Baltic Marine Environment Protection Commission

Third Meeting of the Seventh Baltic Sea Pollution Load Compilation (PLC-7) Project Implementation Group

PLC-7 IG 3-2017

Silkeborg, Denmark, 23-25 May 2018

Document title	Overview of methodologies used in the countries for the assessment
Code	3-2
Category	CMNT
Agenda Item	3 – Finalizing PLC-6 project
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Submitted by	Project Manager
Reference	

Background

The Contracting Parties were requested to provide information on methodologies applied for the PLC-6 assessment, and to shortly describe the national methods, when deviating from the PLC guidelines.

All Contracting Parties have reported on the methodologies, and the attached document includes an overview of the reported methodologies.

Action requested

The Meeting is invited to:

- consider the overview of the methodology and whether it can be used as a product form the PLC-6 project by including a short background and summary to the overview
- agree on the finalization of the product with the aim of forwarding it the PRESSURE 9-2018 for endorsement

Applied methodology for the PLC-6 assessment

May 2018

This document contains an overview of the reported methodology by Contracting Parties.

The information is sorted by country.

The countries has been asked to described the following methods applied for the PLC-6 assessment:

- Calculation of flow and loads (rivers, direct point sources):
- Inputs from unmonitored areas:
- Source apportionment (load and source oriented approach):
- Retention:
- Transboundary inputs:
- Uncertainty on flow, loads, unmonitored and total inputs and on sources:

Information has been provided by all nine contracting parties and was updated by May 2018.

Denmark

By Lars M. Svendsen og Henrik Tornbjerg, DCE

Calculation of flow and loads (rivers, direct point sources):

Denmark overall follows common agreed methodologies. Danish rivers are overall quite small or very small and even reporting 144 monitored rivers Denmark only covers less about half (48 %) of the Danish catchment area to HELCOM convention. It should be remarked that even in unmonitored catchment discharges from point sources >30 PE are monitored.

Denmark has re-reported flow, annual TN and TP inputs for the complete time series (1995 and onwards) also updating some point source data – the main reason for the re-reported being changed methods to estimated losses from unmonitored areas and retention calculation.

The monitoring criteria for point sources have also been unchanged since 1989. The Danish monitoring programme has until recently been focused on nitrogen and phosphorus compounds and organic matter. Since late 1990'ties also some heavy metals and hazardous substances have been monitored on very few, selected rivers and selected major point sources (waste water treatment plants and industries with separate discharge), but these substances are not monitored every year in these rivers. For some heavy metals and most hazardous substances the main part of analysed concentrations have been under the detection limit and no total loads to coastal waters have been calculated as yet.

Analysis has to be performed on accredited laboratories and only few (1-3) laboratories have been involved for the past 4-6 years. Monitoring is until 2006 performed by the Danish Counties, thereafter by the Ministry of the Environment and Food, and they decide which laboratories they contract to perform chemical analysis.

In Denmark all point sources bigger than 30 PE are monitored even if they are situated in the unmonitored (part of) river catchment area. The frequency and sampling method is given in table 1.

Table 1: Annual sampling frequency (minimum) for wastewater treatment plant outflows

Plant capacity (PE)	Frequency/yr (min.)	Sampling method
30 ≤ x < 200	2	Random samples [1)]
200 ≤ x < 1,000	4	Time-weighted daily samples [2)]
1,000 ≤ x < 50,000	12	Flow-weighted daily samples
50,000 ≤ x	24	Flow-weighted daily samples

1) Time-weighted samples, random samples or empirical values, and 2) Time-weighted samples or random samples if the necessary facilities for collection of flow-weighted samples are not available. PE: Person equivalent to be equivalent to 21.9 kg organic matter per year measured as biochemical oxygen demand (BI_5), 4.4 kg total-N per year or 1.0 kg total-P per year for some years, but the P-value will be reduced in future.

Measurement of the water volume discharged is in general continual registration of the water volume on the day in question.

Calculation of total discharges follow the guidelines.

Plants with a capacity > 500PE covers 99% of the total wastewater load to wastewater treatment plants.

In Denmark all point sources bigger than 30 PE are monitored even if they are situated in the unmonitored (part of) river catchment area. The frequency and sampling method is given in the table below:

Table 2 Discharge classes for industries with separate wastewater discharges indicating the amount of nitrogen (total-N), phosphorus (total-P) and organic matter (BI_5 (modified) and COD) discharged together with the sampling frequency.

Discharge class	**Discharge (tonnes/yr)**				**Frequency/yr**
	BOD_5 (mod.)	**COD**	**Total-N**	**Total-P**	
I	0.6 < x < 4.3	1.6 < x < 10.8	0.13 < x < 0.9	0.005 < x < 0.3	2 samples
II	4.3 < x < 21.6	10.8 < x < 54	0.9 < x < 4.4	0.3 < x < 1.5	4 samples
III	21.6 < x < 108	54 < x < 270	4.4 < x < 22	1.5 < x < 7.5	12 samples
IV	x > 108	x > 270	x > 22	x > 7.5	12 samples

Measurement of the water volume discharged is in general continual registration of the water volume on the day in question.

Calculation of total discharges follow the guidelines.

Many heavy metals and hazardous substances are monitored at selected waste water treatment plants and separate discharging industrial plant.

Storwater and scattered dwelling

TN and TP loads are based on statistical information. For stormwaters it used statistics on outlets with rainwater from fortified areas and from overflows with sewage and rainwater. Precipitation is used in the calculation of TN and TP losses.

For scattered dwellings for each household information of type of waster water cleaning system get a theoretical degree of purification, which is combined with number of inhabitants in different types of households and excretion of TN and TP pr person (PE) (annually 4.4 kg TN, 1 kg TP and 21,9 kg BI_5).

Rivers

The annual sampling frequency at each river monitoring site is generally between 12-18. Stage (water level) is recorded continuously (either sampled every 10 minutes or averaged over 10 minutes) at all river monitoring stations. Discharge (cross section of river monitored in several depths in several depth profiles) is measured at least 12 times per year, and continuously run off is calculated using a well-established stage-discharge relationship which take into account any impounding effects on stage caused by aquatic plants. Transport at each river monitoring station is calculated by multiplying daily discharge with daily concentration, the latter estimated by linear interpolation of measured values.

Inputs from unmonitored areas:

Denmark has developed a new standardised method for estimating diffuse losses and loads from unmonitored areas. The new models estimates run off, diffuse losses and loads of nitrogen and phosphorus respectively. To these loads, the load from point sources in unmonitored areas is added. As explain earlier all discharges from point sources >30 PE are monitored, and discharges from scattered dwelling are based on information on number of scattered dwellings and which kind of purification the individual scattered dwellings have. Discharges from storm water overflow are estimated based on precipitation and e.g. the fortified are connect to e.g. an overflow pipe.

Shortly described run-off is calculated for 1 * 1 km grids with use of The National Water Reources Model from Geologic Survey of Greenland and Denmark (the so called “DK-model”), but adjusted and calibrated by NERI with discharge measurements in a lot of rivers to fit with monitored run off in rivers. The run-off is aggregated to monthly values and for 25-50 km^2 polygons (catchments).

