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EE-RU NARVAWATMAN project results.
HARMONIZED METHOD FOR TRANSBOUNDARY NARVA RIVER DISCHARGE ESTIMATION

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11-15 July 2022

Haaliste river, credit, Ilmar Roosmaa, www.Soomaa.com

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Water Management of the Narva River: harmonization and sustention (NarvaWatMan)

Contents

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EUTROPHICATION STATUS OF THE BALTIC SEA 2007-2011, HELCOM

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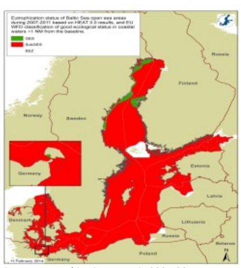

Figure 4. Eutrophication status in 2007-2011 was assessed as affected by eutrophication (red colour, status less than good; sub-GES) in all the open Baltic Sea sub-basins.

HELCOM reported that despite the mitigation measures taken to reduce nutrient inputs to the sea the good **eutrophication** status of the Baltic **Sea has not been achieved**.

Eutrophication - enrichment of water bodies with minerals and nutrients, particularly nitrogen and phosphorus.

Gulf of Finland is one of the areas affected by eutrophication and the Narva river (natural border between Estonia and Russia) is the channel through which nutrients reach the gulf and the sea and **if we want to reduce nutrient inputs we must do this together.**

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Other conserns, uncertainties

- Each country uses its own methods and measured data for the Narva river runoff estimation.
- Narva river runoff estimation: Russia – Narva HPP data, Estonia – data from Narva City monitoring station, which regime is affected by the backwater effect from the sea;
- Ntot and Ptot data sets from Estonia and Russia also differ quite a lot, so the data are difficult to compare;
- Nutrient's estimation is also done by different methods that makes analyses more difficult;
- Water quality in Estonian and Russian rivers is estimated by different methods and the results are difficult to compare;
- The share of nutrient loads from Estonian and Russian in the Narva river is not clear.

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How it all started?

To address these uncertainties, we need a common understanding of the problem, common data and methods, and if they exist, we will be able to find a common solution to problems or what nutrient reduction measures should be implemented.

To solve the problem a support program has been found…aimed to foster cross-border cooperation across the borders between the Republic of Estonia and the Russian Federation for 2014-2020.

Project "Water Management of the Narva River: harmonization and sustention" (NarvaWatMan)

Duration: 3 years, 15.03.2019- **end 14.03.2022, postponed due COVID-19**

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Project "Water Management of the Narva River: harmonization and sustention" (NarvaWatMan)

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Budget: *Total 565 850 EUR (90% Programme co-financing 509 265 EUR, 10% by partners 56 585 EUR)*

Project partners:
- Tallinn University of Technology (Lead Partner, Estonia)
- Federal State Budgetary Institution "State Hydrological Institute" (Partner 2, Russian Federation)
- State company "MINERAL" (Partner 3, Russian Federation).

Associated partners:
- Narva City Government, Department of Architecture and Urban Planning (Estonia)
- Administration of municipal formation «City Ivangorod Kingisepp municipal district of Leningrad Region» (Russia).

Human resources: 5 Professors, more than 20 Scientists and spesialists, MSc and PhD students…

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“Water Management of the Narva River: harmonization and sustention” (NarvaWatMan)

Overall objective: to contribute to the good status of the Baltic Sea.

Objectives:

- Narva river joint water assets effective management.
- Raising awareness and increasing cooperation in the field of environmental protection.
- Fulfilment by Estonia and Russia of International obligations (**Estonia-Russia Joint Commission** on the Protection and Sustainable **Use** of **Transboundary** Water Bodies **and HELCOM**) in achieving a healthy water environment in the Gulf of Finland of the Baltic Sea.

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Objectives

WP-s : Four Core Activities and Communication and Visibility

Development of harmonized methods for:

- **water discharge measurements** and Narva **river runoff** estimation;
- **water sampling and chemical analysis** of the samples, for **annual nutrients (Ntot and Ptot) load evaluation;**
- **joint complex index for water quality assessment;**
- **total nutrient load** estimation and assessment Estonian and Russian contribution to it;

Raised awareness and **increased cooperation** in the field of **environmental protection**.

