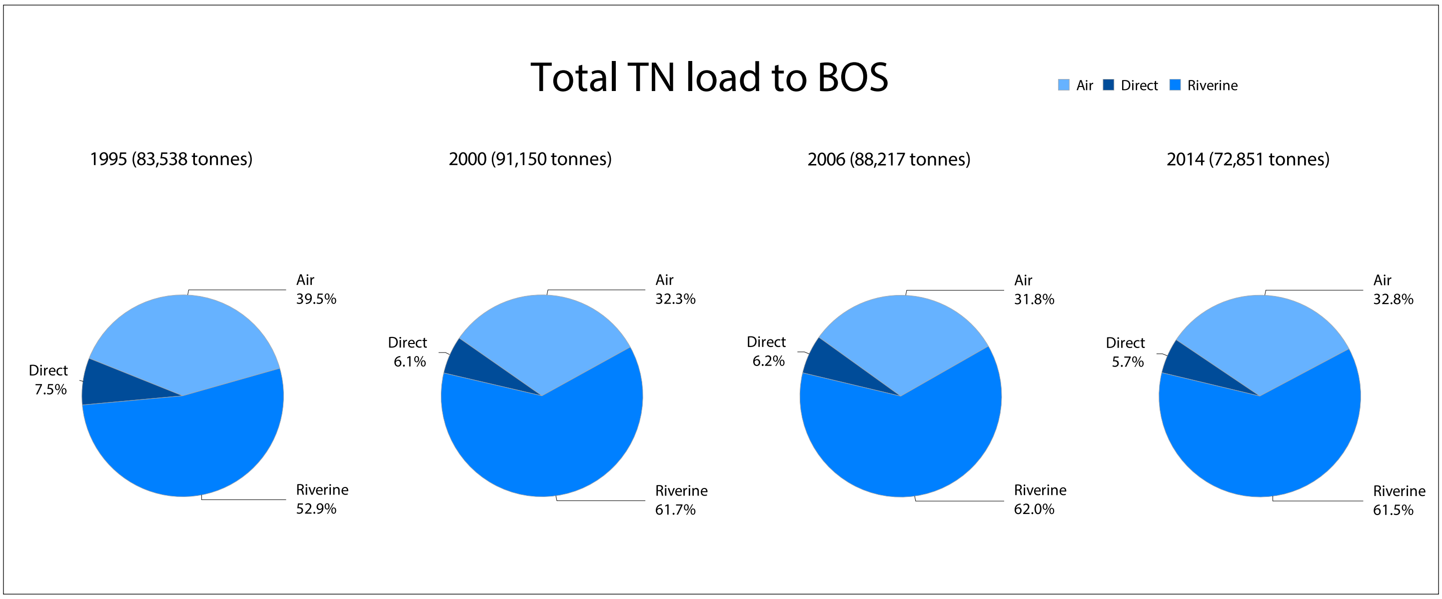

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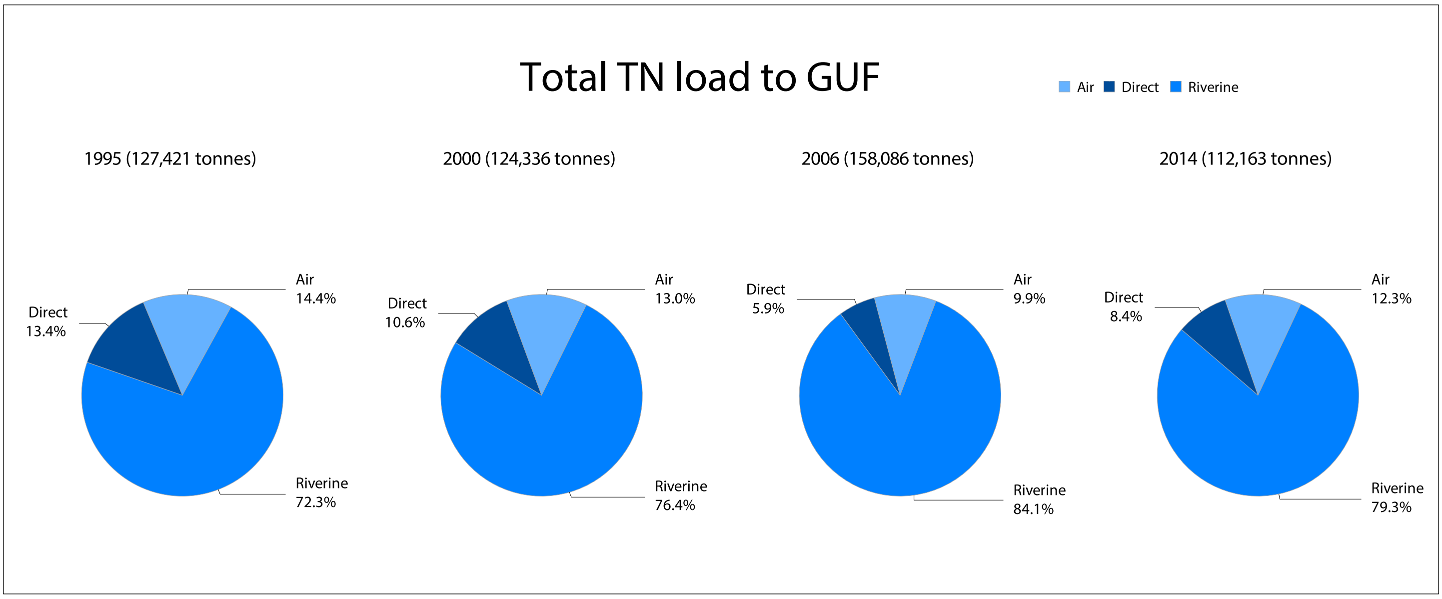

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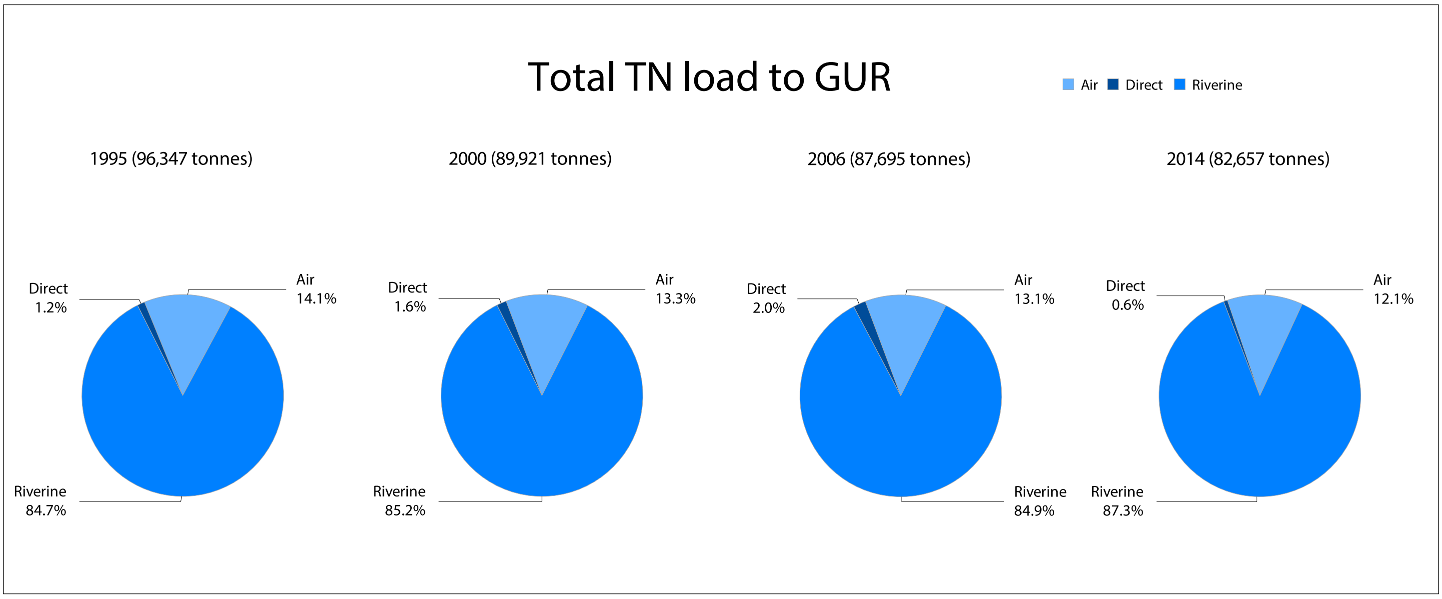

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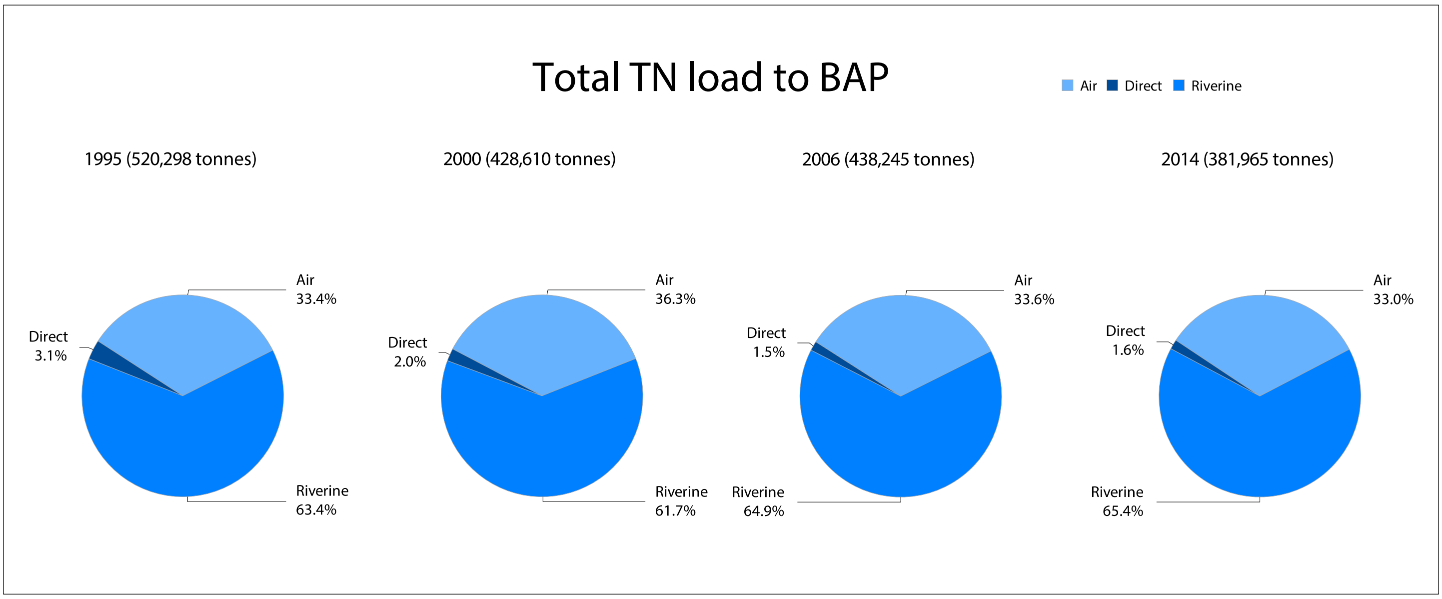

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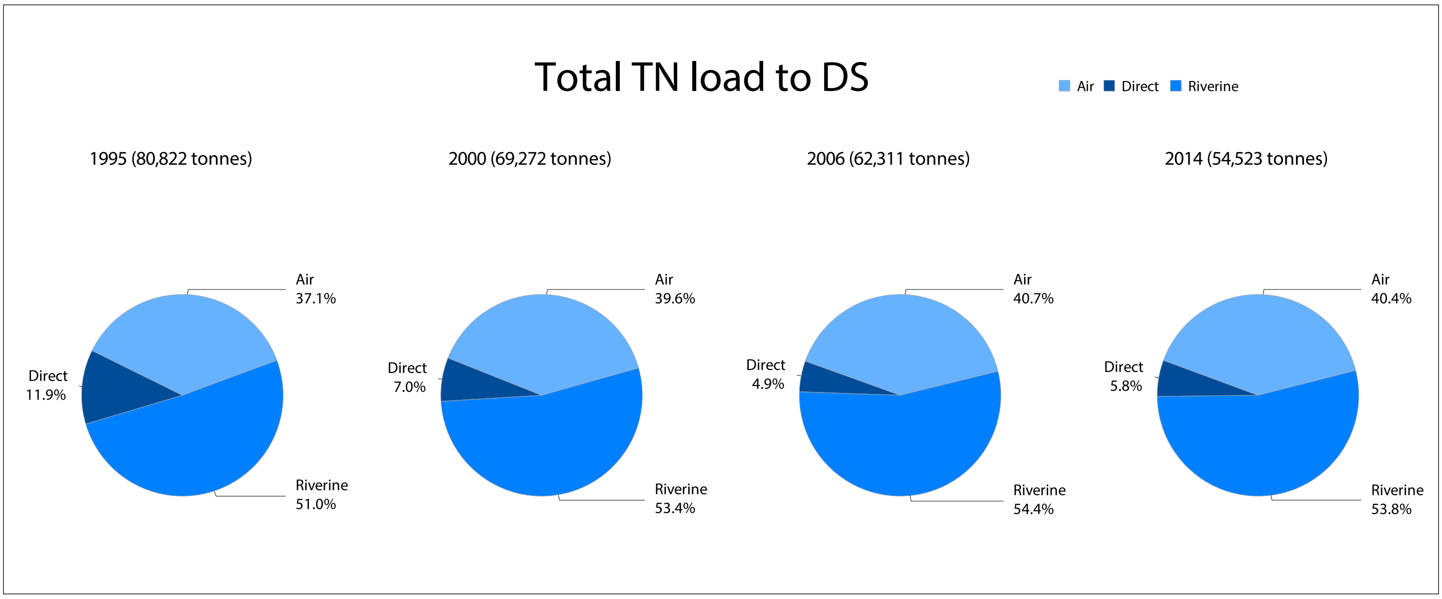

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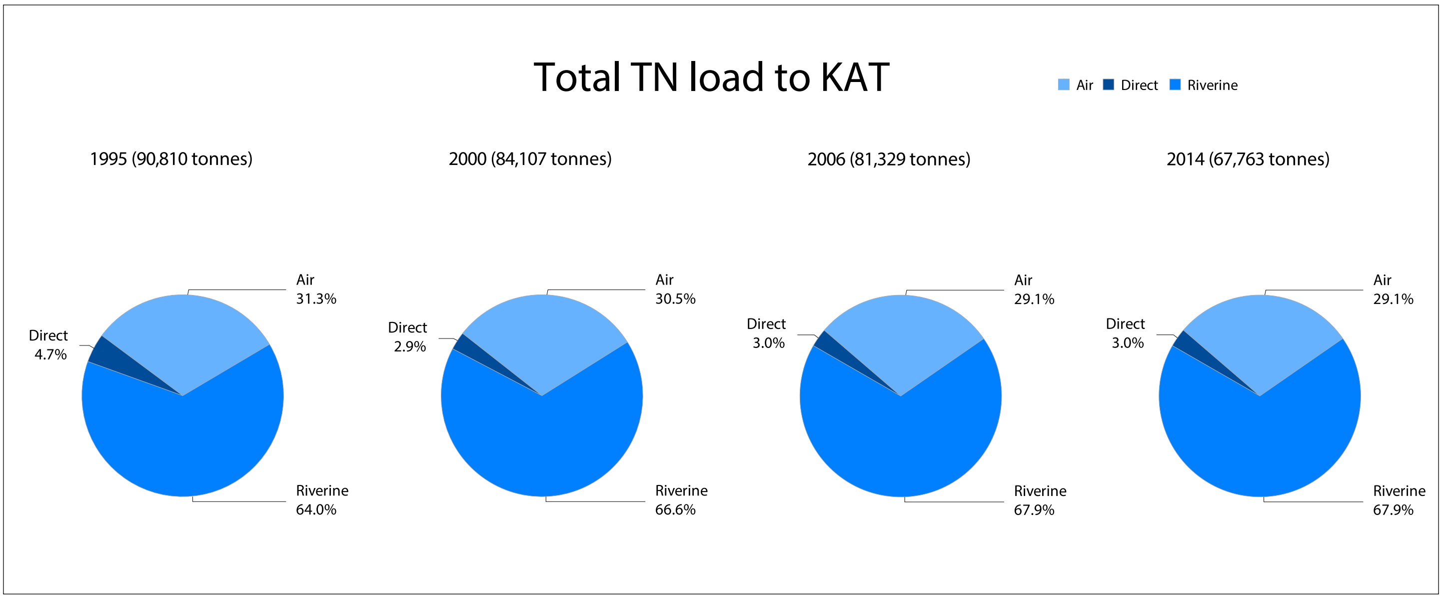

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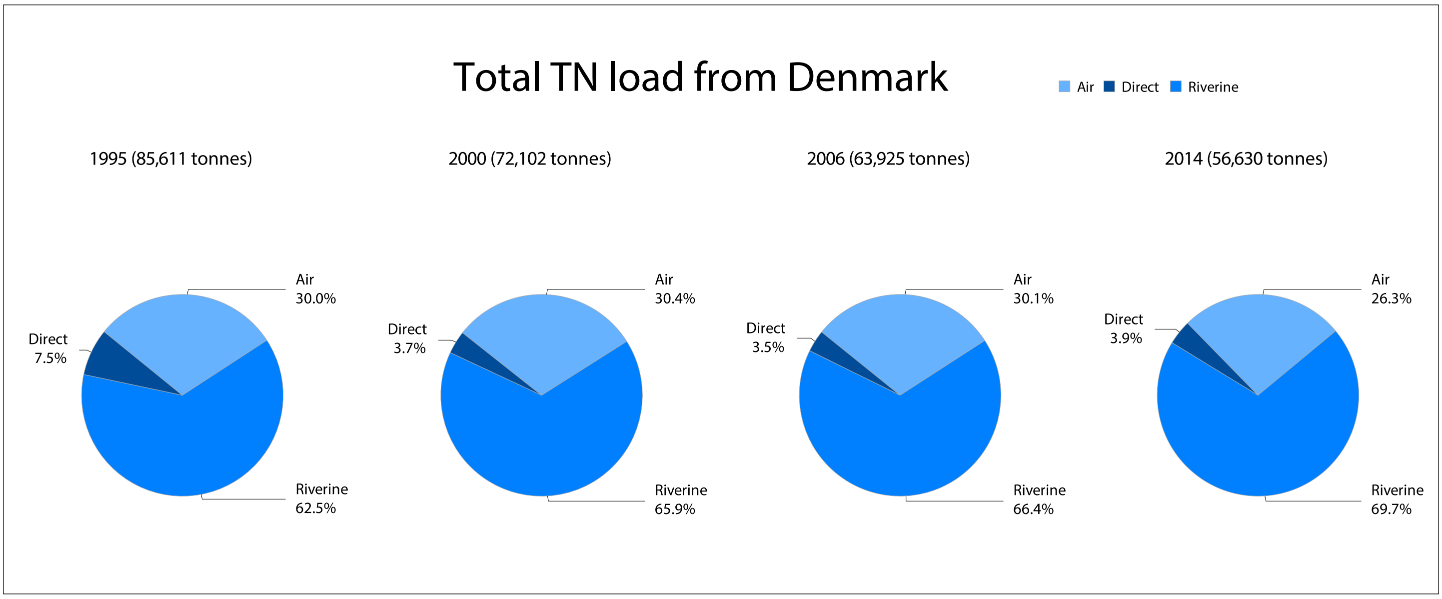

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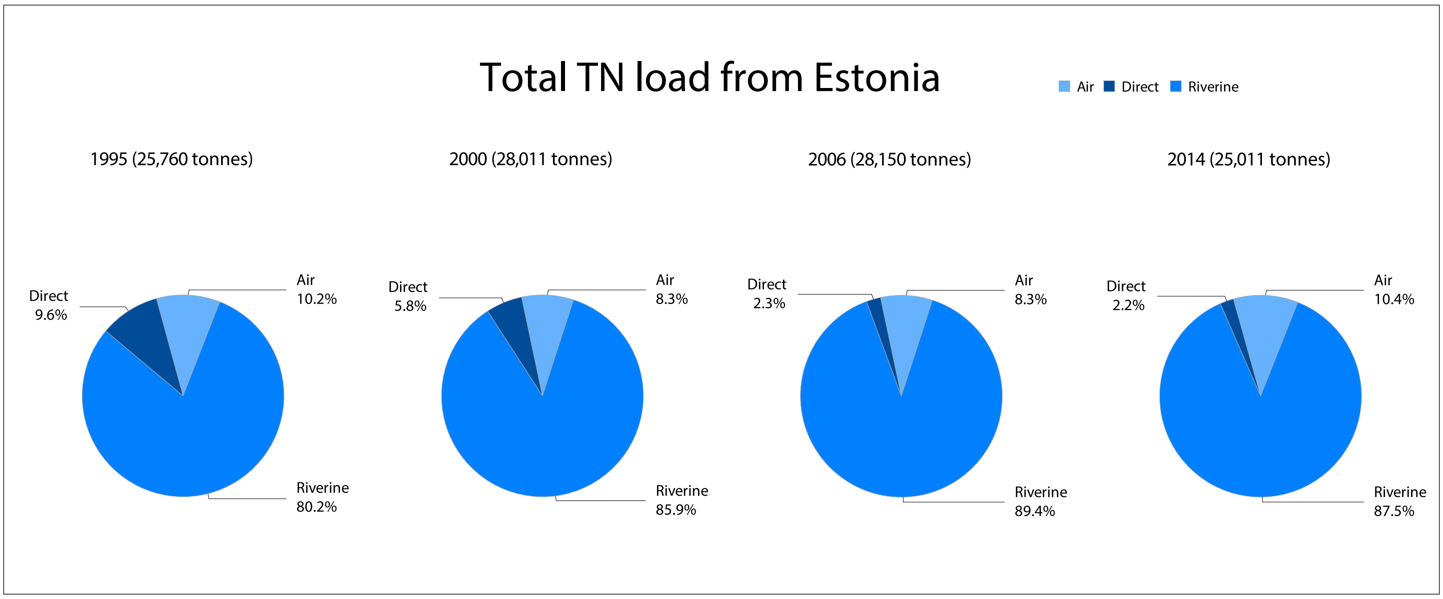

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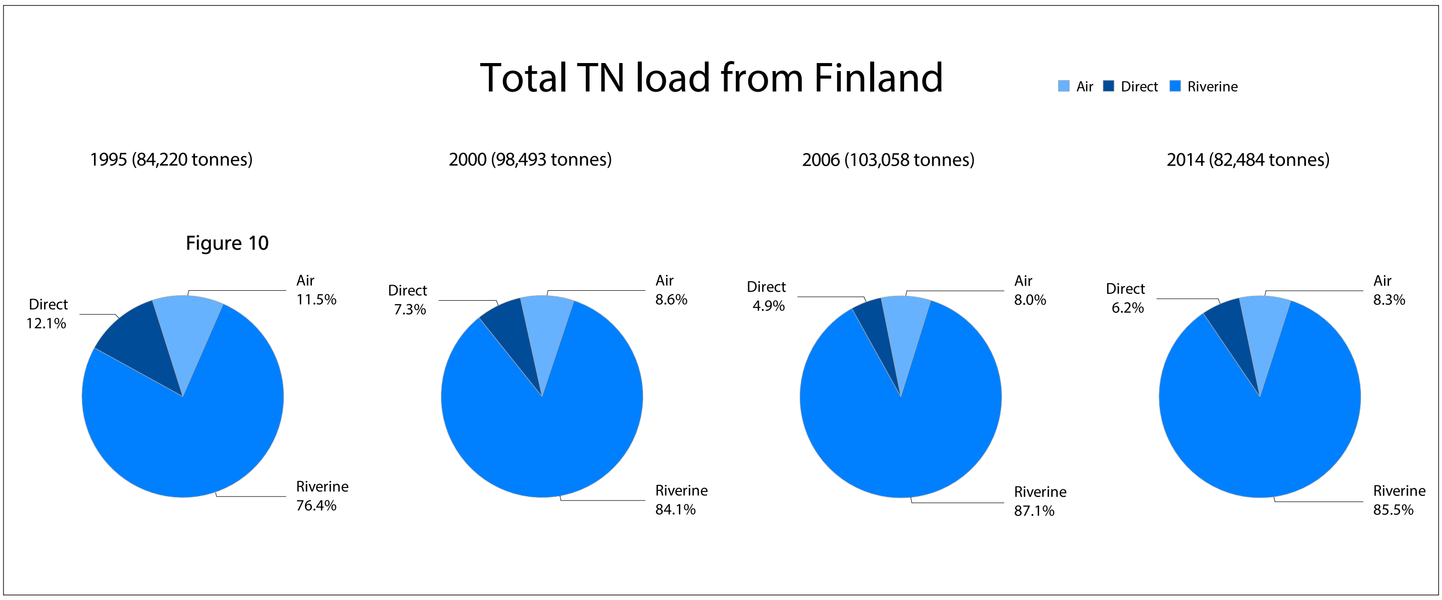
NOTE! Only municipal waste water treatment plants larger than 2000 PE were reported by Estonia.



