OSPAR EMO-RID riverine database: a description

version 6

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by

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1 CONTENTS

EXECUTIVE SUMMARY

The EMO-RID database is constructed with the specific aim to create an input database for marine ecosystem modelling of daily flow and nutrient load values that adheres to the officially reported loads in the OSPAR RID database (version of **2024-03-14**). This daily database will be used in the forthcoming modelling exercises within OSPAR HASEC to support the work on eutrophication. The procedure to derive the daily database is described below in detail. Contracting Parties are expected to carefully read the main procedure description (Section 2, Section 4) and the country specific information (Section 5) relevant to them. Approval is mainly sought on the following decisions:

I. To fill in gaps in the reported RID data using the mean of reported years for missing values, per country, area and compound.
II. To use the average of the reported lower and upper values if the mean has not been reported. If only an upper or lower value has been reported that value will be used as the annual reported load.
III. To adjust averaged values reported for Total N to the upper reported value if the averaged values are lower than the combined value of the annual NO_3 and NH_4 loads. These instances can occur when not all of these compounds have a lower and upper value.
IV. To adjust averaged values reported for Total P to the upper reported values if the averaged values are lower than the reported annual PO_4 loads. These instances can occur when not all of these compounds have a lower and upper value.
V. To re-assign 5% of the riverine flow within an aggregated area to that aggregated area (for use with the direct discharges and unmonitored area loads) if no residual discharge is available for that area for that year. This flow will be subtracted from the annual riverine flow in the affected area.
VI. To use a normalised seasonal signal for the unmonitored areas, to be derived from the largest reported river within the area. If no rivers are reported within the area a constant distribution over the year is applied. Direct discharge loads are not provided with a seasonal signal.
VII. To fill in gaps in the RID records for flow (Table 9), riverine loads (Table 6a) and unmonitored area loads (Table 6b).
VIII. To **not** fill gaps in the RID records for direct discharge loads (Table 5e, containing sewage, industrial, aquaculture and other direct discharges).
IX. To use E-HYPE 4.0 coastal areas (SMHI, Sweden) for distribution of the direct discharges and unmonitored area loads along a countries coastline. This will be applied for all countries involved except Denmark, which will supply daily flow and loads from the simulations underlying their RID reporting. The spatial scale of this work is similar to that of the E-HYPE 4.0 areas.

If countries do not agree with the used daily flow stations for their rivers, as listed in the country-specific sections in the appendix, then they can supply daily flow data (covering as long a time span as possible but at least 2014-2020) as substitute data. The EMORID database is available at https://dataportal.nioz.nl/doi/10.25850/nioz/7b.b.th

1 INTRODUCTION

The EMORID riverine database for ecosystem modelling has been constructed with the express aim to create a database with daily flow and load values that adhere to the reported loads per river, area and country as are reported to the OSPAR RID database. It is based as far as possible on the annual data included in OSPAR RID, augmented with daily flow data and nutrients not reported to OSPAR when possible. The RID database consists of the following tables of importance for this work, provided here for reference:

Table 1.1: RID tables with relevance to the described work.

TABLE	CONTAINS
AREA	List of rivers and aggregated areas
TABLE 9	Area information including flow rates
TABLE 5A	Sewage effluents
TABLE 5B	Industrial effluents
TABLE 5C	Aquaculture discharges
TABLE 5D	Other discharges
TABLE 5E	Total direct discharges
TABLE 6A	Riverine discharges (monitored rivers)
TABLE 6B	Unmonitored area discharges
TABLE 6C	Total riverine inputs (rivers and unmonitored areas)

Within the RID database annual values are reported for individual rivers (Table 6a) and for coastal areas (as designated by each country) for direct discharges (Table 5e) and unmonitored areas (Table 6b). These coastal areas should together cover the entire coastline of a country and are referred to here as aggregated areas. They can encompass none, one or multiple rivers. The aggregated areas can be based on provincial delineation (e.g. Spain), on reporting duties (e.g. UK using PARCOMS areas), on riverine boundaries (e.g. Netherlands) or on model grid (e.g. Denmark). There are further levels of aggregation within the RID database, but only the spatially most fine scale level is used in construction of the EMOPRID database. The coastal areas have flow reported for them in Table 9 of the RID database. If these flow values are equal to the sum of the flow values reported for the rivers within the area then there is no residual flow for that area associated with the reported direct discharges and unmonitored areas loads.

Nutrients included in the ICG-EMO database whenever available are:
NH_4, NO_3, TotalN, PO_4, TotalP, SPM, Si, Fe, NO_2, TALK, DIC, DOC, TOC, POC

Nutrients included in the RID database are:
NH_4, NO_3, TotalN, PO_4, TotalP, SPM

Of the nutrients not included in the RID database that are important for ecosystem modelling silicates are the most important (Si), as this is a required nutrient for diatoms in many ecosystem models. The depletion of silicates usually ends the diatom spring bloom, allowing flagellates to take over. Iron is used by some models as a trace element that can limit growth, though this nutrient is usually not limiting in coastal seas due to high inputs from land. When nutrients not included in RID reporting are available for a certain river they are copied from the ICG-EMO riverine database and scaled according to annual flow values differences.

This report refers to the RID database of **14-03-2024**, as downloaded from the NIBIO github website (https://gitlab.nibio.no/Csilla/rid_database).

1.1 RIVERS INCLUDED IN THE DATABASE

Only rivers listed in table *Area* of the RID database are included in the EMO-RID database, as long as values are available in Table 6a for them.

Daily riverine discharge data is not reported to OSPAR, and the flow values in the RID database (Table 9) are usually derived from the nutrient monitoring (usually monthly). As such, daily flow values need to be located for all reported rivers, in order to preserve the seasonal signal and spread reported loads out over the years. The appendix to this report lists which daily flow stations are used to provide the seasonal signal for each country. As the actual daily flow values are scaled to the reported annual flow for each river, the location of the daily flow station is off minor importance, though if possible the last tidal gauge station is used (last station before the river becomes influenced by the marine environment). However, if a daily flow station is far upstream it will not reflect the seasonal signal from that rivers' catchment area very accurately, as it will represent only a small part of its catchment.

1.2 Distributing direct discharges

Rivers have known locations of entry into the marine environment. In order to use direct discharges as input for the modelling it is necessary that they have a similar point of entry. As direct discharges and unmonitored areas are usually reported over large, aggregated areas (e.g. NO Norwegian Sea) a finer scale division is necessary to spread the reported load along the reported coastline. To this end coastal areas from E-HYPE 4 were used (European application of the HYPE model, SMHI), as supplied by SMHI, Sweden (see Donelly et al, 2016 and https://hypeweb.smhi.se). E-HYPE covers the whole of Europe and is a hydrological model, providing a scientific background to the choice of coastal release points of the direct discharges. See Figure 1.1 for an overview of the applied E-HYPE coastal areas.

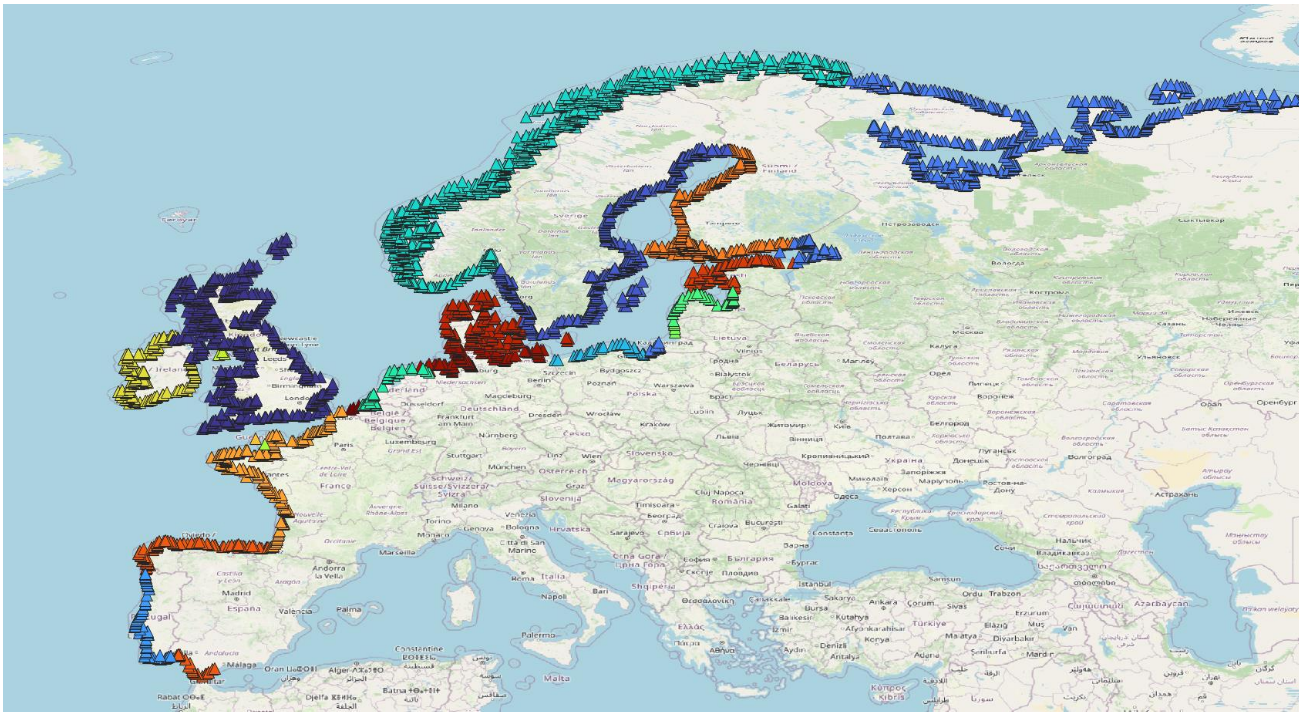

Figure 1.1: coastal areas from E-HYPE 4, coloured by country.