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Objectives

Development of recommendations for:

- improving the accuracy of observations and runoff estimation;
- preparing information on nutrients load to HELCOM and Est-Rus JC;
- nutrient reduction measures aiming at fulfillment of HELCOM ceilings for the Gulf of Finland;

4 Workshops for discussion and approvement of all proposed harmonised methods and recommendations

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First steps: Kick off meeting, Tallinn, 23-24 March 2019

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Final Conference, March 1, 2022

Developed harmonized methods for:

- **water discharge measurements** and Narva **river runoff** estimation;
- **water sampling and chemical analysis** of the samples, for **annual nutrients (Ntot and Ptot) load evaluation;**
- **joint complex index for water quality assessment;**
- **total nutrient load** estimation and assessment Estonian and Russian contribution to it;

Recommendations for:

- improving the accuracy of observations and runoff estimation;
- preparing information on nutrients load to HELCOM and Est-Rus JC;
- nutrient reduction measures aiming at fulfillment of HELCOM ceilings for the Gulf of Finland;

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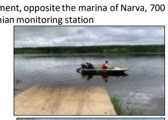
Field measurements, simultaneously

Discharge measurements: 64 discharges were measured, by ADCP…

3 hydrometric cross-sections:

- № 1 – headrace channel of the Narva HEPS, dam bridge 240 m below the channel head;
- № 2 – Narva river, section between fortresses, 150 m above the «Druzba» bridge; Temporary level gauge, 200 m – below Narva HEPS;
- № 3 – Narva river, fishing embankment, opposite the marina of Narva, 700 m below the «Druzba» bridge. Estonian monitoring station



HARMONIZED METHOD FOR TRANSBOUNDARY NARVA RIVER DISCHARGE ESTIMATION

Initial data for the calculation

To justify the methodology, daily (average daily) and hourly data of water levels observations at the following observation points were used:

- the tail water of the Narva HEPS (Narva Hydropower Plant);
- temporary water lever recorder of "State Hydrological Institute" (in the period from 31.07.2019 to 16.06.2020);
- hydrological gauge of the Narva river – Narva city and the city of Narva-Jõesuu.

To obtain the calculated dependencies of the river water runoff estimation methodology on the Estonian side, data from measured water discharges and water levels obtained within the framework of the project in 2019-2020 (57 measured water discharges (MWD)) and water discharges measured on the Estonian monitoring station in the period 2006 - 2014 (128 MWD) were used. For each water discharge measurement, the values of water levels observed at the time of discharge measurement at the Narva HGS tail water (Narva HGS/TW) and Narva – Jõesuu gauges were clarified.

Narva river discharge estimation methodology

The discrepancy between Russian and Estonian long-term data:

- in the daily discharges vary from 346 m^3/s (26/12/2009) to 861 m^3/s (15/04/2010).
- in the monthly discharges - from 2,0 % to 45-46 % (January 2003, 2016).
- in annual water discharges - from 2,6 % (2007) to 28,9 % (2010).

Est – discharges measured, Russia – discharges calculated by electricity production at HEPS

One of the main reasons is the Narva River "backwater" effect from the sea and daily regulation.

Data:

- observations of water **levels** and water **discharges** for period from 2003 to 2020 were used from the Estonian Narva city gauge monitoring station and the Narva-Jõesuu estuary gauge station, from the Russian side - Narva HEPS,
- observations and measurements obtained during joint Russian-Estonian experimental studies 2019-2020 on the mouth part of the Narva River lower the Narva HEPS.

