BASE Project - Implementation of the Baltic Sea Action Plan in Russia

Baltic Marine Environment Protection Commission

Nutrient loads to the Baltic Sea from Kaliningrad Oblast and transboundary rivers

Pilot Activity	Assessment and quantification of nutrient loads to the Baltic Sea from Kaliningrad Oblast and transboundary rivers, and the evaluation of their sources
Implemented by (Main Consultant)	ECOGLOBUS Ltd., Baltic Institute for Ecology of Hydrosphere (BIEH)
Support provided by (EU Expert)	Pöyry Finland Oy
Authors of the report	Dmitry Domnin, Boris Chubarenko, Konstantin Karmanov, Vasiliy Pilipchuk, Anna Korzun, Nadezhda Nagornova, Natalia Oblomkova, Jaakko Saukkoriipi, Esa Salminen
Report compiled by	Dmitry Domnin, Boris Chubarenko, Konstantin Karmanov, Vasiliy Pilipchuk, Anna Korzun, Nadezhda Nagornova, Natalia Oblomkova, Jaakko Saukkoriipi, Esa Salminen
The following people and organizations have participated in the compilation of this report	Dmitry Domnin, Boris Chubarenko, Konstantin Karmanov, Vasiliy Pilipchuk (BIEH) Anna Korzun (ECOGLOBUS Ltd.), Nadezhda Nagornova (Kaliningrad State Technical University) Natalia Oblomkova (SPb PO 'Ecology and Business') Jaakko Saukkoriipi, Esa Salminen (Pöyry Finland Oy)
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Summary

This report presents results of the pilot activity ”Assessment and quantification of nutrient loads and hazardous substances to the Baltic Sea from Kaliningrad Region and the evaluation of their sources” implemented under the BASE Project. These include quantification and assessment of the total annual load of nutrients to the Baltic Sea from Kaliningrad Oblast based on the implemented 4 sampling rounds inthe Pregolya river and its 12 tributaries, in a number of rivers of Curonian and Vistula lagoons. The assessment of the transboundary nutrients inputs to Kaliningrad Oblast (with a specific focus on Neman river and Matrosovka Canal) and proposals for common methodology on how to quantify the transboundary loads are also elaborated and described.

According to the implemented monitroing activities the Instruch, the Angrapa, the Golubaya, the Stream Glubokij, and the Lava River in total bring 8111 tons of total nitrogen and 369 tons of phosphorus a year. Before branching Dejma river total nutrient load of the Pregolya is 5595 tons of total nitrogen and 221 tons of total phosphorus a year. Correspondingly, difference between the values of received nutrients from the tributaries and the data at the station accounts for 2516 tons of nitrogen and 148 tons of phosphorus, that is the amount held by the river itself.

The main tributary of the Pregolya River is the cross-border Lava River, more than half of which water basin is located in Poland.
Total amount of total nitrogen to the Vistula Lagoon is 5384 tons a year, whereas total phosphorus – 529 tons a year. Out of this amount - 69% of nitrogen comes from the Pregolya River and 26% - from the Kaliningrad Waste Canal. For phosphorus the correlation is different: 48% of total nitrogen comes from the Pregolya River and 46% - from the Kaliningrad Waste Canal.

Total amount of total nitrogen in water delivered to Curonian Lagoon in 2013-2014 was 9459 tons per year, and total phosphorus – 332 tons per year.

The assessment of the transboundary nutrient load into the Kaliningrad Oblast (Neman River and Matrosovka Canal) has been made using the ILLM (Institute of Limnology Load Model) According to the results the average annual load in the period 2010-2013 from Russia part of the catchment to the Baltic Sea via Neman and Matrosovka rivers constitutes 700 tonnes of total nitrogen and 200 tonnes of total phosphorous. These figures tentatively constitute 1.6 % for total nitrogen load and 12 % for total phosphorous load coming with river Neman to the Baltic Sea.

The main part of this total Russian load coming with Neman river to the Baltic Sea refer to diffuse sources (more that 70 %), namely to agriculture sector – run-off from arable lands and emissions of organic and mineral runoff from agricultural land and emissions of organic and mineral fertilizers.

Based on carried out works the approximate total nutrient load from the Kaliningard Oblast to the Baltic Sea, coming with main rivers investigated in the BASE Project as well as Russian share in the total load with river Neman, constitutes 10 667 t/a for Ntot and 927 t/a for Ptot.

Received results of hydrological and hydrochemical surveys are a matter of judgment. Thus, for more detailed analysis of water bodies of the Kaliningrad Oblast it would be sensible to elaborate a more frequent monitoring scheme (e.g. carried out monthly), which will include Ntot and Ptot parameters.

Moreover, applying ILLM model on the regular basis for quantification transboundary nutrient load should be ensured by the improvement of the input data, namely the statistical data on amount of the nitrogen and phosphorous appearing with the fertilizer applying, number of animals etc.

All mentioned activities have been implemented in close cooperation with Supporting Consultant (Pöyry Finland Oy) and other experts.

During the pilot activity implementation the its preliminary results have been presented on several relevant HELCOM meeting and also on the special monitoring round table within XV International Environmental Forum “Baltic Sea Day”. All comments received in the outcome of these meetings have been taken into account within pilot project implementation and also when preparing this report.

1 Introduction

Incompleteness of nutrient load data from catchments of Kaliningrad Oblast of Russia prevents measuring the Russian progress in achievement of the nutrient reduction targets in the HELCOM Baltic Sea Action Plan.

To obtain the complete data of the nutrient load from unmonitored areas of Kaliningrad Oblast of Russia as well as the share of Russian load in total load coming with watersheds to Vistula and Curonian Lagoons, including transboundary share, should be estimated. Moreover lack of the data concerning inputs of different sources of the Russian part of the catchment area hinders the developing of the cost effective measures, for achieving HELCOM reduction targets.

This report was prepared under the Agreement between Helsinki Commission (HELCOM) and “Ecoglobus” Ltd. on assessment and quantification of nutrient loads to the Baltic Sea from Kaliningrad Oblast and transboundary rivers, and the evaluation of their sources (within the frameworks of the BASE Project) (“RU Expert”). Pöyry Finland Oy as supporting consultant (“EU Expert”) participated and supported the RU Expert in the work also taking part in the development of the sampling plans and participating the second round of sampling.

The aim of these activities within the BASE Project is quantifying waterborne loads to the Baltic Sea from Russia and assessing the achievement of HELCOM nutrient reduction targets and environmental objectives with regard to eutrophication.

The core objective of the work in the Kaliningrad Oblast is assessment of inflow of biogenic matters to the main water streams of the Oblast. One has conducted the analysis of volume of nitrogen and phosphorus coming from the catchment area. Besides, there was assessment of potential sources of inflow of biogenes, as well as asessment of the Russain share in total load, coming with transboundary rivers. To make an analytical assessment one conducted an integrated programme of works on determination of hydrological and morphometric characteristics of water objects and water sampling on total nitrogen and phosphorus. The monitoring was done in 4 steps in the crucial seasons on 20 water objects.

2 Quantification and assessment of the total annual load of nutrients (to the Baltic Sea from Kaliningrad Oblast)

2.1 Background

The Kaliningrad Oblast is located within the catchment areas of the Vistula and Curonian lagoons which are the part of the Baltic Sea basin (Figure 2.1).

Figure 2.1 – Watershed area of South-eastern Baltic

The Neman is the main river in the basin of the Curonian lagoon. The upper part of its catchment area (47%) is located in Belarus, the rest part in practice is on the territory of Lithuania. The Sheshupe river that is the lowermost largest tributary of the Neman originates from Lithuania and captures the part of the Kaliningrad Oblast. The state border between Lithuania and Russia passes on the Neman river. The Matrosov Canal is the arm of the Neman that is located on the territory of the Kaliningrad Oblast. It begins 48 km above the river mouth, below the Sovietsk town. The length of the river is 40 km, the width is about 70 metres, the depth reaches 3 metres on the fairway. The river falls into the Curonian lagoon.

The Vistula lagoon is the transboundary (between Russia and Poland) insular lagoon with the one strait (the Baltic strait) connecting the lagoon with the Baltic Sea. Formation of the river flow into the lagoon occurs on the territory of Poland and the Kaliningrad Oblast of the Russian Federation. The main river feeding the Vistula lagoon is the Pregolya river with the catchment area of 13.7 thousand km^2. The Pregolya originates from conflux of the rivers of Instruch and Angrapa. The lower part of its basin (49%) takes the major part of the territory of the Kaliningrad Oblast but the upper part of the basin (51%) is on the territory of Poland where almost all its tributaries originates from. Only the small part of its basin (ca 60 km^2) is located in Lithuania in the area of Vyshtynets lake. (Domnin, Chubarenko, 2007).

Thus, each of the country namely Lithuania, Poland and Russia (within the Kaliningrad Oblast) owners the part of the transboundary basins of the Vistula and Curonian lagoons. Therefore the responsibility for quality of waters going from the catchment area to the south-eastern part of the Baltic sea is distributed between these countries. (Domnin, Chubarenko, 2012).

Around 1.53 km^3 of water per year (44%) comes to the Vistula lagoon from the the catchment area of the Pregolya river. All other rivers bring to the lagoon 1.96 km^3 of water per year (56%) [Silich, 1971]. The peculiarity of the flow off from the territory of the catchment area of the Pregolya river is the fact that in the area of Gvargejsk (56 km above the mouth) the main course of the Pregolya river branches into two arms. The first, that is the Pregolya itself, brings 60% of waters into the Vistula lagoon, but the second is the Deyma river that gives about 40% of waters to the Curonian lagoon. [Markova, 1999]. Besides, there is permanent water exchange between the Vistula lagoon and the Baltic sea through the Baltic strait. 20.5 km^3 of water per year goes from the lagoon to the sea, and back to the lagoon – 17 km^3; the existing variance in 3.5 km^3 of water per year is the fresh-water component of the water balance of the Vistula lagoon.[Silich, 1971].

The following rivers are referred to the right tributaries of the Pregolya: the Instruch, Gremyachiya, Glubokaya, Gurievka, Lakovka; to the left tributaries: the Angrapa, Golubaya, Bolshaya, Lava, Gvardejskaya, Bobrovaya, Bajdyukovka. Moreover, on the territory of the Kaliningrad Oblast some large rivers such as Primorskaya, Nelma, Prokhladnaya and Mamonovka, and the Kaliningrad Waste Channel fall into the Vistula lagoon. The Lava river, being the main tributary of the Pregolya, is regulated. Thereare two hydro power stations: in the town of Pravdinsk and in the settlement of Kurortny (non-operational).

According to the data from Kaliningrad Center of Hydrometeorology and Monitoring of Environment the average annual river discharge of the Pregolya river (the station of Gvardejsk before braiding of river channel) amounts 77 m^3/s, of the Matrosov Canal (the station of Mostovoye) – 130 m^3/s.

More than a half of the catchment area (54%) is occupied by agricultural areas. By 16% is accounted for by deciduous and mixed forests and open spaces, ca 9% – for coniferous forest, 3% is occupied by lands of towns and 2% is accounted for by surface inland water bodies. (Figure 2.2).

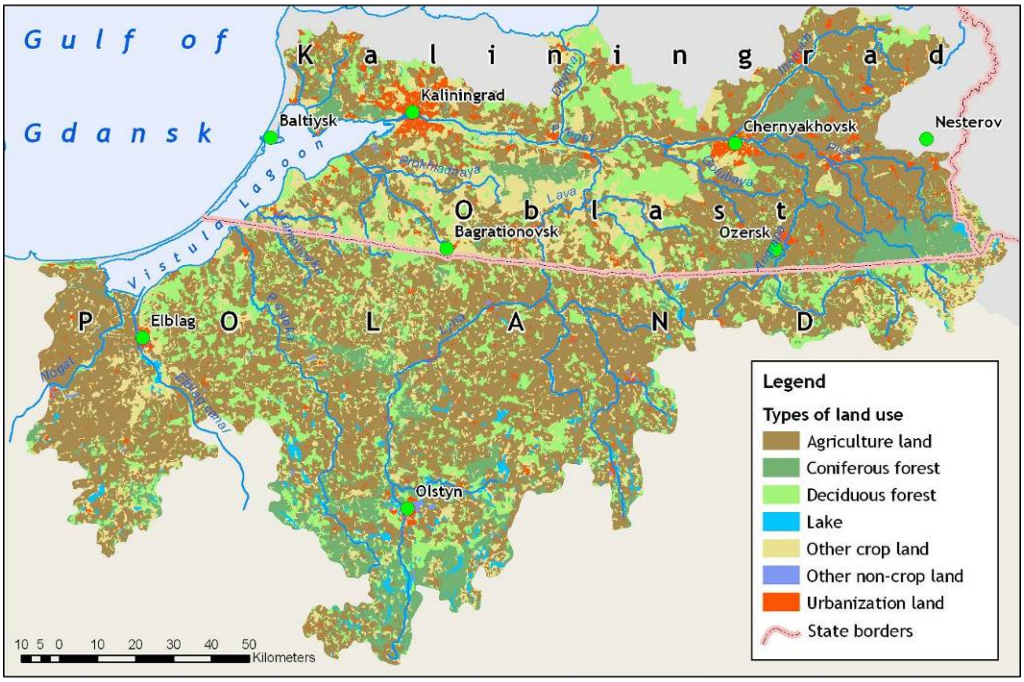


Figure 2.2 - The scheme of use of lands of the catchment area of the Vistula lagoon

To the main point pollution source one can refer waste waters of the settlements of the region itself and adjacent territories. The agricultural lands are referred to diffuse sources where mineral and organic fertilizers from animal farms are being applied to. There are peaty soil, fine-grained soil, medium-grained soil and coarse-grained soil, morainicrubbly clay on the territory of the catchment area.

2.2 Description of the previous and ongoing monitoring activities for nutrient loads assessment

Today Kaliningrad Center of Hydrometeorology and Monitoring of Environment is the main organization conducting continuous monitoring of the state of surface water objects. The Center collects information on hydrological and hydrochemical parameters of water objects. Table 2.1.

Table 2.1 Hydrological and hydrochemical parameters measured on the main water objects of the Kaliningrad Oblast.

No	River	Station	Hydrological parr.	Hydrochemical parr.
1	Matrosovka	Mostovoe	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4
	Neman	Sovetsk	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4
	Sheshupe	Dolgoe	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4
2	Pregolya	Chenyakhovsk	Level, discharge	
3	Pregolya	Gvardeysk	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4
4	Pregolya	Kaliningrad		N-NH_4, N-NO_3, N-NO_2, P-PO_4

5	Deyma	Gvardeysk	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4
6	Deyma	Polessk	Level	
7	Instruch	Uliyanovo	Level, discharge	
8	Angrapa	Berestovo	Level	N-NH_4, N-NO_3, N-NO_2, P-PO_4
	Lava	Znamensk		N-NH_4, N-NO_3, N-NO_2, P-PO_4
9	Lava	Rodniki	Level, discharge	
10	Mamonovka	Mamonovo	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4
11	Nelma	Kostrovo	Level, discharge	N-NH_4, N-NO_3, N-NO_2, P-PO_4

On the materials of the Scheme of integrated use and protection of water objects the today`s technical state of the existing stations of the state observation network does not meet the modern requirements and there is a need to make technical re-equipment and modernization including installation of automated measurement systems. The state observation network requires development including opening of additional monitoring points and modernization of monitoring technologies. Currently there is no a united basin programme coordinating activities of all departments conducting monitoring in the Kaliningrad Oblast. The disadvantage of hydrochemical monitoring is the fact that measured hydrochemical indicators and frequency of sampling from water objects do not meet recommendations of HELCOM: data on total content of nitrogen and phosphorus are absent among the measured indicators.

It is worth noting that the target indicators of water quality on compounds of nitrogen (ammonium (NH_4-N) and nitrate (NO_3-N) nitrogen) and phosphorus (phosphate phosphorus (PO_4-P)) are provided in accordance with the Russian regulatory framework. However, for purposes of eutrophication prevention of the Baltic Sea within implementation of the Action plan of HELCOM on the Baltic Sea by Russia, rationing of compounds of nitrogen and phosphorus should be carried out according to such indicators as total nitrogen (N_{tot}) and total phosphorus (P_{tot}). There is no data on indicators of water quality either in the programme of hydrochemical monitoring of surface waters performed by Federal state budgetary institution «Kaliningrad Center for Hydrometeorology and Environmental Monitoring» or in the Russian system of maximum permissible concentrations (MPS).

Apart from the official state hydrological monitoring on the determined network of stations, works on analysis of the main hydrological parameters and sampling on hydrochemical indicators are being carried out by leading profile organizations of the Kaliningrad Oblast within study and scientific programmes. These organizations are as follows: Kaliningrad State Technical University, Immanuel Kant Baltic Federal University, and P.P. Shirshov Institute of Oceanology Atlantic Branch of Russian Academy of Science.

2.3 Monitoring program under the BASE project

The monitoring programme was executed in 4 phases covering all crucial seasons: summer (round 1, 1-7 July 2013), autumn (round 2, 30 September - 6 October 2013), winter (round 3, 3-11 February2014), and spring (1-4 April 2014). Measurements have been conducted on 20 water objects in 32 monitoring points of the Kaliningrad Oblast. However, as the project moved forward changes were made in the set of sampling points. These changes were connected with necessary of conducted measurement sand identifying some other potential polluters. The full list of points where the observations were executed is presented below: (Table 2.2).

Table 2.2 The list of the sampling points and hydrometric sections

№	Title	Location	Latitude	Longitude	Hydro	Chem	Round of sampling			
							1	2	3	4
1	The Instruch, the right tributary of the Pregolya	Maevka, automobile bridge	54.65904	21.81044	+	+	+	+	+	+
2	The Angrapa, the left tributary of the Pregolya	Chernyakhovsk, automobile bridge	54.64304	21.80840	+	+	+	+	+	+
3	The Lakowka, the right tributary of the Pregolya	Pregolsky (Kaliningrad), automobile bridge	54.69411	20.42401	+	+	+	+	+	-
4	The Gurievka, the right tributary of the Pregolya	Pribreznoye (Kaliningrad), automobile bridge	54.69785	20.60984	+	+	+	+	+	+
5	The strean of Gluboky, the right tributary of the Pregolya	Talpaki, automobile bridge	54.65253	21.34963	+	+	+	+	+	+
6	The Gremyachiya, the right tributary of the Pregolya	Sovhoznoye, automobile bridge	54.64911	21.67912	+	+	+	-	-	-
7	The Lava, the left tributary of the Pregolya	Znamensk, railway bridge	54.61881	21.22585	+	+	+	+	+	+
8	The Baidyukowka, the left tributary of the Pregolya	Tumanovka, automobile bridge	54.63727	20.94259	+	+	+	-	-	-
9	The Bobrovaya, the left tributary of the Pregolya	Suvorovo, automobile bridge	54.62245	21.05423	+	+	+	-	-	-
10	The Gvardejskaya, the left tributary of the Pregolya	Zarechnoye, automobile bridge	54.62759	21.00244	+	+	+	-	-	-
12	The Golubaya, the left tributary of the Pregolya	Mezdurechiye, automobile bridge	54.62553	21.52840	+	+	+	+	+	+
13	The Deima, the right tributary of the Pregolya	Polessk, automobile bridge	54.86400	21.11483	+	+	+	+	+	+
14	The Matrosov Canal, the mouth, the left tributary of the Neman	Zapovednoye	55.02735	21.30552	-	+	+	+	+	+
15	Sheshupe, the left tributary of the Neman	Lesnoye, automobile bridge	55.01939	22.21436	+	+	+	+	+	+

№	Title	Location	Latitude	Longitude	Hydro	Chem	Round of sampling			
							1	2	3	4
16	The Prokhladnaya, falling into the Vistula lagoon	Svetloye, automobile bridge	54.56974	20.36730	+	+	+	+	+	+
16a	The Prokhladnaya, falling into the Vistula lagoon	Ushakovo, automobile bridge	54.61210	20.24660	-	+	+	+	+	+
17	Kaliningradsky take-out canal, falling into the Primorskaya bay	The mouth	54.69699	20.06596	+	+	+	+	+	+
24	The Primorskaya,falling into the Primorskaya bay	Primorsk, railway bridge	54.73710	20.01948	+	-	+	+	+	+
24a	The Primorskaya, falling into the Primorskaya bay	Primorsk, automobile bridge	54.72864	20.00893	-	+	+	+	+	+
25	The Nelma, falling into the Primorskaya bay	Kostrovo, automobile bridge	54.74514	20.16492	+	-	+	+	+	+
25a	The Nelma, falling into the Primorskaya bay	The mouth	54.72193	20.05025	-	+	+	+	+	+
26	The Pregolya, falling into the Vistula lagoon	Kaliningrad, double-level bridge	54.70578	20.48984	+	+	+	+	+	+
27	The Pregolya, falling into the Vistula lagoon	Gvardejsk, automobile bridge, above the rivers Pregolya and the Deyma indelta	54.63878	21.07698	+	+	+	+	+	+
28	The Matrosov Canal, the left arm of the Neman	Mostovoye,automobile bridge	55.14805	21.58564	+	+	+	+	+	+
29	The Shesupe, the left tributary of the Neman	Zarechnoye,below the Russian-Lithuanin border	54.97215	22.57278	-	+	+	+	+	+
30	The stream of Medveziy falls in the Baltic sea	Sokolniki, railway bridge	54.94754	20.42892	+	+	+	+	+	+
31	The Lava, the lest tributary of the Pregolya	Ryabonino, below the Russian-Polish border	54.38075	21.015	-	+	-	+	+	+
32	The Lava, the left tributary of the Pregolya	Pravdinsk, belowthe Pravdinskoye reservoir	54.4446	21.02197	-	+	-	+	+	+
33	The stream of Medveziy falls in the Baltic sea	Sokolniki, automobile bridge	54.93415	20.43742	+	+	-	+	+	+
34	The Lava	Dalnee	54.490764	21.06396	+	+	-	-	+	+
35	The Lava	Rodniki	54.528328	21.20495	-	+	-	-	+	+
36	The stream of Medvezhiy	Kamenka	54.928916	20.42120	+	+	-	-	+	+

Sampling points and hydrologic sections for some water objects were separated with the purpose of more qualitative determination of hydrological characteristics by means of available instruments. Such insignificant removings had no influence on the quantity of flow. The picture 3 presents all sampling points and hydrologic sections with grading on the rounds.

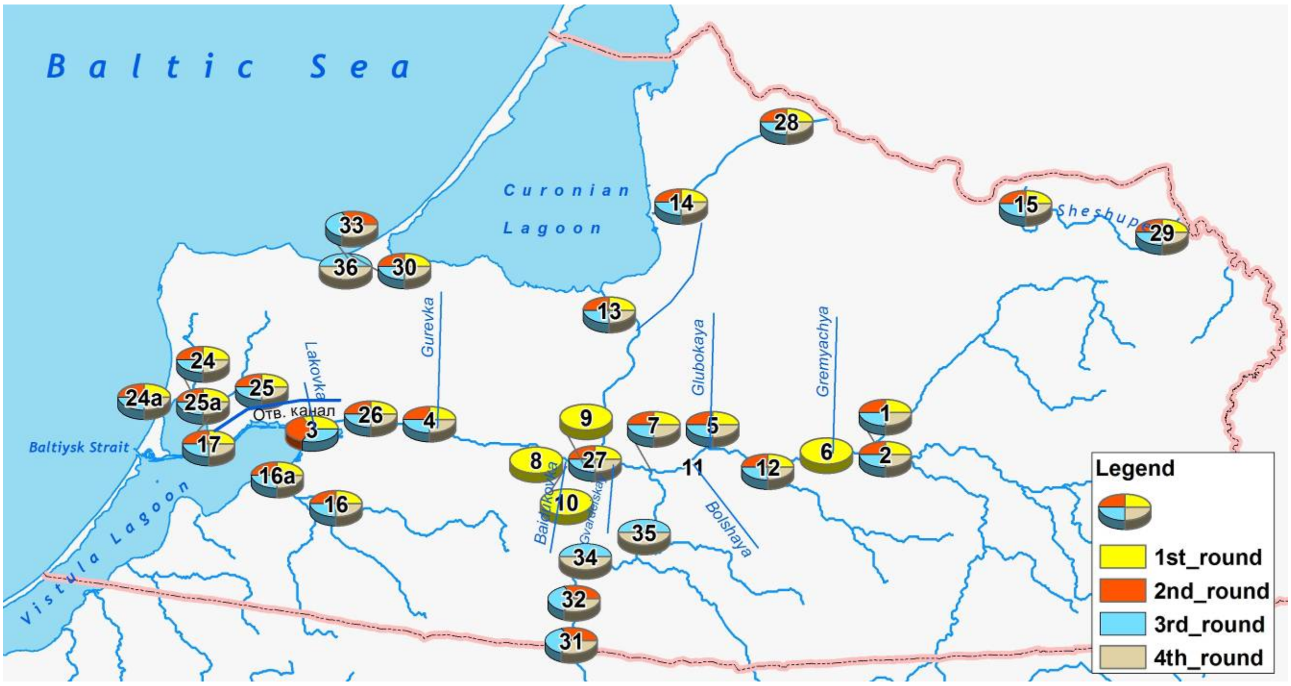


Figure 2.3 - The scheme of location of the monitoring points

2.4 Hydrological and hydrochemical works carried out under the BASE project

Hydrological and hydrochemical surveys on water objects of the Kaliningrad Oblast were executed by two groups in threes: the first group was on an off-highway vehicle (to approach the smallest water objects), the second group was on a small vessel (to make surveys and samplings in the wide and deep river reaches). A sampling site for mouth river reaches was chosen within such distance from the intake basin that one could make the influence on qualitative water composition of the water objects impossible, and avoid impacts of water masses under wind surge.

Water samples were collected in the middle of water streams in the surface layer (0.5 m) by means of batometer of the Niskin system (for wide beds) or by hand (for narrow beds). After this water samples were transferred into plastic containers of 0.5 litres. Ways of samplings were chosen in accordance to the local conditions namely from bridges, craft or fording.

Water samples in the special thermal containers with briquettes for cooling were rapidly (during one day) delivered to the laboratory, where they were frozen till transportation to the Laboratory of Surface and Marine Water Chemistry of the Environmental Monitoring Centre of Federal State Budgetary Institution «North West Hydrometeorological Department», St.Petersburg.

Measurement of discharge of water was executed on to the data of velocity and area of cross-section of a bed which, it their turn, were measured by means of instruments. Measurements for narrow beds were conducted from bridges and fording, and following set of instruments were used:

Depth measurements up to 1.5 m were conducted using hydrometric rod with a 1 cm scale pitch range, over 1.5 m – using sea gage with a 10 cm scale pitch range. Width measurements of beds of rivers were carried out using wire ropak with a 50 cm scale pitch range. Measurement of flow velocity on benthal, middle and subsurface horizons of a bed cross-section (on center of verticals every metre of a bed section from one to the other shore, Figure 2.4) were conducted using following devices:

- hydrometric miniflow meter GMTsM-1 (ГМЦМ-1) (less than 30 cm depth);
- Discharge meter with register ISP-1 (ИСП-1) (more than 30 cm depth).

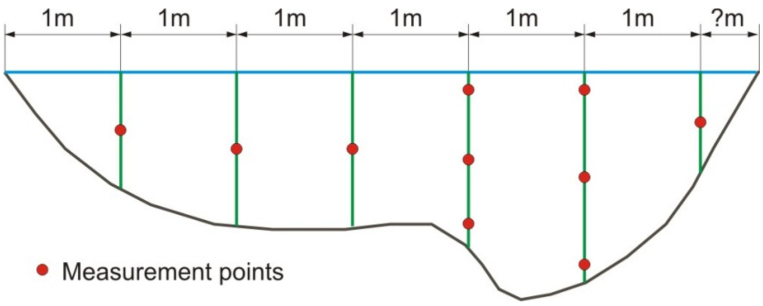


Figure 2.4 - Positions of flow velocity measurement points on verticals a bed section

Measurements for wide beds were conducted using small floating craft. Depth measurement was executed by means of hydrophysical probe SeaGuard. This device uses a principle of water pressure determination and transfers it to a relevant depth. Width measurement of beds of rivers was carried out using the global positioning system with the depth finder of Garmin GPSmap 421s.

Measurement of flow velocity of a bed cross-section (on verticals every 5 metres of a bed section from one to the other shore) were conducted using a hydrophysical probe SeaGuard (the principle of Doppler sensor). Measurement frequency is 2 seconds (Figure 2.5). But number of measuring points and verticals on a cross-section of a stream is strongly dependent on the characteristics and morphometry of the stream. Hence the measurements was planned site specific.

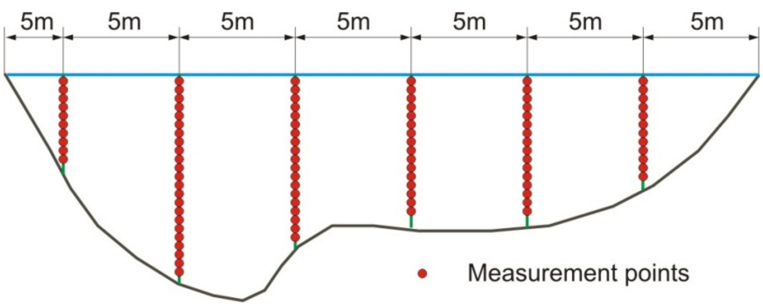


Figure 2.5 - Positions of flow velocity measurement points on verticals a bed section

Discharge of water (**Q**), going through hydrologic section is estimated using a formula:

$$Q = W * V,$$ where

W – Cross-Section Area (m^2),

V – Average Flow Velocity (m/c).

Cross-Section Area(**W**) is calculated as:

$$W = B * h_{mean},$$ where

B – Bed Width in hydrologic section

H_{mean}– Average Bed Depth in hydrologic section

Samples taken in the Kaliningrad Oblast were transported to the Saint-Petersburg Laboratory of the FSI “North-West Department of Hydrometeorology and Environmental Monitoring”, which participated in the HELCOM PLC-6 Project. Chemical analyses were conducted with accordance to the state official methodology.

According to these documents the content of the total nitrogen and total phosphorous were determined by analyzing thoroughly mixed unfiltered samples. Detailed description of the analyzing methodology presented in the Annex 1.

Parallel samples were analyzed by the EU Expert (see Table 2.3)

2.4.1. Joint sampling round

Joint sampling mission to the rivers and streams in Kaliningrad oblast was executed in September-October 2013 during the second sampling round. Mission included sampling from five different sampling points, which is statistically inadequate for a proper intercalibration test. The sampling was executed in hydrochemical stations 3, 17, 24a, 25a and 26 (Fig. 2.3). A member of the EU consultant (Pöyry Finland Oy) participated also to the sampling. The samples were stored on a cold box and to a freezer for the storage before transportation. Samples were transported to Finland by the EU consultant to further analysis. The delay of samples in transportation was in total of two days. It should be noted that the samples were not pretreated (filtrated, preserved, etc.) before the transportation and storage. Samples were analyzed in a Finnish accreditation service (FINAS) accredited (T003, http://www.finas.fi) laboratory of Finnish Environment Institute (SYKE).

The results of the parallel samples can be found from table (Table 2.3). As can be seen the total nitrogen (N-Tot) concentrations of the Finnish laboratory were higher in every single case and total phosphorus (P-Tot) concentrations were higher in three times out of five, which indicates that the usage of results of the Russian laboratory leads to an underestimation of the nutrient loads to Baltic Sea. One should keep in mind that the comparison is affected by the elongated delay of samples during transportation from Russia to Finland, especially in case the samples were not preserved prior transportation. One would however expect that the difference in nutrient concentrations would be the opposite than observed. The most significant difference of the results was related to the total nitrogen concentrations of the Kaliningrad waste canal (FI/RU = 1,35).

Table 2.3 The results of the total nutrient analyses of five sampling locations in Kaliningrad oblast. The difference (FI/RU) is calculated dividing the concentration of the Finnish laboratory by the corresponding concentration of the Russian laboratory.

Sampling point	Finnish laboratory [mg/l]		Russian laboratory [mg/l]		Difference (FI/RU)	
	N-Tot	P-Tot	N-Tot	P-Tot	N-Tot	P-Tot
3	1,8	0,31	1,53	0,27	1,18	1,15
17	40	5,1	29,7	4,95	1,35	1,03
24a	1,2	0,22	1,13	0,19	1,06	1,16
25a	1,3	0,18	1,27	0,19	1,02	0,95
26	3,9	0,21	3,5	0,22	1,11	0,95

2.5 Sampling strategy and sampling programme improvements

The programme of water sampling on content of total nitrogen and total phosphorus and conduction of works on determination of hydrological parameters was elaborated in such a way that to cover all large waterways of the Kaliningrad Oblast. Monitoring stations were mostly located in the mouth river reaches in order to determine quantity of biogenes coming from catchment areas. However, on some rivers additional monitoring points were added. Thus, samplings and hydrological works were conducted on the Pregolya river above the rivers Pregolya and the Deyma in delta. Moreover, on the transboundary rivers of Sheshupe, Lava and the Matrosov Canal one organized the stations located directly below the state border of Russia with Lithuania and Poland.

As the programme moved forward, on the small rivers, where biogenic load was low (nutrients load was 0.1% from load of Pregolya River) in the first sampling round, the decision was taken to close a number of stations. However, for the Lava river which is the main pollutant source for the Pregolya one has introduced a number of metrical section lines in order to determine sources of potential water pollution by biogenic material.

- **1st sampling round program (Summer)**

Conduction of hydrological measurements and water samplings on the rivers of the Kaliningrad Oblast for summer period were conducted in the rainless hydrological period from 1 to 7 July 2013.

Preliminary reconnaissance observations were carried out before conduction of fieldworks directed at measurement of discharge of water on the water objects and samplings in the Kaliningrad Oblast namely in the basins of the Pregolya and Neman taken place on the 25-27 June 2013. As a result on the water objects one chose stations for samplings and section lines for water discharge measurement (Figure 2.6).

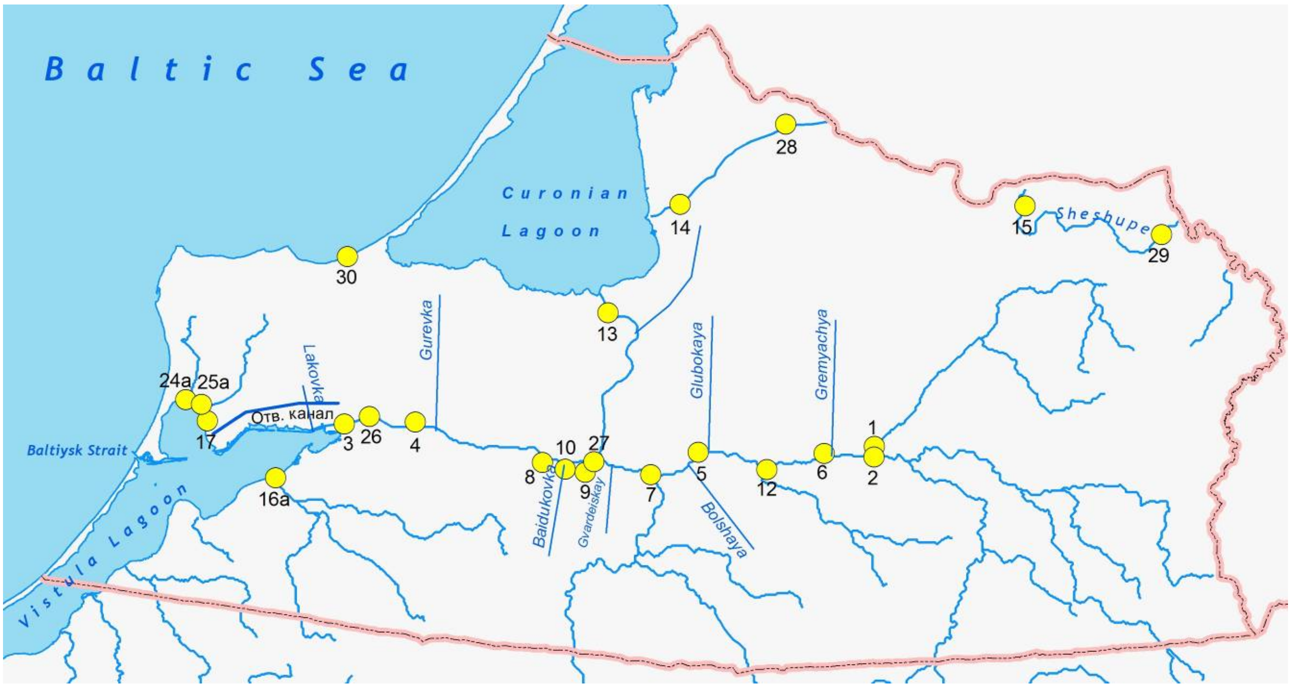


Figure 2.6 - Location of sampling stations in the 1st round (1-7 July 2013) of the fieldwork.

While choosing the sampling stations one firstly took into account the stations on large rivers falling into the Vistula and Curonian lagoons and the Baltic Sea. The attention was paid to accessibility of sampling under any weather conditions, complexity of sampling and opportunity of determination of hydrological characteristics. In total 23 stations were chosen for sampling and 3 additional stations for water discharge measurement. Methodology of sampling of water and flow measurements was described in paragraph 2.2.

Station 1.The River Instruch, Right Tributary of the Pregolya River, Majevka settlement

Figure 2.7 – The River Instruch Bed Reach, downstream (Photo: Domnin, 06.07.2013)

Table 2.4 Hydrological and Hydrochemical Characteristics of the River Instruch in Summer Season 2013

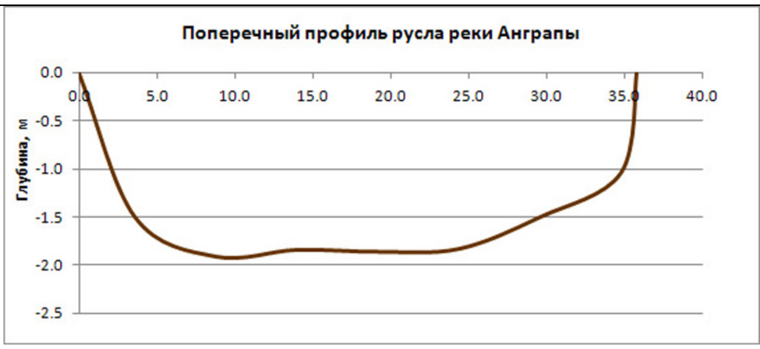
Parameter	**Value**
Bed Width, m	29.9
Maximum Depth, m	1.4
Cross-Section Area, m^2	27.5
Average Flow Velocity, m/s	0.03
Discharge, m^3/s	0.9
Temperature, °C	21.3
Ntot Concentration (Measurement uncertainty), mg/l	0.90 (±0.1)
Ptot Concentration (Measurement uncertainty), mg/l	0.081 (±0.009)

Figure 2.8 – Cross Section of the River Instruch Bed, 06.07.2013

Station 2.The River Angrapa, Left Tributary of the River Pregolya, Chernyakhovsk.

Figure 2.9 – The River Angrapa Bed Reach, downstream (Photo: Domnin, 06.07.2013)

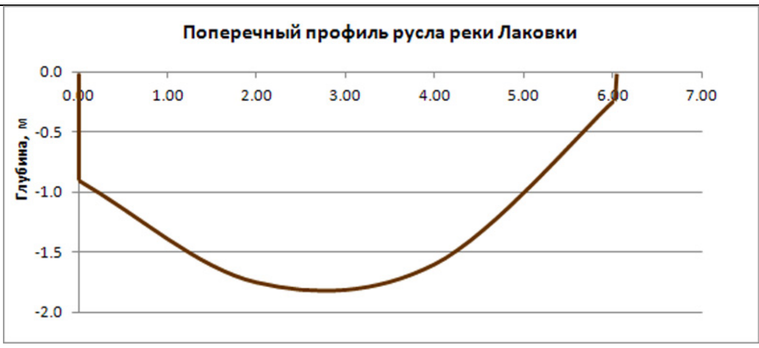
Table 2.5 Hydrological and Hydrochemical Characteristics of the River Angrapa in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>35.8</td></tr>
<tr><td>Maximum Depth, m</td><td>1.9</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>58.7</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.19</td></tr>
<tr><td>Discharge, m^3/s</td><td>11.2</td></tr>
<tr><td>Temperature, °C</td><td>21.6</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.24 (±0.13)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.117 (±0.011)</td><td>Figure 2.10 – Cross Section of the River Angrapa Bed, 06.07.2013</td></tr>
</table>

Station 3.The River Lakovka, Right Tributary of the River Pregolya, Pregolskiy Settlement

Figure 2.11 – The River Lakovka Estuary, downstream (Photo: Domnin, 01.07.2013)

Table 2.6 Hydrological and Hydrochemical Characteristics of the River Lakovka in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>6.0</td></tr>
<tr><td>Maximum Depth, m</td><td>1.8</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>6.8</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.08</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.6</td></tr>
<tr><td>Temperature, °C</td><td>18.7</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.61 (±0.16)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.406 (±0.030)</td><td>Figure 2.12 – Cross Section of the River Lakovka Bed, 01.07.2013</td></tr>
</table>

Station 4.The River Gurjevka (Muelen), Right Tributary of the River Pregolya, Pribrezhnoe Settlement

Figure 2.13 – Swamp Estuary of the River Gurjevka, in downstream direction (Photo: Domnin, 01.07.2013)

Table 2.7 Hydrological and Hydrochemical Characteristics of the River Gurievka in Summer Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s	0.23	
Discharge, m^3/s	0.3	
Temperature, °C	18.5	
Ntot Concentration, (Measurement uncertainty), mg/l	2.25 (±0.21)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.89 (±0.060)	

Station 5.The Stream of Glubokij, Right Tributary of the River Pregolya, Talpaki Settlement

Figure 2.14 – The Stream Glubokij Bed Reach, upstream (Photo: Domnin, 06.07.2013)

Table 2.8 Hydrological and Hydrochemical Characteristics of the Stream Glubokij in Summer Season 2013

Parameter	**Value**
Bed Width, m	4.2
Maximum Depth, m	1.7
Cross-Section Area, m^2	7.1
Average Flow Velocity, m/s	0.15
Discharge, m^3/s	1.1
Temperature, °C	20.5
Ntot Concentration, (Measurement uncertainty), mg/l	1.36 (±0.14)
Ptot Concentration, (Measurement uncertainty), mg/l	0.09 (±0.010)

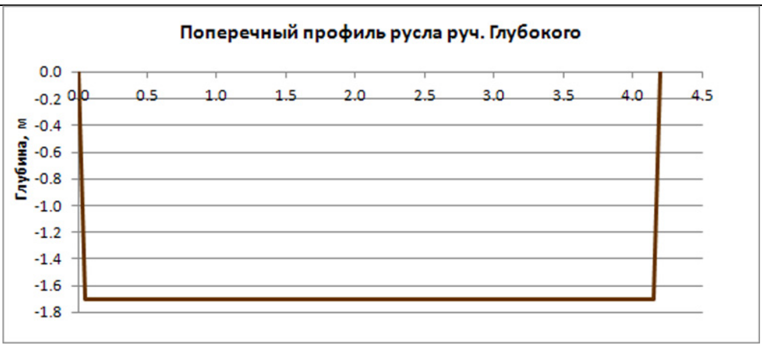


Figure 2.15 – Cross Section of the Stream Glubokij Bed, 06.07.2013

Station 6.The River Gremyachia, Right Tributary of the River Pregolya, Sovkhoznoe Settlement

Figure 2.16 – The River Gremyachia Bed Reach, in downstream direction (Photo: Domnin, 06.07.2013)

Table 2.9 Hydrological and Hydrochemical Characteristics of the River Gremyachia in Summer Season 2013

Parameter	**Value**
Bed Width, m	4.3
Maximum Depth, m	0.7
Cross-Section Area, m^2	2.0
Average Flow Velocity, m/s	0.03
Discharge, m^3/s	0.1
Temperature, °C	18.9
Ntot Concentration, (Measurement uncertainty), mg/l	1.36 (±0.14)
Ptot Concentration, (Measurement uncertainty), mg/l	0.114 (±0.011)

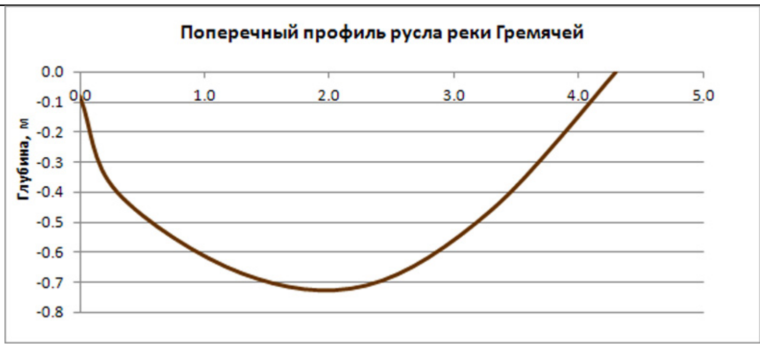
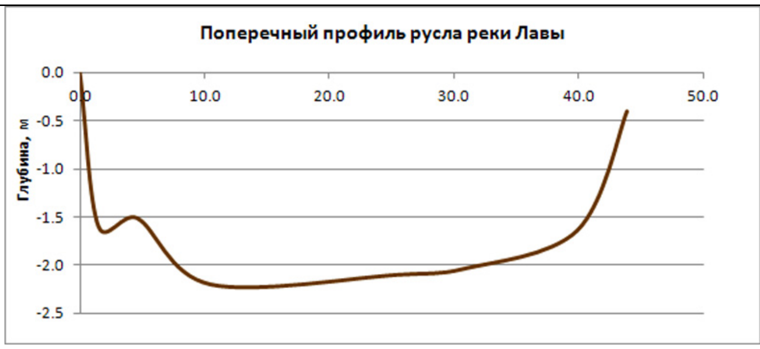


Figure 2.17 – Cross Section of the River Gremyachia Bed, 06.07.2013

Station 7.The River Lava, Left Tributary of the River Pregolya, Znamensk Settlement

Figure 2.18 – The River Lava Bed Reach, in downstream direction (Photo: Karmanov, 04.07.2013)

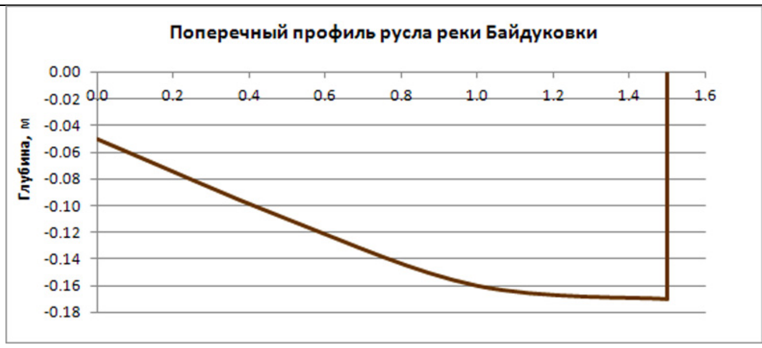
Table 2.10 Hydrological and Hydrochemical Characteristics of the RiverLava in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>43.9</td></tr>
<tr><td>Maximum Depth, m</td><td>2.1</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>72.1</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.51</td></tr>
<tr><td>Discharge, m^3/s</td><td>36.6</td></tr>
<tr><td>Temperature, °C</td><td>21.9</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>3.01 (±0.27)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.156 (±0.014)</td><td>Figure 2.19 – Cross Section of the River Lava Bed, 04.07.2013</td></tr>
</table>

Station 8.The River Bajdukovka, Left Tributary of the River Pregolya, Tumanovka Settlement

Figure 2.20 – The River Bajdukovka Bed Reach, in downstream direction (Photo: Domnin, 04.07.2013)

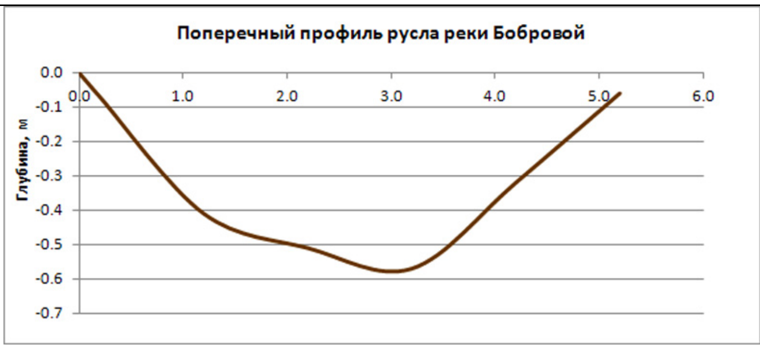
Table 2.11 Hydrological and Hydrochemical Characteristics of the River Bajdukovka in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>1.5</td></tr>
<tr><td>Maximum Depth, m</td><td>0.17</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>0.2</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.09</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.02</td></tr>
<tr><td>Temperature, °C</td><td>22.4</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.50 (±0.15)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.137 (±0.013)</td><td>Figure 2.21 – Cross Section of the River Bajdukovka Bed, 04.07.2013</td></tr>
</table>

Station 9.The River Bobrovaya, Left Tributary of the River Pregolya, Suvorovo Settlement.