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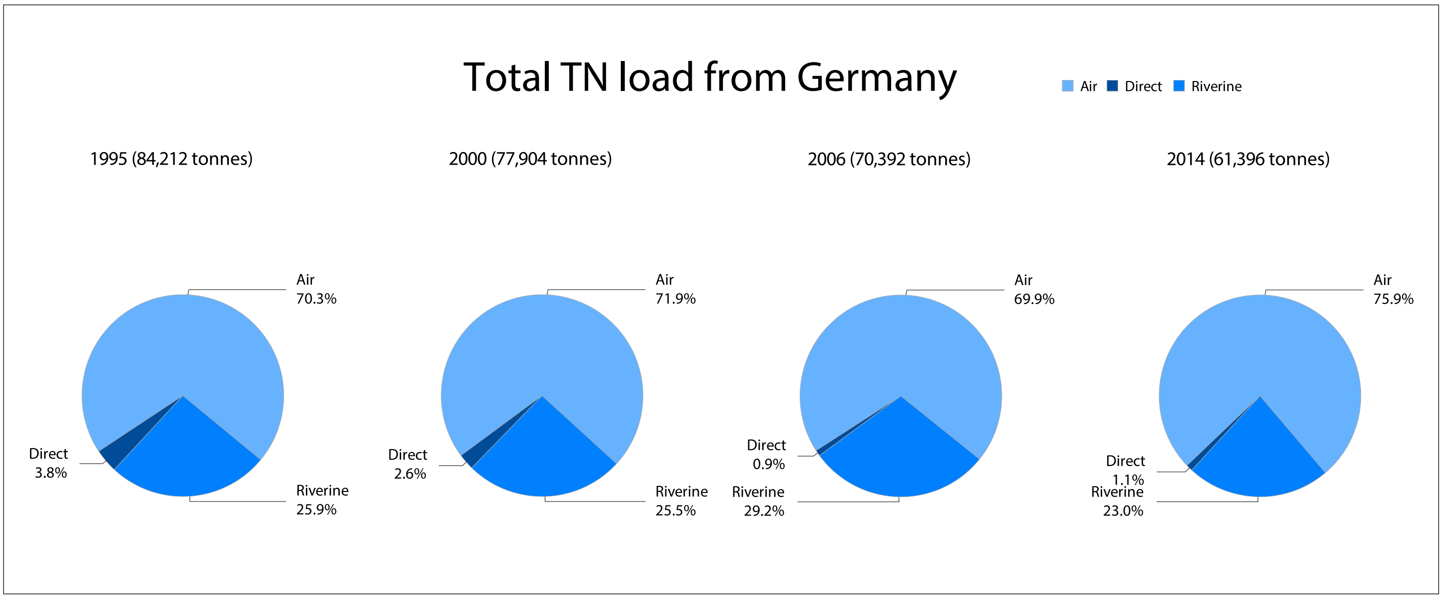

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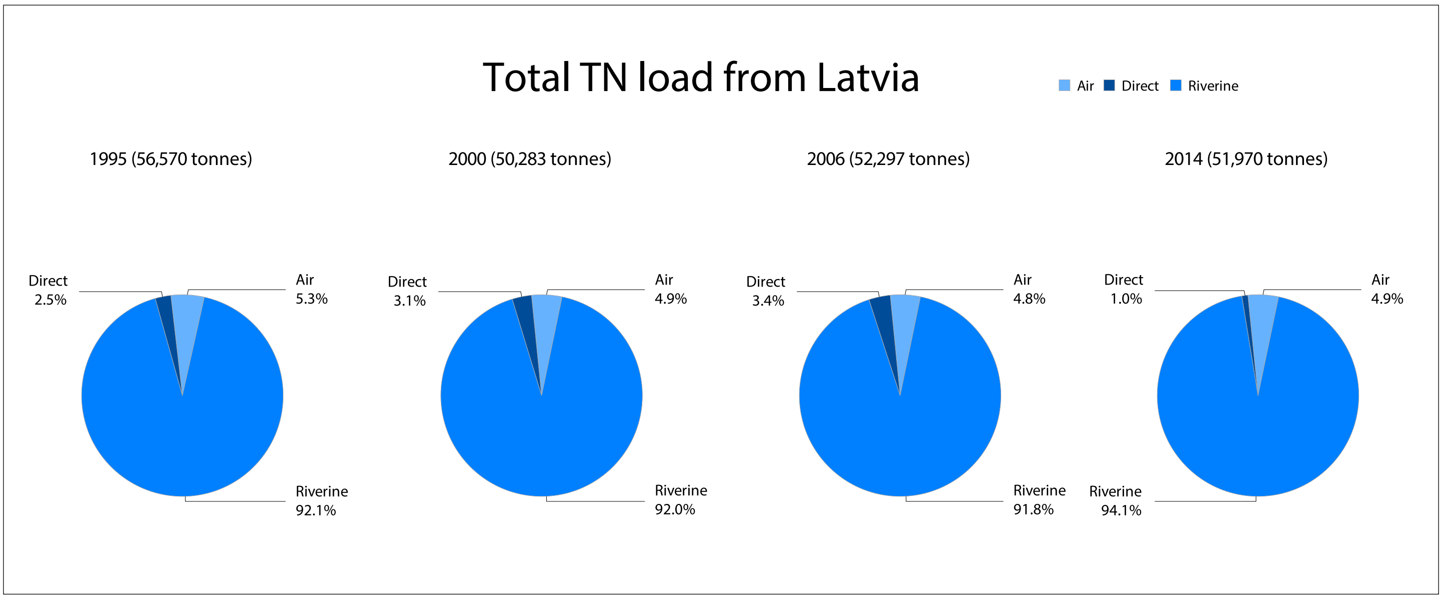

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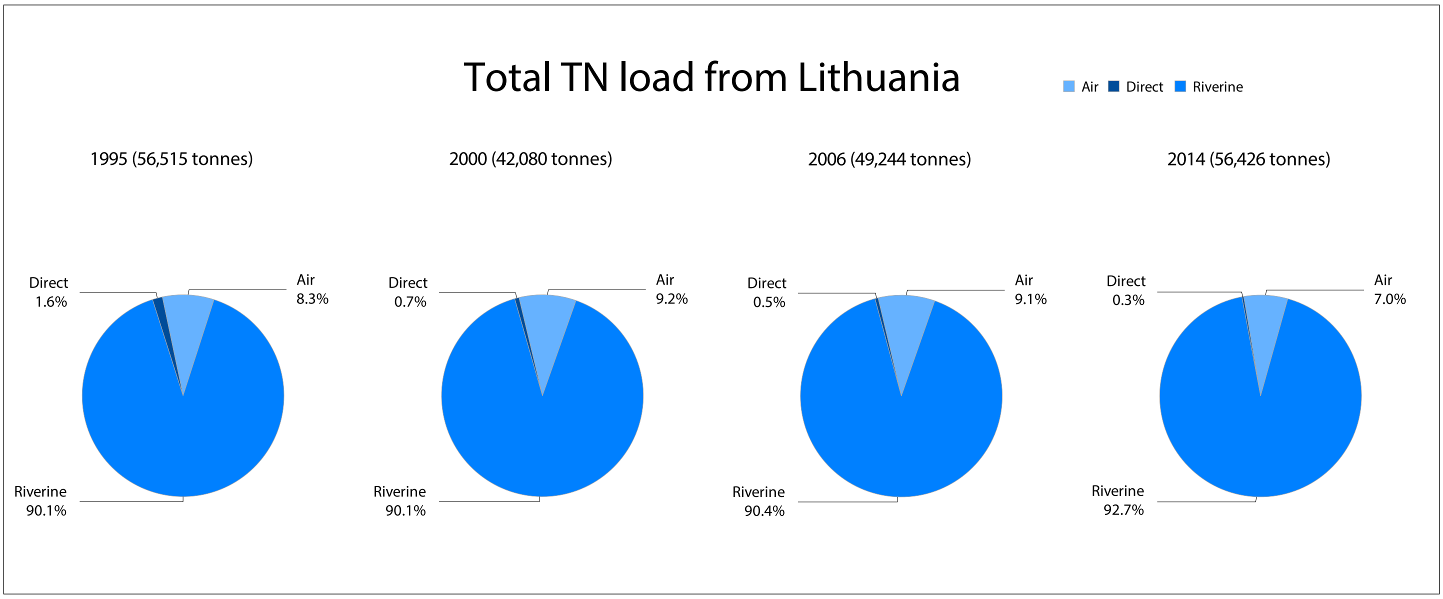

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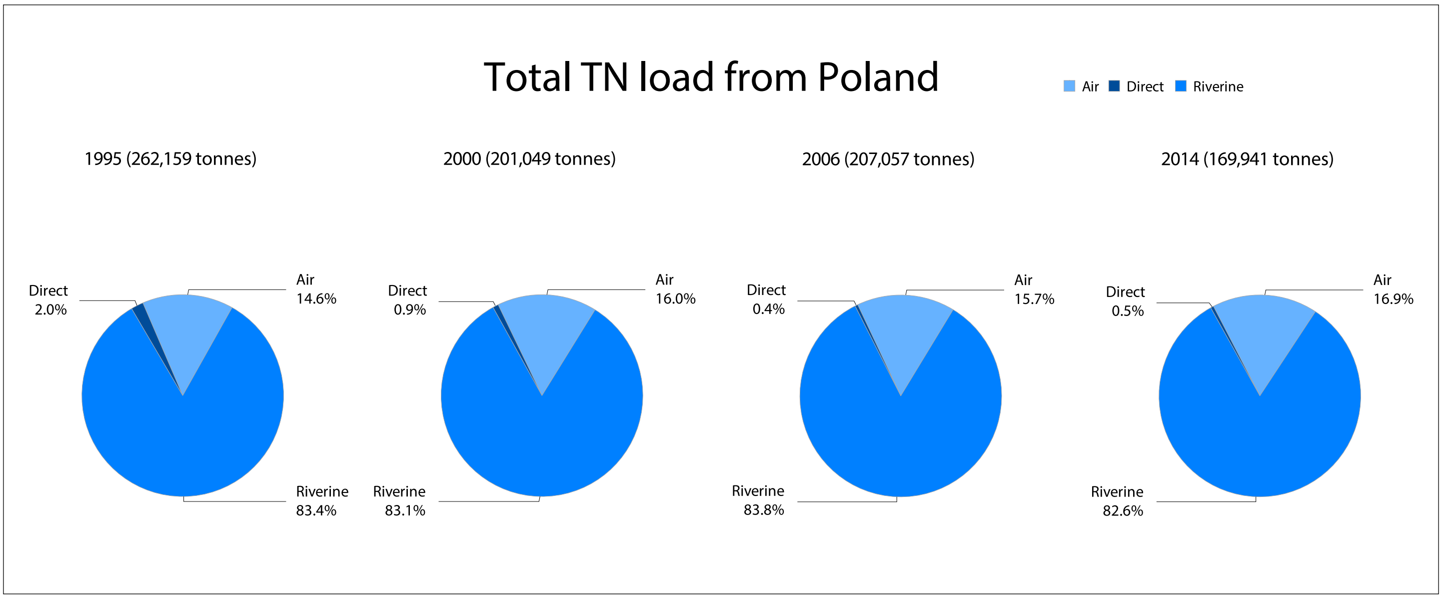

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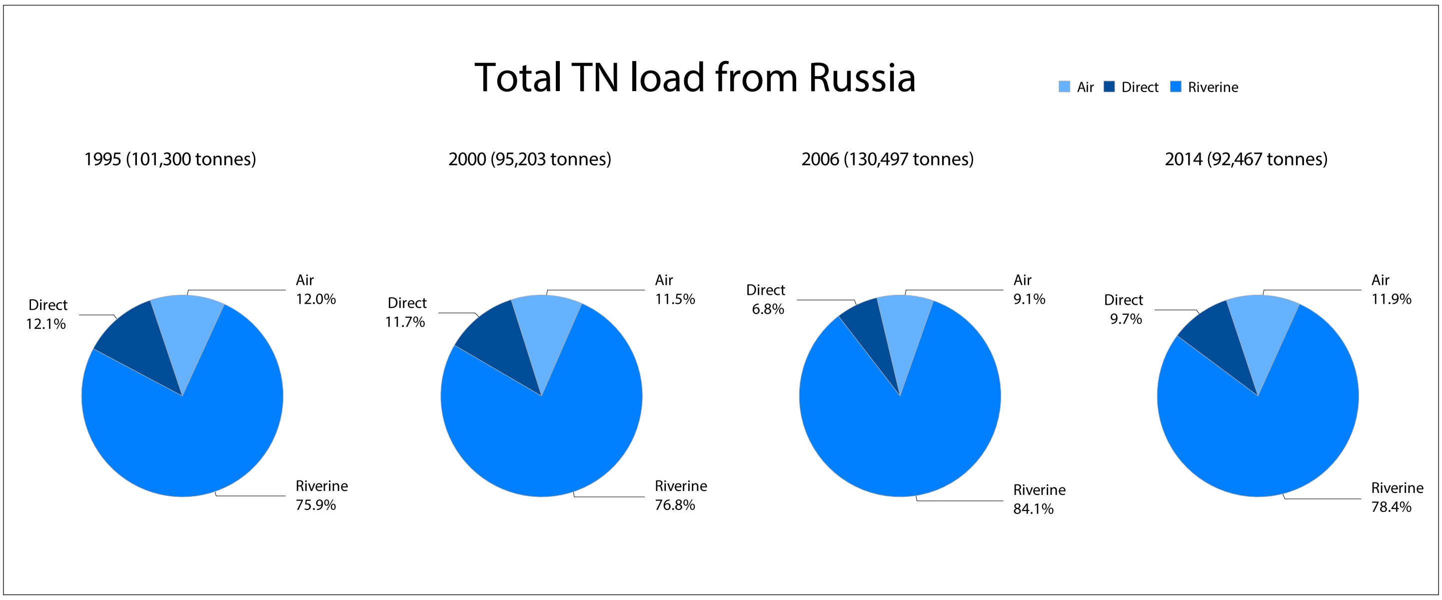

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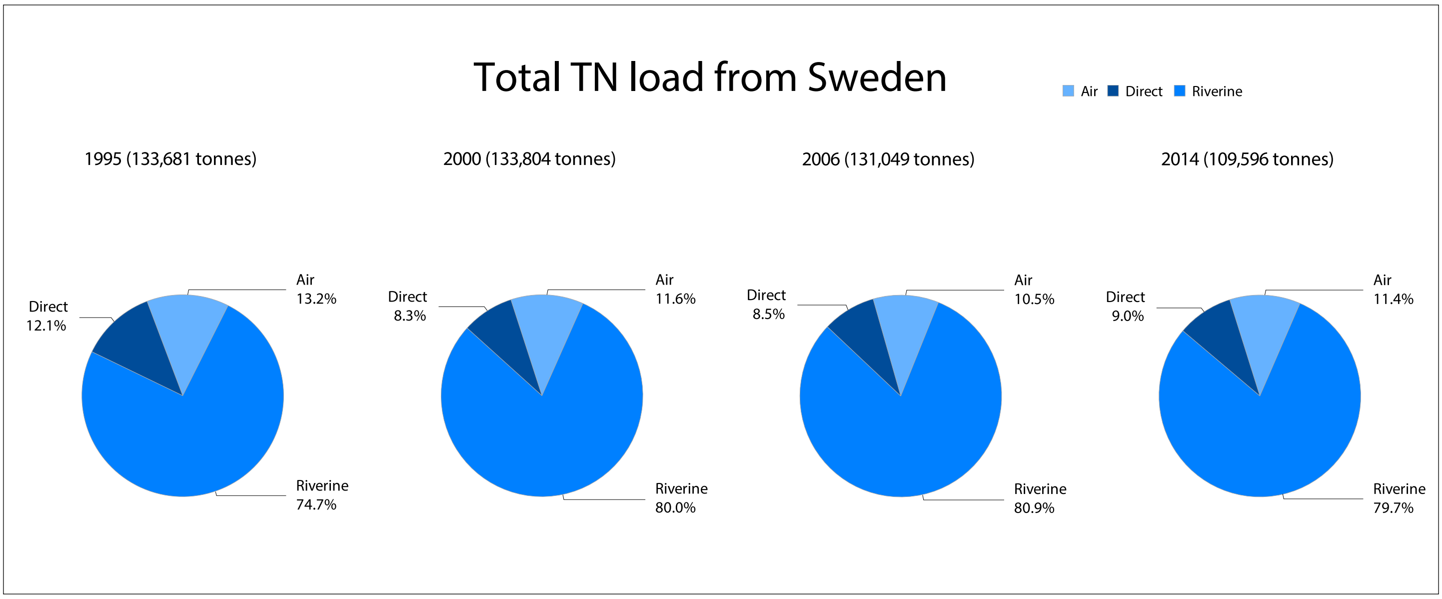


Figure 17

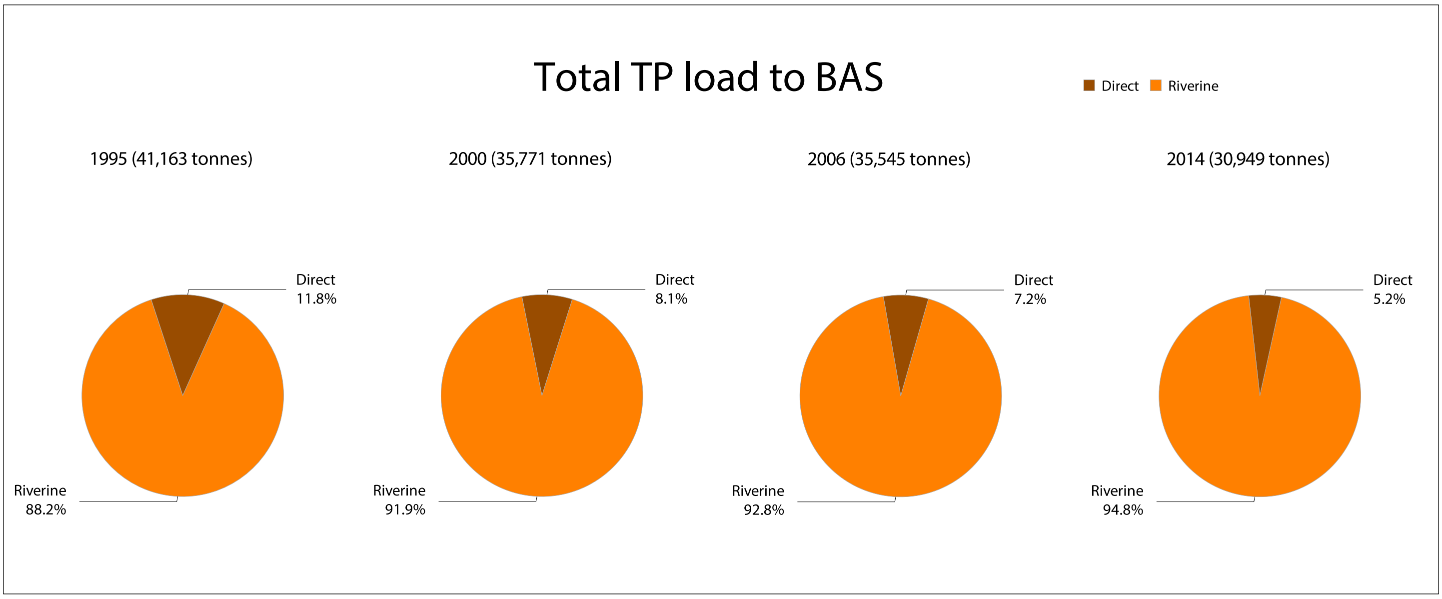
Changes in the main pathways of phosphorus input

The overall pattern for both total phosphorus load as well as share of different pathways is quite different from the patterns observed for nitrogen. Nonetheless total average inputs for both phosphorus and nitrogen for the entire Baltic Sea have reduced over time (Figures 1 and 18). The differences stand out when observing the inputs to the different basins, and the share contributed by the different countries. The differences are mainly because the long-term focus to reduce nutrient load has been on phosphorus, as the main regulating nutrient for eutrophication in the Baltic Sea (except from the more saline waters in the Danish Straits and Kattegat for example). Meanwhile, less attention has been given to nitrogen, until more recently.

Although there has been a focus to reduce phosphorus loads for quite a substantial time, the reduction measures have been implemented over different time periods in different countries, which is evident when comparing the total phosphorus loads, as well as the shares of the pathways (Figures 18-34). Denmark, Finland, Germany, and Sweden started to implement measures to reduce the impact from point-sources (direct and inland sources) before HELCOM measurements began, by improving waste water treatment plants. This means that these early reductions and the effect on the phosphorus loads to the Baltic Sea cannot be seen in the HELCOM data. In these countries, measures are now more oriented to diffuse sources like agricultural losses and scattered dwellings, as the possibility for further reduction of emissions from waste water treatment plants are comparatively small and quite expensive.

The main tendencies revealed over the evaluated period show that for the whole Baltic Sea, as well as for the majority of its basins, there is a decrease in the total phosphorus load over time (Figure 18-25). For the Bothnian Sea and the Gulf of Finland the main reduction appears in 2014 (Figures 20-21). The only basin without any obvious reduction in the total phosphorus load is the Gulf of Riga (Figures 22). More or less the same picture is given for the country-wise phosphorus loads, with a general decrease for Estonia, Germany, Poland, and Sweden (Figures 27, 29, 32, and 34), an early decrease (in 1995) for Denmark (Figure 26), and a late decrease for Finland, Lithuania, and Russia (Figures 28, 31, and 33). No clear trends can be seen for Latvia (Figure 30).

For the changes in proportions of the different pathways most countries show a decrease in their share of direct point-sources over time. The main difference between countries is how large the change is and when it occurs (Figures 26-33). The only country that does not have any clear trend in changed pathways is Sweden (Figure 34). Consequently, the share of the direct point-sources for most basins as well as for the whole Baltic Sea is decreasing over the period evaluated (Figures 18-25). The only exception to this general tendency is the Bothnian Bay, where there is no clear trend (Figure 19).



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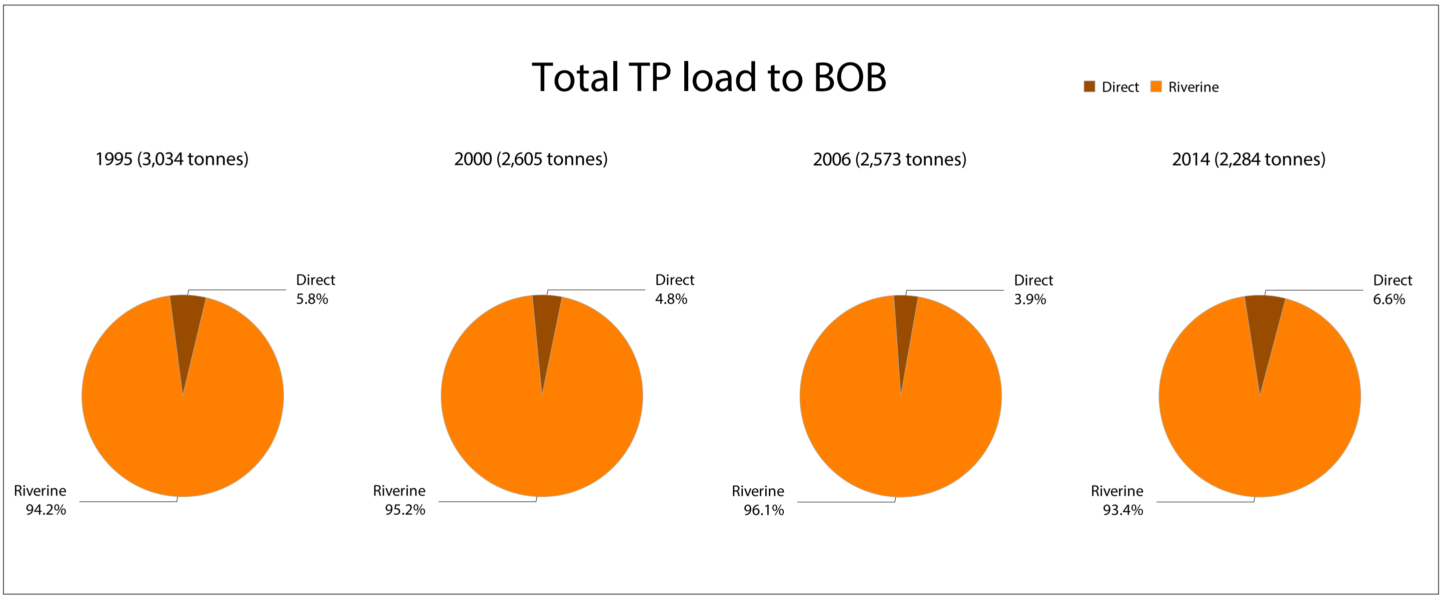

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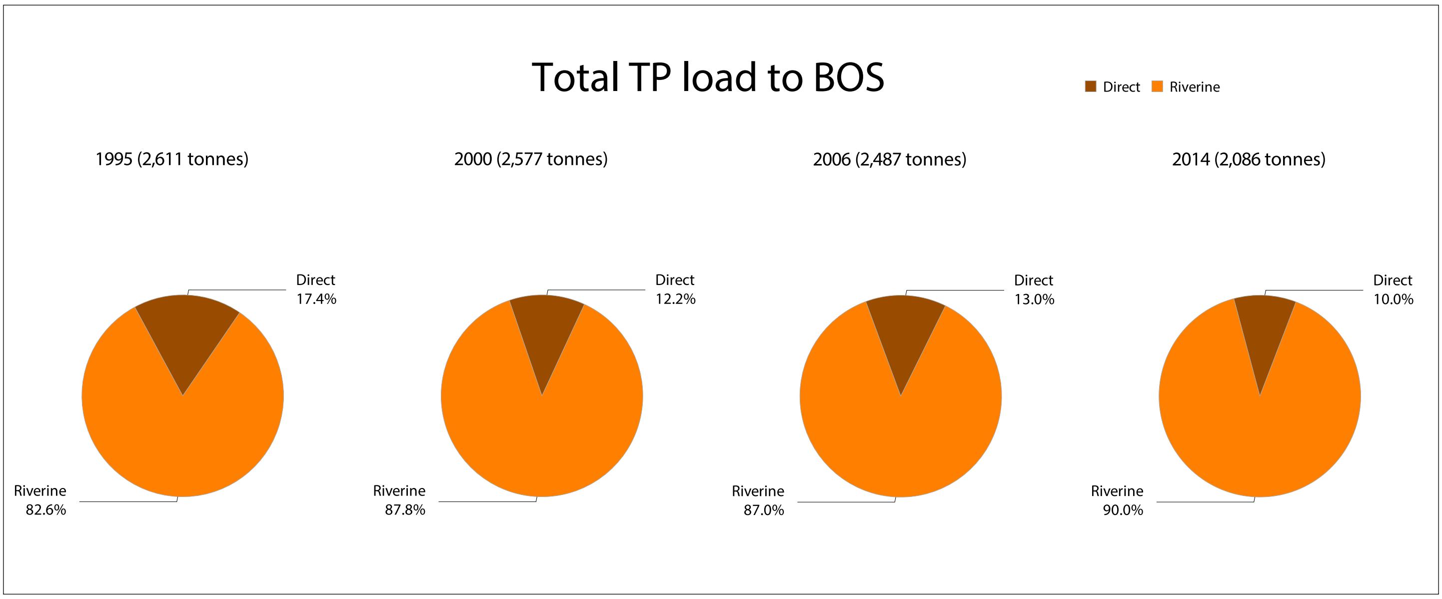

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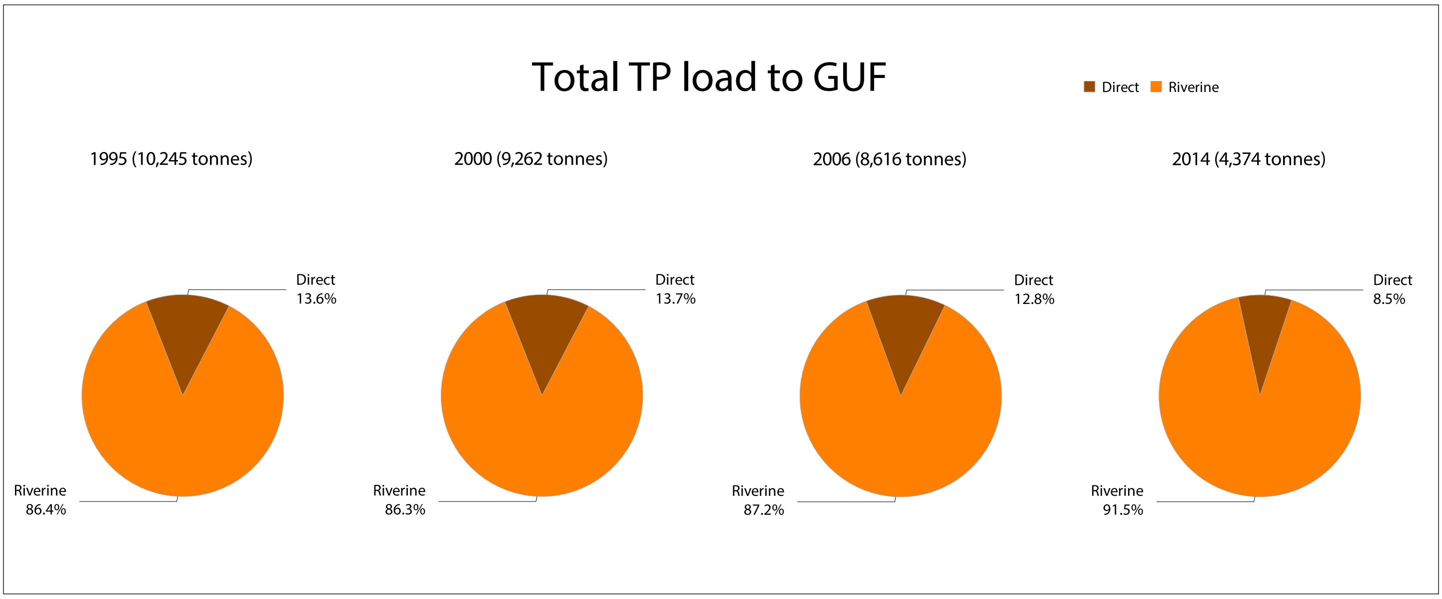