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Discharge estimation methodology

Various methods for discharge estimation were analysed from Estonian side:

DISCHARGE RATINGS USING SIMPLE STAGE-DISCHARGE RELATIONS	• Currently in use in Estonia • Discharge depends on the stage alone	$Q = C_D B H^{\beta}$
DISCHARGE RATINGS USING THE VELOCITY INDEX METHOD	• Variable backwater • Constantly velocity measuring • A=f(H) • $V=f(V_i)$	$Q = VA$
DISCHARGE RATINGS USING SLOPE AS A PARAMETER	• Backwater or very unsteady flow • At a given stage, the slope is a variable	$\left(Q_m/Q_r\right) = \left(F_m/F_r\right)^n$
LINEAR INTERPOLATION	• Linear interpolation between available discharge values	

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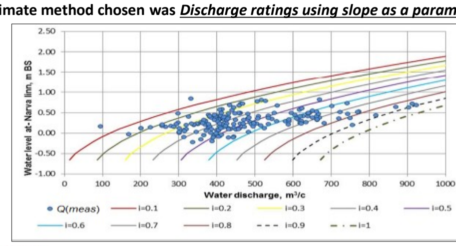
Discharge estimation methodology

The ultimate method chosen was *Discharge ratings using slope as a parameter*



Dependence of water discharge on the water level of the Narva – Narva linn and the slope of the water surface at the Narva HGS(TW) - Narva linn

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The main provisions of the methodology for the water flow regime in the downstream of the Narva HEPS, close to steady (stationary)

The best calculated dependence is obtained in the form of a multiple regression equation using the following predictors:

- the water level at the Narva city (Narvalinn) gauge, expressed in m of the Baltic System;
- the square of the water level according to the gauge Narva city (H_{Narva}^2);
- the slope of the water surface on the Narva River section from the tail water of the Narva HEPS to the Narva city gauge ($I_{HEPS(TW)–Narva}$), expressed in ppm (‰).

$$Q(H_{Narva\ linn}, I_{HGC(TW)--Narva}) = 46,9 + 241.3905 H_{Narva\ l} + 119,22152 H^2_{Narva\ l} + 732,105 I_{HGC(TW)—Narva\ linn}.$$

The equation has the following approximation quality characteristics:
$\tilde{q}_{av}$ = 0,0, $\sigma_{\tilde{q}}$ = 0,081.

Narva linn – Narva city

Unsteady flow movement

The greatest data discrepancies were observed during periods of intensive daily regulation of discharges at the Narva HEPS, up to a complete shutdown of the turbines.

In such conditions, it is necessary to take into account the effects of unsteady movement and calculations must be performed based on **frequent observations of water levels and slopes** of the water surface.

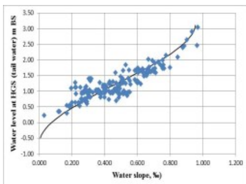
It has been determined that the mode of unsteady flow movement can be detected only from observations of water levels downstream of the HEPS or according to the AHC (automated hydrological complex) of SHI. According to observations at the GP Narva, it was impossible to identify the dependencies of Q(H) and I(H) of steady motion.

To estimate the unsteadiness of the flow, the parameter is used

$$\chi = \frac{|\Delta I|}{I_{st}},$$

$|\Delta I|$ – the modulus of the difference in the slopes of the water surface: the observed I_m and the slope of the steady flow I_{st}. River flow downstream of the Narva HGS should be considered to be steady if the value of the parameter χ does not exceed the value of 0,05: $\chi \leq$ 0,05.

Dependence of the slopes of the water surface on the water levels in the conditions of steady flow at the site downstream from the Narva HGS to the gauge Narva linn



Dependence of water discharges on water levels of steady flow

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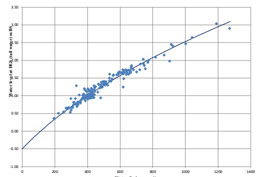

$I(H_{HEPS/TW-}) = 0.0763 + 0.2135\,H_{HEPS/TW} + 0.1286\,H^2_{HEPS/TW} - 0.0342\,H^3_{HEPS/TW}$

$Q(H_{HGS/TW-}) = 100{,}52 + 264.7608\,H_{HGS/TW} + 33{,}676\,H^2_{HGS/TW}.$

The main provisions of the methodology for the conditions of pronounced unsteadiness of the flow in the tail water of the Narva HEPS

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To calculate water discharges during periods of intensive daily regulation with pronounced unsteadiness of the flow, the Jones equation was used :

$$Q_p = Q_{st}\sqrt{\left|1+\frac{\Delta I}{I_{st}}\right|}$$

Q_{st} and Is_t are water discharges and slope of the water surface of steady flow, respectively;
$\Delta I = I - I_{st}$, I is the observed slope of the water surface.