Figure 2.22 – The River Bobrovaya Bed Reach, in downstream direction (Photo: Domnin, 04.07.2013)

Table 2.12 Hydrological and Hydrochemical Characteristics of the River Bobrovaya in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="7">
</td></tr>
<tr><td>Bed Width, m</td><td>5.2</td></tr>
<tr><td>Maximum Depth, m</td><td>0.6</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>1.7</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.08</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.14</td></tr>
<tr><td>Temperature, °C</td><td>19.5</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.71 (±0.17)</td><td></td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.121 (±0.012)</td><td>Figure 2.23 – Cross Section of the River Bobrovaya Bed, 04.07.2013</td></tr>
</table>

Station 10. The River Gvardejskaya, Left Tributary of the River Pregolya, Zarechnoe Settlement

Figure 2.24 – The River Gvardejskaya Bed Reach, upstream (Photo: Domnin, 04.07.2013)

Table 2.13 Hydrological and Hydrochemical Characteristics of the River Gvardejskaya in Summer Season 2013

Parameter	**Value**
Bed Width, m	3.0
Maximum Depth, m	0.4
Cross-Section Area, m^2	0.8
Average Flow Velocity, m/s	0.03
Discharge, m^3/s	0.02
Temperature, °C	20.1
Ntot Concentration, (Measurement uncertainty), mg/l	1.94 (±0.19)
Ptot Concentration, (Measurement uncertainty), mg/l	0.228 (±0.018)

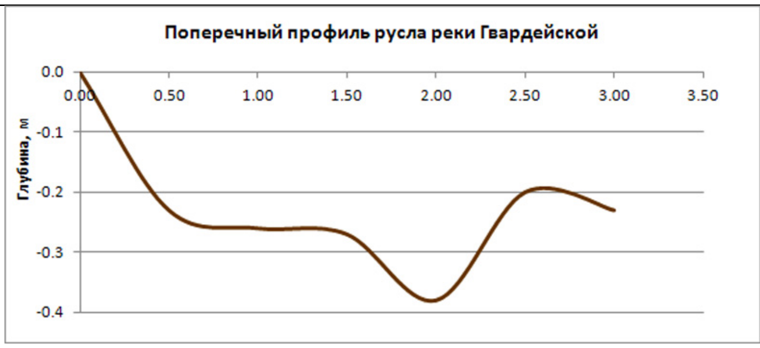
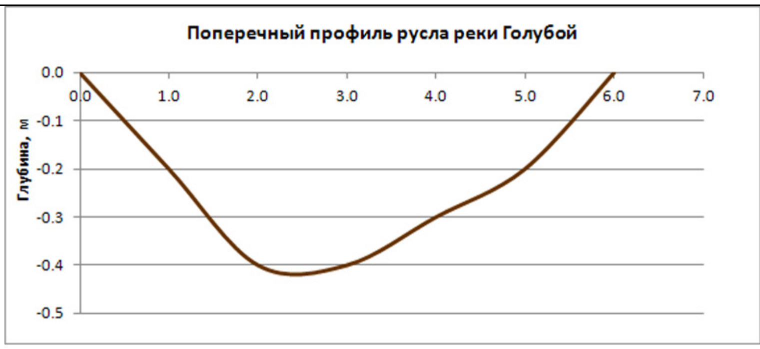


Figure 2.25 – Cross Section of the River Gvardejskaya Bed, 04.07.2013

Station 12.The River Golubaya, Left Tributary of the River Pregolya, Mezhdurechie

Figure 2.26 – The River Golubaya Bed Reach, downstream (Photo: Domnin, 06.07.2013)

Table 2.14 Hydrological and Hydrochemical Characteristics of the River Golubaya in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>6.0</td></tr>
<tr><td>Maximum Depth, m</td><td>0.4</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>1.5</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.09</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.14</td></tr>
<tr><td>Temperature, °C</td><td>20.2</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.85 (±0.18)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.195 (±0.016)</td><td>Figure 2.27 – Cross Section of the River Golubaya Bed, 06.07.2013</td></tr>
</table>

Station 13.The River Deyma, Left Armof the River Pregolya, Polessk

Figure 2.28 – The River Deyma Bed Reach, in downstream direction (Photo: Karmanov, 05.07.2013)

Table 2.15 Hydrological and Hydrochemical Characteristics of the River Deyma in Summer Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s	20.5	
Temperature, °C	22.4	
Ntot Concentration, (Measurement uncertainty), mg/l	2.22 (±0.21)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.137 (±0.013)	

Station 14.The Matrosov Canal (estuary), Zapovednoe Settlement

Figure 2.29 – The Matrosov Canal Bed Reach, in downstream direction (Photo: Karmanov, 05.07.2013)

Table 2.16 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Summer Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.18 (±0.12)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.06 (±0.08)	

Station 15.The River Sheshupe, Left Tributary of the River Neman, Lesnoe Settlement

Figure 2.30 – The River Sheshupe Bed Reach, upstream (Photo: Domnin, 05.07.2013)

Table 2.17 Hydrological and Hydrochemical Characteristics of the River Sheshupe in Summer Season 2013

Parameter	Value
Bed Width, m	50.3
Maximum Depth, m	3.8
Cross-Section Area, m^2	93.0
Average Flow Velocity, m/s	0.1
Discharge, m^3/s	9.3
Temperature, °C	24.8
Ntot Concentration, (Measurement uncertainty), mg/l	1.17 (±0.12)
Ptot Concentration, (Measurement uncertainty), mg/l	0.073 (±0.009)

Figure 2.31 – Cross Section of the River Sheshupe Bed, 05.07.2013

Station 16.The River Prokhladnaya, Ushakovo Settlement
Station 16a.Svetloe Settlement

Figure 2.32 – The River Prokhladnaya Estuary (Ushakovo Settlement), in downstream direction (Photo: Domnin, 02.07.2013)

Figure 2.33 – The River Prokhladnaya Bed Reach (Svetloe Settlement), in downstream direction (Photo: Domnin, 02.07.2013)

Table 2.18 Hydrological and Hydrochemical Characteristics of the River Prokhladnaya in Summer Season 2013

Parameter	**Value**
Bed Width, m	9.0
Maximum Depth, m	1.2
Cross-Section Area, m^2	9.3
Average Flow Velocity, m/s	0.27
Discharge, m^3/s	2.5
Temperature, °C	16.5
Ntot Concentration, (Measurement uncertainty), mg/l	1.60 (±0.16)
Ptot Concentration, (Measurement uncertainty), mg/l	0.173 (±0.015)

Figure 2.34 – Cross Section of the River Prokhladnaya Bed, 02.07.2013

Station 17.The Kaliningrad Canal, Estuary

Figure 2.35 – The Kaliningrad Canal Bed Reach, upstream (Photo: Domnin, 01.07.2013)

Table 2.19 Hydrological and Hydrochemical Characteristics of the Kaliningrad Canal in Summer Season 2013

Parameter	**Value**
Bed Width, m	2.8
Maximum Depth, m	0.5
Cross-Section Area, m^2	1.4
Average Flow Velocity, m/s	0.9
Discharge, m^3/s	1.3
Temperature, °C	19.0
Ntot Concentration, (Measurement uncertainty), mg/l	24.30 (±1.97)
Ptot Concentration, (Measurement uncertainty), mg/l	5.199 (±0.332)

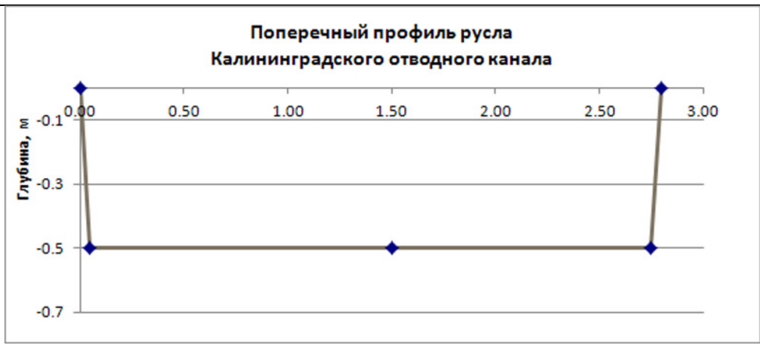


Figure 2.36 – Cross Section of the Kaliningrad waste canal Bed, 01.07.2013

Station 24, 24a.The River Primorskaya, Primorsk

Figure 2.36 – The River Primorskaya Estuary, upstream (Photo: Domnin, 01.07.2013)

Figure 2.37 – The River Primorskaya Bed Reach, upstream (Photo: Domnin, 01.07.2013)

Table 2.20 Hydrological and Hydrochemical Characteristics of the River Primorskaya in Summer Season 2013

Parameter	Value
Bed Width, m	3.5
Maximum Depth, m	0.6
Cross-Section Area, m^2	1.1
Average Flow Velocity, m/s	0.09
Discharge, m^3/s	0.1
Temperature, °C	13.8
Ntot Concentration, (Measurement uncertainty), mg/l	1.78 (±0.17)
Ptot Concentration, (Measurement uncertainty), mg/l	0.341 (±0.25)

Figure 2.38 – Cross Section of the River Primorskaya Bed, 01.07.2013

Station 25, 25a.The River Nelma, Kostrovo Settlement

Figure 2.39 – The River Nelma Estuary, in downstream direction(Photo: Domnin, 01.07.2013)

Figure 2.40 – The River Nelma Bed Reach, in downstream direction (Photo: Domnin, 01.07.2013)

Table 2.21 Hydrological and Hydrochemical Characteristics of the River Nelma in Summer Season 2013

Parameter	**Value**
Bed Width, m	7.0
Maximum Depth, m	0.25
Cross-Section Area, m^2	1.3
Average Flow Velocity, m/s	0.3
Discharge, m^3/s	0.4
Temperature, °C	13.6
Ntot Concentration, (Measurement uncertainty), mg/l	1.85 (±0.18)
Ptot Concentration, (Measurement uncertainty), mg/l	0.428 (±0.031)

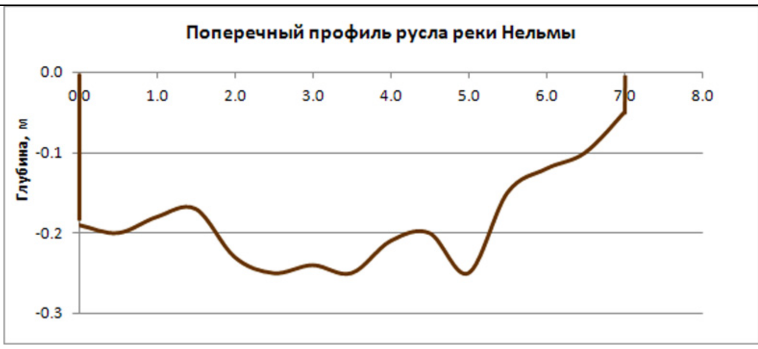


Figure 2.41 – Cross Section of the River Nelma Bed, 01.07.2013

Station 26.The River Pregolya, Kaliningrad

Figure 2.42 – The RiverPregolya Bed Reach, in downstream direction (Photo: Karmanov, 03.07.2013)

Table 2.22 Hydrological and Hydrochemical Characteristics of the River Pregolya in Summer Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>60</td></tr>
<tr><td>Maximum Depth, m</td><td>6.9</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>317</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.1</td></tr>
<tr><td>Discharge, m^3/s</td><td>30.5</td></tr>
<tr><td>Temperature, °C</td><td>20.1</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.75 (±0.17)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.139 (±0.013)</td><td>Figure 2.43 – Cross Section of the River Pregolya Bed, 03.07.2013</td></tr>
</table>

Station 27.The River Pregolya, Gvardejsk

Figure 2.44 – The River Pregolya Bed Reach, in downstream direction (Photo: Karmanov, 04.07.2013)

Table 2.23 Hydrological and Hydrochemical Characteristics of the River Pregolya in Summer Season 2013

Parameter	**Value**
Bed Width, m	74
Maximum Depth, m	3.1
Cross-Section Area, m^2	127
Average Flow Velocity, m/s	0.38
Discharge, m^3/s	48.8
Temperature, °C	21.3
Ntot Concentration, (Measurement uncertainty), mg/l	1.46 (±0.15)
Ptot Concentration, (Measurement uncertainty), mg/l	0.170 (±0.015)

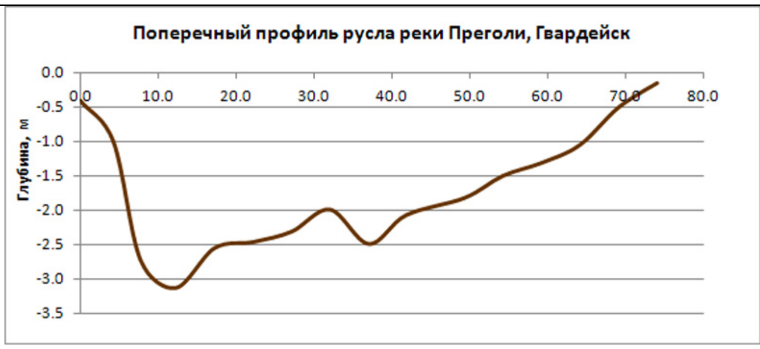


Figure 2.45 – Cross Section of the River Pregolya Bed, 03.07.2013

Station 28.The Matrosov Canal, Mostovoe Settlement

Figure 2.46 – The Matrosov Canal Bed Reach, in downstream direction (Photo: Karmanov, 05.07.2013)

Table 2.24 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Summer Season 2013

Parameter	**Value**
Bed Width, m	67
Maximum Depth, m	3.5
Cross-Section Area, m^2	95
Average Flow Velocity, m/s	0.63
Discharge, m^3/s	60.1
Temperature, °C	23.7
Ntot Concentration, (Measurement uncertainty), mg/l	1.23 (±0.13)
Ptot Concentration, (Measurement uncertainty), mg/l	0.082 (±0.009)

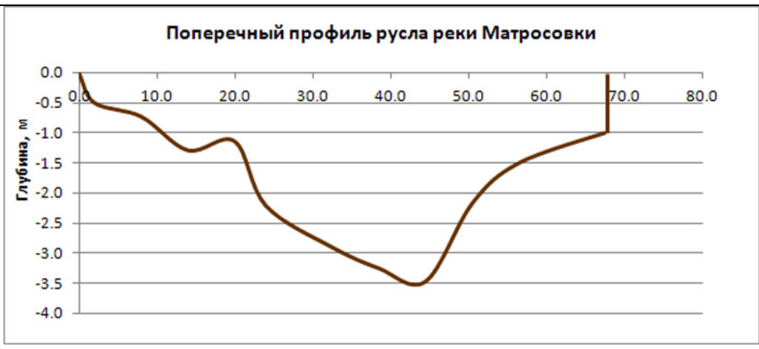


Figure 2.47 – Cross Section of the Matrosov Canal, 05.07.2013

Station 29.The River Sheshupe, Zarechnoe Settlement

Figure 2.48 – The River Sheshupe Bed Reach, upstream (Photo: Domnin, 05.07.2013).

Table 2.25 Hydrological and Hydrochemical Characteristics of the River Sheshupe in Summer Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.25 (±0.13)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.077 (±0.009)	

Station 30.The Stream Medvezhij, Estuary, Sokolniki Settlement

Table 2.26 Hydrological and Hydrochemical Characteristics of the Stream Medvezhij in Summer Season 2013

Parameter	Value
Bed Width, m	2.0
Maximum Depth, m	0.25
Cross-Section Area, m^2	0.4
Average Flow Velocity, m/s	0.08
Discharge, m^3/s	0.03
Temperature, °C	18.0
Ntot Concentration, (Measurement uncertainty), mg/l	1.96 (±0.19)
Ptot Concentration, (Measurement uncertainty), mg/l	1.707 (±0.112)

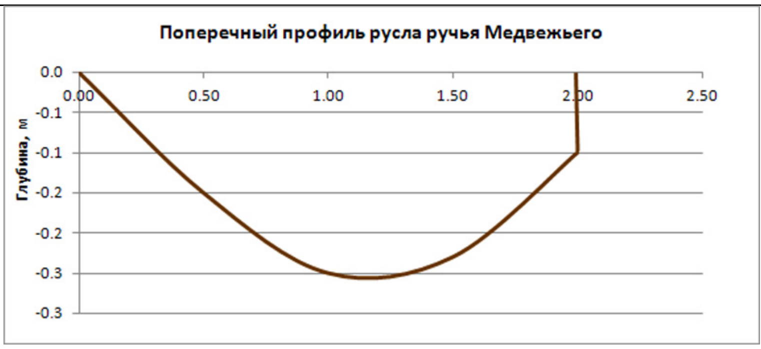


Figure 2.49 – Cross Section of the Stream Medvezhij Bed, 05.07.2013

Figure 2.50 – Distribution of Total Nitrogen Concentration in Water (mg/l) based on Data Analysis of Samples collected during Summer Low-Water Season

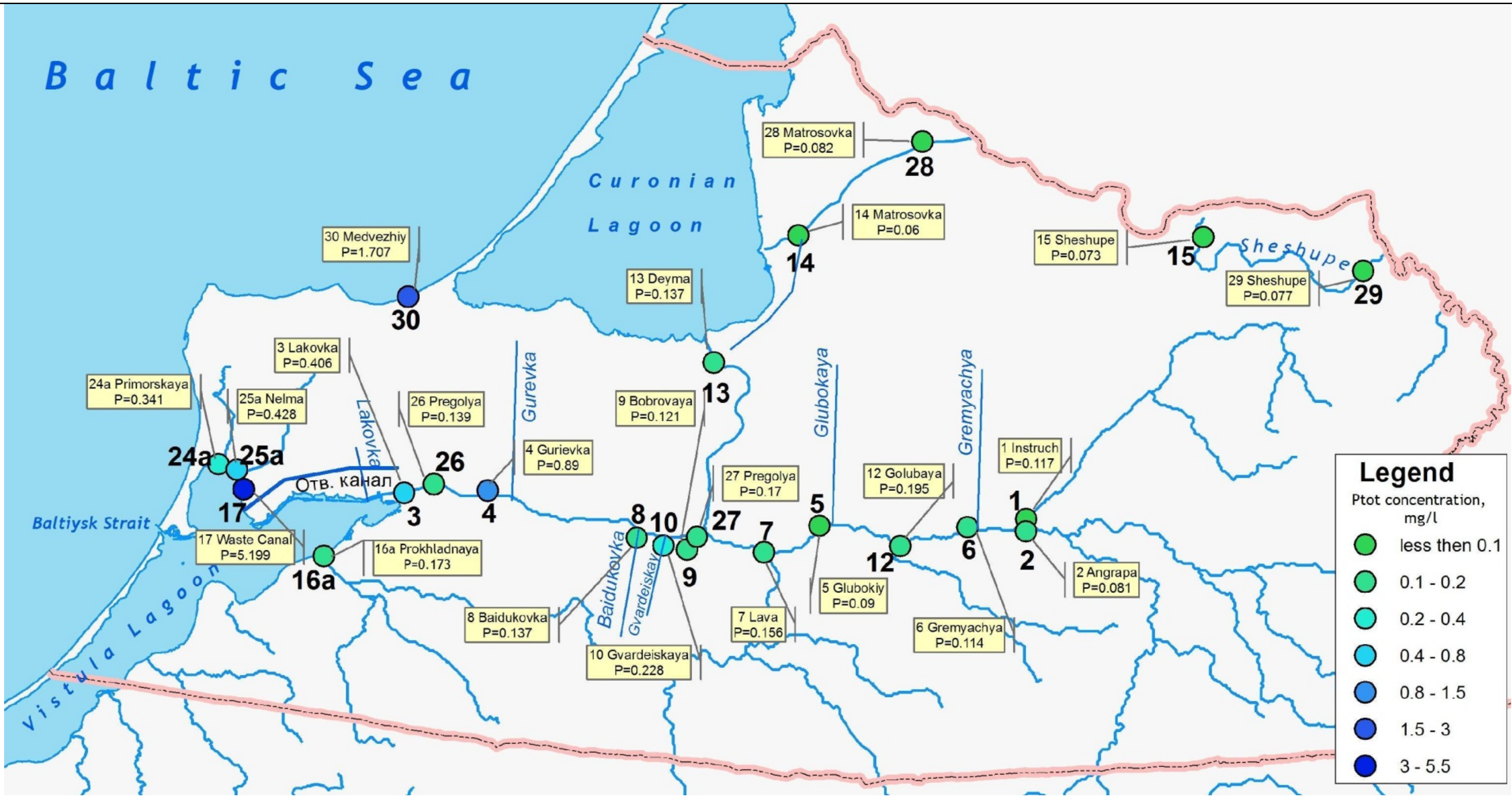


Figure 2.51– Distribution of Total Phosphorus Concentration in Water (mg/l) based on Data Analysis of Samples collected during Summer Low- Water Season

- **2nd and the following sampling rounds program, changes made and justifications for the changes (Autumn)**

During two sampling rounds (in summer and autumn seasons 2013) 55 samples were collected. The greatest amount of biogenic substances can be traced in big rivers and their tributaries of the Kaliningrad Oblast such as the Pregolya, the Deyma, the Lava, the Sheshupe, and the Matrosov Canal. Biogenes are formed both on the territory of the Kaliningrad Oblast and the bordering states of Lithuania and Poland, being transported along the cross-border river systems. Hydrological measurements and water sampling on the rivers of the Kaliningrad Oblast for the autumn season took place in a post freshet period (30 September – 6 October 2013).

According to the first sampling and hydrological measurements round several stream flows with potentially low biogenic elements removal into the receiving stream were identified. The following rivers can be classified among them: the Gremyachia (StationNo 6), the Bajdukovka (No 8), the Bobrovaya (No 9), the Gvardejskaya (No 10). Access to the River Bolshaya (No 11) was blocked. Based on the analysis of the received data the program was adjusted – the above mentioned stations were excluded and three new ones added: two on the River Lava and one on the Stream Medvezhij (Figure 2.52).

Figure 2.52 - Location of sampling stations for the second round (30 September – 6 October 2013).

In total 22 sampling stations and three extra stations for water flow measurements were settled.

Station 1.The River Instruch, Right Tributary of the River Pregolya, Maevka Settlement

Figure 2.53 – The River Instruch Bed Reach, downstream (Photo: Domnin, 02.10.2013)

Table 2.27 Hydrological and Hydrochemical Characteristics of the River Instruch in Autumn Season 2013

Parameter	**Value**
Bed Width, m	33.9
Maximum Depth, m	2.1
Cross-Section Area, m^2	52.1
Average Flow Velocity, m/s	0.18
Discharge, m^3/s	9.4
Temperature, °C	8.9
Ntot Concentration, (Measurement uncertainty), mg/l	3.76 (±0.33)
Ptot Concentration, (Measurement uncertainty), mg/l	0.132 (±0.012)

Figure 2.54 – Cross Section of the River Instruch Bed, 02.10.2013

Station 2.The River Angrapa, Left Tributary of the River Pregolya, Chernyakhovsk

Figure 2.55 – TheRiver Angrapa Bed Reach, downstream (Photo: Domnin, 02.10.2013)

Table 2.28 Hydrological and Hydrochemical Characteristics of the River Angrapa in Autumn Season 2013

Parameter	**Value**
Bed Width, m	35.8
Maximum Depth, m	2.4
Cross-Section Area, m^2	62.7
Average Flow Velocity, m/s	0.4
Discharge, m^3/s	24.9
Temperature, °C	8.6
Ntot Concentration, (Measurement uncertainty), mg/l	2.13 (±0.20)
Ptot Concentration, (Measurement uncertainty), mg/l	0.093 (±0.010)

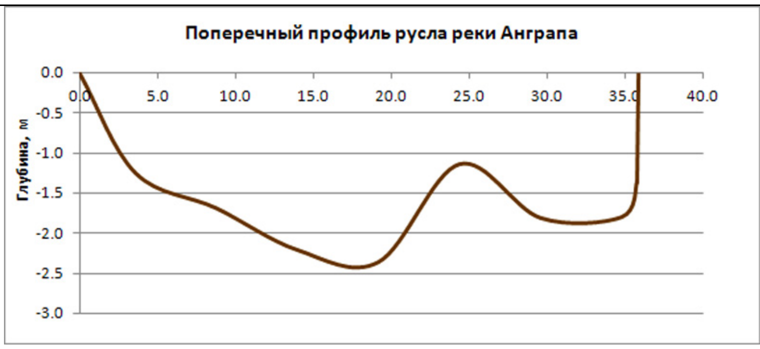


Figure 2.56 – Cross Section of the River Angrapa Bed, 02.10.2013

Station 3.The River Lakovka, Right Tributary of the River Pregolya, Pregolskij Settlement

Table 2.29 Hydrological and Hydrochemical Characteristics of the River Lakovka in Autumn Season 2013

Parameter	**Value**
Bed Width, m	6.0
Maximum Depth, m	1.8
Cross-Section Area, m^2	6.8
Average Flow Velocity, m/s	0.01
Discharge, m^3/s	0.02
Temperature, °C	9.3
Ntot Concentration, (Measurement uncertainty), mg/l	1.53 (±0.15)
Ptot Concentration, (Measurement uncertainty), mg/l	0.273 (±0.021)

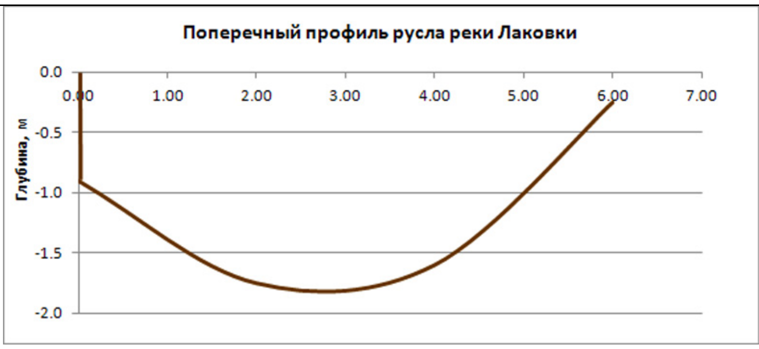


Figure 2.57 – Cross Section of the River Lakovka Bed, 30.09.2013

Station 4.The River Gurjevka (Muelen), Right Tributary of the River Pregolya, Pribrezhnoe Settlement

Figure 2.58 – Swamp Estuary of the River Gurjevka, in downstream direction (Photo: Domnin, 30.09.2013)

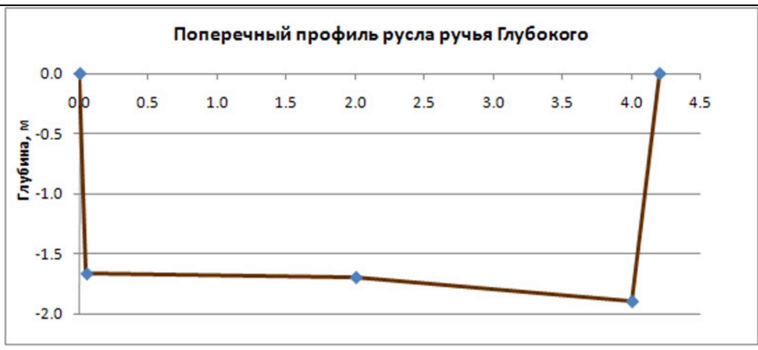
Table 2.30 Hydrological and Hydrochemical Characteristics of the River Gurjevka in Autumn Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2	2.6	
Average Flow Velocity, m/s	0.41	
Discharge, m^3/s	1.0	
Temperature, °C	9.8	
Ntot Concentration, (Measurement uncertainty), mg/l	2.26 (±0.21)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.539 (±0.038)	

Station 5.The Stream Glubokij, Right Tributary of the River Pregolya, Talpaki Settlement

Figure 2.59 – The Stream Glubokij Bed Reach, upstream (Photo: Domnin, 02.10.2013)

Table 2.31 Hydrological and Hydrochemical Characteristics of the Stream Glubokij in Autumn Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>4.2</td></tr>
<tr><td>Maximum Depth, m</td><td>1.9</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>7.4</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.1</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.7</td></tr>
<tr><td>Temperature, °C</td><td>8.3</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>0.81 (±0.09)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.044 (±0.007)</td><td>Figure 2.60 – Cross Section of the Stream Glubokij Bed, 02.10.2013</td></tr>
</table>

Station 7.The River Lava, Left Tributary of the River Pregolya, Znamensk Settlement

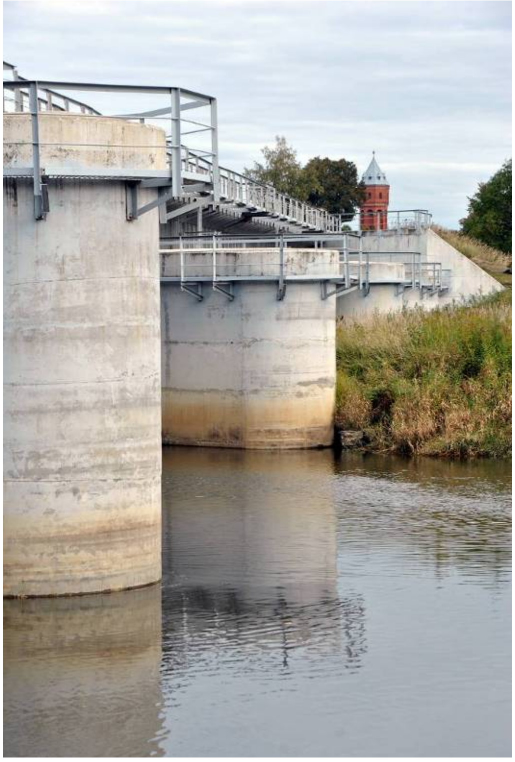
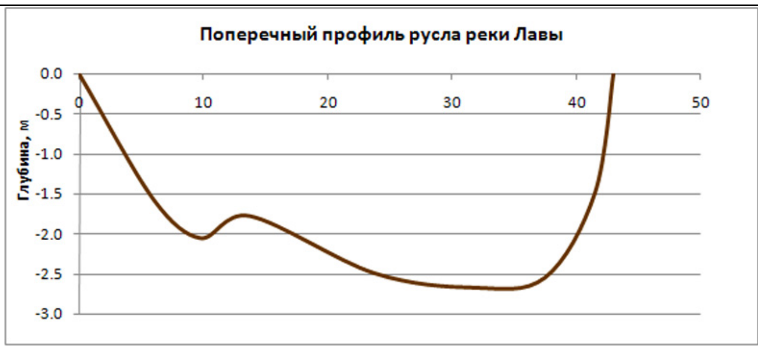


Figure 2.61 – The River Lava Bed Reach, in downstream direction (Photo: Domnin, 02.10.2013)

Table 2.32 Hydrological and Hydrochemical Characteristics of the River Lava in Autumn Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>43</td></tr>
<tr><td>Maximum Depth, m</td><td>2.7</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>90</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.34</td></tr>
<tr><td>Discharge, m^3/s</td><td>30.1</td></tr>
<tr><td>Temperature, °C</td><td>9.8</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>4.04 (±0.35)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.107 (±0.011)</td><td>Figure 2.62 – Cross Section of the River Lava Bed, 02.10.2013</td></tr>
</table>

Station 12.The River Golubaya, Left Tributary of the River Pregolya, Mezhdurechie

Figure 2.63 – The River Golubaya Bed Reach, in downstream direction (Photo: Domnin, 02.10.2013)

Table 2.33 Hydrological and Hydrochemical Characteristics of the River Golubaya in Autumn Season 2013

Parameter	**Value**
Bed Width, m	17.4
Maximum Depth, m	1.1
Cross-Section Area, m^2	18.5
Average Flow Velocity, m/s	0.07
Discharge, m^3/s	1.3
Temperature, °C	8.1
Ntot Concentration, (Measurement uncertainty), mg/l	1.54 (±0.15)
Ptot Concentration, (Measurement uncertainty), mg/l	0.09 (±0.010)

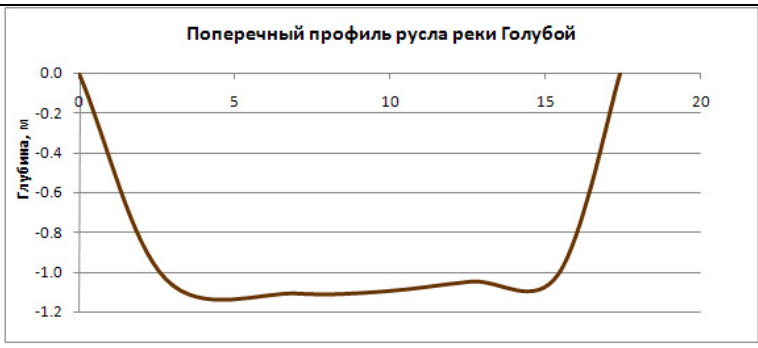


Figure 2.64 – Cross Section of the River Golubaya Bed, 02.10.2013

Station 13.The River Deyma, Right Armof the River Pregolya, Polessk

Figure 2.65 – The River Deyma Bed Reach, in downstream direction (Photo: Karmanov, 03.10.2013)

Table 2.34 Hydrological and Hydrochemical Characteristics of the River Deyma in Autumn Season 2013

Parameter	**Value**
Bed Width, m	93
Maximum Depth, m	4.9
Cross-Section Area, m^2	294
Average Flow Velocity, m/s	0.12
Discharge, m^3/s	34.4
Temperature, °C	9.9
Ntot Concentration, (Measurement uncertainty), mg/l	3.28 (±0.29)
Ptot Concentration, (Measurement uncertainty), mg/l	0.13 (±0.12)

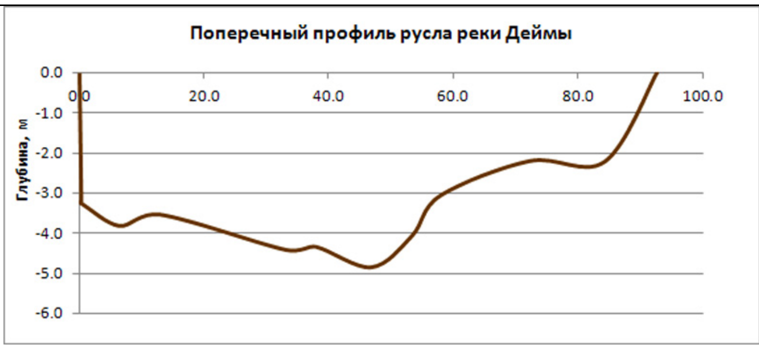


Figure 2.66 – Cross Section of the River Deyma Bed, 03.10.2013

Station 14.The Matrosov Canal (estuary), Zapovednoe Settlement

Figure 2.67 – The Matrosov Canal Bed Reach, in downstream direction (Photo: Karmanov, 03.10.2013)

Table 2.35 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Autumn Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.75 (±0.17)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.081 (±0.009)	

Station 15.The River Sheshupe, Left Tributary of the River Neman, Lesnoe Settlement

Figure 2.68 – The River Sheshupe Bed Reach, upstream (Photo: Domnin, 03.10.2013)

Table 2.36 Hydrological and Hydrochemical Characteristics of the River Sheshupe in Autumn Season 2013

Parameter	**Value**
Bed Width, m	55
Maximum Depth, m	3.8
Cross-Section Area, m^2	120
Average Flow Velocity, m/s	0.37
Discharge, m^3/s	44.6
Temperature, °C	9.9
Ntot Concentration, (Measurement uncertainty), mg/l	4.46 (±0.39)
Ptot Concentration, (Measurement uncertainty), mg/l	0.091 (±0.010)

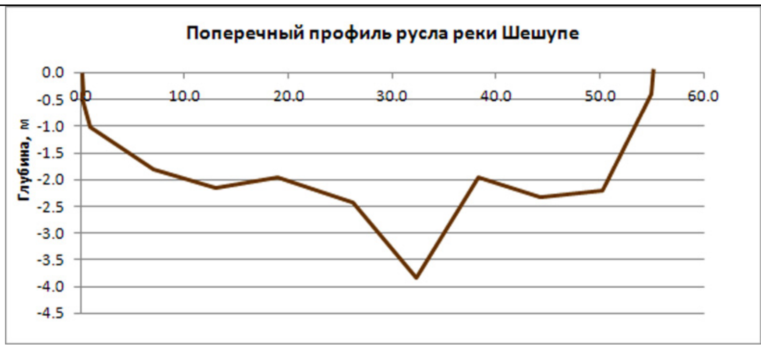


Figure 2.69 – Cross Section of the River Sheshupe Bed, 03.10.2013

Station 16.The River Prokhladnaya, Ushakovo Settlement
Station 16a.Svetloe Settlement

Figure 2.70 – The River Prokhladnaya Estuary (Ushakovo Settlement), upstream (Photo: Domnin, 04.10.2013)

Figure 2.71 – The River Prokhladnaya Bed Reach (Svetloe Settlement), in downstream direction (Photo: Domnin, 04.10.2013)

Table 2.37 Hydrological and Hydrochemical Characteristics of the River Prokhladnaya in Autumn Season 2013

Parameter	Value
Bed Width, m	9.0
Maximum Depth, m	1.4
Cross-Section Area, m^2	8.6
Average Flow Velocity, m/s	0.14
Discharge, m^3/s	1.2
Temperature, °C	5.9
Ntot Concentration, (Measurement uncertainty), mg/l	1.55 (±0.15)
Ptot Concentration, (Measurement uncertainty), mg/l	0.147 (±0.013)

Figure 2.72 – Cross Section of the River Prokhladnaya Bed, 04.10.2013

Station 17. The Kaliningrad Canal, Estuary

Figure 2.73 – The Kaliningrad Canal Reach, upstream (Photo: Domnin, 30.09.2013)

Table 2.38 Hydrological and Hydrochemical Characteristics of the Kaliningrad Canal in Autumn Season 2013

Parameter	Value
Bed Width, m	2.8
Maximum Depth, m	0.8
Cross-Section Area, m^2	2.1
Average Flow Velocity, m/s	0.8
Discharge, m^3/s	1.6
Temperature, °C	11.3
Ntot Concentration, (Measurement uncertainty), mg/l	29.7 (±2.41)
Ptot Concentration, (Measurement uncertainty), mg/l	4.949 (±0.316)

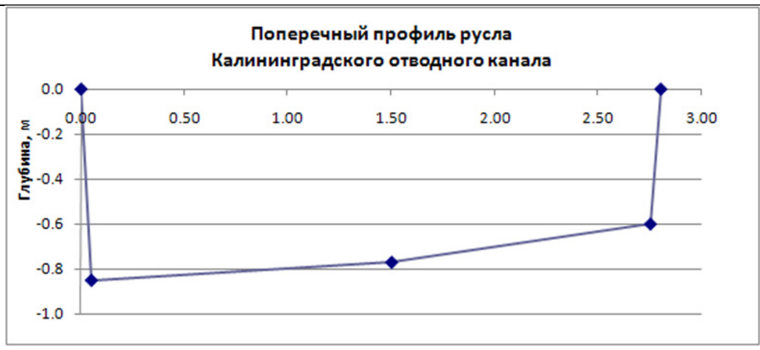


Figure 2.74 – Cross Section of the Kaliningrad Canal, 30.09.2013

Station 24, 24a.The River Primorskaya, Primorsk

Figure 2.75 – The River Primorskaya Estuary, upstream, (Photo: Domnin, 30.09.2013)

Figure 2.76 – The River Primorskaya Bed Reach, upstream (Photo: Domnin, 30.09.2013)

Table 2.39 Hydrological and Hydrochemical Characteristics of the River Primorskaya in Autumn Season 2013

Parameter	**Value**
Bed Width, m	3.5
Maximum Depth, m	0.8
Cross-Section Area, m^2	3.7
Average Flow Velocity, m/s	0.37
Discharge, m^3/s	1.4
Temperature, °C	8.5
Ntot Concentration, (Measurement uncertainty), mg/l	1.13 (±0.12)
Ptot Concentration, (Measurement uncertainty), mg/l	0.187 (±0.016)

Figure 2.77 – Cross Section of the River Primorskaya Bed, 30.09.2013

Station 25, 25a.The River Nelma, Kostrovo Settlement

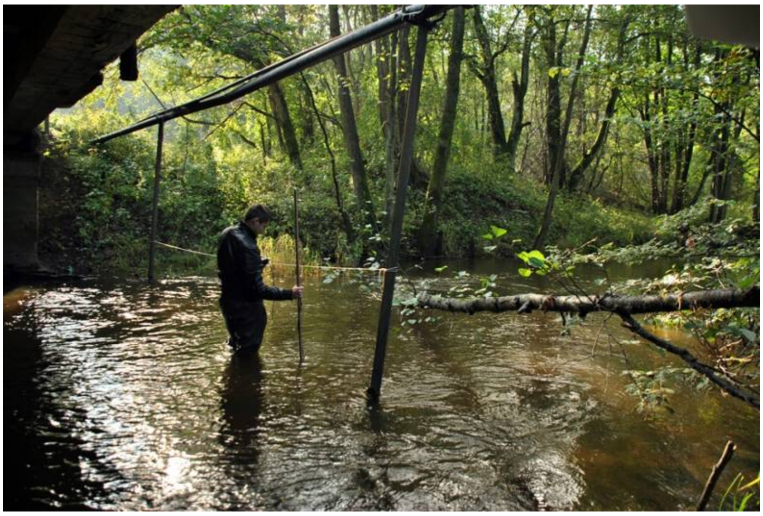


Figure 2.78 – The River Nelma Bed Reach, in downstream direction (Photo: Domnin, 30.09.2013)

Table 2.40 Hydrological and Hydrochemical Characteristics of the River Nelma in Autumn Season 2013

Parameter	Value
Bed Width, m	7.5
Maximum Depth, m	0.5
Cross-Section Area, m^2	3.3
Average Flow Velocity, m/s	0.36
Discharge, m^3/s	1.2
Temperature, °C	8.2
Ntot Concentration, (Measurement uncertainty), mg/l	1.27 (±0.13)
Ptot Concentration, (Measurement uncertainty), mg/l	0.185 (±0.016)

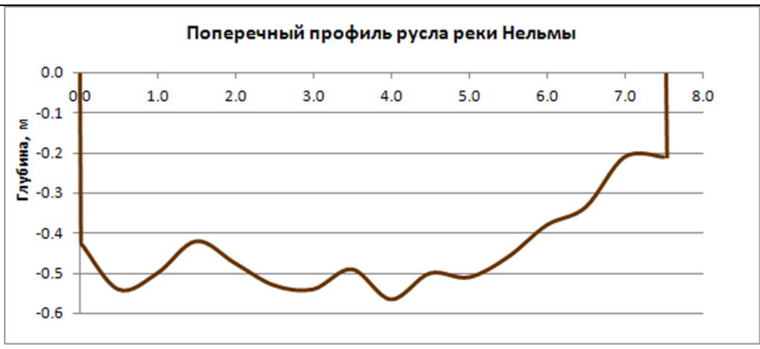


Figure 2.79– Cross Section of the River Nelma Bed, 30.09.2013

Station 26.The River Pregolya, Kaliningrad

Figure 2.80 – The River Pregolya Bed Reach, in downstream direction (Photo: Karmanov, 30.09.2013)

Table 2.41 Hydrological and Hydrochemical Characteristics of the River Pregolya in Autumn Season 2013

Parameter	Value
Bed Width, m	93
Maximum Depth, m	6.9
Cross-Section Area, m^2	444
Average Flow Velocity, m/s	0.13
Discharge, m^3/s	55.7
Temperature, °C	9.5
Ntot Concentration, (Measurement uncertainty), mg/l	3.47 (±0.31)
Ptot Concentration, (Measurement uncertainty), mg/l	0.224 (±0.018)

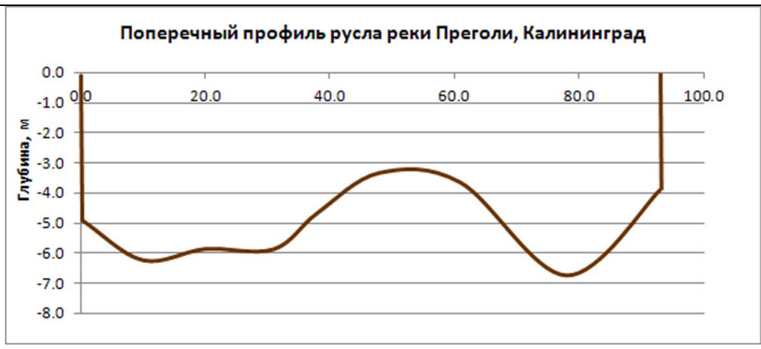
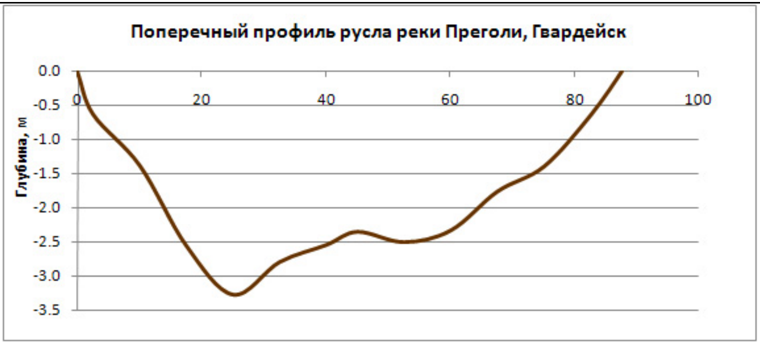


Figure 2.81 – Cross Section of the River Pregolya Bed

Station 27.The River Pregolya, Gvardejsk

Figure 2.82– The River Pregolya Bed Reach, in downstream direction (Photo: Karmanov, 02.10.2013)

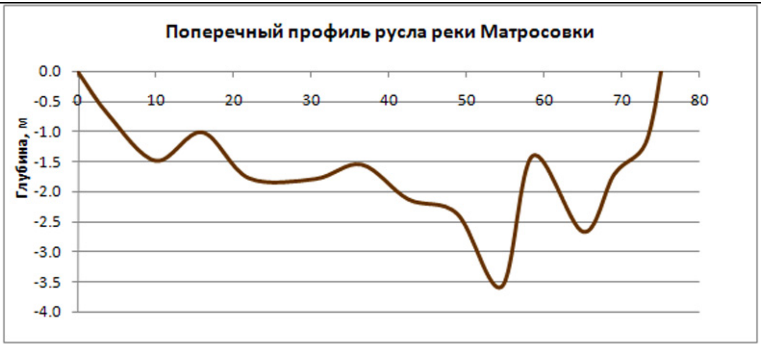
Table 2.42 Hydrological and Hydrochemical Characteristics of the River Pregolya in Autumn Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>88</td></tr>
<tr><td>Maximum Depth, m</td><td>3.3</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>176</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.38</td></tr>
<tr><td>Discharge, m^3/s</td><td>67.3</td></tr>
<tr><td>Temperature, °C</td><td>10.0</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>3.05 (±0.27)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.113 (±0.011)</td><td>Figure 2.83 – Cross Section of the River Pregolya Bed, 02.10.2013</td></tr>
</table>

Station 28.The Matrosov Canal, Mostovoe Settlement

Figure 2.84 – The Matrosov Canal Bed Reach, in downstream direction (Photo: Karmanov, 03.10.2013)

Table 2.43 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Autumn Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>75</td></tr>
<tr><td>Maximum Depth, m</td><td>3.6</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>106</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.54</td></tr>
<tr><td>Discharge, m^3/s</td><td>57.8</td></tr>
<tr><td>Temperature, °C</td><td>11.3</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.82 (±0.18)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.076 (±0.009)</td><td>Figure 2.85– Cross Section of the Matrosov Canal, 03.10.2013</td></tr>
</table>

Station 29.The River Sheshupe, Zarechnoe Settlement

Figure 2.86 – The River Sheshupe Bed Reach, upstream (Photo: Domnin, 03.10.2013).

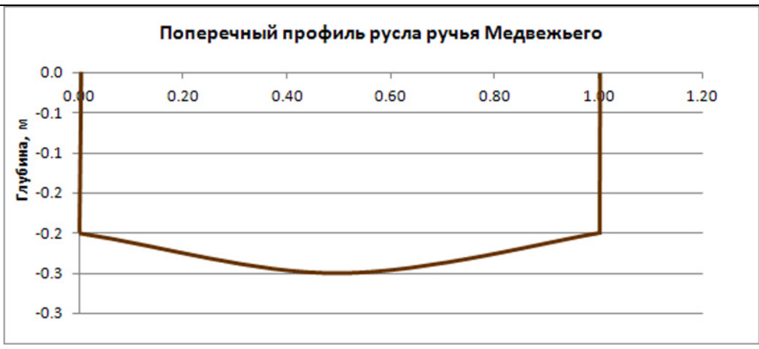
Table 2.44 Hydrological and Hydrochemical Characteristics of the River Sheshupe in Autumn Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	4.47 (±0.39)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.101 (±0.010)	

Station 30.The Stream Medvezhij, Estuary, Sokolniki Settlement

Figure 2.87– The Stream Medvezhij Estuary, in downstream direction (Photo: Domnin, 05.10.2013).

Table 2.45 Hydrological and Hydrochemical Characteristics of the Stream Medvezhij in Autumn Season 2013

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>1.0</td></tr>
<tr><td>Maximum Depth, m</td><td>0.25</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>0.2</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.97</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.21</td></tr>
<tr><td>Temperature, °C</td><td>7.5</td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.44 (±0.15)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.275 (±0.021)</td><td>Figure 2.88– Cross Section of the Stream Medvezhij Bed, 05.10.2013</td></tr>
</table>

Station 31. The River Lava, Ryabinino Settlement

Table 2.46 Hydrological and Hydrochemical Characteristics of the River Lava in Autumn Season 2013.

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	3.31 (±0.29)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.099 (±0.010)	

Station 32.The River Lava, Pravdinsk

Figure 2.89 – The River Lava Bed Reach, in downstream direction (Photo: Domnin, 02.10.2013).

Table 2.47 Hydrological and Hydrochemical Characteristics of the River Lava in Autumn Season 2013

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.30 (±0.13)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.104 (±0.011)	

Station 33.The Stream Medvezhij, Sokolniki Settlement

Figure 2.90 – The Stream Medvezhij Bed Reach, upstream (Photo: Domnin, 05.10.2013).