Further two models calculate nitrogen and phosphorus monthly flow-weighted concentrations, respectively for different unmonitored catchments. Calculations of diffuse losses are done on a monthly basis for 25-50 km^2 polygons (catchments). These flow weighted concentration are multiplied by the calculated flow from 1*1 km grid to calculate diffuse losses including natural background losses. Relevant point source discharges are added. Thereafter retention of nitrogen and phosphorus in rivers, lakes and wetlands are deducted from the calculated diffuse losses to get estimate of the riverine loads in unmonitored areas. Retention are estimated using lake retention models, denitrification and net retention of phosphorus in rivers and wetlands (and due to flooding) and taking into account lake, river and wetland characteristics.

The nitrogen model are based on data from 84 agricultural catchments without big lakes and the monthly flow weighted nitrogen concentrations are calculated for 25-50 km^2 polygons as a function of:

- soil type (% sandy soils) (based on map scale 1:500000)
- percentages of cultivation (from central detailed database)
- degree of drainage (based on 205*205 m rastermap)
- monthly precipitation (daily data from 10*10 km grids)
- monthly average air temperature (daily from 20*20 km grid)
- nitrogen surplus based on national

The phosphorus model are based on data from 24 agricultural catchments without big lakes and the monthly flow weighted nitrogen concentrations are calculated for 25-50 km^2 polygons as a function of:

- soil type (% sandy soils) (based on map scale 1:500000)
- percentages of cultivation (from central detailed database)
- regional baseflow index (BFI) based on geo-region type, soil type and amount of organogenic soils
- monthly precipitation (daily data from 10*10 km grids)
- percentages of meadows, bog and moor and nitrogen surplus based on national

The total run off and load of nitrogen and via rivers from Denmark since 1995 have therefore been recalculated with the above mentioned new models, and that is the reason for tree-reporting the complete flwo oand TN and TP loads time series for the PLC-6 assessment. In average for Denmark the new models results in lowering annual nitrogen loads via rivers with 6-7 %, but on an annual basis with from approx. 15 % lower up to the same loads as compared with former reporting. Concerning phosphorus loads via rivers in average the revised load are 6 % higher, but on an annual basis loads is between 10 % lower to + 15 % higher compared with former reporting. In some catchments there are some major differences compared with former results, and DCE are investigating the reasons behind.

For further details see. **A distributed modelling system for simulation of monthly runoff and nitrogen sources, loads and sinks for ungauged catchments in Denmark.** / Windolf, Jørgen; Thodsen, Hans; Troldborg, Lars; Larsen, Søren Erik; Bøgestrand, Jens; Ovesen, Niels Bering; Kronvang, Brian. I: Journal of Environmental Monitoring, Bind 13, 2011, s. 2645-2658.

Source apportionment (load and source oriented approach):

Denmark follow the PLC guidelines for the load and source oriented approach.

Retention:

Retention are modelled for larger lakes, small ponds and lakes, streams and restored wetlands.

Larger lakes.

All larger lakes for which both an inlet and an outlet has been identified are in this context defined as larger lakes. For each lake, the external annual nitrogen load has been estimated using the aboved mentioned model and the annual nitrogen-retention is calculated using a N-retention model. The lake N-retention model includes water residence time and average lake depth. The model is based on monitoring data on annual inflow and outflow of water and nitrogen from 21 lakes over a 15 year period.

Small ponds and lakes. The Danish landscape is dotted with more then 100.000 small ponds and lakes. With the aim to identify the number of minor lakes having a significant potential for N retention the following criteria were established

- Each lake should at least have an identifiable stream outlet and/or “have contact” with at least two ditches.A total of 5930 smaller lakes were identified to meet the criteria.
- No topographics catchment areas are available for these lakes. Hence the calculationof nitrogen retention is based on assigned lakes area specific mean annual retention rates between 60 and 400 kg N ha-1 per year.
- The ranges of retention rates aimes to reflect the differences between lakes located in areas with varying farming intensities and varying soil characteristics.
- Inter-annual variation in the area-specific N retention rates is calculated based on the assumption that it follows the relative inter-annual variation in nitrogen retention in determined from mass balances in 16 Danish lakes.

Streams. The calculation of nitrogen retention in streams are based on 41 referenced studies of nitrate denitrification in streams and rivers in different parts of the world reviewd by Kronvang et al. These showed that annual awerage nitrate denitrification rates were higher in stream channels wider than 2 m than in stream channels less than 2 m wide. The total length of the different width classes was extracted from a national dataset. Inter-annual variation in N retention rates in streams is presumed to parallel the relative inter-annual nitrogen retention in 16 larger Danish lakes.

Restored wetlands. Experience from Denmmark following he effect of restored riparian wetlands shows a net removal of nitrogen amounting up to 190 kg N per hectare retored wetland per year. Data on the location of restored wetlands in Denmark since 1998 are recorded in GIS and information on the annual areas of restored wetlands is extracted and stores in GIS. Inter-annual variation in the nitrogen retention rate is assumed to parallel the inter-annual variation in nitrogen retention in 16 larger Danish lakes.

Transboundary inputs:

Denmark has no transboundary rivers to take into account.

Uncertainty on flow, loads, unmonitored and total inputs and on sources:

[Denmark are working on making some new istimates on uncertainty – will be provide at the latest in June 2018]

Estonia

Loads calculation for PLC-6 in Estonia
The calculations are carried out according to PLC-6 Guidelines.

The annual load for every monitored river is calculated for the measurement site. The load from the unmonitored part of the river catchment area is estimated as a part of the unmonitored areas (GUF, GUR, BAP).

The amount of monitored rivers, reported for Helcom varies slightly and currently the number of these rivers is 15. Among these rivers is one transboundary river (Pärnu river) and one border river (Narva river). All our monitored rivers have both hydrological and chemical measurements stations however, in some cases these stations are not located in the same place.

Flow in chemical station

If hydrological station is not in the same place with chemical station then taking into account the fact that the distances between stations are not big the flow in chemical station is calculated:

$$Q_{ch.st.} = Q_{hyd.st.} \frac{S_{ch.st.}}{S_{hyd.st.}}$$

$Q_{ch.st.}$ – flow in chemical station

$Q_{hyd.st.}$ – flow in hydrological station

$S_{ch.st.}$ – catchment area in chemical station

$S_{hyd.st.}$ – catchment area in hydrological station

The annual input calculation using daily river flow and daily concentration (interpolated)

We have daily flow data and monthly chemical data. Using linear interpolation the concentrations (C_t) for days where pollutants have not been measured are calculated. The annual input (*L*), as kg a^{-1}, is estimated by:

$$L = 0.0864 \sum_{t=1}^{n} (Q_t \cdot C_t)_t$$

$\sum$ - denotes summation
n - number of days
C_t - daily concentrations C for day t
Q_t - daily flow Q for day t

Concentrations are given in mg l^{-1} (for nutrients – for heavy metals, concentrations are given as µg/l), river flow as l s^{-1}. The estimate in the equation is multiplied by 0.0864 to obtain the daily loads that are summarized in the equation over the whole year for nutrient and by 0.0000864 for heavy metals.