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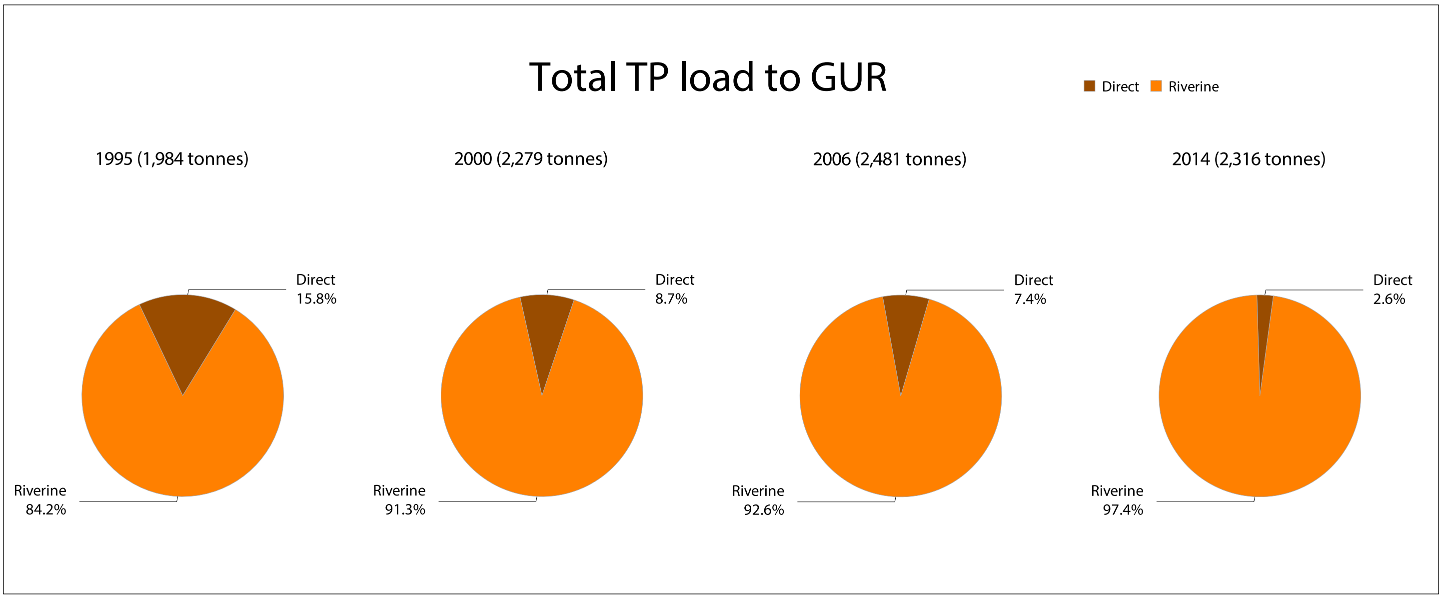

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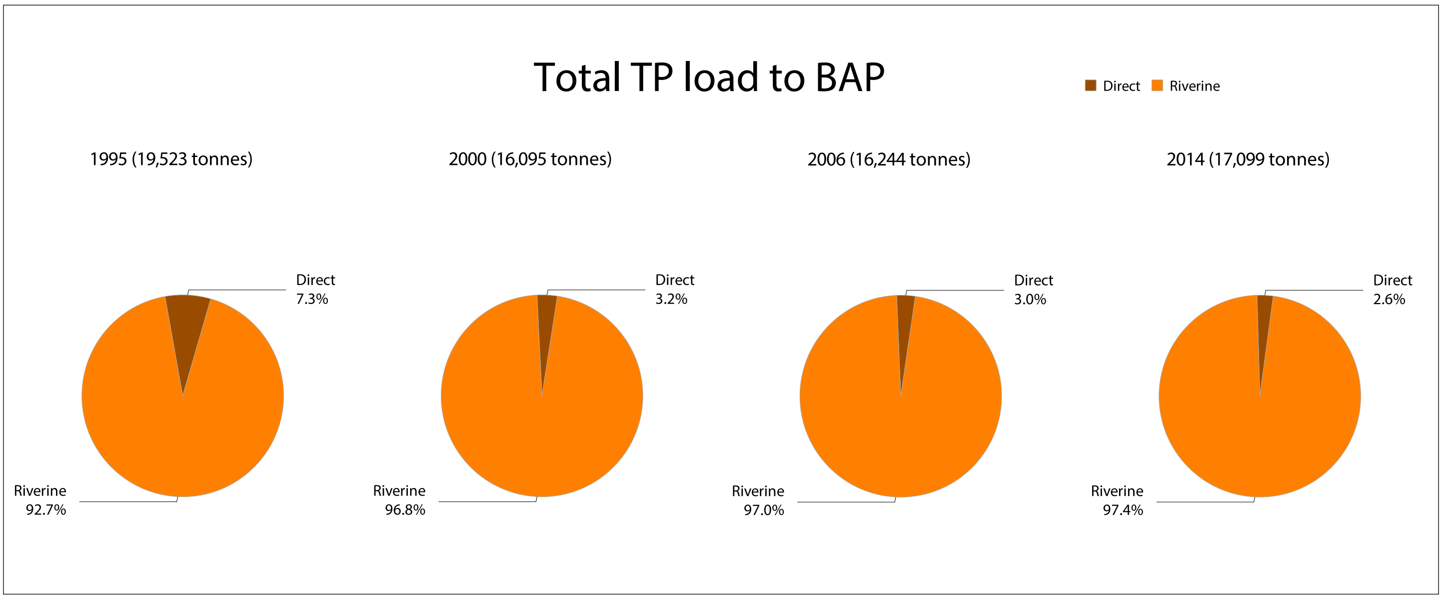

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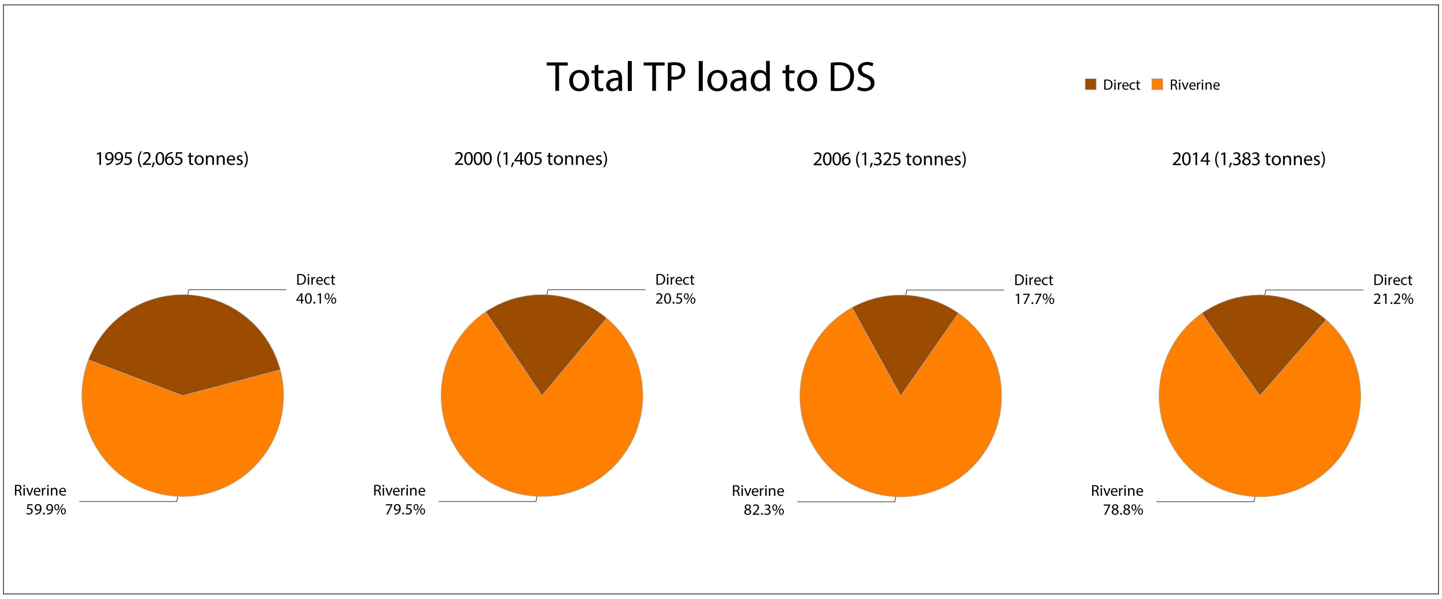

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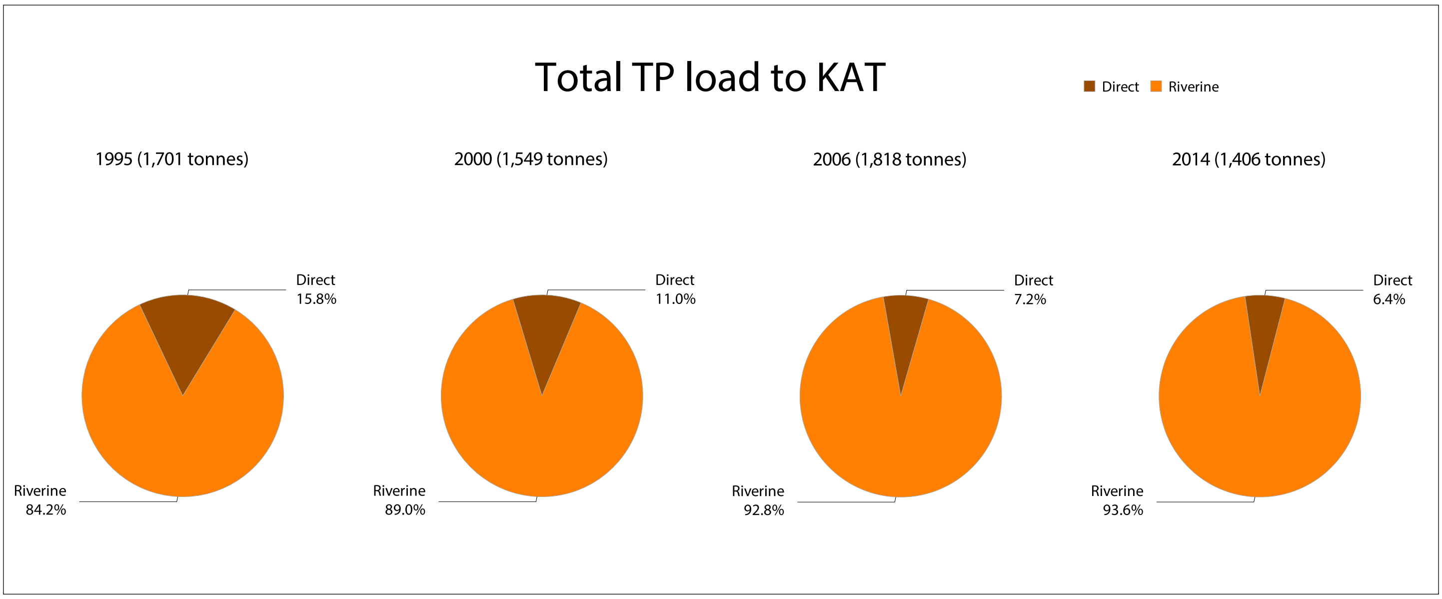

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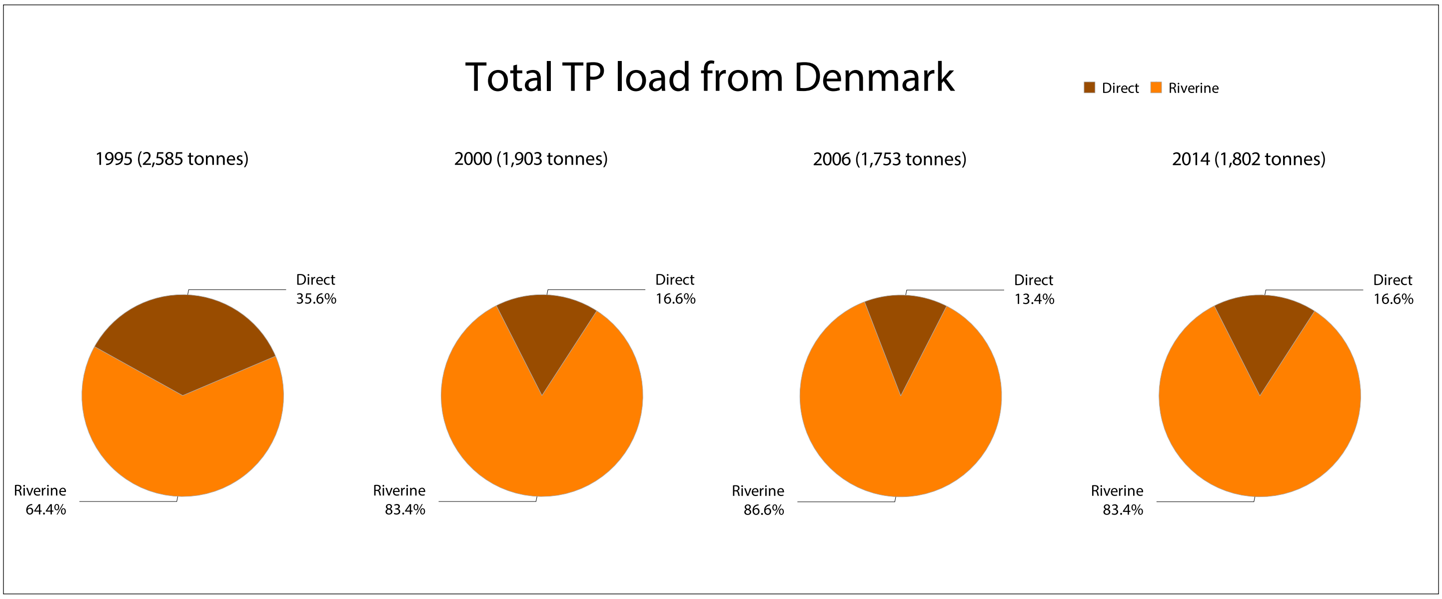

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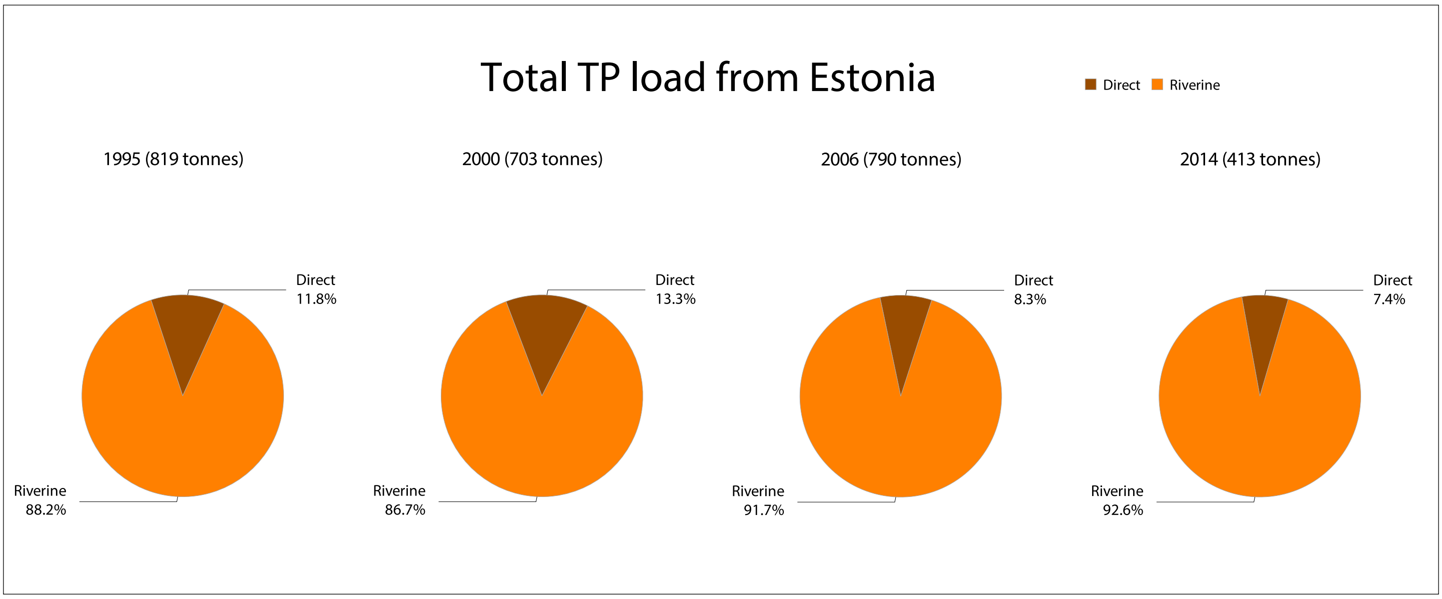

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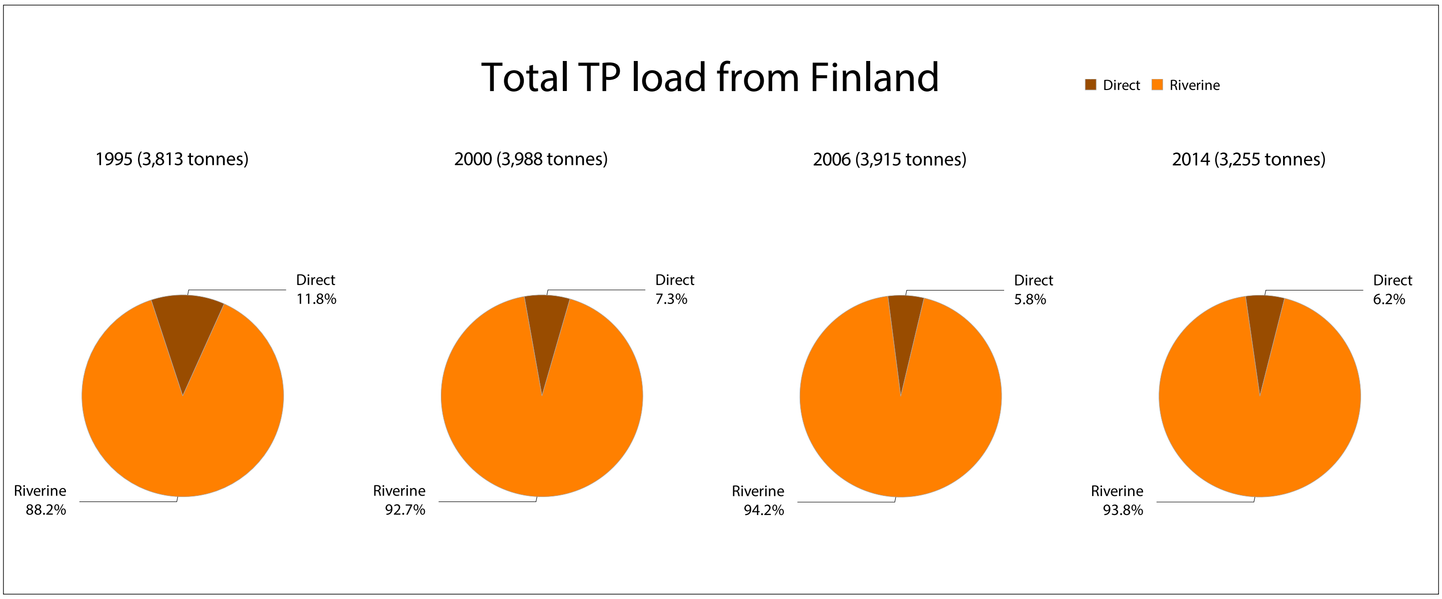

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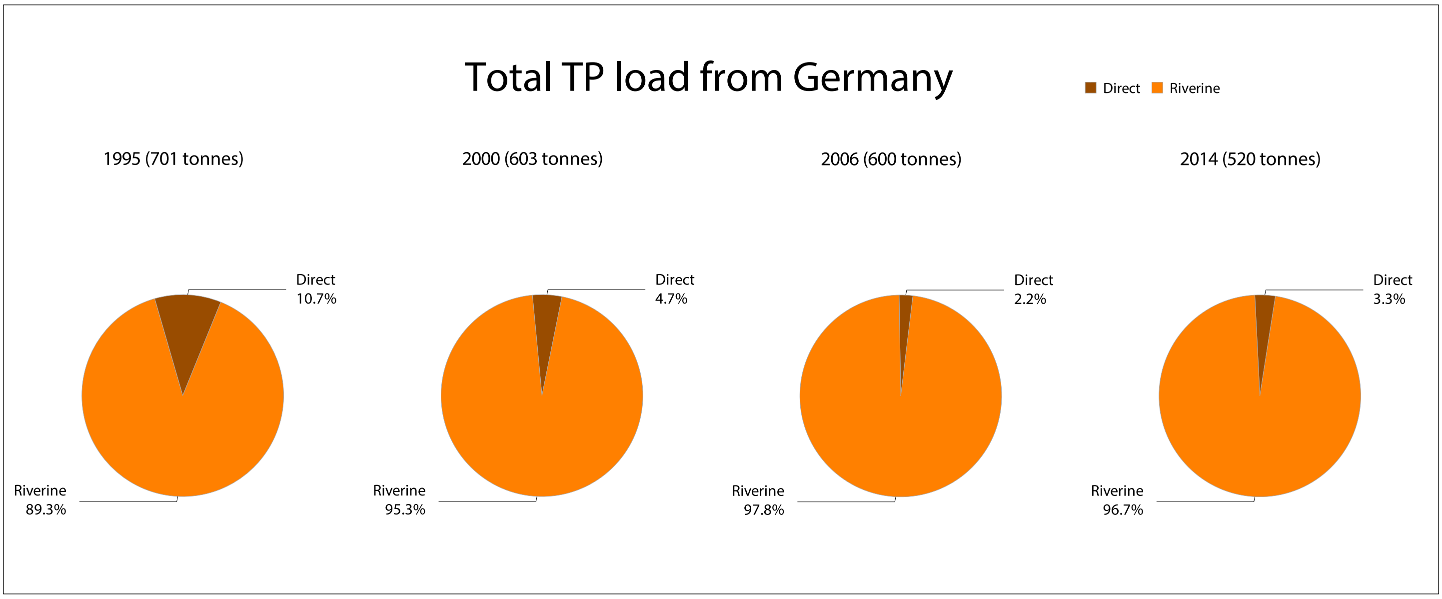

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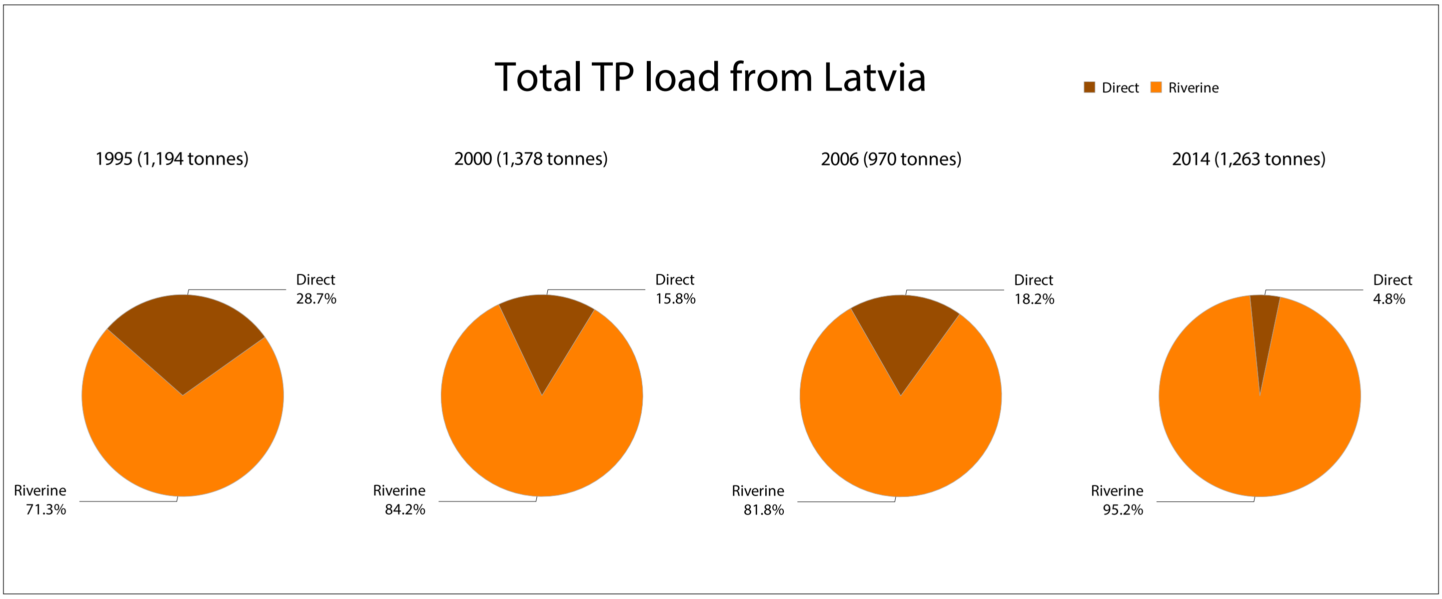

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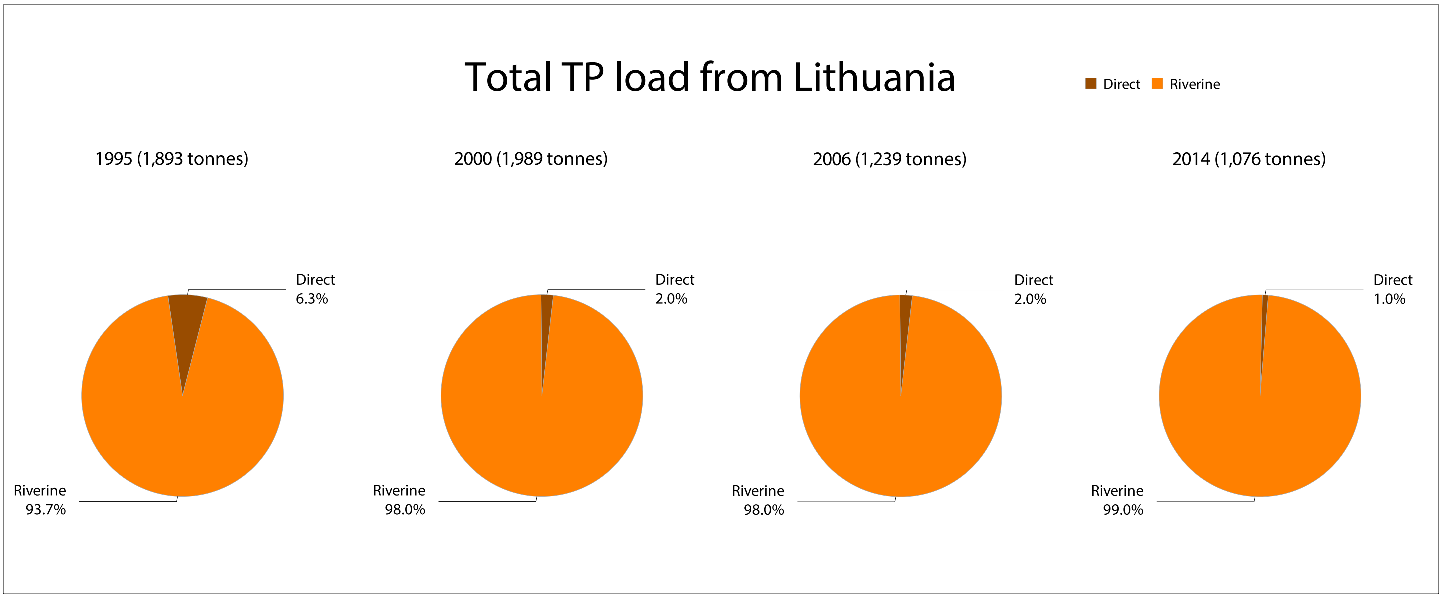

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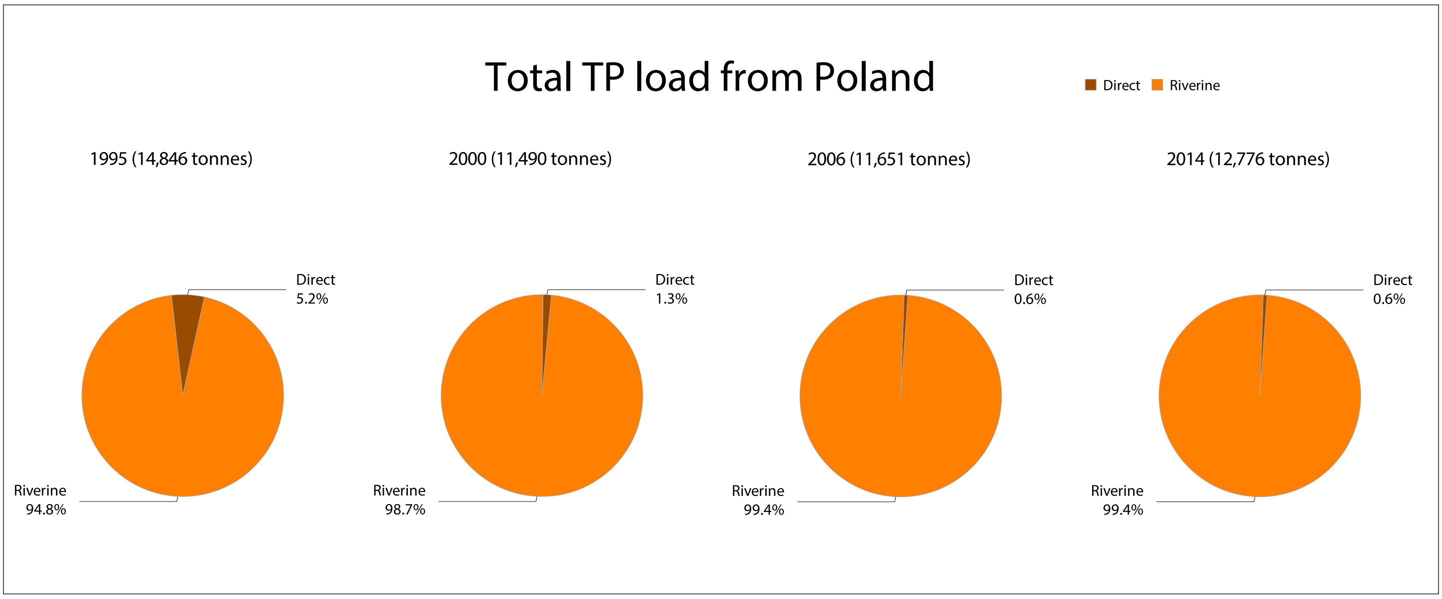

