Baltic Marine Environment Protection Commission

Second Meeting of the Eight Baltic Sea Pollution Load Compilation (PLC-8) Project Implementation Group

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Background

NarvaWatMan Project (Water Management of the Narva River: harmonization and sustention period) is continuing. The calculation methodology has been selected and the data collection process almost finished. At the moment Project team is estimating nutrient input from various sources of the Narva river immediate catchment. The aim of the current activities - test countries methods and define combination which better reflects the nutrient input to the Gulf of Finland.

The activities are expected to be finished according to deadlines in 2021. The proposals on joint methodology determining the share of contributions from Estonian and Russian territory in the total N and P export by Narva river to the Gulf of Finland could be used for PLC-8 reporting based on source appointment data produced by Estonia and Russia according the national procedures.

The document “Methodology to quantify contribution of various sources to the formation of nutrient loading with the Narva River” is attached to this document.

Action requested

The Meeting is invited to:

- take note of the methodology for estimating nutrient input from various sources of the Narva river immediate catchment
- discuss the possibilities to utilize results of the NarvaWatMan Project for PLC-8 purposes.

Methodology to quantify contribution of various sources to the formation of nutrient loading with the Narva River

Narva river immediate catchment (pilot or test catchment) has been delineated to identify several sub-catchments (figure 1).

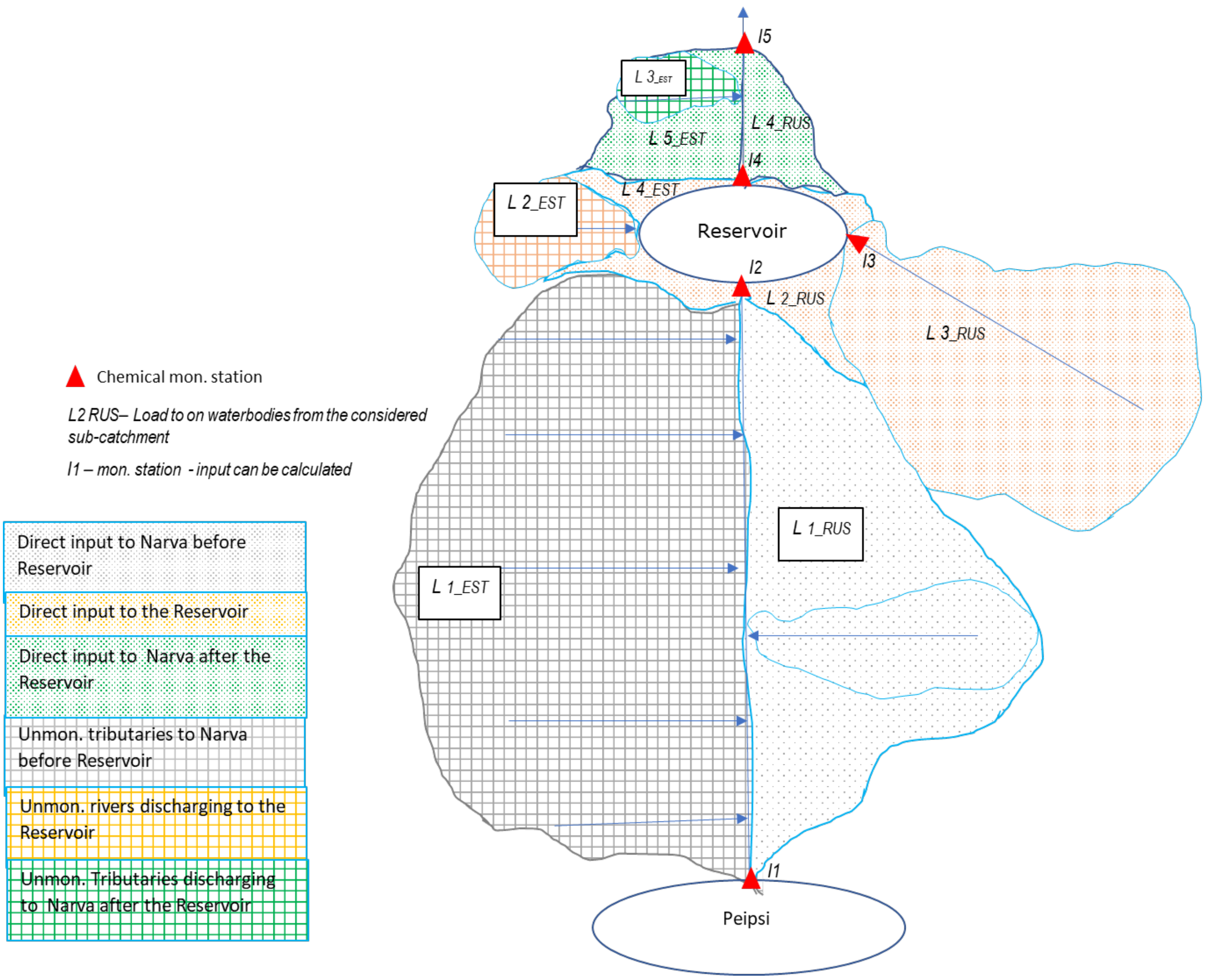

Figure 1 – Scheme for Narva river immediate catchment delineation

The monitoring data will be used to compare estimated input and input calculated based on the monitoring data. Inputs will be estimated for each sub-catchment using following mass balance equations:

Subsection 1 (Narva before Reservoir)

$I_2 = (I_1 + L_{1\_EST} + L_{1\_RUS}) * (1 - R_{1-2})$ (1)

Subsection 2 (Narva Reservoir)

$I_4 = (I_3 + I_2 + L_{2\_EST} * (1 - R_{2\_EST}) + L_{4\_EST} + L_{2\_RUS}) * (1 - R_{2-4})$ (2)

Subsection 3 (Monitored tributary – Plussa river)

$I_3 = L_{3\_RUS} * (1 - R_{3\_RUS})$ (3)

Subsection 4 (Narva from Reservoir till mouth)

$I_5 = (I_4 + L_{3\_EST} * (1 - R_{3\_EST}) + L_{5\_EST} + L_{4\_RUS}) * (1 - R_{4-5})$ (4)

Monitored inputs will be calculated as follows:

$I_1 \ldots I_5$ – total annual N and P input [t/a], calculated as:

$$I_i = 10^{-6} * \sum W_{imonth} * C_{imonth} \quad (5)$$

where

W_{imonth} - monthly water volume, m^3/month

C_{imonth} - measured N and P monthly concentration, mg/l

R_{1-2}, R_{2-4}, R_{4-5}– retention in Narva river main watercourse and Reservoir, unit fractions, defined according to the following equation:

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

Value of the hydraulic load HL is proportional to the specific runoff q [dm^3 km^{-2} sec^{-1}] and inversely proportional to the lake percentage W [% of catchment total area]:

$$HL = 3.15q/W \quad (7)$$

The specific runoff q [dm^3 km^{-2} s^{-1}] is determined with the runoff y [mm $year^{-1}$] as follows

$$q = 0.03171\ y \quad (8)$$

Nutrient load L (to the receiving waters, including catchment retention) will be calculated by following equation :

$$L = Lpoint + Ldif = L_{point} + L_{scattered} + L_{agri} + L_{other\_dif} + L_{atm} \quad (9)$$

L_{point} – based on statistical data for individual point sources, t/a

$L_{scattered}$ – based on person equivalent coefficients using the equation:

$$L^{N,P}_{scattered} = PE^{N,P} * l^{N,P}_{PE}\left(1 - R^{N,P}_{catchment}\right) * 365/1000 \quad (10)$$

where

$L^{N,P}_{scatterd}$ – N, P load from scattered dwellings, kg/a;

$PE^{N,P}$ – scattered population, as population equivalents;

$l^{N,P}_{PE}$ - population equivalent value (12 g/d for nitrogen and 1,6 g/d for phosphorus);

$R^{N,P}_{catchment}$ – retention (in model $R^{N,P}_{catchment}$=0.95 is used for scattered population load, 365 – days in year, 1000 – grams in kilograms)

L_{agri} – using 2 different approaches

1st approach – to be decided

2st approach – IEEP method used in Russia:

$$L_{agri} = \sum_{i=1}^{n_1} A_i (M_{soil\ i}\, K_1 + (\alpha_1 M_{min\ i} + \alpha_2 M_{org\ i}) K_6)\, K_2 K_3 K_4 K_5 / 1000 \quad , \quad (11)$$

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;

L_{other_dif} - diffuse load on catchment from the emission of nutrients from various types of land surface (natural and anthropogenic) excluding agricultural areas and load from population not connected to sewage system, is calculated as follows:

$$L_{other\_dif} = (C_u A_u + C_{for} A_{for} + C_{swa} A_{swa} + C_{mix} A_{mix}) y_i/1000, \quad (12)$$

where *Cu*, *Cfor*, *Cswa* and *Cmix* are the specific concentrations of nutrients in runoff from urban areas, the forest, swamps/peatlands land surface and mixed areas, accordingly [mg l^{-1}]. There are to datasets of specific concentrations: used in Estonian (approach 1) and in Russia (approach 2) Values for mean runoff conditions (280 -300 mm per year) are provided in the table 1.

Au, *Afor*, *Aswa* and *Amix* are the areas of the mentioned types, respectively, of a land surface [km^2],

y_i is a runoff from the above-mentioned areas [mm $year^{-1}$].

Table 1 - Specific concentrations of nutrients from different areas used in Estonia (approach 1) and Russia (approach 2).

Type of land cover	Swamps+ Peatland;	Forests	Urban areas (roads, paved areas)	Mixed (Other)
Runoff of total nitrogen, the mean value for kg/ha/a (Estonian estimates)	1.9...12	1.5...4.5		3
Runoff of total nitrogen, the mean value for kg/ha/a (Russian estimates)	2.1*		6.9	4.2
Runoff of total phosphorus, the mean value for kg/ha/a (Estonian estimates)	0.03...0.48	0.027…0.30		0.12
Runoff of total phosphorus, the mean value for kg/ha/a (Russian estimates)	0.15*		0.6	0.36

* there is an idea to use long-term measurements in upper reaches of the Plussa river to update these values

L_{atm} - Atmospheric load onto water surface area calculated:

$$L_{atm}=W*D \qquad (13)$$

where,

W- water surface area, km^2

D – annual deposition rates for N and P, kg /km^2 (table 2).

Table 2 – Total nitrogen and total phosphorous depositions rates used in Estonian and Russian assessments

Estimates	N deposition, kg /km^2	P deposition, kg /km^2
Estonian data	440	8.1
Russian data	0	3.2