Values under the limit of quantification

If measured concentrations are below limit of quantification (LOQ), the estimated concentration is calculated using the equation:

Estimation = ((100%-A) • LOQ)/100

where A=percentage of samples below LOQ

Border river

Estonian and Russian common border river is Narva river (total catchment area 58126 km^2, Estonian part is 30,2 %). It is agreed that Estonian part is 1/3 of total load. Estonia has in Narva river 2 hydrochemical stations (7 km from mouth and outflow from Peipsi), 2 hydrological stations (20 km from mouth outflow from Peipsi). Unfortunately, since 2015 the hydrological measurements are stopped (Russian authorities do not give permission). Year 2015 load is still calculated on the basis of estimated flow and since 2016 Estonia has to report Narva river catchment as unmonitored area.

Quantification of inputs from point sources.

Load from point sources is calculated on the basis of quarterly reports forwarded to our Agency of Environment. These reports must provide four times a year every water consumer who has permission of water use. These reports contain quarterly average concentrations and quarterly total flow. The annual inputs in kg a^{-1} is calculated as follows:

$$L = \sum_{i=1}^{n} Q_i * C_i * 0.001$$

L - annual inputs (kg a^{-1})
Q_i - wastewater volume of period i (m^3)
C_i - average concentration of period i (mg l^{-1})
n = 4, number of quarters in the year

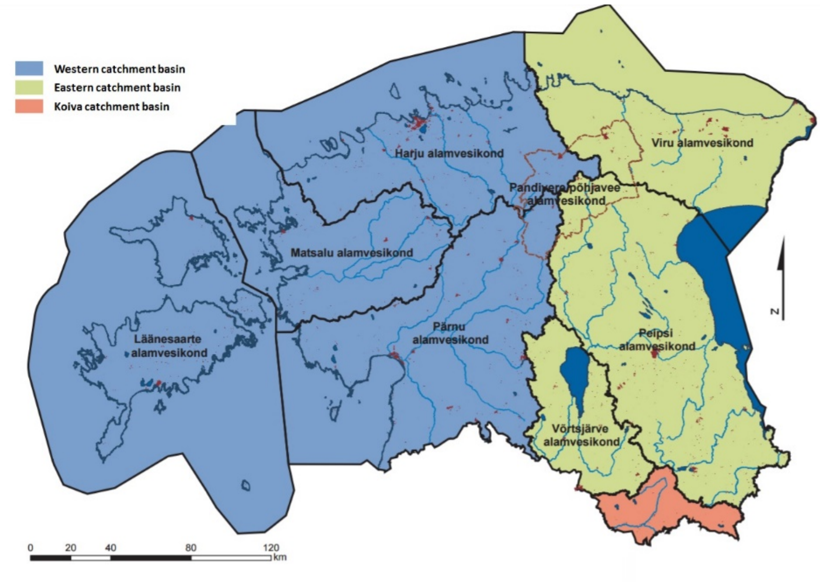
Quantifying diffuse losses of nutrients from monitored areas
At the moment the diffuse load of nutrients is calculated provisionally in a simplified form.

$$L_{diffuse} = L_{total} - L_{point} R$$

$L_{diffuse}$ - annual diffuse inputs (kg a^{-1})
L_{total} - annual total inputs according to measurements in chemical stations (kg a^{-1})
L_{point} - annual point sources inputs (calculated as sum of quarterly reports forwarded to Agency of Environment)(kg a^{-1})
R - retention coefficient (it is assumed that the loss due to retention is 10%)

Annual inputs from point sources is calculated on the basis of reports forwarded to Agency of Environment taking into account the retention.

Unmonitored area calculation.



Estonia is divided into three catchment basins (Western, Eastern and Koiva) and into eight sub-basins (Läänesaarte, Matsalu, Harju, Pärnu, Viru, Peipsi, Võrtsjärve and Koiva). We calculate average specific runoff for every subcatchment area. For the unmonitored area inside the subcatchment we use the average specific runoff of this subcatchment. Monitored and unmonitored areas may be different for different parameters depending on the monitoring program.

For compilation of periodic report (source-orientated approach) a simple coefficient-based model (Estmodel) is used. This model is now under development and the first priority is to get more realistic coefficient values. A short description of this model is presented in: *Ennet, P., Pachel, K., Viies, V. Jürimägi, L, Elken, R. (2008). Estimating water quality in river basins using linked models and database. Estonisan Journal of Ecology, 57(2), 83-99.*

REMARKS

1. Currently our databases are under development and checking. It appears that we have problems with the accuracy of the historical data, especially concerning the point sources.
2. Since from 2015 we do not have permission to measure flow in Narva river. For 2015 we are using the estimated flow for Narva river. The load from Narva river is an essential part of the Estonian total load.

Finland

By Antti Rääke

Riverine discharges

Altogether 30 monitored rivers were included in the PLC-6 work. These monitored rivers comprise about 90% of the Finnish Baltic Sea catchment area. Water flow was measured continuously in each river and water quality samples were taken flow proportionally, usually 12 to 20 times per year. Load from unmonitored areas was estimated by extrapolating the results of the nearby monitored catchment areas (with same type of land use and soil characteristics). The annual river discharges for nutrients were calculated by multiplying the mean monthly concentration by the monthly flow and summing up the monthly loads. Missing monthly concentrations were replaced with seasonal means.

Estimation of loading

Point source load

Nutrient load estimation from municipalities and industrial plants were based on regular measurements made according to the guidelines given by the Finnish environmental authorities. In some cases it is impossible to separate municipal and industrial discharges, because especially waste waters of food production plants is usually treated in municipal waste water treatment plants. Nutrient load estimation for fish farms was based on production statistics, amount of feed and nutrient content of the feed, using the equations in the PLC-6 Guidelines.

Diffuse load

Small drainage basins and small experimental areas were used in the estimations of diffuse source loading. The network of drainage basins for water quality monitoring consists altogether of 45 basins with different type of land use in different parts of the country. Water flow was measured continuously and water quality samples were taken flow proportionally 35-55 times per year.

Estimation of the losses of phosphorus and nitrogen from agricultural land to surface waters in Finland is based on the monitoring of N and P fluxes from 11 small agricultural drainage basins and from four agriculturally loaded river basins in south and southwestern Finland (Rekolainen et al. 1995, Vuorenmaa et al. 2001). The size of the small basins vary from 0.12 to 15 km^2, and the river basins from 870 km^2 to 1300 km^2. The agricultural land use of the basins varied from 23 to 100%. The monitoring schemes were based on continuous water flow measurement and flow weighted water quality sampling. Using this data, annual N and P flux estimates were calculated, by subtracting possible point-source loads and estimated losses from forested areas and the natural background. The up-scaling of the losses of phosphorus to cover whole Finnish arable land area is based on the ICECREAM model, which takes into account the topography, the structure of soil and agricultural production in different river basins (Tattari et al. 2001). The hydrology of the original model has been modified for Finnish conditions. The most remarkable change is in the model the inclusion of snow accumulation, snow melt and soil frost processes. For nitrogen SOILN-N model was used (Johnsson et al. 1987).