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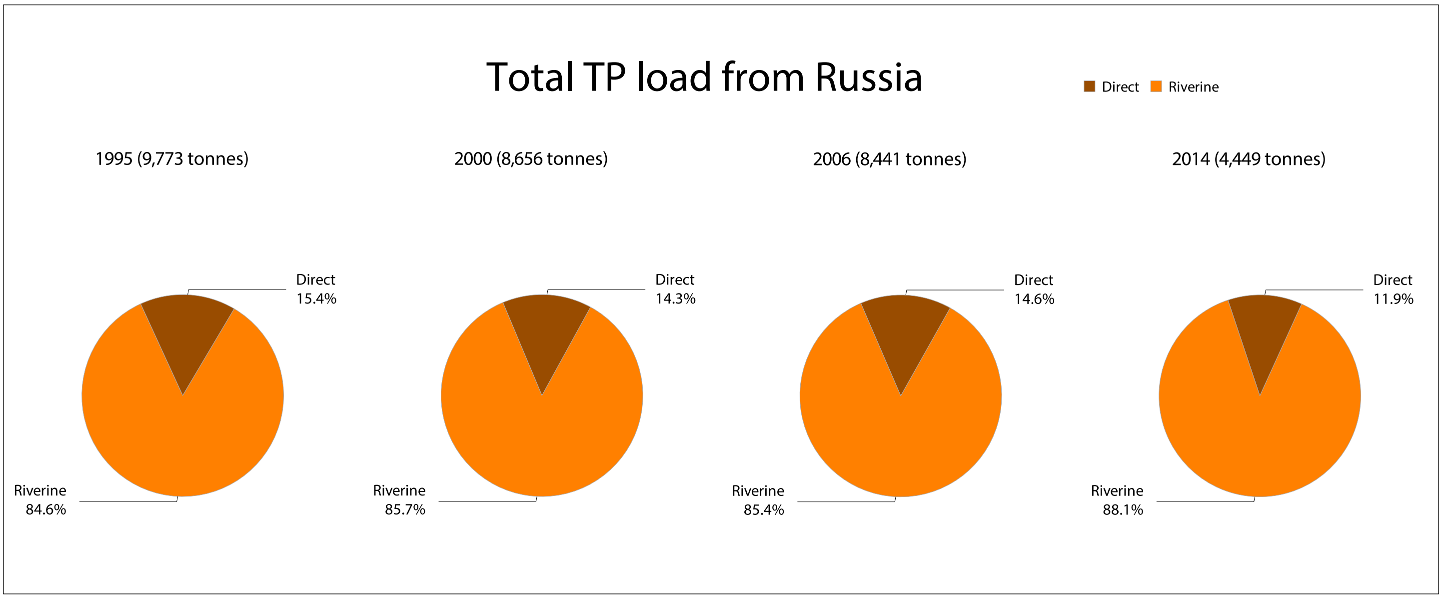

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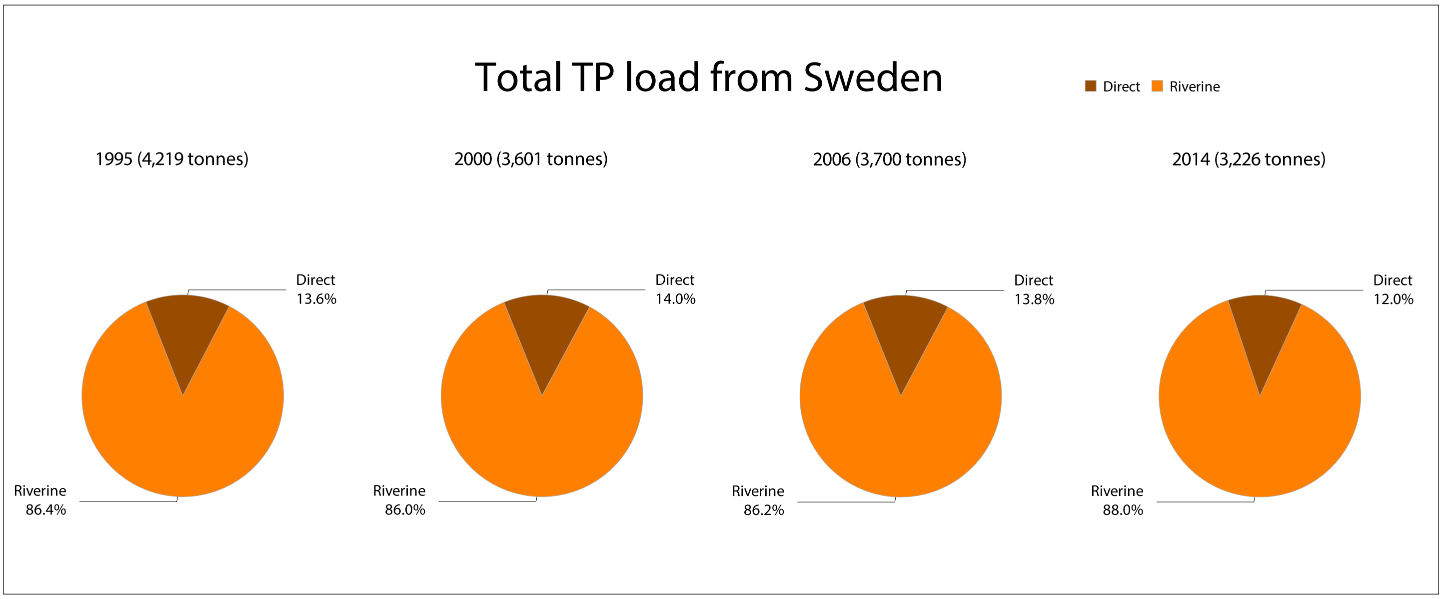


Figure 34

Sources of riverine nitrogen and phosphorus to the Baltic Sea

Source apportionment of riverine loads can be used as an instrument to estimate the contributions of different diffuse and point sources, to total riverine nitrogen and phosphorus loads entering the Baltic Sea. It is used to assess the importance of different anthropogenic sources and the contribution of natural background losses. Source apportionment can be performed using one of two approaches, either based on loads to inland waters (source approach or gross load) or at the river mouth (load approach or net load) (see also HELCOM 2015). Generally, these two approaches give different results because the retention is normally lower for sources situated close to the coast, as well as in large rivers, whereas the retention is higher for upland areas since the water travels a longer route before it enters the sea (see also nutrient retention in inland surface waters). Another reason for differing results may be because different methodologies are used to estimate diffuse sources for the two approaches. The results presented below, and in Figures 35-69, all derive from the load-oriented approach, meaning that they refer to net loads to the Baltic Sea, that take the retention in the catchment areas into account.

Note that in this assessment all source-apportionment data from Germany and Poland refer to the originally agreed assessment year 2012, whereas all other countries refer to 2014, which was later decided to be the assessment year. As Germany and Poland had already started their data collection when the year was changed, it was decided that they would continue their work using the original year for the assessment.

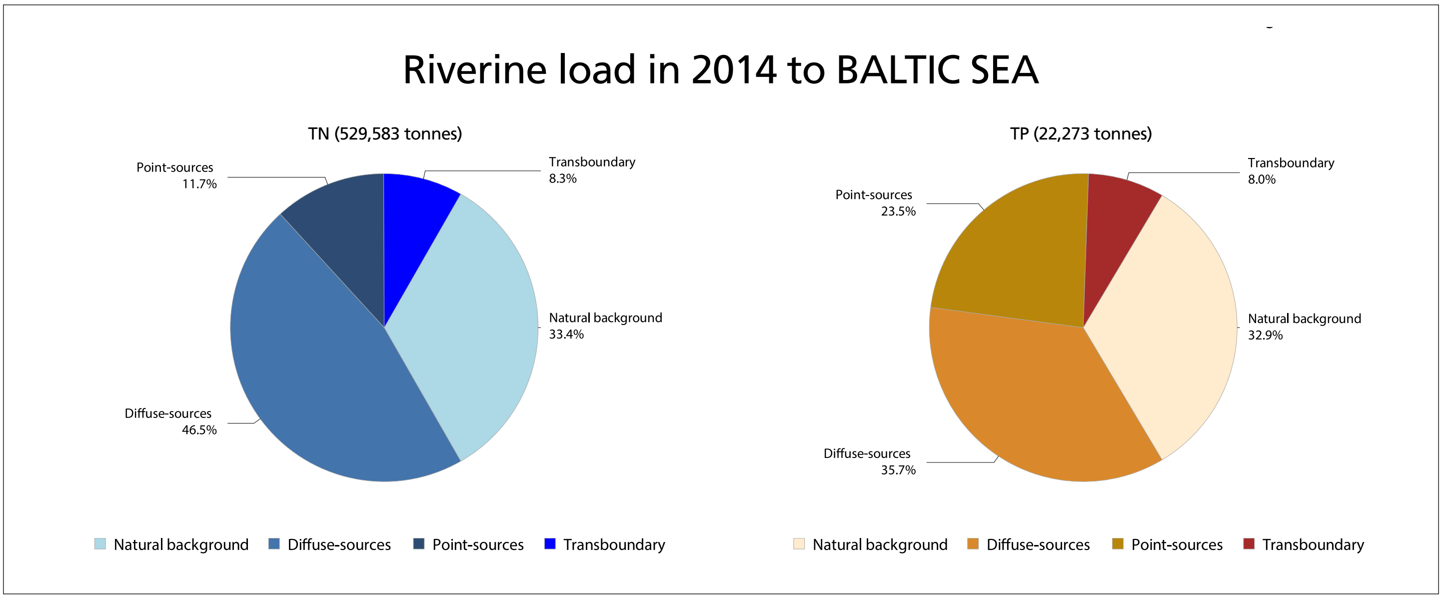
Sources of riverine nutrient loads in the Baltic Sea area

Natural background loads of nitrogen and phosphorus make up around one third of the total load of nutrients to the Baltic Sea (Figure 35). This is about twice as large a proportion compared to the estimates in PLC5 (HELCOM 2011). The reason for this large difference is probably due to changed estimates of background loads in the present assessment. However, there are large differences in the proportion of natural background loads for the different Baltic Sea basins (Figures 36-42). The largest proportion of natural load occurs in the Gulf of Finland (68% for nitrogen, and 59% for phosphorus), and Bothnian Bay (65% for both nitrogen and phosphorus), whereas the lowest proportions are in the Gulf of Riga (12% for nitrogen, and 11% for phosphorus).

Among the anthropogenic sources, the diffuse sources (mainly from agricultural activities) constitute the major part, making up 46% of the total riverine nitrogen load and 36% of the total riverine phosphorus load to the Baltic Sea (Figure 35). The large differences in the amount of land utilised for agriculture (see also Figure 58), as well as agricultural practices over the Baltic Sea catchment, are reflected by the varying contributions that diffuse sources make to total nutrient load (Figures 36-42). High impact is found in the Gulf of Riga (57% for nitrogen, and 42% for phosphorus), and for nitrogen also in the Danish Straits (68% for nitrogen), and Kattegat (59% for nitrogen).

Point-sources are important for riverine nutrient loads to the Baltic Sea, and constitute 12% of the total nitrogen load and 24% of the total phosphorus load (Figure 35). The variability in importance of point-sources is even greater than for the other nutrient sources (Figures 36-42). The lowest impact from point-sources is found in the Gulf of Riga (1% for nitrogen, and 4% for phosphorus), but there are also other basins where the proportion for nitrogen is lower than 10%, including Bothnian Bay (6-7%), the Gulf of Finland and Kattegat (8%). High impact from point-sources is found in the Baltic Proper (18% for nitrogen, 33% for phosphorus), and in the Danish Straits (43% for phosphorus).

However, some caution needs to be taken when assessing the various riverine nutrient sources to the Gulf of Riga, as it has not been possible to allocate any specific sources to a large proportion of the nutrient load. These loads are classified as trans-boundary as they originate in upstream countries, mainly Belarus (Figure 39). In total, the trans-boundary load to the Gulf is 30% for nitrogen, and 42% for phosphorus. This increases uncertainty in source apportionments substantially for this basin. Substantial trans-boundary loads are also found for the Baltic Proper with 10 to 11% of the nutrient loads originating in countries upstream of the HELCOM countries (Figure 40).



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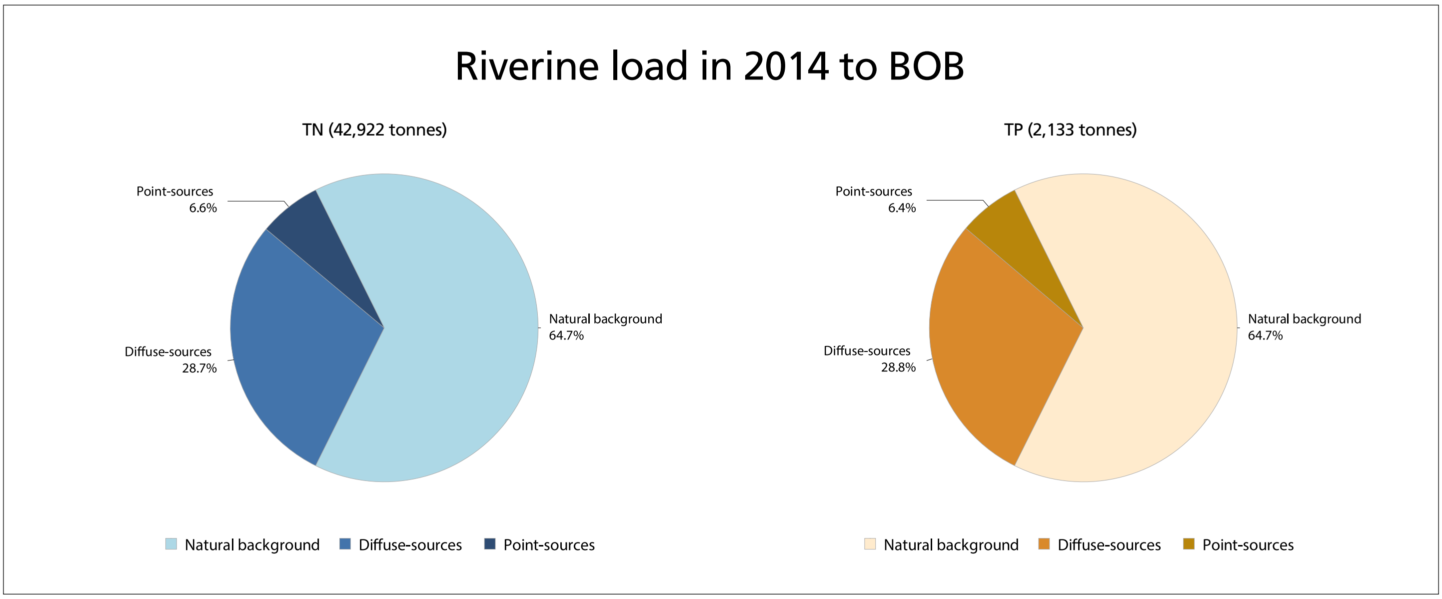

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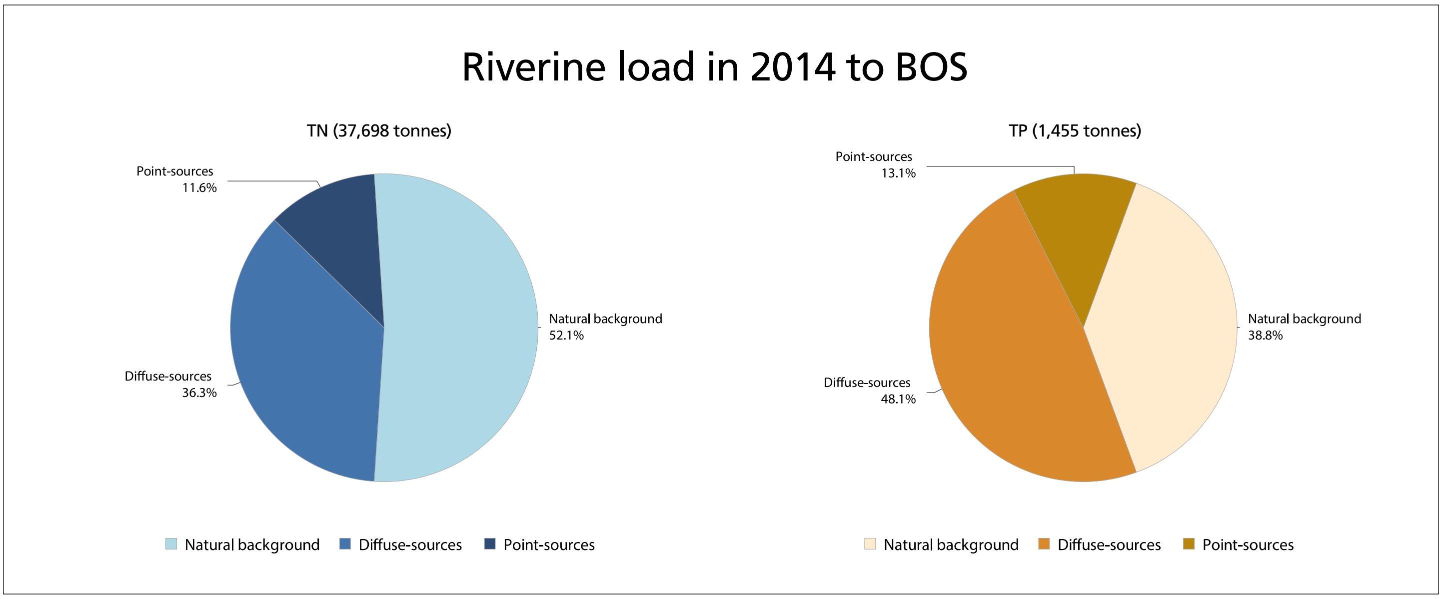

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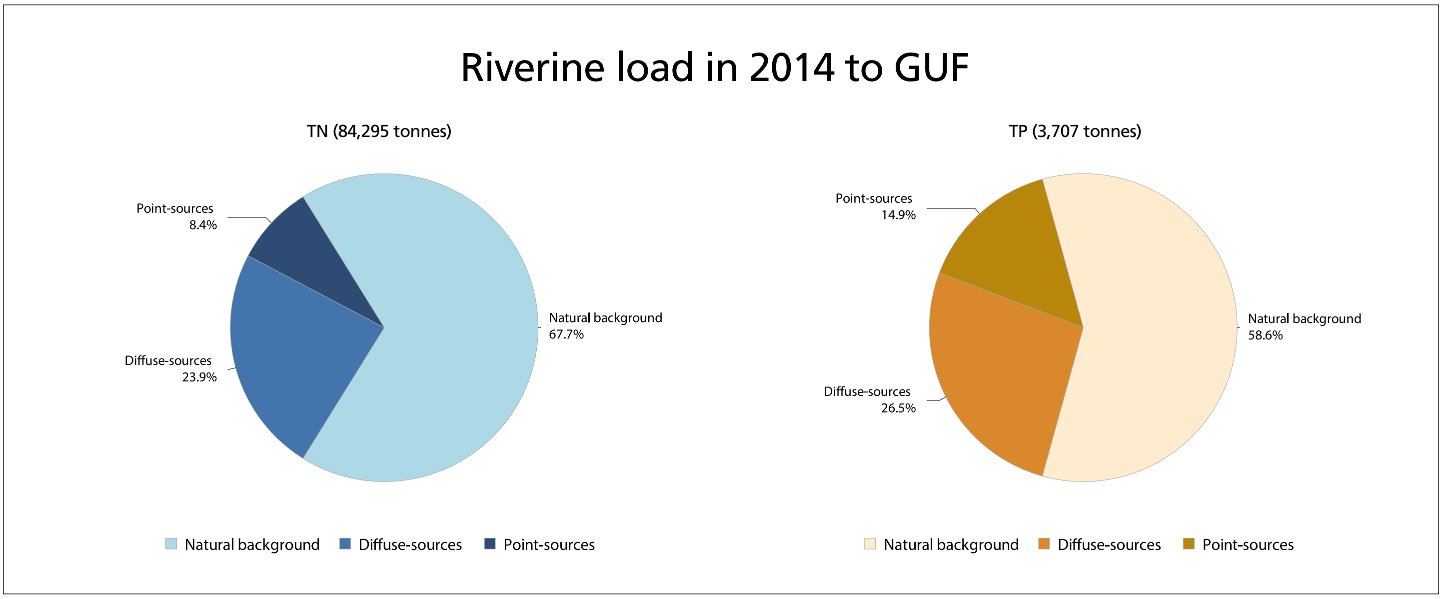

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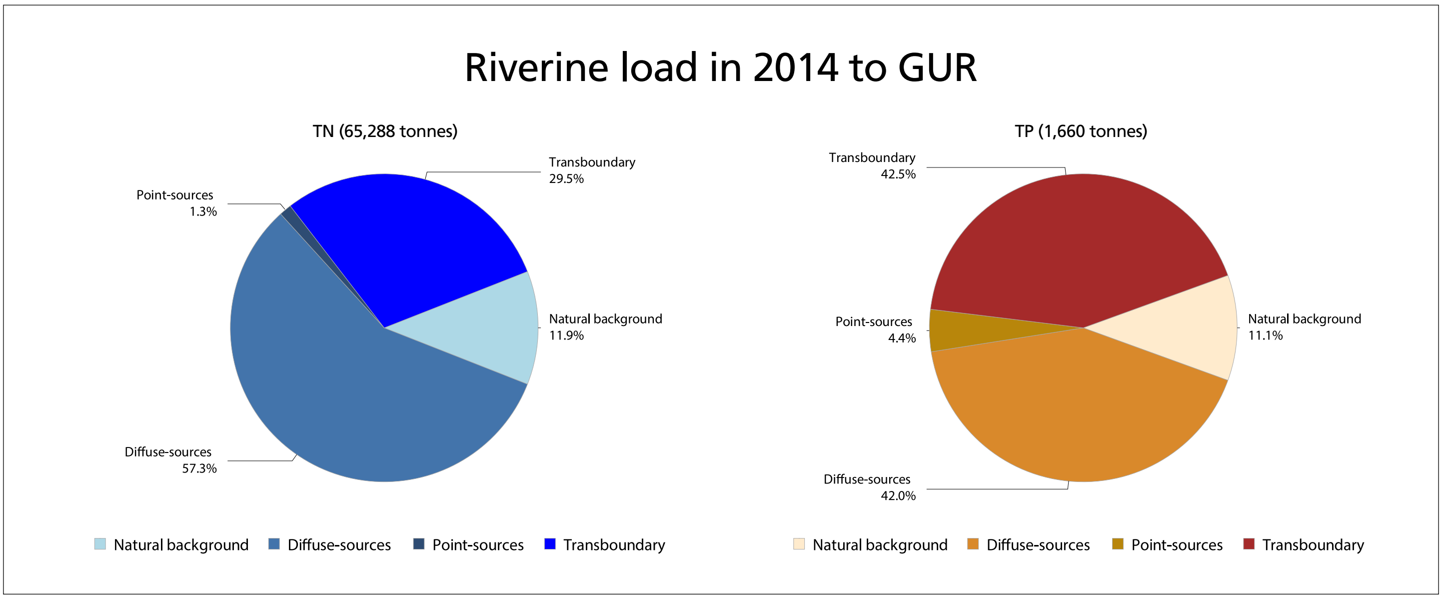

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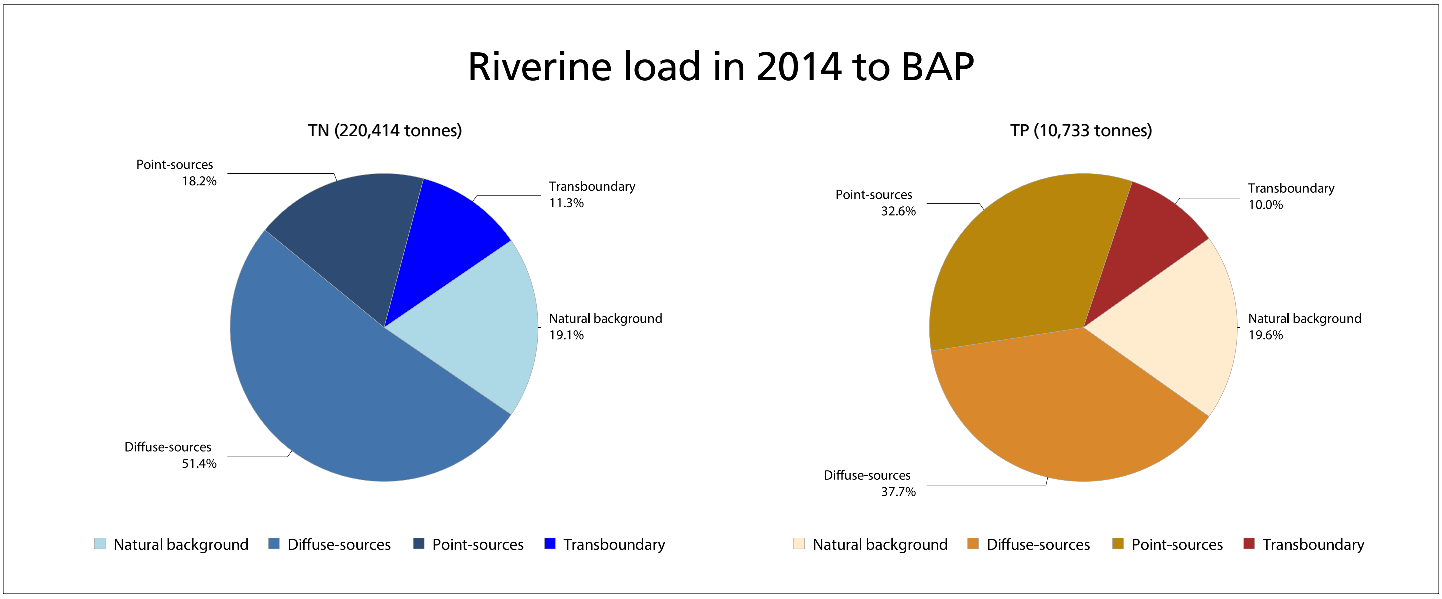