The number of E-HYPE areas per country differs with the length of its coastline (Table 1.2). Iceland is not included in E-HYPE 4.0 but as Iceland has no reported direct discharges or unmonitored areas this is not important at this stage. Areas can be added by hand if Iceland starts to report these loads.

Table 1.2: number of rivers and E-HYPE 4.0 coastal areas per included country.

Country		# rivers	# E-HYPE areas
BE	Belgium	7	1
DE	Germany	33	91
DK	Denmark	158	305
EE	Estonia	15	70

ES	Spain	50	101
FI	Finland	27	198
FR	France	38	154
IRL	Ireland	18	147
ISL	Iceland	2	0
LT	Lithuania	3	4
LV	Latvia	10	31
NL	Netherlands	4	34
NO	Norway	10	803
PL	Poland	1	30
PT	Portugal	2	1
RU	Russia	13	50
SE	Sweden	42	318
UK	United Kingdom	37	479
EMORID	**Files in database**	**470**	**2817**

1.3 Availability

The EMORID database of daily flow and nutrients loads covers all reported rivers and direct discharge areas as reported to OSPAR and HELCOM by individual countries. Derived via the proceedings described in this document it contains 470 riverine files and 2817 direct discharge files, and spans the period 01-01-1990 to 31-12-2022. The EMORID database is available via the NIOZ Dataverse portal via its doi: 10.25850/nioz/7b.b.th

https://dataportal.nioz.nl/doi/10.25850/nioz/7b.b.th

The data files are available as one large zip file but are also downloadable per country. In additional this report and the associated appendix are available there, as is the overview of how the Danish FV4 areas were linked to E-HYPE 4.0 areas and existing rivers.

2 Procedure

To create a RID compliant daily flow and load riverine database for ecosystem modelling, a number of assumptions have been made. These are due to the different objectives of the RID annual database compared to the new EMO-RID daily database. The modelling requires continuous time series for discharge and loads as input for the different models, and as such needs an annual RID value for each river, year and compound. Unfortunately, the RID database is not complete.

Actions to complete the RID database

1. Missing annual flow values (blanks, NI, 0 entries) in the RID database are replaced with the mean of the reported values between 1990 and 2020 (per river, per country). Not using the whole RID time span 1989-2022 is due to suspected errors in some of the 2022 data (FR) and the low amount of data available for 1989.
2. Missing annual nutrient values (blanks, NI, 0 or not included years) are replaced with the mean of the reported values between 1990 and 2020 (per river, per country, per nutrient) for Table 6a (riverine) and Table 6b (unmonitored areas). Missing nutrient values in Table 5e (total direct discharges) are not filled, as the sources of these discharges (sewage, industrial, aquaculture, other) is not assumed to be continuous.

3. If a nutrient has no mean annual value but only a lower and an upper annual value, then the mean is calculated as (lower + upper)/2.0, due to lack of information. If only a lower or upper value is included in the database then the mean is taken as that value.
4. If no mean is available and the average of the lower and upper value is used for Total N, this value is compared with the associated reported values for NO_3 and NH_4. When the averaged value for Total N is found to be lower than the combined value of NO_3 and NH_4 only the upper value is used for Total N. See Figure 2.3 for an example of the RID data underlying these actions.
5. If no mean is available and the average of the lower and upper value is used for Total P, this value is compared with the associated reported value for PO_4. When the averaged value for Total P is found to be lower than the reported value for PO_4, then only the upper value is used for Total P.
6. Per aggregated area (direct discharges, unmonitored areas) per year a residual flow is calculated by taking the original area flow and subtracting all original riverine flow in that area from it. Any remaining flow is listed as the area flow for that unmonitored area. If the residual flow is ≤ 0 then 5% of all riverine flow in that area is selected for the unmonitored area flow for that year. The discharge values for the rivers in that area are reset to 95% of their original flow for that year. Whether this fall back option is invoked or not can change between years for any given area. Here original data refers to the data as it is in the RID database, without filling in any missing data.
7. If there are no rivers in an aggregated area (used for direct discharges and unmonitored areas) then the average of the years with positive residual flow data is used.

Results from filling in the RID database

1. With no gap filling for Table 5e (direct discharges) there can be 0 direct discharges for unreported years for countries that do not report unmonitored areas. These countries are Belgium, Iceland, the Netherlands, Portugal, Spain and the UK. In those cases, for those countries and those years, loads will be limited to their riverine inflow points.
2. Using (lower + upper)/2.0 for the mean when there is no mean reported can result in a large error both under or above the real mean value, as the lower and upper values may only have occurred for a short time, and give no information on actual day to day variation of the river or area, and thus on the mean value.
3. The corrections applied per day per river/area and nutrient, as listed above, can result in EMORID database loads that are higher than the reported RID loads (Figure 2.4). This is unavoidable given the patchy RID reporting in places, but usually occurs before 2014 (agreement 04.14 of the RID principles determining the submission of a single value, rather than lower and upper estimates). Applying the procedure as outlined above adheres to the precautionary principle that when there is doubt the highest reported loads are used.

Actions to create daily flow and load files

To create riverine files the following procedure is followed **per country per river**. See Figure 2.1 for a schematic overview.

1. Daily flow data is read for each river listed with annual data in RID Table 6a (rivers), when available
2. Gaps in the daily flow data are filled using linear interpolation (gaps ≤ 50 days) and climatologies (gaps > 50 days, using linear interpolation for 1 week between the observations and the climatology at the start and end of the gap period)
3. Gaps in the RID database Table 6a are filled
4. Gaps in the RID database Table 9 (flow rates) are filled
5. Annual discharge is read from RID Table 9 (area information)

6. Annual loads are read from the filled RID Table 6a (rivers)
7. The daily flow data is normalised
8. The annual discharge data (per year) is multiplied with the normalised daily flow data
9. The annual load data (per year, per nutrient) is multiplied with the normalised daily flow data
10. The daily discharge and loads are written to file

To create the direct discharge files the following procedure is applied **per country per aggregated area.** The number of aggregated areas per country is determined using the level indicator and occurrence of data in Tables 5e and 6b. See Figure 2.2 for a schematic overview of the procedure.

1. Gaps in RID Table 9 are filled
2. Gaps in RID Table 6b (unmonitored areas) are filled
3. Annual residual flow is calculated per reporting area, if ≤ 0 then 5% of the river flow in that area is used
4. Annual loads are read from RID Table 5e (total direct discharges) and filled Table 6b (unmonitored areas)
5. Daily flow data for all the rivers in the area is read and stored, as are their river mouth locations from the ICG-EMO riverine database
6. The daily unmonitored area flow is taken as the normalised flow from the nearest area river
7. The daily direct discharges flow is taken as a normalised flow spread equally across the year
8. The annual unmonitored area load (Table 6b) is multiplied with the normalised daily unmonitored area flow data
9. The annual direct discharge load (Table 5e) is multiplied with the normalised daily direct discharge flow
10. The daily residual flow is taken as the combined direct discharges and unmonitored area flow, multiplied the annual residual flow value
11. The resulting daily residual flow and daily combined loads are spread equally over all E-HYPE areas within the aggregated area
12. The daily discharge and loads are written to file, 1 file for each E-HYPE area within the aggregated area

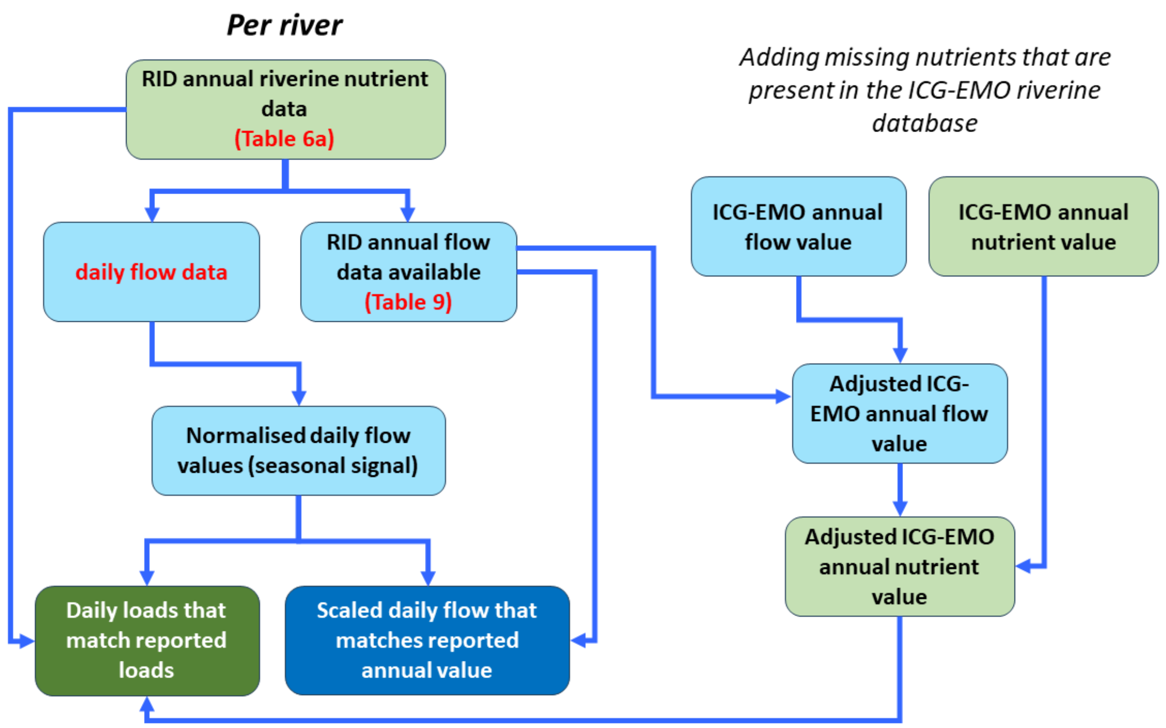

Figure 2.1: Schematic representation of the procedure to derive daily flow and load values for reported rivers. Note that HELCOM data is treated in the same way.