The values of Q_{st} and I_{st} are determined from hourly observations of the water level according to dependencies on the previous slides. The values of ΔI are determined from hourly observations of water levels in the tail water of the Narva HGS and at the Narva city hydrological monitoring station.

Comparison of estimated water discharges of the Narva river below the Narva HEPS (HPP) by diferent methods

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Year / Method	2003	2004	2005	2006	2007	2008	2009	2010	2011
Estimations of average annual water discharges, m³/c									
HEPS	313	469	434	271	341	424	478	440	431
Met.SHI	342	501	475	288	368	441	482	528	466
Est	391	483	459	287	350	441	495	574	514
Discrepancies in average annual water discharges, %									
Met.SHI	-8.5	-6.4	-8.6	-5.9	-7.3	-3.9	-0.8	-16.7	-7.5
Est	-19.9	-2.9	-5.4	-5.6	-2.6	-3.9	-3.4	-23.3	-16.1
Average quadratic discrepancies of average monthly water discharges, %									
Met.SHI	11.1	7.6	12.2	9.1	10.5	6.8	2.3	20.4	11.1
Est	27.0	11.2	18.3	8.5	8.2	12.3	20.7	28.9	19.3

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Year / Method	2012	2013	2014	2015	2016	2017	2018	2019	2020
HEPS	362	390	300	297	323	485	418	314	378
Met.SHI	394	456	328	344	349	521	445	326	387
Est	436	486	411	390	409	579	432	353	403
	Discrepancies in average annual water discharges, %								
Met.SHI	-8.1	-14.5	-8.5	-13.7	-7.45	-6.07	-6.07	-3.68	-2.33
Est	-17.0	-19.8	-27.0	-23.8	-21.0	-3.24	-3.24	-11.1	-6.20
Average quadratic discrepancies of average monthly water discharges, %									
Met.SHI	12.1	17.7	9.2	17.8	8.29	9.0	9.0	8.4	5.0
Est	20.9	22.1	29.6	31.8	24.4	25.3	25.3	27.6	18.0

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Recommendations…

In order to obtain the average annual discharge of the Narva River agreed between Russia and Estonia and submit it to international organizations (for example, to HELCOM), the average annual (monthly, daily) values of water discharge calculated according to the calculation formulas at the Narva HGS (HEPS) and according to the hydrometric river runoff estimation method for the Estonian gauge of the Narva river – Narva city are averaged through the arithmetic mean.

In order to improve the accuracy of water discharge measurements and calculations of the runoff of the Narva River in the future, it is necessary to implement a number of recommendations related to the graduation of the Narva HGS (HEPS), the opening of an additional level gauge on the Estonian side, etc. Detailed recommendations are presented in a separate document.

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SAMPLING ON NARVA RIVER DURING THE PROJECT

- Sampling took place at two locations on the Narva River
  1) ~ 11 km from the river delta
  2) ~ 6 km from the river delta
- Sampling carried out:

	2019	2020	2021
1	21/08/2019	Canceled due to Covid	20/05/2021
2	16/10/2019		16/06/2021
3			24/08/2021
4			07/09/2021

- Analyzed in the laboratory: N_{tot}, P_{tot}
- Measured on-site: pH, conductivity, dissolved oxygen
- Standard methods EST: ISO standards EVS-EN ISO 6878 for phosphorus, ISO 11905 and ISO 13395 for nitrogen.

1 March 2022, NarvaWatMan, Final Conference

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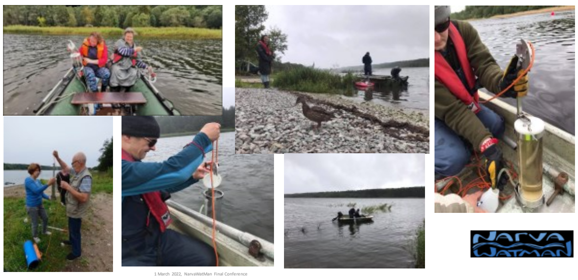
Samples were taken with a bathometer