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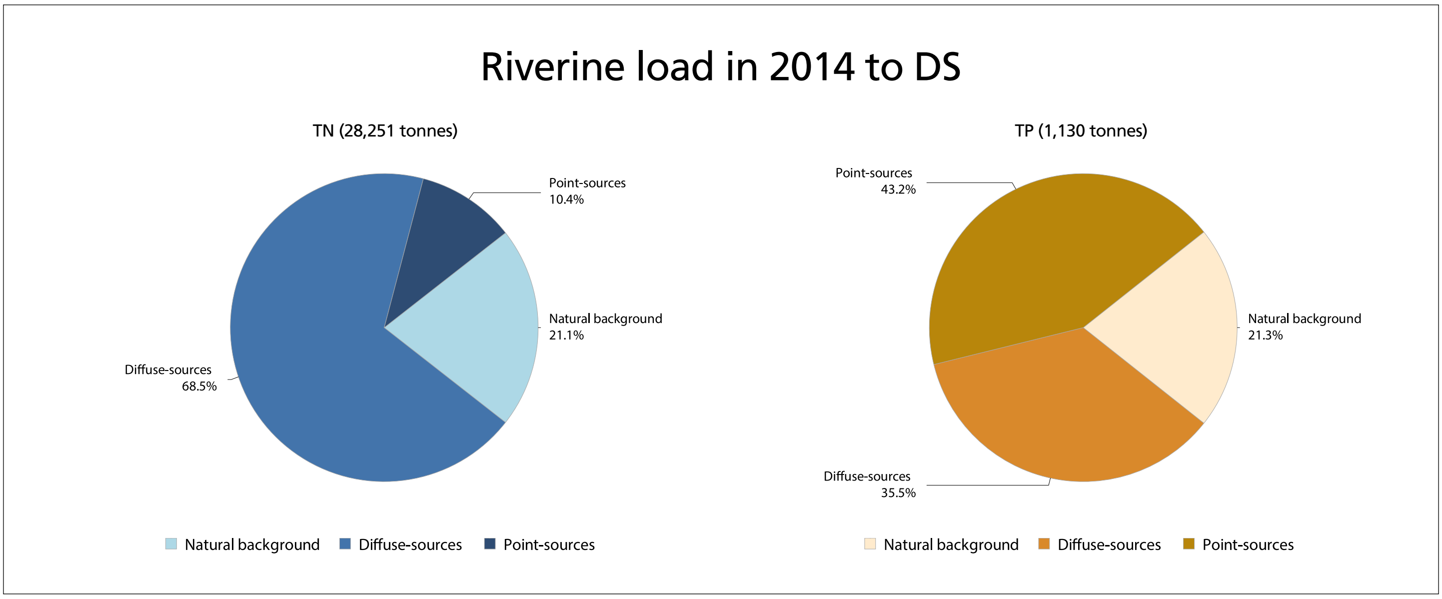

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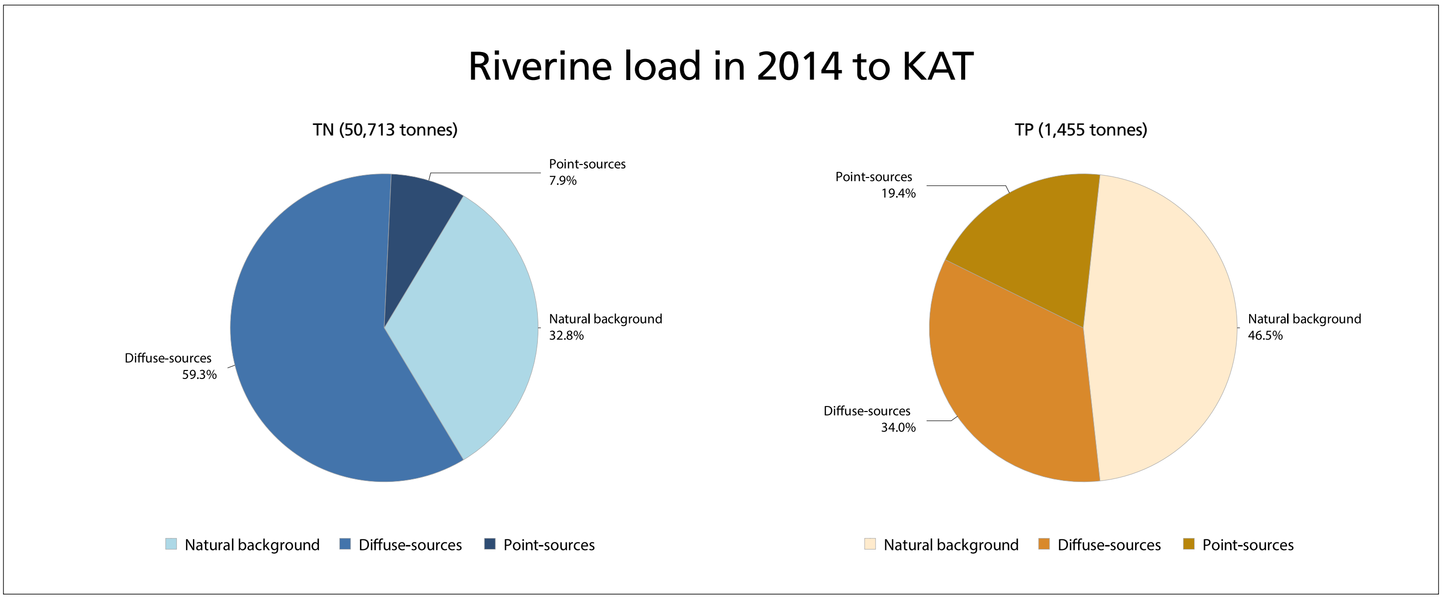

Figure 42

Country-wise distribution of sources of nutrient loads

It is only with great caution that the source apportionment may be assessed at country or basin-wise level, especially since the nutrient allocation modelling may vary from country to country, and does not always follow the HELCOM PLC-Water guidelines (HELCOM 2016). Detailed information on the nutrient sources, including nutrient loss from agriculture and atmospheric deposition on inland water surfaces, has only been given by Germany, Denmark, Finland, Lithuania, Poland, and Sweden, whereas the other HELCOM countries have reported a more generalised source apportionment.

It should also be noted that some of the minor point sources (for example storm water effluent and scattered dwellings) are handled differently by different contracting parties, and they may be included in the diffuse sources or in point sources. Also, the definition of scattered dwelling can be rather different in different countries. For example, in Denmark it is less than 30 PE, whereas in some CP's less than 300 PE.

The most important **German** nutrient source for the Baltic Sea is agricultural activity, which makes up 78% of the nitrogen load, and 51% of the phosphorus load (Figure 46). Other important anthropogenic sources, especially for phosphorus, are point-sources (20%) and urban areas (22%), whereas they are less important for nitrogen (9% and 4% respectively). The atmospheric deposition is limited to 9% for nitrogen, and 8% for phosphorus.

Note that these data are based on the German MSFD reporting and differ from PLC reporting. For MSFD, Germany does not report on natural background losses and uses aggregated data from 2012 to 2014.

The nutrient riverine inputs from **Denmark** are to a large extent dominated by agriculture (Figure 43). For Nitrogen, the diffuse loads constitute 74% of the total load, while for phosphorus they make up 38% of the load. The natural background constitutes 19% for nitrogen, and 29% for phosphorus. Point-sources are very important for the phosphorus loads (33%), but less important for nitrogen (6%). The contribution of atmospheric deposition is very minor (1% for nitrogen, 0.1% for phosphorus), due to the very limited amount of lake surface areas.

Diffuse sources are the main contributor to the **Estonian** riverine nutrient load (Figure 44). Most likely, the main diffuse source is agriculture in this case. For nitrogen diffuse sources constitute 64% of the load, whereas the corresponding proportion for phosphorus is 75%. The natural background losses are substantial (34% for nitrogen, and 21% for phosphorus). On the other hand, point-sources are less important for the total loads (2% for nitrogen, and 4% for phosphorus). No information has been reported on the importance of atmospheric deposition.

For **Finland** the natural background loads are very important and make up some 44% and 34% of the total loads for nitrogen and phosphorus, respectively (Figure 45). Also, the losses from agriculture are notable with 38% for nitrogen, and 53% for phosphorus. The point-sources constitute some 10% of the loads, and atmospheric deposition is quite significant, especially for nitrogen (8%), and slightly less for phosphorus (3%). The comparatively high proportion for deposition is due to the relatively high amount of lake surface area in Finland.

The riverine nutrient loads travelling via **Latvia** to the Baltic Sea is heavily influenced by trans-boundary loads from upstream countries, (mainly Belarus), and constitute some 37% of the total nitrogen, and 46% of the total phosphorus loads, respectively (Figure 47). It has not been possible to allocate these loads to any specific sources, but it is likely that agricultural activities and point-sources are important in these upstream countries, as is the case in the HELCOM countries. Of the Latvian nutrient sources, the diffuse sources are heavily dominating (53% for nitrogen and 40% for phosphorus). Point-sources only make up a small share of the total riverine loads (0.5% for nitrogen, 2% for phosphorus). No information has been reported on the importance of atmospheric deposition.

The trans-boundary loads are a very important part of the **Lithuanian** total nutrient loads to the Baltic Sea (Figure 48), and similar to Latvia, with Belarus as an important source outside the HELCOM countries. Trans-boundary nitrogen loads constitute 25% of the total load via Lithuania, and the corresponding proportion for phosphorus is 34%. Also in this case it has been impossible to allocate these loads to any specific sources, but again it is likely that agricultural activities and point-sources are important in these upstream countries, as is the case with the HELCOM countries. Agricultural activities are the major nutrient source for the total Lithuanian loads with 56% for nitrogen, and 42% for phosphorus. The natural background levels are 12% for nitrogen, and 11% for phosphorus, whereas point-sources represent 4% of the nitrogen load and 13% of the phosphorus load. Atmospheric deposition only constitutes a small fraction of the total nutrient load (2% for nitrogen).

The nutrient loads from **Poland** are characterised by comparatively large proportions from agriculture and from point-sources (Figure 49). For phosphorus, the point-sources share is even larger than the agricultural share (42%, and 34%, respectively). For nitrogen, the contrary occurs with 31% from point-sources, and 45% from agricultural activities. The natural background is 16% for nitrogen, and 18% for phosphorus, and the proportion of atmospheric deposition is quite small (3% for nitrogen, 1% for phosphorus). A rather small fraction of the total loads originates in upstream countries, and these trans-boundary loads constitute 4-5% of the total loads that reach the Baltic Sea via Poland.

The **Russian** riverine nutrient loads to the Baltic Sea have been reported to mainly consist of natural background losses (Figure 50). In total 83% of the nitrogen loads are considered to have a natural origin, and the corresponding proportion for phosphorus is 65%. Of the anthropogenic sources, diffuse sources dominate with 10% for nitrogen, and 21% for phosphorus, whereas point-sources constitute 6% of the nitrogen loads, and 14% of the phosphorus loads. No information has been reported on the importance of atmospheric deposition.

The nutrient loads from **Sweden** are to a large degree characterised by a significant proportion of natural background losses (Figure 51), accounting for around 54% of the total nitrogen load, and 66% of the total phosphorus load. Of the anthropogenic nutrient sources, agriculture and point-sources constitute 25% and 11% for the total nitrogen load, and 14%, and 16% respectively for the total phosphorus load. Atmospheric deposition is important in comparison to most other HELCOM countries, especially for nitrogen (10% of total loads), but also for phosphorus (4%). The comparatively large impact of atmospheric deposition is due to the high share of lake surface area in Sweden (approximately 10% of the total land area). Recent national studies estimate that the background nutrient losses from agricultural land in Sweden is in the order of half of the losses reported in the present publication. The anthropogenic impact is correspondingly higher with the same absolute amount. These new findings will be taken into account in future assessments.

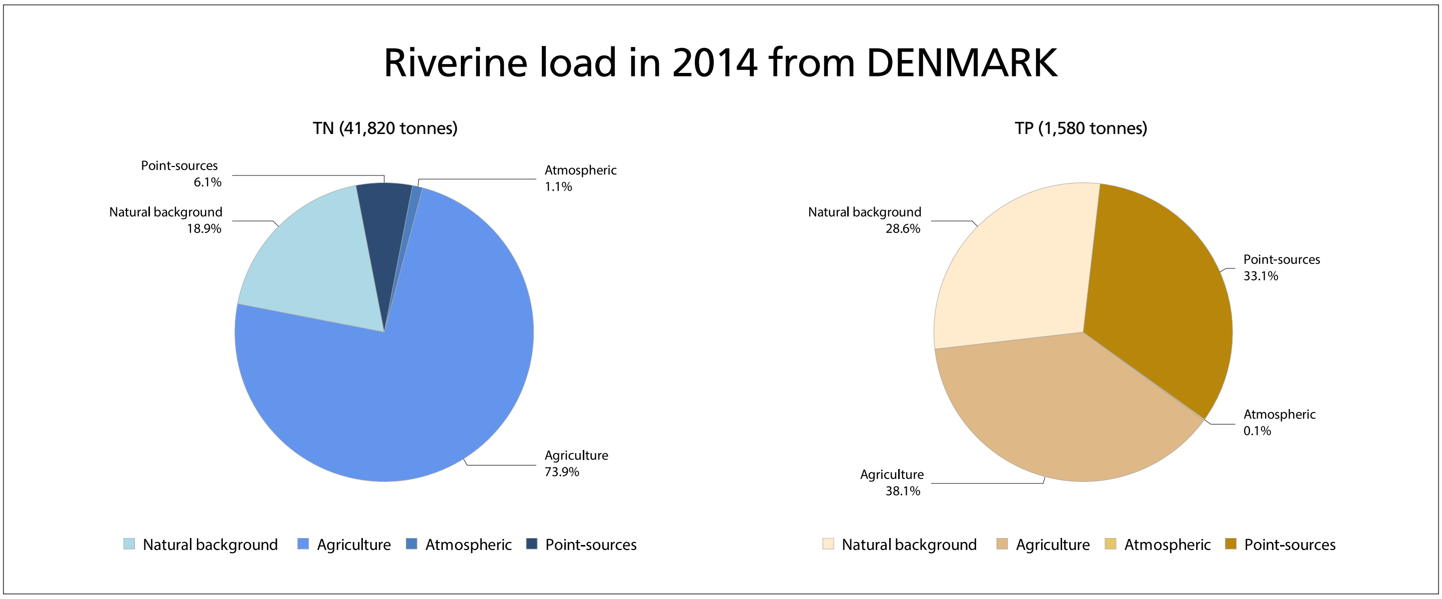

Figure 43

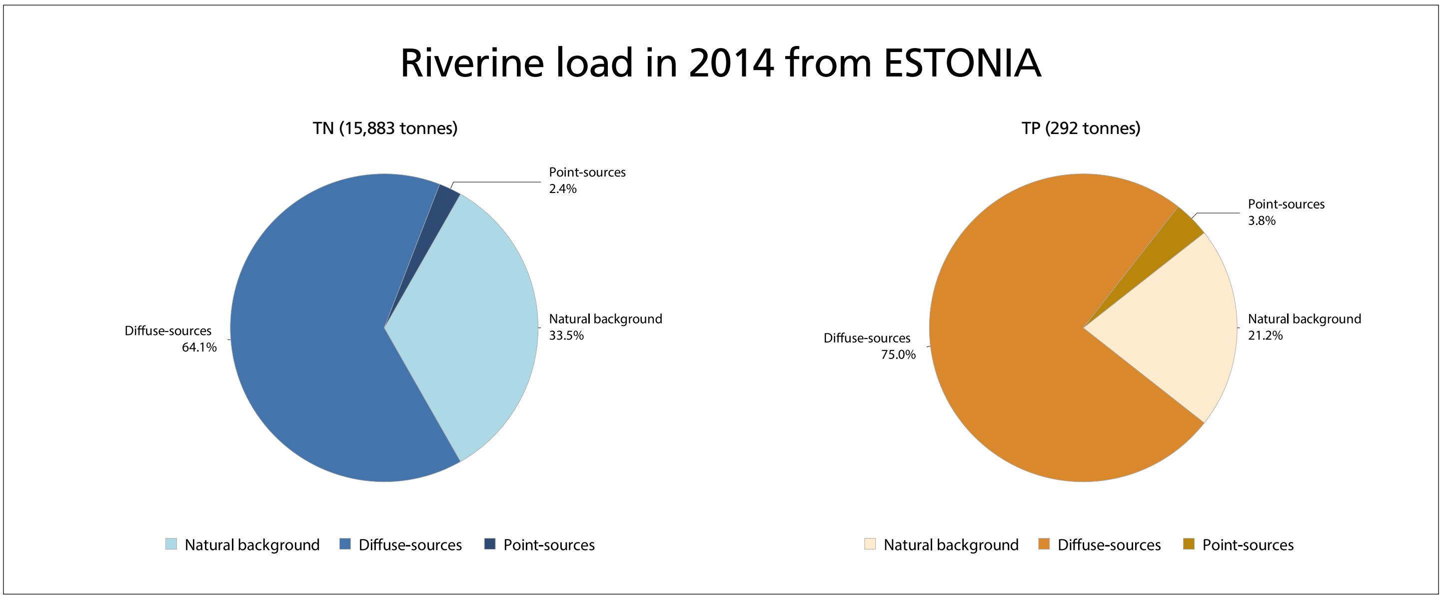

Figure 44

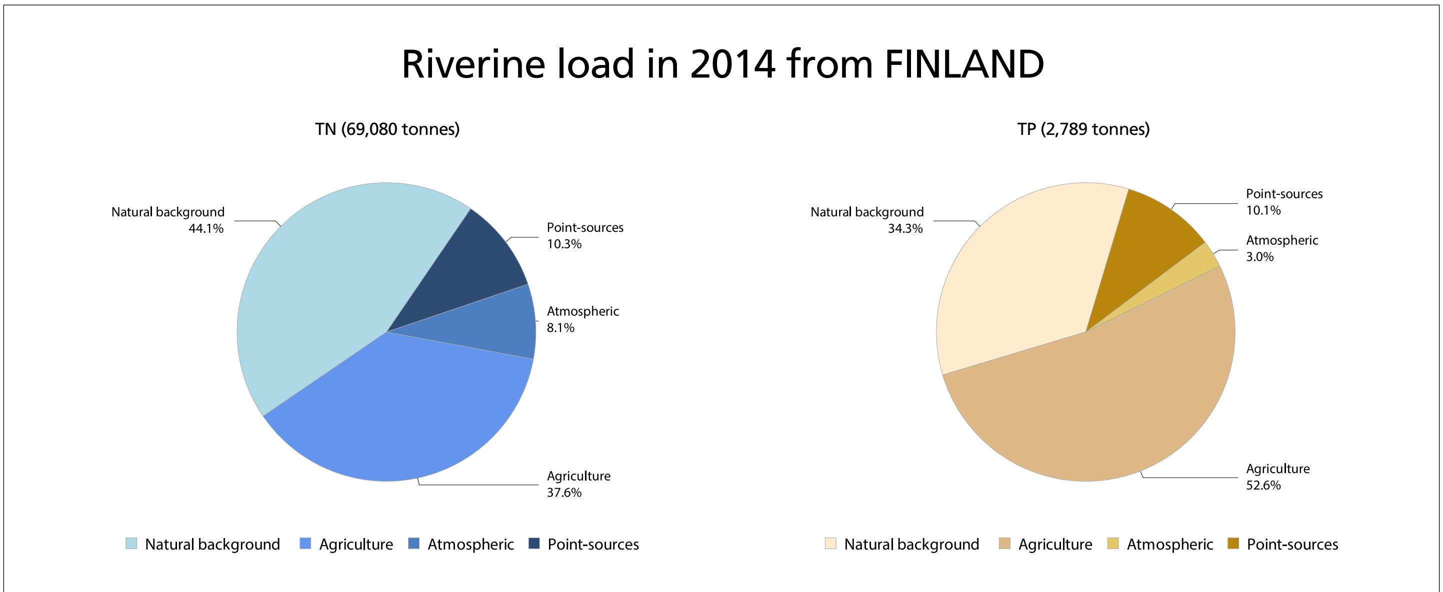

Figure 45

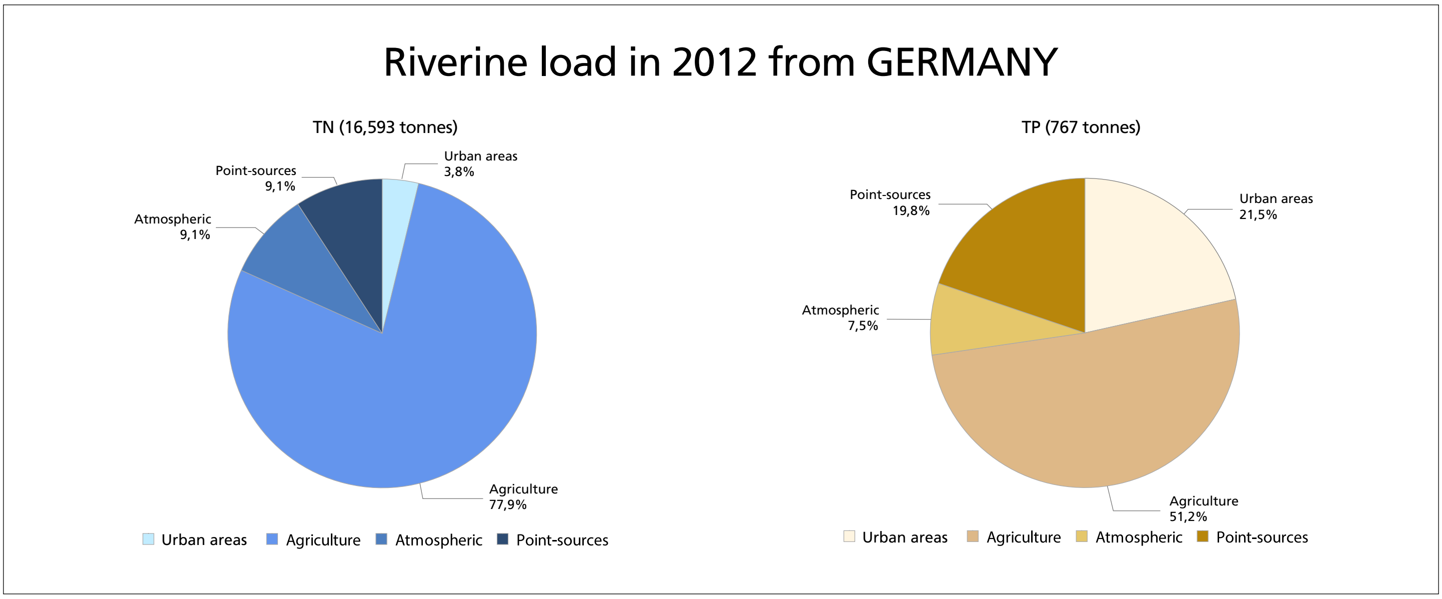

Figure 46

Note! The data from MSFD reporting were used. In the MSFD reporting Germany did not estimate any natural background losses.