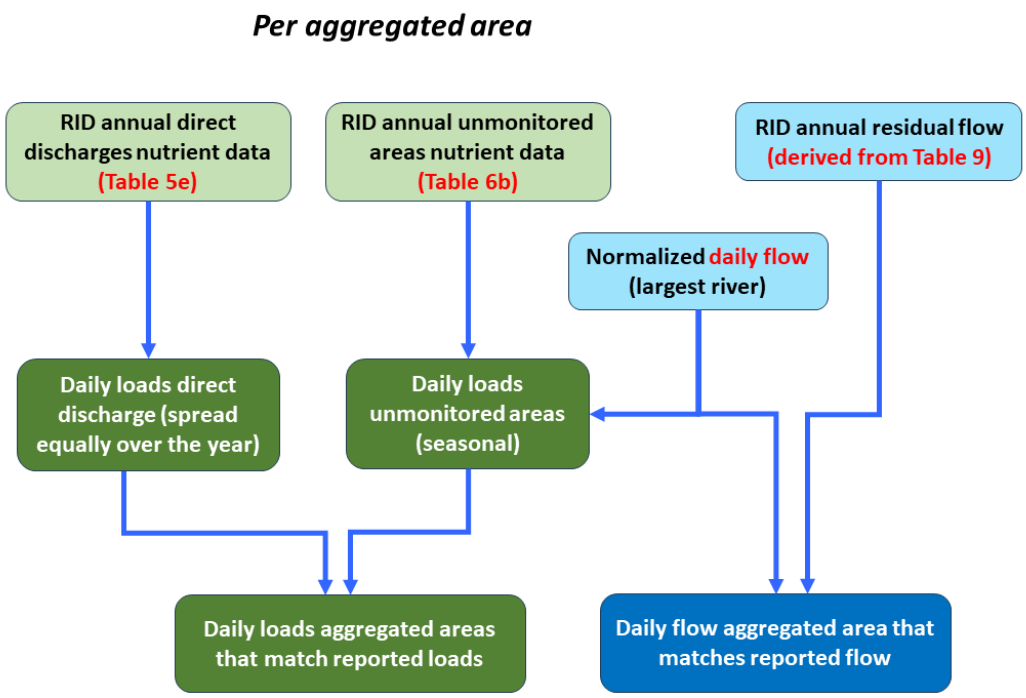

Figure 2.2: Schematic representation of the procedure to arrive at daily flow and load files for the aggregated areas, which represent both the direct discharges and unmonitored areas here. Note that HELCOM data is treated in the same way.

Risle

country	year	Input_Tab	areaID	determ	lower_s	lower	upper_	upper	mean_s	mean
France	2018	6a	10	NH4 8		0.013		0.014		
France	2018	6a	10	NO3 9		4.32		4.32		
France	2018	6a	10	TotalN 11		2.011		4.777		

Figure 2.3: Example of mismatch between lower and upper values for a particular river for a particular year. Here, the mean value for TotalN (determinant ID 11) will be much lower than the mean for NO3 (determinant ID 9), as the lower value for NO3 is likely missing. Determinant ID 8 refers to NH4, area ID 10 refers to the Risle river.

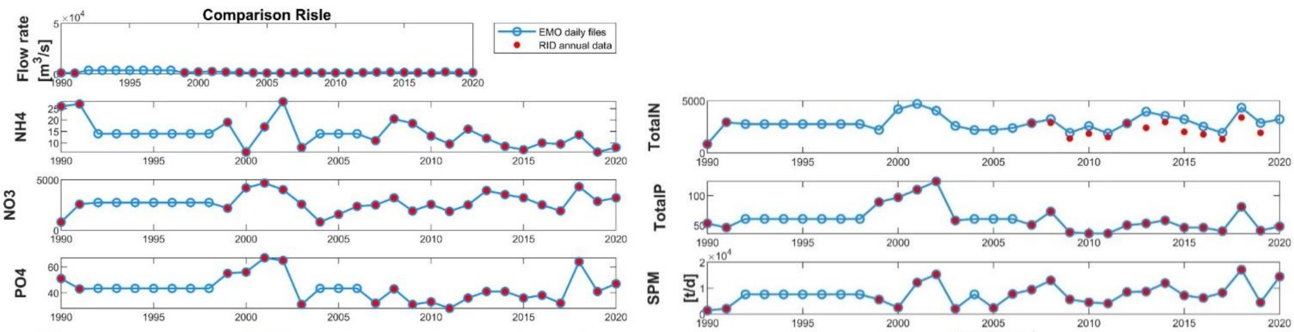

Figure 2.4: Comparison of EMORID loads (EMO daily files) and original RID loads for the French river Risle (RID ID 10). For Total N the values have been adjusted upwards to reflect the inconsistency of the Total N versus the NO3 data for this river in the RID database. The large axis range for flow is due to the unrealistically high flow value submitted for 2022.

3 HELCOM DATABASE

HELCOM data for riverine and unmonitored areas was downloaded from the HELCOM PLC database at https://nest.su.se/helcom_plc/ on 15-Dec-2023. The data covers riverine inputs and unmonitored areas for the years 1995-2021. Daily flow data was sourced where possible from the global runoff database centre (GRDC, https://portal.grdc.bafg.de) but could not be found for all reported rivers. When no daily flow data was found an equal distribution of the reported annual flow over the year was assumed. Where HELCOM areas overlapped with OSPAR areas (Kattegat) only OSPAR reported rivers and loads where used (see Figure 3.1).

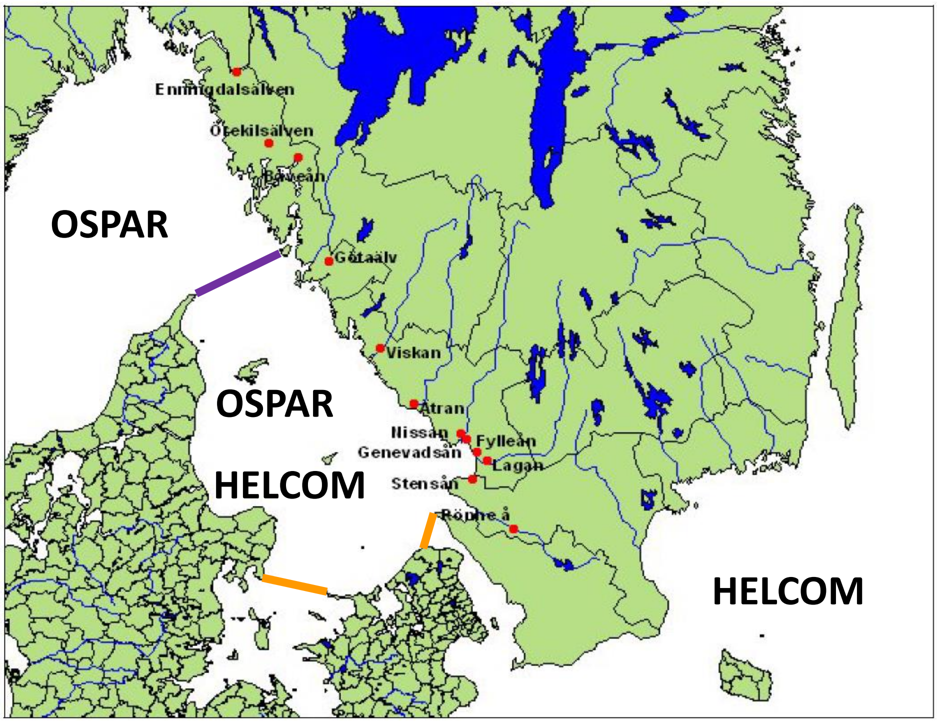

Figure 3.1: Site map showing the Kattegat region which falls under both OSPAR and HELCOM, leading to double reporting. The purple line indicates the end of the HELCOM areas while the orange lines indicate the end of the OSPAR areas. Location figure taken from Swedish RID reporting.

Unfortunately, the double reporting has led to small inaccuracies along the way: it has been noted that for some Swedish rivers the reported loads to OSPAR and HELCOM are not identical. However, the observed differences were small, in the order of 1-2 kt/y.

4 GENERAL ISSUES – RID DATABASE

To construct a daily, continuous, riverine database for ecosystem modelling it is necessary to fill in gaps in the current RID database. Within the RID database there are blank entries, 0 entries (Figure 4.1) and NI entries (No Information). Regarding tables 5 and 6 there are also missing years, that is, the complete database entry for that country, river/area, year and nutrient is not included. Table 9 (discharge) is complete in years, and shows that for discharge about 10% of the values are missing in the RID database (Table 4.1). The high amount of missing data in Tables 5 and 6 for mandatory compounds (Table 4.1) are partly due to lack of reporting in the earlier years, as well as nonreporting. For instance, the UK does not report on unmonitored areas, while France has only reported direct discharges for the years 2003, 2004, 2005 and 2009.

country	year	areaID	flowRate	LTA
Ireland	2002	6	0	1313.28
Ireland	2003	6	0	1749
Ireland	2004	6	0	
Netherlands	2004	226	0	
Netherlands	2005	222	0	
Netherlands	2005	223	0	
Spain	2003	66	0	518.4
Spain	2005	58	0	1200
Spain	2005	68	0	178
UK	2021	188	0	0
UK	2021	191	0	0

Figure 4.1: zero values for annual discharge in the RID database

Table 4.1: Missing values in the different tables, representing 0 values, NI (No Information) values, blank cells and missing (no entry line in the database) values. Table 9 (flow) is complete for years, unlike Tables 5 and 6.