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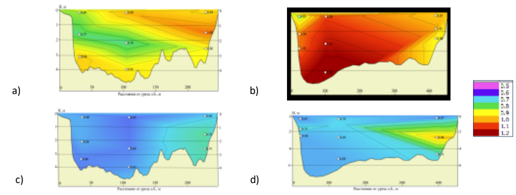
Joint method for annual riverine nutrients load evaluation

Ntotal distribution



Ntot distribution at hydrochemical cross-sections №4 (a and c) and №5 (b and d) on 21.08.2019 (a and b) and 16.10.**2019** (c and d)

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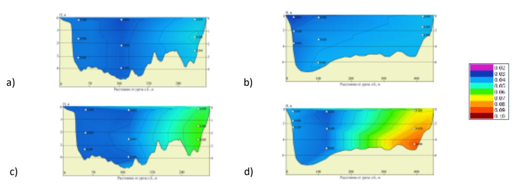
Ptotal distribution



Ptot distribution at hydrochemical cross-sections №4 (a and c) and №5 (b and d) on 21.08.2019 (a and b) and 16.10.**2019** (c and d)

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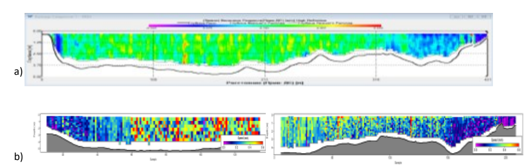
Discharge distribution



Discharge distribution at hydrochemical **cross-sections №4** on 21.08.2019 (a) and 05.09.2021 (b)

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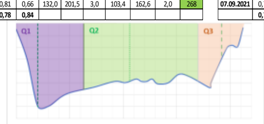
Ntot load

Cross-section 4

	I	II	III	Q1	Q2	Q3	Load1	Load2	Load3	Sum
21.08.2019	0,86	0,89	0,96	56,7	141,0	2,3	48,7	125,5	2,3	176
16.10.2019	0,67	0,66	0,73	98,7	201,1	3,2	66,4	132,8	2,3	202
20.05.2021	0,70	0,72	0,99	166,0	477,4	6,9	116,2	345,3	6,8	468
16.06.2021	0,84	0,82	0,95	136,5	278,4	4,4	114,2	228,3	4,2	347
24.08.2021	0,80	0,80	0,73	136,0	226,0	4,0	108,8	180,8	2,9	293
07.09.2021	0,78	0,81	0,66	132,0	201,5	3,0	103,4	162,6	2,0	268
	0,78	**0,78**	**0,84**							

Cross-section 5

	I	II	III	Q1	Q2	Q3	Load1	Load2	Load3	Sum
21.08.2019	0,97	1,17	0,96	83,0	113,0	5,4	80,8	132,2	5,2	218
16.10.2019	0,69	0,69	0,78	109,1	127,7	66,2	74,9	88,1	51,6	215
20.05.2021	0,71	0,72	1,01	218,0	290,2	142,0	154,1	209,9	143,4	507
16.06.2021	0,87	0,81	1,00	151,0	176,7	91,6	131,4	142,6	91,6	366
24.08.2021	0,76	0,77	0,73	139,0	142,6	84,4	106,1	110,3	61,9	278
07.09.2021	0,75	0,75	0,69	123,0	144,2	69,4	92,3	108,1	47,7	248
	0,76	**0,75**	**0,86**							



Annual riverine nutrients load evaluation

Ntot/Ptot load

Ntot, an = $(Ntot,_{RGM} + Ntot, BVH\pi r^2$

k Est = 0,78 k Rus = 0,22

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WQI for NarvaWatMan project

- For the evaluation of water quality in the project, the so called **Canadian WQI (CCME WQI)** was chosen as a base method
- The CCME WQI (2001) is based on the index developed by the British Columbia Ministry of Environment, Lands and Parks
- The CCME WQI can be applied in a variety of situations because of its ease of calculations and flexibility
- The WQI equation is made up of 3 factors $WQI = \frac{F_1 + F_2 + F_3}{3}$

F_1 **Scope** - percent of parameters that exceed (or are below if e.g. O_2) the standards or limit values
F_2 **Frequency** - percentage of individual tests that exceed the standards or limits.
F_3 **Amplitude** - represents the amount by which failed test values do not meet their guidelines.