The effects of forestry activities (ditching, clear-cut felling, ploughing, hummocking, fertilization etc.) were evaluated on the basis of regional forestry statistics. The specific yearly net load from forestry activities was approximated using leaching coefficients obtained from the Finnish and Swedish surveys.

Nutrient inputs from scattered dwellings were estimated on the basis of estimated annual waste water production per person and the level of equipment in handling of lavatory and sanitary wastes (table 1). Per capita load estimates were 50 g/d BOD, 14 g/d NTOT and 2.2 g/d PTOT.

Atmospheric deposition on lake surfaces was gained by multiplying specific deposition by the surface area of the lakes. Deposition was measured on 13 stations located in the river catchment areas. Nutrient concentrations were analysed from the integrated monthly samples of rain water.

The estimation of natural leaching was based on coefficients obtained from the monitoring programmes of small drainage basins (table 2).

Table 2. Natural leaching coefficients for different parts of Finland.

	kg P km^{-2} a^{-1}	kg N km^{-2} a^{-1}
Southern Finland	6	200
Central Finland	5	120
Northern Finland	5	80
Northern Lapland	2	50

Calculation of retention

The estimation of retention of nutrients in freshwater is based on mass balance calculations. Usually retention of nitrogen and phosphorus was calculated only for the whole catchment area, but in larger river basins it was also calculated for sub-catchment areas in case there were continuous flow measurements and representative concentration measurements (at least 12 times per year). Retention was calculated using data from 2008 - 2014.

The retention was calculated according to the following formula:

$$RET = Q_{IN} + (L_{POINT} + L_{AGRI} + L_{ATM} + L_{FOREST} + L_{SCAT} + L_{BACK}) - Q_{OUT},$$ where

Q_{IN} = incoming riverine load

Q_{OUT} = outflowing riverine load

L_{POINT} = point source load (industry, municipalities, fish farming)

L_{AGRI} = agricultural nutrient load

L_{ATM} = direct atmospheric deposition to the lakes

L_{FOREST} = load from forestry activities

L_{SCAT} = load from scattered dwellings

L_{BACK} = natural leaching

Retention of nutrients in freshwaters is in Finland mainly connected to chemical, physical and biological processes taking place in lakes. Unmonitored river catchments and coastal areas in Finland have only very limited amount of lakes, and thus retention in these areas is negligible.

Source apportionment

Source apportionment was based on the measured (point source) or estimated (diffuse) load figures and retention calculations.

References

Johnsson,H., Bergström, L. and Jansson, P-E. 1987. Simulated nitrogen dynamics and losses in a layered agricultural soil. Agriculture, Ecosystems and Environment. 18:333-356.

Rekolainen, S., Pitkänen, H., Bleeke, A. & Felix, S. 1995. Nitrogen and phosphorus fluxes from Finnish agricultural areas to the Baltic Sea. Nordic Hydrology 26: 55-72.

Tattari, S., Bärlund, I., Rekolainen, S., Posch, M., Siimes, K., Tuhkanen, H-R. and Yli-Halla, M. 2001. Modelling field-scale sediment yield and phosphorus transport in Finnish clayey soils. Transactions of the ASAE.

Vuorenmaa, J., Rekolainen, S., Lepistö, A., Kenttämies, K. & Kauppila, P. 2001. Losses of nitrogen and phosphorus from agricultural and forest areas in Finland during the 1980s and 1990s. Environmental Monitoring & Assessment. (accepted).

Germany

Applied methodology for the PLC 6 assessment from GERMANY

Descriptions filled in by Dietmar KOCH, dietmar.koch@uba.de

Calculation of flow and loads (rivers, direct point sources):
The annual load calculation is based on daily river flow and interpolated concentration values for days where substances were not measured.

Calculations of flow and loads from direct point sources are based on continuous measurements carried out by the operator of the plant using standardized DIN methods. The measurement instrumentation is regularly calibrated to ensure high quality of results. Monitoring and control of outflow and operation of some WWTPs is carried by institutions authorised by the German Bundeslaender concerned.

Inputs from unmonitored areas: Between 23% and 52% of the German catchment areas are not monitored. Calculation of inputs are based on flow and loads from monitored areas assuming similar conditions prevailing in unmonitored areas. This may lead to an overestimation of inputsin some catchment areas.

Source apportionment (load and source oriented approach):
Germany generally applies the source orientated approach and uses results from the MoRE model. This is based on different pathways of substances, which, mainly depending on the land use, are subject to processes of transformation, losses and retention within inland surface waters in relation to their sources.

Retention:
Germany is able to report values for selected catchment areas (Schlei/Trave and Warnow/Peene) only. The current structure of the MoRE model does not provide for estimating retention values by sub-catchment individually. In order to improve the understanding of retention processes especially in the German catchment areas of the Baltic Sea, UBA Germany has planned to undertake a new project. It aims at a description of the retention process in rivers using the node-edge approach included in the MoRE Model.

Transboundary inputs: not applicable; the river ODER enters the Baltic Sea on the territory of Poland that takes responsibility for reporting of inputs.

Uncertainty on flow, loads, unmonitored and total inputs and on sources:
Not yet estimated.

LATVIA

Descriptions filled in by (name): *__Ilga Kokorite_*, e-mail: ilga.kokorite@lvgmc.lv

When describing the method just insert further lines.

Calculation of flow and loads (rivers, direct point sources) :

Water flow is calculated from the automatic measurements of water level and flow measurements in the main hydrological phases.

Riverine loads are calculated as follows:

$$L = \sum_{i=1}^{12} W \, x \, C$$

W – volume of monthly runoff;

C – monthly water concentration (monthly discrete samples)

Data on point sources are obtained from the national data base "Ūdens-2" (Water-2). Pollution loads there are reported by the operators of waste-water treatment plants.

Inputs from unmonitored areas:

Areal extrapolation of the monitored load in the upstream or neighbouring catchments.

$L_{unmon} = L_{mon}/A_{mon} * A_{unmon}$,

where: L_{unmon} = unmonitored load (t/y, kg/y)

L_{mon} = monitored load (t/y, kg/y)

A_{mon} = area of the monitored catchment (km^2)

A_{unmon} = area of the unmonitored catchment (km^2)

Source apportionment (load and source oriented approach):

Load oriented approach was used as described in the GELCOM Guidelines for Waterborne Pollution Inputs to the Baltic Sea (equations on page 54).

Data on point sources are obtained from the national data base "Ūdens-2" (Water-2).

Export coefficients of Ntot and Ptot from diffuse background sources (forest territories) were obtained from the Latvian State Forest Research Institute "Silava".

Retention:

Retention was calculated following Behrendt H., Opitz D. (1999) Retention of nutrients in river systems: dependence on specific runoff and hydraulic load. In Man and River Systems (pp. 111-122). Springer Netherlands.