Compound	Table	0 [%]	NI [%]	Blank [%]	missing [%]
NH4-N	5e	1	2	0	66
NH4-N	6c	1	0	1	44
NO3-N	5e	1	2	0	69
NO3-N	6c	0	0	1	42
PO4-P	5e	1	2	0	70
PO4-P	6c	1	0	1	43
N-Total	5e	0	0	0	63
N-Total	6c	1	0	1	45
P-Total	5e	0	0	0	63
P-Total	6c	2	0	1	44
SPM	5e	0	1	0	64
SPM	6c	0	0	1	45
Q	9	0	4	7	0

It is assumed that the annual discharge for rivers large enough to report to OSPAR RID are very unlikely to be 0. The 10% of missing flow data undermines the accuracy of the resulting EMO-RID database, as gap filling techniques are applied when (usually) observational flow data is available. It should also be noted that for the countries that report direct discharges (all except Iceland) several countries only report Total N and Total P direct discharges, and have not reported direct discharge data for NO_3, NH_4 and PO_4. These countries are Belgium, France, Ireland and Portugal. This will lead to discrepancies between nutrient input in models that use NH_4, NO_3, PO_4 only and those that use TotalN, TotalP only. However, direct discharges are expected to be small compared to riverine and unmonitored area loads.

A comparison between the different sources is given in Figure 4.2. Here EMO2020 refers to the ICG-EMO loads used in the 2020 modelling exercise, OSPAR refers to the RID database, FilledRID refers to the filled RID database and EMORID refers to the new ICG-EMO RID-compliant database. Differences vary per year per country, but here 2015 is shown as this is closest to the 2009-2014 period used in the 2020 exercise (the EMO2020 database has varying coverage for later years).

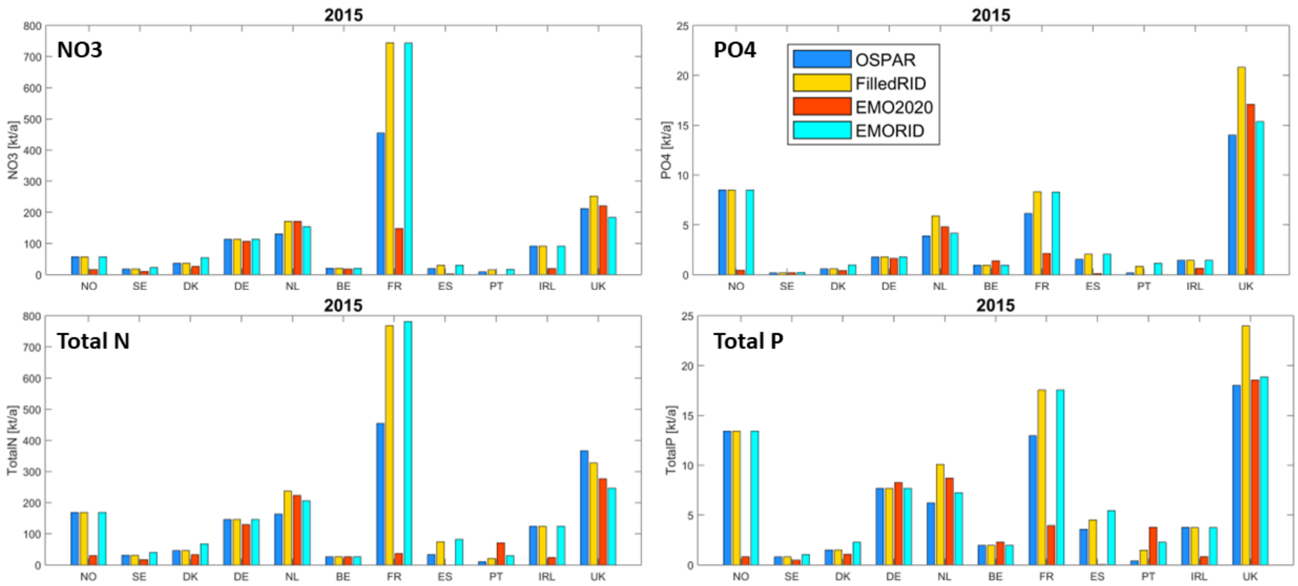

Figure 4.2: Comparison of country loads for 2015, for the original ICG-EMO database (EMO2020, used in the 2020 ICG-EMO modelling exercise) and the RID reported loads (OSPAR), the filled RID loads (FilledRID) and the new RID-compliant ICG-EMO database (EMORID).

In general the ICG-EMO loads (EMO2020, which do not include direct discharges or unmonitored areas in general) underestimate reported loads for most countries. For France and Spain the ICG-EMO database lacks many rivers reported to RID (resulting in much lower loads). Norway, Sweden and Denmark are characterised by large nutrient loads from unmonitored areas, either due to geography (Norway, Sweden) or due to high agricultural loads (Denmark). As Denmark has submitted calculated daily loads to EMORID based on their 2022 calculations their loads do not necessarily match the loads of other years, due to model improvements. For the Netherlands , Germany and Ireland the EMO2020 data set included more rivers than officially reported but no direct discharges. Dutch EMO2020 data included 18 smaller rivers no longer reported on by the Dutch INPUT delegation. As the Netherlands does not report on unmonitored areas or direct discharges (they measure nearly all their landmass) the EMO2020 NL loads are slightly higher than the reported OSPAR loads (4 rivers) and the EMORID loads (4 rivers) but lower than the FilledRID loads which fully accounts for all originally reported 26 rivers. The German EMO2020 data included a correction for unmonitored areas, resulting in only a small difference with officially reported loads (mainly the direct discharges). Irish EMO2020 loads represented more rivers, which does not compensate for the lack of unmonitored area data or direct discharge data for this country. Belgium loads are similar for all sources, with the main difference that in the EMO2020 database their largest river (the Scheldt) was constructed using Dutch data (from the estuarine part) and therefore designated as a Dutch river. For the UK the EMO2020 database includes more rivers than officially reported, and includes direct discharges and an estimate of unmonitored area loads. UK entries to the RID database are based on PARCOMS area, and as such do not represent individual rivers. As the UK does not report unmonitored areas to OSPAR currently the ICG-EMO loads are higher for this country (unmonitored areas are estimated at ~37% of the landmass for mainland UK, see Littlewood & Marsh, 2005). For Portugal the EMO2020 loads are higher than those of EMORID as it includes 8 Portuguese rivers, whereas the official RID data only includes 2 (no other discharges reported). Portuguese riverine nutrient data is sparse though, and may not represent actual loads very well.

Differences between the unfilled RID data and the filled RID data used for the presented procedure are visualised in Figure 4.3 (difference = 100%*(FilledRID-RID)/RID). Here, negative values are due to errors in the original RID database for total country loads. For example, negative UK values relate to RID entries for Table 5e (total direct discharges) that do not match the upper or lower values given, but instead are a copy of the Table 6c (total riverine) values (see Figure 4.4). As riverine loads are usually much higher than direct discharges this results in a too high load for the original RID data. The EMORID database is based on the filled RID database (no gaps remaining) and is constructed bottom up, i.e. all individual river and area loads are added up (aggregated totals are not used). The displayed FilledRID values follow the same approach, so that individual riverine or unmonitored area gaps are filled before values are added to the country total. Errors like the one shown in Figure 4.4 have been corrected before the filled RID loads were used to create the EMORID database. Countries that display negligible differences between the RID data and the filled RID data have supplied full data to OSPAR.

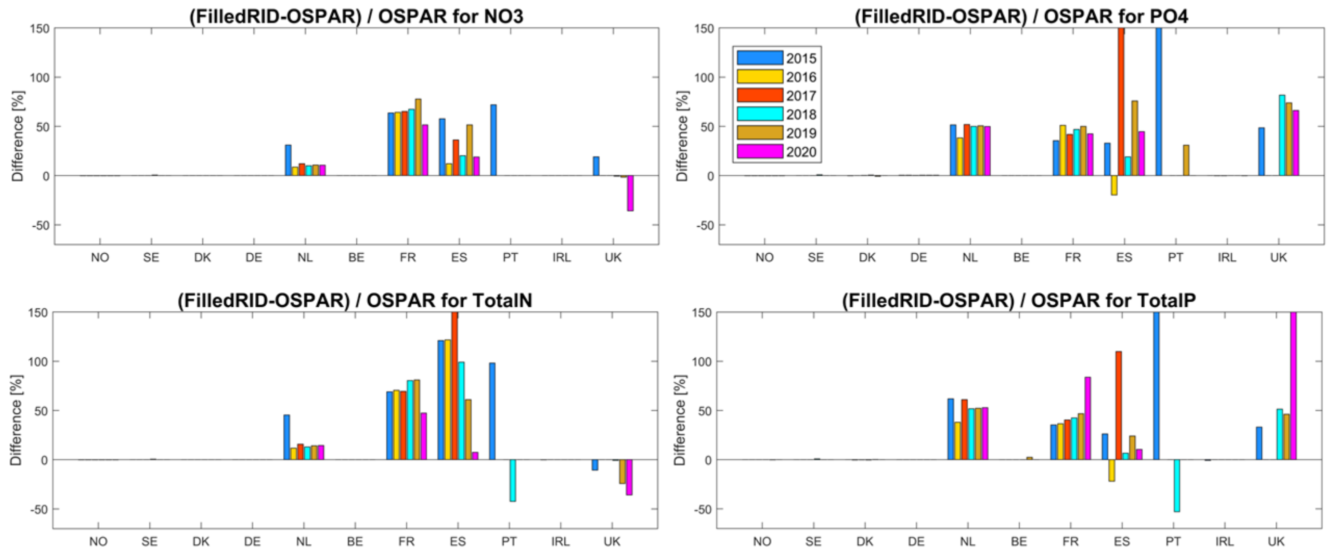

Figure 4.3: Difference between the RID data and the filled RID data used for creation of the EMORID database. The difference for the UK Total P load for 2020 is over 490%. Positive values indicate years where the filled RID load is higher than the reported RID load.