<55	55-65	65-80	80-90	90-100
Bad	Poor	Moderate	Good	Excellent

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Limit values for WQI

Nr	Parameter	Limit values		
		type A dark	type B light	Narva river
1	pH	6.5-8.5	6.5-8.5	6.5-8.5
2	O_2; % Winter (dec-apr)	60	70	70
	Warm time (may – nov)	70	80	80
3	Conductivity; µS/cm	620	420	350
4	BOD_5; mgO_2/l	2,3	2,3	2,0
5	COD_{Cr}; mgO/l	61	29	34
	COD_{Mn}; mgO/l	40	19	22
6	N_{tot}; mgN/l	1,6	1,6	1,0
7	NH_4^+; mgN/l	0,2	0,2	0,1
8	NO_3^-; mgN/l	1,0	1,0	0,3
9	P_{tot}; mgP/l	0,06	0,07	0,05
10	PO_4^{3-}; mgP/l	0,04	0,02	0,02

- Questionnaire to the experts
- Proposals of parameters and their limit values (working seminars with experts)
- Chosen limit values in agreement with experts in both Estonia and Russia

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Long term results (8-17 years)

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Russian rivers

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Utroya	Утроя_Пот_ПВХ										67,7	69,7	67,4	71,2	64,3	61,9	76,6	63,7
Velikaya	Великая_Вяз_ПВХ									83,9	100,0	96,8	89,3	79,8	91,7	90,1	89,4	81,0
Velikaya	Великая_Псков_РГМ	59,9	71,6	65,9	61,4	63,0	66,6	76,9	78,5	69,6	70,3	69,7	69,8	68,9	67,1	67,9	80,3	73,6
Gdovka	Гдовка_РГМ	61,2	76,6	61,6	59,2	61,1	73,0	77,1	70,1	81,8	66,9	71,4	65,0	52,5	67,6	71,3	52,9	66,0
Zhelcha	Желча_РГМ	81,0	94,5	93,7	89,8	91,0	81,8	79,0	69,6	93,0	80,7	88,5	90,1	81,6	85,0	74,7	87,4	81,0
Plussa	Плюсса_Сл_РГМ	78,8	80,8	86,1	74,1	83,3	72,7	81,8	85,6	84,6	89,7	84,4	92,8	93,4	78,4	81,1	87,1	83,1
Narva	Нарва_исток_БВХ									81,3	84,5	84,8	92,7	83,8	82,4	83,2	81,2	86,0
Narva	Нарва_Ив_РГМ				74,7	87,2	82,1	88,6	87,6	86,4	84,9	90,1	91,9	84,8	90,7	85,2	80,5	83,7

Estonian rivers

River	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Narva_Narva	71.3	72.8	71.0	71.0	74.7	71.2	75.3	81.7	76.6	85.4	83.9	90.9	89.9	86.5	82.2	86.1	88.2
Narva_Vasknarva	81.8	84.3	73.6	83.4	74.7	71.9	73.3	83.5	78.6	83.6	90.3	91.1	93.4	91.1	85.4	88.2	93.9
Emajõgi_Kavastu	54.6	62.5	65.6	62.6	63.1	62.8	64.3	63.6	67.3	60.2	67.8	69.1	66.1	59.9	68.4	70.7	66.9
Avijõgi	64.1	72.3	71.4	64.6	75.4	66.9	66.7	72.0	67.0	67.5	70.0	67.0	68.2	64.0	71.6	64.3	68.1
Alajõgi	78.1	76.9	87.8	74.8	82.5	73.1	82.5	85.4	77.8	83.7	90.4	88.2	87.8	77.2	89.2	89.4	81.8

<55	55-65	65-80	80-90	90-100
Bad	Poor	Moderate	Good	Excellent

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Water Quality Index (WQI) map, 2019

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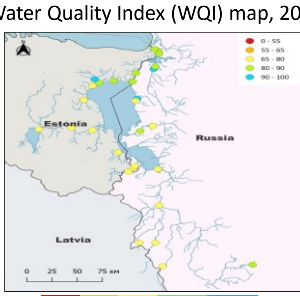