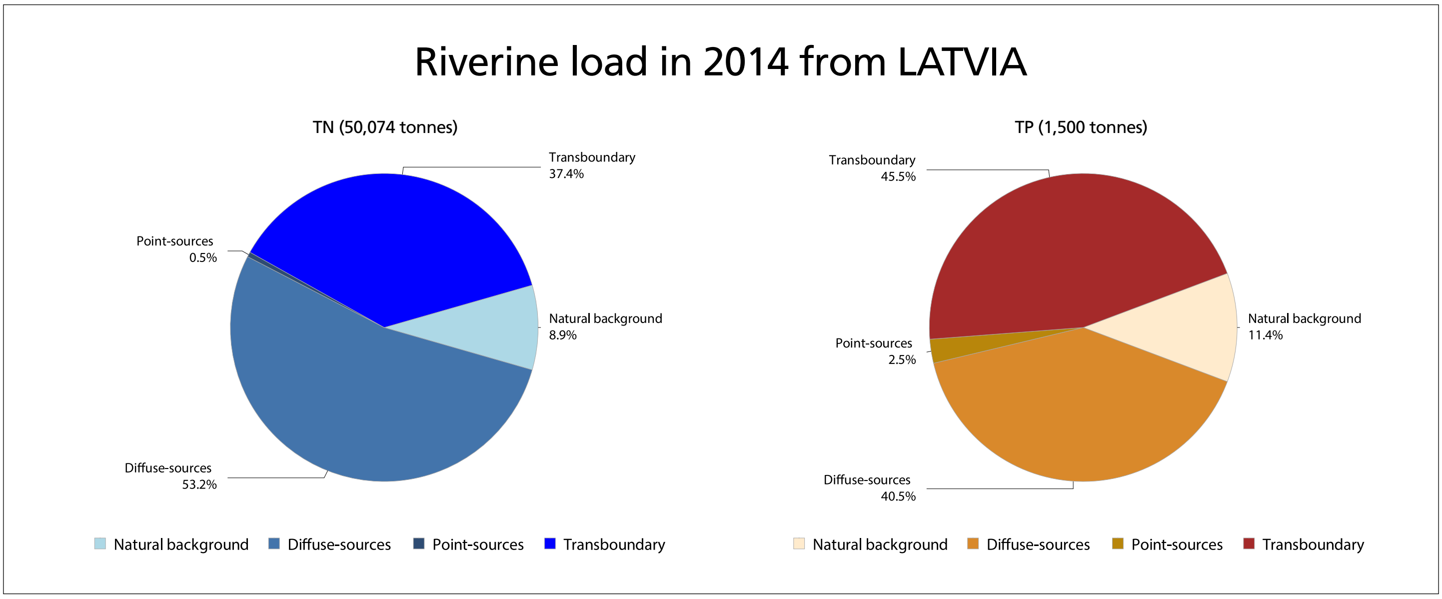

Figure 47

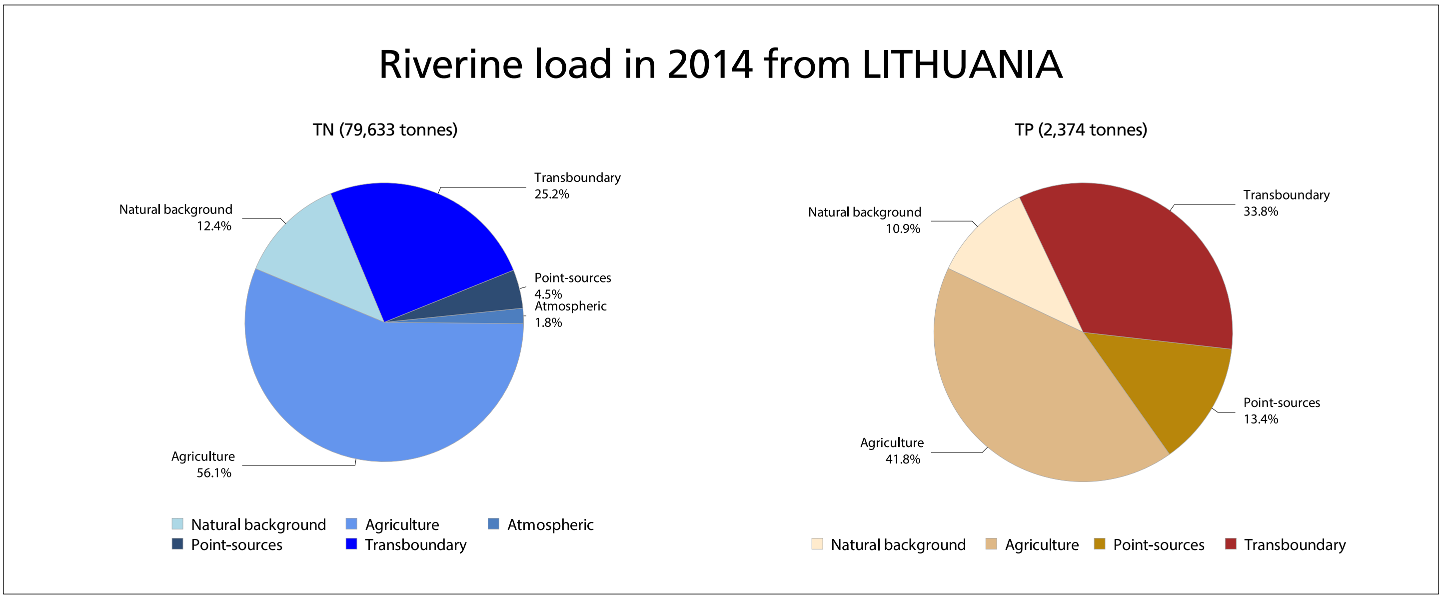

Figure 48

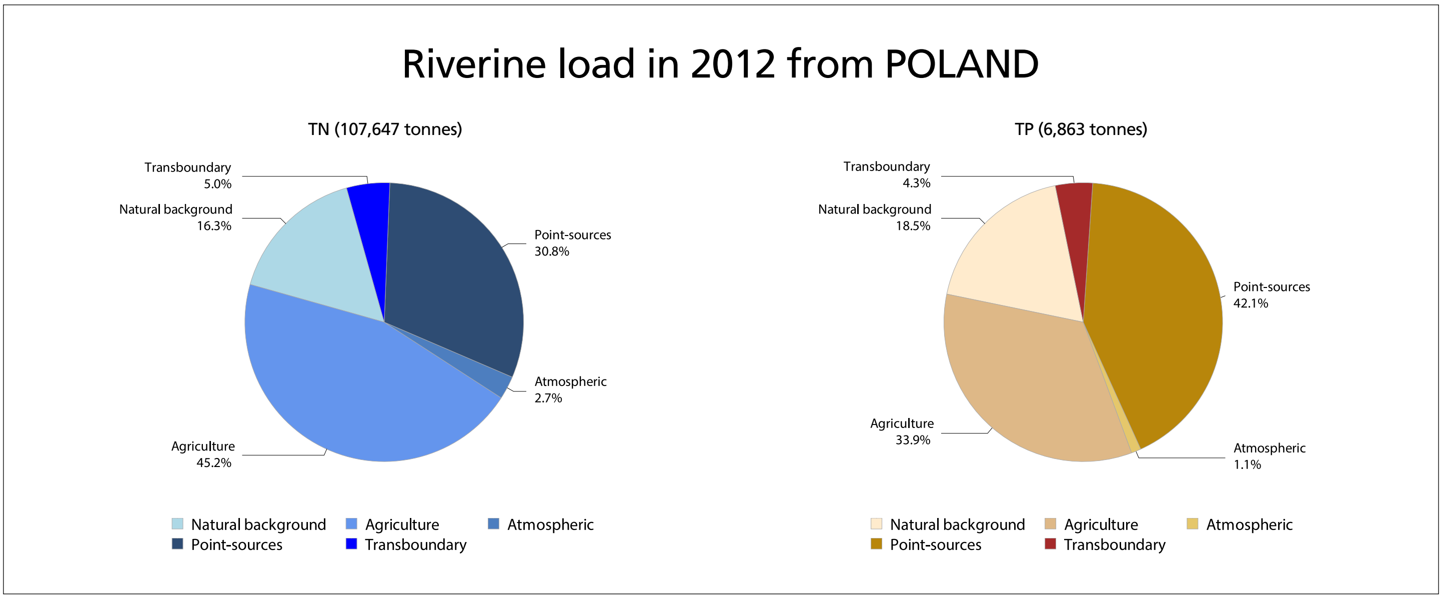

Figure 49

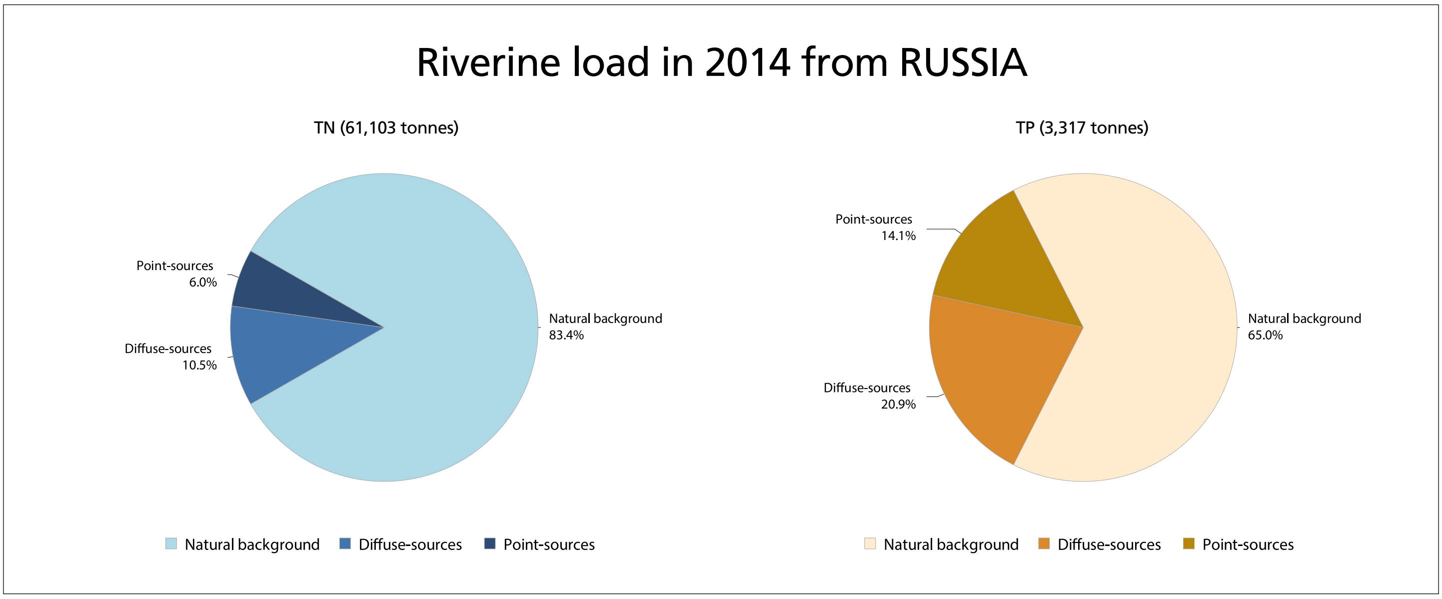

Figure 50

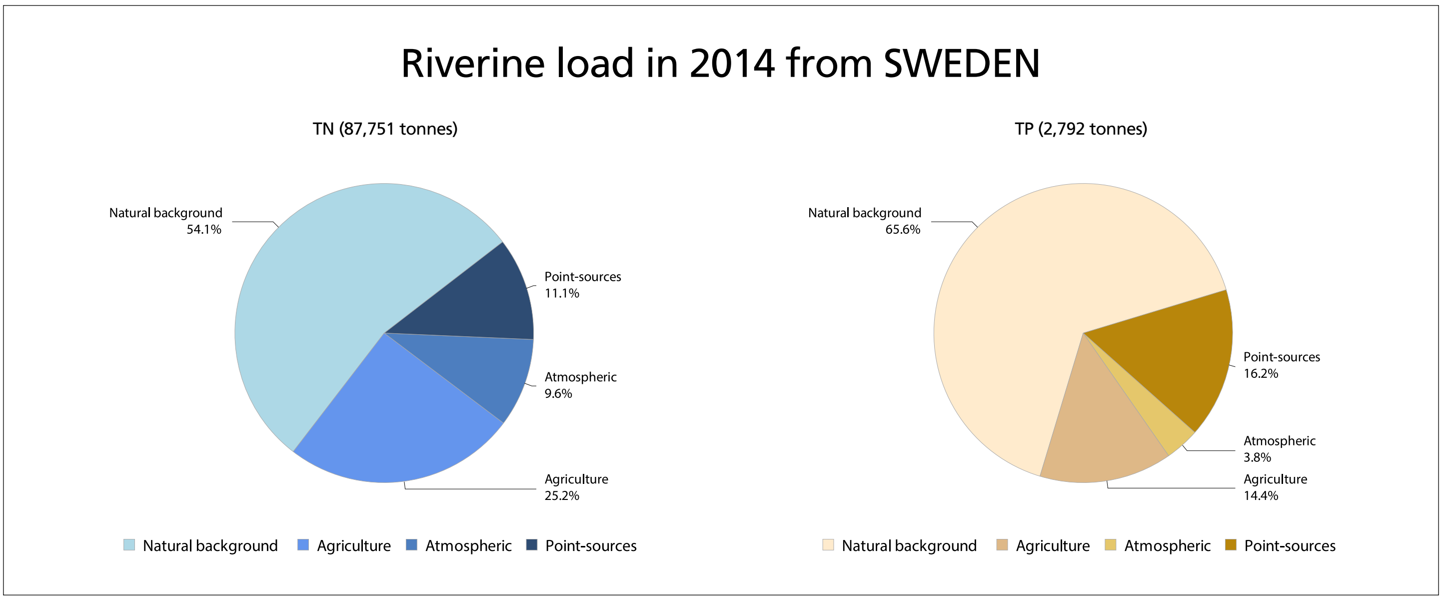

Figure 51

Area-specific losses and retention

The dominant source of riverine nutrients to the Baltic Sea are the diffuse sources. Since these sources are to a large degree dominated by agricultural nutrient losses, there is a large similarity in the geographical distribution of area-specific[1] nitrogen and phosphorus losses from diffuse sources and agriculture (Figures 52-55), as well as concerning the total riverine area-specific losses (Figures 56-57). In addition, there is also a good agreement between the areas with high diffuse losses as well as agricultural nutrient losses, and the proportion of land used for agriculture (Figure 58). There is also a comparatively good relationship between the diffuse nutrient losses and the number of inhabitants per unit catchment area (Figure 59).

The highest area-specific losses are found in the South-Southwestern part of the Baltic Proper, to the Kattegat, as well as in the Eastern part of the Baltic Proper, to the Gulf of Riga and Gulf of Finland (Figures 52-57). Also, the comparatively small Finnish rivers draining into the Bothnian Sea and Bothnian Bay constitute rather high area-specific losses. However, when comparing spatial distributions of area-specific losses, it is necessary to bear in mind that the size of the catchment area is important, since eventual hot-spots in large water systems may be "diluted" if they are incorporated into large areas with less nutrient input. This is quite evident when comparing the Finnish rivers draining westwards (into the Bothnian Bay and Bothnian Sea) and the small rivers draining into the Gulf of Finland with larger river systems draining to the Gulf of Finland. Also, this could at least partly explain higher area-specific losses associated with Finish rivers draining into the Bothnian Bay and the Bothnian Sea than the corresponding losses from the considerably larger Swedish rivers draining to the same basins that, like the Finnish rivers systems, are dominated by nutrient loads from large forested areas considered to be close to natural background levels (Figures 60-61).

The nutrient loads from direct point-sources are to a large degree dominated by municipal waste water treatment plants (MWWTs), although rather large industrial point-sources exist, especially along the Swedish coast, and to some degree along the Finnish coast (Figures 62-65). Comparatively many smaller MWWTs are found along the Finnish, Swedish and Danish coastlines, whilst the other HELCOM countries mostly have a few larger plants in connection with large coastal cities (Figures 64-65). Nutrient loads from sea-based aquaculture activities mainly have an impact in Finland (Archipelago Sea), Denmark, and to some extent in Sweden (Figures 66-67).

Retention of nutrients is defined as the removal or transformation of phosphorus and nitrogen species in surface waters of river systems, including adjoining lakes and during river valley floods. Estimates of retention is necessary for the quantification of nutrient losses, taking into account removal of nutrients on the way form land-based sources to marine environment. Moreover, the retention information may be used to estimate the effect of remedial measures on inland sources that aim to reduce nutrient loads to the sea. Retention is to a large degree influenced by the residence time of the inland water systems. Hence, factors like percentage of surface freshwater and wetlands, and topography, highly influence retention. For example, especially large and deep lakes increase phosphorus removal due to sedimentation. Meanwhile, for nitrogen various kinds of wetlands and periodically flooded areas may influence the de-nitrification, producing nitrogen gas that departs to the atmosphere. The opposite may also occur, especially for phosphorus where the sediments in highly eutrophic lakes may act as an internal phosphorus source. However, in general the longer the water and the nutrients are retained in a water system, the larger the nutrient retention will be, meaning that long river systems often promote higher retention.

The factors that affect the retention vary across the Baltic Sea catchment area, which makes it difficult to fully harmonize the methods of calculating nutrient retention in inland surface waters. Hence, the estimated retentions are to be regarded as approximate estimates. Note that the nutrient inputs to the Baltic Sea given by according to the load-oriented approach earlier has already taken the inland retention in freshwater into account as these inputs are the estimated net inputs to the Sea.

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1 Area-specific nutrient losses are defined as the amount of nutrients lost or transported per unit area (generally in kg/km2 or formerly kg/ha). It is mainly used to compare nutrient loads from different areas.

The largest proportion of total nitrogen and phosphorus retention in the total river system catchments in 2014 (2012 in Germany and Poland) have been reported for the catchments draining into the Gulf of Finland, as well as from Poland, and some areas in the Southern part of Sweden (Figures 68 and 69, respectively). In addition, for some smaller catchments in Latvia, the Kaliningrad area of Russia, as well as Germany and Denmark both the nitrogen and phosphorus retention has been reported to be high (45 to 88%). For phosphorus, retention in the same range is also reported for Lithuania, and the central part of Sweden (Figure 69). The lowest nutrient retention has been reported for Estonia. However, this low figure is probably not realistic, and more likely due to methodological issues (retention data is lacking from this area), as there is no reason to believe that the nutrient retention in one country or area draining to the Baltic Sea would be just a fraction of the retention in neighboring areas. Also, there are some considerable differences in retention for trans-boundary river systems that probably also result from differences in methodology and/or data availability. An example of this is the Belarusian trans-boundary rivers entering Lithuania, Latvia, and Poland (Figures 68 and 69).

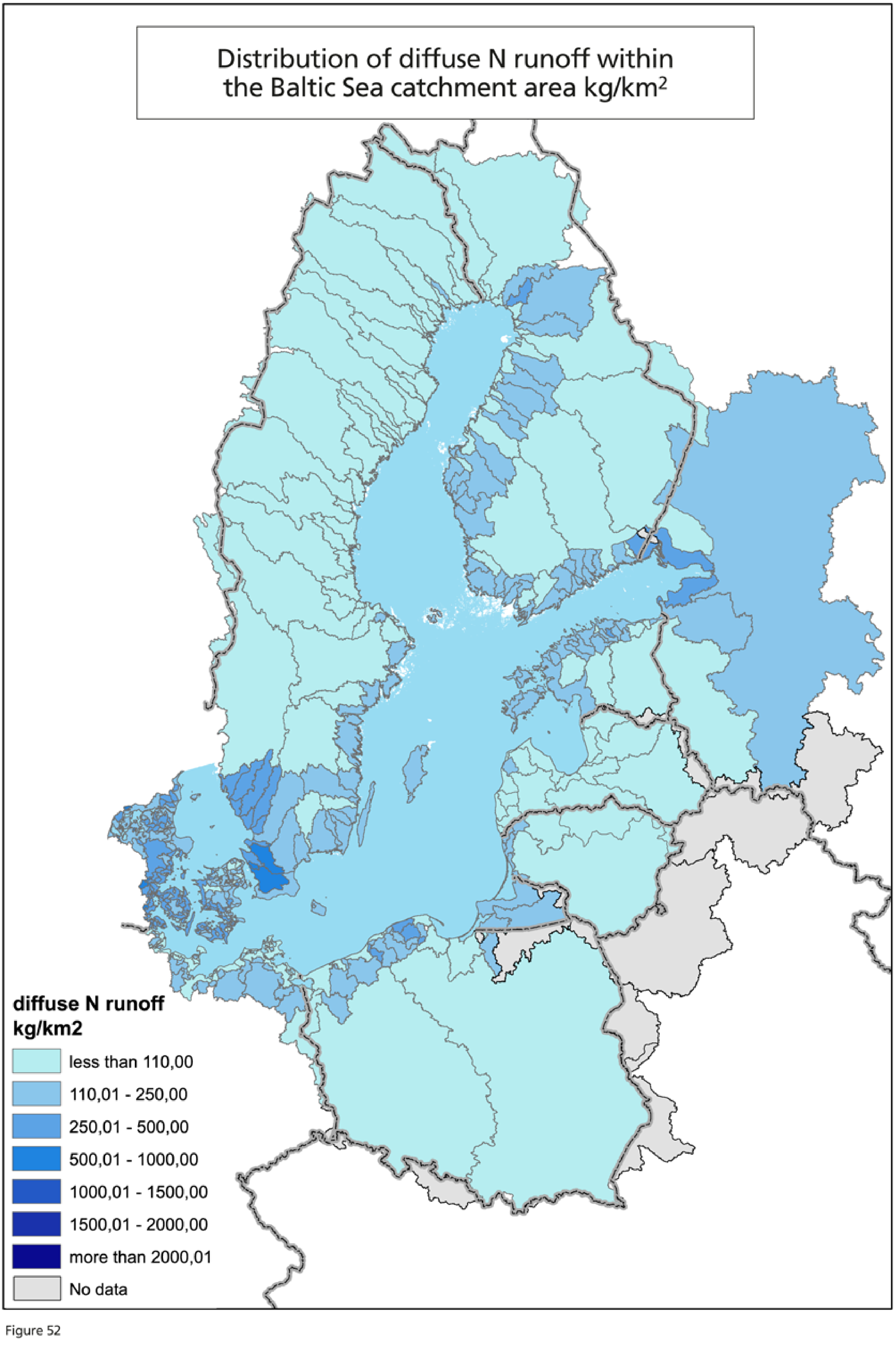

Distribution of diffuse N runoff within
the Baltic Sea catchment area kg/km2
diffuse N runoff
kg/km2
less than 110,00
110,01 - 250,00
250,01 - 500,00
500,01 - 1000,00
1000,01 - 1500,00
1500,01 - 2000,00
more than 2000,01
No data

Figure 52

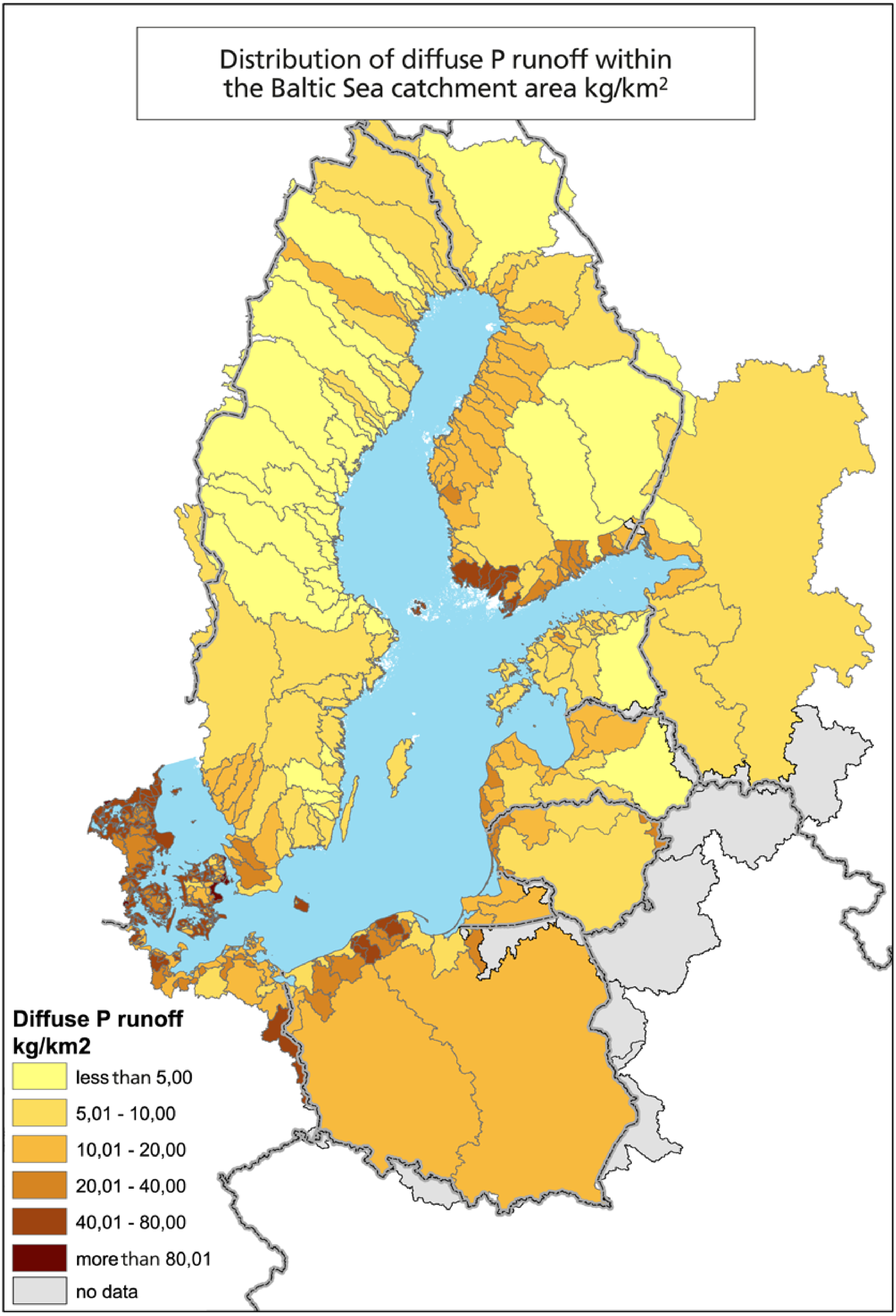

Distribution of diffuse P runoff within the Baltic Sea catchment area kg/km²
Diffuse P runoff kg/km2
less than 5,00
5,01 - 10,00
10,01 - 20,00
20,01 - 40,00
40,01 - 80,00
more than 80,01
no data

Figure 53

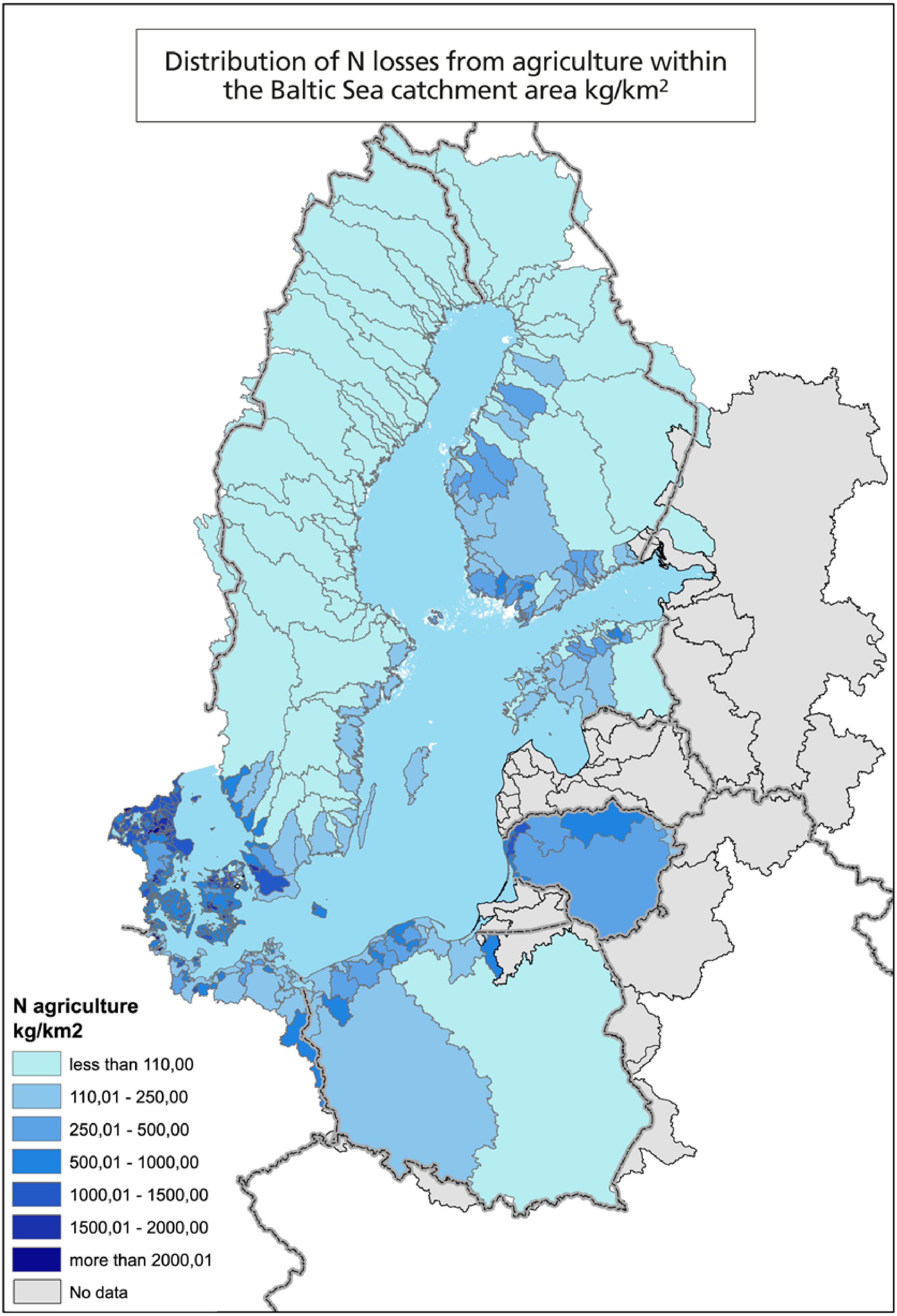
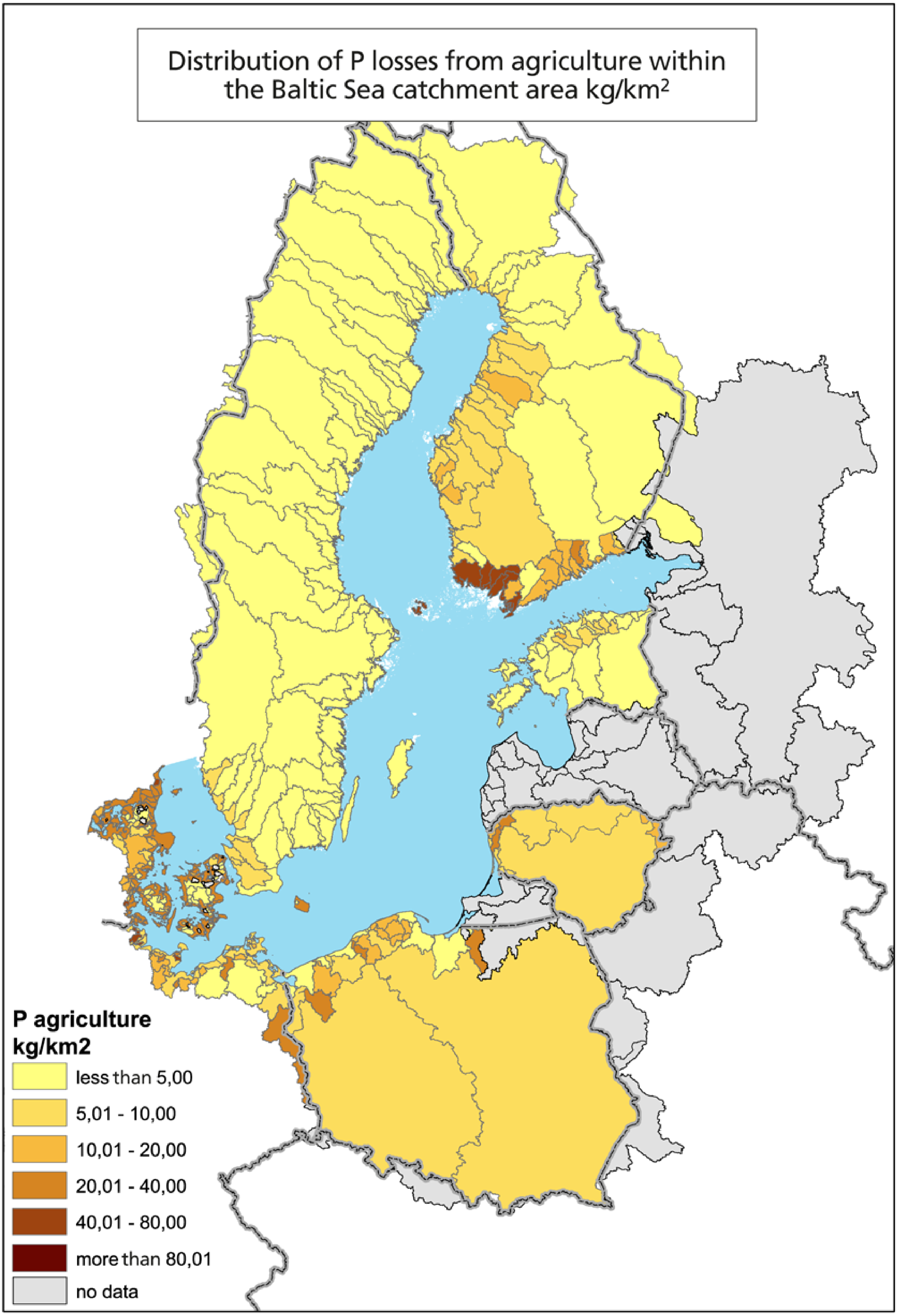