Table 2.48 Hydrological and Hydrochemical Characteristics of the Stream Medvezhij in Autumn Season 2013

Parameter	Value
Bed Width, m	1.4
Maximum Depth, m	0.2
Cross-Section Area, m^2	0.22
Average Flow Velocity, m/s	0.31
Discharge, m^3/s	0.07
Temperature, °C	8.0
Ntot Concentration, (Measurement uncertainty), mg/l	0.71 (±0.09)
Ptot Concentration, (Measurement uncertainty), mg/l	0.115 (±0.011)

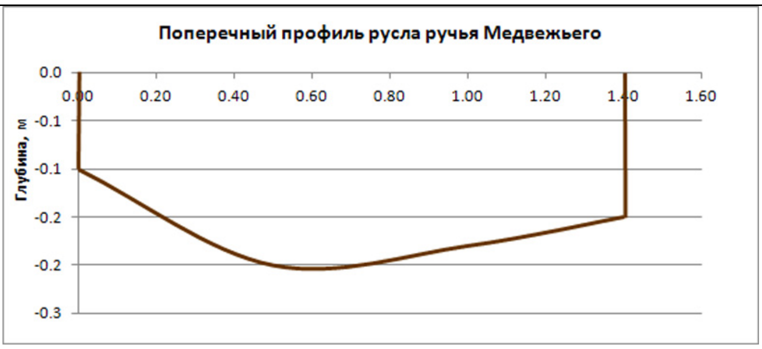


Figure 2.91– Cross Section of the Stream Medvezhij Bed, 05.10.2013

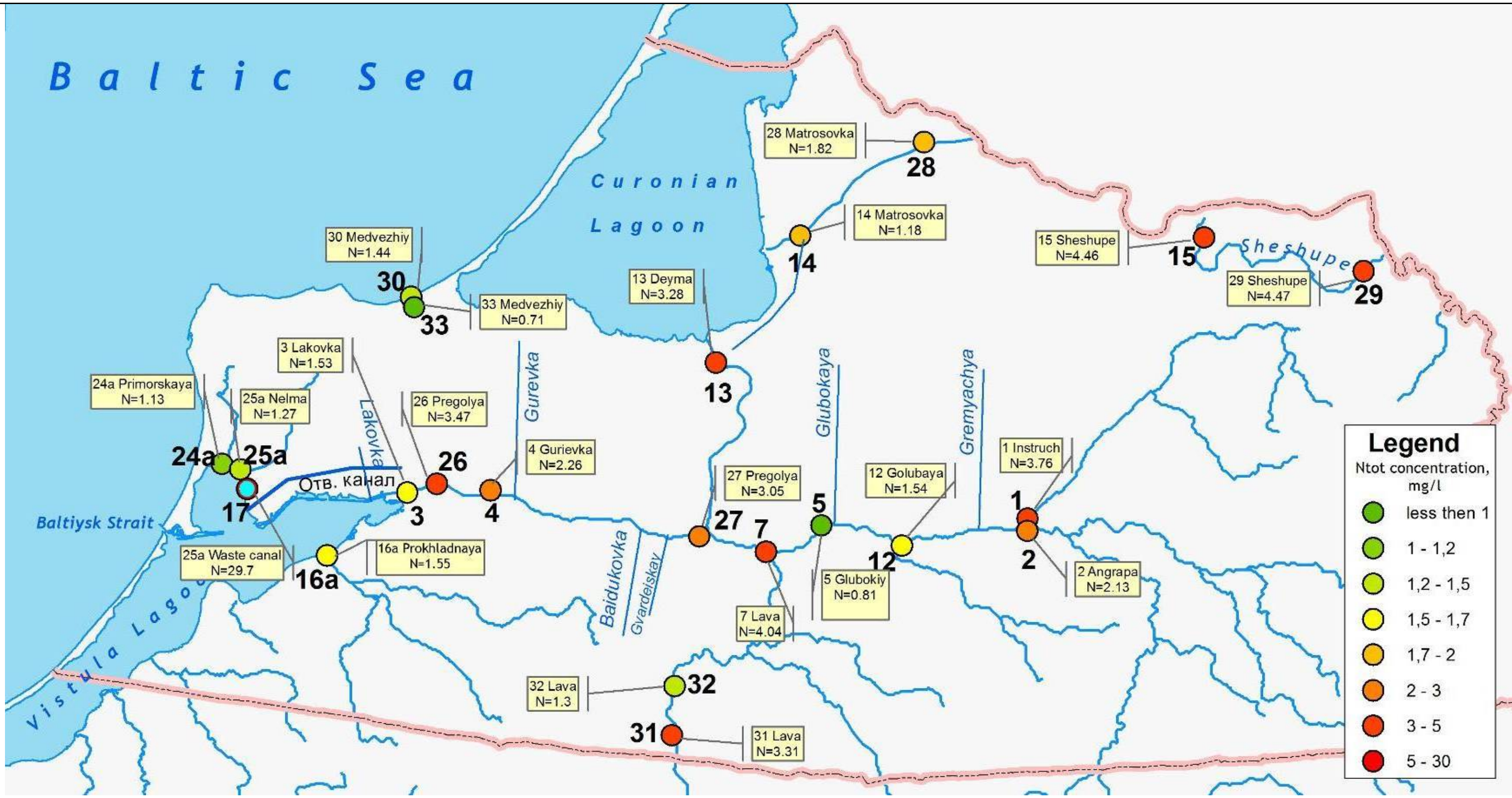


Figure 2.92 – Distribution of Total Nitrogen Concentration in Water (mg/l) based on Data Analysis of Samples collected during Autumn Season

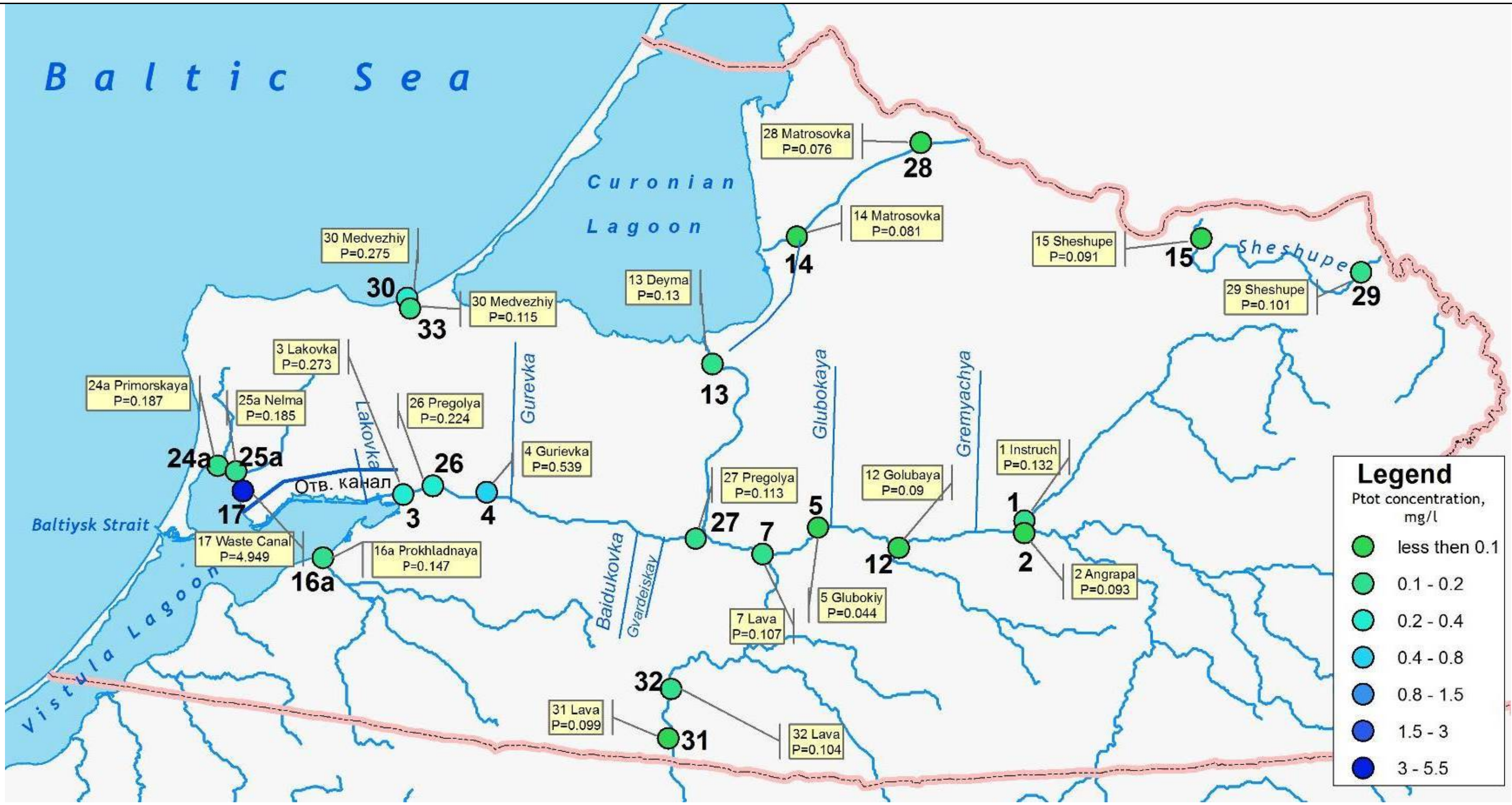


Figure 2.93 – Distribution of Total Phosphorus Concentration in Water (mg/l) based on Data Analysis of Samples collected during Autumn Season

- **3rd and the following sampling rounds program, changes made and justifications for the changes (Winter)**

Hydrological measurements and water sampling on the rivers of the Kaliningrad Oblast for the winter season took place in a winter low-water period (02-11 February 2014). During this periodal most all rivers were ice-covered. Thus, measurements were carried out from the ice-covered rivers surface and required specific preparation of sampling stations, namely, holes in the ice were drilled for each vertical profile and ice slush was extracted.

According to the second sampling and hydrological measurements round it was revealed that int he Lava River one cannot ice anabruptincrease of the dissolved biogenes concentration from the Pravdinsk Reservoir to the River Estuary. As a result for the third round two new stations on the Lava River and one station on the Medvezhij Stream were settled. (Figure 2.94.)

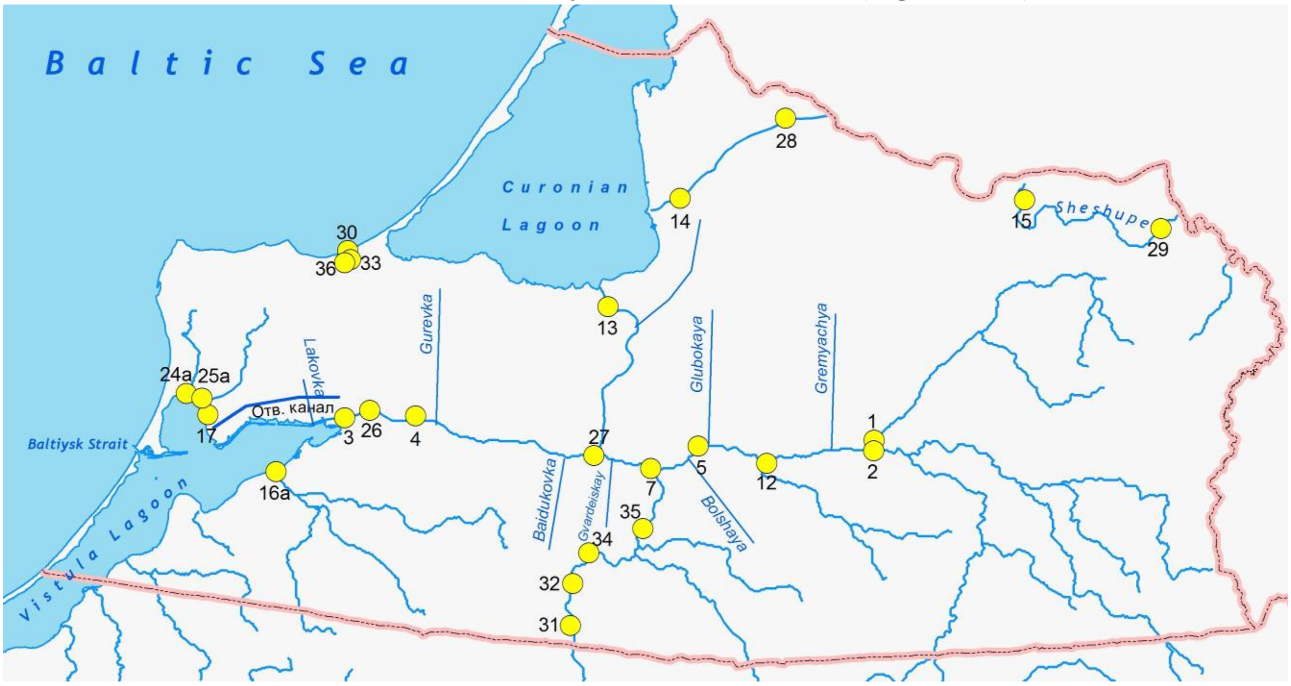
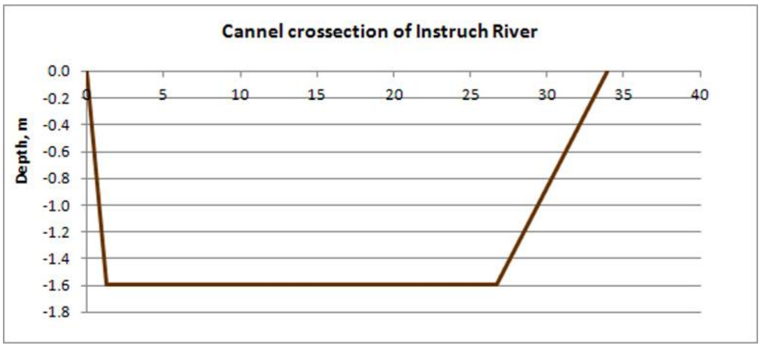


Figure 2.94 - Location of Sampling Stations for the Third Measuring Round (02-11 February 2014)

Station 1.River Instruch, Right Tributary of the River Pregolya, Maevka Settlement

Figure 2.95 – Instruch River Bed Reach, downstream (Photo: Domnin, 10.02.2014)

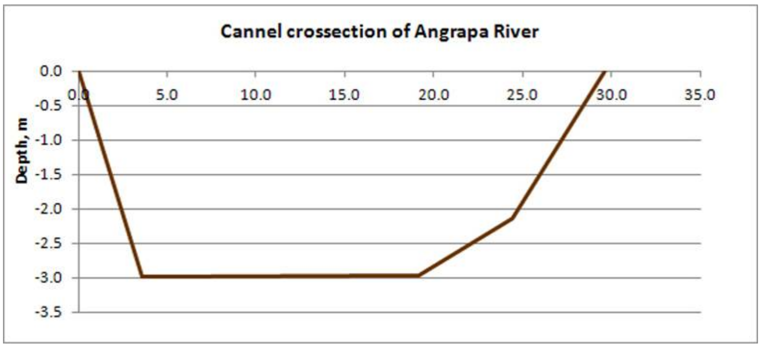
Table 2.49 Hydrological and Hydrochemical Characteristics of the Instruch River in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>33.9</td></tr>
<tr><td>Maximum Depth, m</td><td>1.6</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>53.9</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.08</td></tr>
<tr><td>Discharge, m^3/s</td><td>4.3</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.73 (±0.17)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.095 (±0.010)</td><td>Figure 2.96 – Bed Cross-Section of the Instruch River, 10.02.2014</td></tr>
</table>

Station 2.River Angrapa, Left Tributary of the River Pregolya, Chernyakhovsk

Figure 2.97 – Angrapa River Bed Reach, downstream (Photo: Domnin, 10.02.2014)

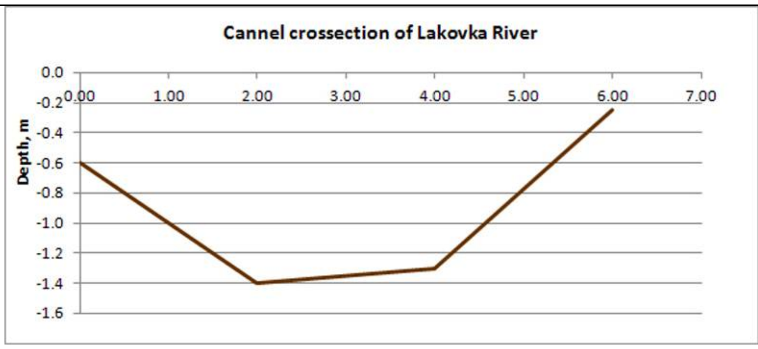
Table 2.50 Hydrological and Hydrochemical Characteristics of the Angrapa River in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>29.6</td></tr>
<tr><td>Maximum Depth, m</td><td>3.0</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>79.7</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.47</td></tr>
<tr><td>Discharge, m^3/s</td><td>37.5</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.62 (±0.16)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.07 (±0.008)</td><td>Figure 2.98 – Bed Cross-Section of the Angrapa River, 10.02.2014</td></tr>
</table>

Station 3. River Lakovka, Right Tributary of the River Pregolya, Pregolskij Settlement

Figure 2.99 – Lakovka River Bed Reach, upstream (Photo: Kartanov, 6.02.2014)

Table 2.51 Hydrological and Hydrochemical Characteristics of the Lakovka River in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>6.0</td></tr>
<tr><td>Maximum Depth, m</td><td>1.4</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>5.33</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.003</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.02</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>2.09 (±0.20)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.282 (±0.022)</td><td>Figure 2.100 – Bed Cross-Section of the Lakovka River, 06.02.2014</td></tr>
</table>

Station 4. River Gurjevka (Muelen), Right Tributary of the River Pregolya, Pribrezhnoe Settlement

Figure 2.101 – Gurjevka River Estuary, in downstream direction (Photo: Karmanov, 06.02.2014)

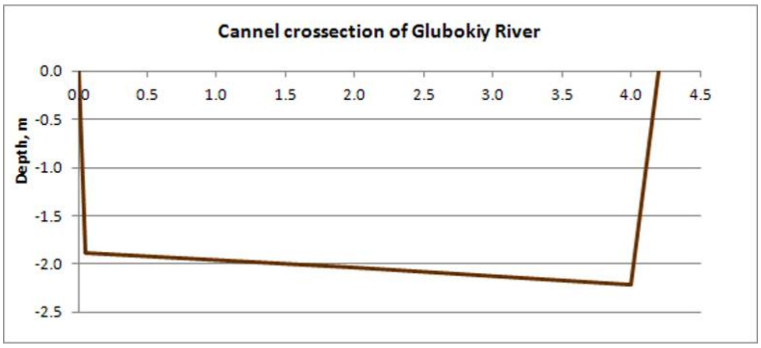
Table 2.52 Hydrological and Hydrochemical Characteristics of the Gurjevka River in Winter Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2	1.6	
Average Flow Velocity, m/s	0.3	
Discharge, m^3/s	0.5	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	2.84 (±0.26)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.253 (±0.020)	

Station 5.Stream Glubokij, Right Tributary of the River Pregolya, Talpaki Settlement

Figure 2.102– Glubokij Stream Bed Reach, downstream (Photo: Domnin, 10.02.2014)

Table 2.53 Hydrological and Hydrochemical Characteristics of the Glubokij Stream in Winter Season 2014

Parameter	**Value**	
Bed Width, m	4.2	
Maximum Depth, m	2.2	
Cross-Section Area, m^2	8.6	
Average Flow Velocity, m/s	0.05	
Discharge, m^3/s	0.43	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.25 (±0.13)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.076 (±0.009)	Figure 2.103– Bed Cross-Section of the Glubokij Stream, 10.02.2014

Station 7. River Lava, Left Tributary of the River Pregolya, Znamensk Settlement

Figure 2.104 – Lava River Estuary, in downstream direction (Photo: Pilipchuk, 11.02.2014)

Table 2.54 Hydrological and Hydrochemical Characteristicsof the Lava River, Znamensk, in Winter Season 2013

Parameter	**Value**
Bed Width, m	31.7
Maximum Depth, m	4.2
Cross-Section Area, m^2	130
Average Flow Velocity, m/s	0.4
Discharge, m^3/s	52.0
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	2.81 (±0.25)
Ptot Concentration, (Measurement uncertainty), mg/l	0.136 (±0.013)

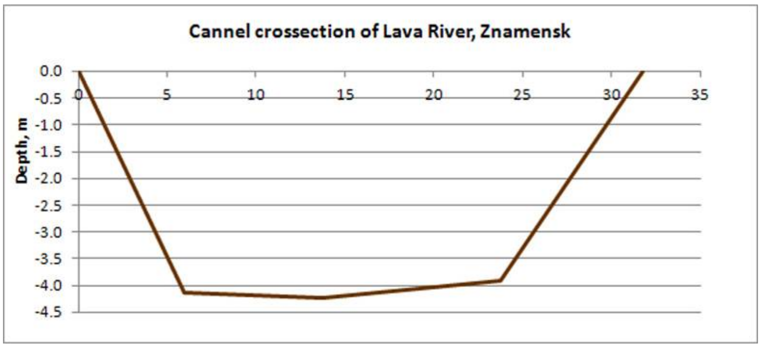


Figure 2.105 – Bed Cross-Sectionof the Lava River, 11.02.2014

Station 12. River Golubaya, Left Tributary of the River Pregolya, Mezhdurechie Settlement

Figure 2.106 – Golubaya River Bed Reach, in upstream direction (Photo: Domnin, 10.02.2014)

Table 2.55 Hydrological and Hydrochemical Characteristics of the Golubaya River in Winter Season 2014

Parameter	Value
Bed Width, m	17.4
Maximum Depth, m	1.3
Cross-Section Area, m^2	22.6
Average Flow Velocity, m/s	0.35
Discharge, m^3/s	7.2
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	1.75 (±0.17)
Ptot Concentration, (Measurement uncertainty), mg/l	0.167 (±0.015)

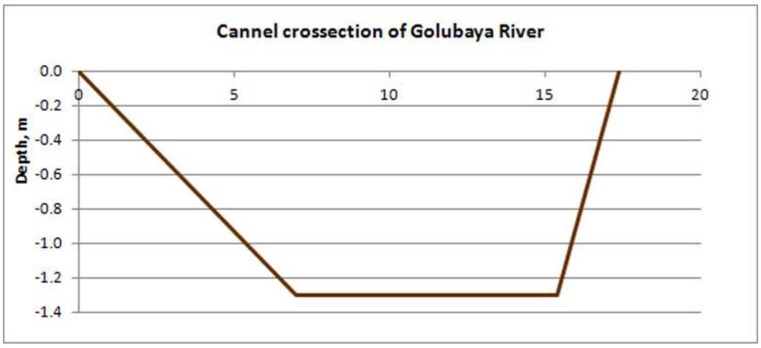


Figure 2.107– Bed Cross-Section of the Golubaya River, 10.02.2014

Station 13.River Deyma, Right Arm of the River Pregolya, Polessk

Figure 2.108 – Deyma River Bed Reach, in downstream direction (Photo: Domnin, 05.02.2014)

Table 2.56 Hydrological and Hydrochemical Characteristics of the Deyma River in Winter Season 2014

Parameter	**Value**
Bed Width, m	93
Maximum Depth, m	3.6
Cross-Section Area, m^2	305
Average Flow Velocity, m/s	0.15
Discharge, m^3/s	45.8
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	2.4 (±0.22)
Ptot Concentration, (Measurement uncertainty), mg/l	0.09 (±0.010)

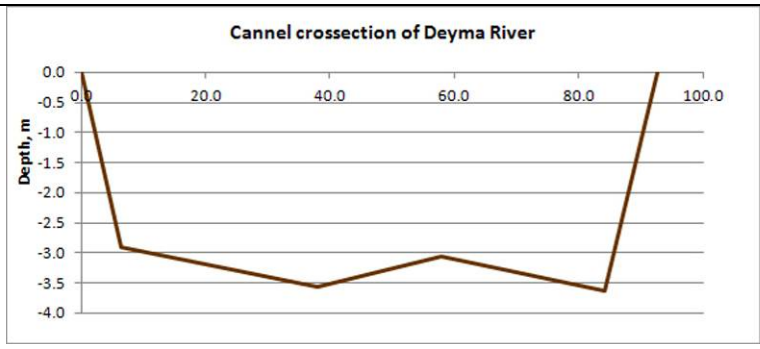


Figure 2.109 – Bed Cross-Section of the Deyma River, 05.02.2014

Station 14. Matrosov Canal (estuary), Zapovednoe Settlement

Figure 2.110 – Matrosov Canal Reach, in downstream direction (Photo: Domnin, 05.02.2014)

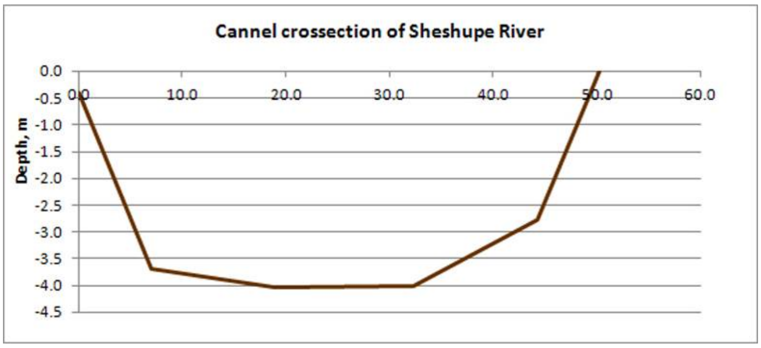
Table 2.57 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Winter Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	4.04 (±0.35)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.07 (±0.008)	

Station 15. River Sheshupe, Left Tributary of the River Neman, Lesnoe Settlement

Figure 2.111 – Sheshupe River Bed Reach, in downstream direction (Photo: Domnin, 10.02.2013)

Table 2.58 Hydrological and Hydrochemical Characteristics of the Sheshupe River in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>50.3</td></tr>
<tr><td>Maximum Depth, m</td><td>4.0</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>146</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.16</td></tr>
<tr><td>Discharge, m^3/s</td><td>23.3</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>4.3 (±0.37)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.064 (±0.008)</td><td>Figure 2.112 – Bed Cross-Section of the Sheshupe River, 10.02.2013</td></tr>
</table>

Station 16.River Prokhladnaya, Ushakovo Settlement
Station 16a.Svetloe Settlement

Table 2.59 Hydrological and Hydrochemical Characteristics of the Prokhladnaya River in Winter Season 2014

Parameter	**Value**
Bed Width, m	9.0
Maximum Depth, m	2.0
Cross-Section Area, m^2	17.8
Average Flow Velocity, m/s	0.06
Discharge, m^3/s	1.1
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	2.8 (±0.25)
Ptot Concentration, (Measurement uncertainty), mg/l	0.23 (±0.018)

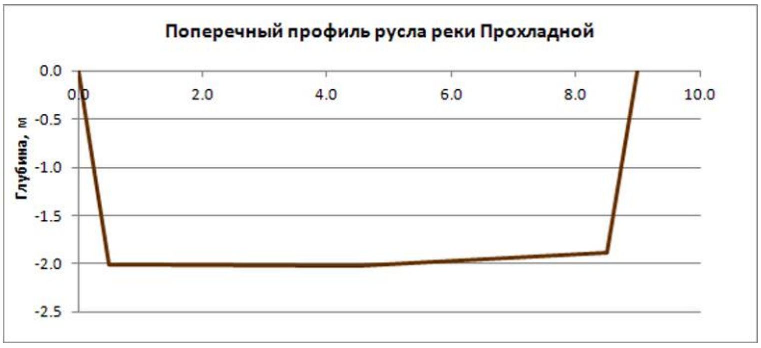
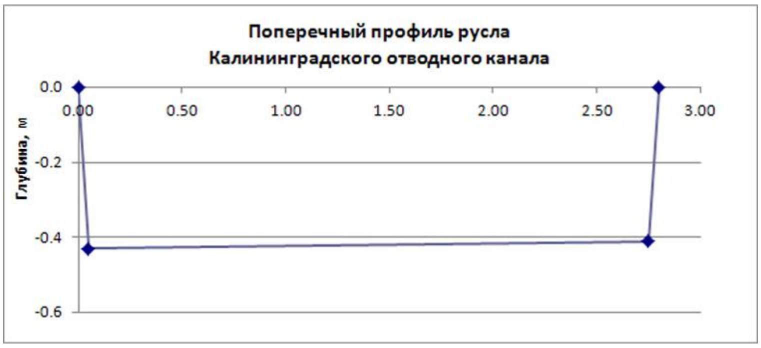


Figure 2.113 – Bed Cross-Section of the Prokhladnaya River, 04.02.2014

Station 17. Kaliningrad Waste Canal, Estuary

Figure 2.114 – Kaliningrad Waste Canal Bed Reach, in upstream direction (Photo: Karmanov, 03.02.2014)

Table 2.60 Hydrological and Hydrochemical Characteristics of the Kaliningrad Canal in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>2.8</td></tr>
<tr><td>Maximum Depth, m</td><td>0.4</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>1.2</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.97</td></tr>
<tr><td>Discharge, m^3/s</td><td>1.1</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>40.0 (±3.23)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>6.305 (±0.401)</td><td>Figure 2.115 – Bed Cross-Section of the Kaliningrad Canal, 03.02.2014</td></tr>
</table>

Station 24, 24a.River Primorskaya, Primorsk

Figure 2.116 – Primorskaya River Bed Reach, in upstream direction (Photo: Kartanov, 03.02.2014)

Table 2.61 Hydrological and Hydrochemical Characteristics of the Primorskaya River in Winter Season 2014

Parameter	**Value**
Bed Width, m	3.0
Maximum Depth, m	0.8
Cross-Section Area, m^2	2.1
Average Flow Velocity, m/s	0.29
Discharge, m^3/s	0.61
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	1.22 (±0.13)
Ptot Concentration, (Measurement uncertainty), mg/l	0.223 (±0.018)

Figure 2.117 – Bed Cross-Section of the Primorskaya River, 03.02.2014

Station 25, 25a.River Nelma, Kostrovo Settlement

Figure 2.118 – Nelma River Bed Reach, in downstream direction (Photo: Karmanov, 03.02.2013)

Table 2.62 Hydrological and Hydrochemical Characteristics of the Nelma River in Winter Season 2014

Parameter	**Value**	
Bed Width, m	8.3	
Maximum Depth, m	0.4	
Cross-Section Area, m^2	2.8	
Average Flow Velocity, m/s	0.27	
Discharge, m^3/s	0.8	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.46 (±0.15)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.226 (±0.018)	Figure 2.119 – Bed Cross-Section of the Nelma River, 03.02.2014

Station 26. River Pregolya, Kaliningrad

Table 2.63 Hydrological and Hydrochemical Characteristics of the Pregolya River in Winter Season 2014

Parameter	Value
Bed Width, m	50
Maximum Depth, m	5.3
Cross-Section Area, m^2	375
Average Flow Velocity, m/s	0.09
Discharge, m^3/s	33.8
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	2.73 (±0.25)
Ptot Concentration, (Measurement uncertainty), mg/l	0.137 (±0.013)

Figure2.120 – Bed Cross-Section of the Pregolya River, 03.02.2014

Station 27.River Pregolya, Gvardejsk

Figure 2.121 – Pregolya River Bed Reach, in downstream direction (Photo: Domnin, 10.02.2014)

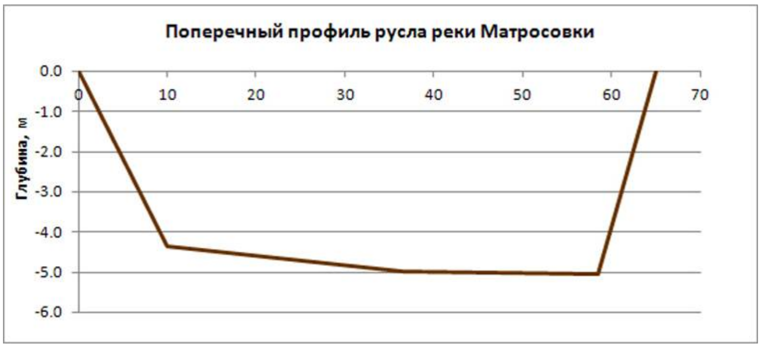
Table 2.64 Hydrological and Hydrochemical Characteristics of the Pregolya River in Winter Season 2014

Parameter	**Value**	
Bed Width, m	68	
Maximum Depth, m	3.6	
Cross-Section Area, m^2	155	
Average Flow Velocity, m/s	0.4	
Discharge, m^3/s	62.2	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.87 (±0.18)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.137 (±0.013)	Figure 2.122 – Bed Cross-Section of the Pregolya River, 10.02.2014

Station 28. Matrosov Canal, Mostovoe Settlement

Figure 2.123 – Matrosov Canal Bed Reach, in downstream direction (Photo: Domnin, 05.02.2014)

Table 2.65 Hydrological and Hydrochemical Characteristicsof the Matrosov Canal in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="7">
</td></tr>
<tr><td>Bed Width, m</td><td>65</td></tr>
<tr><td>Maximum Depth, m</td><td>5.1</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>234</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.46</td></tr>
<tr><td>Discharge, m^3/s</td><td>108.4</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>2.85 (±0.26)</td><td></td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.087 (±0.009)</td><td>Figure 2.124 – Bed Cross-Section of the Matrosov Canal, 05.02.2014</td></tr>
</table>

Station 29. River Sheshupe, Zarechnoe Settlement

Figure 2.125– Sheshupe River Bed Reach, in downstream direction (Photo: Domnin, 10.02.2014).

Table 2.66 Hydrological and Hydrochemical Characteristics of the Sheshupe River in Winter Season 2014.

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	4.37 (±0.38)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.076 (±0.009)	

Station 30. Stream Medvezhij, Estuary, Sokolniki Settlement

Table 2.67 Hydrological and Hydrochemical Characteristics of the Medvezhij Stream in Winter Season 2014

Parameter	Value
Bed Width, m	1.6
Maximum Depth, m	0.3
Cross-Section Area, m^2	0.4
Average Flow Velocity, m/s	0.36
Discharge, m^3/s	0.15
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	1.81 (±0.17)
Ptot Concentration, (Measurement uncertainty), mg/l	0.182 (±0.015)

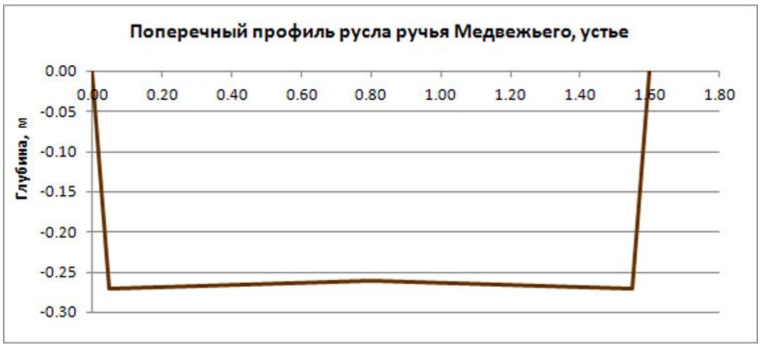


Figure 2.126 – Bed Cross-Section of the Medvezhij Stream, 11.02.2014

Station 31.River Lava, Ryabinino Settlement

Table 2.68 Hydrological and Hydrochemical Characteristics of the Lava River in Winter Season 2014

Parameter	Value	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	4.9 (±0.42)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.173 (±0.015)	

Station 32. River Lava, Pravdinsk

Figure 2.127 – Lava River Bed Reach, in downstream direction (Photo: Pilipchuk, 11.02.2014).

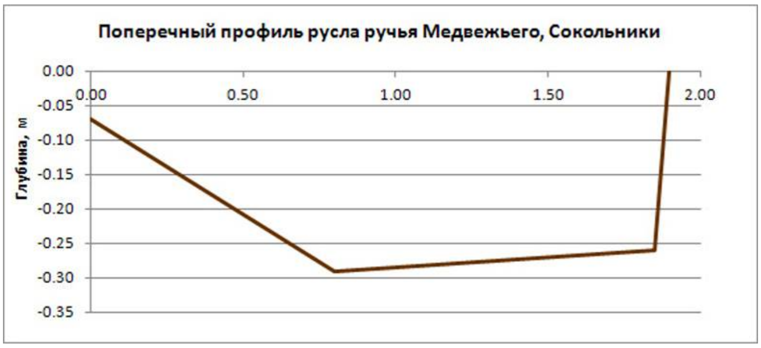
Table 2.69 Hydrological and Hydrochemical Characteristics of the Lava River in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>45</td></tr>
<tr><td>Maximum Depth, m</td><td>1.8</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>65</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.61</td></tr>
<tr><td>Discharge, m^3/s</td><td>39.6</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>2.5 (±0.23)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.099 (±0.010)</td><td>Figure 2.128 – Bed Cross-Section of the Lava River, Pravdinsk, 11.02.2014</td></tr>
</table>

Station 33.Stream Medvezhij, Sokolniki Settlement

Figure 2.129 – Stream Medvezhij Bed Reach, in downstream direction (Photo: Pilipchuk, 11.02.2014).

Table 2.70 Hydrological and Hydrochemical Characteristics of the Stream Medvezhij in Winter Season 2014

Parameter	**Value**	
Bed Width, m	1.9	
Maximum Depth, m	0.3	
Cross-Section Area, m^2	0.4	
Average Flow Velocity, m/s	0.3	
Discharge, m^3/s	0.12	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.69 (±0.17)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.336 (±0.025)	Figure 2.130 – Bed Cross-Section of the Stream Medvezhij, 11.02.2014

Station 34. River Lava, Dalnee Settlement

Figure 2.131 – Lava River Bed Reach, in downstream direction (Photo: Pilipchuk, 11.02.2014).

Table 2.71 Hydrological and Hydrochemical Characteristics of the Lava Riverin Winter Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	2.74 (±0.25)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.104 (±0.011)	

Station 35. River Lava, Rodniki Settlement

Figure 2.132 – Lava River Bed Reach, in downstream direction (Photo: Pilipchuk, 11.02.2014).

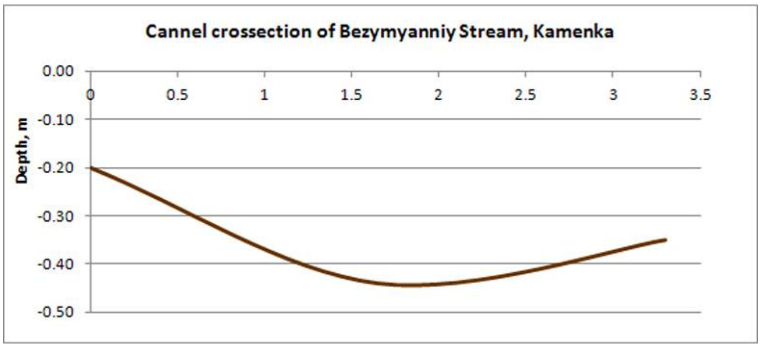
Table 2.72 Hydrological and Hydrochemical Characteristics of the Lava River in Winter Season 2014

Parameter	**Value**	
Bed Width, m	21	
Maximum Depth, m	4.0	
Cross-Section Area, m^2	53.4	
Average Flow Velocity, m/s	0.61	
Discharge, m^3/s	32.4	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	3.08 (±0.28)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.131 (±0.012)	Figure 2.133 – Bed Cross-Section of the Lava River, Rodniki, 11.02.2014

Station 36.Stream Bezymyannij, Kamenka Settlement

Figure 2.134 – Bezymyannij Stream Bed Reach, in downstream direction (Photo: Pilipchuk, 11.02.2014)

Table 2.73 Hydrological and Hydrochemical Characteristics of the Bezymyannij Stream in Winter Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>3.3</td></tr>
<tr><td>Maximum Depth, m</td><td>0.4</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>1.1</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.04</td></tr>
<tr><td>Discharge, m^3/s</td><td>0.04</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>2.34 (±0.22)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.143 (±0.013)</td><td>Figure 2.135 – Bed Cross-Section of the Bezymyannij Stream, 11.02.2014</td></tr>
</table>

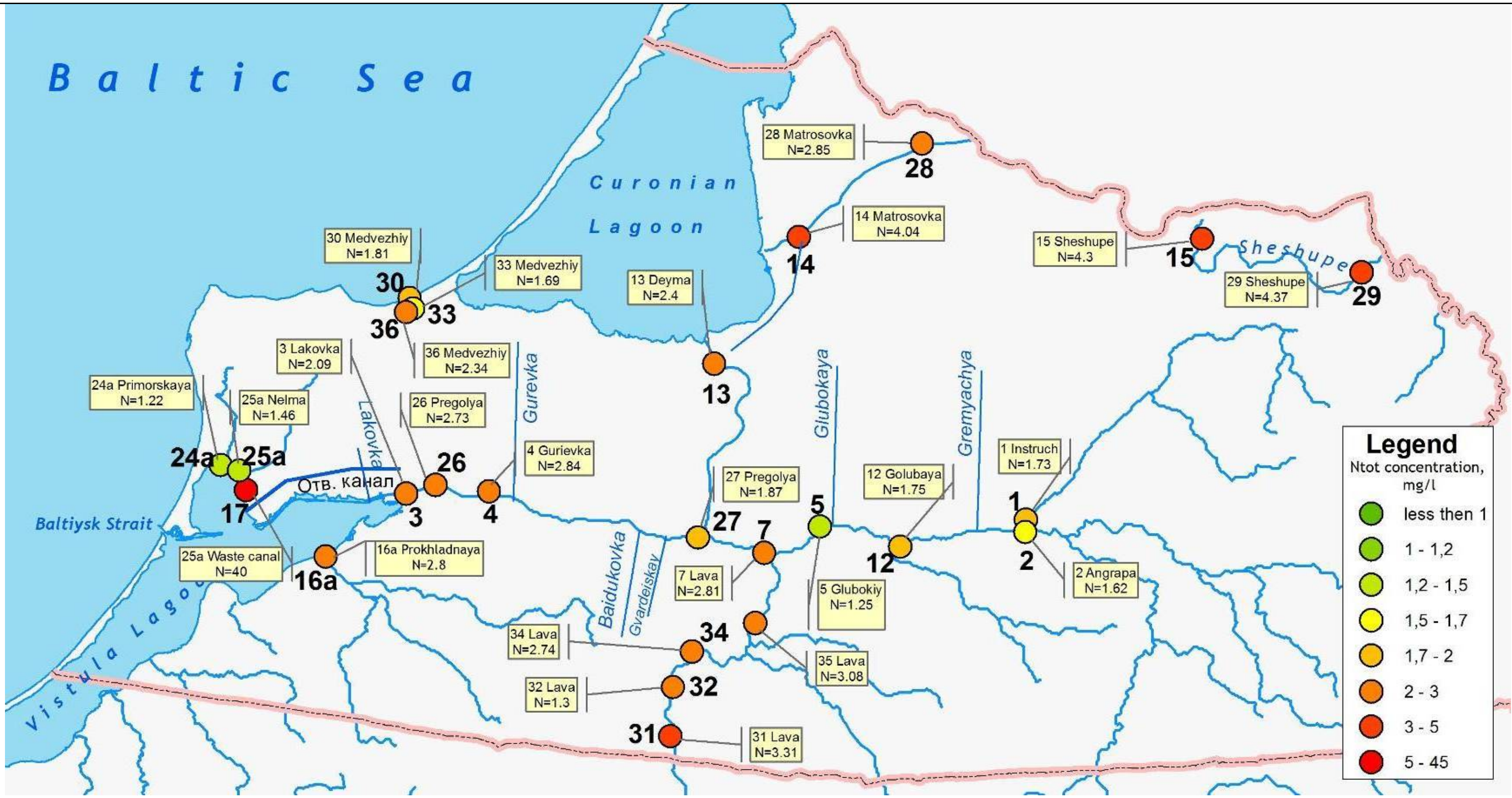


Figure 2.136 – Distribution of Total Nitrogen Concentration in Water (mg/l) based on Data Analysis of Samples collected during Winter Season

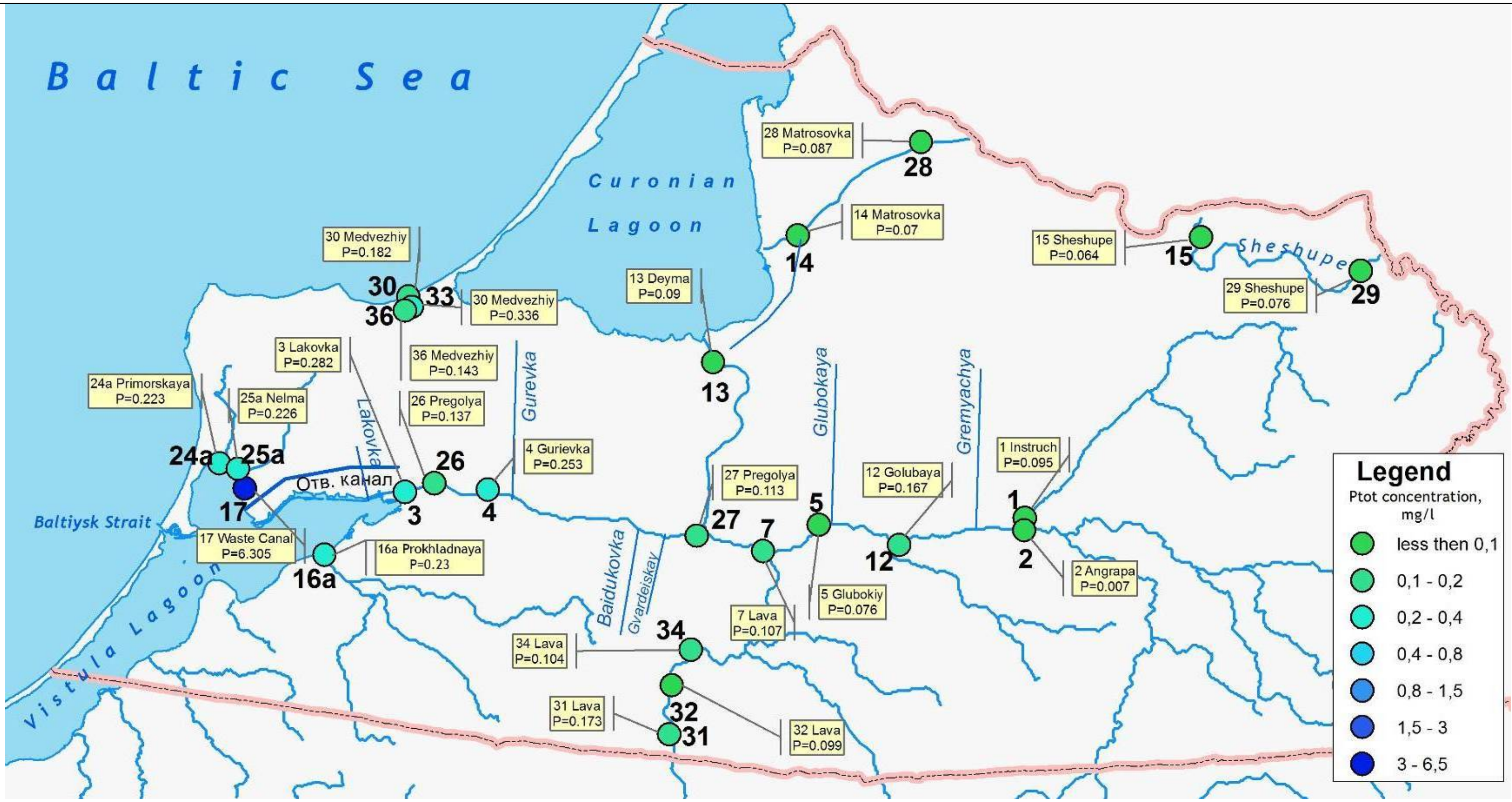


Figure 2.137 – Distribution of Total Phosphorus Concentration in Water (mg/l) based on Data Analysis of Samples collected during Winter Season

- **4th and the following sampling rounds program, changes made and justifications for the changes (Spring)**

Hydrological measurements and water sampling on the rivers of the Kaliningrad Oblast for the spring season took place in a spring high-water period (01-03 April 2014). During this periodal most all rivers were characterized by the main bed overflowing.

Taking into account absence of any current on the Lakovka River at the measuring period sampling and measurements were not conducted at the station (No 3).