Bad	Poor	Moderate	Good	Excellent

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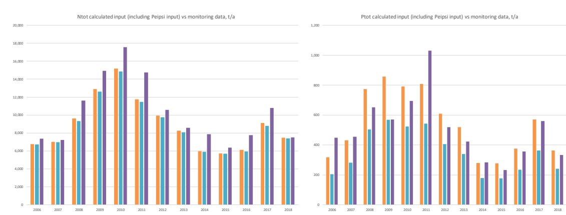
Proposals for developing a joint methodology determining the share of contributions from Estonian and Russian territory in the total nutrient load coming with river Narva to the Gulf of Finland



Shares of nutrient load from diferent sources, Est and Rus, %

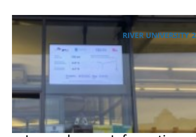
Nitrogen	Russian contribution, %	Estonian Contribution, %
Total input to the sea according to the Russian method	73	27
Total input to the sea according to the Estonian method	77	23
Point sources loads	20	80
Natural background loads according to the Russian method	88	12
Natural background loads according to the Estonian method	89	11
Natural areas	91	9
Agricultural loads according to the Russian method	66	34
Agriculture loads according to the Estonian method	76	24
Agricultural areas	70	30
Urban (artificial areas)	43	57

Phosphorous	Russian contribution, %	Estonian Contribution , %
Total input to the sea according to the Russian method	81	19
Total input to the sea according to the Estonian method	71	29
Point sources loads	76	24
Natural background loads according to the Russian method	88	12
Natural background loads according to the Estonian method	89	11
Natural areas	91	9
Agricultural loads according to the Russian method	72	28
Agriculture loads according to the Estonian method	77	23
Agricultural areas	70	30
Urban (artificial areas)	43	57

Activities and results, 2019-2022

- Field measurements
- Developed harmonized methods
- Recommendations
- Environmental awareness and cooperation events

Four eco-marathons: 2 summer and 2 winter...thematic: eco-art, eco-sport,eco-lab,competition teaching excellence



Narva Joaoru house, Information panel
https://narvailm.visitnarva.ee

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Reseach outputs

Three Master's theses, defended at Tallinn University of Technology (2020, 2021) ;

Four PhD students;

Organization of special sessions on the Baltic Sea Day Forum (St-Peterburg) with presentations of the project results (2019, 2021);

Presentation of the project results at the meetings of **HELCOM** and **Estonia-Russia Joint Commission** on the Protection and Sustainable Use of Transboundary Water Bodies;

Two research papers have been already published, two are in the pipeline…

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Reseach outputs

Workshops: 4 with participation of more than 40 experts totally from both countries;

Four developed methods on: runoff estimation, nutrients distribution by the depths and widths, water quality index assessment, estimation of nutrients input from different sources …

Three documents with recommendations…

The water quality of the Narva river is GOOD!

At the source and mouth of the river! In the future – focus on the Lake Peipsi catchment area…

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Conclusions and perspectives

Challenges

Data availability in the Narva river catchment area from Estonia and Russia:

- not enough monitoring sites, agreed from the both sides,
- not enough measured data, especially extremes,
- non homogeneous data,
- field measurements were impossible in time, crossing the river was stopped (COVID restriction)
- different observation periods,
- different measured chemical parameters, different units,
- not enough statistical, especially chemical, data,
- different approaches for estimation river runoff and pollution loads from different sources,

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„Perspectives"

- To analyse existing monitoring sites for their representativeness; to agree on a new location for the hydrological and hydrochemical monitoring sites on the Narva River as proposed in the Recommendations;
- To develop a common database for hydrological, chemical and biological data from the whole Narva river (and Lake Peipsi) catchment area; common GIS; to carry out experimental measurements to investigate the pollution loads from different land types…
- To grant special status to the Narva river, Narva reservoir and Lake Peipsi to enable the water border to be crossed for scientific and monitoring purposes

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THANK YOU

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MORE INFORMATION HERE: www.narvawatman.com

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