Distribution of N losses from agriculture within the Baltic Sea catchment area kg/km²
N agriculture kg/km2
less than 110,00
110,01 - 250,00
250,01 - 500,00
500,01 - 1000,00
1000,01 - 1500,00
1500,01 - 2000,00
more than 2000,01
No data

Figure 54



Distribution of P losses from agriculture within the Baltic Sea catchment area kg/km2
P agriculture
kg/km2
less than 5,00
5,01 - 10,00
10,01 - 20,00
20,01 - 40,00
40,01 - 80,00
more than 80,01
no data

Figure 55

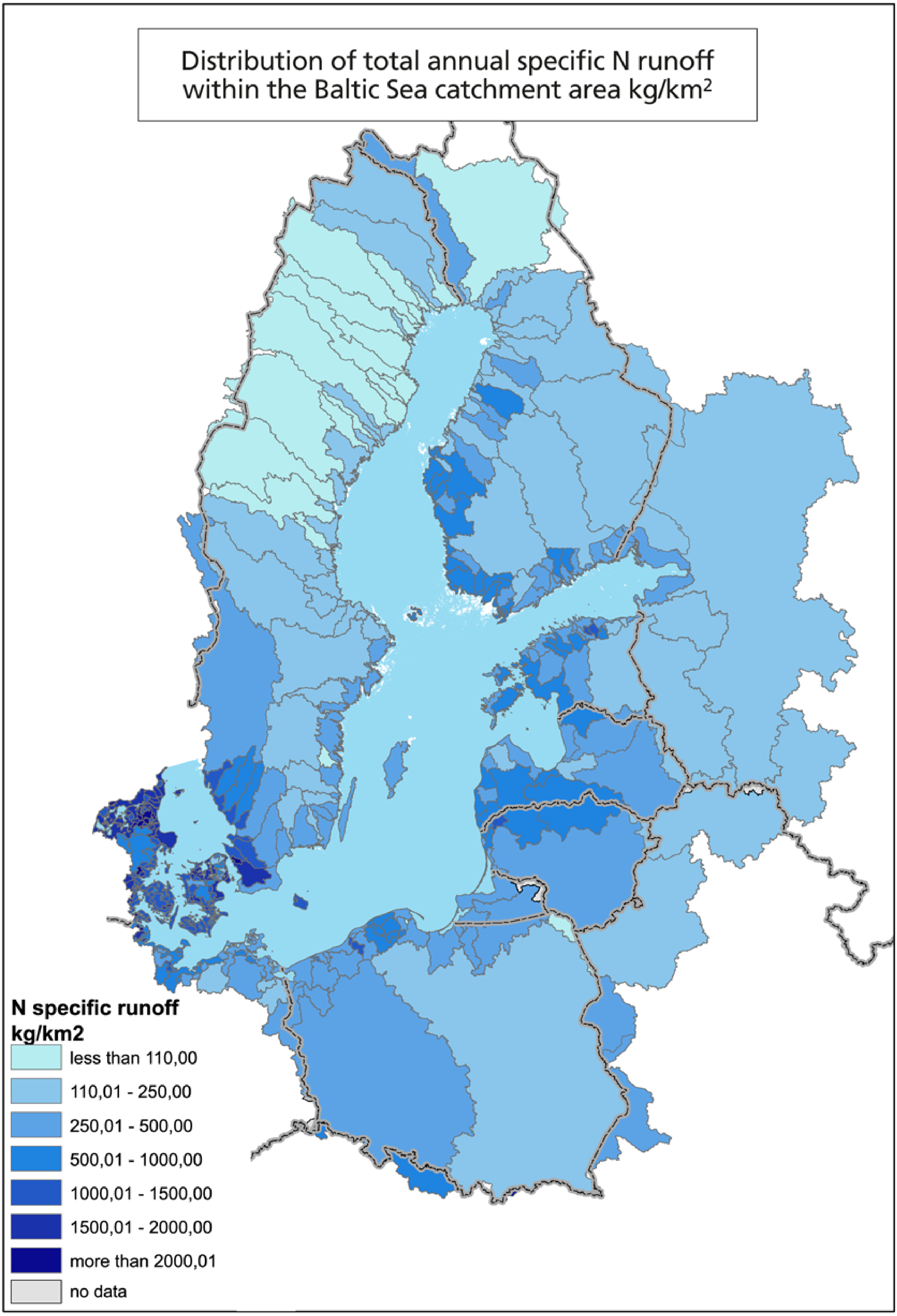

Distribution of total annual specific N runoff within the Baltic Sea catchment area kg/km2
N specific runoff kg/km2
less than 110,00
110,01 - 250,00
250,01 - 500,00
500,01 - 1000,00
1000,01 - 1500,00
1500,01 - 2000,00
more than 2000,01
no data

Figure 56

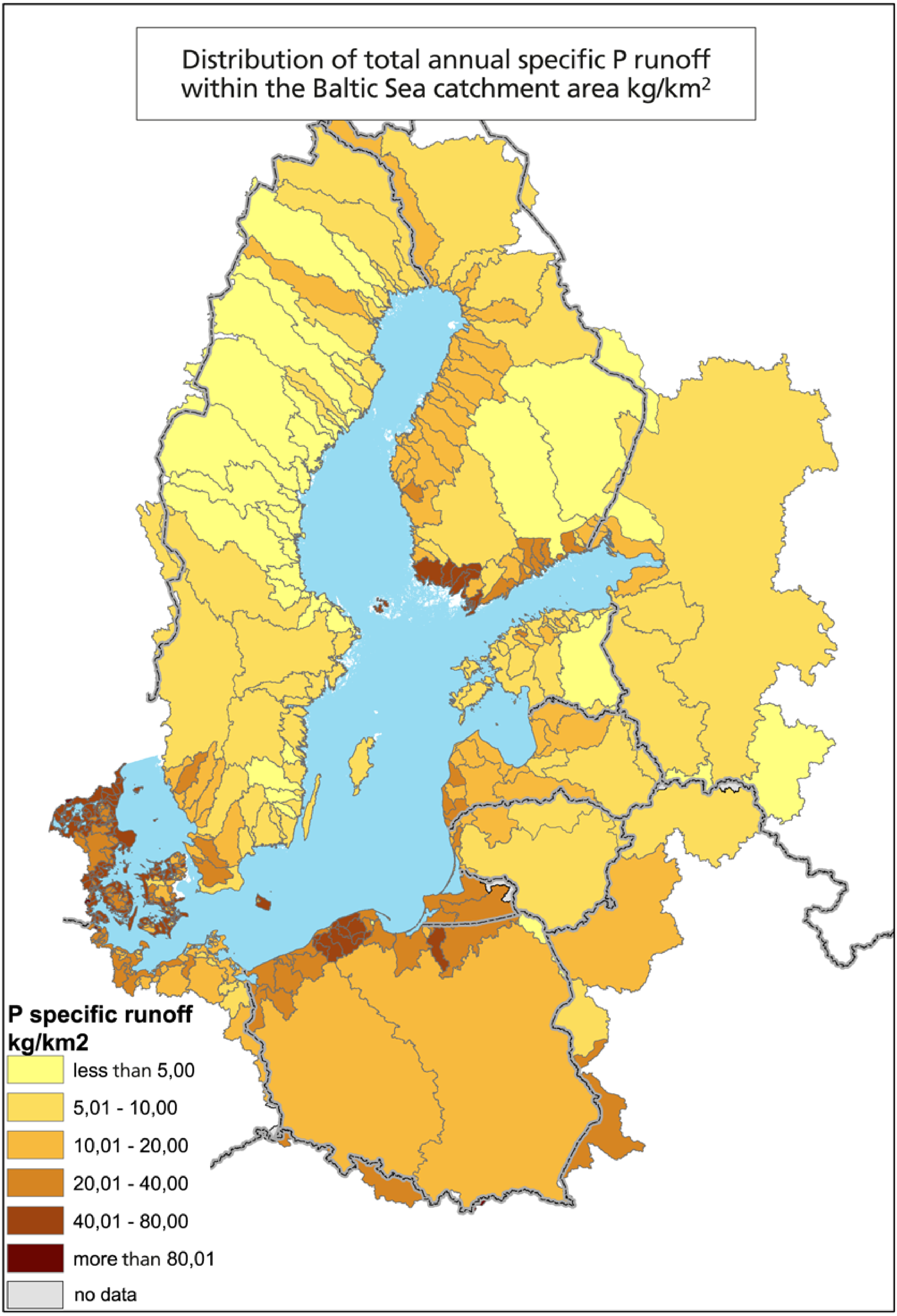

Distribution of total annual specific P runoff within the Baltic Sea catchment area kg/km2
P specific runoff kg/km2
less than 5,00
5,01 - 10,00
10,01 - 20,00
20,01 - 40,00
40,01 - 80,00
more than 80,01
no data

Figure 57

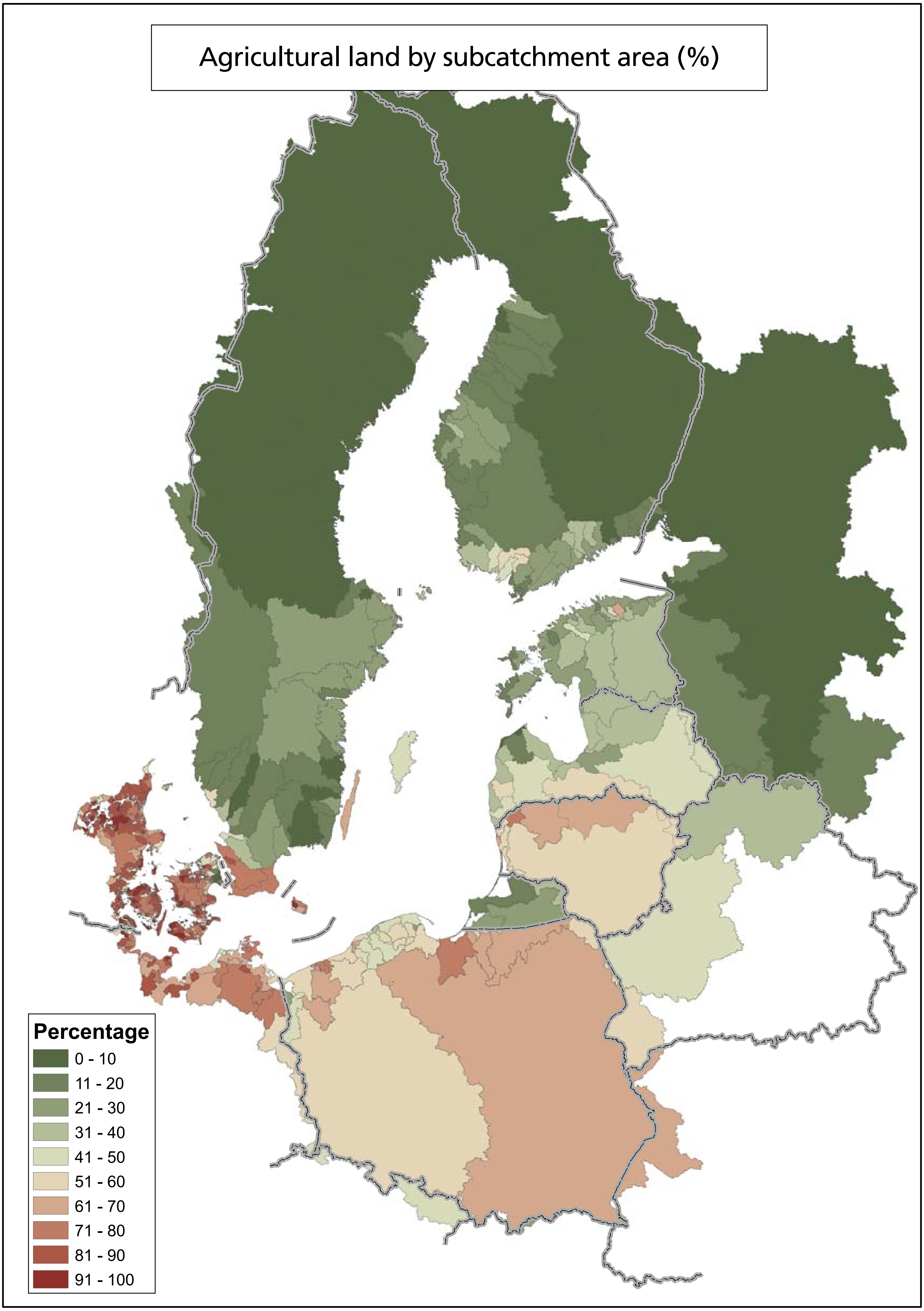

Agricultural land by subcatchment area (%)
Percentage
0 - 10
11 - 20
21 - 30
31 - 40
41 - 50
51 - 60
61 - 70
71 - 80
81 - 90
91 - 100

Figure 58

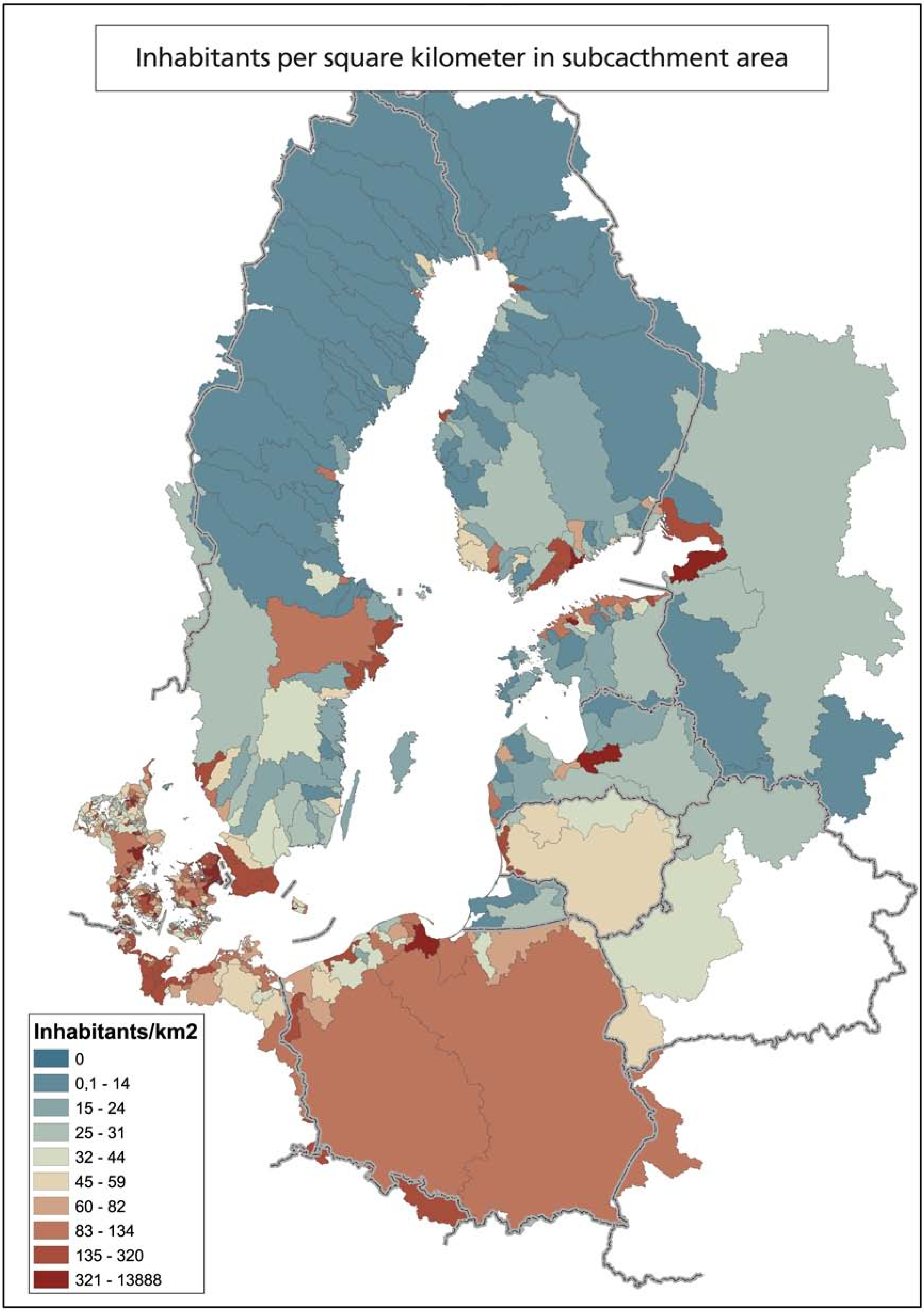

Inhabitants per square kilometer in subcacthment area
Inhabitants/km2
0
0,1 - 14
15 - 24
25 - 31
32 - 44
45 - 59
60 - 82
83 - 134
135 - 320
321 - 13888

Figure 59

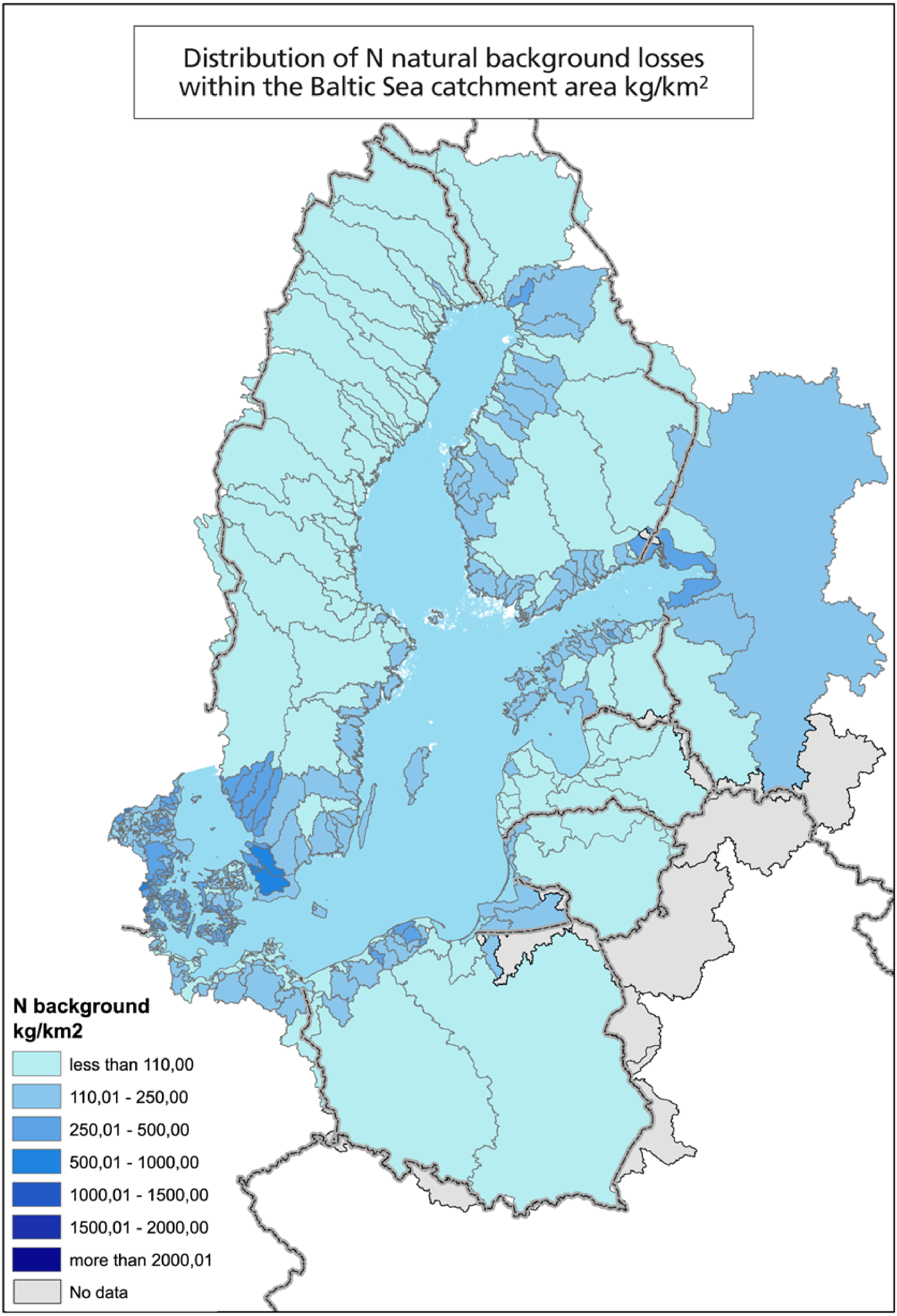

Distribution of N natural background losses within the Baltic Sea catchment area kg/km2
N background kg/km2
less than 110,00
110,01 - 250,00
250,01 - 500,00
500,01 - 1000,00
1000,01 - 1500,00
1500,01 - 2000,00
more than 2000,01
No data

Figure 60

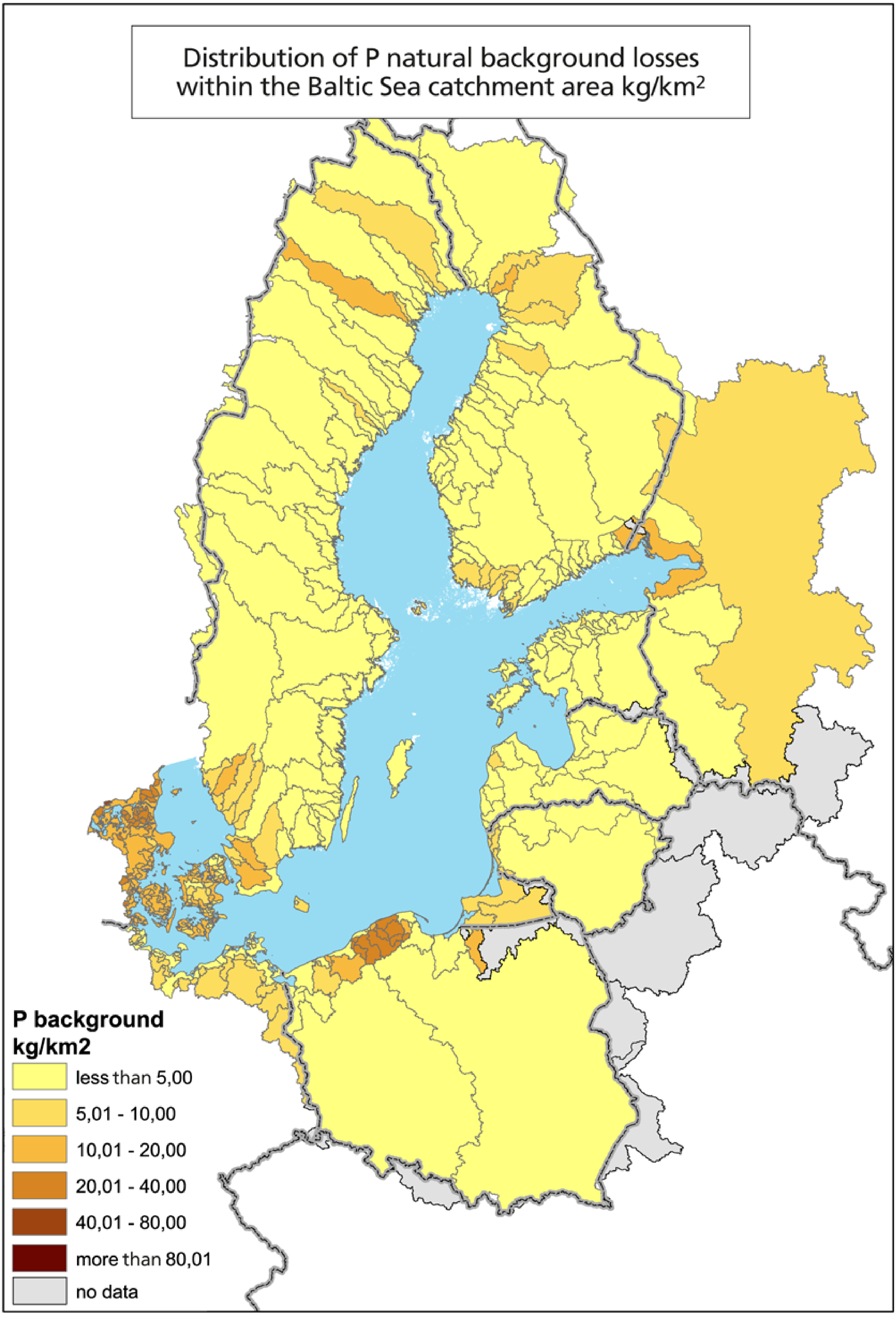

Distribution of P natural background losses
within the Baltic Sea catchment area kg/km2
P background
kg/km2
less than 5,00
5,01 - 10,00
10,01 - 20,00
20,01 - 40,00
40,01 - 80,00
more than 80,01
no data