country	year	Input_Tab	areaID	determ	lower_	lower	upper_	upper	mean_	mean	comme
UK	2020	5a	99	10		0.4121218484565		0.4461218484565			
UK	2020	5b	99	10		0.00042697		0.00677697			
UK	2020	5e	99	10		0.4125488184565		0.4528988184565		8.23084993614361	
UK	2020	6c	99	10		8.22350277771626		8.23819709457097		8.23084993614361	0

Figure 4.4: example of mismatched loads for PO4 (ID 10) in the RID database. Area 99 is the country total. The mean value for table 5e is wrong.

Ideally the new EMORID database should give exactly the same values as the filled RID database. Figure 4.5 shows this is not the case. Differences arise for varying reasons.

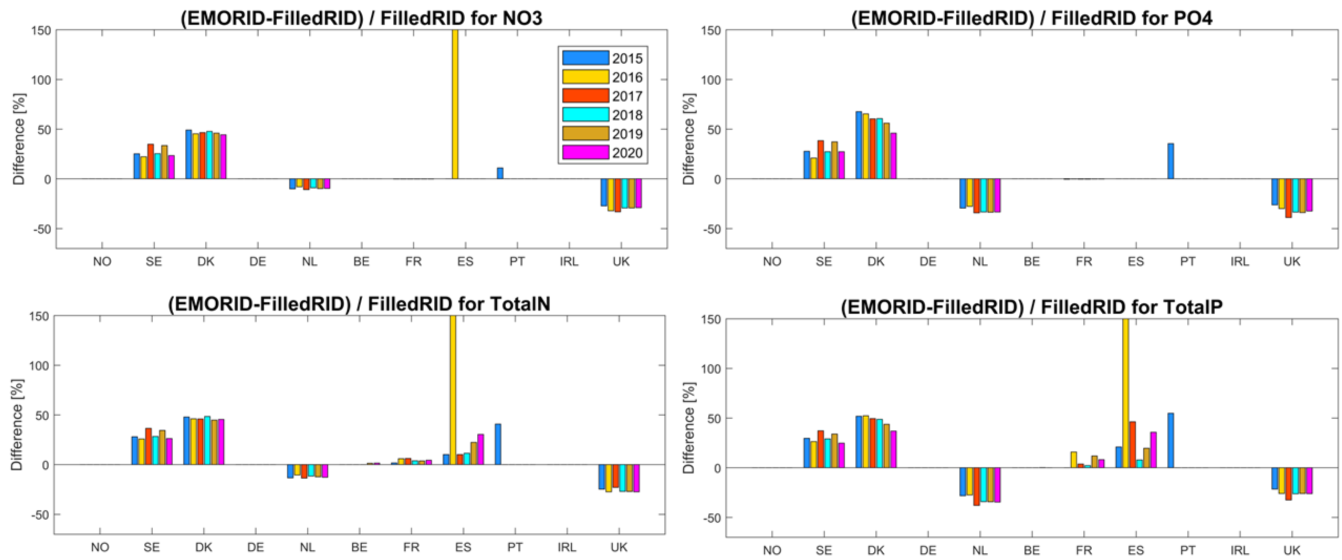

Figure 4.5: Difference between the filled RID database and the EMORID database, per year and compound.

The processing revealed several types of RID database entry errors:

- Entries in 5e that are outside of the range of the given 5e lower and upper values, but do match the (much higher) associated value in 6c
- Entries where the lower and upper values are switched
- Entries in table 6c that do not have any corresponding values in 6a or 6b
- Entries in Table 6c that doe not match the corresponding value in Table 6a in the absence of unmonitored area loads

Some examples below provide a snapshot of comparisons between the new EMORID loads (RID-compliant ICG-EMO daily files) and the reported RID loads.

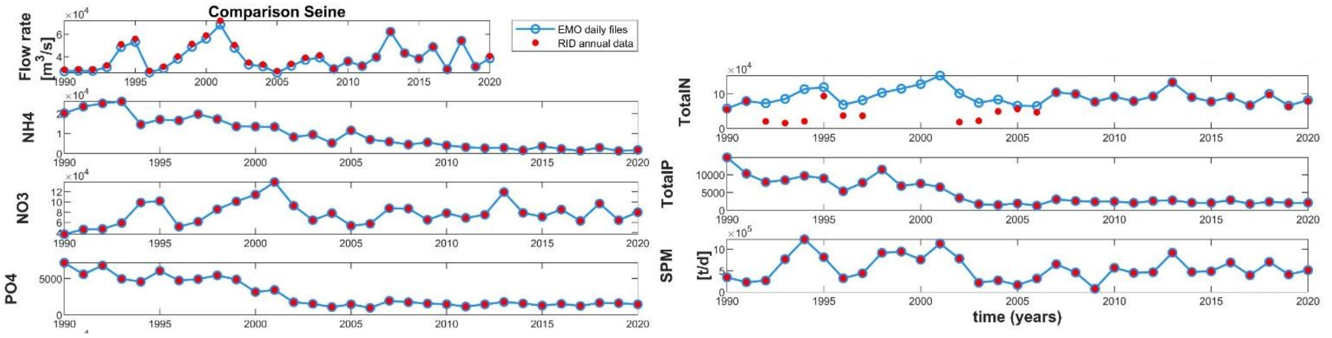

Figure 4.6: example of riverine load comparison, here for the Seine, France. Note the discrepancies in flow (using 5% of the flow for direct discharges) and Total N load (due to inconsistencies between the reported NO_3 loads and the reported Total N loads)..

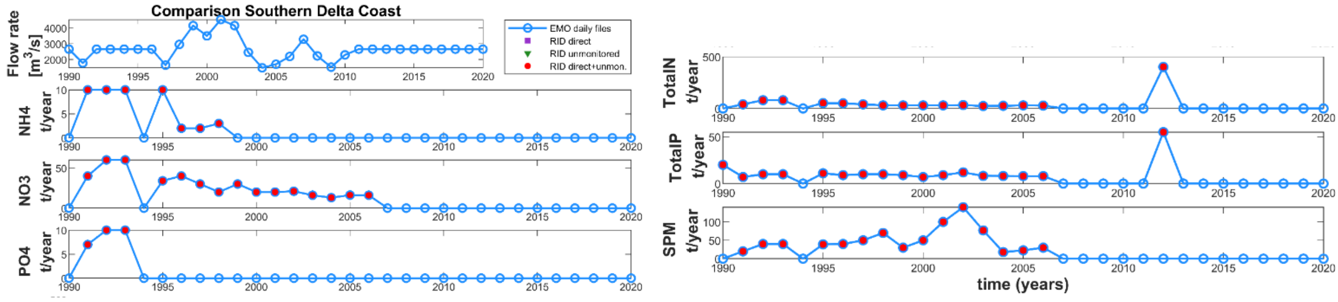

Figure 4.7: example of direct discharges, here for the Netherlands Southern Delta Coast. As the Netherlands do not report unmonitored areas the total direct discharges are 0 when no direct discharges are reported. The area does not include any reported rivers..

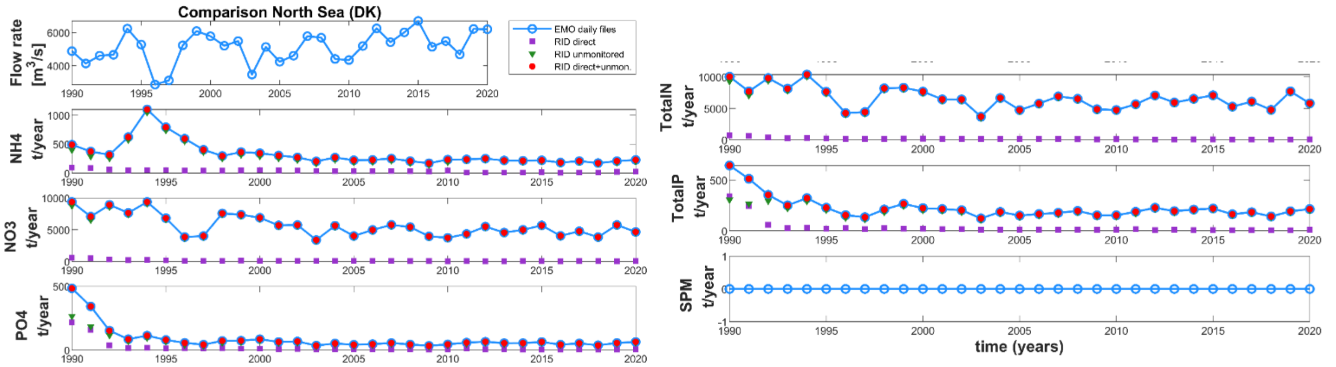

Figure 4.8: Example of direct discharge comparison for Denmark, North Sea coast. Denmark reports both direct discharges and unmonitored areas.