Retention coefficient for nitrogen: $R_{SN}=6.3((Q*86,4*0.365)/As)^{-0.78}$

Retention coefficient for phosphorus: $R_{SN}=4,7((Q*86,4*0.365)/As)^{-0.76}$

where Q is a discharge and area of surface waters in catchment $As=A_{lake}+0.001*A^{1.185}$ (A_{lake} – area of lakes in a catchment, A area of a catchment)

Retention R = $R_{SN,SP}$*Load

Transboundary inputs:

For the Rivers Bārta, Venta, Lielupe, and Daugava.

At first, measured monthly concentrations at the border station and extrapolated discharges are used to calculate yearly load coming from a neighbouring country. In the case of the Daugava Rivers, the load is distributed between RU and BY by taking into the account the catchment area in these countries as well as the estimates of retention from the Tables 8.2. and 8.3 in "Guidelines for Waterborne Pollution Inputs to the Baltic Sea".

Uncertainty on flow, loads, unmonitored and total inputs and on sources:

In following hydrological stations the uncertainty in flow measurements was estimated to be 7 %: IRBE at VICAKI, BARTA at DUKUPJI. In following hydrological stations the uncertainty in flow measurements was estimated to be 12 %: SALACA at LAGASTE, GAUJA at SIGULDA, DAUGAVA at JEKABPILS, VENTA at VENDZAVA, LIELUPE at MEZOTNE.

Uncertanity of the monitored river load was calculated following Harmel, R.D., Cooper, R.J., Slade, R.M., Haney, R.L., Arnold, J. G. (2006) Cumulative uncertainty in measured streamflow and water quality data for small watersheds. *Transactions of the ASABE*, *49*(3), 689-701.

$$EP = \sqrt{\sum(E_Q^2 + E_C^2 + E_{PS}^2 + E_A^2)},$$

where: EP – cumulative uncertainty;

E^2_Q – uncertainty in discharge measurements (±%);

E^2_C – uncertainty in sample collection (grab sampling at single point, random time) ±25% dissolved; >50% suspended constituents);

E^2_{PS} – uncertainty in sample preservation and storage (for $N\text{-}NO_3$ ± 2%, for P_{tot} ± 7%);

E^2_A – uncertainty in laboratory analysis (±%, data from the analytical quality checks of the Laboratory of LEGMC);

Uncertainty of total loads and sources was not estimated.

Lithuania

LITHUANIA

Calculation of flow and loads (rivers, direct point sources):

Lithuania uses two separate approaches for calculating data required for annual and periodic reporting. Annual flows and loads are calculated from daily river water flow and monthly water quality monitoring data using formulas provided in PLC guidelines. Daily water flow is recalculated to monthly flow averages. Averaged monthly flow and monthly concentrations are used in load calculation (PLC guidelines formula 4.2). All specific details could be observed by examining actual annual load calculation spreadsheet. As it comes to direct point sources, they are few. Yearly data about them are provided by companies or municipalities responsible for those point sources.
For periodic reporting flow and loads are calculated using the SWAT model. The model has been prepared for all Lithuanian territory with the most detailed data available in the country. Model and its preparation and additional alteration are described in the model preparation documentation and the methodological notes for the PLC data preparation.

Inputs from unmonitored areas:

Loads and flow from unmonitored areas for annual reporting are calculated using area proportional method described in the guidelines (PLC guidelines formula 7.1). Minija river (neighboring basin to the unmonitored areas) concentrations and flow at the outflow are used together with Minija and unmonitored areas area ratio to calculate loads from unmonitored areas. However, in the periodic reporting modeling approach was used to calculate loads and flows from unmonitored areas.

Source apportionment (load and source oriented approach):

Source apportionment data are prepared using model results. Averaged data for the period of 2007-2014 are provided in reporting in order to cover all period between periodic reportings and avoid extreme deviations of one year biases as year 2014 have particularly low flow and irregular flow distribution during the year. Therefore Lithuanian sources apportionment data represents averaged environmental conditions for last 8 years.
The model is fed with physical data about environment, climate, discharges of point sources, agricultural activities, etc. As the SWAT model is in category of physically based and semi-distributed parameters catchment models, processes occurring in the environment are simulated by the model. All sources apportionment data are based on simulation results. Only atmospheric deposition is calculated using additional deposition data and results are added after aggregating modeling results. The final loads from all the distributed sources were reduced by some percentage to leave final loads the same, but including atmospheric deposition category. This methodology is described in the methodological notes for the PLC data preparation.

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Retention:

Retention has been calculated using modeling. The routing of pollutants from different sources has been tracked through river network. This allowed calculating retention of all pollutants as well as track pollutants by sources. The SWAT model is based on physical parameters. It simulates processes occurring in the river channel as diffusion, sedimentation, resuspension, break down of pollutants, etc. Thus, total retention is based on simulation of those processes occurring in the river.

Transboundary inputs:

Modeling is used to calculate reported transboundary loads and flows needed in the annual and periodic reporting for the exception of loads and flow coming from Belarus. Belarus loads and flow are calculated using monthly concentration and daily flow monitoring data at the border. The calculation is done the same way as for main rivers in the annual reporting (PLC guidelines formula 4.2). Beside modeling and monitoring data, area proportional method is used as well in calculating transboundary loads. Only for Sventoji river transboundary loads and flows coming from Latvia are calculated using area proportional method. This is done because modeling results for the Latvian part of basin were not inline with monitored outflow results. The prepared model does not cover territories of other countries with real input data. Thus, approximations to generate transboundary data does not work well for all modeled rivers.

All data for river basins going to Latvia from Lithuania are modeled. Sesupe loads and flow leaving Lithuanian to Kaliningrad and coming back to Nemunas river are not modeled, but returning loads and flow are increased by area proportional coefficient. Loads and flow leaving Nemunas to Kaliningrad through Matrosovka channel is calculated by flow proportional coefficient, which was calculated from measured Matrosovka flow data. More detailed explanations of model configuration could be found in the model preparation documentation.

Uncertainty on flow, loads, unmonitored and total inputs and on sources:

Uncertainties on flow or loads have not been calculated or reported by Lithuania.

POLAND

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Calculation of flow and loads (rivers, direct point sources):

Direct Point Sources

- Procedure of calculating loads and flows from point sources has been carried out according to HELCOM Guidelines recommendations.

The methodology of calculating loads from point sources assumes that for each discharge, information about at least one measurement of required parameters and quantity of wastewater were available. Loads are calculated by the following equation:

$$La = 365 \cdot \frac{1}{n} \sum_{i=1}^{n} Q_i \cdot C_i$$

L_a = Annual load

Q_i = Wastewater volume on sampling day [l/day]

C_i = Concentration of the period i [mg/l]

n = Number of sampling days

This algorithm does not take into account the seasonal variability. In this case the results of the estimation may differ from real size.
Based on above method and data from The National Programme for Municipal Waste Water Treatment (KPOŚK), loads (BOD_5, COD, total phosphorus, total nitrogen) from MWWTPs into inland surface waters have been calculated.

Diffuse source

In order to perform load quantification, Poland is divided into 135 subcachments.

For each of 135 subcatchments, total waterborne inputs from diffuse sources entering to the Baltic Sea are obligatory to quantify.