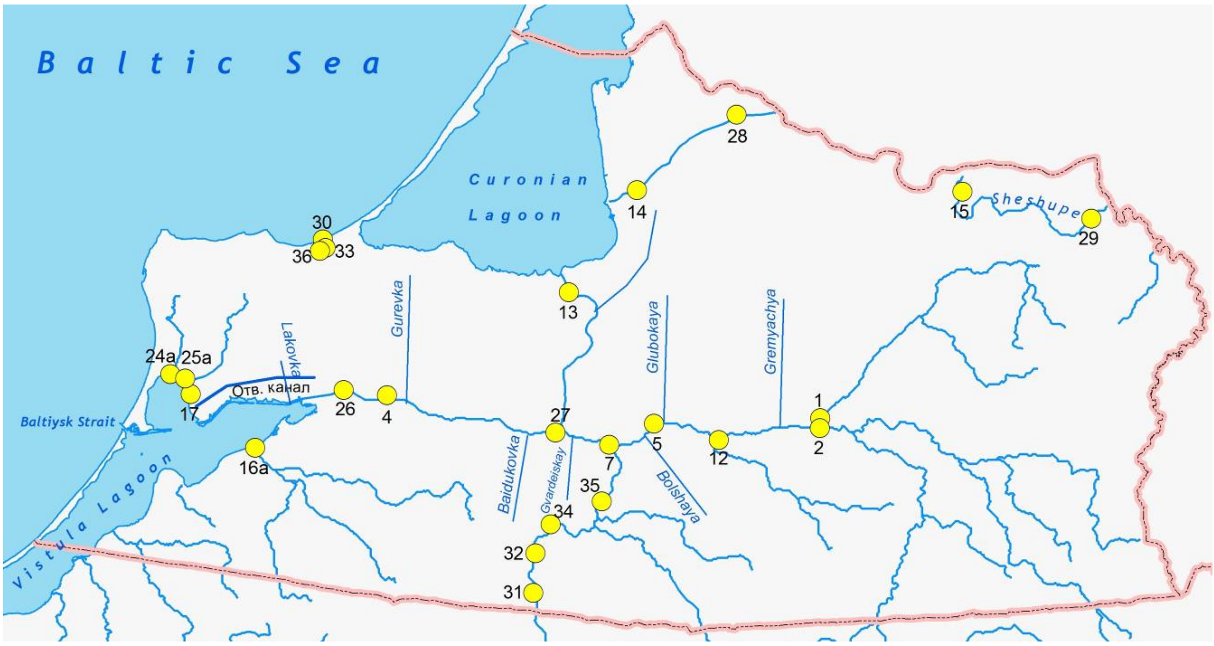
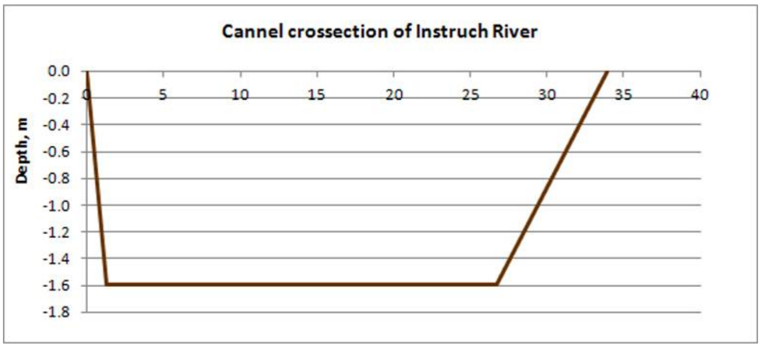


Figure 2.138 -Location of Sampling Stations for the Fourth Measuring Round (01-03 April 2014)

Station 1. River Instruch, Right Tributary of the River Pregolya, Maevka Settlement

Figure 2.139 – River Instruch Bed Reach, downstream (Photo: Pilipchuk, 03.04.2014)

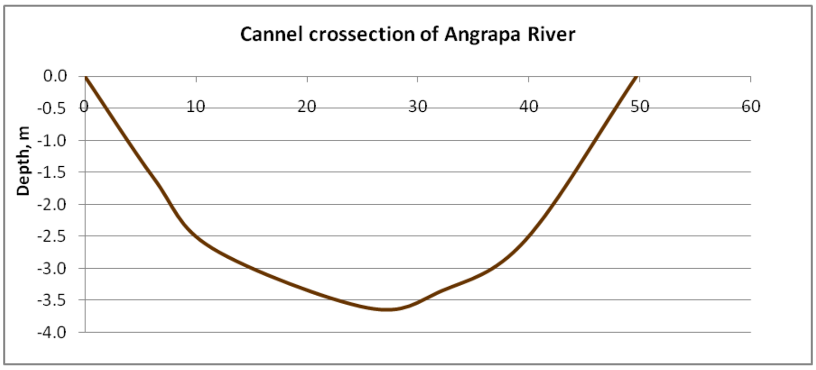
Table 2.74 Hydrological and Hydrochemical Characteristics of the Instruch River in Spring Season 2014

Parameter	**Value**	
Bed Width, m	33.9	
Maximum Depth, m	1.6	
Cross-Section Area, m^2	53.9	
Average Flow Velocity, m/s	0.46	
Discharge, m^3/s	4.3	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	2.22 (±0.21)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.176 (±0.015)	Figure 2.140 – Bed Cross-Section of the Instruch River, 03.04.2014

Station 2. River Angrapa, Left Tributary of the River Pregolya, Chernyakhovsk

Figure 2.141 – Angrapa River Bed Reach, downstream (Photo: Pilipchuk, 03.04.2014)

Table 2.75 Hydrological and Hydrochemical Characteristics of the Angrapa River in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="7">
</td></tr>
<tr><td>Bed Width, m</td><td>49.7</td></tr>
<tr><td>Maximum Depth, m</td><td>3.62</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>137.27</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.24</td></tr>
<tr><td>Discharge, m^3/s</td><td>33.49</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.93 (±0.18)</td><td></td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.104 (±0.011)</td><td>Figure 2.142 – Bed Cross-Section of the Angrapa River, 03.04.2014</td></tr>
</table>

Station 4.River Gurjevka (Muelen), Right Tributary of the River Pregolya, Pribrezhnoe Settlement

Figure 2.142 – Gurjevka River Estuary, in downstream direction (Photo: Domnin, 01.04.2014)

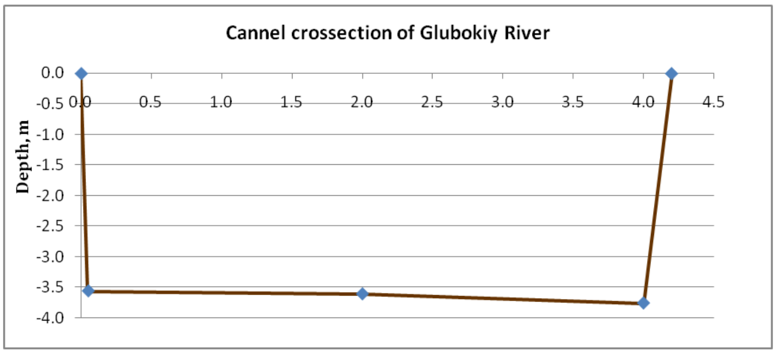
Table 2.76 Hydrological and Hydrochemical Characteristics of the Gurjevka River in Spring Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2	2.8	
Average Flow Velocity, m/s	0.41	
Discharge, m^3/s	1.15	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	2.06 (±0.19)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.193 (±0.016)	

Station 5. Stream Glubokij, Right Tributary of the River Pregolya, Talpaki Settlement

Figure 2.144 – Glubokij Stream Bed Reach, downstream (Photo: Pilipchuk, 03.04.2014)

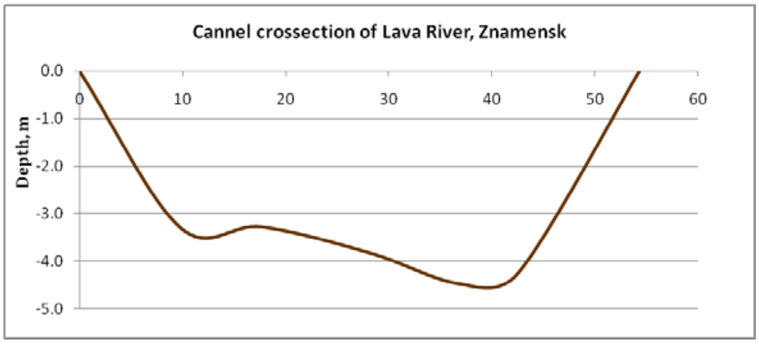
Table 2.77 Hydrological and Hydrochemical Characteristics of the Glubokij Stream in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>4.2</td></tr>
<tr><td>Maximum Depth, m</td><td>3.76</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>15.3</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.24</td></tr>
<tr><td>Discharge, m^3/s</td><td>3.64</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.52 (±0.15)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.093 (±0.010)</td><td>Figure 2.145 – Bed Cross-Section of the Glubokij Stream, 03.04.2014</td></tr>
</table>

Station 7.River Lava, Left Tributary of the River Pregolya, Znamensk Settlement

Figure 2.146 – Lava River Estuary, in downstream direction (Photo: Pilipchuk, 02.04.2014)

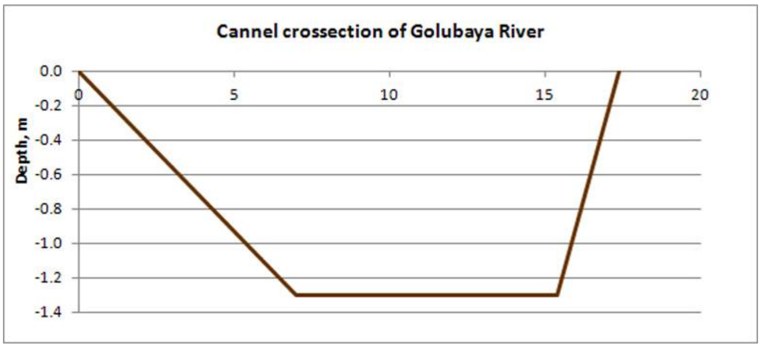
Table 2.78 Hydrological and Hydrochemical Characteristics of the Lava River, Znamensk, in Spring Season 2014

Parameter	**Value**	
Bed Width, m	54.3	
Maximum Depth, m	4.46	
Cross-Section Area, m^2	207.32	
Average Flow Velocity, m/s	0.52	
Discharge, m^3/s	107.39	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	3.55 (±0.31)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.127 (±0.012)	Figure 2.147 – Bed Cross-Section of the Lava River, 02.04.2014

Station 12. River Golubaya, Left Tributary of the River Pregolya, Mezhdurechie Settlement

Figure 2.148 – Golubaya River Bed Reach, in upstream direction (Photo: Pilipchuk, 03.04.2014)

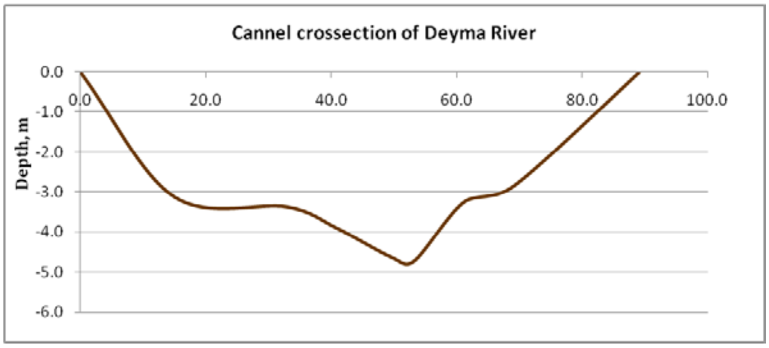
Table 2.79 Hydrological and Hydrochemical Characteristics of the Golubaya River in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>17.4</td></tr>
<tr><td>Maximum Depth, m</td><td>1.3</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>22.6</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.27</td></tr>
<tr><td>Discharge, m^3/s</td><td>7.9</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.42 (±0.14)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.112 (±0.011)</td><td>Figure 2.149 – Bed Cross-Section of the Golubaya River, 03.04.2014</td></tr>
</table>

Station 13. River Deyma, Right Arm of the River Pregolya, Polessk

Figure 2.150 – Deyma River Bed Reach, in downstream direction (Photo: Pilipchuk, 03.04.2014)

Table 2.80 Hydrological and Hydrochemical Characteristics of the Deyma River in Spring Season 2014

Parameter	**Value**	
Bed Width, m	89.2	
Maximum Depth, m	3.69	
Cross-Section Area, m^2	329.28	
Average Flow Velocity, m/s	0.41	
Discharge, m^3/s	133.59	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	3.18 (±0.28)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.13 (±0.012)	Figuren 2.151– Bed Cross-Section of the Deyma River, 03.04.2014

Station 14. Matrosov Canal (estuary), Zapovednoe Settlement

Figure 2.152 – Matrosov Canal Bed Reach, in downstream direction (Photo: Pilipchuk, 03.04.2014)

Table 2.81 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Spring Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m^2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	2.58 (±0.24)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.067 (±0.008)	

Station 15. River Sheshupe, Left Tributary of the River Neman, Lesnoe Settlement

Figure 2.153 – Sheshupe River Bed Reach, in downstream direction (Photo: Pilipchuk, 03.04.2014)

Table 2.82 Hydrological and Hydrochemical Characteristics of the Sheshupe River in Spring Season 2014

Parameter	Value
Bed Width, m	79.7
Maximum Depth, m	3.9
Cross-Section Area, m^2	246.7
Average Flow Velocity, m/s	0.30
Discharge, m^3/s	73.24
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	4.09 (±0.36)
Ptot Concentration, (Measurement uncertainty), mg/l	0.062 (±0.008)

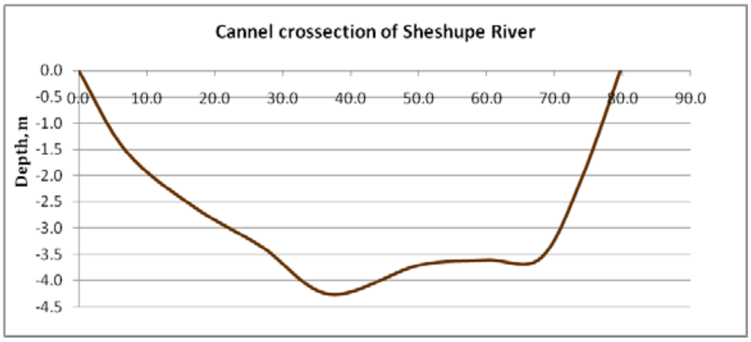


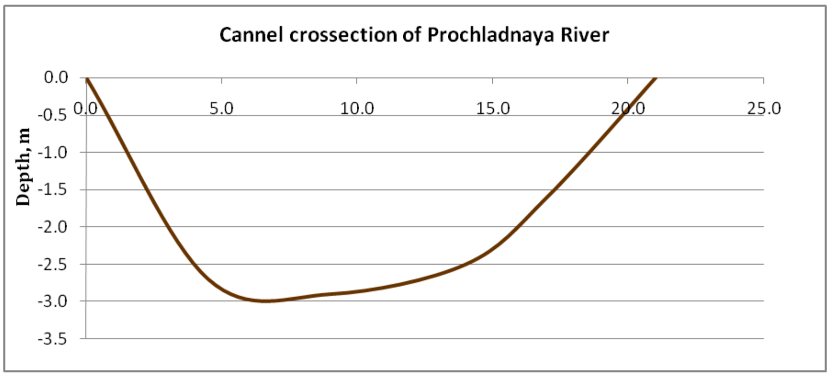
Figure 2.154 – Bed Cross-Section of the Sheshupe River, 03.04.2014

Station 16. River Prokhladnaya, Ushakovo Settlement
Station 16a. Svetloe Settlement

Figure 2.155 Svetloe Settlement, in downstream direction (Photo: Domnin, 02.04.2014)

Figure 2.156 River Prokhladnaya, Ushakovo Settlement (Photo: Domnin, 02.04.2014)

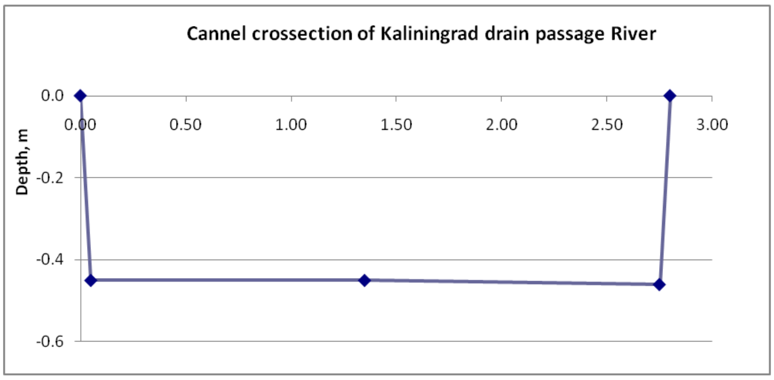
Table 2.83 Hydrological and Hydrochemical Characteristics of the Prokhladnaya River in Spring Season 2014

Parameter	**Value**	
Bed Width, m	21	
Maximum Depth, m	2.43	
Cross-Section Area, m^2	50.93	
Average Flow Velocity, m/s	0.20	
Discharge, m^3/s	10.31	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.36 (±0.14)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.177 (±0.015)	Figure 2.157– Bed Cross-Section of the Prokhladnaya River, 01.04.2014

Station 17. Kaliningrad Canal, Estuary

Figure 2.158– Kaliningrad Canal Bed Reach, in upstream direction (Photo: Domnin, 01.04.2014)

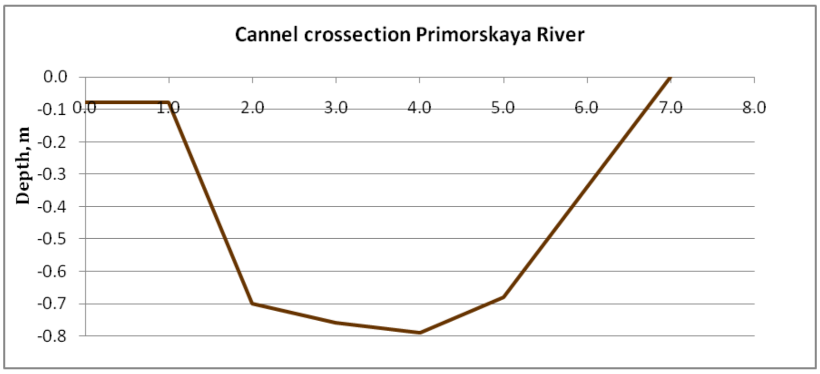
Table 2.84 Hydrological and Hydrochemical Characteristics of the Kaliningrad Canal in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>2.8</td></tr>
<tr><td>Maximum Depth, m</td><td>0.45</td></tr>
<tr><td>Cross-Section Area, m^2</td><td>1.27</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>1.12</td></tr>
<tr><td>Discharge, m^3/s</td><td>1.42</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>37.3 (±3.01)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>6.501 (±0.414)</td><td>Figure 2.159– Bed Cross-Section of the Kaliningrad Canal, 01.04.2014</td></tr>
</table>

Station 24, 24a. River Primorskaya, Primorsk

Figure 2.160 – Primorskaya River Bed Reach, in upstream direction (Photo: Domnin, 01.04.2014)

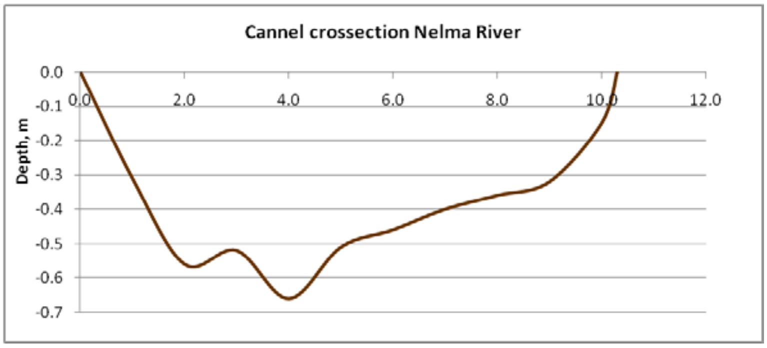
Table 2.85 Hydrological and Hydrochemical Characteristics of the Primorskaya River in Spring Season 2014

Parameter	**Value**	
Bed Width, m	7.0	
Maximum Depth, m	0.49	
Cross-Section Area, m2	3.43	
Average Flow Velocity, m/s	0.51	
Discharge, m^3/s	1.73	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.66 (±0.16)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.25 (±0.020)	Figure 2.161 – Bed Cross-Section of the Primorskaya River, 01.04.2014

Station 25, 25a. River Nelma, Kostrovo Settlement

Figure 2.162 – Nelma River Bed Reach, in downstream direction (Photo: Domnin, 01.04.2014)

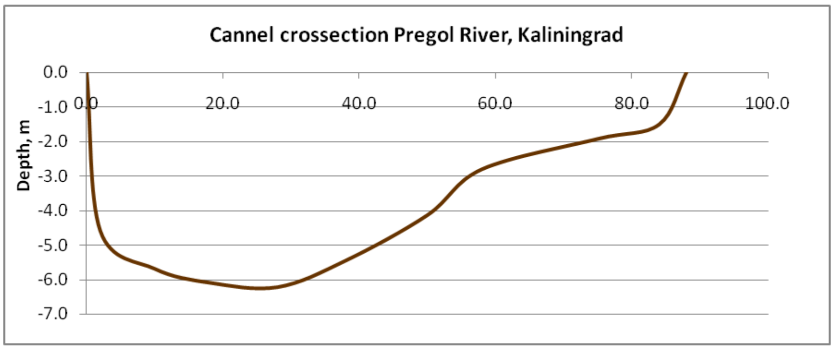
Table 2.86 Hydrological and Hydrochemical Characteristics of the Nelma River in Spring Season 2014

Parameter	**Value**	
Bed Width, m	10.3	
Maximum Depth, m	0.43	
Cross-Section Area, m2	4.38	
Average Flow Velocity, m/s	0.31	
Discharge, m^3/s	1.38	
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	1.71 (±0.17)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.205 (±0.017)	Figure 2.163 – Bed Cross-Section of the Nelma River, 01.04.2014

Station 26.River Pregolya, Kaliningrad

Figure 2.164 River Pregolya, Kaliningrad, in downstream direction (Photo:Domnin, 01.04.2014)

Table 2.87 Hydrological and Hydrochemical Characteristics of the Pregolya River in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="7">
</td></tr>
<tr><td>Bed Width, m</td><td>88</td></tr>
<tr><td>Maximum Depth, m</td><td>4.28</td></tr>
<tr><td>Cross-Section Area, m2</td><td>352.25</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.17</td></tr>
<tr><td>Discharge, m^3/s</td><td>61.06</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>1.9 (±0.18)</td><td></td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.174 (±0.015)</td><td>Figure 2.165 – Channel Cross-Section of the Pregolya River , 01.04.2014</td></tr>
</table>

Station 27. River Pregolya, Gvardejsk

Table 2.88 Hydrological and Hydrochemical Characteristics of the Pregolya River in Spring Season 2014

Parameter	Value
Bed Width, m	88.8
Maximum Depth, m	3.47
Cross-Section Area, m2	307.88
Average Flow Velocity, m/s	0.9
Discharge, m^3/s	276.65
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	6.25 (±0.53)
Ptot Concentration, (Measurement uncertainty), mg/l	0.132 (±0.012)

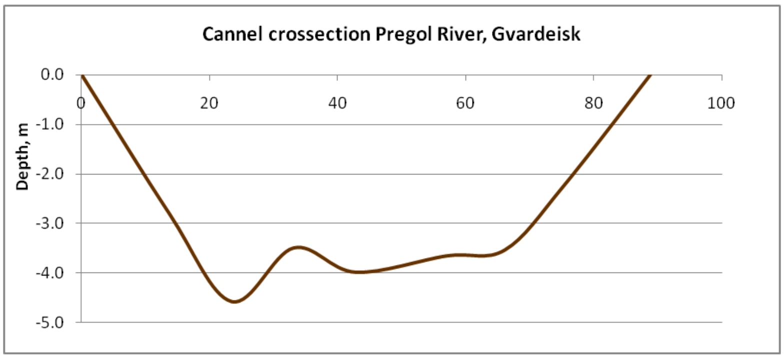
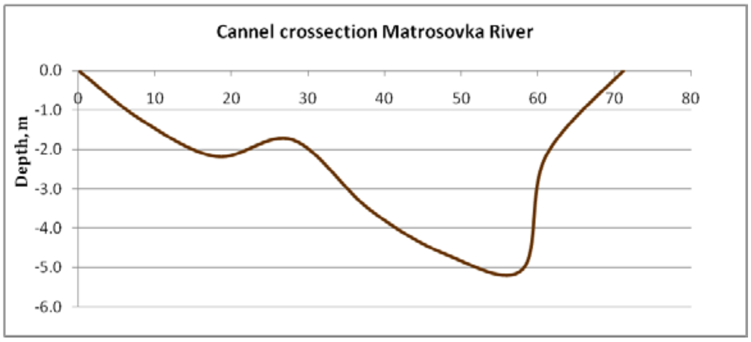


Figure 2.166 – Bed Cross-Section of the Pregolya River, 02.04.2014

Station 28. Matrosov Canal, Mostovoe Settlement

Figure 2.167 – Matrosov Canal Bed Reach, in downstream direction (Photo: Pilipchuk, 03.04.2014)

Table 2.89 Hydrological and Hydrochemical Characteristics of the Matrosov Canal in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>71.2</td></tr>
<tr><td>Maximum Depth, m</td><td>5.04</td></tr>
<tr><td>Cross-Section Area, m2</td><td>209.33</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.92</td></tr>
<tr><td>Discharge, m^3/s</td><td>192.58</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>3.95 (±0.35)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.076 (±0.009)</td><td>Figure2.168 – Bed Cross-Section of the Matrosov Canal, 03.04.2014</td></tr>
</table>

Station 29. River Sheshupe, Zarechnoe Settlement

Table 2.90 Hydrological and Hydrochemical Characteristics of the Sheshupe River in Spring Season 2014

Parameter	Value
Bed Width, m	
Maximum Depth, m	
Cross-Section Area, m2	
Average Flow Velocity, m/s	
Discharge, m^3/s	
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	4.18 (±0.36)
Ptot Concentration, (Measurement uncertainty), mg/l	0.073 (±0.009)

Station 30. Stream Medvezhij, Estuary, Sokolniki Settlement

Table 2.91 Hydrological and Hydrochemical Characteristics of the Medvezhij Stream in Spring Season 2014

Parameter	Value
Bed Width, m	1.6
Maximum Depth, m	0.34
Cross-Section Area, m2	0.47
Average Flow Velocity, m/s	0.67
Discharge, m^3/s	0.29
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	1.61 (±0.16)
Ptot Concentration, (Measurement uncertainty), mg/l	0.131 (±0.012)

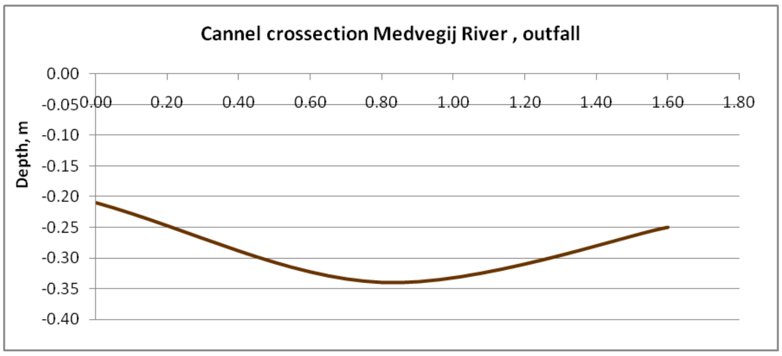


Figure 2.169 – Bed Cross-Section of the Medvezhij Stream, 02.04.2014

Station 31. River Lava, Ryabinino Settlement

Figure 2.170 – River Lava, Ryabinino Settlement, in downstream direction (Photo: Pilipchuk, 02.04.2014)

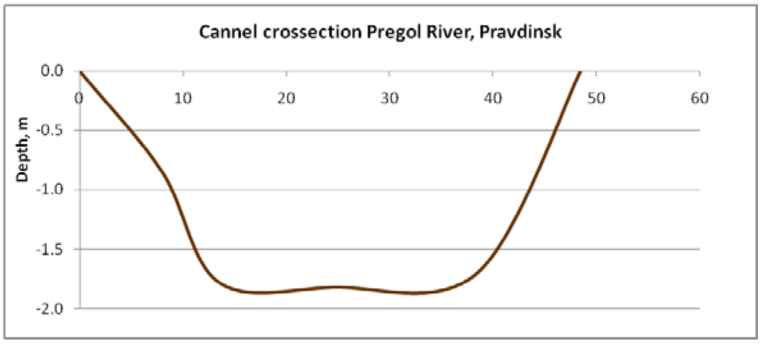
Table 2.92 Hydrological and Hydrochemical Characteristics of the Lava River in Spring Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	4.91 (±0.42)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.127 (±0.012)	

Station 32. Lava River, Pravdinsk

Figure 2.171 – Lava River Bed Reach, in downstream direction (Photo: Pilipchuk, 02.04.2014).

Table 2.93 Hydrological and Hydrochemical Characteristics of the Lava River in Spring Season 2014

<table>
<tr><th>Parameter</th><th>Value</th><td rowspan="8">
</td></tr>
<tr><td>Bed Width, m</td><td>48.5</td></tr>
<tr><td>Maximum Depth, m</td><td>1.82</td></tr>
<tr><td>Cross-Section Area, m2</td><td>74.57</td></tr>
<tr><td>Average Flow Velocity, m/s</td><td>0.71</td></tr>
<tr><td>Discharge, m^3/s</td><td>52.76</td></tr>
<tr><td>Temperature, °C</td><td></td></tr>
<tr><td>Ntot Concentration, (Measurement uncertainty), mg/l</td><td>6.26 (±0.53)</td></tr>
<tr><td>Ptot Concentration, (Measurement uncertainty), mg/l</td><td>0.14 (±0.013)</td><td>Figure 2.172 – Bed Cross-Section of the Lava River, Pravdinsk, 02.04.2014</td></tr>
</table>

Station 33. Stream Medvezhij, Sokolniki Settlement

Figure 2.173 – Medvezhij Stream Bed Reach, in downstream direction (Photo: Pilipchuk, 02.04.2014).

Table 2.94 Hydrological and Hydrochemical Characteristics of the Medvezhij Stream in Spring Season 2014

Parameter	**Value**
Bed Width, m	1.9
Maximum Depth, m	0.3
Cross-Section Area, m2	0.4
Average Flow Velocity, m/s	0.35
Discharge, m^3/s	0.13
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	0.86 (±0.10)
Ptot Concentration, (Measurement uncertainty), mg/l	0.155 (±0.014)

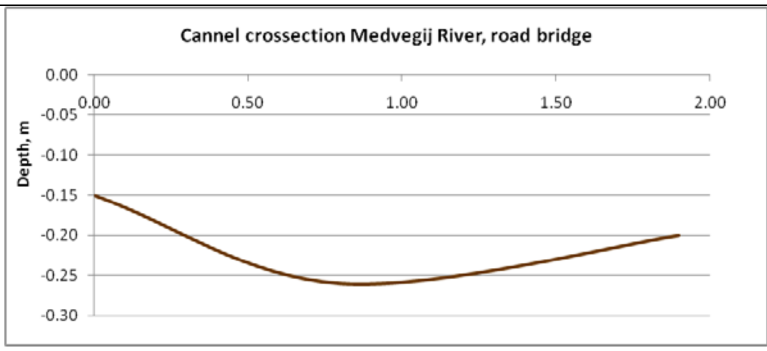


Figure 2.174 – Bed Cross-Section of the Medvezhij Stream, 02.04.2014

Station 34. River Lava, Dalnee Settlement

Figure 2.175 – Lava River Bed Reach, in downstream direction (Photo: Pilipchuk, 02.04.2014).

Table 2.95 Hydrological and Hydrochemical Characteristics of the Lava River in Spring Season 2014

Parameter	**Value**	
Bed Width, m		
Maximum Depth, m		
Cross-Section Area, m2		
Average Flow Velocity, m/s		
Discharge, m^3/s		
Temperature, °C		
Ntot Concentration, (Measurement uncertainty), mg/l	5.78 (±0.49)	
Ptot Concentration, (Measurement uncertainty), mg/l	0.136 (±0.013)	

Station 35. River Lava, Rodniki Settlement

Table 2.96 Hydrological and Hydrochemical Characteristics of the Lava River in Spring Season 2014

Parameter	Value
Bed Width, m	35.3
Maximum Depth, m	4.0
Cross-Section Area, m2	108
Average Flow Velocity, m/s	0.8
Discharge, m^3/s	86.41
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	5.94 (±0.51)
Ptot Concentration, (Measurement uncertainty), mg/l	0.139 (±0.013)

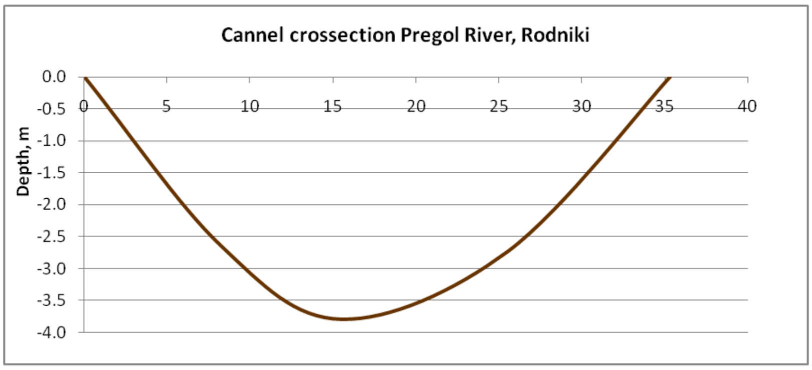


Figure 2.176 – Bed Cross-Section of the Lava River, Rodniki, 02.04.2014

Station 36. Stream Bezymyannij, Kamenka Settlement

Table 2.97 Hydrological and Hydrochemical Characteristics of the Bezymyannij Stream in Spring Season 2014

Parameter	**Value**
Bed Width, m	3.8
Maximum Depth, m	0.67
Cross-Section Area, m2	1.7
Average Flow Velocity, m/s	0.08
Discharge, m^3/s	0.14
Temperature, °C	
Ntot Concentration, (Measurement uncertainty), mg/l	1.76 (±0.17)
Ptot Concentration, (Measurement uncertainty), mg/l	0.189 (±0.016)

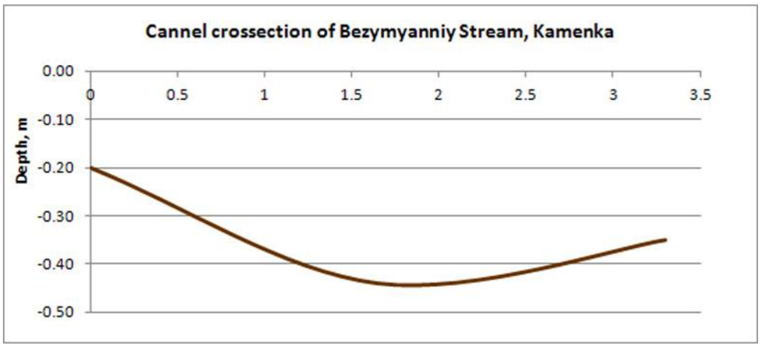


Figure 2.177 – Bed Cross-Section of the Bezymyannij Stream, 02.04.2014

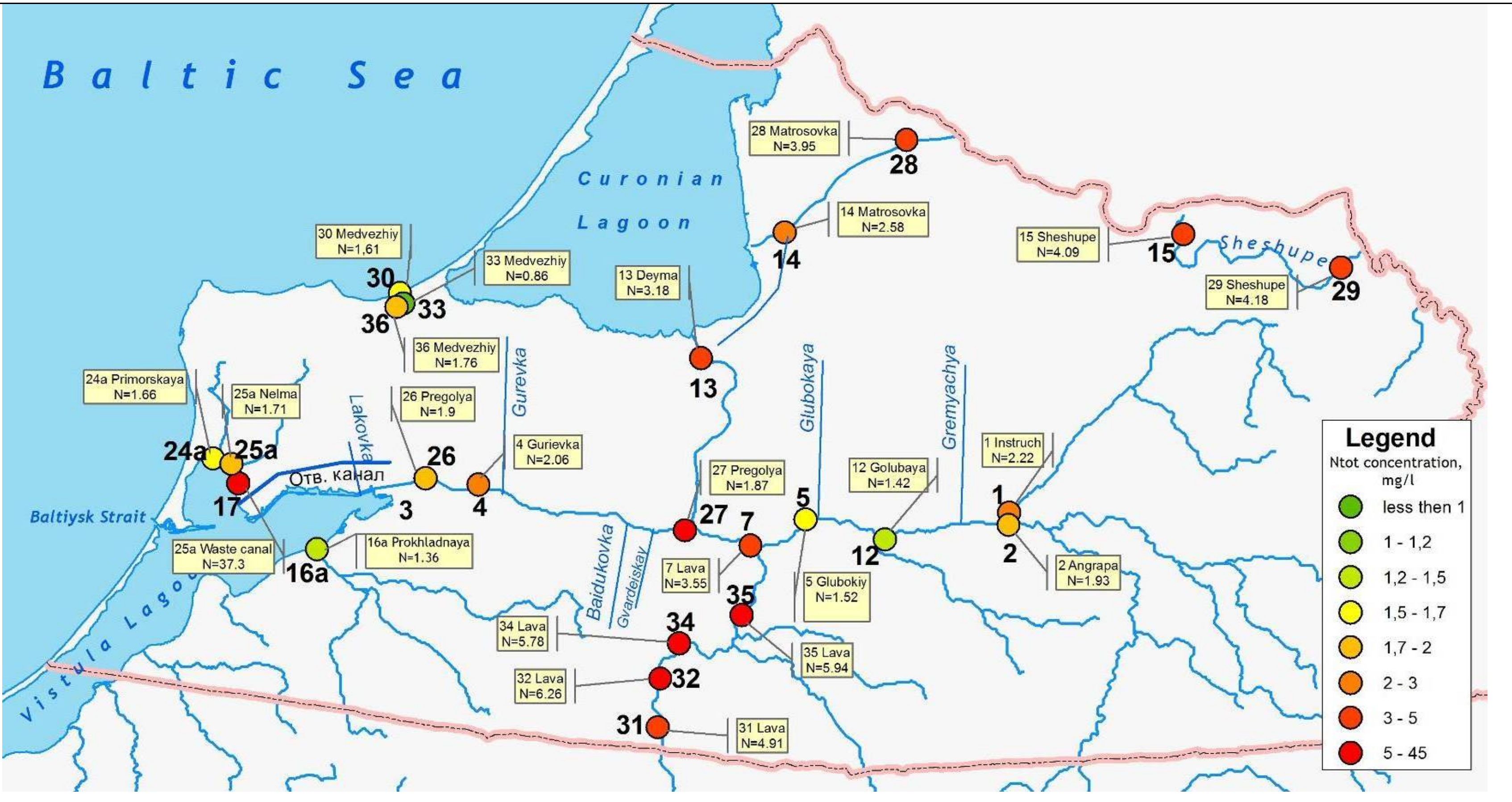


Figure 2.178– Distribution of Total Nitrogen Concentration in Water (mg/l) based on Data Analysis of Samples collected during Spring Season

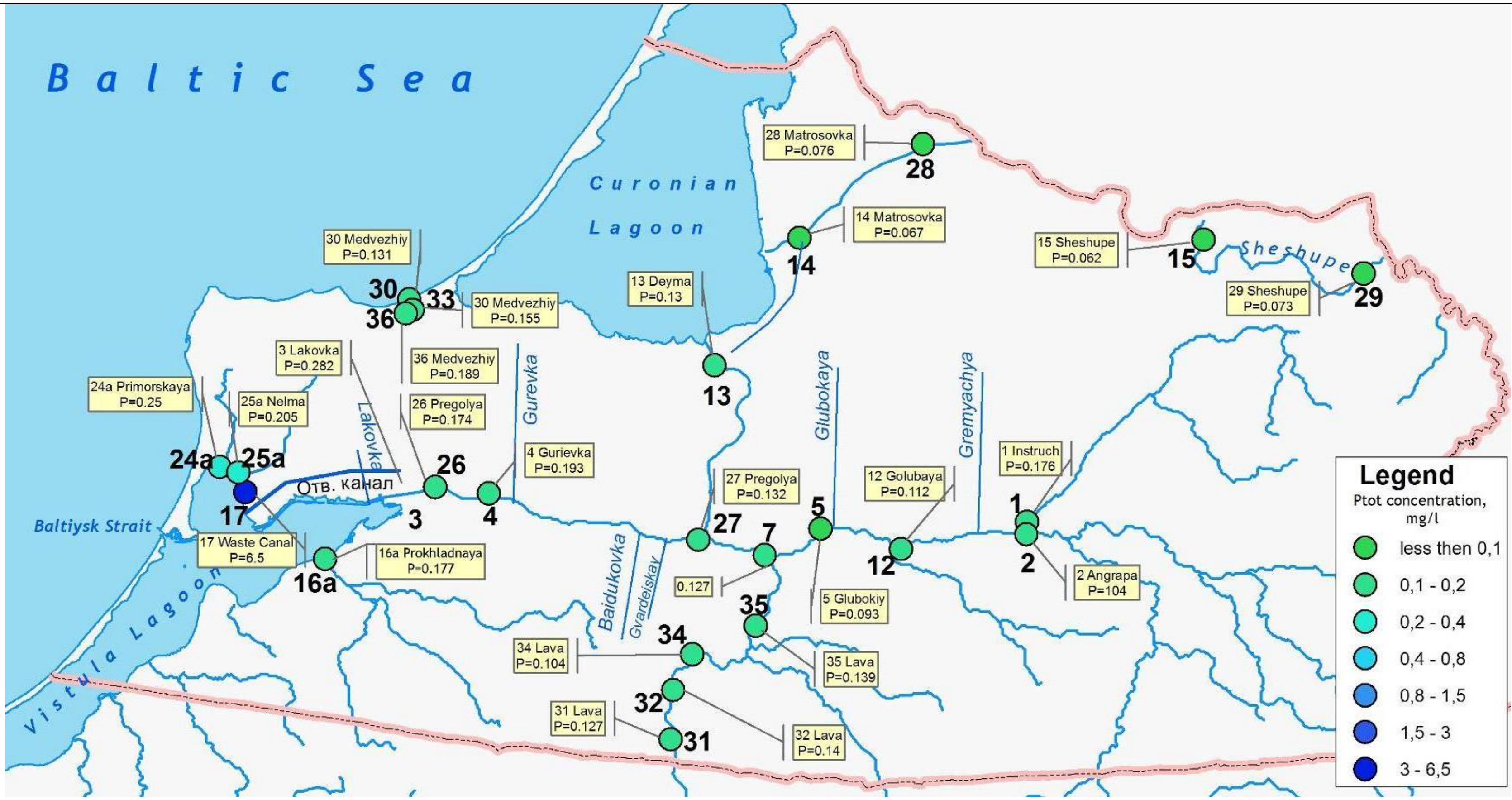


Figure 2.179– Distribution of Total Phosphorus Concentration in Water (mg/l) based on Data Analysis of Samples collected during Spring Season

2.6 Calculation of annual nutrient inputs according to the hydrological and hydrochemical works project BASE

2.6.1 Methodology of calculations

According to PLC Guidelines measurements and sampling at water bodies should be carried out not less than 12 times a year. However, guided by technical requirements and taking into consideration funding possibilities monitoring activities were carried out only 4 times during the monitoring period. Nevertheless, all measurements were conducted within the key hydrological phases: summer low-water period, autumn high-water period, winter low-water and freeze-up periods, and spring flooding. For the annual loads calculations based on the data received it is necessary to reconstruct the information omitted between the measurements. For this reason the method of linear interpolation was implemented.

This method utilizes interpolated concentration values (C_i) for days were pollutants have not been measured. If daily discharge (Q) is not available, it should be estimated by linear interpolation.

Concentrations are denoted $C_i, i = 1,2,\ldots n$. When the linear interpolation is made, the last measurements from the previous year and the first measurements from the following year should be used.

When daily concentrations and discharges have been calculated, then the annual input (*L*), as kg

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

a^{-1}, is estimated by:

Σ = denotes summation

n = number of days

Concentrations are given in mg l^{-1}, discharge as l s^{-1}. The estimate in the equation is multiplied by 0.0864 to obtain a daily load.

2.6.2 Results and discussion

2.6.2.1 Nutrients load assessment

According to the monitoring results it was revealed that not all water bodies of the Kaliningrad Oblast influence the structure of receiving water areas of the Baltic Sea, Vistula and Curonian Lagoons.

After the first monitoring round several tributaries of the River Pregolya with a potentially low level of biogenic load were identified. These are rivers: the Gremyachia, the Bajdukovka, the Bobrovaya, and the Gvardejskaya. Besides, access to the River Bolshaya was blocked. Based on the results the program was adjusted – the above mentioned waterflows were excluded and three new ones added: two on the River Lava and one on the Brook Medvezhij. According to the second sampling and hydrological measurements round it was revealed that in the Lava River one can notice an abrupt increase of the dissolved biogenes concentration from the Pravdinsk

Reservoir to the River Estuary. As a result two new stations on the Lava River and one station on the Medvezhij Stream were settled. During the winter monitoring period there was no current on the Lakovka River, so sampling and measurements were not conducted at the station.

In general, it should be mentioned that the program carried out allows to estimate the total input of nutrients both from the territory of the Kaliningrad Oblast and boundary states.

Results of analysis for each sampling station presented below:

Station 1. River Instruch, Right Tributary of the River Pregolya, Maevka Settlement

Maximum concentration of total nitrogen was observed in autumn sampling period (3.8 mg/l), whereas maximum concentration of total phosphorus – in spring flooding period (0.176 mg/l). Minimum concentration of total nitrogen and phosphorus was measured in summer low-water period. (Figure 2.180)

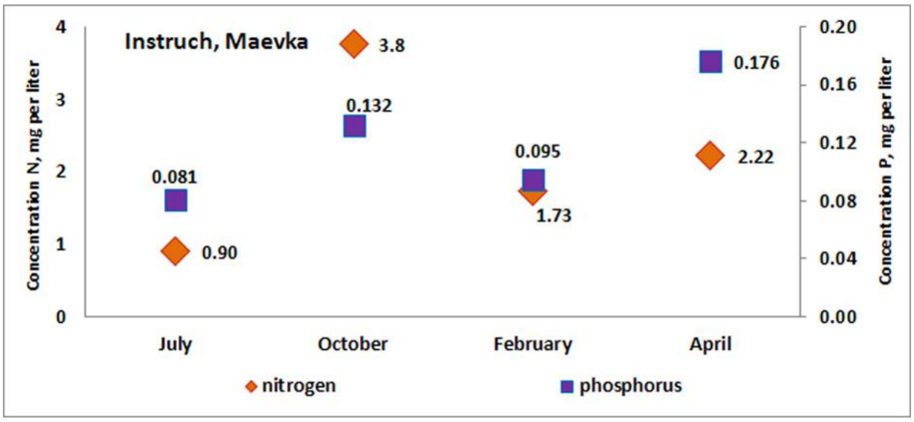


Figure 2.180– Concentration of Total Nitrogen and Phosphorus in Water for the Instruch River (Maevka) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 11.1 m^3/s. During the year significant difference in total nitrogen and phosphorus loads can be traced. Maximum values are noticed in spring flooding period (Figure 2.181). In total, within a year 766 tons of total nitrogen and 48 tons of total phosphorus are received from the Instruch River basin.

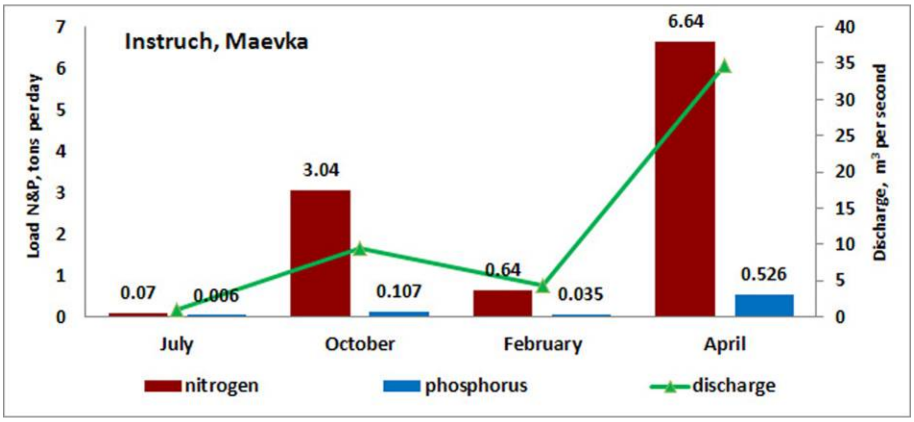


Figure 2.181– Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Instruch River (Maevka) in Monitoring Period

Station 2. River Angrapa, Left Tributary of the River Pregolya, Chernyakhovsk

Main tributary of Angrapa River (Pissa River) is regulated river by Vistynets Lake. Maximum concentration of total nitrogen was observed in autumn sampling period (2.1 mg/l), whereas maximum concentration of total phosphorus – in summer low-water period (0.117 mg/l). Minimum concentration of total nitrogen was traced in summer low-water period, whereas phosphorus – in winter low-water period (Figure 2.182).

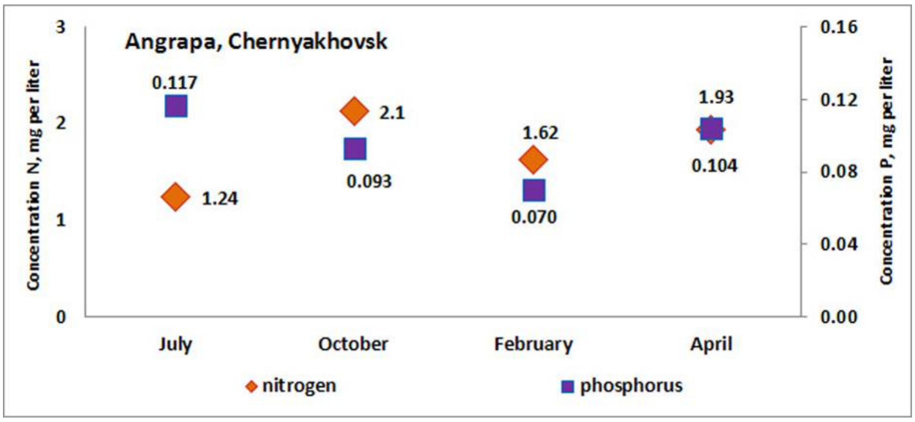


Figure 2.182– Concentration of Total Nitrogen and Phosphorus in Water for the Angrapa River (Chernyakhovsk) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 25.8 m^3/s. During the year increase of total nitrogen and phosphorus load was traced. Maximum values are noticed in spring flooding period (Figure 2.183). In total, within a year 1445 tons of total nitrogen and 75 tons of total phosphorus are received from the Angrapa River basin.

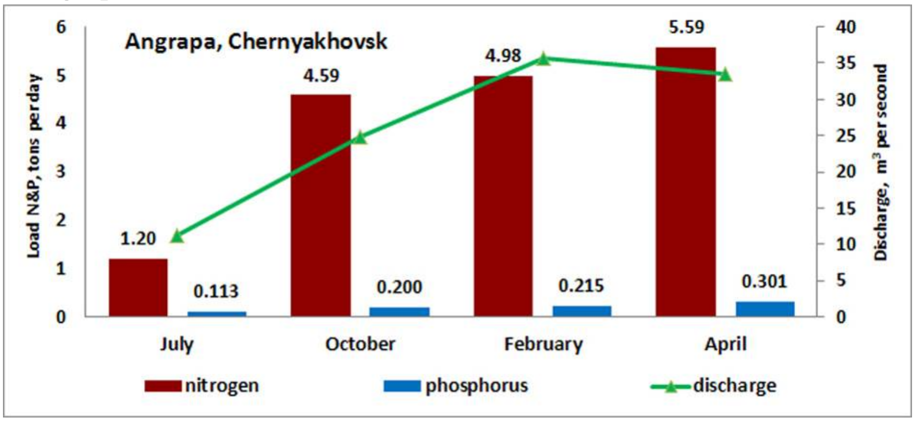


Figure 2.183– Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Angrapa River (Chernyakhovsk) in Monitoring Period

Station 3. River Lakovka, Right Tributary of the River Pregolya, Pregolskij Settlement

Maximum concentration of total nitrogen was observed in winter sampling period (2.09 mg/l), whereas maximum concentration of total phosphorus – in summer low-water period (0.406 mg/l). Minimum concentration of total nitrogen and phosphorus was traced in autumn flooding period (Figure 2.184).

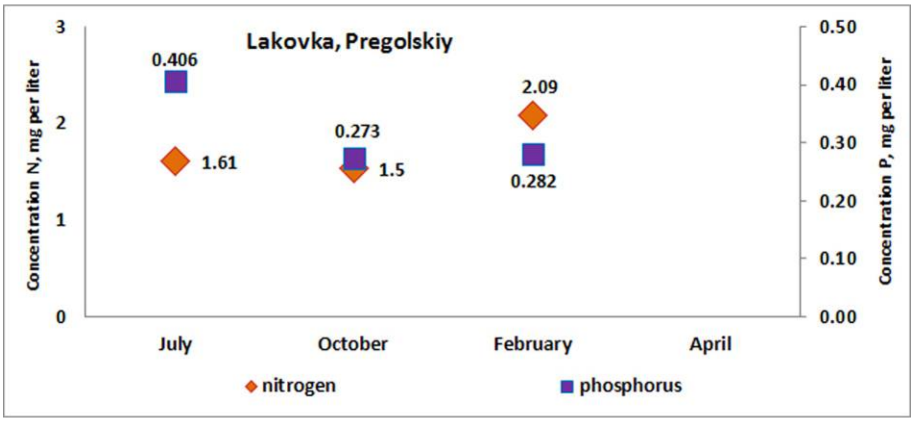


Figure 2.184– Concentration of Total Nitrogen and Phosphorus in Water for the Lakovka River (Pregolskij) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 0.2 m^3/s. During the year significant difference of total nitrogen and phosphorus load was traced. Maximum values are noticed in summer low-water period (Figure 2.185). In total, within the monitoring period 5 tons of total nitrogen and 1 ton of total phosphorus are received from the Lakovka River basin.