5 COUNTRY SPECIFIC ISSUES

5.1 BALTIC

Thie Baltic countries have been included based on the annual data reported to HELCOM and daily flow data sources from the global run-off data centre (GRFD). Sweden supplied all necessary data, while Denmark has provided daily loads for all their areas. German Baltic rivers and areas have been included on the same basis as the remaining Baltic countries, using publicly available daily flow data (Global Run-off Data Centre) and the HELCOM reported annual loads. These other countries (Finland, Russia, Estonia, Latvia, Lithuania and Poland) have no obligation to OSPAR (Russia does not report to OSPAR RID on Area I discharges) and therefore have not officially approved the EMORID database. However, their associated riverine daily load files are based on officially reported annual data for load and discharge (HELCOM database), with the daily flow data used only to incorporate a seasonal signal in the discharge and load data.

5.2 BELGIUM

Belgium applies the standard delineation between rivers and aggregated areas, except that rivers are level 3 and aggregated areas level 2. Exceptions are the Gent-Terneuzen canal and the Schelde, both of which are listed as level 2 but occur only in Tables 6a, 6c (Riverine inputs, Total riverine inputs). Belgium reports on 3 aggregated areas, but only the Western Coastal area has associated data in the RID database.

Daily flow data for Belgium was supplied the country's representative at an early stage, and does not always cover the desired period of 1990-2020. Not all listed rivers include data in Table 6a, and those who do not are therefore ignored. This applies to the following rivers:

Table 5.1: Belgium rivers for which daily flow data has not been obtained.

RIVER	FLOW STATION	RID DATA
BEVERDIJK	Grote Beverdijkvaart (Nieuwpoort)	No data in Tables 5/6
BLANKENBERGSE VAART	No station known	No data in Tables 5/6
LISSEWEGE VAART	No station known	No data in Tables 5/6
LANGELEED	No station known	No data in Tables 5/6
VLADSLO VAART	No station known	No data in Tables 5/6

5.3 DENMARK

Denmark has supplied daily data at high spatial resolution from the modelling that has generated the discharge and loads supplied to OSPAR and HELCOM. The spatial resolution of the supplied data is similar to that of the E-HYPE areas, but lacks a lat, lon position. Hence, and for reasons of similarity, all Danish areas were assigned to existing E-HYPE areas and rivers (which do have a location) which fell into their polygon (Figure 5.1). The remaining Danish areas were manually assigned a position, on the coast if applicable or in the middle of the polygon otherwise (offshore areas). Danish areas that were more inland but part of a river catchment were assigned to the associated river. Thus, loads from a Danish area were distributed (split) over all E-HYPE areas and rivers include in it, providing the E-HYPE files. Rivers could span more than 1 Danish area and all areas associated with it were added up to represent that river, including fractionation due to the presence of E-HYPE areas, providing the riverine files. A full overview of the allocations is provided in the separate excel spreadsheet DK_FV4_areas.xlsx.

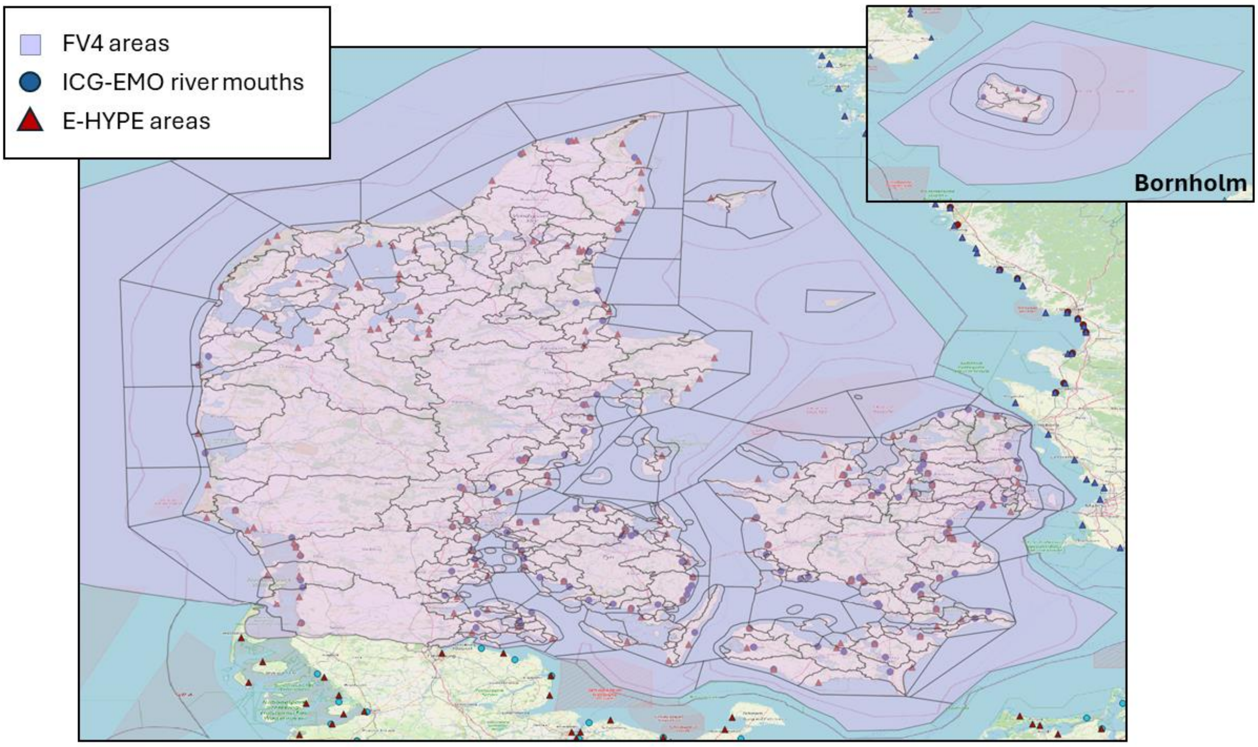

Figure 5.1: Danish FV4 areas and the used river mouth locations and E-HYPE area locations

5.4 France

France uses a higher spatial level of aggregation than other countries, resulting in 4 different levels of areas. Rivers have been chosen to represent level 4, aggregated areas have been chosen to represent level 2. Several rivers did not have any data in Tables 5 and/or 6, and so were discarded.

Issues:

- The reported annual flow values for 2022 (Table 9) are much higher than those for previous years for all rivers. This data is not used in the presented procedure, which covers 1990-2020.
- The river II-LB-NB-J1J2 is not associated with an obvious river. The river L'Urne was selected to represent this river.

Areas altered

AREA NAME	RID ID	IS A	ISSUES
II-LB-NB-J1J2	22	River	Some annual flow values present, loads present. No obvious river associated with this "river". The larger area code indicates North Bretagne, so the river L'Urne was chosen to provide daily flow values for this river

Areas not included

AREA NAME	RID ID	IS A	ISSUES
II-AP-PC-AA	1	River	Annual flow present, no entries in Table 6a at all. Discarded.
II-SN-SE-H7	9	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area

II-SN-NC-DOUVE	12	River	Annual flow values present. Only has Table 6a loads for 1989, Table 6b data present. Discarded as included in larger area (6b loads).
II-SN-SC-I6	17	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area
IV-LB-SB-J4	24	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area
IV-AG-BA-S1	37	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area
IV-AG-GD-P9	40	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area
IV-AG-GG-O9	44	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area
IV-AG-CL-S3S4	45	River	Annual flow present, no entries in Table 6a, data in Table 5e, 6b. Discarded as included in larger area

5.5 Germany

Germany adheres to the common RID standard of 3 levels of areal aggregation, but does not stick to the normal division of 0 (total country), 1 (aggregated areas for direct discharges and unmonitored areas) and 2 (rivers). Instead, level 1 represents both rivers and aggregated areas for direct discharges. The river Jade is listed only in Table 5e, so only as an area for direct discharges. Within the German RID data the aggregated areas of Jade, Eider Estuary, Ems Estuary and Weser Estuary do not have associated discharge values (RID Table 9). In order to have flow values available for the aggregated areas the German RID data was re-ordered into separate rivers and estuaries (at separate levels), with rivers assigned to the estuary area ID, and the estuaries assigned to the North Sea (DE) area. The Jade area was added to the Weser Estuary area, so that the Weser river can provide a residual flow for the area. The Elbe was added as an additional river. To represent the Elbe Estuary values listed in Table 6a (riverine loads). These changes do not affect the total loads per area or per river for German RID data.

Daily flow data for HELCOM reported rivers was requested from the German representatives but could not be delivered within the given time frame. Hence, German HELCOM rivers used flow data where available and otherwise distributed the annual flow values equally over the year (i.e. no seasonal signal). The overview of used stations on HELCOM rivers can be found in the appendix.

5.6 Great Britain

The UK uses PARCOMS areas to report both riverine discharges, direct discharges and unmonitored areas. As such, it has a higher spatial resolution in the direct discharges than most countries, and a lower spatial resolution in riverine discharges. Some PARCOMS areas are small, sometimes centred around 1 larger river (e.g. Humber Estuary, Thames), but others are spatially quite large (e.g. Scottish and Northern Ireland areas), encompassing several larger rivers. The UK does not report separately on unmonitored areas. As a result, the original ICG-EMO loads are higher than those reported to RID, as ICG-EMO does account (in a coarse way) for unmonitored areas and also includes direct discharges of sewage and industrial origin for the UK. It should be noted that the UK is by no means the only large country not reporting unmonitored areas. Crown dependencies like the Isle of man, the Channel islands and similar areas are not included here as they do not report nutrient loads to OSPAR.