Figure 61

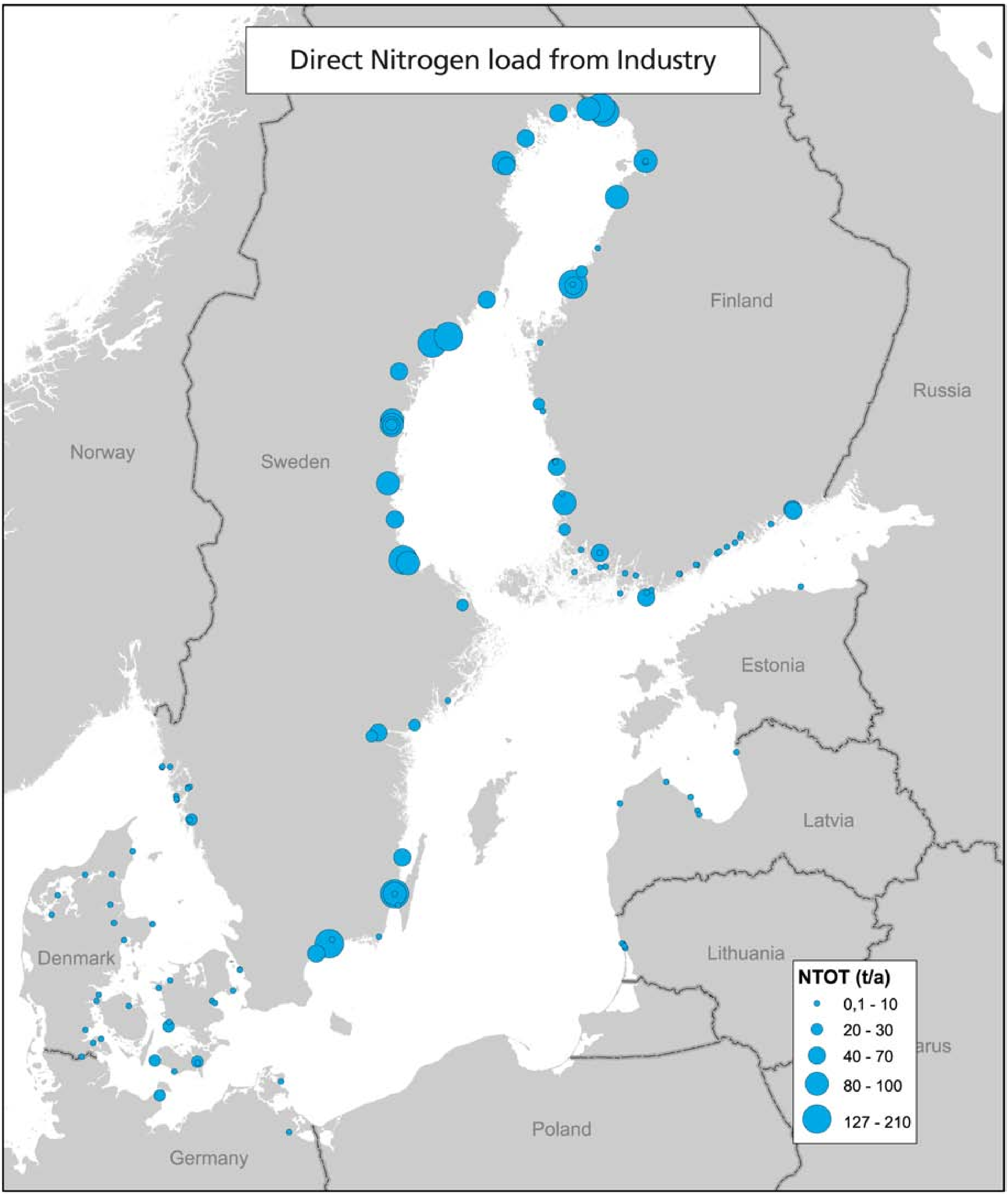
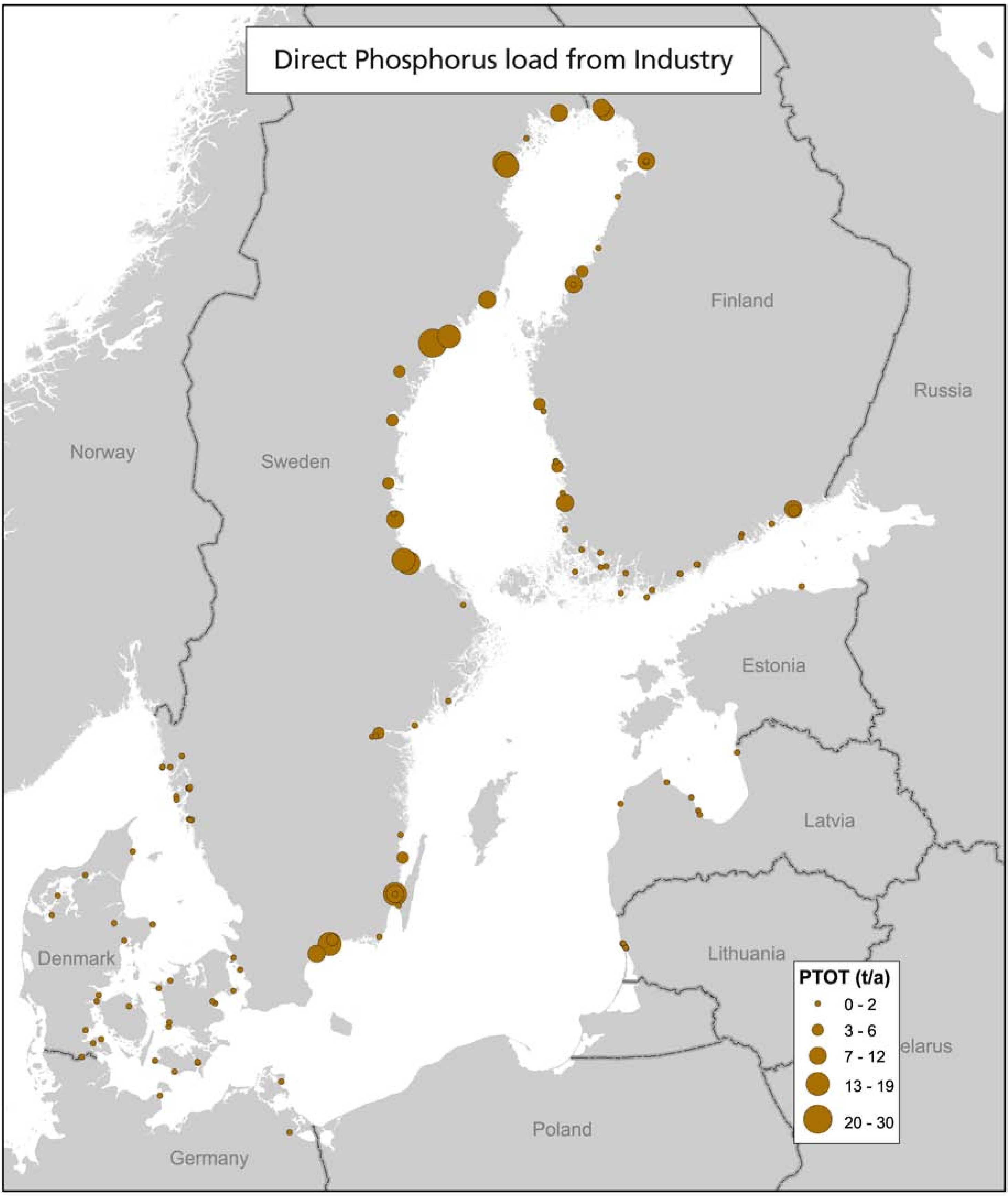

Direct Nitrogen load from Industry
Finland
Russia
Norway
Sweden
Estonia
Latvia
Lithuania
Denmark
Poland
Germany
NTOT (t/a)
0,1 - 10
20 - 30
40 - 70
80 - 100
127 - 210

Figure 62



Direct Phosphorus load from Industry
Norway
Sweden
Finland
Russia
Estonia
Latvia
Lithuania
Denmark
Germany
Poland
elarus
PTOT (t/a)
0 - 2
3 - 6
7 - 12
13 - 19
20 - 30

Figure 63

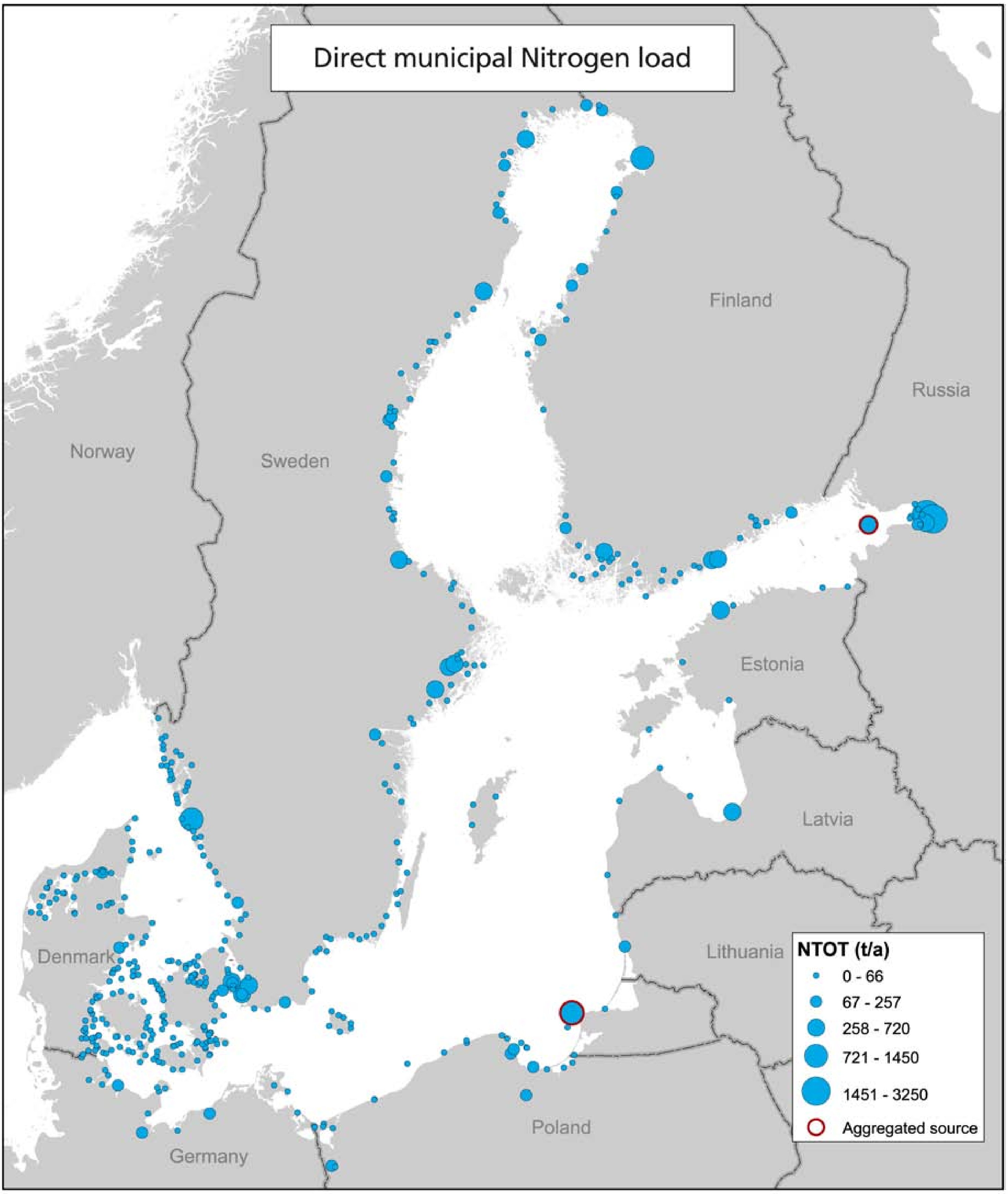

Direct municipal Nitrogen load
Finland
Russia
Norway
Sweden
Estonia
Latvia
Lithuania
Denmark
Poland
Germany
NTOT (t/a)
0 - 66
67 - 257
258 - 720
721 - 1450
1451 - 3250
Aggregated source

Figure 64

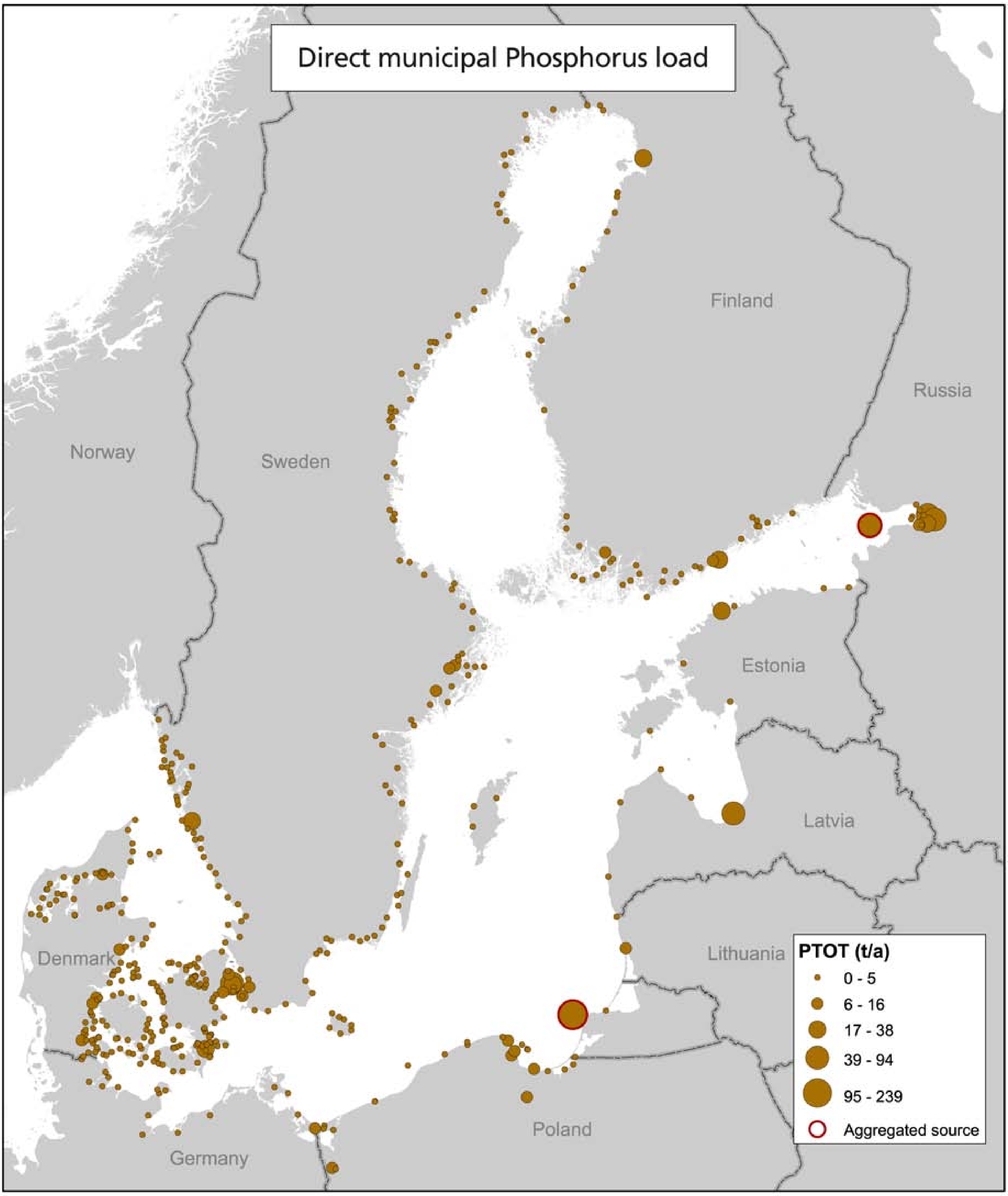
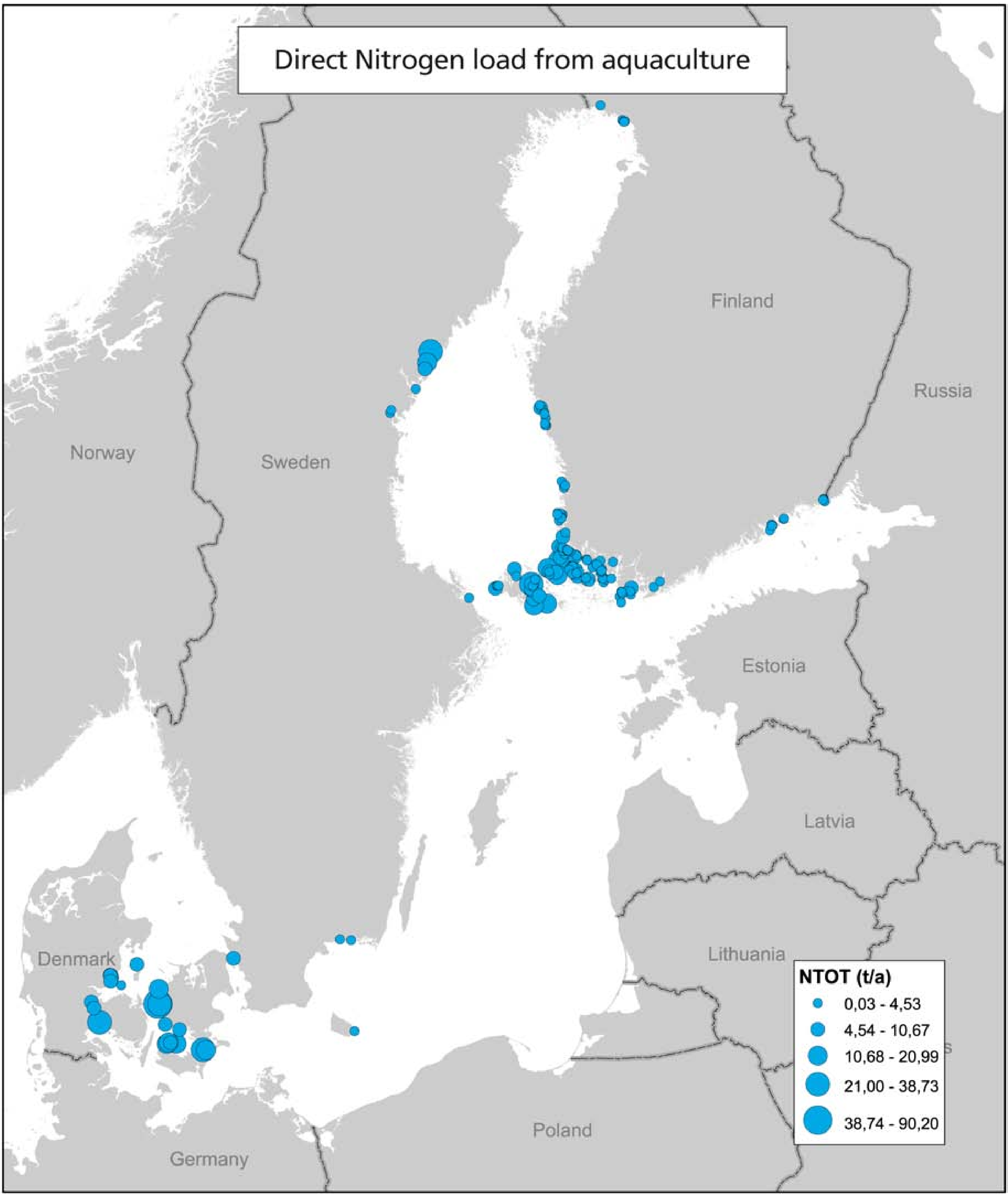


Figure 65 NOTE! Only municipal waste water treatment plants larger than 2000 PE were reported by Estonia.



Direct Nitrogen load from aquaculture
Finland
Russia
Norway
Sweden
Estonia
Latvia
Denmark
Lithuania
Poland
Germany
NTOT (t/a)
0,03 - 4,53
4,54 - 10,67
10,68 - 20,99
21,00 - 38,73
38,74 - 90,20

Figure 66

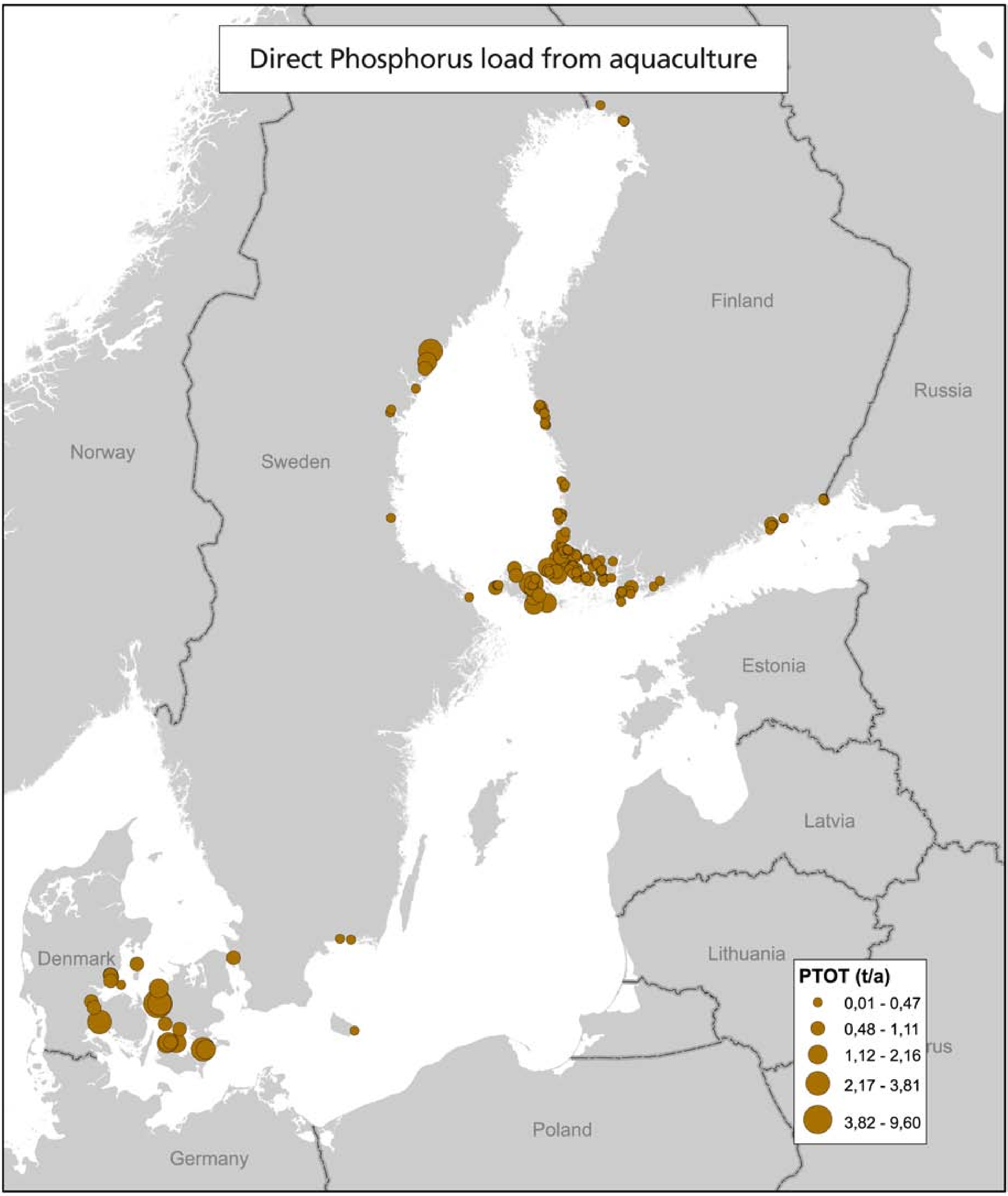
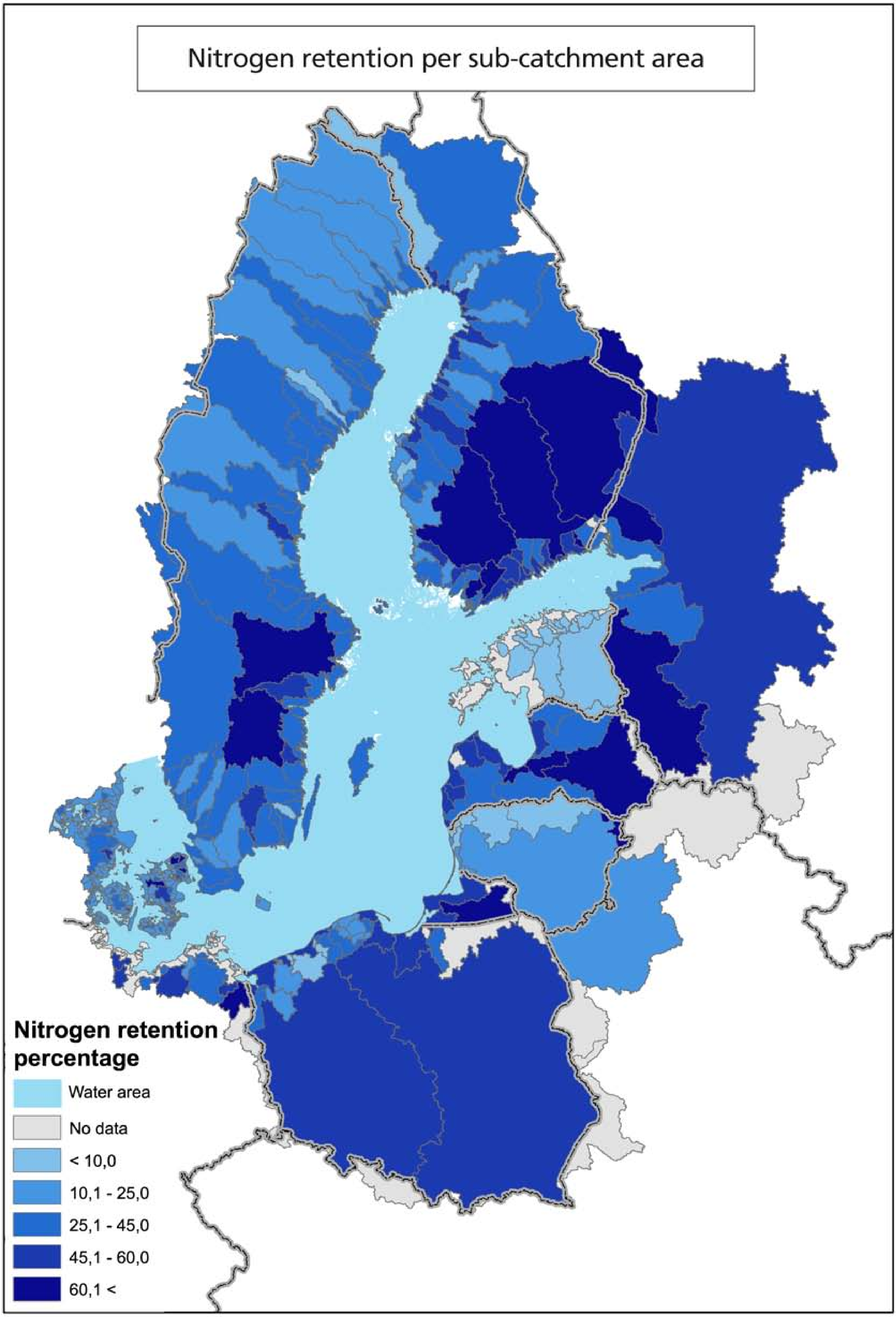
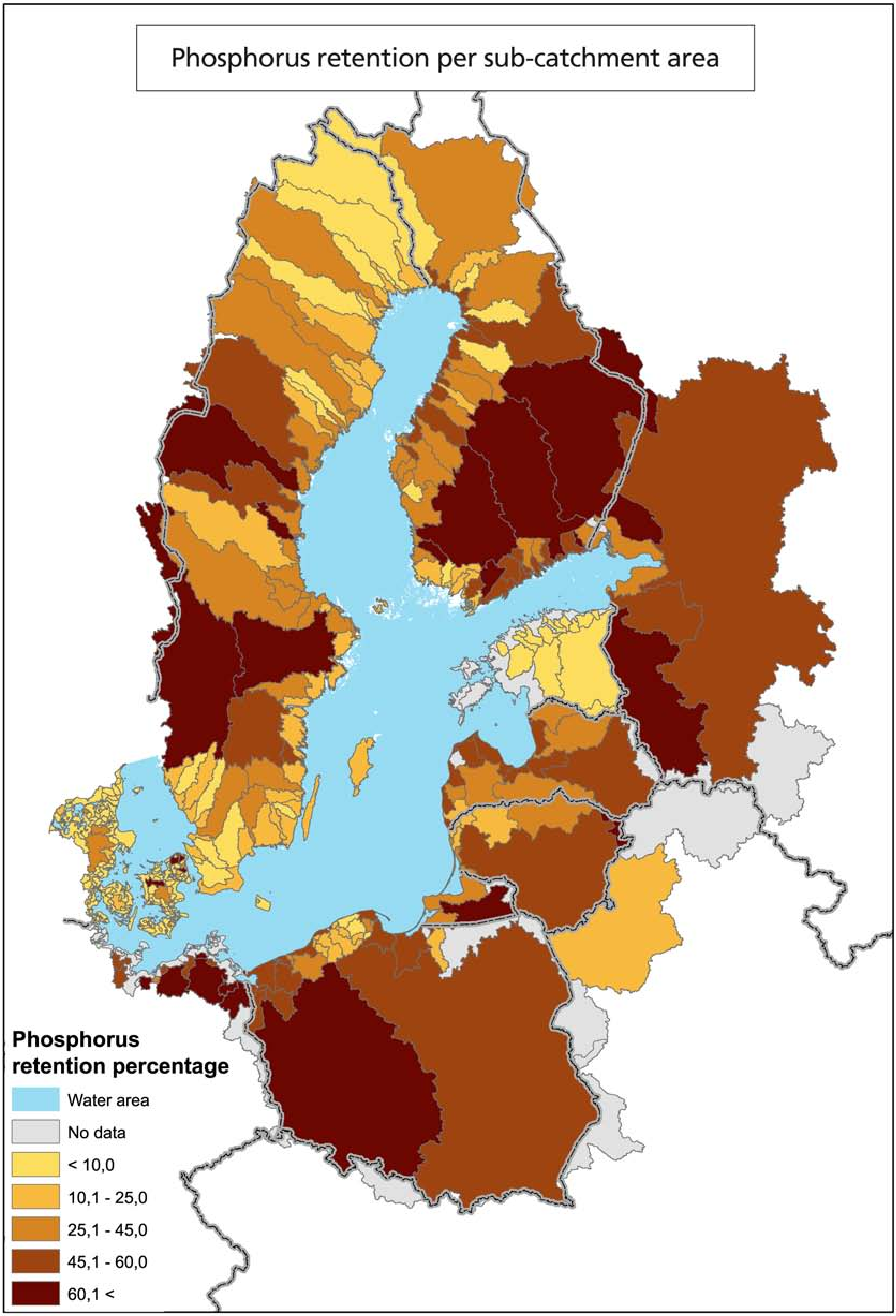

Direct Phosphorus load from aquaculture
Finland
Russia
Norway
Sweden
Estonia
Latvia
Denmark
Lithuania
PTOT (t/a)
0,01 - 0,47
0,48 - 1,11
1,12 - 2,16
2,17 - 3,81
3,82 - 9,60
Poland
Germany

Figure 67



Nitrogen retention per sub-catchment area
Nitrogen retention percentage
Water area
No data
< 10,0
10,1 - 25,0
25,1 - 45,0
45,1 - 60,0
60,1 <

Figure 68



Phosphorus retention per sub-catchment area
Phosphorus retention percentage
Water area
No data
< 10,0
10,1 - 25,0
25,1 - 45,0
45,1 - 60,0
60,1 <

Figure 69

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