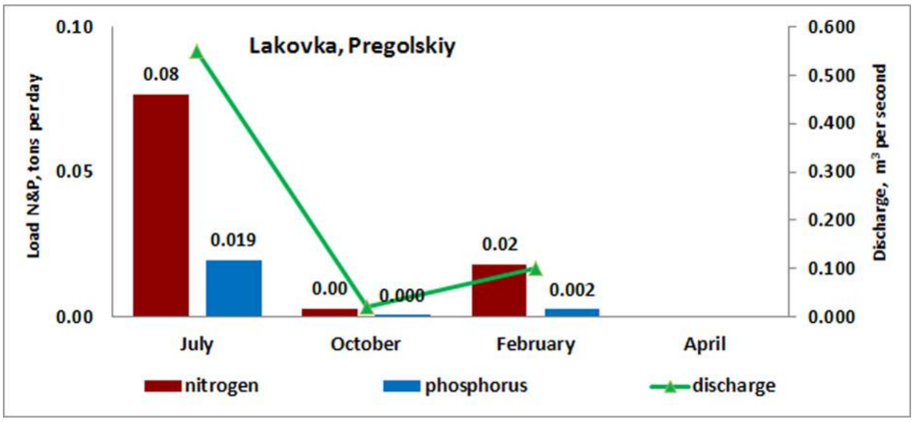


Figure 2.185– Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Lakovka River (Pregolskij) in Monitoring Period

Station 4. River Gurjevka (Muelen), Right Tributary of the River Pregolya, Pribrezhnoe Settlement

Maximum concentration of total nitrogen was observed in winter sampling period (2.84 mg/l), whereas maximum concentration of total phosphorus – in summer low-water period (0(0.89 mg/l). Minimum concentration of total nitrogen and phosphorus was traced in spring flooding period (Figure 2.186).

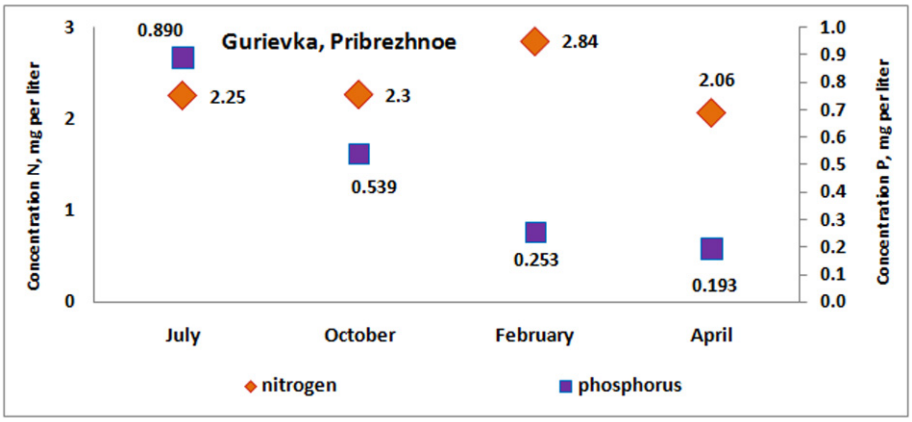


Figure 2.186– Concentration of Total Nitrogen and Phosphorus in Water for the Gurievka River (Pribrezhnoe) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 0.7 m^3/s. During the year significant difference of total nitrogen and phosphorus load was traced. Maximum values are noticed in autumn flooding and spring high-water periods (Figure 2.187). In total, within the monitoring period 54 tons of total nitrogen and 10 tons of total phosphorus are received from the Gurjevka River basin.

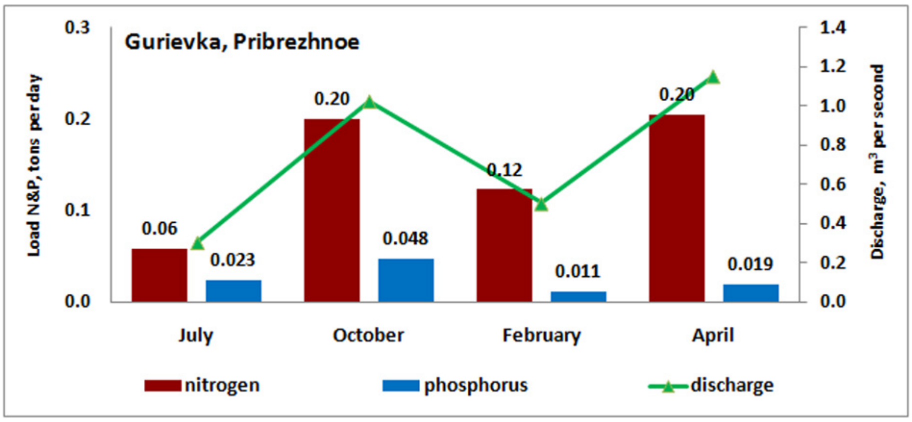


Figure 2.187– Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Gurievka River (Pribrezhnoe) in Monitoring Period

Station 5. Stream Glubokij, Right Tributary of the River Pregolya, Talpaki Settlement

Maximum concentration of total nitrogen and phosphorus was observed in spring sampling period (1.52 mg/l and 0.093 mg/l correspondingly). Minimum concentration was traced in autumn flooding period (Figure 2.188).

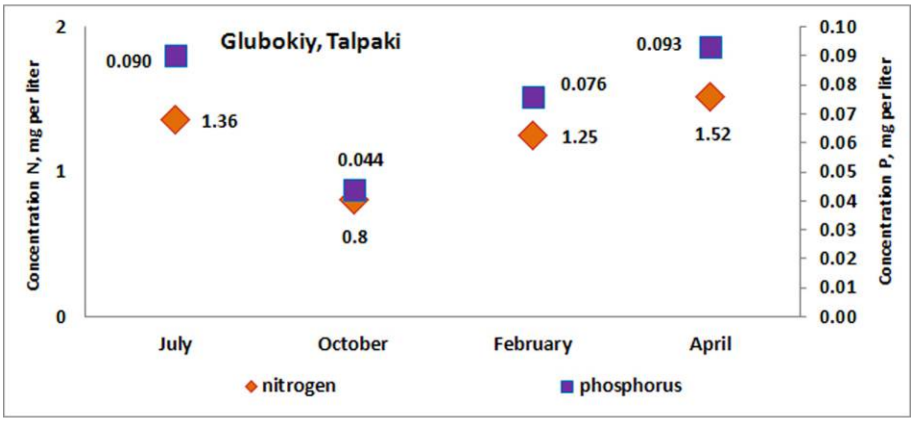


Figure 2.188 – Concentration of Total Nitrogen and Phosphorus in Water for the Glubokij Stream (Talpaki) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 1.3 m^3/s. During the year significant difference of total nitrogen and phosphorus load was traced. Maximum values are noticed in spring high-water periods (Figure 2.189). In total, within a year 54 tons of total nitrogen and 3 tons of total phosphorus are received from the Glubokij Stream basin.

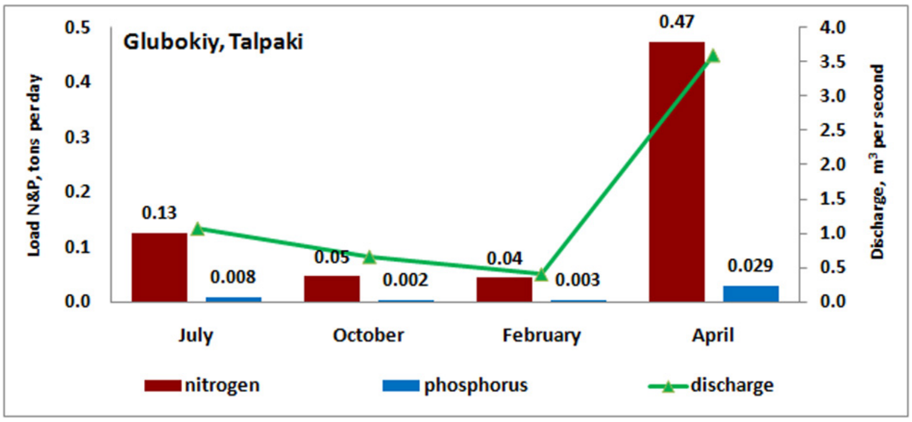


Figure 2.189– Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Glubokij Stream (Talpaki) in Monitoring Period

Station 6. River Gremyachia, Right Tributary of the River Pregolya, Sovkhoznoe Settlement

Taking into consideration that measurements were carried out on the river only at the first summer round, concentration of total nitrogen and phosphorus was 1.36 mg/l and 0.114 mg/l (Figure 2.190).

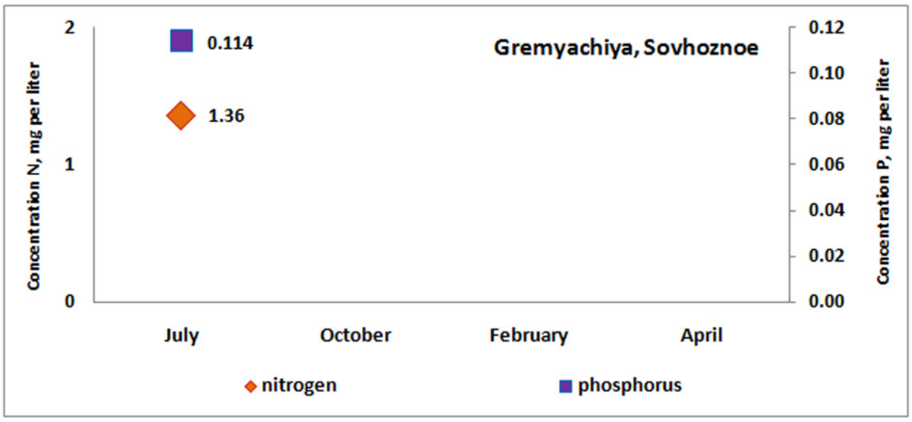


Figure 2.190 – Concentration of Total Nitrogen and Phosphorus in Water for the Gremyachia (Sovhoznoe) in Monitoring Period

Flow discharge within the monitoring period was 0.06 m^3/s (Figure 2.191).

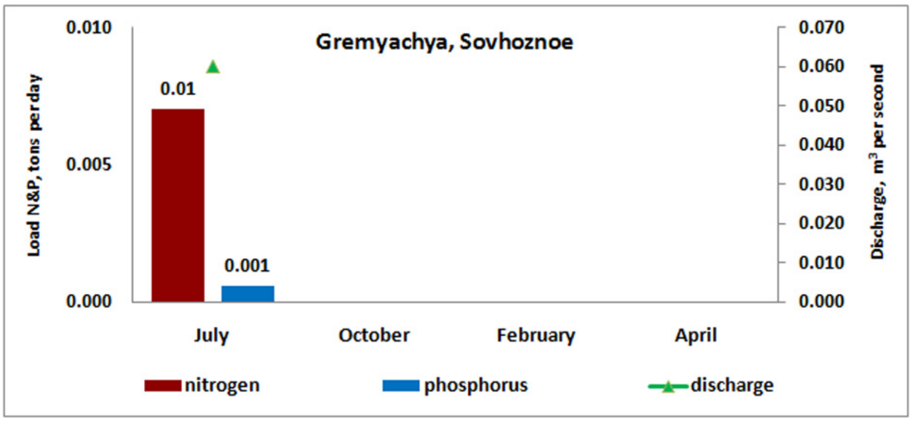


Figure 2.191 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Gremyachia (Sovhoznoe) in Monitoring Period

Station 7. River Lava, Left Tributary of the River Pregolya, Znamensk Settlement

Maximum concentration of total nitrogen was observed in autumn sampling period 4.0 mg/l), whereas maximum concentration of total phosphorus – in summer low-water period (0.156 mg/l). Minimum concentration of total nitrogen was traced in winter low-water period, whereas phosphorus – in spring high-water (Figure 2.192).

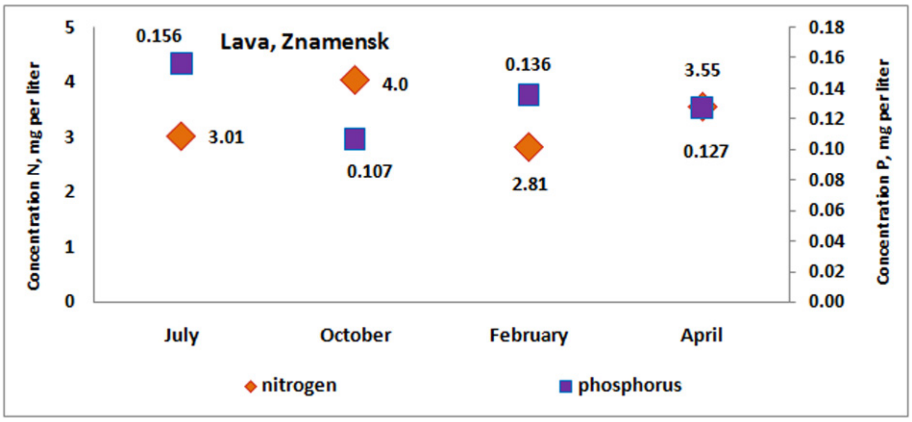


Figure 2.192 – Concentration of Total Nitrogen and Phosphorus in Water for the Lava River (Znamensk) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 53.1 m^3/s. During the year slow growth of total nitrogen and phosphorus load was traced. Maximum values are noticed in spring high-water period (Figure 2.193). In total, within a year 5595 tons of total nitrogen and 221 tons of total phosphorus are received from the Lava River basin.

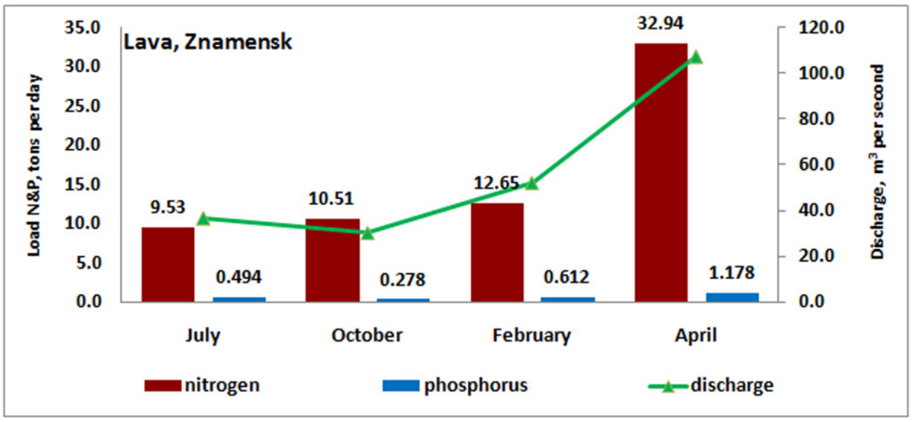


Figure 2.193 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Lava River (Znamensk) in Monitoring Period

Station 8. River Bajdukovka, Left Tributary of the River Pregolya, Tumanovka Settlement

Taking into consideration that measurements were carried out on the river only at the first summer round, concentration of total nitrogen and phosphorus was 1.5 mg/l and 0.137 mg/l correspondingly (Figure 2.194).

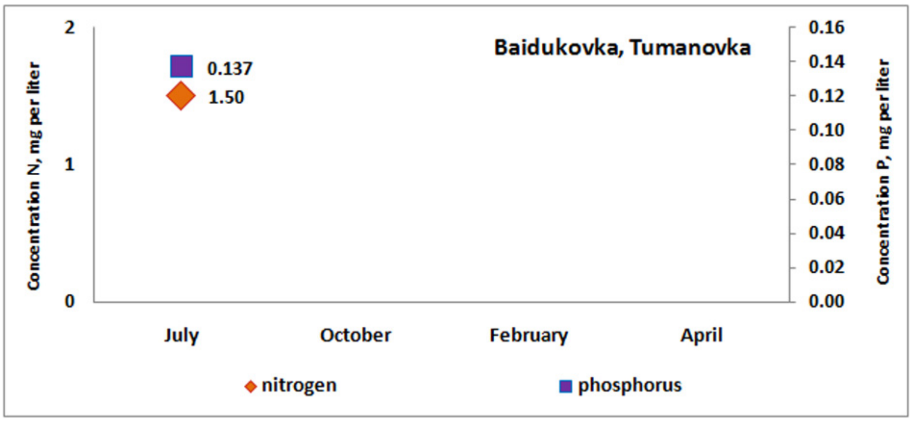


Figure 2.194 – Concentration of Total Nitrogen and Phosphorus in Water for the Baidukovka River (Tumanovka) in Monitoring Period

Flow discharge within the monitoring period was 0.02 m^3/s (Figure 2.195).

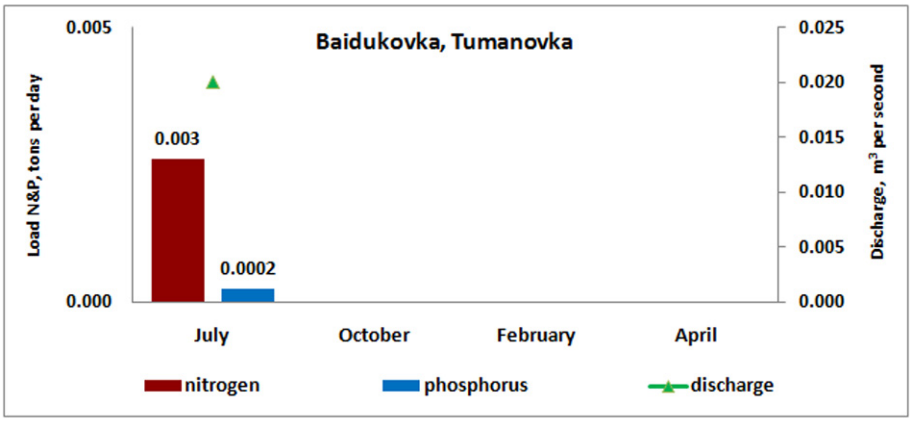


Figure 2.195 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Baidukovka River (Tumanovka) in Monitoring Period

Station 9. River Bobrovaya, Left Tributary of the River Pregolya, Suvorovo Settlement

Taking into consideration that measurements were carried out on the river only at the first summer round, concentration of dissolved nitrogen and phosphorus was 1.71 mg/l and 0.121 mg/l correspondingly (Figure 2.196).

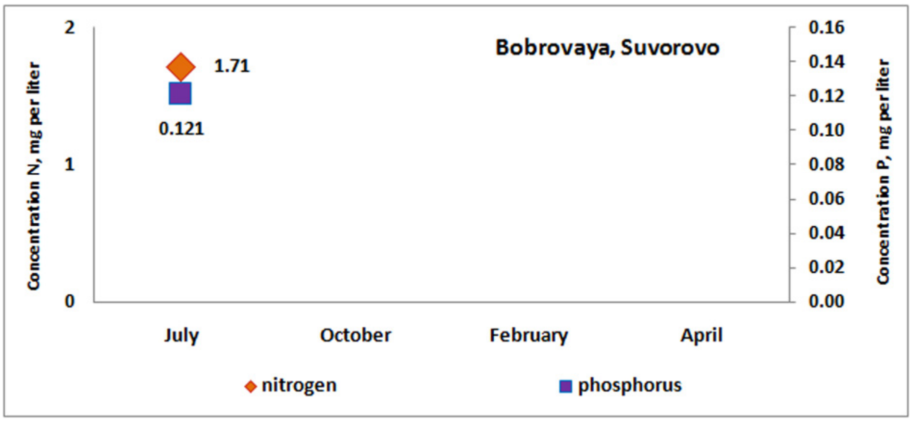


Figure 2.196 – Concentration of Total Nitrogen and Phosphorus in Water for the Bobrovaya River (Suvorovo) in Monitoring Period

Flow discharge within the monitoring period was 0.14 m^3/s (Figure 2.197).

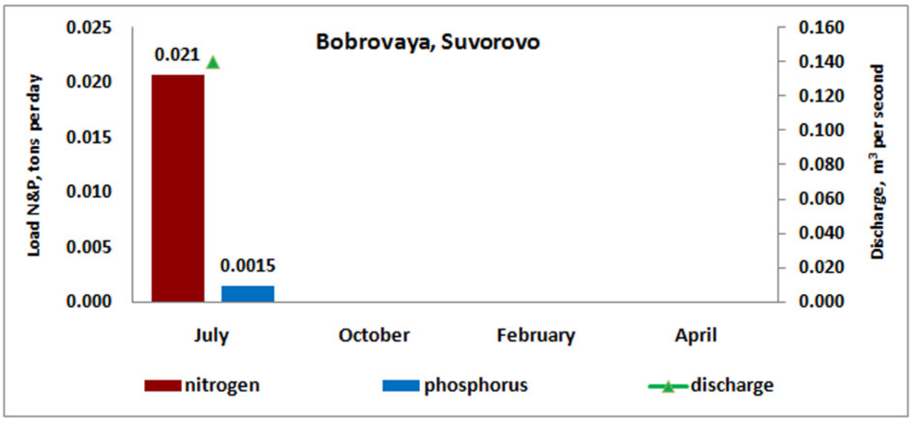


Figure 2.197 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Bobrovaya River (Suvorovo) in Monitoring Period

Station 10. River Gvardejskaya, Right Tributary of the River Pregolya, Zarechnoe Settlement

Taking into consideration that measurements were carried out on the river only at the first summer round, concentration of total nitrogen and phosphorus was 1.94 mg/l and 0.228 mg/l correspondingly (Figure 2.198).

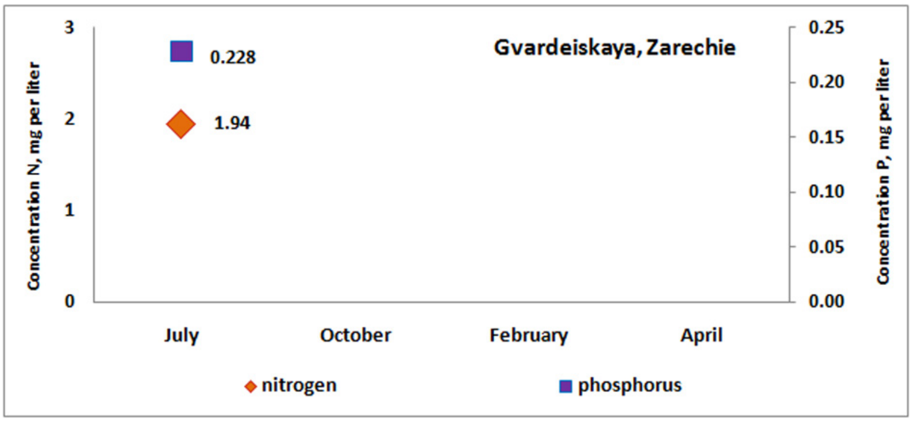


Figure 2.198 – Concentration of Total Nitrogen and Phosphorus in Water for the Gvardejskaya River (Zarechnoe) in Monitoring Period

Flow discharge within the monitoring period was 0.02 m^3/s (Figure 2.199).

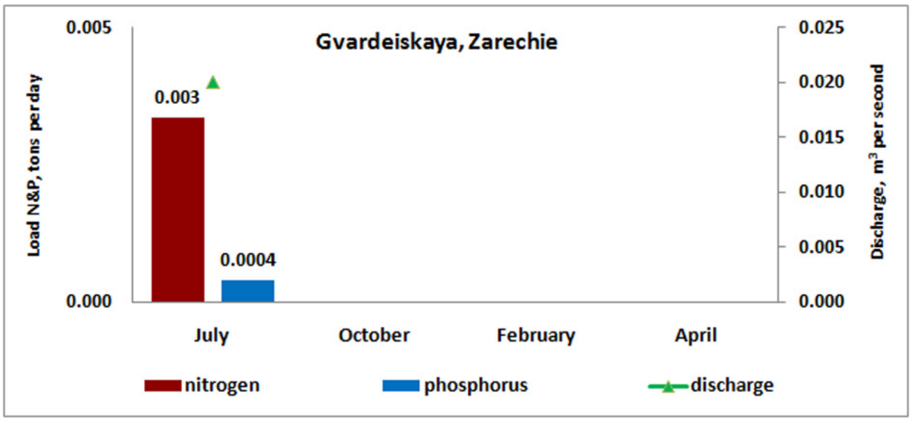


Figure 2.199 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Gvardejskaya River (Zarechnoe) in Monitoring Period

Station 12. River Golubaya, Left Tributary of the River Pregolya, Mezhdurechie

Maximum concentration of total nitrogen and phosphorus was observed in summer sampling period (1.85 mg/l and 0.195 mg/l correspondingly). Minimum concentration of nitrogen was traced in spring high-water period, whereas phosphorus – in autumn flooding period (Figure 2.200).

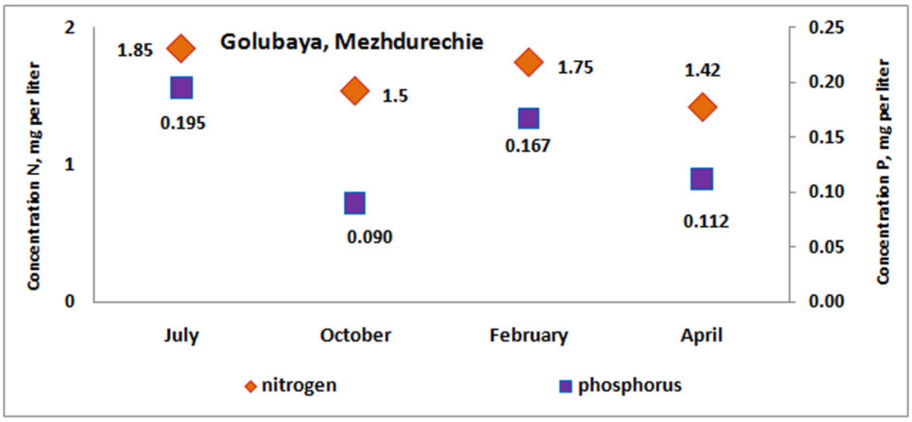


Figure 2.200– Concentration of Total Nitrogen and Phosphorus in Water for the Golubaya River (Mezhdurechie) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 4.9 m^3/s. During the year slow growth of total nitrogen and phosphorus load was traced. Maximum values are noticed in spring high-water period (Figure 2.201). In total, within a year 250 tons of total nitrogen and 22 tons of total phosphorus are received from the Golubaya River basin.

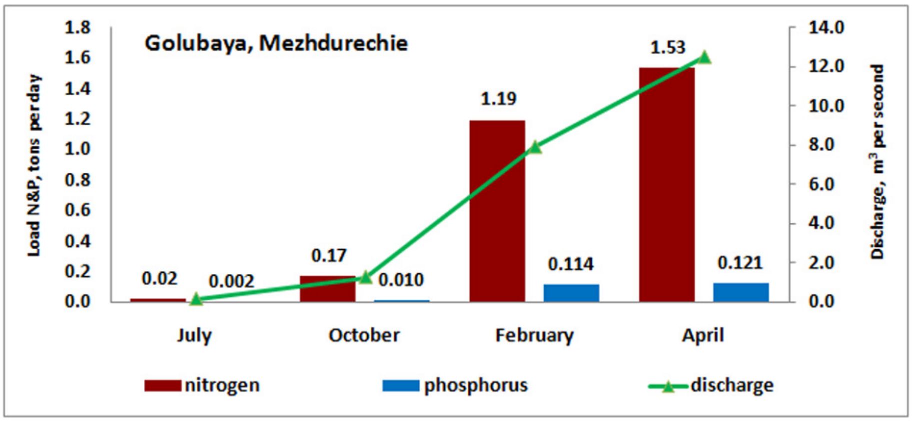


Figure 2.201 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Golubaya River (Mezhdurechie) in Monitoring Period

Station 13. River Deyma, Right Arm of the River Pregolya, Polessk

Maximum concentration of totalnitrogen was observed in autumn sampling period (3.3 mg/l), whereas phosphorus – in summer low-water season. Minimum concentration of nitrogen was traced in summer low-water period, whereas phosphorus – in winter low-water season (Figure 2.202).

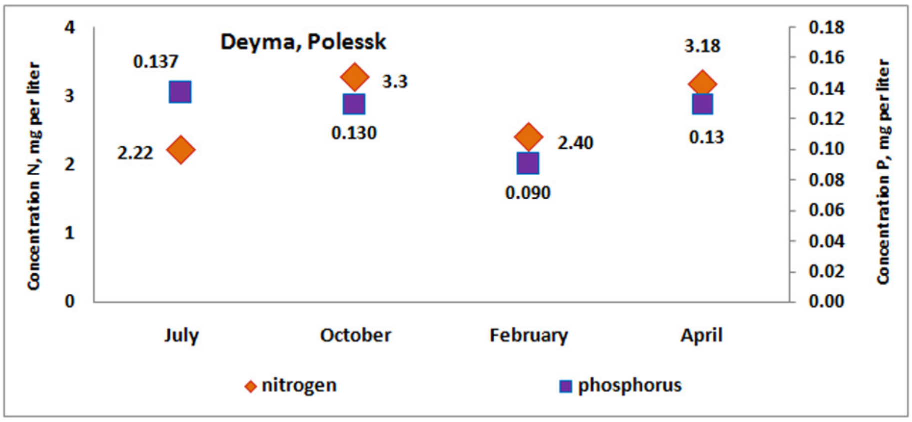


Figure 2.202 – Concentration of Total Nitrogen and Phosphorus in Water for the Deyma River (Polessk) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 51.5 m^3/s. During the year growth of total nitrogen and phosphorus load was traced. Maximum values are noticed in spring high-water period (Figure 2.203). In total, within a year 4584 tons of total nitrogen and 198 tons of total phosphorus are received from the Deyma River basin.

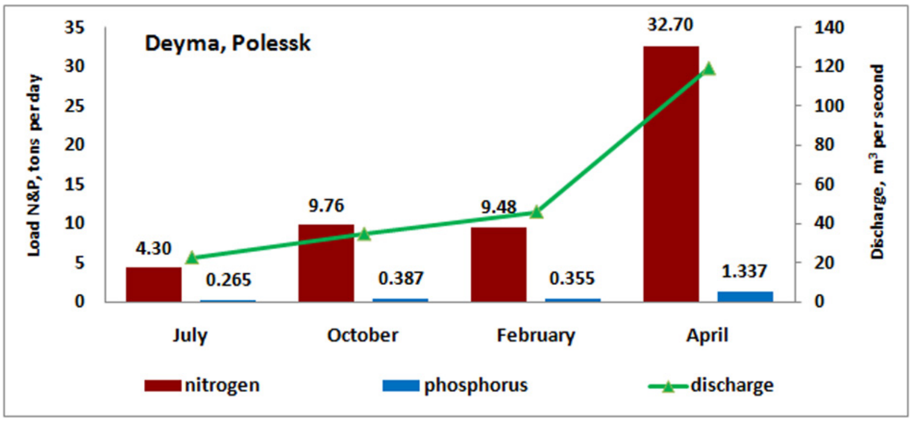


Figure 2.203 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for Deyma River (Polessk) in Monitoring Period

Station 14. Matrosov Canal (estuary), Zapovednoe Settlement

Maximum concentration of total nitrogen was observed in winter sampling period (4.04 mg/l), whereas phosphorus – in autumn flooding season. Minimum concentration of nitrogen and phosphorus was traced in summer low-water period (Figure 2.204).

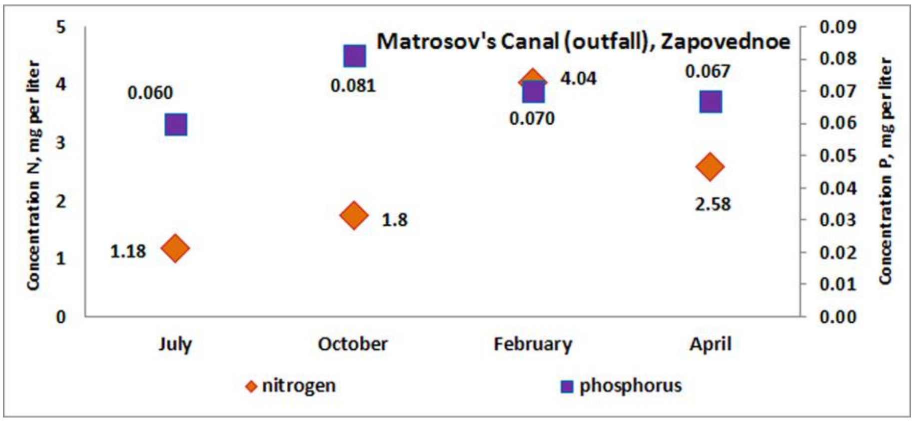


Figure 2.204 – Concentration of Total Nitrogen and Phosphorus in Water for the Matrosov Canal (Zapovednoe) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 83.2 m^3/s. Disbalance of water discharge may be associated with regulated flow of the Neman River, because the canal is its branch. During the year one can notice a growth of total nitrogen load, where maximum values are traced within spring high-water season (Figure 2.205). Values of phosphorus concentration are similar all year round. In total, within a year 4876 tons of total nitrogen and 133 tons of total phosphorus are received from the Matrosov Canal basin.

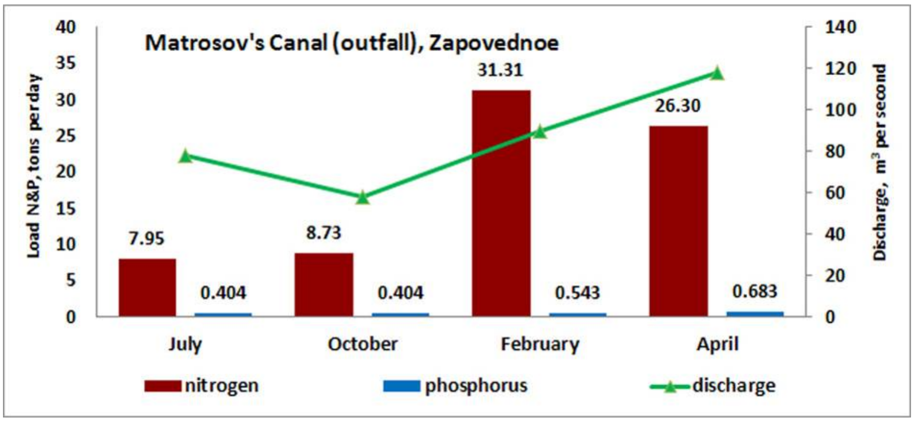


Figure 2.205 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Matrosov Canal (Zapovednoe) in Monitoring Period

Station 15. River Sheshupe, Left Tributary of the River Neman, Lesnoe Settlement

Maximum concentration of total nitrogen and phosphorus was observed in autumn sampling period (4.5 mg/l and 0.091 mg/l). Minimum concentration of nitrogen was traced in summer low-water period, whereas phosphorus – in spring high-water season (Figure 2.206).

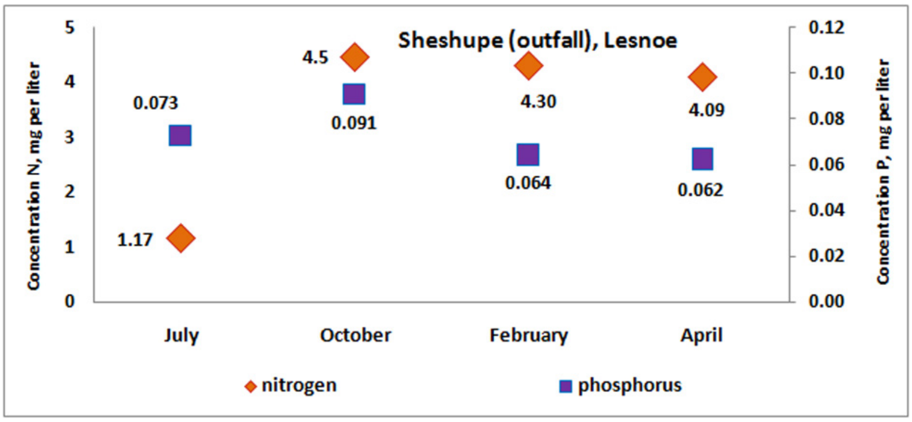


Figure 2.206 – Concentration of Total Nitrogen and Phosphorus in Water for the Sheshupe River (Lesnoe) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 38.0 m^3/s. During the year one can notice fluctuations of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.207). In total, within a year 4501 tons of total nitrogen and 87 tons of total phosphorus are received from the Sheshupe River basin.

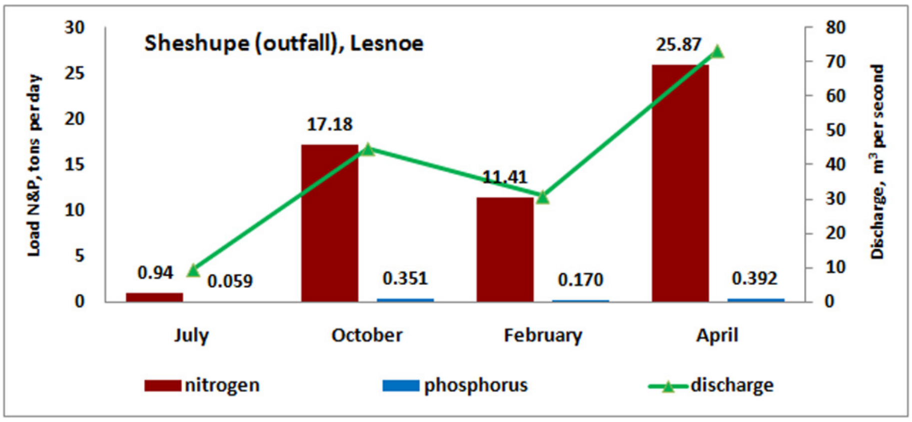


Figure 2.207 – Daily nutrients load of total nitrogen and phosphorus, flow discharge for Sheshupe River (Lesnoe)in monitoring days.

Station 16. River Prokhladnaya, Ushakovo Settlement. Station 16a. Svetloe Settlement

Maximum concentration of total nitrogen and phosphorus was observed in winter sampling period (2.8 mg/l and 0.23 mg/l). Minimum concentration of nitrogen was traced in spring high-water period, whereas phosphorus – in autumn flooding season (Figure 2.208).

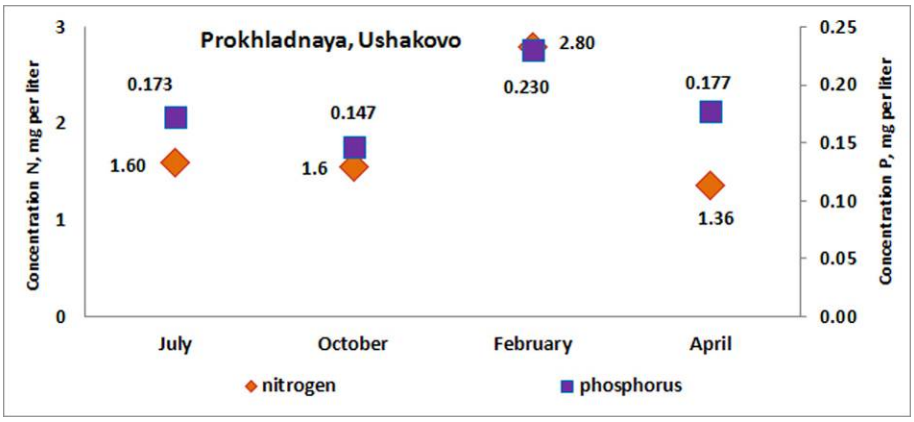


Figure 2.208 – Concentration of Total Nitrogen and Phosphorus in Water for the Prokhladnaya River (Ushakovo) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 3.5 m^3/s. During the year total nitrogen and phosphorus load increased. Maximum values are traced within spring high-water season (Figure 2.209). In total, within a year 187 tons of total nitrogen and 20 tons of total phosphorus are received from the Prokhladnaya River basin at this station.

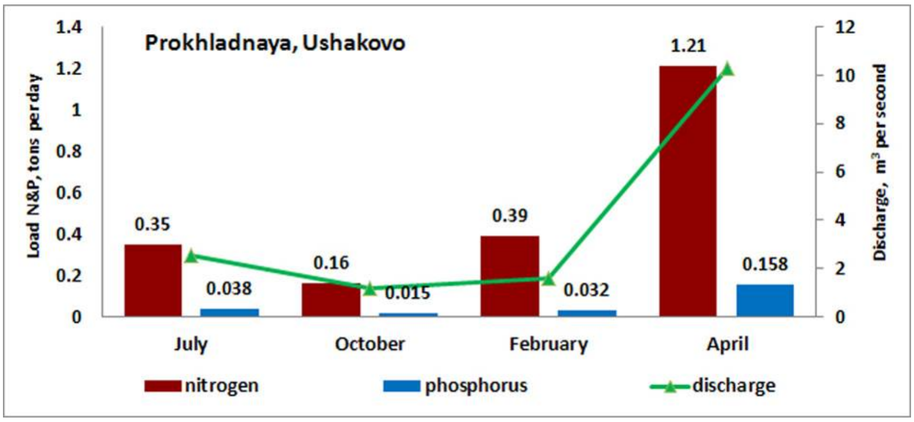


Figure 2.209 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Prokhladnaya River (Ushakovo) in Monitoring Period

Station 17. Kaliningrad Waste Canal, Estuary

Maximum concentration of total nitrogen was observed in winter sampling period (40 mg/l), whereas phosphorus – in spring high-water season. Minimum concentration of nitrogen was traced within summer low-water period, whereas phosphorus – in autumn flooding season (Figure 2.210).

However, specifics of the Canal are the following: the amount of biogenes in it mainly depends not on the natural factors, but the amount of Kaliningrad municipal waste discharge.

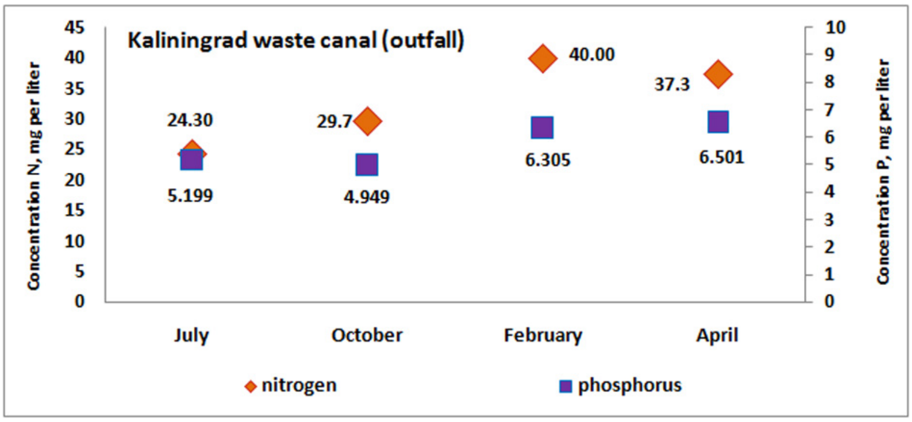


Figure 2.210 – Concentration of Total Nitrogen and Phosphorus in Water for the Kaliningrad Canal in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is practically constant and accounts for 1.3 m^3/s. During the year total nitrogen and phosphorus load has insignificant fluctuations as well. Maximum values are traced within spring high-water season (Figure 2.211). In total, within a year 1380 tons of total nitrogen and 242 tons of total phosphorus are received from the Kaliningrad Canal at this station.

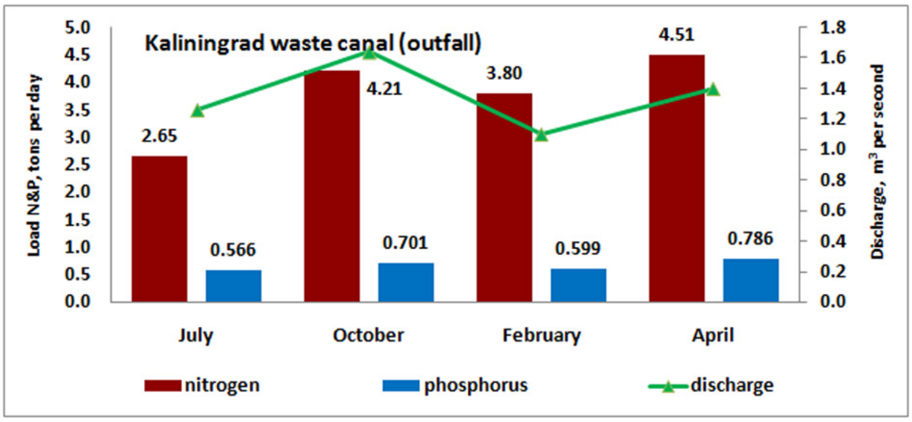


Figure 2.211 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Kaliningrad Canal in Monitoring Period

Station 24, 24a. River Primorskaya, Primorsk

Maximum concentration of total nitrogen and phosphorus was observed in summer sampling period (1.78 mg/l and 0.341 mg/l). Minimum concentration of nitrogen and phosphorus was traced in autumn flooding season (Figure 2.212).

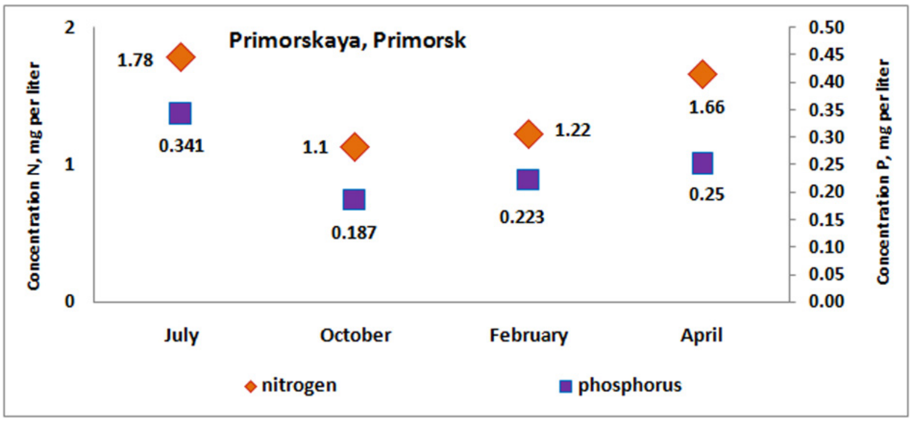


Figure 2.212 – Concentration of Total Nitrogen and Phosphorus in Water for the Primorskaya River (Primorsk) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 1.1 m^3/s. During the year one can notice an oscillating growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.213). In total, within a year 46 tons of total nitrogen and 8 tons of total phosphorus are received from the Primorskaya River basin at this station.

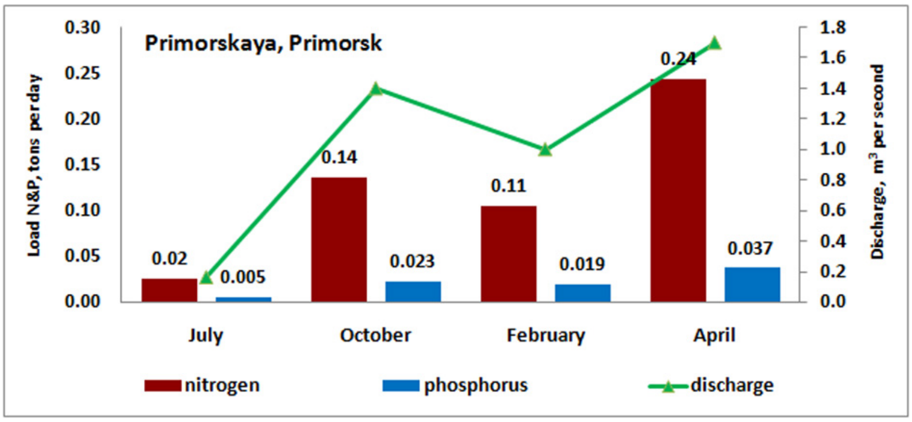


Figure 2.213 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Primorskaya River (Primorsk) in Monitoring Period

Station 25, 25a. River Nelma, Kostrovo Settlement

Maximum concentration of total nitrogen and phosphorus was observed in summer sampling period (1.85 mg/l and 0.428 mg/l). Minimum concentration of nitrogen and phosphorus was traced in autumn flooding season (Figure 2.214).

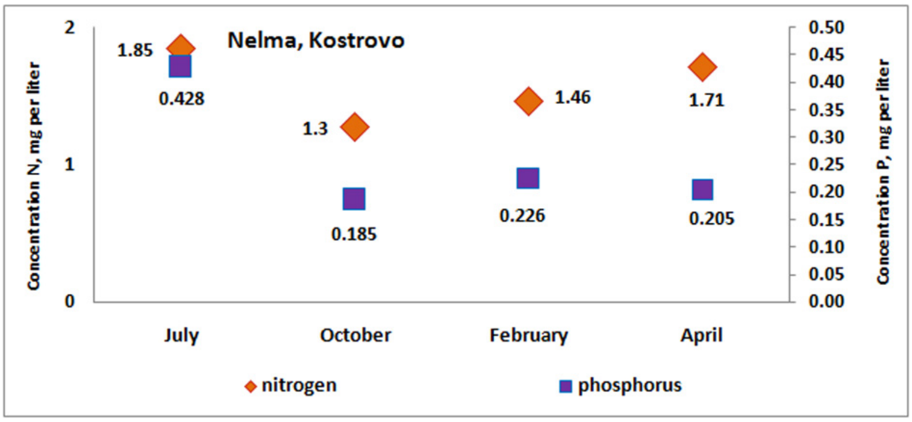


Figure 2.214 – Concentration of Total Nitrogen and Phosphorus in Water for the Nelma River (Kostrovo) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 0.9 m^3/s. During the year one can notice an oscillating growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.215). In total, within a year 46 tons of total nitrogen and 7 tons of total phosphorus are received from the Nelma River basin at this station.