There are two PARCOMS areas that consist solely of direct discharges: E4 and E7. For these areas there are only 0 values included in RID Table 9. The areas do have RID data in Table 5e so they require an associated (annual) flow for processing (most models will apply concentrations as input rather than loads). Daily flow data will provide the annual flow values here, without correction as there are no provided annual flow values in the RID database. For area E4 there was no daily flow data available at all from the National River Flow Archive. Instead, daily flow data from the river Skerne at Bradbury was used. The Skerne is a tributary to the Tees river in area E5, and is located closest to the area E4. For location of entry into the North Sea the town of Peterlee is used. Area E7 has no associated annual flow data in Table 9, and has been linked to the Gypsey Race river. Area E8 is linked to the Humber system, here represented by the river Trent.

Table 5.2: UK PARCOMS areas and associated rivers, which are used both for daily flow data and as area riverine outflow point.

GREATBRITAIN	E1	RIVER USED
GREATBRITAIN	E2	Tyne
GREATBRITAIN	E3	Wear
GREATBRITAIN	E4	Location at the town of Peterlee, data used from the Skerne at Bradbury
GREATBRITAIN	E5	Tees
GREATBRITAIN	E6	Esk at Whitby
GREATBRITAIN	E7	Gypsey Race
GREATBRITAIN	E8	Trent
GREATBRITAIN	E9	Ely Ouse
GREATBRITAIN	E10	Yare
GREATBRITAIN	E11	Chelmer
GREATBRITAIN	E12	Thames
GREATBRITAIN	E13	Great Stour
GREATBRITAIN	E14	Adur
GREATBRITAIN	E15	Test
GREATBRITAIN	E16	Frome
GREATBRITAIN	E17	Exe
GREATBRITAIN	E18	Tamar
GREATBRITAIN	E19	Camel
GREATBRITAIN	E20	Taw
GREATBRITAIN	E21	Parrett
GREATBRITAIN	E22	Severn
GREATBRITAIN	E23	Usk
GREATBRITAIN	E24	Neath
GREATBRITAIN	E25	Tywi
GREATBRITAIN	E26	Teifi
GREATBRITAIN	E27	Dee at Chester
GREATBRITAIN	E28	Mersey
GREATBRITAIN	E29	Lune
GREATBRITAIN	E30	Eden at Carlisle
GREATBRITAIN	NI1	Lower Bann
GREATBRITAIN	NI2	Lagan
GREATBRITAIN	SC1	Nith
GREATBRITAIN	SC2	Clyde
GREATBRITAIN	SC2a	Lochy
GREATBRITAIN	SC2b	Helmsdale
GREATBRITAIN	SC3	Spey
GREATBRITAIN	SC4	Tay
GREATBRITAIN	SC5	Forth

DECISION: use the PARCOMS areas as rivers, so 1 single outflow point per area based on the location of the largest river in the area. This means that direct discharges are spread along the coastline, but that rivers are concentrated to 1 per area. Some of the PARCOMS areas are relatively large and contain multiple major rivers.

The UK has confirmed use of the selected river outflow points from each PARCOMS area (Table 5.2).

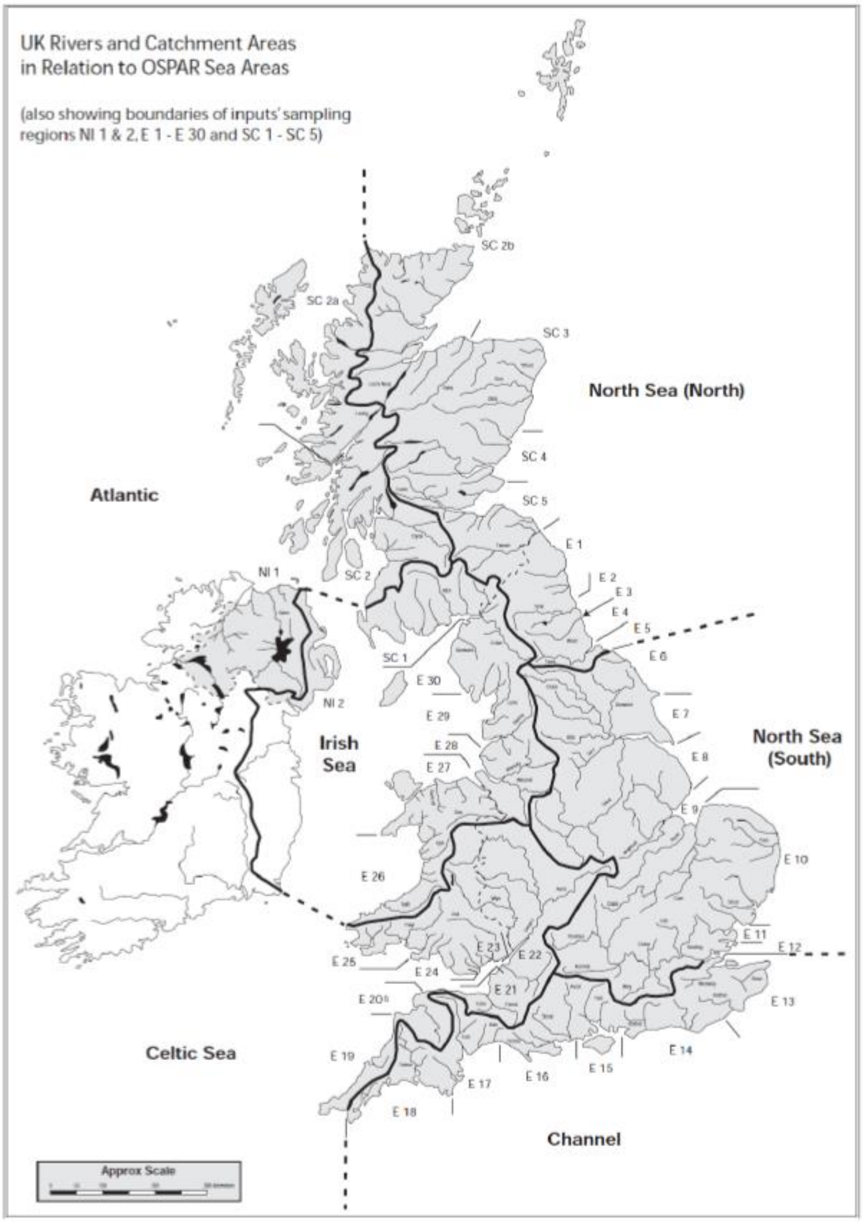

Figure 5.2: the UK PARCOMS areas. Note the use of large spatial areas in Wales, Scotland and Northern Ireland as well as in East Anglia, the Lake District and the southern coast.

5.7 ICELAND

Iceland entries in the RID database are limited to 2 rivers: the Thjorsa (Þjórsá við Urriðafoss) and the Olfusa (Ölfusá við Selfoss). Daily flow data for these rivers has been sourced from the global runoff database centre (GRDC, https://portal.grdc.bafg.de).

5.8 IRELAND

Irish daily flow data was supplied by Joe McGovern (Marine Institute, Galway) and sourced from the Office of Public Works (OPW) and the Environmental Protection Agency (EPA). The Electrical Supply Board kindly provided daily flow data for the following stations: Shannon tailrace (Parteen Weir), Lee (Inniscarra) and Liffey (Leixlip). Their data for the Erne (Cathleen Falls) was supplied at an earlier data and does not fully cover 2020.

As Ireland reports direct discharge data for all years, but only unmonitored area data since 2013 the EMO-RID database loads for Ireland are higher than those reported for the period 1990-2012 (gap filling for unmonitored areas). Ireland does report one annual flowrate for area 22 (unknown) for 1996. The area is not listed in tables 5 or 6 and so has been discarded.

5.9 The Netherlands

The Netherlands has changed the number of rivers it reports on for RID table 6a (riverine discharges), see Figure 5.3. The decision was taken in 2011 to report only on national rivers (Rhine, Meuse, Noordzeekanaal, Lake IJssel) and no longer report provincial rivers (Table 5.3). The latter account for less than 5% of the countries nitrogen load (Bert Bellert, NL representative for INPUT, pers. comm.). The declining trend in TotalN load reflects the impacts of nutrient regulation measures, and is not affected by the changing number of rivers included (as the loads are dominated by the Rhine/Meuse system). The Netherlands does not report on unmonitored areas, as they effectively measure 99% of their European landmass. The reported discharge for aggregated areas is equal to that of the rivers in each area, so no residual flow is reported. Belgium started reporting on the Gent-Terneuzen Canal in 2011 and continuous to report on this river.

The Netherlands reports one set of loads for the Ijsselmeer (Lake Ijssel), even though 2 separate sets of sluices are used to discharge water into the Wadden Sea (~ 23 km apart), both of which have their own recorded daily discharge data. The western Scheldt (ID 222) is listed as an aggregated area, not as a river (the Scheldt river is reported on by Belgium). Loads for the Western Scheldt are included in Table 6a up to and including 2015. The same area has entries in the direct discharges (Table 5e) up to 1997 only.