PLC-6 pollution load compilation covers nitrogen and phosphorus loads from following diffuse source:

Agricultural land;

Forestry and other unmanaged land

Scattered dwellings;

Storm water and overflow;

Atmospheric deposition directly on inland surface waters

Agricultural land

In order to calculate nutrient losses from agricultural land for each of 135 subcatchments, following steps have been taken:

1. Monitoring points for each mini-catchment have been selected and annual average nitrates/phosphates concentration was calculated
2. Agricultural land for each mini-catchment was estimated
3. Annual water outflow from mini-catchments was estimated and part of outflow coming from agriculture was calculated.

The quantification of nutrient losses from agricultural land into surface waters, was carried out based on concentration of nutrients in drainage water, at 1500 monitoring points. The samples of nutrient concentration in drainage water were taken two times per year (in spring and autumn).

The first step was to calculate subcatchment load based on nitrate/phosphate concentration and outflow from subcatchment. As a result, mineral part of nitrogen (phosphorus) in surface water was received.

$$L_{r(N,P)} = m \cdot C_{Wr(N,P)} \cdot Q_Z$$

$L_{r(N,P)}$- Phosphorus(P) or nitrogen(N) discharge to water body (kg/a)

$Cw_{r(N,P)}$ – average nitrate (phosphate) concentration (mg/l) in outflow.

Q_z – average flow in subcatchment (l/(s*km^2))

M - unit conversion coefficient - 0.31536

To obtain more reliable data, it was necessary to estimate correction factor $Z_{N,P}$, which takes into account nutrient loads from other nitrogen (phosphorus) compounds. $Z_{N,P}$ was calculated as:

$$Z_N = \frac{\overline{C}_{Ntotal}}{\overline{C}_{NNO3}} \quad ; \qquad Z_P = \frac{\overline{C}_{Ptotal}}{\overline{C}_{PPO4}}$$

Total loads of total nitrogen(***Lr_{Nog}***) and total phosphorus(***Lr_{Pog}***) are calculated as:

$$L_{rNog} = Z_N \cdot L_{rN} \cdot A_r \qquad ; \qquad L_{rPog} = Z_P \cdot L_{rP} \cdot A_r$$

$L_{r\,N}$ - estimated nitrogen load (kg/(ha*a))

$L_{r\,P}$ - estimated phosphorus load (kg/(ha*a))

Z_N - nitrogen correction factor

Z_P - phosphorus correction factor

A_r - area of agricultural land (ha)

Forestry and other unmanaged land.

Spatial resolution of loads from managed forestry and other managed land depends on slope of the land average slopes within the catchment area and permeability of soils. To calculate nitrogen and phosphorus loads, adjusting average slope, and predominant category of soil permeability for each catchment area, was needed. Thus, nitrogen and phosphorus content in precipitation and flow weighted concentration from managed forestry has been verified.

Specific nutrient load from managed forestry and other managed land was calculated by applying the following equation:

$$L_{t(N,P)} = m \cdot C_{Wt(N,P)} \cdot Q_Z$$

L_t - individual nitrogen (phosphorus) load (kg/(ha*a))

Cw_t - flow weighted concentration of period t (mg/l)

Q_z - average outflow volume in a given period t (l/(s*km^2))

M - unit conversion coefficient - 0.31536

The average slope within the catchment area	Permeability of soils	Flow weighted concentration Cw_t	
		nitrogen mgN/l	phosphorus mgP/l
Slope ≤ 2%	good	**0,31**	**0,038**
	average	**0,75**	**0,038**
	bad	**1,09**	**0,038**
Slope > 2%	good	**0,31**	**0,038**
	average	**0,75**	**0,038**
	bad	**1,22**	**0,038**

Total loads of total nitrogen(Lt_{Nog}) and total phosphorus(Lt_{Pog}) are calculated as:

$$L_{tN} = L_{tN} \cdot A_t \quad ; \qquad L_{tP} = L_{tP} \cdot A_t$$

L_{tN} *-the nitrogen load in water outflow kg/(ha*a)*

L_{tP} *- the phosphorus load in water outflow kg/(ha*a)*

A_t - catchment area used (ha)

Scattered dwelling:

Nutrient losses from scattered dwelling was defined based on the data from Central Statistical Office of Poland, referring to the households not connected to the municipal sewage systems.

Assuming that average nitrogen/phosphorus load, produced by single person is 4,4 kg N/a and 0,8 kg P/a, load could be quantified as follows:

$$L_l = N_s \cdot l_{N,P} \cdot B$$

L_l - load from scattered dwelling (kg/a)

N_s -population not connected to sewage system

$l_{N,P}$ - average nitrogen/phosphorus load, produced by single person (kg/a)

B - coefficient related to load entering inland surface waters (0,4-N, 0,2-P - according to HARP guidelines)

Rainwater constructions and overflows

Quantification of nutrient losses from rainwater constructions and overflows has been carried out according to HARP, 2000 guidelines. The total nitrogen and phosphorus discharges from the separate sewer system may be estimated by the following equation:

$$L_{dN,P} = A_u \cdot d_{N,P}$$

$L_{dN,P}$ -the total nitrogen and phosphorus discharges from combined sewer overflows (kg/a)

A_u - sealed urban area connected to combined sewer system (ha)

$d_{N,P}$ -specific nitrogen and phosphorus discharges from sealed urban area (kg/ha*a)

Calculated for Poland average specific nitrogen and phosphorus discharges by separate sewer systems in 2011 were d_N = 14 kg N/ha for nitrogen and d_P = 1,2 kg P/ha for phosphorus.

Atmospheric deposition on inland surface waters

In order to estimate nutrient losses from atmospheric deposition, data from chemistry of precipitation monitoring and CORINE Land Cover have been used. The calculation method assumes that total nitrogen and phosphorus content in the precipitation enters inland surface waters.

$$Lo_{N,P} = S_w \cdot qs_{N,P}$$

$L_{ON,P}$ - nutrient load from atmospheric deposition on inland surface waters (t/a)

S_w - sum of surface waters in catchment (km^2) according to CORINE Land Cover

$q_{sN,P}$ - annual area specificnitrogen/phosphorus load (kg/km^2)

Source apportionment:

Source apportionment has been carried out according to PLC guidelines.

The source apportionment was made by a summary of discharges from point sources and diffuse sources and then the percentage of various sources of pollution in the total discharge charge has been calculated. The riverine load has been calculated according to source apportionment.

Inputs from unmonitored areas:

Recommended method form PLC-6 Guidelines has been used. Load has been estimated according:

$$L_n = L_m \frac{A_n}{A_m}$$

L_n	Load from unmonitored area A_n
L_m	Known load coming from monitored area A_m
A_n	Area of unmonitored hydrological basin
A_m	Area of monitored hydrological basin

Retention:

Retention in accordance with requirements of PLC Guidelines- Horst Behrendt & Dieter Optiz Method.