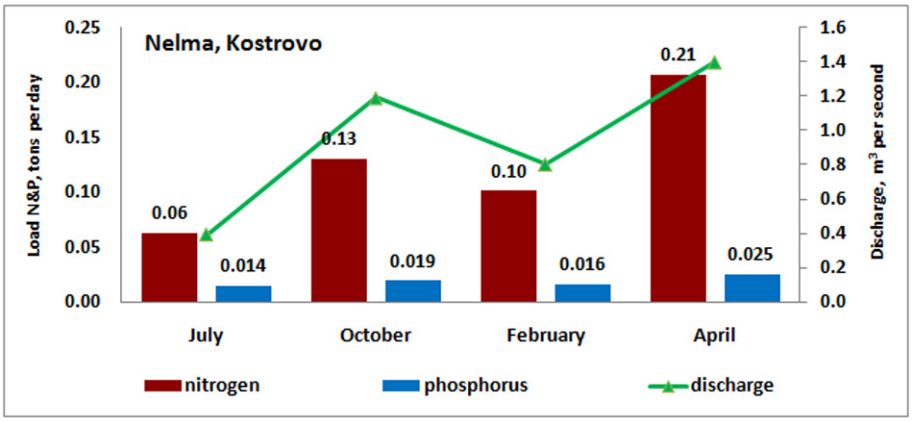


Figure 2.215 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Nelma River (Kostrovo) in Monitoring Period

Station 26. River Pregolya, Kaliningrad

Maximum concentration of total nitrogen and phosphorus was observed in autumn sampling period (3.5 mg/l and 0.224 mg/l). Minimum concentration of nitrogen and phosphorus was traced in summer low-water season (Figure 2.216).

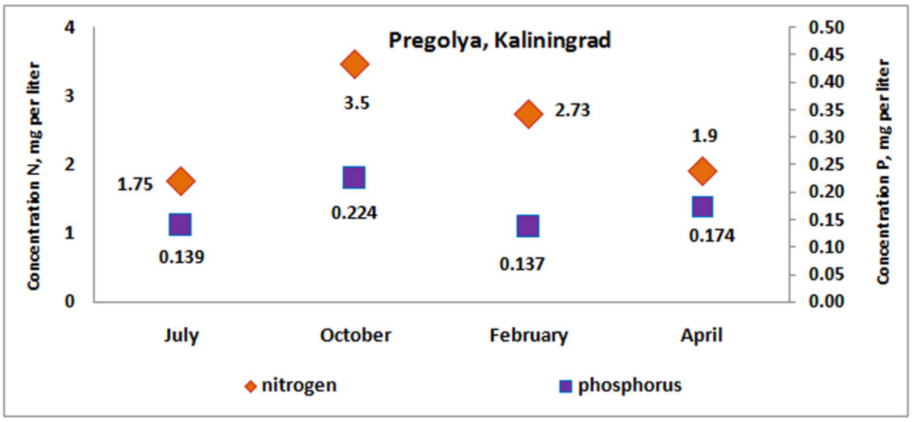


Figure 2.216 – Concentration of Total Nitrogen and Phosphorus in Water for the Pregolya River (Kaliningrad) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 46.1 m^3/s. During the year one can notice oscillation in total nitrogen and phosphorus load. Maximum values are traced within autumn flooding season (Figure 2.217). In total, within a year 3716 tons of total nitrogen and 252 tons of total phosphorus are received from the Pregolya River basin at this station.

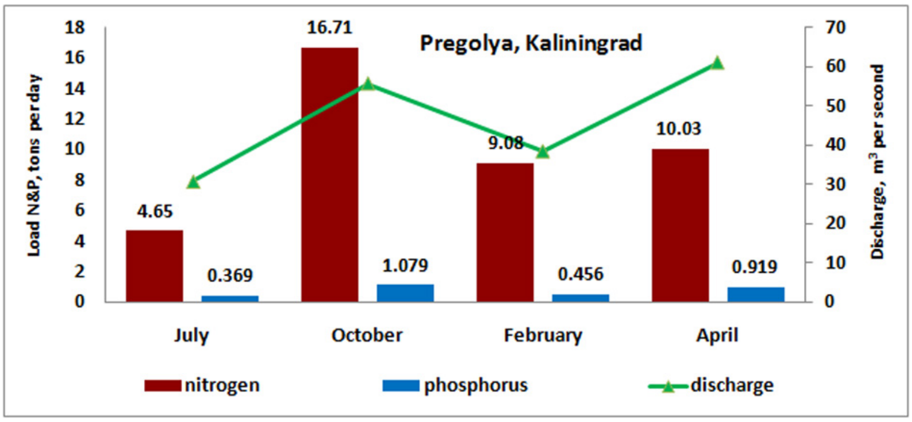


Figure 2.217 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Pregolya River (Kaliningrad) in Monitoring Period

Station 27. River Pregolya, Gvardejsk

Maximum concentration of total nitrogen was observed in spring sampling period (6.25 mg/l), whereas phosphorus – in summer low-water season. Minimum concentration of nitrogen was traced within summer low-water period, whereas phosphorus – in autumn flooding season (Figure 2.218).

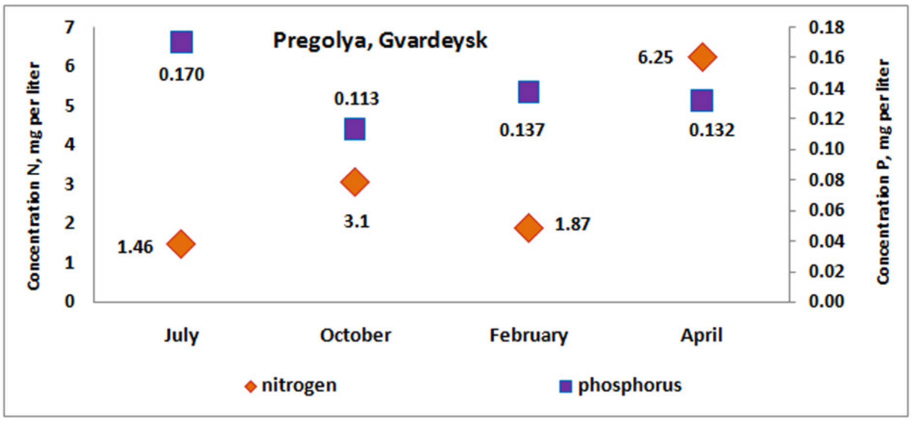


Figure 2.218 – Concentration of Total Nitrogen and Phosphorus in Water for the Pregolya River (Gvardejsk) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 87.3 m^3/s. During the year one can notice a growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.219). In total, within a year 5855 tons of total nitrogen and 252 tons of total phosphorus are received from the Pregolya River basin at this station.

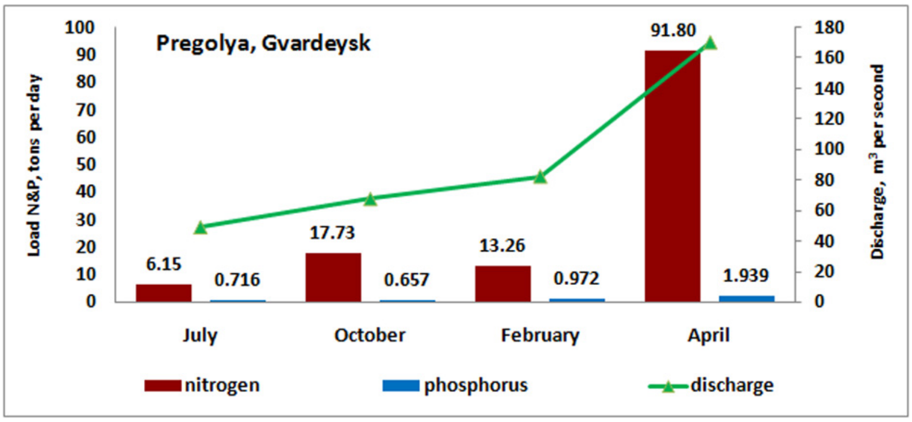


Figure 2.219 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Pregolya River (Gvardejsk) in Monitoring Period

Station 28. Matrosov Canal, Mostovoe Settlement

Maximum concentration of total nitrogen was observed in spring sampling period (3.95 mg/l), whereas phosphorus – in winter low-water season. Minimum concentration of nitrogen was traced within summer low-water period, whereas phosphorus – in autumn flooding season and spring high-water period (Figure 2.220).

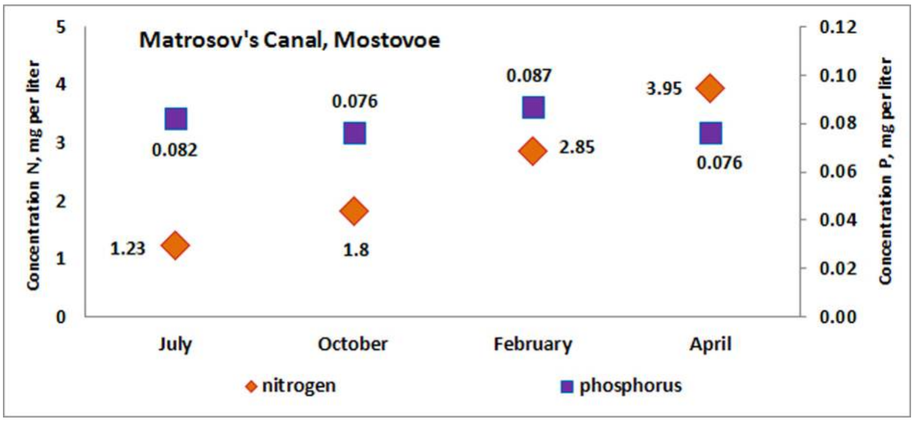


Figure 2.220 – Concentration of Total Nitrogen and Phosphorus in Water for the Matrosov Canal (Mostovoe) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 83.2 m^3/s. Disbalance of water discharge may be associated with regulated flow of the Neman River, because the canal is its branch. During the year one can notice a growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.221). In total, within a year 6555 tons of total nitrogen and 211 tons of total phosphorus are received from the Matrosov Canal at this station.

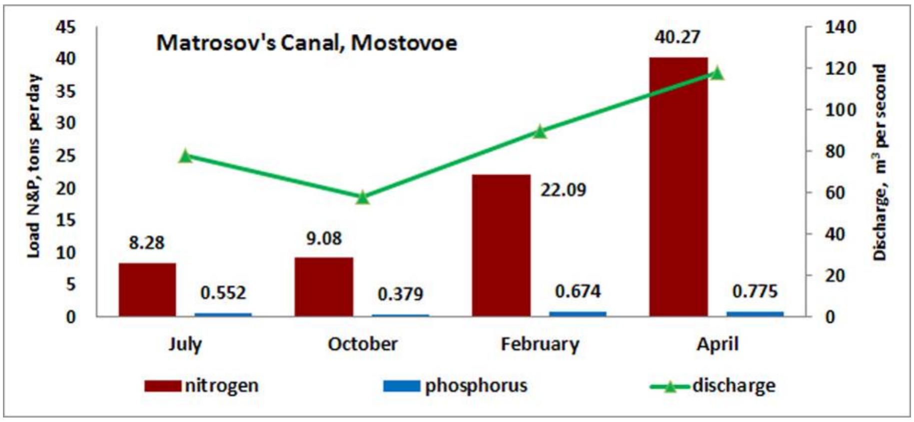


Figure 2.221 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Matrosov Canal (Mostovoe) in Monitoring Period

Station 29. River Sheshupe, Zarechnoe Settlement

Maximum concentration of total nitrogen and phosphorus was observed in autumn sampling period (4.5 mg/l and 0.101 mg/l, correspondingly). Minimum concentration of nitrogen was traced within summer low-water period, whereas phosphorus – in spring high-water period (Figure 2.222).

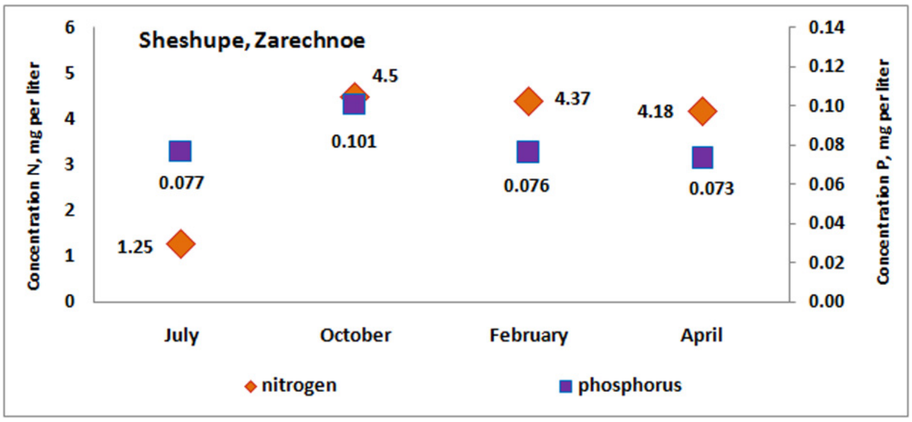


Figure 2.222 – Concentration of Total Nitrogen and Phosphorus in Water for the Sheshupe River (Zarechnoe) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 39.0 m^3/s. During the year one can notice an oscillating growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.223). In total, within a year 4574 tons of total nitrogen and 99 tons of total phosphorus are received from the Sheshupe River basin at this station.

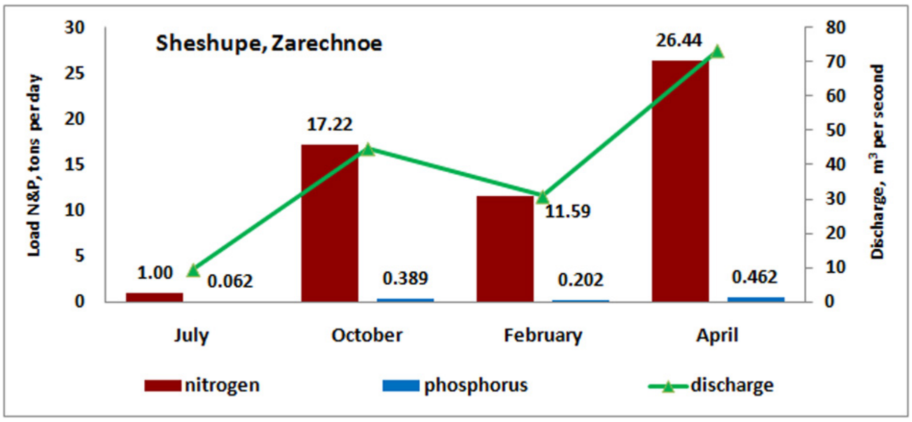


Figure 2.223 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Sheshupe River (Zarechnoe) in Monitoring Period

Station 30. Stream Medvezhij, Estuary, Sokolniki Settlement

Maximum concentration of total nitrogen and phosphorus was observed in summer sampling period (1.96 mg/l and 1.707 mg/l, correspondingly). Minimum concentration of nitrogen was traced within summer low-water period, whereas phosphorus – in spring high-water period (Figure 2.224).

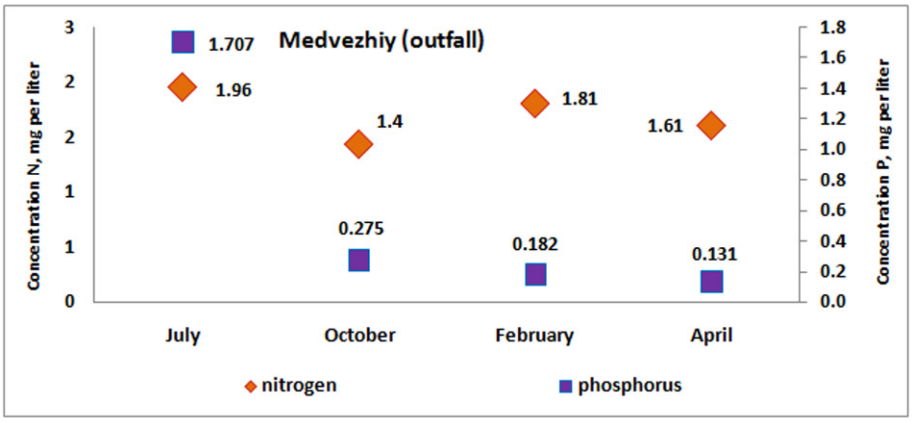


Figure 2.224 – Concentration of Total Nitrogen and Phosphorus in Water for the Medvezhij Stream (estuary) in Monitoring Period

Average annual flow discharge (according to the monitoring results and further interpolation) getting through the river station is 0.2 m^3/s. During the year one can notice an oscillating growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.225). In total, within a year 9 tons of total nitrogen and 2 tons of total phosphorus are received from the Medvezhij Stream basin at this station.

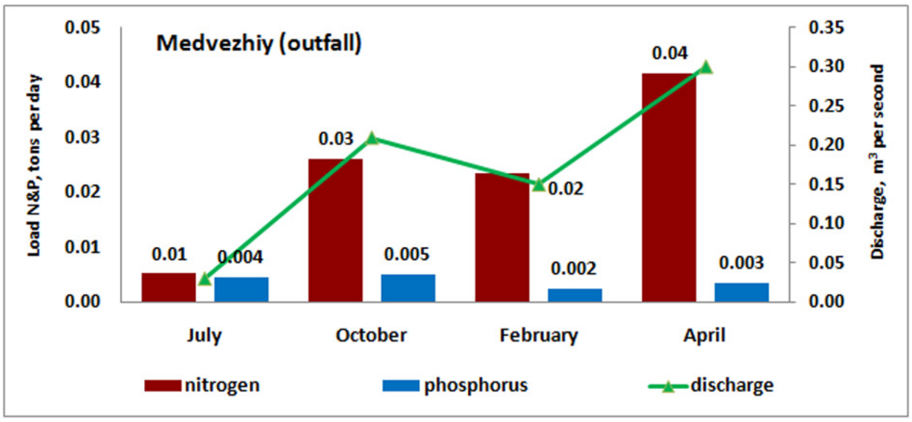


Figure 2.225 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Medvezhij Stream (estuary) in Monitoring Period

Station 31. River Lava, Ryabinino Settlement

In summer period measurements were not conducted. Maximum concentration of total nitrogen was observed in spring sampling period (4.91 mg/l), whereas phosphorus – within winter low-water season. Minimum concentration of nitrogen and phosphorus was traced within autumn flooding period (Figure 2.226).

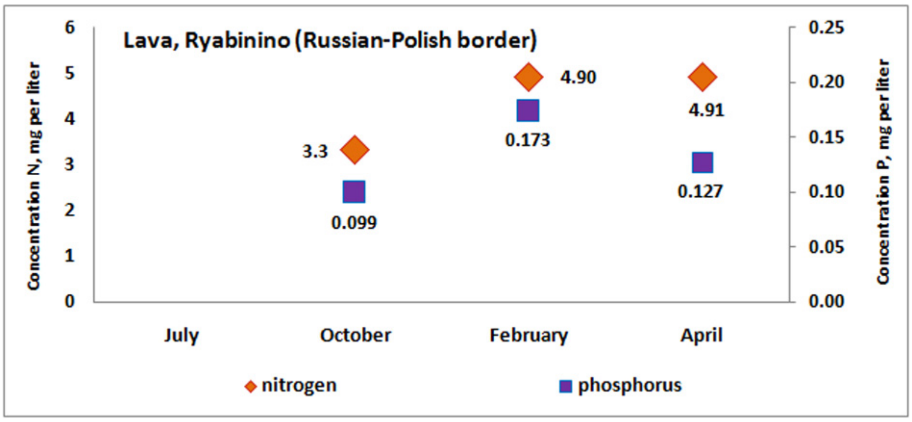


Figure 2.226 – Concentration of Total Nitrogen and Phosphorus in Water for the Lava River (Ryabinino) in Monitoring Period

Average annual flow discharge for the monitoring period (according to the monitoring results and further interpolation) received from the station in Pravdinsk is 26.0 m^3/s. Lava River is regulated river by Pravdinsk reservoir. During the year one can notice a growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.227). In total, within a year 1867 tons of total nitrogen and 59 tons of total phosphorus are received from the Lava River basin at this station.

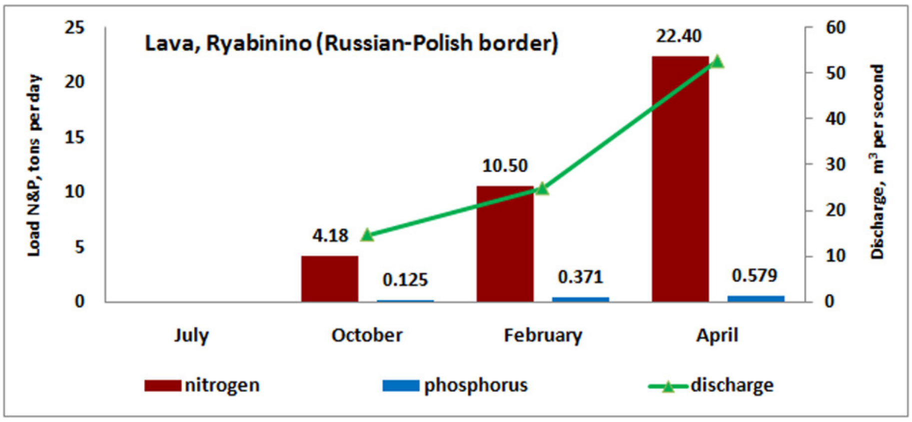


Figure 2.227 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Lava River (Ryabinino) in Monitoring Period

Station 32. River Lava, Pravdinsk

In summer period measurements were not conducted. Maximum concentration of total nitrogen and phosphorus was observed in spring sampling period (6.26 mg/l and 0.14 mg/l, correspondingly). Minimum concentration of nitrogen was traced within autumn flooding period, whereas phosphorus – in winter low-water season (Figure 2.228).

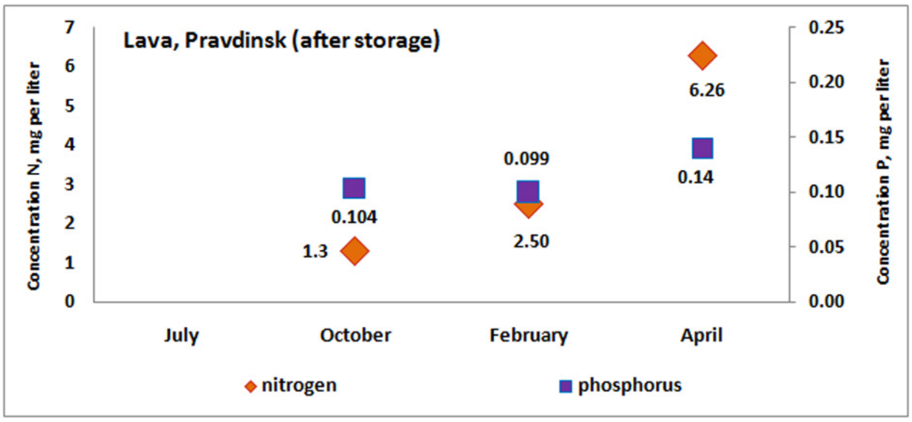


Figure 2.228 – Concentration of Total Nitrogen and Phosphorus in Water for the Lava River (Pravdinsk) in Monitoring Period

Average annual flow discharge for the monitoring period (according to the monitoring results and further interpolation) is 26.0 m^3/s. Lava River is regulated river by Pravdinsk reservoir. During the year one can notice a growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.229). In total, within a year 1350 tons of total nitrogen and 46 tons of total phosphorus are received from the Lava River basin at this station.

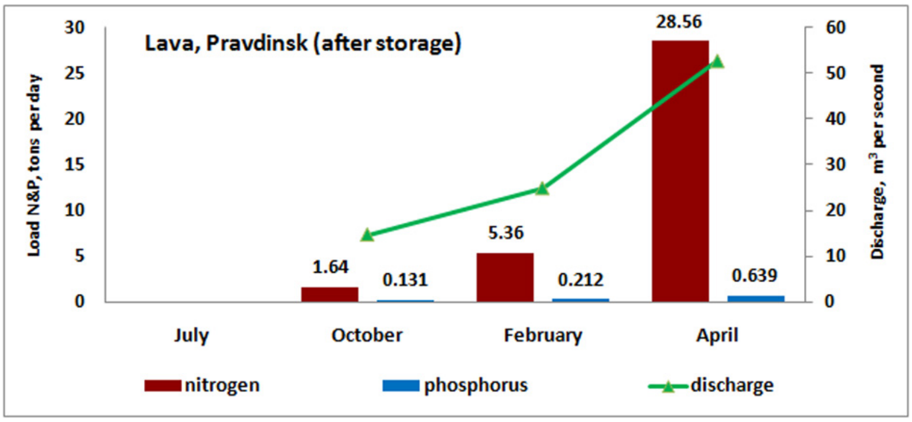


Figure 2.229 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Lava River (Pravdinsk) in Monitoring Period

Station 33. Stream Medvezhij, Sokolniki Settlement

In summer period measurements were not conducted. Maximum concentration of total nitrogen and phosphorus was observed in winter sampling period (1.69 mg/l and 0.336 mg/l, correspondingly). Minimum concentration of nitrogen and phosphorus was traced within autumn flooding period (Figure 2.230).

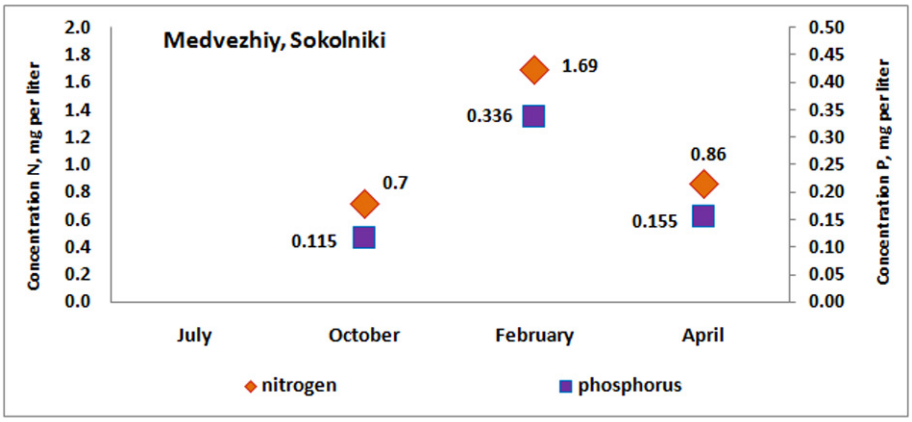


Figure 2.230 – Concentration of Total Nitrogen and Phosphorus in Water for the Medvezhij Stream (Sokolniki) in Monitoring Period

Average annual flow discharge for the monitoring period (according to the monitoring results and further interpolation) is 0.1 m^3/s. Maximum values of biogenic load are traced within winter low-water season (Figure 2.231). In total, within the monitoring period 2 tons of total nitrogen and 0.4 tons of total phosphorus are received from the Medvezhij Stream basin at this station.

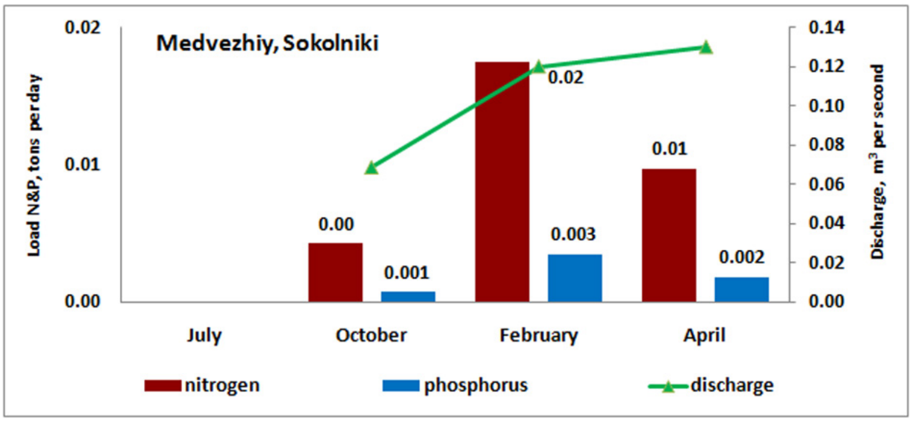


Figure 2.231 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Medvezhij Stream (Sokolniki) in Monitoring Period

Station 34. River Lava, Dalnee Settlement

In summer and autumn periods measurements were not conducted. Maximum concentration of total nitrogen and phosphorus was observed in spring sampling period (5.78 mg/l and 0.136 mg/l, correspondingly). Minimum concentration of nitrogen and phosphorus was traced within winter low-water period (Figure 2.232).

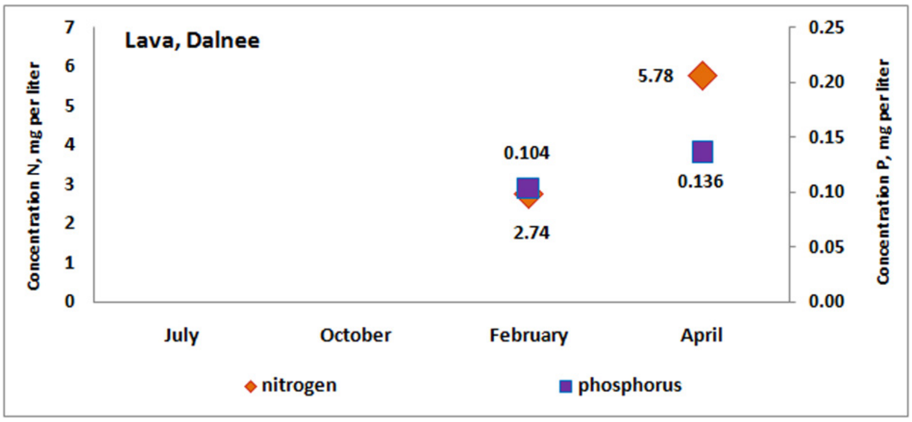


Figure 2.232 – Concentration of Total Nitrogen and Phosphorus in Water for the Lava River (Dalnee) in Monitoring Period

Average annual flow discharge for the monitoring period (according to the monitoring results and further interpolation) received from the station in Rodniki Settlement is 60.0 m^3/s. Lava River is regulated river by Pravdinsk reservoir.During the monitoring period one can notice a growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.233). In total, within the monitoring period 1406 tons of total nitrogen and 38 tons of total phosphorus are received from the Lava River basin at this station.

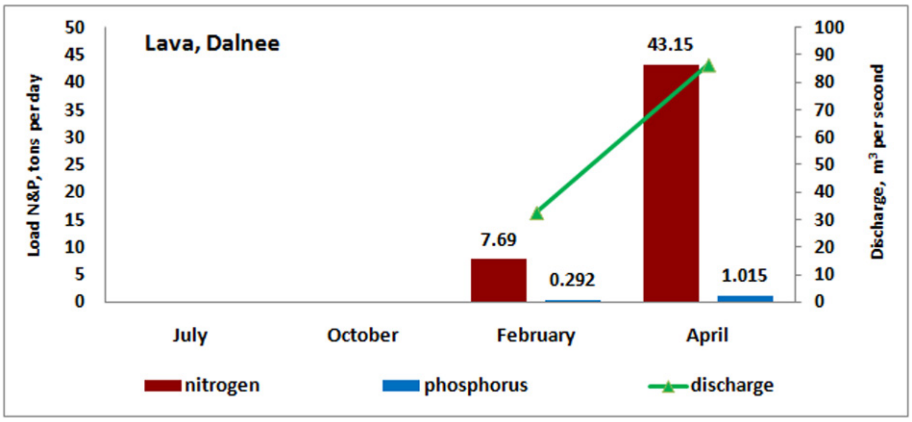


Figure 2.233 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Lava River (Dalnee) in Monitoring Period

Station 35. River Lava, Rodniki Settlement

In summer and autumn periods measurements were not conducted. Maximum concentration of total nitrogen and phosphorus was observed in spring sampling period (5.94 mg/l and 0.139 mg/l, correspondingly). Minimum concentration of nitrogen and phosphorus was traced within winter low-water period (Figure 2.234).

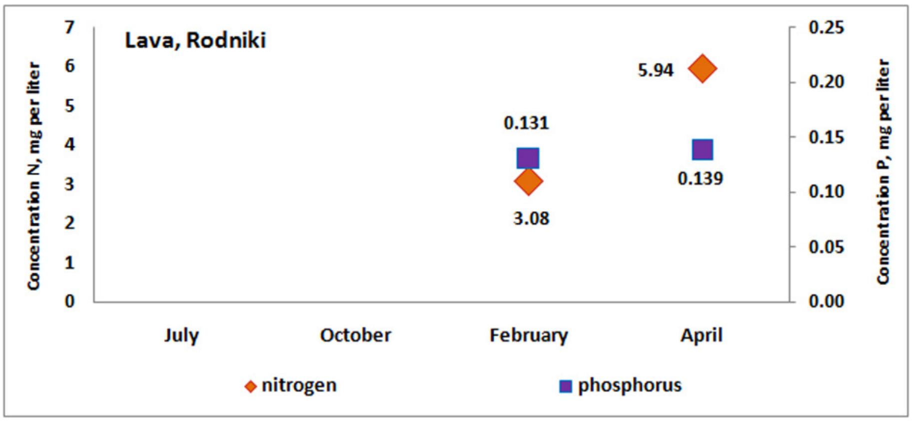


Figure 2.234 – Concentration of Total Nitrogen and Phosphorus in Water for the Lava River (Rodniki) in Monitoring Period

Average annual flow discharge for the monitoring period (according to the monitoring results and further interpolation) is 60.0 m^3/s. Lava River is regulated river by Pravdinsk reservoir. During the monitoring period one can notice a growth of total nitrogen and phosphorus load. Maximum values are traced within spring high-water season (Figure 2.235). In total, within the monitoring period 1479 tons of total nitrogen and 42 tons of total phosphorus are received from the Lava River basin at this station.

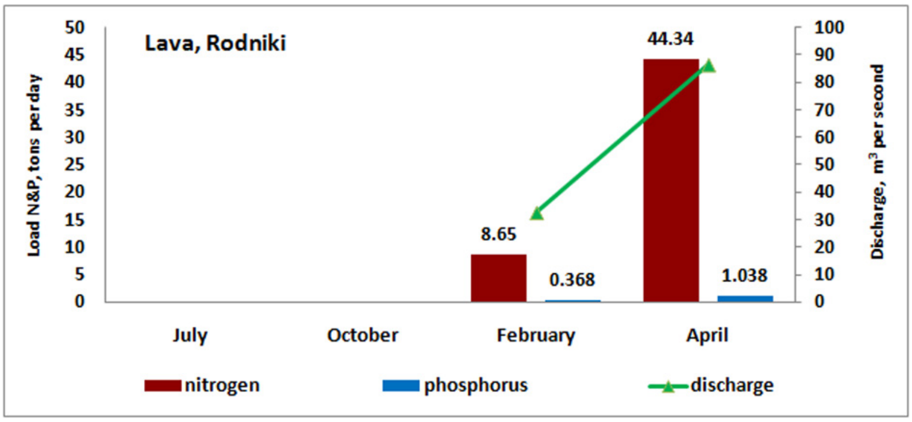


Figure 2.235 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Lava River (Dalnee) in Monitoring Period

Station 36. Stream Bezymyannij, Kamenka Settlement

In summer and autumn periods measurements were not conducted. Maximum concentration of total nitrogen was observed in winter sampling period (2.34 mg/l), whereas phosphorus – within spring high-water season (Figure 2.236).

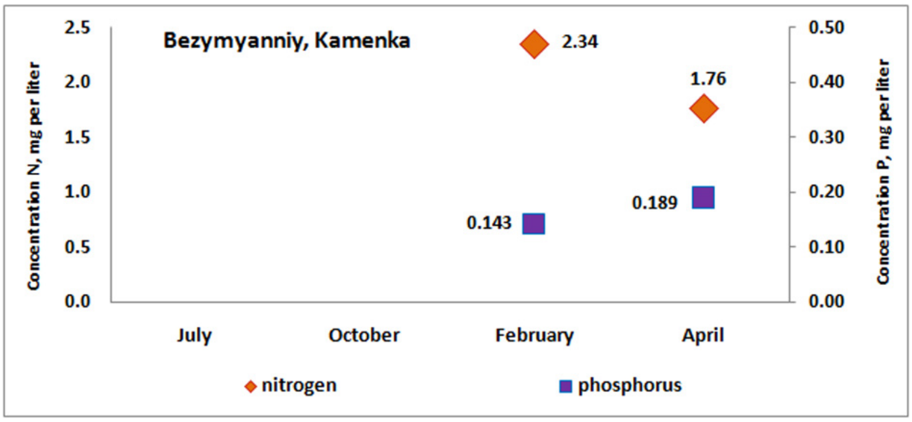


Figure 2.236 – Concentration of Total Nitrogen and Phosphorus in Water for the Bezymyannij Stream (Kamenka) in Monitoring Period

Average annual flow discharge for the monitoring period (according to the monitoring results and further interpolation) is 0.1 m^3/s. Maximum values of biogenic load are traced within spring high-water season (Figure 2.237). In total, within the monitoring period 0.9 tons of total nitrogen and 0.1 tons of total phosphorus are received from the Bezymyannij Stream basin at this station.

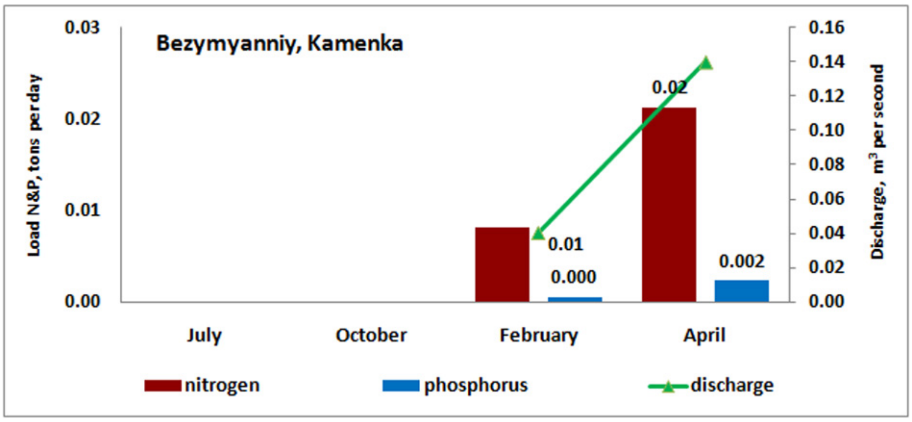


Figure 2.237 – Daily Nutrients Load of Total Nitrogen and Phosphorus, Flow Discharge for the Bezymyannij Stream (Kamenka) in Monitoring Period

2.6.2.2 Load formation in the Pregolya river catchment

The following big tributaries are mainly employed in the Pregolya water stream formation: the Instruch, the Angrapa, the Golubaya, the Stream Glubokij, and the Lava River. According to the measurements conducted in 2013 – 2014 all these rivers in total bring 8111 tons of total nitrogen and 369 tons of phosphorus a year. Near Gvardejsk the Dejma arm flows out of the River Pregolya. Before this branching total nutrient load of the Pregolya is 5595 tons of total nitrogen and 221 tons of total phosphorus a year. Correspondingly, difference between the values of received nutrients from the tributaries and the data at the station accounts for 2516 tons of nitrogen and 148 tons of phosphorus, that is the amount held by the river itself (Figures 2.238,2.239).

However, data collected at the estuary stations on the Pregolya (in Kaliningrad) and the Deyma (in Polessk) show the increase of total load (2445 tons of nitrogen and 196 tons of phosphorus) on Lagoons.

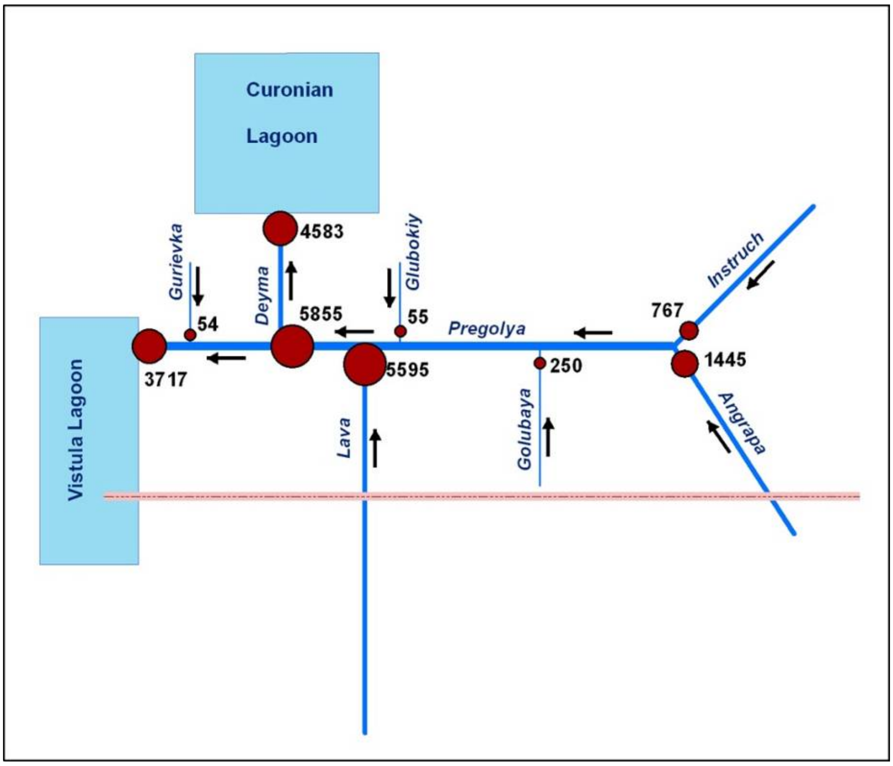


Figure 2.238- Total Amount of Total Nitrogen carried by the Pregolya and its Tributaries

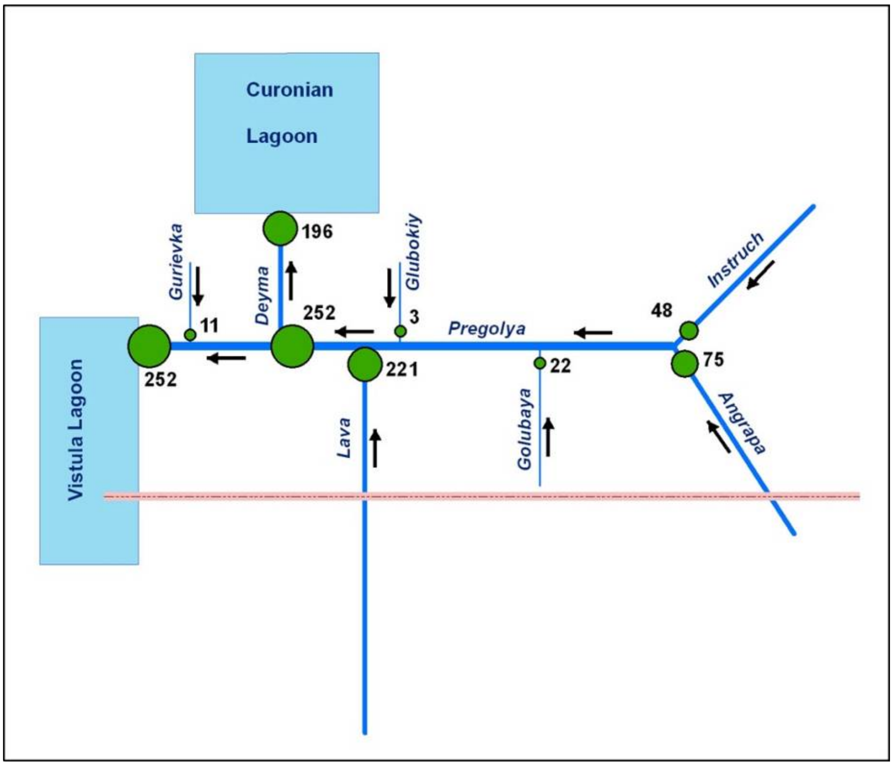


Figure 2.239 -Total Amount of Total Phosphorus carried by the Pregolya and its Tributaries

2.6.2.3 Input of the main tributaries and assessment of load formation in the tributaries' basins

The main tributary of the Pregolya River is the transboundary Lava River, more than half of which water basin is located in Poland. So, the greatest part of the nutrient load comes to the Kaliningrad Oblast from the transboundary territory. The amount of nutrients that come from the Polish territory make not less than half of the total amount which is later carried out to the Pregolya and further to the Baltic Sea. Besides, straight after the national Russian-Polish border there is the Pravdinsk reservoir that feeds the Pravdinsk hydroelectric power station. According to autumn and winter monitoring rounds this reservoir keeps half of the nutrient load that comes from the upstream (Figure 2.240, 2.241). In spring season the amount of beogenes however increases during reservoir. But this fact can be associated with a huge amount of water that passes through the reservoir.

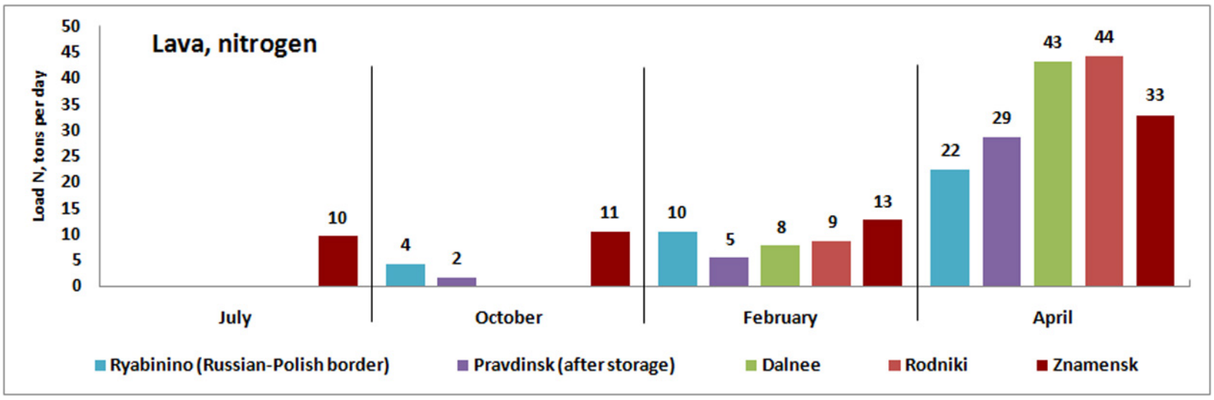


Figure 2.240– Space Variations of Total Nitrogen, carried out by the Lava River in monitoring days

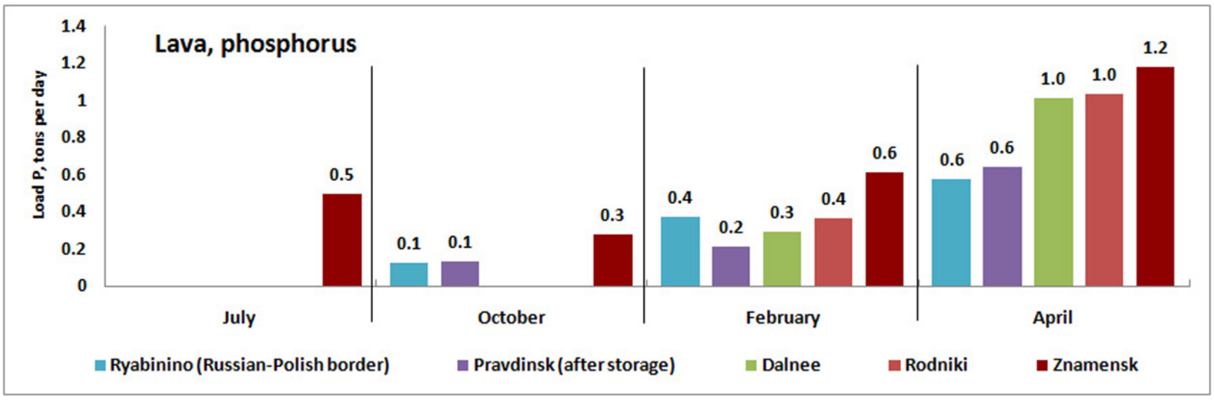


Figure 2.241– Space Variations of Total Phosphorus, carried out by the Lava River in monitoring days

2.6.2.4 Total Load on Vistula and Curonian Lagoons and assessment of the nutrient load retention in the Kaliningrad Oblast

Total load on the water area of Vistula and Curonian Lagoons is composed of the amount of total nitrogen and phosphorus that can be found in the waters of the main rivers feeding them.

For Vistula Lagoon to the main rivers we can recon the following ones: the Pregolya, the Prokhladnaya, the Nelma, the Primorskaya, and the Kaliningrad Waste Canal. Estimation of the nutrient load received from the Mamonovka river catchment was not carried out. Total amount of total nitrogen in water is 5384 tons a year, whereas total phosphorus – 529 tons a year (Figures 2.242, 2.243).