Table 5.3: Dutch reported rivers

RIVER	ACTIVE REPORTED PERIOD
LAKE IJSSEL (IJSSELMEER)	1990-present
MEUSE (HARINGVLIETSLUIZEN)	1990-present
NORTH SEA CANAL (NOORDZEEKANAAL)	1990-present
RHINE (MAASSLUIS)	1990-present
DAMSTERDIEP	1990-2010
DEN HELDER (HELSDEUR)	1990-2010
DUURSWOLD	1990-2010
EEMSKANAAL	1990-2010
GREVELINGENMEER	2006-2010
HARLINGEN	1990-2010
KANAAL GENT - TERNEUZEN	1990-2010, 2014
KATWIJK (OUDE RIJN)	1990-2010
LAUWERSMEER (LAKE LAUWERS)	1990-2010, 2014
NIEUWE STATENZIJL	1990-2010
OOSTERSCHELDE (KRAMMERSLUIZEN)	1990-2010
OOSTOEVER	1990-2010
POLDER EFFLUENTS OOSTERSCHELDE	1990-2010
POLDER EFFLUENTS WESTERSCHELDE	1990-2010
ROPTAZIJL	1990-2010
SCHEVENINGEN	1990-2010
SPUIKANAAL BATH	1990-2010, 2012-2015
TERMUNTERZIJL	1990-2010
TEXEL	1990-2010
VLOTWATERING	1990-2010
WIERINGERMEER	1990-2010
ZUIDERDIEP	2006-2010
ZWARTE HAAN	1990-2010

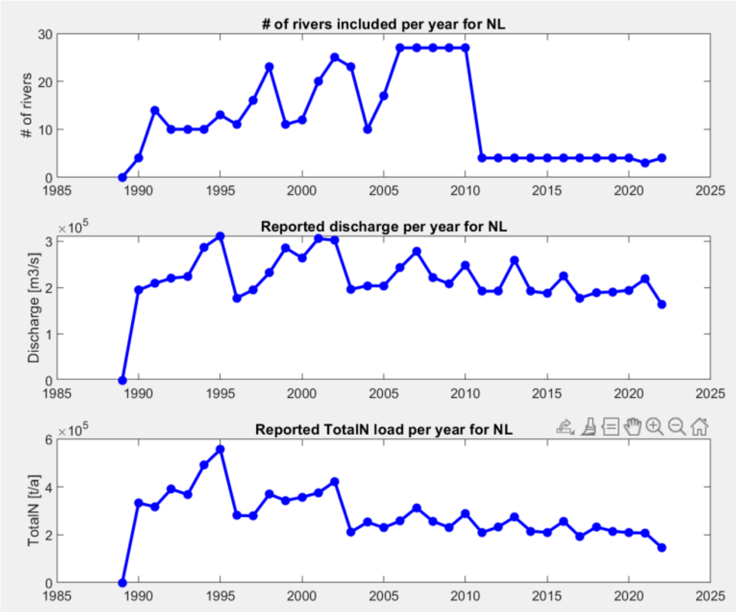

Figure 5.3: Top: the number of rivers included in the Netherlands RID reporting of table 6a (riverine loads). Middle: the reported discharge for all reported rivers. Bottom: the reported Total N load for all reported rivers..

DECISION: Only use 4 rivers for the Netherlands: Rhine, Meuse, North Sea Canal and Lake IJssel, as the focus is on the period 2015-2020. Lake IJssel to use a single discharge point (avoid splitting the loads over the 2 separate sluice systems), as most ecosystem models applied here will not resolve the Wadden Sea spatially. The single discharge location was chosen as Breezanddijk.

5.10 Norway

Norway reports on major rivers but also on tributary rivers (which are monitored less often) and which are reported on the aggregated spatial scale of the unmonitored areas (72T: Tributary Rivers - Norwegian Sea, 73T: Tributary Rivers - Barents Sea, 75T: Tributary Rivers – Skagerak, 83T: Tributary Rivers - North Sea). For this reason, as the tributary rivers do not have associated locations, the discharge and loads associated with the tributary rivers was added to the unmonitored area discharge and loads for these areas. As a result, the loads associated with the tributary rivers are spread along the coastlines of each region using the E-HYPE areas.

Of the rivers listed in the Area Table the Suldalslagen (165) and Inner Oslofford (170) do not have any entries in Table 6a (riverine loads), nor in any of the other Tables under consideration here (Tables 5, 6). These rivers will therefore not be used in the construction of the EMORID database.

Daily flow data was sourced from NVE, with selected stations given in the appendix. There was no obvious station for the river Orreelva, station 28.11.0 (Lye 2) was chosen instead. The same applies to the Inner Oslofjord, where flow data from 2 local rivers was sourced (Lysakerelven, Akerselva) but not used as this river is excluded from the analysis.

5.11 Portugal

Portugal reports tributaries to the Tejo on level 2 and both rivers and aggregated areas on level 1. The RID database entries include the rivers Tejo, Douro and Ria de Aveiro, as well as several rivers entering the Tejo estuary. The Minho river is included in Table Area but not reported to avoid confusion with the Spanish reporting of this border river. The Ria de Aveiro only has entries for 1990, all NI (No Information), so effectively Portugal only reports on the Douro and Tejo rivers. The Tejo river is listed both under Tejo (ID 228, before 2004) and Omnias (ID 238, 2004 onwards). Only 3 aggregated areas are reported (Tejo estuary, Tejo, Sines), which are located around the Tejo Estuary and south of Setubal (Sines), meaning that there is no full coverage of the

Portuguese coastline with areas reporting unmonitored areas and/or direct discharges. The area Sines has only NI flowrate entries in Table 9 and blank entries in Table 5e for 1990. Effectively, there are therefore only 2 aggregated areas for Portugal: Tejo and Tejo Estuary. All data entries for direct discharges refer to years before 2004. Portugal has requested that any data from before 2004 is discarded, due to data quality issues. This has been honoured, with the implication that Portugal only has direct discharge loads reported for 2012 and 2018 for the area Bay of Biscay and Iberian Coast (PO), for aquaculture, sewage, industrial and other. This area is therefore not regarded in the EMORID database due to too few data. Unmonitored areas are not reported by Portugal, so only 2 rivers remain to represent Portuguese loads into the marine environment: the Tejo and the Douro. For these rivers, the reporting covers 2010-2022.

Daily flow data was sourced from SNIRH (https://snirh.apambiente.pt/) and from Francisco Campuzano. Portugal does not report unmonitored areas, so that areas outside of the Tejo and Douro catchments (and those of the border rivers reported by Spain) are not reported on in terms of riverine discharges.

Table 5.4: Portuguese daily flow station allocation.

RIVER	STATION	TIME SPAN
TEJO	ALMOUROL (17G/02H)	1974 - 2023
DOURO	ALBUFEIRA DE CRESTUMA (R.E.) (07G/01A)	1997 - 2023

5.12 Spain

The riverine data still needs to be processed, but direct discharges have been completed. Spain reports on the 2 border rivers with Portugal (Miño, Guadiana). However, the Miño is only reported as an agger=gated area, not as a river. The border river with France (Bidasoa) is not reported. Reporting is on 3 levels, with level 3 representing some tributaries to rivers at level 2. Level 1 areas are used here as aggregated areas, despite some areas in level 2 representing a subdivision of areas in level 1. These areal subdivisions do not contain any riverine data (no entries in Table 6a) and are therefore not used in the riverine analysis. Spain reports on 50 individual rivers. The river Grande is assumed to be the river Grande de Porto.

Spanish flow data has been sourced from the Spanish Centro de Estudios y Experimentación de Obras Públicas (CEH, CEDEX, https://ceh.cedex.es/web/default.htm), and provided by IEO A Coruña (Luz García-García). Daily flow data was available up to September 2020, in most cases. Not all needed daily flow data could be sourced, however, and in places substitute rivers were used to provide the seasonal signal. The appendix has a full overview of which substitute rivers were used when daily flow data was missing.

ASSUMPTION: The river listed as Grande (36) is assumed to be the river Rio Grande de Porto

5.13 Sweden

Sweden has supplied all necessary information, including discharge and nutrient loads spanning 1969 to 2022 for both OSPAR and HELCOM areas. This data includes monthly nutrient values, not used yet (as annual RID loads are used for now for all countries) and daily flow values for all rivers. Of the reported OSPAR rivers listed in the RID database several have no data entries, these rivers are the Fylleån , Genevadsån, Himleån, Rolfsån, Suseån, Stensån, Strömsån and Vege å. On the HELCOM side the river Gothemsån has no associated nutrient data, only a few flow data years. It should be noted that Swedish riverine NO_3 data was found in the OSPAR RID database but not in the HELCOM database.

6 ERROR CORRECTION

Following the release of the original EMORID database on August 1st 2024a few issues and 1 correction have been applied. The correction was amended in the EMORID version as of 2025-Dec-16. Known but included errors :

- The French 2022 discharge values are very high in places (i.e. factor 5-10 higher than usual). This does not apply to all rivers, but applies to rivers in all areas.

Corrected errors:

- The TALK, DIC, DOC and TOC values, if present, were too low in the original release and have been corrected as of **2024-Dec-16**. This applies to all files but these values, which were copied from the ICG-EMO riverine database and corrected for difference in flow, only occur for rivers in some countries in he OSPAR region.

7 DATA STORAGE

The OSPAR ICG-EMO riverine database is kept by Sonja van Leeuwen (sonja.van.leeuwen@nioz.nl) at the NIOZ institute (Royal Netherlands Institute for Sea Research), Coastal systems (COS) department. The data is made available via the NIOZ Dataverse repository and deposited data has a DOI associated with it. It is also available upon personal request. As soon as the new EMORID database (ICG-EMO RID-compliant database of riverine inputs for ecosystem models) is finished and approved by the partaking countries the database will be uploaded to the NIOZ Dataverse repository and given a DOI.

8 REFERENCES

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