Transboundary inputs:

Transboundary loads has been calculated based on measurements of State Environmental Monitoring at monitoring points. Where it was possible, an average flow rate of 2012 has been used, in other cases the flow rate of the long term annual averages.

$$La = C_{śr} \cdot Q_{śr} \cdot W_j$$

La	- annual load t/a
$C_{śr}$	- average sample concentration mg/l
$Q_{śr}$	- average volume m^3/s
W_j	- coefficient (3600s*24h*366days or 365days)/1000000

Applied methodology for the PLC 6 assessment from: RUSSIA (country)

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When describing the method just insert further lines.

In general, Russia follows the methodology described in the PLC-6 guidelines.

Calculation of flow and loads (rivers, direct point sources):

The annual monitored river discharges for nutrients were calculated by multiplying the monthly concentration by the monthly flow and summing up the monthly loads (equation 4.2 from the PLC-6 Guideline). Initial data (flow and concentrations values) provided within state monitoring. In cases, there some of the parameters missing in the monitoring programme specific estimates have been used (e.g. Pregolya river total nitrogen and total phosphorous concentrations were obtained from the BASE Project screening activities).

Direct point sources load obtained from the state statistical reporting, based on the continuous measurements implemented by natureusers.

Inputs from unmonitored areas:

Estimation of the nutrient pollution from unmonitored areas has been implemented using Institute of Limnology Loading Model (detailed description provided below).

Source apportionment (load and source oriented approach):
Source apportionment implemented using Institute of Limnology Loading Model.

The basic components of the total annual load on catchment (Ltot) of Ptot and Ntot are the loads from point sources (Lp), diffuse load from agricultural production in the area (Lagr), diffuse emission of nutrients from various types of land surface not effected by agriculture (Le), atmospheric deposition (La):

$$L = \left(L_{agr} + L_c + L_{P1} + L_a\right), \quad (1)$$

The point sources include the discharges of sewage waters of the industrial, agricultural and municipal enterprises. The official source of data on sewage discharges are state statistical forms ("2TPVodhoz").

The diffuse load on catchment from the emission of nutrients from various types of land surface (natural and anthropogenic) excluding agricultural areas Lc is calculated as follows:

$$Lc = (Cu\ Au + Cnat\ Anat + Cmix\ Amix)\ y/1000, \quad (2)$$

where Cu, Cnat and Cmix are the specific concentrations of nutrients in runoff from urban areas, the natural land surface and mixed areas, accordingly [mg l -1],

Au, Anat and Amix are the areas of the mentioned types, respectively, of a land surface [km2], y is a runoff from the catchment [mm year-1].

Urban areas represent the input from sparse population that is not connected to sewer networks and treatment facilities. Values of *y* from the whole catchment or its parts can be taken from measurements or calculated using distribution functions or using a hydrological model.

Kondratyev (2007) reported that the phosphorus load from atmospheric depositions (La = da A) ranges from 0.002 to 0.005 t km-2 y-1 . Here, a value of 0.0032 t km-2 y-1 was used. Value La for nitrogen load is zero, if it is assumed that nitrogen deposition from the atmosphere (loss with deposits + fixed by biota) equals removal by denitrification (Behrendt, Dannowski, 2007).

Nutrient load, generated on agricultural areas, calculated based on the method proposed by Institute of Institute for Engineering and Environmental Problems in Agricultural Production (Saint-Petersburg, Russia). The method is fitted for North-West region of Russia conditions and based on following equation:

$$L_{agr} = \sum_{i=1}^{n_1} A_i \left(M_{soil\,i} K_1 + (\alpha_1 M_{\min i} + \alpha_2 M_{org\,i}) K_6 \right) K_2 K_3 K_4 K_5 / 1000 \quad , \qquad (3)$$

where M soil i , M min i and M org i – N and P content in the plough layer, as well as amount of organic and mineral fertilizer applied on field, owned by i agricultural enterprise, kg/ha;

Ai – field area, owned by i agricultural enterprise, ha; n1 – number of agricultural enterprises;

α1 – coefficient, related to the uptake of mineral fertilizer by crops;

α2 – coefficient, related to the uptake of organic fertilizer by crops;

K1 – coefficient describing nutrients outflow from plough;

K2 – coefficient describing distance of agricultural areas from receiving water bodies;;

K3 – coefficient for soils type (by origin);

K4 – coefficient describing soil texture;

K5 – coefficient for accounting land use structure;

K6 – coefficient for describing status of applying BAT for application mineral and organic fertilizer by agricultural enterprises.

Background (natural) load component [t y-1] is a part of the non-point nutrient load calculated as follows:

$$Lnat = Rt\ [da\ A + yCnatA\ (1-W/100)/1000] \qquad (4)$$

where *da* – coefficient for mass exchange with atmosphere;

W – share of lake area in percentage;

Rt – retention factor.

Retention:

For calculation of the discharge of Ptot and Ntot from the catchment and loading on water body L [tons year-1] the following equation is used (Behrendt, Opitz, 1999):

$$L=Rt\ Ltot+Ldirect = (1-Rr)\ Ltot +Ldirect =Ltot-Lret+Ldirect, \qquad (5)$$

where Rt and Rr are dimensionless factors of discharge and retention, Ltot is the nutrient load on catchment [t y-1], Lret is the retention by catchment (Lret = Rr Ltot) [t y-1], Ldirect – direct load on water body [t y-1].

$$R_r = k_{cal}(1-\frac{1}{1+aHL^b}), \qquad (6)$$

Value of the hydraulic load HL is proportional to the specific runoff q [dm3 km- 2 sec-1] and inversely proportional to the lake percentage W [% of catchment total area]:

$$HL=3.15q/W. \qquad (7)$$

The specific runoff q [dm3 km-2 s -1] is determined with the runoff y [mm year-1] as follows

$$q = 0.03171\ y. \qquad (8)$$

Transboundary inputs:

Transboundary load has been defined based on shares and methods used in PLC 5.5 Project and actual monitoring data for 2014.

Uncertainty on flow, loads, unmonitored and total inputs and on sources:

Uncertainty of total loads and sources has not been estimated

References:
1. BaltHazAR II project, Component 2.2: Building capacity within environmental monitoring to produce pollution load data from different sources for e.g. HELCOM pollution load compilations. Modeling the Luga river.
2. Behrendt H., Dannowski R. Nutrients and heavy metals in the Odra River System. - Weissensee Verlag Publ., Germany, 2007, 337 p.

3. Behrendt H., Opitz D. Retention of nutrients in river systems: dependence on specific runoff and hydraulic load. - Hydrobiologia, 1999, 410: 111-122.
4. Kondratyev S.A., 2007: Formirovanie vneshney nagruzki na vodoemy: problemy modelirovaniia (Formation of external loading on water bodies: problems of modeling). Nauka, St. Petersburg, 255 p, (in Russian).
5. To develop method and calculate nitrogen and phosphorous load originate from agricultural production activities in the catchment as well potential reduction when applying BAT (In Russian: Разработать методику и выполнить расчет диффузной нагрузки азота, фосфора на водосбор при ведении сельскохозяйственной деятельности и потенциала ее снижения при использовании НДТ в сельском хозяйстве). Report about scientific and research work, IEEP RAS, 2015, 22 p.
6. To implement scientifically grounded assessment for sources appointment of nutrient input from river catchments within Russian part of the Baltic Sea catchment in 2014 (In Russian: Выполнить научно-обоснованную оценку долевого вклада всех источников в формирование в 2014 г. фактической биогенной нагрузки на водосборных бассейнах рек, впадающих в Балтийское море с российской части водосборного бассейна), Report about scientific and research work, RSHU, 2016.