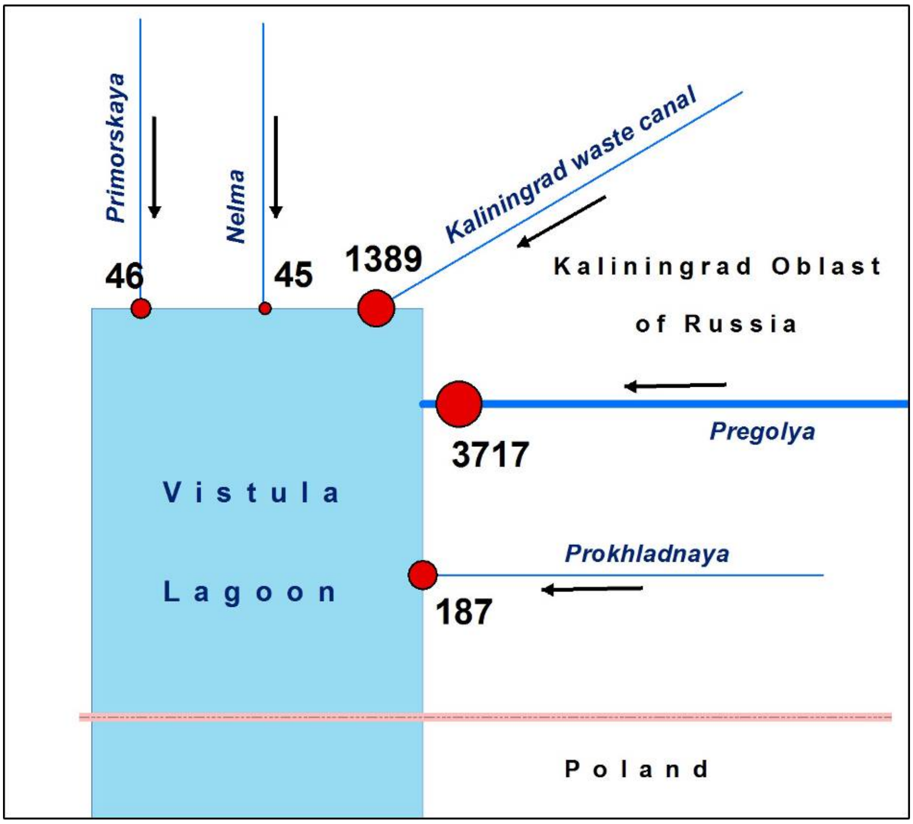


Figure 2.242- Total Load of Total Nitrogen when Getting into Vistula Lagoon. Calculations for 2013-2014

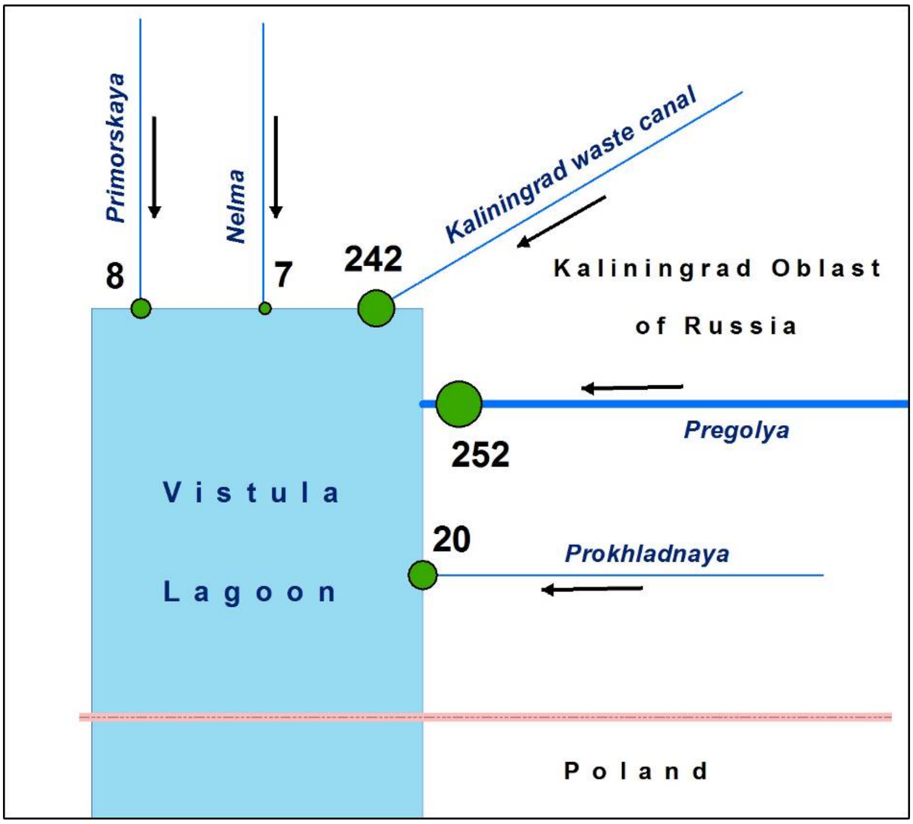


Figure 2.243-Total Load of Total Phosphorus when Getting into Vistula Lagoon. Calculations for 2013-2014

For Curonian Lagoon to the main rivers we can recon the following ones: the Deyma (arm of the Pregolya), and the Matrosov Canal. Total amount of total nitrogen in water delivered into the Lagoon in 2013-2014 is 9459 tons a year (Figure 2.244), whereas total phosphorus – 332 tons a year (Figure 2.245).

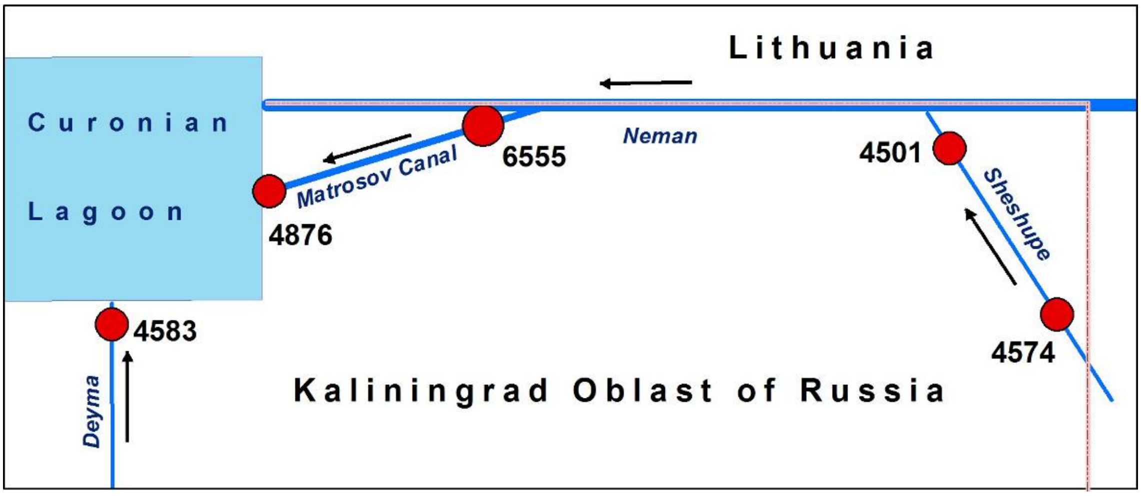


Figure 2.244- Total Load of Total Nitrogen in Water when Getting into Curonian Lagoon.
Calculations for 2013-2014

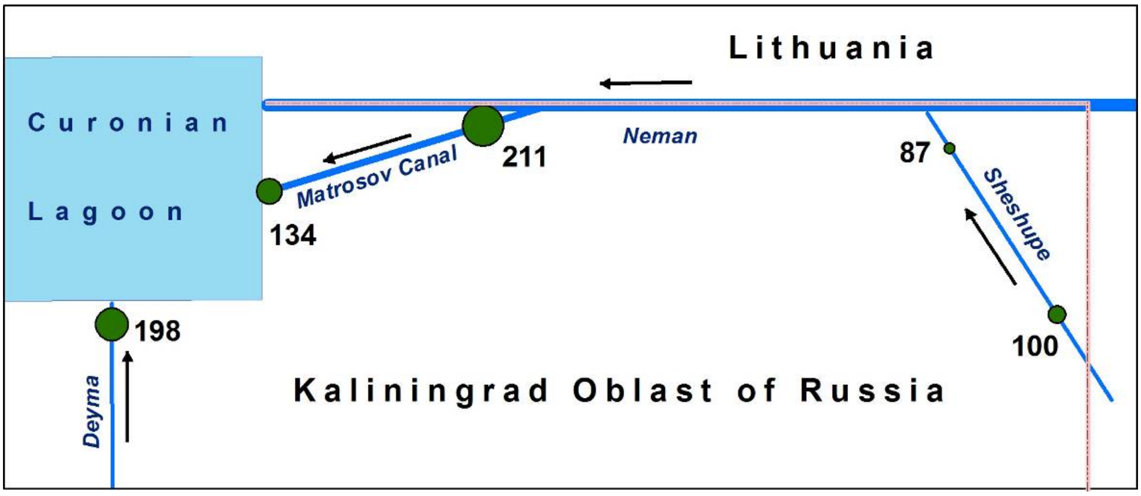


Figure 2.245- Total Load of Total Phosphorus in Water when Getting into Curonian Lagoon.
Calculations for 2013-2014

It should be mentioned that the Matrosov Canal is an arm located in delta of the cross-border Neman River (between Russia and Lithuania) and channels some waters out of the river. According to the monitoring analysis when waters from the Neman River come to the territory of the Kaliningrad Oblast total annual load of nitrogen is 6555 tons and phosphorus – 211 tons. At the same time load in the river mouth is dropping to 4876 tons per year and 134 tons per year correspondingly. Thus, 25% of total nitrogen and 37% of total phosphorus were kept on the territory of the Kaliningrad Oblast.

Similar situation with nutrints retention on the territory of the Kaliningrad Oblast is monitored for the Sheshupe River (Figure 2.245). So, 4574 tons per year of total nitrogen is delivered with waters, whereas 4501 tons are discharged, retention is 1%; 100 tons per year of total phosphorus is delivered with waters, whereas 87 tons are discharged, retention is 13%.

Nowadays the majority of settlements in the Kaliningrad Oblast do not have modern water and waste water treatment facilities. Generally, municipal waste water treatment plants carry out just primary clarification. Thus, the main pollutants of the rivers surface waters are the settlements located in the Pregolya catchment. The major cities are the administrative centres of the districts: Chernyakhovsk, Gusev, Nesterov, Gvardejsk, Pravdinsk, and Ozersk. The administrative centre of the oblast – Kaliningrad itself – does not discharge municipal waste waters into the Pregolya River, but channel it out through the Kaliningrad Waste Canal into the Primorskaya Buchta (bay). This engineering construction is an open canal. Contaminated water is partially cleaned when exposed to air, when nitrogen and phosphorus compounds get oxygenized.

During spring high water season the amount of nutrints carried by all rivers doubles compared with other key seasons. However, total nitrogen and phosphorus concentration on the contrary falls by 10-50% compared to previous periods.

Analyzing the runoffs of the Pregolya River calculated in the framework of the BASE project and daily measurements made by the Hydrometeorological Centre of Russia it should be noted that within-year variability is preserved. So, winter and summer runoffs are less than average annual ones, whereas spring and autumn are higher. Besides, spring high-water that usually occurs in March was recorded in 2014 – in April (Figure 2.246). Average annual runoff officially corresponds to 77 m^3/s (official data of Kaliningrad Center of environmental monitoring for 2009-2013),whereas according to the measurements carried out within the BASE project – 87m^3/s.

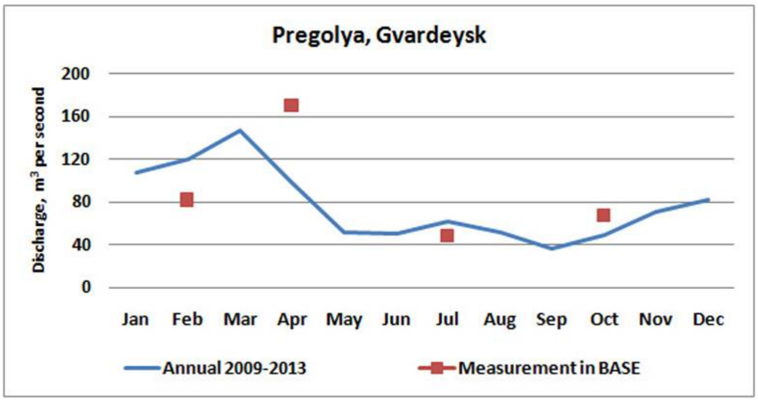


Figure 2.246 – Correlation of the Pregolya River runoff according to the data received within the BASE project and daily measurements.

Changes in nutrient load on water objects depends directly on the rivers runoffs. Thus, the level of correlation between the measured runoff and the amount of received nutrients fluctuates between 0.46 (in the Kaliningrad Waste Canal) and 0.99 (in other rivers) – for total nitrogen, and between 0.43 (the Gurjevka) and 0.99 (in other rivers) – for total phosphorus.

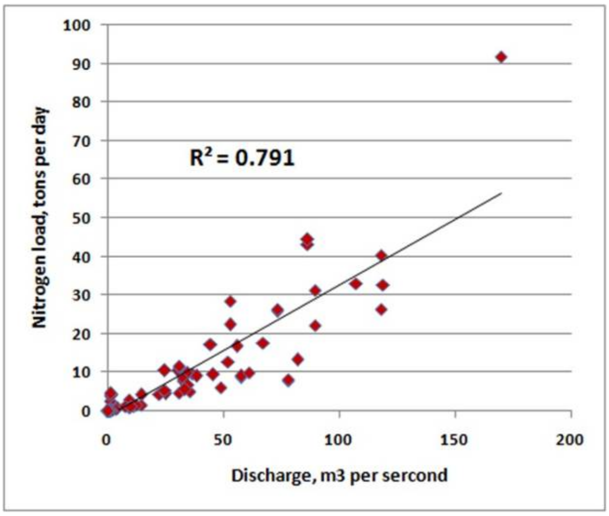


Figure 2.247- Correlation of the amount of received total nitrogen with water discharge values calculated in the framework of monitoring activities of the BASE project.

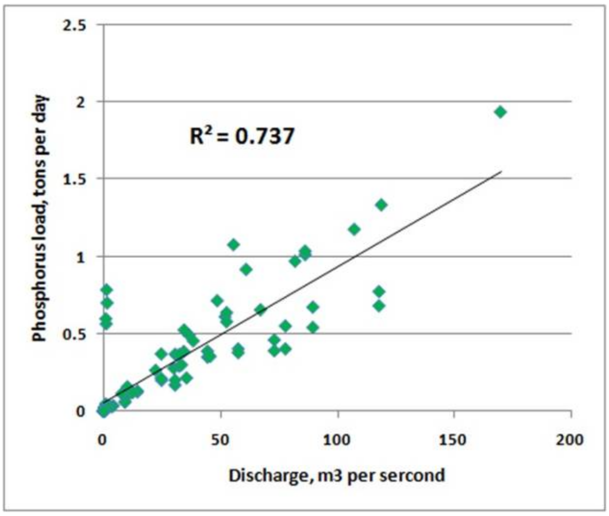


Figure 2.248- Correlation of the amount of received total phosphorus with water discharge values calculated in the framework of monitoring activities of the BASE project.

The main sources of pollutants of the rivers are the settlements located in the Pregolya catchment. The major cities are the administrative centres of the districts: Chernyakhovsk, Gusev, Nesterov, Gvardejsk, Pravdinsk, and Ozersk.

Taking into account that official data on nutrient load includes only mineral nutrients and is available only for 2012, it is not correct to compare the data received in the framework of the BASE project and Hydrometeorological Centre measurements. However, comparing the data for the Pregolya River (Gvardeysk), we observe a similar seasonal dynamics of concentration for nitrogen and phosphorus (Figures 2.249, 2.250).

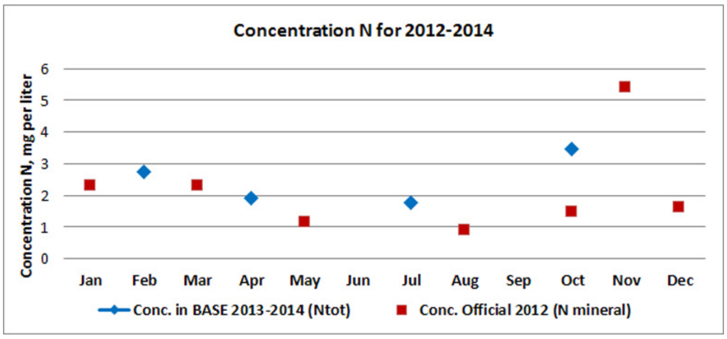


Figure 2.249- Comparing of seasonal dynamics of total nitrogen concentration for BASE monitoring period (2013-2014) with official data of mineral nitrogen concentration (2012)

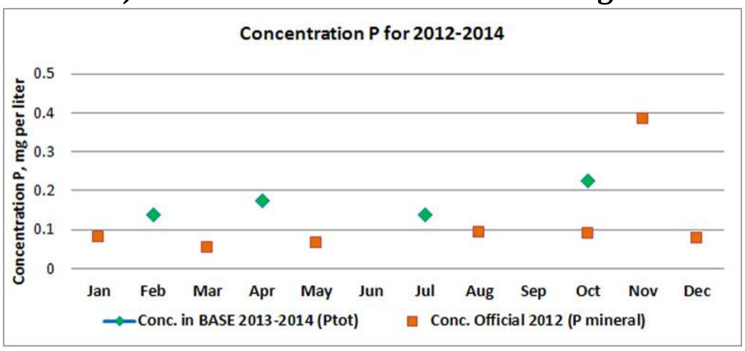


Figure 2.25- Comparing of seasonal dynamics of total phoshorus concentration for BASE monitoring period (2013-2014) with official data of mineral phoshorus concentration (2012)

2.6.3 Quality assurance and uncertainties

Uncertainty results from the limited time of monitoring activities that were carried out just in key seasons but on regular basis.

In view of absence of the monitoring data the information on diffuse sources and natural background nutrient concentrations in the main channel of the Pregolya River and its tributaries was not analyzed.

Nutrient load sampling was carried out only from the surficial unit, so the data of vertical distribution of nutrients concentrations and flows in the main channel of the Pregolya River lacks.

As the programme moved forward, on the small rivers, where biogenic load was low (nutrients load was 0.1% from load of Pregolya River) in the first sampling round, the decision was taken to close a number of stations. However, for the Lava river which is the main pollutant source for the Pregolya one has introduced a number of metrical section lines in order to determine sources of potential water pollution by biogenes.

Uncertainties in the results of water discharge exist for some rivers. Causes of uncertainties are different for each river.

A significant difference value for water discharge has for rivers Angrapa and Instruch. Instruch River has a typical hydrograph with a minimum in summer and winter and a maximum in spring and autumn. Angrapa River has a maximum in autumn winter and spring. Despite the fact that the mouth of these rivers are nearby and nourish Pregolya River, water in their riverbeds regulated with differently. River Instruch does not have large lakes and ponds. But main tributary of Angrapa River (Pissa River) is regulated river by Vistynets Lake.

The largest tributary of the River Pregolya - Lava River - is regulated river by Pravdinsk reservoir.

Disbalance for water discharge of Matrosovka Canal may be associated with regulated flow of the Neman River, because the canal is its branch.

Discharges into the Kaliningrad waste canal regulated by sewage disposal from Kaliningrad.

Hydrographs of some small rivers (Glubokiy, Golubaya, Lakovka, Medveziy) have atypical form. However, to verify the correctness of the measurements made impossible, since we had only four measurements rounds and previous monitoring program for them is absent. In addition, local use of water (water intake and discharge) can affect the value of runoff in rivers.

2.7 Conclusion and recommendations

The analysis of values of total nitrogen and phosphorus received from the catchments formed both on the territory of the Kaliningrad oblast and bordering states was carried out. The monitoring program aimed at defining both water bodies hydrological and morphometric characteristics and nutrient load water sampling was carried out for the purpose of objective analysis. This program comprises all main seasons: summer (round 1, 1-7 July 2013), autumn (round 2, 30 September – 6 October 2013), winter (round 3, 3-11 February 2014), and spring (1-4 April 2014). Monitoring took place on 20 water bodies of the Kaliningrad oblast at 32 monitoring stations.

The greatest annual water discharge at hydrological sections was observed on the following rivers: the Pregolya (before dividing into arms) - 92 m^3/s, the Sheshupe - 39 m^3/s, and on the Matrosov Canal - 85 m^3/s.

Nearly all rivers of the Kaliningrad Oblast are characterized by interseasonal variability of water discharge (maximum in spring). The exception is the Kaliningrad Waste Canal and mouth part of the Pregolya River and Matrosov Canal where seasonal variability of the given parameter is absent. Causes of atypical hydrological component are different processes. Namely. Tributaries of Pregolya River (Angrapa with Pissa, Lava, Gurievka) have regulated parts. Mouth of Pregolya River has backwater from the Vistula Lagoon. Matrosov Canal is branch of regulated Neman River. Moreover, the local water abstraction and discharge of water can affect the hydrology of most small rivers.

The greatest concentration of both total nitrogen and total phosphorus was observed in the Kaliningrad Waste Canal. Its average annual value accounts for 33 mg/l (for total nitrogen), and 5.7 mg/l (for total phosphorus). Such high values are connected with the transportation of Kaliningrad poorly cleaned waste waters.

Changes in nutrient load on water objects depends directly on the rivers runoffs.

The following big tributaries are mainly employed in the Pregolya water stream formation: the Instruch, the Angrapa, the Golubaya, the Stream Glubokij, and the Lava River. According to the measurements conducted in 2013 – 2014 all these rivers in total bring 8111 tons of total nitrogen and 369 tons of phosphorus a year. Near Gvardejsk the Dejma arm flows out of the River Pregolya. Before this branching total nutrient load of the Pregolya is 5595 tons of total nitrogen and 221 tons of total phosphorus a year. Correspondingly, difference between the values of received nutrients from the tributaries and the data at the station accounts for 2516 tons of nitrogen and 148 tons of phosphorus, that is the amount held by the river itself.

The main tributary of the Pregolya River is the cross-border Lava River, more than half of which water basin is located in Poland. So, the greater part of the nutrient load is estimated to be originated to the Kaliningrad Oblast from the boundary territory. The amount of nutrients that come from the Polish territory make not less than half of the total amount which is later carried out to the Pregolya and further to the Baltic Sea. Besides, straight after the national Russian-Polish border there is the Pravdinsk reservoir. According to autumn and winter monitoring rounds this reservoir keeps half of the nutrient load that comes from the upstream.

Total load on the water area of Vistula and Curonian Lagoons is composed of the amount of total nitrogen and phosphorus that can be found in the waters of the main rivers feeding them. Total amount of total nitrogen in water is 5384 tons a year, whereas total phosphorus – 529 tons a year. Out of this amount - 69% of nitrogen comes from the Pregolya River and 26% - from the Kaliningrad Waste Canal. For phosphorus the correlation is different: 48% of total nitrogen comes from the Pregolya River and 46% - from the Kaliningrad Waste Canal.

Total amount of total nitrogen in water delivered to Curonian Lagoon in 2013-2014 was 9459 tons per year, and total phosphorus – 332 tons per year.

Retention by the Matrosov Canal on the territory of the Kaliningrad Oblast is 25% of total nitrogen and 37% of total phosphorus. Nutrient retention by the Sheshupe River is the following: 1% of total nitrogen and 13% of total phosphorus – on the territory of the Kaliningrad Oblast.

The received results are a matter of judgment. Thus, for more detailed analysis of water bodies of the Kaliningrad Oblast it would be sensible to elaborate a more frequent monitoring scheme (e.g. carried out monthly).

3 Assessment of the transboundary nutrient inputs to Kaliningrad Oblast with a specific focus on the river Neman and Matrosovka Canal

3.1 Background

On 3 October 2013 during HELCOM Copenhagen Ministerial Meeting all Contracting Parties agreed on revised Country Allocated Reduction Targets (CARTs). CARTs have been elaborated in accordance with "polluter pays principle" based on the actual country-wise average annual nutrient load in period 1997-2003, called reference load.

Transboundary nutrient load have been divided between countries and also included in the reference load for each country.

CARTs have been elaborated in accordance with "polluter pays principle" based on the normalized country-wise average annual nutrient load in period 1997-2003, called reference load.

Transboundary nutrient load have been divided between countries taking into account durface water retention in the Country(ies) receiving transboundary inputs and also included in the reference load for each country.

Methodology for country-wise allocation of the transboundary load differs in accordance with administrative location of different water objects.

Then the rivers head belongs to one country, and flowing in the other country (eg, r. Western Dvina, r. Lava, r. Wegorapa) share the load of the upstream country determined on the basis of monitoring data on the border between the two countries and values of load retention in the downstream country.

There are special cases of transboundary rivers, which flows along the border between the two countries. Neman river refer to this case and can be considered as border river.

There is still no enough data for using existing methodology to accurately determine the contribution of each country in nutrient loading in the outfalls of these rivers.

When the CARTs were elaborated the allocation of the transboundary loads have been made using approximate methods. For example, share of each country input (Estonia and Russia) in nutrient load coming with border river Narva to the Baltic Sea have been calculated based on the ratio of the catchment area situated in the Estonia and Russia correspondingly.

Aim of this work is to assess in more accurate way the share of Russian territory in the nutrient load formation coming with the river Neman and its branch Matrosovka canal to the Baltic Sea, with view to come up with the recommendation how to estimate this share on regular basis and ensuring measuring Russian progress in meeting revised CARTs.

3.2 Overview of the existing methods for calculation nutrient load from the catchments basins

3.2.1 List of the existing methods

Inflow of the dissolved substances in rivers represents the integral characteristic of the chemical composition of surface waters formation process. In natural conditions it is defined by physico-chemical and biological processes intensity, actively occurred in the contact zone between water and crust of weathering; in techno genesis natural background values changed in connection to the anthropogenic pressure.

Nowadays the questions of the waterborne nutrient inputs to the Baltic Sea and its sub-basins received much attention.

Currently there are two approaches for assessment of the waterborne nutrient load. According to the approach pointed in [2,52,53,49,26, 35-38], the external load from the catchment area on the water body defined (system " catchment - river"), which consists of the load from point sources and diffuse sources, includes calculation of the load retention coefficients by the catchment. In addition, the origin of the load determinate as anthropogenic or natural. So the main process of such approach is quantitate assessment of the internal load from the catchment area on the water body, which finally formatted the nutrient input via rivers to the sea. The essential condition for practical using of this approach for real water objects is presence of the information concerning main nutrient sources in the catchment.

The following methods are based on the above mentioned approach:

1) Method for calculation of the nutrient input and for assessment of the perspective small rivers pollution status. 0212.19-99 [54]. Method elaborated for the natural conditions of the Belorussia and for small ecosystems, that is why within this task it’s applying seems inappropriate.

2) Landscape-Hydrological method for evaluation average long-term multiyear characteristics of nutrients emissions in the ravine and the riverine network of small flat river [55]. Feature of this method is that the analysis of modern approaches for assessment the performance of mainly diffuse pollution of water bodies implemented by author, noted the advantages and disadvantages of these methods for calculating them, as "the leaching coefficients", physical and statistical, mathematical modeling. Since the author considers mainly diffuse sources of nutrient runoff, the use of this method will not fully display the flow of nutrients within the studied watersheds.

3) Model of nutrient inputs from the catchment area based on FyrisNP model version 3.1 of the Swedish Institute of Agricultural Sciences. Model successfully tested on the Pregolya river catchment in the Kaliningrad region [2, 52] and can be used in this work. However, it is worth to consider, that the model developed for the Southern regions of Sweden, so some of the components of nutrient runoff, such as nutrient runoff from agricultural areas may be overstated.

4) ILLM - nutrient load model. Nutrient load model ILLM (Institute of Limnology Load Model) developed at the Institute of Limnology RAS [26, 35-38] and is used to calculate total external load of nitrogen and phosphorus on the common water bodies from the catchment. Model takes in to account existing limitations in information provided by the state monitoring system of water bodies and state statistical reporting on wastewater discharges and agricultural

activities in the catchment areas in the North-Western Federal District of Russia. The model takes into account the contribution of point and nonpoint sources in the form of nutrient loading on the catchment area, allows the calculation the removal of impurities from the catchment, including influence of hydrological factors and retention of nutrients by watershed and hydrographic network, while also taking into account the mass exchange with the atmosphere. The final result of the simulation is quantitative assessment the nutrient load to the water body from the watershed and its individual components. Step of the calculation is 1 year, which is explained by annual resolution of the initial information and HELCOM requirements for reducing the average annual values of load to the Baltic Sea. The model has been verified in several objects located in the Russian part of the Gulf of Finland catchment. Currently, the model successfully used to solve the problems of assessing the nutrients runoff from the catchment areas and selecting the possible ways of load reducing on water bodies [53]. According to the results of the EU BaltHazAR II project component 2.2 (2012) "Building capacity within environmental monitoring to produce pollution load data from different sources for e.g. HELCOM pollution load compilations” [57] concluded that "for a preliminary assessment, the ILLM model can be used to calculate the nutrient load on the Baltic Sea from non-monitored and partly-monitored areas in the Russian part of catchment area". Thus, to achieve the goal of this work it is recommended to conduct the assessment using a model developed at the Institute of Limnology RAS [58].

Alternative method for assessing nutrient load from the reservoir to the receiving watercourse is the approach pointed in [50,51,39,42], suggesting the nutrients and organic matter transport through the watercourse outlet located as close as possible to the mouth and observe the flow of nutrients from the catchment area. In this case, the resulting nutrient load will reflect the sum of the natural and anthropogenic components. The amount of nutrient retention by the catchment can be estimated only approximately based on the water quality in the cross-sections above and below the main point and diffuse sources of nutrient. Given the fact that there are almost no natural areas on the catchments of many rivers within the European part of the Russian Federation, the natural background part of nutrient load in this case is extremely small, and the main burden will be formatted due to anthropogenic factors. Thus, riverine nutrient load can be conditionally accepted as formed by the anthropogenic component.

It should be noted that the use of this method requires less of the actual data (only hydrological and hydrochemical monitoring data in river outlet is necessary), however this method characterized by a lower information content and structural properties. Thus, it is practically impossible to estimate the amount of nutrients and organic matter retained on the surface catchment, it is difficult to determinate the share of anthropogenic and natural load in the overall load with watercourse, moreover it is impossible to assess the background load using only this method.

Description of this method contained in the directive document "RD 52.24.748-2010. Guidance document. Improved method for determination of pollutants runoff with rivers" (approved by RosHydroMet 11.11.2010) [56]. For carrying out calculation using this method the long-term hydrochemical and hydrological data for the considered (background and control) cross-sections in needed. In addition, this method allows to determinate only the anthropogenic load and that is clearly insufficient to implement this work.

Thus, to implement the objectives of the study (a realistic assessment of Russia's contribution in nutrient load formation coming with river Neman to the Baltic Sea, and clarifying values of necessary reductions in nutrient loading from the Russian part of the Baltic Sea catchment area), preferably using methods allowing evaluation of all nutrient runoff components from the catchment. This will contribute to more objectively evaluation of the existing load to the Baltic Sea from the Russian part of the catchment and to more grounded evaluation of the needed reducing. Obviously, to accomplish the task it is appropriate to use the model for calculation of nutrient load, prepared in accordance with the recommendations of the Helsinki Commission and calibrated almost at all major watersheds of the North-West of Russia [26, 35, 38, 41, 53, 58, 59, 63], as well as permissible to use for calculating the approximate nutrient load for geographically close watersheds, particularly for Kaliningrad region river basins.

3.2.2 General conditions of the “Methodic for calculating background nutrients runoff from the catchment area of the Baltic Sea -ILLM – nutrient load model [37, 38, 53]

3.2.2.1 General information and main definitions

Based on the ToR requirements, primarily, it is appropriate to consider "Methodic for assessing nutrients retention in monitored rivers systems in the Russian part of the Baltic Sea catchment", developed on the basis of the HELCOM recommendations, adapted and tested by the group of authors [26, 35, 36 37, 38].

As the methodic for calculation nutrient load retention by the hydrographic network of the catchment the scheme of the calculation, pointed in HELCOM Guidance for pollution load compilation has been used, which allows to estimate total average annual nutrient retention by the hydrographic network and catchment without detailed investigation of influence separate rivers and lakes, as well as interannual deviations of the studied process.

Nutrient load on the water object [25] – the amount of nutrients released to the reservoir during the reporting interval, calculated per unit water area or volume of water mass - a permanent factor in determining the quality of water, affecting the chemical composition of the sediments and hydrobiological processes.

Point sources [25] – Municipalities, industries and fish farms that discharge (defined by location of the outlet) into monitored areas, unmonitored areas or directly to the sea (coastal or transitional waters).

Diffuse sources [25] - Sources without distinct points of emission, e.g. agricultural and forest land, natural background sources, scattered dwellings, atmospheric deposition (mainly in rural areas).

Natural background losses [25] – Losses from unmanaged land and that part of the losses from managed land that would occur irrespective of anthropogenic e.g. agricultural activities.

Substances run-off from the catchment [25] – amount of the substance, carried out from the catchments borders with rain and snowmelt runoff per time unit.

Rate of the run-off – The amount of the substance, carried out from area unit with rain and snowmelt runoff per time unit.

Retention – The amount of a substance lost/retained during transport in soil and/or water including groundwater from the source to a recipient water body. Often retention is only related to inland surface waters in these guidelines.

Runoff depth – Rainfall depth on the catchment area without run-off loses (filtration, evaporation) per time unit.

Unit discharge – Volume of the flowing rainfall and snowmelt waters per area unit and per time unit.

Hydraulic load of the water object – Increasing of the water level in the water object due to inflow per time unit.

3.2.2.2 Calculation method

1. For calculation phosphorous total (Ptot) and nitrogen total retention (Ntot) by the catchment area L_{ret} [t/a] the following formula used [26, 27]:

$$L_{ret} = (1 - R_r) \cdot L_{tot} = R_t \cdot L_{tot} \,, \qquad (1)$$

where R_r - dimensionless retention coefficient,
R_t - dimensionless emission coefficient,
L_{tot} – total load on the catchment area [t/a].

2. Quantitative assessment of retention and emission coefficients carried out using following correlation [27, 28, 35-37, 59]

$$R_t\ (P_{tot.}) = 1 - R_r\ = \frac{1}{1 + a_1 q^{b_1}},$$

$$R_t\ (N_{tot.}) = 1 - R_r\ = \frac{1}{1 + a_2 HL^{b2}}, \qquad (2)$$

where HL – hydraulic load [m/a],
$a_{1,2}$ and $b_{1,2}$ – dimensionless empirical parameters (Table 3.1).

Table 3.1 Values of the empirical parameters in the formula 2 [27, 28, 37, 59]

Parameter	Catchment area	a_2	b_2	a_1	b_1
$P_{tot..}$	For all catchments	13,3	-0,93	26,6	-1,71
	<1000 km^2	57,6	-1,26	41,4	-1,93
	1000 – 10000 km^2	9,3	-0,81	21,7	-1,55
	>10000 km^2	26,9	-1,25	28,8	-1,80

N_{min}	For all catchments	5,9	-0,75	-	-
	<1000 km^2	3,3	-0,65		
	1000 – 10000 km^2	4,4	-0,62		
	>10000 km^2	10,9	-0,94		
$N_{tot.}$	For all catchments	1,9	-0,49	-	-

3. Value of the hydraulic load HL proportional to the unit area discharge q [l km^{-2} sec^{-1}] and inversely to the relative water surface area W [% of the total catchment area]:

$$HL = \frac{3.15\,q}{W}$$

(3)

For the whole Neman catchment area W=3 % [59], for the catchement area within Kaliningrad region– 2 % [4, 15, 21].

4. Value of the unit area discharge q [l km^{-2} sec^{-1}] linked with depth of runoff y [mm/a] by the following formula

q = 0,03171y.

(4)

Value of the depth of runoff y from whole catchment or its parts may be determinate in accordance with results of the in-situ measurements, and calculated in accordance to relative distribution function or hydrological model. Average long-term flow (modulus of flow) constitute about 220 mm/a for Kaliningrad region. For the Neman catchment area 250 mm/a [21].

5. Total load on the catchment area (L_{tot}) calculated using following formula:

$L_{tot} = L_p + L_e + L_{mf} + L_{of} + L_{pop} + L_a - L_c$.

(5)

where: L_p - loads from point sources;

L_e - diffuse emission of nutrients from various types of land surface;

L_{mf} - load from mineral fertilizers;

L_{of} - load from manure;

L_{pop} – load from population;

L_a - atmospheric deposition,

L_c - crop uptake.

All terms in equation (5) have the dimension [t/a].

6. The main point sources of pollution are wastewater discharges from industrial and municipal WWTP. The official source of data on sewage discharges are statistical forms ("2TPVodhoz") of the Ministry of Natural Resources and Ecology. These data are presented as annual averages.

7. The diffuse load on catchment from the emission of nutrients from various types of land surface (natural and anthropogenic) Le is calculated as follow:

$$L_e = (C_f y_f A_f + C_u y_u A_u + C_{nat} y_{nat} A_{nat} + C_{mix} y_{mix} A_{mix}) / 1000,$$

(6)

where C_f , C_u , C_{nat} and C_{mix} – are the specific concentrations of nutrients in runoff from actively cultivated areas, urban areas, the natural land surface and mixed areas, accordingly [mg/l=g/m^3],

y_f , y_u , y_{nat} and y_{mix} – are depths of runoff from corresponding type of the underlying surface [mm/a],

A_f , A_u , A_{nat} и A_{mix} – are the areas of the mentioned types, respectively, of a land surface [km^2].

Value of C_f , C_u , C_{nat} and C_{mix} presented in the Table 3.2.

Table 3.1 Concentration (mg/l) Ptot. and Ntot. in soil water and primary hydrographic network for different types of underlying surface [30, 31, 32]

Underlying surface	Mixed	Natural	Arable land	Urban land
P_{tot}	0,12	0,05	0,08	0,20
N_{tot}	1,4	0,7	3,1	2,3

7.1 Value of the depth of runoff y from whole catchment or its parts may be determinate in accordance with results of the in-situ measurements, and calculated in accordance to relative distribution function or hydrological model. For the Neman catchment area 250 mm/a [21]. For mixed, natural and cropland the value of runoff 250 mm/a supposed to be used for river Neman. For urbanized areas values for the cities located in the basin of river Narva [46] have been calculated: 732.33 mm/a; 730.5 mm/a; 744 mm/a. For calculations it is useful to take 735.6 mm/a by applying it to urban areas located in the basin of river Neman, given the relative geographic proximity between watershed district of Neman and Narva.
7.2 Load on the catchment, formatted by the mineral fertilizers applying L_{mf} defined based of the state statical reporting.
7.3 If we assume that the whole manure, formed on farms and poultry remaining within the catchment, than L_{of} can be approximated as follows (7):

$$L_{of} = \sum_j k_{f\,j} N_j / 1000,$$

(7)
where k_f – the coefficient of emission Ptot or Ntot by one animal j [kg/a],
N – the number of animal j.
Values of the k_f coefficients for different animals present in the Table 3.3.

Table 3.2 Coefficients of emission to surface waters of Ptot or Ntot [kg /a], by one animal [33].

Animal	P_{tot}	N_{tot}
Cows	18,9	77,1
Pigs	3,36	14,4
Poultry	0,28	1,14

Approximate assessment of the diffuse nutrient load on the receiving water object, originated form population (country inhabitants, in settlements without sewage system) L_{pop}, can be made with annual averaging using following formula:

$$L_{pop} = \sum_j k_{pj} N_{p\,j} / 1000,$$

(8)
где k_p – coefficient of emission by one inhabitant [kg/a]; for $P_{tot.}$=0,033 kg/person a year [63], for $N_{tot.}$=5 kg/person a year [64].
N_p – number of country inhabitants, in settlements without sewage system and WWTP. In this work for calculating the size of the total rural population has been used due to the fact that in Russia the majority of rural settlements have no sewage system and also have no treatment. In some cases there are septic tanks, but the number of such systems nowadays very little.
It should be noted that in this work nutrient load generated by organic fertilizers - is a potential maximum value of the load with the full use of all manure, formed within the catchment, as

fertilizer for agricultural land. Possibly, the result will be overestimated relative to reality. However, in the conditions with absence of reliable information or sufficiently problematic to get this information about nutrient flows within the catchment, this assumption seems to be most appropriate for this work [53].
7.4 Phosphorus load formed by atmospheric deposition ($L_a = \alpha$ A), is given according to field observations α = 0,002 – 0,005 t/a*km^2 [26, 29].
7.5 L_a value for nitrogen load assumed to be zero based on the assumption on the equality of the values of nitrogen deposition from the atmosphere (precipitation rate with + fixing biota) and volatilization as a result of denitrification [28].
10. For the estimation of the uptake of nutrients from the catchment with crop Lc the following equation is used: [53, 59, 63]:

$$L_c = \beta \cdot U \cdot A_f ,$$

(9)
где β – is the crop uptake [t/ a*km^2];
A_f – is the area of actively cultivated fields [km^2].
U – crop capacity [t/a*km^2]
Results crop uptake calculation for the fields in the Leningrad region in the 2007 present in the Table 3.4

Table 3.3 Nutrient uptake values with crops, calculated for Leningrad region for 2007. (2007, is similar to the mean hydraulicity year [34])

Crops	Area (hectare)	Crop capacity [centner/a*km^2]	Crop Ptot uptake [t/ a*km^2]	Crop Ntot uptake [t/ a*km^2]
Corn	29100	29.5	1,16	7,23
Potato	45700	140	0,92	7,00
Vegetables	6900	326	1,42	9,78
Fodder	212400	326	1,42	9,78
Average for catchement			1,32	9,10

3.3 General characteristic of the Russian part of the Neman river catchment

3.3.1 Natural features of the Neman river basin and its tributary river Shesupe

One of the biggest river systems in the eastern part of the Baltic Sea is river Neman. Fisheries significance Neman river is determined by two factors. Firstly, it is the habitat of a number of anadromous and semi-anadromous fish species, with their places of spawning, feeding and wintering . Secondly, fish reproduction in the Curonian Lagoon is largely dependent on the conditions of spawning in the Neman river [45] for a number of fish species.

However, Neman river experiencing significant anthropogenic impact. Pollutants and nutrients in the Lower Neman collected from enormous territory - Belarus, Lithuania and Russia. Because of these and other reasons, the environmental conditions in the lower reaches of the river deteriorated. This is indicated by long-term monitoring data, observed pollutants concentrations, as well as changes in fish communities, population and environmental condition [45].

Neman (Nemunas) river basin located in four countries. The river originates in the Republic of Belarus, the origins of some of its tributaries, in particular, river Sheshupe, is the territory of the Republic of Poland. In its middle Neman river flows through the territory of the Republic of Lithuania, in the lower part - on the territory of the Kaliningrad region. Its falls into the Curonian Lagoon of the Baltic Sea. In the lower reaches at the distance about 100 km the Neman (Nemunas) river become the border between the Kaliningrad region and the Republic of Lithuania (Figure 3.1).

Figure 3.1 - Schematic map of the river basin. In the lower reaches of the Neman **river** (**Kaliningrad region** river basins**:** **№** 11. Neman river basin**:** 11.1 Basin of the in the eastern part of the Curonian Lagoon (canal Matrosovka**,** ch**.** Golovkinsky**,** r**.** **Shluzovaya,** r. Chlebnaya**,** r**.** Uzkaya, r**.** Shirokaya , r**.** Zaychiaya**,** r**.** Ulitka**,** r**.** Zlaya**).** 11.2 Basin of the Sheshupe river

River flow overregulated. Downstream the 240 km from mouth the net of Velno-Tiltas nicks (extent 4 km) is situated.

In pre-mouth part (downstream Sovetsk city, in 48 km form the mouth) the river Matrosovka, discharged to the Curonian Lagoon, separated from the Neman river. River Matrosovka by the Nemonin and Primorskiy canals (7-8 km form the mouth) in two places connected with river Nemoninkoy through Nemonin and afterwards through Polesskiy canal with Deyma river.

Deltaic lowlands area of about 2000 square km, its level varies from 0.4 m to 5.0 m, rarely up to 10.0 m above sea level. Deltaic plain has two hypsometric levels: modern delta (0.5 - 2.0 m above sea level) and the ancient delta (16-20 m above sea level).

Almost all the rivers in the Neman delta and in the Curonian Lagoon basin connected by channels, forming a single reclamation system. Most rivers canalized, they receive the water pumped from the polder lands. The natural state of the river has undergone great changes.

The left bank of the delta is protected from flooding during high by the earthen dams which extend for tens of kilometers along the southern shore of the main branch of the Neman, the gulf coast and on both banks of the river Matrosovka. Dam’s height gradually decreases from 4-5 m in the delta top to 2 m on gulf coast. In Neman delta there is an open drainage network with mechanical water lifting.

There are many rapids and shoals which impede navigation in the beds of the Neman and Matrosovka. To maintain the required depths beds are straightened and narrowed by special dike dams, due to which the flow velocity increases in the main course and deposition of river sediment near the shallows decreases. Dike dams also ensuring more stable position of the bed.

Neman (Nemunas) river basin has a very extensive hydrographic network. Throughout its length the river receives many tributaries, which, in their turn, have tributaries of the second, third and higher orders. The largest tributaries of the main river: right bank - Minia, Jura, Nyavezhis, Vilia (with r.Shvyantoyey) Merkys etc.; left bank - Tylzha, Sheshupe etc.

Length of the river Neman is 937 km, the catchment area is 98.2 km^2 (to Sovetsk city- 91.8 km^2) (Tables 5,6). The maximum width of the river at low water can reach 180-350 m; during floods the river spreads to 1-1.5 km, and on the right bank of the delta (without bank up)- up to 5 km. Depths on reaches are 3-4 m and 1.5-2.5 m on the shallows. Average flow velocity in the shallows of 0.8 - 1 m/s , on reaches 0.6-0.8 m/s . During flooding Discharge increases up to 1.5 m/s or more. Close to the mouth river flow velocity gradually decrease [17]. The average value of the slope of the river in the upper stream 0,16 ‰, on average - 0,23 ‰ and in lower - 0,10 ‰ [43].

Table 3.4 General information about river Neman water resources

River	Receiving water object	Leigh, km		Catchment area, km^2	Annual water volume, km^3
		Total	In Kaliningrad region		
Neman	Curonian Lagoon	937	115	101000 (mouth)[21]	25,1
Sheshupe	Neman	308	102	6120	0,52
Watercourses of the Neman delta	Curonian Lagoon	-	-	2375 [44]	-

Table 3.5 Neman river catchment area [43]

Total Neman river catchment area, km^2	Country	Catchment area, km^2	Share of the catchment area, %
98200	Lithuania	46795	47,7
	Belorussia	45600	46,4
	Russia	3132	3,2
	Poland	2554	2,6
	Latvia	98	0,1

Neman - river of the flat type, with mixed feeding and predominance of snow feeding. Share of snow feeding decreases from east to west, while the contribution of rainwater and groundwater increase. The role of snow feeding increases in years with severe, prolonged, snowy winters; in years with warm and average winters the contribution of rain feeding increases. Similar effect occurred in connection with dryness of the year: in dry years, when little rain falls, the importance of snow feeding increases.

The average annual water flow before branches separation - about 600 m^3/s (Figure 3.2). Of these, approximately 10% flows through the river Matrosovka and about 55% over the river Severnaya (Skirvite) and about 35% - over the river Atmata [17]. Long-term average run-off rate on the territory of the Republic of Lithuania increased from 6.1 to 6.7, within the Kaliningrad region its decrease to 6.3 $l/s^* km^2$.

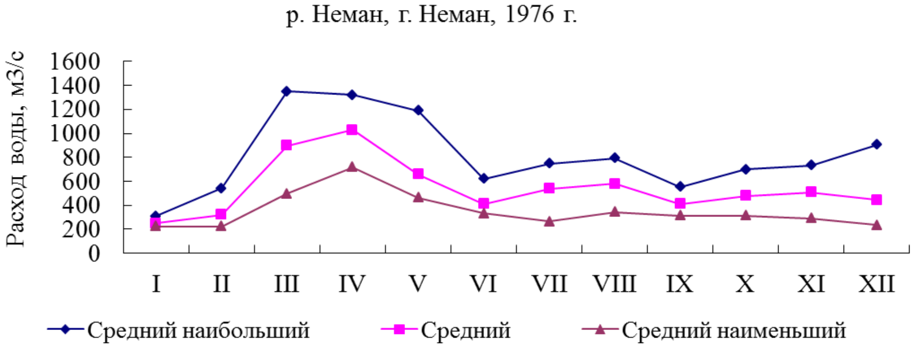


Figure 3.1 – Specific Neman river flows value [7, 8] (blue line – average[1] maximum; light pink line – average; dark pink line average minimum)

Water regime of the rivers in the Neman basin is characterized by spring high-watre, summer and winter low-water periods, as well as by summer, autumn and winter floods. The maximum flow in Lithuania occurs in April, in Sovets city - in March. Winter runoff (December - February) - minimal and supported by floods. The ratio between the spring and summer-autumn period is determined by the with dryness of the year (Figure 3.3).

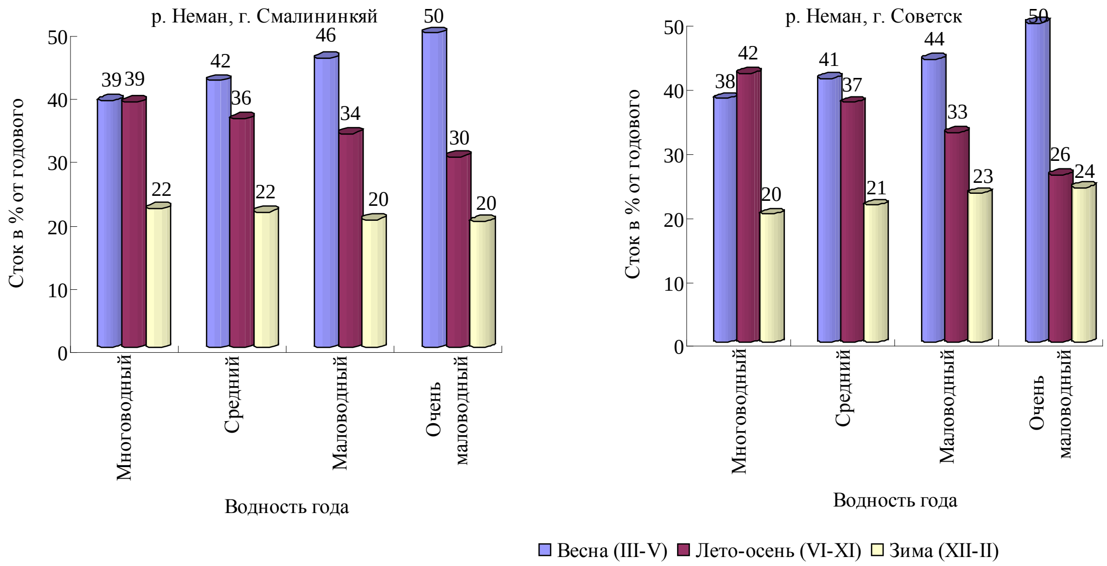


Figure 2.3 - Calculated seasonal flow distribution[2] in the % to annual in the Neman river depending on the dryness of the year [21] (blue bar – spring; pink bar – summer-autumn; white bar – winter)

[1] Illustrated hydrograph was built based on data, presented in State Water Cadastre with the date of publication of 1988 (volume 1, issue 4), which collects the long-term data of regime and resources of surface waters of the USSR. In used State Water Cadastre are given the actual values of the monthly flow rate for the River Neman in the river station of Neman city for 1976. Thus represented hydrograph was built using 1976 data

Winter low water lasts from early December to early March. It is characterized by the passage of high floods during the frequent and long-on thaws. Height of flood waves depends on the snow amount and intensity of snowmelt. In abnormally warm winters the passing of two or three flood waves is observed.

Spring floods in the middle and lower parts of the river normally occurs in March, ends in May. Flood peak occurs at the end of March - beginning of April. The average duration of the flood is about 60, minimum duration - more than 30, maximum 90 days. Passing of several waves is feature of the spring flood, which caused by the nature of snowmelt throughout the basin. In years with early flood the level rise interrupted by cooling, so flood prolonged. Recession spring high water occurs slowly and usually interrupted by first rain floods.

The transition to the summer low water occurs smoothly. Summer-autumn low water lasts on average from early June to the end of October. Low-water unstable, interrupted by rain floods. Run-off gradually decreases from June to September, but in wet years in this period, it may increase [21].

In autumn due to heavy rains there is a smooth increase in run-off and water levels, which leads to prolonged flooding. Autumn floods, compared to the summer, more persistent, but the height of the rising somewhat less: 0.5-1 m in the middle and 1-2 m in wet years [17].

Spring water heating usually begins in March and continues until July-August. In some years the water temperature in summer can rise to 28-30° or more. Since the beginning of the cooling temperature drops smoothly and mostly at night. By day it remains unchanged or even increased by 0,1-0,3 ° due to the heat produced by water surface as the result of solar radiation absorption. In December, the intensity of the cooling water increases.

When water temperature is 0,3-0,4° C the shore ice appear, at 0,2° C begins autumn ice drift. Water temperature freeze at 0,0 - 0,2° C. In some years during the winter river opening water temperature may rise to 2 ° and above.

First ice formations (shore ice, sludge ice) appear, on average, in early December, in cold years in late October - early November, in the warmest - at the end of the second decade of January. During approximately a month the first ice formations often changed to the pure water due to the instability of the thermal regime.

Freeze-up is usually established in mid-December. The earliest frost was observed at the end of the first decade of November. In some years, when the first half winter is characterized by frequent thaws, freezing of the river installed only in late January - early February. Often thaw, even in midwinter cause temporary opening, movements of the ice, sometimes cleaning of river from ice.

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[2] Diagramms were built according to the source presented in the source list under № 21: Surface Water Resources of the USSR, edited by V.E. Vodogretskogo. “Surface water resources of the USSR” - a series of monographs representing scientific compilated data on rivers regimes, lakes and reservoirs, wetlands, as well as guidelines for calculating the elements of the water regime, both in the presence and in the absence or insufficiency of observations. In this source all data are presented based on material on the rivers regime at the stations of the Hydrometeorological Service and other agencies for the period from the beginning of their actions till 1962. For alignment the Neman River (Smalininkai town) reporting period - 150 years, for the alignment in the Sovetsk town - 17 years (Table 46, page 88).

Maximum thickness of the ice and the timing of its occurrence vary depending on the severity of the winters. In mild winters, the thickest ice - 10-15 cm, observed in the first week of February. In mild and severe winters ice in late February - early March usually reaches a thickness of 30-40 cm, sometimes 45 cm. Exceptionally massive ice cover observed in severe winters - ice thickness can reach 60 - 75 cm [21].

Duration of the ice period from the first ice formations until the last day of ice is an average of 3.5 months, the lowest - about one, the highest - more than 5 months.

Sheshupe river is a first order left tributary of the Neman river. Its catchment located in the three coutries. Derived from the lake in the Republic of Poland. Moving north, above the Calvary city, where enters the territory of the Republic of Lithuania. Bypassing of Kudirkos Naumiestis city it turns to the Kaliningrad region, where by the considerable distance flows along the border between Russia and Lithuania. Approximately 55^0 it move away from the border and flows in general direction of the west. Bypassing the village Livensky it makes a big loop to the south, then from the village Tushino, flows to north up to discharge in the river Neman.

Sheshupe (Šešupė) third longest (298 km) and the fourth largest by catchment area (6105 km^2) Neman river tributary discharging to it from left side in 85 km from the mouth. Lithuania currently owns 80% (4899 km^2) of catchment area and 53% (158 km) of the river length. Upper course of Sheshupe river (27 km, basin area 287 km^2) situated in Poland, the western part of the median and the lower parts of the river (62 km, 919 km^2) - in Russia, with which Lithuania also shares 52 km of the border bed. About 8% of the Sheshupe basin area consists of swamps, mainly lowland.

Sheshupe basin includes 269 lakes (larger than 0.5 ha) with a total area of it is 68.2 km^2, (lake presence 1.1%). 57 lakes (10.5 km2) situated on the Poland territory, Russia owns 11 lakes (0.98 km^2).

Sheshupe has 13 tributaries, with length more than 20 km, the longest of them are follows: Nova (length 69 km, catchement area 403 km^2), Sesartis (60.5 km, 198 km^2) Pilve (57 km, 330 km^2) dovin (47 km, 589 km^2), Vishakis (44.5 km, 333 km^2), Širvinta (44 km, 1313 km^2). Average flow value in the mouth of the Sheshupe river reaches 34.2 m^3 / s. In dry summer conditions river becomes strongly shallow [45].

As the main river, Sheshupe refers to the flat rivers with mixed feeding, but the distribution of its individual components is much more uniform: the share of rain falls is 37 - 48 %, the snow (spring runoff) - 26 - 37%, ground waters - 16 - 37% [21]. Contribution of snow feeding increases in years with severe, prolonged, snowy winters, whereas in years with warm and average winters the share of the rain increases. A similar effect occurs due dryness of the year: in dry years, when little rain falls, the importance of snow feeding increases.

Annual average flow value for river Sheshupe according to long-term data, is 35.4 m^3 / s [17]. Mean annual runoff rate before entering the Kaliningrad region are: average - 5.6, maximum - 8.7, minimum 3.2 l / s • km^2. Downstream due to tributaries input, as well as due to reducing of the lake and swamp presence coefficient, these figures slightly increase.

Water regime of the Sheshupe river, as well as the main river, defined by climatic conditions, characteristics of the underlying surface (topography, wetlands, lakes, forests etc.), the type of water feeding and to some extent repeats the water regime of the main river. Spring snowmelt flood is high enough, in most dry years at this time flows constitute up to 73 - 77 % of the annual flow of the river; in wet years , this figure falls to 44%. Summer low water interrupted by rain floods. Autumn rain floods usually well expressed. In the summer- autumn season river carries more than 30% of annual runoff in wet years and only 11 - 8 % - in the most dry years. Sufficiently high floods caused by sharp and prolonged thaws, typical for the winter also, the water volume during this period in dry years exceeds the summer-autumn runoff.

As for the Neman, flow distribution in Shesupe river is largely dependent on the dryness of the year, but the ratio between the amount of runoff in different seasons differs from the main river. Summer-autumn run-off exceeds winter only in wet years, the average water flow during both these seasons is almost the same, and in the Kaliningrad region in winter the river slightly more abounding than in the summer-autumn season. In dry years, when little rain falls in the summer and autumn there is less water than in winter, while near village Dolgoe winter runoff twice as much that summer and autumn (Figure 3.4).

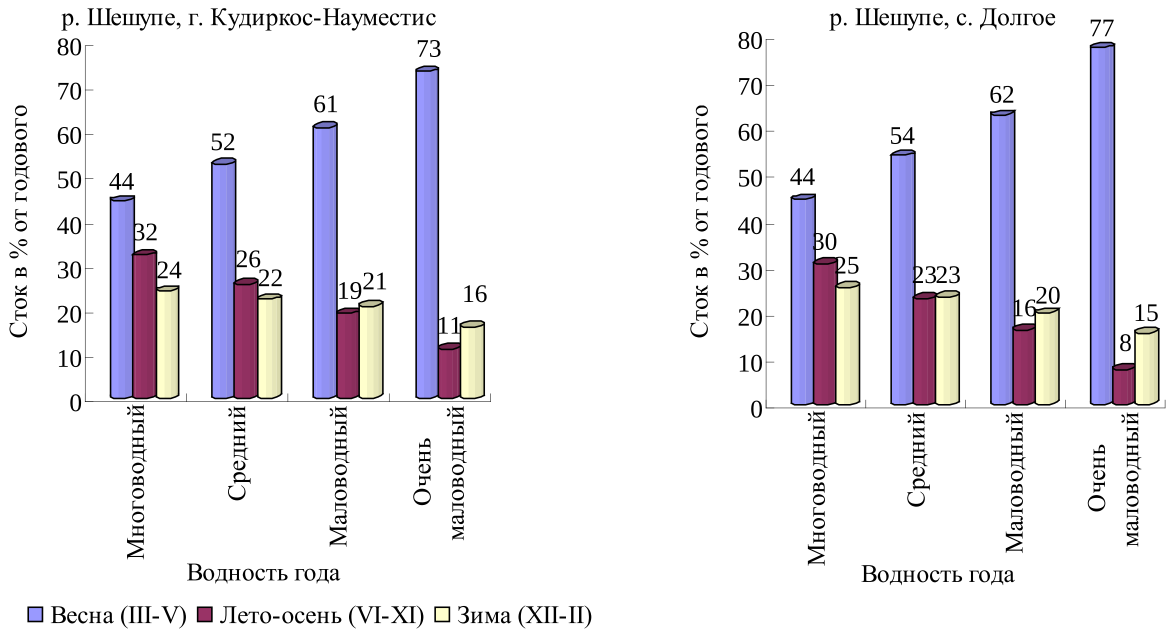

Figure 3.3 – Calculated seasonal flow distribution in the % to annual in the Sheshupe river depending on the dryness of the year.
(blue bar – spring; pink bar – summer-autumn; white bar – winter)

Spring flooding , according to average long-term data, usually begins in mid-March and ends in late April - early May , the average duration of floods is 50 days, the maximum may exceed 70 , the lowest - less than 20 days . With early snowmelt flood more lengthed , its first decline interrupted by rain floods .

Low water summer-fall lasts on average from mid- June to the first decade of October , winter - the last days of December to early March . During the drought period is usually observed several floods due to rains.

Sheshupe river is characterized by large (up to 5-6 m) amplitude of the annual level fluctuations.

Temperature conditions, in general, the same as for Neman river in the middle and lower parts. Beginning ice appearance (frazil ice drift) occurred in the first half of December, freezing set in the third week of December, spring break begins in mid-March.

3.3.2 Hydrochemical features and water quality

According to the Scheme of complex use and protection of water bodies for Kaliningrad Oblast (Table 3.7) , concentrations of the BOD5 and COD exceeds maximum allowable concentration all along Neman river (including Sheshupe river). However there is no exceeding of phosphates phosphorous concentrations. Concerning the ammonia nitrogen concentrations there are several exceeds in the Neman river after main cities. The nitrite nitrogen concentration higher that maximum allowable concentration only in the Shesupe river near village Dolgoe.

Table 3.7 Diagnosis of water quality in water bodies

River, cross-section	Dissol. O_2, mg/l	BOD_5, mgO_2/l	COD, mgO/l	N-NO3, mg/l	N-NH4, mg/l	P-PO4, mg/l
Maximum allowable concentration - fishery use	**>6**	**2.0**	**-**	**0.02**	**0.4**	**0.2**
Maximum allowable concentration - water use	**>4**	**2.0**	**15.0**	**-**	**1.5**	**3.5**
Maximum allowable concentration – animal drinking	**>4**					
Maximum allowable concentration recreation	**>4**	**4.0**	**30.0**			
Neman river catchment						
r. Neman, 0,5 km upstream Neman city	11.0 / 8.8	3.01 / 3.77	30.35 / 36.63	0.02 / 0.05	0.37 / 0.65	0.06 / 0.08
r. Neman, 2 km downstream Neman city	10.5 / 8.3	3.24 / 4.07	35.01 / 39.87	0.02 / 0.06	0.42 / 0.79	0.06 / 0.09
r. Neman, 1,5 km downstream Sovetsk city	10.1 / 8.0	3.59 / 4.80	35.70 / 40.20	0.02 / 0.07	0.48 / 0.93	0.07 / 0.10
r. Shesupe Dolgoe village	10.0 / 7.1	3.08 / 4.07	32.36 / 38.03	0.03 / 0.07	0.56 / 1.03	0.07 / 0.11

Note: The color of the cell shows excess regulatory compliance (different types of the Maximum allowable concentration); Values of water quality: the numerator - weighted averages; denominator - the maximum values (for dissolved oxygen - minimum value)

3.3.3 Socio-economic characteristics and sources of pollution of the Neman river catchment

According to the information for 1st January 2009 the population in the Russian part of the Neman river catchment constitutes approximately 120 000 persons, 58,3 % is urban population and 41,7 % rural inhabitants [43].
Neman river catchment partly includes 7th municipal districts of the Kaliningrad region (Table 3.8).

Table 3.8 Administrative units of the Kaliningrad region with Neman (outfall) and Shesupe catchments

Catchment area	Administrative unit	Area, km^2
Neman river (outfall part)	Polesskiy municipal district	300
	Nemanskiy municipal district	490
	Sovetsk	44
	Chernyahovskiy municipal district	217
	Slavskiy municipal district	1328
Sheshupe river	Nesterovskiy municipal district	342
	Krasnozmanenskiy municipal district	716
	Nemanskiy municipal district	46
Neman river	Krasnozmanenskiy municipal district	91
Total catchment within Russia	3574	

Industry in the Russian part of the Neman river basin developed insignificantly.

The main objects of human impact are two major pulp and paper mills located in the cities of the Soviet and the Neman cities, however according to the BASE Project report “Preparation of hot spots report including hot spot questionnaire” the influence of these enterprises are insignificant. Other possible sources are wastewaters from Krasnoznamensk, Nesterov (r.Sheshupe), Neman, Sovietsk (r. Neman). From surface water resources sectors of the economy uses about 5 % of surface runoff formed in the area and 0.6 % of the total runoff. Groundwater use is 32 % of the groundwater storage [43].

Characteristics of point sources in the Neman basin (including tributary Sheshupe) is presented based on the data [48].

Concerning the diffuse pollution, based on the several assessments, Kaliningrad region might be the source of the 30% of total load on the catchment for organic substances and total nitrogen [40].

For all Neman river catchment within Russian following sources can be referred to the categories diffuse:

- storm water run-off from urban areas, directly discharged to the water objects and do not counted in the storm water sewage system;
- run-off from agricultural land;
- emissions from animals;
- run-off from the rural settlements, which do not have sewage system and WWTP.

3.3.4 Polder lands and marsh complexes

Polders - drained and cultivated lowland stretch of coast. In the Kaliningrad region polders situated Slavskiy and Polesskiy municipal districts. To bleed-off excess of water the dense network of open and closed drainage structure and canals created. Part of polders due to constant flooding during floods and heavy rains, swamps and become unsuitable for agriculture, and forestry.

Thus, contemporary polder lands in the region become similar to natural wetlands ecosystems. It is worth noting that within the outfall part of Neman river catchement the largest marshes in the region are situated [4, 15, 22] - Gribben (3250 ha) , Olhovoe(4990 ha), Ostrovnoe (2300 ha), Tarasovskoe (5164 ha), as well as specially protected under the international program " Thelma "- Lauknenskoe (3723 ha) and Goat (1382 ha) [4]. In addition, in the delta lowlands are more than a dozen smaller area marshes - from 100 to 1,000 hectares. (Figure 3.5)

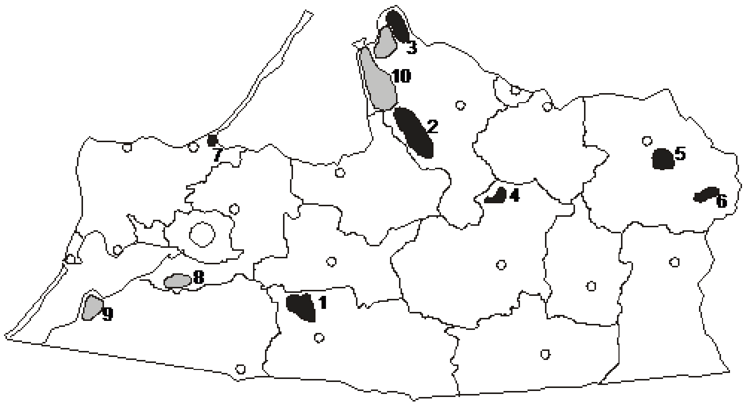

Figure 3.5 – Marshes within Kaliningrad region (2, 3, 5, 6, 10 - within the river Neman basin)

It must be taken into account that the structure of wetland ecosystems ensuring maximum retention of substances, particularly nutrients, on the surface of the catchment, which is important when assessing the flow of pollution from the catchment area into the receiving water object.

Nowadays swamp of the region very likely to the only natural ecosystems preserved in its natural state, so in this work marsh system, including the polder land, considered as natural territories.

3.4 Estimation of the nutrient load the Russian part of the Neman River catchment Area

1. By following the usable methodology [35-38] define the Russian part of the Neman River catchment area for the following calculations. Knowing, that within Russian Federation the Neman River drains the Kaliningrad region territory, define the coverage zones, which situated within the considered catchment area based on the estimations conducted by authors [44]. The Neman River catchment area within the Russian Federation is 3574 km^2 (Table 3.8).

2. Estimate the runoff rate value q [liters km^{-2} sec^{-1}] is necessary for the following calculations, which is correlated to the depth of y [mm year^{-1}]

$$q = 0{,}03171 \cdot y$$

q = 0,03171*250=7,928 liters km^{-2} sec^{-1}.

3. The hydraulic load value HL is in proportion to runoff rate q [liters km^{-2} sec^{-1}] and inversely to the relative area of the water surface W [% from the total catchment area]:

HL=3,15*7,928/2=12,487 m year^{-1}

4. Quantitative assessment of the retention factor *Rt* is:

Rt	Ntot.	$\frac{1}{1+1{,}9\cdot 12{,}487^{-0{,}49}}$,	0,645
	Ptot.	$\frac{1}{1+21{,}7\cdot 7{,}928^{-1{,}55}}$,	0,533

For biogenic substantion retention estimation the following formulas were chosen based on considerations. In the Frumin's and Get'man's paper (№ 59 in the list of sources) the updated and advanced R_t calculation formulas, with reference on the Behrendt's, Dannowski's, 2007 paper, are given. The similar improvements are mentioned in the Ershova's paper from 2013 (№ 53 in the list of sources), where the reference on the Behrendt's, Opitz's, 2000 methodology is given. With that, the a and b various values for the total phosphorous and total nitrogen are provided. Since for the total nitrogen the a_2 and b_2 parameters are given, therefore the R_t calculation was conducted using the recommended formula. For the total phosphorous R_t calculation it is possible to use both formulas. However, the formula with the use of empirical parameter a_1 and b_1 gives the bigger value of the retention coefficient. Therefore this formula was used for the total phosphorous retention coefficient calculation. As well, it stands to mention, the differences in retention coefficient, calculated using two different formulas, is insignificant – 0,081 (the estimations using both formulas are given below in the respective section.

The Timeframe for all calculated parameters - 1 year, it means all values which are used in formulas - annual average. The resulting retention coefficient for the Russian part of the Neman River catchment area has not been verified, as the calculations were made on the watershed for the first time. Verification of the model itself was carried out according to the watershed for the Leningrad region, as evidenced by numerous publications and abstracts of thesises. Given the fact that the Kaliningrad region is geographically close to Leningrad region, and together they estabilish the same (Northwestern) Federal District, it was decided to use this technique to calculate the removal and retention of nutrients from the Neman River catchment area. However, studying only some natural features of the Kaliningrad region the large retention coefficient can be simply explained. The slopes of considered part of the catchment area are small enough, that is why the mouth reach of the streams are in backwater of receiving waters, in some dry years or individual phases of the water regime (for example, in the summer runoff low) it is no flow into the bay at all. Watersheds between the tributaries of various orders made conditional, as some of this territory is below sea level at around -1 m. In addition, discharge of the watercourses to the Curonian Lagoon is regulated mechanically. So, only on the territory of the Nizhnenemanskoyl lowland more than 50 pumping.

Estimate summand expressions, which are characterize the summand load on the catchment (L_{tot}):

$L_{tot} = L_p + L_e + L_{mf} + L_{of} + L_{pop} + L_a - L_c$. [t year^{-1}].

where: L_p - load, developed by point sources;

L_e – dispersal emission of the chemical substances by different types of the underlying surface,

L_{mf} – load formed with applying the mineral fertilizers,

L_{of} – load formed by organic fertilizers,

L_{pop} – load from rural settlement, which don't have sewerage and treatment facilities,

L_a – the atmospheric load,

L_c – the chemical substances removal due harvesting,

The catchment load formed by point sources. The main point sources of surface water pollution are discharges of wastewater from industrial and municipal enterprises. The official source of information about wastewater discharges[3] are statistical forms 2TPVodhos by Ministry of Natural Resources and Environment. The data contained in these forms is given with annual average-out. L_p sets based on official statistics (Table 3.9). The load formed by point sources is calculated for the period of 2010-2012. Herein, only the mineral constituents is taken into account in the total phosphorus input, since the intake data of organic and gross phosphorus is lacked. The recordings of data for the mineral constituents are allowed to reduce the likely error of the estimations.

L_p ($N_{tot.}$)=20,0 t/year, L_p ($P_{tot.}$)=1,3 t/year.

[3] Contribution of point and diffuse sources is based on available statistical official data. Data on point sources are given in the form 2-TP-vodhoz, which in the course of this work was requested by the appropriate authorities of the Russian Federation. Information about point sources within considered catchment is shown in the table 3.9. As the basis for the diffuse sources data, first all the data about different land cover areas was used. Information about land structure and use within the catchment was collected as the result of analysis of the report "About land's state and use in the Kaliningrad region". Moreover, for obtaining maximum precise assessment the information available in the internet was considered, for example data, presented in the passports of municipal districts, which situated in the considered catchment.

Table 3.9 The layout of the data on the flow of nutrients from a set of point sources in the Russian part of the catchment area of the Neman River, t/year

Period for which information is available (2010/2011/2012)	Name of the point sources set	N tot.	P tot. (mineral constituents)
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge directly to the Neman River from the arm of the river to the mouth of the Sheshupe River	0 0 0	0 0 0
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge directly to the Neman River from the mouth the Sheshupe River to town of Neman	0 0 0	0 0 0
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge directly to the Neman River from the town of Neman to town of Sovetsk (town of Neman)	13,24 11,28 9,95	0,56 0,52 0,33
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge directly to the Neman River from town of Sovetsk to the mouth (town of Sovetsk)	54,4 57,13 89,00	0,94 2,79 2,48
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge directly to the Sheshupe River	6,57 1,53 0,97	0,11 4,22 0,12
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge to water objects of the Sheshupe River private catchment	17,55 10,76 19,92	0,37 4,36 0,28
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge to water objects of the Tilga River private catchment	0,13 0,07 0,07	0,01 - -
2010 year 2011 year 2012 year	The point sources, implemented wastewater discharge to water objects of the Matrosovka private catchment	0 0 0	0 0 0

Load on the catchment area formed by diffuse sources.

Calculate the load developed by atmospheric fall-outs ($L_a = \alpha A$), where α=0,003, A – area of considered catchment area, take equal to 38778 km^2, since the atmospheric fall-outs accounted for overall considered area:

L_a ($P_{tot.}$)=0,003*3574=10,7 t/year.

The value L_a for a nitric load takes to be equal to zero based on assumption about the value equality of the nitrogen intake from atmosphere (fall-outs + biota fixation) and losses in response to denitrification.

The calculation L_e (dispersed emissions of the chemical substances by various types of underlying surface) is as follows.

$$L_e = (C_f y_f A_f + C_u y_u A_u + C_{nat} y_{nat} A_{nat} + C_{mix} y_{mix} A_{mix}) / 1000,$$

where C_f , C_u , C_{nat} и C_{mix} – average concentrations of the biogenic matter in the drainage from the field, urbanized area, natural underlying surface, combined territory correspondingly [mg dm^{-3}= g m^{-3}],

y_f , y_u , y_{nat} и y_{mix} – depth of runoff from the listed underlying surface types [mm $year^{-1}$],

A_f , A_u , A_{nat} и A_{mix} – areas of the listed underlying surface types [km^2].

The values of the parameters are presented in Tables 3.10 and 3.11.

The calculation of data for the corresponded areas with the different types of underlying surface was conducted based on official statistic data, published in the public and accessible for general public sources [9, 22, 43, 48, 67]. Herewith, the following types of soils are reckoned to the combined territory: reserve lands, disturbed soils, rural soils are not used in the agricultural sector and marked as “others”. The natural territories are divided to soils, occupied by forest vegetation, peat land complexes and polder soils, as well as soils under the water.

The information regarding the soil categories and their distribution across the administrative-territorial units are given in the municipal district certificates, available in internet, for example, http://polessk.gov39.ru/-l-r.

Table 3.10 The areas of different underlying surface types within the Russian part of the Neman River catchment area, required for the calculation of the dispersed emissions of the chemical substances by various types of underlying surface

Administrative-territorial unit within the basin	Crop lands (agricultural lands), km^2	Natural territories, km^2			Combined territories, km^2	Urbanized territories, km^2	Total, km^2
		Forests	Peat lands[4] and polder soils	Soils under water			
Polessky district	118,2	146,5	0,8	5,8	9,2	19,7	300
The town of Sovetsk	-	-	-	-	-	44	44
Slavsky district	64,2	369,8	667	44,3	91	92	1328
Nemansky district	457,5	29,2	-	3,8	7,2	38,4	536
Nesterovsky district	215,6	91	-	2	7,6	25,8	342
Krasnoznamensky district	400	202	-	3	92	110	807
Chernyakhovsy district	100	20	-	3	14	80	217
Total, km^2	1356	859	668	62	221	410	3574

Table 3.11 Parameters, required for the calculation of the dispersed emissions of the chemical substances by various types of underlying surface

Underlying surface		Combined	Natural	Crop lands (agricultural lands), km^2	Urbanized territories, km^2
C, g/m^3	$P_{tot.}$	0,12	0,05	0,08	0,20
	$N_{tot.}$	1,4	0,7	3,1	2,3
У, mm/year		300	300	250	735,6

Kondrat'ev S.A. and his co-authors [36-38] proposed précised parameters for the calculation of the dispersed emissions, which allow different types of the underlying surface. Particularly these data are used in calculations for receiving more accurate results.

[4] From peatlands removal of nitrogen and phosphorus were estimated by the emission factor calculated for wetlands (Table 3.12). Probably the proposed emission factors represent average values for different types of swams - upland, lowland, and of transition.

Table 3.12 Emission factors (kg km^{-2} year^{-1}) Ptot и Ntot in discharges from the various types of underlying surface [37]

Underlying surface	Combined (mixed)	Forest	Peat lands	Crop lands	Urbanized territories
$P_{tot.}$	26	5	0,5	16	57
$N_{tot.}$	300	250	350	1500	800

The values of the nitrogen and phosphorus loads, formed by various types of underlying surface are:

Total nitrogen

$L_e(N_{tot.})$ = 300*221+250*859+350*668+1500*1356+800*410 = 2876850 kg/year = 2877 t/year.

Total phosphorus

$L_e(P_{tot.})$ = 26*221+5*859+0,5*668+16*1356+57*410 = 55441 kg/year = 55,4 t/year.

The resulting data for the emission of biogenic substances from the various types of underlying surface within the Russian part of the Neman River catchment area are presented in Table 3.13.

Table 3.13 Biogenic substances emission from the various types of underlying surface within the Russian part of the Neman River catchment area, t/year (adapted from 2010-2013 years)

Underlying surface	Combined (mixed)	Forest	Peat lands	Crop lands	Urbanized territories	Underlying surface
Ptot.	5,7	4,3	0,3	21,7	23,4	55,4
Ntot.	66,3	214,7	233,8	2034	328	2877

Load on the catchment area formed applying the mineral fertilizers Lmf, are set based on official statistic data. Actual data of the mineral fertilizers application is lacked in free access; in statistics digests opened for public these data are not given. For the tentative estimation Lmf the standards of the application rate of the mineral phosphorous and nitrogen fertilizers for Kaliningrad region will be used. The soils of this region are belonged to European-West-Siberian taiga-forest region, to zone of derno-podzolic soils of the south taiga [4]. According the data [70], the fertilizers standards related to the derno-podzolic soils for the planned calculations are 33 kg/ha - nitrogen fertilizers (in terms of nitrogen) abd 45 kg/ha – phosphorous fertilizers (for P_2O_5, in terms of phosphor – 20 kg/ha).

The areas of the territories under crop and arable land, as well the calculations of the nitrogen and phosphor intake with mineral fertilizers are given in Table 3.14.

Table 3.14 The biogenic substances intake in result of applying fertilizers, t/year

Administrative district	The district area, ha	The district area in the Neman River catchment, ha	The crop land area in the district, ha	The crop land area in the Neman River catchment, ha	L_{mf}(N), t/year	L_{mf}(P), t/year
Krasnoznamensky	128000	80700	9078,3	5723,6	188,9	114,5
Nemansky	69830	53600	10823,45	8307,8	274,2	166,2
Nesterovsky	106100	34200	26312,2	8481,4	279,9	169,6
Polessky	83430	30000	8145,95	2929,1	96,7	58,6
Slavsky	134907	132800	9370,78	9224,4	304,4	184,5
Chernyakhovsy	128600	21700	10093,74	1703,2	56,2	34,1
Total	-	-	-	36369,6	1200,2	727,4

Suppose, that all animal manure and dung produced on farms and poultry farms remain in the frame of considered catchment area, then tentative load estimation L_{of} in the formula is made in the following way:

where k_f – emission factor $P_{tot.}$ or $N_{tot.}$ from one domestic animal j name [kg year-1],

N – the amount of the domestic animals (or poultry).

The values of the factor kf for the different types of domestic animals or poultry are presented in Table 3.15.

Table 3.15 Emission factors (kg year^{-1}) $P_{tot.}$ и $N_{tot.}$ of one domestic animal and poultry [33, 63].

Name	$P_{tot.}$	$N_{tot.}$
Cattle	18,9	77,1
Pigs	3,36	14,4
Ewes, goats	1,3	5,3
Poultry	0,28	1,14

The population of domestic animals and poultry in 2013 for the Kaliningrad region is received from official statistic data, which is presented on different internet-sources: http://kaliningradtoday.ru/economics/2581600/ (Table 3.16). For the considered territory the average values are taken, based on assumption of uniform distribution of animals and poultry within the region.

Table 3.16 The animal population (thousands of animal unit) and poultry (thousands of animal unit) in 2013 in Kaliningrad region

Administrative-district within the basin	Total area, thousand. km^2	Animal unit and poultry, animal units			
		Cattle	Pigs	Ewes, goats	Poultry
Kaliningrad region	15,1	83000	166200	71000	2072000
Within the considered catchment area	3,6	19788	39624	16927	494000

In [63] for more accurate estimate the modified formula for the calculation of load from organic fertilizers is given

$$L_{of} = \frac{K_{ж} \sum_j k_j N_j + K_n k_j N_j}{1000},$$

where $K_{ж}$ —the input coefficient of the biogenic substance from the animal manure to the water bodies, is equal to 0,38 for the total phosphor and 0,22 for the total nitrogen («Determination of priority actions to reduce the impact eutrophication on the North-West region of Russia on the Gulf of Finland (PRIMER project)», SYKE, 2009) [63];

$K_{п}$ — the input coefficient of the biogenic substance from the dung to the water bodies, is equal to 0,04 for the total phosphor and 0,16 for the total nitrogen («(«Determination of priority actions to reduce the impact eutrophication on the North-West region of Russia on the Gulf of Finland (PRIMER project)», SYKE, 2009) [63].

Therefore, the load formed by organic fertilizers from *animal* habitation is equal:

Total nitrogen

L_{of} ($N_{tot.}$) = 0,22*(77,1*19788+14,4*39627+5,3*16927)/1000=481 t/year

Total phosphorus

L_{of} ($P_{tot.}$) = 0,38*(18,9*19788+3,36*39627+1,3*16927)/1000=201 t/year

Therefore, the load formed by organic fertilizers from *poultry* habitation is equal:

Total nitrogen

L_{of} ($N_{tot.}$) = 494000*1,14*0,16/1000=90 t/year

Total phosphorus

L_{of} ($P_{tot.}$) = 494000*0,28*0,04/1000=6 t/year

The input of the biogenic substance from the animal manure and dung to the water bodies taking into account the retention coefficient are given in Table 3.17.

Table 3.17 The inputs of total nitrogen and total phosphorus from animal habitation, 2013, t/year

Biogenic substances	Cattle	Pigs	Ewes, Goats	Poultry	Total
$N_{tot.}$	336	126	20	90	571
$P_{tot.}$	142	51	8	6	207

It should be noted, that in presented calculation the nutrient load, formed by the organic fertilizers input – it is the maximum in posse of the load value under the assumption of complete usage of all amount of the animal manure and dung as a fertilizer for the agricultural land produced within the basin. It is possible that the obtained result can be overrated relative to the reality. However, with the lack of reliable information about biogenic flows within the catchment area or sufficient uncertainty of their obtainment, such assumption is most reasonable for this work [53].

An approximate estimate of diffuse load L_{pop} from rural settlements by the population not connected to the sewer system and wastewater treatment plants, carried out by the following formula annual averaging:

$$L_{pop} = \sum_{j} k_{pj} N_{p\,j} / 1000,$$

where k_p – coefficient of nutrients emission from one rural inhabitant for коэффициент j denomination [kg/a]; for $P_{tot.}$=0,033 kg/person a year[63], for $N_{tot.}$=5 kg/person a year [64]. Emission of the total nitrogen by one person defined by following method: in accordance with [64] normally one healthy human emit 10-15 g/day of total nitrogen. In appropriate for the calculation to take average value – 12,5 g/day, which gives approximately 5 kg/a.

N_p – number of rural inhabitants, not connected to the sewerage system and wastewater treatment plants.

It was assumed that number of rural inhabitants not connected to the sewerage system is the same as the total number of the rural inhabitants, because bigger part of the rural settlements on the Russian territory does not covered by the sewage system.

Total population of the rural inhabitants in the Neman river catchment (Russian part) for 2012 according to the statistical reports is 38215 persons.

Results of the nutrient load calculation from population presented in the Table 3.18.

Table 3.18 The total rural population within the Russian part of the Neman River catchment area, 2012

Administrative-district within the basin	The total rural population	$N_{tot.}$	$P_{tot.}$
Polessky district	4208	21,0	0,1
Nemansky district	6370	31,9	0,2
Nesterovsky district	3908	19,5	0,1
Krasnoznamensky district	5572	27,9	0,2
Chernyakhovsy district	1817	9,1	0,1
Slavsky district	16340	81,7	0,5
In total within the catchment area	38215	191,1	1,3

Comparison of nutrient loads from diffuse and point sources shown in the Table 3.19.

Table 3.19 Load of $N_{tot.}$ and $P_{tot.}$ (t/a) form diffuse and point sources in the Neman river basin (Russian part), 2010-2013

Nutrients	Point sources	Diffuse sources								
		Run-off from urban land	Run-off from arable lands	Run-off form forests land (Natural territories)	Run-off from swampy lands (Natural territories)	Run-off form mixed territories	Emissions from animals	Emissions from poultry	Emissions from rural population	Emissions from applying mineral fertilizer
$N_{tot.}$	20	328	2034	214,7	233,8	66,3	481	90	191,1	1200
$P_{tot.}$	1,3	23,4	21,7	4,3	0,3	5,7	201	6	1,3	727

Obvious, that main load comes from the diffuse sources, namely agricultural sector.

With the view to quantitatively assess load losses with crops uptake the following relation has been used:

$$L_c = \beta \cdot U \cdot A_f / 1000,$$

where β – is the crop uptake [t/a*km^2],

A_f – is the area of actively cultivated fields [km^2].

U – crop capacity [t/a*km^2]

Area of actively cultivated fields defined based on the existing available statistical data.

The average crop uptake values, defined for conditions of the non-black soils Russian zone [36], have been used in calculation. Based on the statistical data, collected from the official sources, the Table 3.20 have been created, which shows the input data for assessment nutrient losses with crops uptake in Kaliningrad region for 2013.

Table 3.20 Input data for assessment nutrient losses with crops uptake in Kaliningrad region (within Neman basin) for 2013.

Crop	Crop uptake Ntot value, kg/center	Crop uptake P2O5 value, kg/center	Crop capacity, center/hectar	Area of actively cultivated fields, hectar	Uptake Ntot, t/a	Uptake P_2O_5, t/a	Uptake Ptot, t/a
Corn	2,8	1,1	41,4	21581	2501,7	982,8	429,1
Potato	0,43	0,17	219	372	35,0	13,8	6,0
Vegetables	0,55	0,18	220	1696	205,2	67,2	29,3
Fodder	0,37	0,15	40	11842	175,3	71,1	31,0
Total	-	-	-	-	**2917,2**	1134,9	**495,5**

Nutrient load on the Neman catchment area within Russia (L_{tot}) assessed by following.

$L_{tot}(N_{tot.})$=20+0+2877+1200+481+90+191,1-2917=1942 t/a

$L_{tot}(P_{tot.})$=1,3+10,7+55,4+727+201+6+1,3-496=507 t/a

From the total load on the catchment the significant part of the nutrients are retained due to natural climate features and mosaic structure of the catchment:

$L_{ret}(N_{tot.})$=0,645*1942=1253 t/a

$L_{ret}(P_{tot.})$=0,533*507=270 t/a

So the load from Russian part of the Neman river reached the Baltic Sea constitutes:

L ($N_{tot.}$)=1942-1253=689 t/a

L ($P_{tot.}$)=507-270=237 t/a

Assessment of the natural background load share in the total load in the Neman river from catchment surface conducted based on the data pointed in the works [37,36] and corroborated by the independent method in the work [59], grounded on the following findings.

The background component in the nutrient input is defined as the difference between the load and nutrient runoff from natural areas including the amount of retained nitrogen and phosphorus by the land. So natural background load constitutes following figures in the obtained calculations.

$L_{nat}(N_{tot.})$=449-(0,645*449)=159 t/a

$L_{nat}(P_{tot.})$=4,6-(0,533*4,6)=2,1 t/a

Natural background load in the total nutrient input with river Neman constitute 42 % for total nitrogen and 1,0 % for total phosphorous.

All calculated feature used in the applied methodic presented in the Table 3.21.

Table 3.21 Results of the annual nutrient load with river Neman calculation originating from Russian part of the catchment for period 2010-2013

Parameter	Lettering	Value	
		$N_{tot.}$	$P_{tot.}$
Catchment area (within Russia), km^2	A	3574	
Retention, t/a	L_{ret}	**1253**	**270**
Retention coefficient	R_t	0,645	0,533
Nutrient load on the catchment, t/a	L_{tot}	**1942**	**507**
Hydraulic load, m/a	HL	7,928	
Rate of the run-off, $l*sec/km^2$	q	250	
Share of water surface, %	W	2	
Runoff depth, mm/a	y	250	
Load form point sources, t/a	L_p	20,0	1,3
Diffuse load from the emission of nutrients from various types of land surface, t/a	L_e	2877	55,4
Load, formatted by the mineral fertilizers applying, t/a	L_{mf}	1200	727
Load, formatted by the organic fertilizers applying, t/a	L_{of}	571	207
Load from rural population, t/a	L_{pop}	191	1,3
Number of domestic animals and poultry, thousand heads	N_{Cattle}	19788	
	N_{Pigs}	39624	
	$N_{Poultry}$	494000	
	$N_{goat,sheep}$	16927	
Atmospheric load, t/a	L_a	0	10,7
Losses of nutrients with crops uptake, t/a	L_c	2917	496
Load from Russia part of the catchment to the Baltic Sea via Neman, t/a	L	**689**	**237**

Obtained figures for the Russian part of the Neman river catchment can be compared only with materials presented in [4] on the map “Anthropogenic loads on the riverine network”. Data actual for the beginning of the 2000’s. For the considered catchment annual input of total nitrogen and total phosphorous significantly, all most twice, higher and that is naturally due to intensifying of agriculture and increasing of the population since that times. If this tendency will maintenance it is necessary to calculate maximum allowable export of nutrients from the Russian part of the Neman catchment to the Curonian Lagoon.

In generally, total load from the Russian part of the catchment with Neman river for the period 2010-2013 mainly consist of the diffuse load (the share of diffuse sources – 80 %), load from the point sources is insignificant, share less that 2% (Table 3.22).

Table 3.22 Main components of the nutrient load on the river Neman with the Russian part of its catchment area for the period 2010-2013, t/a

Component	Ntot.	Ptot.
	2010-2013	
Emissions from land (by different types of lying surface)	2877	55,4
Mass exchange with atmosphere, La	0	10,7
Point sources dischrges, Lp	20,0	1,3
Organic fertilizer (deliverables from cattle and pigs), Lof	481	201
Organic fertilizer (deliverables from poultry), Lof	90	6
Mineral fertilizer, Lmf	1200	727
Total on the Russian part of the catchment	4668	1001
Uptake with crops, Lc	2917	496
Retention by catchment and hydrographic network, Lret	1253	270
Load from the Russian part of the catchment in total load with Neman	689	237
Including natural background load, Lnat	290	2,1

In the diffuse sources the order of significance as follows. Main input originated from the agriculture – run-off of the mineral and organic fertilizer and emissions from the arable lands (more than 60% - for Ntot and 70 % - for Ptot). Main contributor of Ptot is mineral fertilizer/ Rest diffuse sources constitutes 2-10 %. Smallest load originating from rural populations (Table 3.23).

Table 3.23 Share of the diffuse sources in the total nutrient load received by the Neman river, %

Component of total load	Ntot.	Ptot.
Emissions from arable land	42 %	2,2 %
Organic fertilizer	12 %	21 %
Mineral fertilizer	25 %	73 %
Emissions from natural land	9,3 %	0,5 %
Emissions from urban land	7 %	2,4 %
Emissions from mixed land	1,4 %	0,6 %
Emissions from rural population, not connected to the sewerage system	4 %	0,3 %

3.5 Uncertainty, related to the load calculation using the model

To estimate the load from point sources to the watershed requires a considerable amount of information about the manufactured production, technological features of production, water consumption, waste water treatment, etc. The volume, composition and dynamics of wastewater discharge are determined by technological, socio-economic and other factors and not always have a scientific explanation. The occurrence of difficulties in collecting this kind of data and performing the subsequent calculations are clear. Therefore, as a rule, when developing the models of the pressure formation on water bodies, the contribution of point sources is described approximately through the official statistical reporting information on discharges and conducted in accordance with the official long-term plans to improve the system of wastewater treatment on the considered plants. Unauthorized and irregular discharges may be considered only if there is reliable information, which is extremely difficult to get. Currently, the main official source of information on wastewater discharges is statistical forms 2TPVodhoz of Ministry of Natural Resources and Environment. The data contained in these forms are provided with an annual averaging, which imposes restrictions on the relevant calculating schemes and mathematical models in which these data are used.

In general, the accuracy of the performed evaluations largely depends on the reliability of the source data, pledged in the model. In our calculations the state official statistical reporting information officially submitted to the objectives of the study are mainly used. Information on the agricultural usage of territories, yield, etc. was also obtained from official public sources. The accuracy of the initial information is confirmed by references to the source. Errors, with which the data are given in statistical books, shared on the Internet, as well as in forms of governmental accounting, have not been separately identified.

The test results of the applied model are given in monograph [Kondratyev S.A. and co-authors, 2010], which shows a satisfactory correspondence between the measured and calculated characteristics of the low reliability of data monitoring and state statistical reporting. In addition, similar conclusions were made in the paper of A.A. Ershova [A.A. Ershova, 2013], which concludes that the model can be used for an approximate evaluation of the nutrient load to the Baltic Sea from the unexplored and insufficiently studied watersheds of Russia. It is important to note that the results of the model calibration and verification are based on a comparison of measured and simulated characteristics, which depend on used materials for field measurements and statistical reports data, can indicate only the rough values of the obtained parameters. The obtained values can be considered as a basis for further calculations and observations, which increase the accuracy of assessments.

3.6 Conclusions

For implementing this task of the BASE Project the ILLM (Institute of Limnology Load Model) has been used. This model intended for calculation total external load of nitrogen and phosphorus on the common water bodies from the catchment and takes in to account existing limitations in information provided by the state monitoring system of water bodies and state statistical reporting on wastewater discharges and agricultural activities in the catchment areas in the North-Western Federal District of Russia.

With the view to obtain the maximum reliable results input data for the model calculations has been collected from state and regional authorities (Neva Ladoga Water Basin Administration, Kaliningrad Hydromet Service etc.), scientific organizations and Lithuanian representatives. Morover, information from existing literature sources have been analyzed. Some information has been also kindly given from other BASE Project segments etc.

According to the implemented calculation average annual load in the period 2010-2013 from Russia part of the catchment to the Baltic Sea via Neman and Matrosovka rivers constitutes 700 tonnes of total nitrogen and 200 tonnes of total phosphorous, where the natural background load constitutes 290 and 2.1 tonnes of total nitrogen and total phosphorus correspondingly. The main part of this total Russian load refer to diffuse sources (more that 70 %), namely to agriculture sector – run-off from arable lands and emissions of organic and mineral runoff from agricultural land and emissions of organic and mineral fertilizers. It must be admitted that compared to the app. total load with river Neman (based on the Lithuanian data for 2010) Russian share tentatively constitutes 1.6 % for total nitrogen and 12 % for total phosphorous.

Comparison of the obtained results with assessments made earlier [53, 58, 26, 35-38, 46, 47, 65] and also with assessments based on the other methodic [59, 62], shown comparability of the results and also sufficiency of the applied method for calculation nutrient load in the conditions with several limitations and lacks of the input data.

4 General conclusions and recommendations

According to the implemented activities, namely hydrological and hydrochemical surveys, sampling and analysis of Pregolya River and its 12 tributaries, in Matrosovka Canal, Kaliningrad waste water discharge Canal and quantification of the transboundary nutrient load into the Kaliningrad Oblast (Neman River and Matrosovka Canal) taking into account retention the following conclusions can be drawn:

1. The following big tributaries are mainly employed in the Pregolya water stream formation: the Instruch, the Angrapa, the Golubaya, the Stream Glubokij, and the Lava River. According to the measurements conducted in 2013 – 2014 all these rivers in total bring 8111 tons of total nitrogen and 369 tons of phosphorus a year. Before branching Dejma river total nutrient load of the Pregolya is 5595 tons of total nitrogen and 221 tons of total phosphorus a year. Correspondingly, difference between the values of received nutrients from the tributaries and the data at the station accounts for 2516 tons of nitrogen and 148 tons of phosphorus, that is the amount held by the river itself.

2. The main tributary of the Pregolya River is the cross-border Lava River, more than half of which water basin is located in Poland. So, the greatest part of the nutrient load comes to the Kaliningrad Oblast from the boundary territory. The amount of nutrients that come from the Polish territory make not less than half of the total amount which is later carried out to the Pregolya and further to the Baltic Sea. Besides, straight after the national Russian-Polish border there is the Pravdinsk reservoir. According to autumn and winter monitoring rounds this reservoir keeps half of the nutrient load that comes from the upstream.

3. Total amount of total nitrogen to the Vistula Lagoon is 5384 tons a year, whereas total phosphorus – 529 tons a year. Out of this amount - 69% of nitrogen comes from the Pregolya River and 26% - from the Kaliningrad Waste Canal. For phosphorus the correlation is different: 48% of total nitrogen comes from the Pregolya River and 46% - from the Kaliningrad Waste Canal.

4. Total amount of total nitrogen in water delivered to Curonian Lagoon in 2013-2014 was 9459 tons per year, and total phosphorus – 332 tons per year.

5. Retention by the Matrosov Canal on the territory of the Kaliningrad Oblast is 25% of total nitrogen and 37% of total phosphorus. Nutrient retention by the Sheshupe River is the following: 1% of total nitrogen and 13% of total phosphorus – on the territory of the Kaliningrad Oblast.

6. For quantification of the transboundary nutrient load into the Kaliningrad Oblast (Neman River and Matrosovka Canal) the ILLM (Institute of Limnology Load Model) is suitable one. The results obtained applying this model shown good comparability with similar assessments.

7. Average annual load in the period 2010-2013 from Russia part of the catchment to the Baltic Sea via Neman and Matrosovka rivers constitutes 700 tonnes of total nitrogen and 200 tonnes of total phosphorous, where the natural background load constitutes 290 and 2.1 tonnes of

total nitrogen and total phosphorus correspondingly. These figures tentatively constitute 1.6 % for total nitrogen load and 12 % for total phosphorous load coming with river Neman to the Baltic Sea.

8. The main part of this total Russian load coming with Neman river to the Baltic Sea refer to diffuse sources (more that 70 %), namely to agriculture sector – run-off from arable lands and emissions of organic and mineral runoff from agricultural land and emissions of organic and mineral fertilizers.

9. The approximate total nutrient load from the Kaliningard Oblast to the Baltic Sea, coming with main rivers investigated in the BASE Project as well as Russian share in the total load with river Neman, constitutes 10 667 t/a for Ntot and 927 t/a for Ptot.

It should be noted that received results of hydrological and hydrochemical surveys are a matter of judgment. Thus, for more detailed analysis of water bodies of the Kaliningrad Oblast it would be sensible to elaborate a more frequent monitoring scheme (e.g. carried out monthly), which will include Ntot and Ptot parameters.

Moreover, applying ILLM model on the regular basis for quantification transboundary nutrient load should be ensured by the improvement of the input data, namely the statistical data on amount of the nitrogen and phosphorous appearing with the fertilizer applying, number of animals etc.

References

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Annex 1. Description of the chemical analysis methodology

Chemical analyses have been implemented by the Laboratory of the North-West Department of Hydrometeorology and Environmental Monitoring, Federal State Institution (HYDROMET) in the Saint-Petersburg. This laboratory participated in the PLC-6 Project intercalibration and also in the 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”. The quality assurance procedures and the professional capacity of the laboratory have been proven in comparison tests, and further ensured in the cross-sampling and analyzing activities of the Balthazar Project.

HYDROMET laboratory April 2012. Photograph by T. Väisänen.

Chemical analysis for BASE Project were conducted with accordance to the state official methodic.

According to these documents the content of the total nitrogen and total phosphorous determined by analyzing thoroughly mixed unfiltered sample.

Measurement of mass concentration of total phosphorus based on the transfer of all phosphorus compounds in orthophosphates by oxidation with potassium persulfate in acidic medium under heating. Orthophosphate is then determined by the photometric method for forming reaction molybdophosphoric heteropolyacid.

Measuring the mass concentration of total nitrogen is based on the oxidation of nitrogen containing compounds by heating with potassium persulfate in alkaline solution. The nitrogen contained in organic and inorganic compounds, the reaction is converted into nitrate, which is further reduced copper-clad metal cadmium to nitrite, followed by the last definition of the color reaction with Griess reagent.

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