Sweden

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Calculation of flow and loads (rivers, direct point sources):

Daily water flow and monthly concentrations (interpolated to daily concentrations) are used to calculate the monthly and annual loads for the 43 monitoring stations included in the national monitoring programme on river mouths. These monitoring stations are to some degree supported by other national and regional monitoring sites to support the estimation of loads from unmonitored areas.

Point sources

Wastewater treatment plants with more than 200 person equivalents (p.e.) and industries are monitored at the facilities on regular bases by the facility owners. As part of the authorities control the facility owner are obliged to report the data to the Swedish Portal for Environmental Reporting (SMP). The facility owner report the annual loads and the data reported are based on this data. Fish farms also report load data to SMP, these data are typically estimated by the facility owner from the fish feed.

Smaller wastewater treatment plants with less than 200 person equivalents (p.e.) are not obliged to report their data to the authorities, therefor the load is estimated by multiplying the number of p.e. and a coefficient that is based on the treatment technic used. The coefficient and the estimated incoming nutrient content are adjusted to Swedish conditions.

Inputs from unmonitored areas:

For minor river systems that do not have any national monitoring site in the lower parts of the rivers the loads are estimated with the area-specific load from other similar rivers in the area.

The load from unmonitored areas downstream monitoring sites are quantified by the area specific loss from the monitored parts, and the loads are included in the amounts given for the monitored areas. Generally, the monitored parts of the rivers cover some 95-100% of the total areas. Though, there are some exceptions like Rönneån where the monitoring station covers only 51 % of the total area. In addition to the area-specific load from the upper monitored area, the load from the unmonitored area is also estimated with the weighted area-specific load from other similar rivers in the area as the lower stretches are contain more farmland compared to the forested upper part of the catchment area.

Source apportionment (load and source oriented approach):

The Source oriented approach.

The load of nutrients (nitrogen and phosphorus) to lakes and rivers has been calculated for about 23100 Swedish WFD water body catchments, average size 11 km^2. The general system approach is described in Brandt et al (2009), but several of the models and data included have been developed or exchanged since PLC5, as briefly described below. The load comes from point sources (wastewater treatment plants, industries, and fish plants) and from diffuse pollution (land use leaching, storm water, scattered dwellings, and the deposition on lakes). Land use leakage within a catchment is calculated by land use area (km^2) multiplied by runoff (l/s/km^2) and a specific concentration describing leakage concentration in runoff water for the current land use (mg/l). Atmosphere deposition on land surface is included in the specific concentration land use leakage.

Daily mean runoff has been simulated using the HYPE model in about 37 000 subcatchment for year 2014. Based on the daily runoff, yearly and monthly average values have been calculated. The load is calculated specifically for year 2014 (crop area, land use area, point source load, runoff).

The specific concentrations for nitrogen and phosphorus leaching from agricultural land have been calculated using the NLeCCS system. NLeCCS, which is a system for calculating normal leakage from arable land, includes the simulation tools SOILNDB (based on SOIL / SOILN models) for nitrogen and ICECREAMDB (based on the ICECREAM model) for phosphorus. NLeCCS system takes into account the most important factors (both farming methods and natural endowments) that affect the leaching of nutrients from agricultural land. Simulation input data regard fertilization, manuring, atmospheric deposition, crop yield, catch crops, protection zones, agricultural practice, climate data, crop rotations, crops, soil type, soil phosphorous, soil slope.

Specific concentrations from land use of forest, clearcut forest, wetlands, alpine and other open land use is based on data from representative areas within the regional and national monitoring programs and on data from new targeted monitoring campaigns in Southern Sweden carried out after PLC5. The specific concentrations are based on data from streams.

Storm water surface runoff coefficients and specific concentrations of urban land use comes from the database of the StormTac model. The specific concentrations were geographically adjusted using weighting by the deposition rate of nitrogen.

Diffuse load from scattered dwellings was calculated using the number of population not connected to wastewater treatment plants, load per person, reduction efficiencies of techniques and municipal information of the techniques used.

Deposition of nitrogen on lake surfaces is based on calculations using the MATCH model and assimilated data, while the deposition of phosphorus is a median value for all of Sweden based on monitoring data.

Point source load is calculated based on direct measurements at the facility (including data reported to the Swedish Portal for Environmental Reporting, SMP). Load from small point sources of wastewater treatment facilities are calculated based on loads with regard to other data such as type of treatment technology and number of persons equivalents connected and load per person.

The load oriented approach.

The net load to the sea is calculated with retention modelled using the SMED-HYPE model for all 23100 catchments. The total source apportioned load calculated to the river mouths was weighted to the total PLC annual river load reported in monitored and unmonitored rivers, and all sources were adjusted according to the weight.

The major differences in method and data from PLC5 to PLC 6 is the use of new, high resolution land-use and soil type maps, new data concerning purification in off-mains sewerage and storm water as well as a new elevation database (with 2 m horizontal resolution). The elevation database has been used to calculate slope steepness, which is of great importance for estimates of phosphorus leakage. New monitoring observations in forest areas in southwestern Sweden have provided a better understanding of nutrient leakage in woodland areas and a new nutrient retention model has been developed as a result. The runoff has been calculated with a new model HYPE and the retention has been calculated using the new SMED-HYPE model.

Retention:
The retention from source to sea was calculated using the SMED- HYPE model in all 23100 WFD water body catchments. SMED-HYPE retention builds upon the HYPE-model (Lindström et al 2010). In lakes and rivers the nutrient processes are described similarly in both HYPE and SMED-HYPE. The major differences are the model description of the land use leakage (SMED_HYPE land use leakage described in the source oriented approach above) and the local river retention. Internal load from the lake sediments (negative retention) was reported for lakes where the mass balance was supported by inlet to outlet monitoring data.

Reference:
Lindström, G., Pers, C.P., Rosberg, R., Strömqvist, J., Arheimer, B. 2010. Development and test of the HYPE (Hydrological Predictions for the Environment) model – A water quality model for different spatial scales. Hydrology Research 41.3-4:295-319.

Transboundary inputs:
Swedish catchments do not contribute to any significant transboundary output to the neighboring countries. The load from Norwegian and Finnish catchments contributing to Swedish catchment was calculated using Corine LandCover as land use representation, thus not including anthropogenic land use sources. Point source loads were delivered from Finland to Sweden to be able to calculate retention in Torne river more correctly. Transboundary load was not reported by Sweden in PLC6. Additional calculations are currently being performed to better represent the transboundary anthropogenic sources contributing from Norway and Finland to Swedish catchments.

Uncertainty on flow, loads, unmonitored and total inputs and on sources:
The uncertainty of sources has large variations due to the different underlying data and model performances. The uncertainty has not been reported for sources by Sweden for the PLC6.