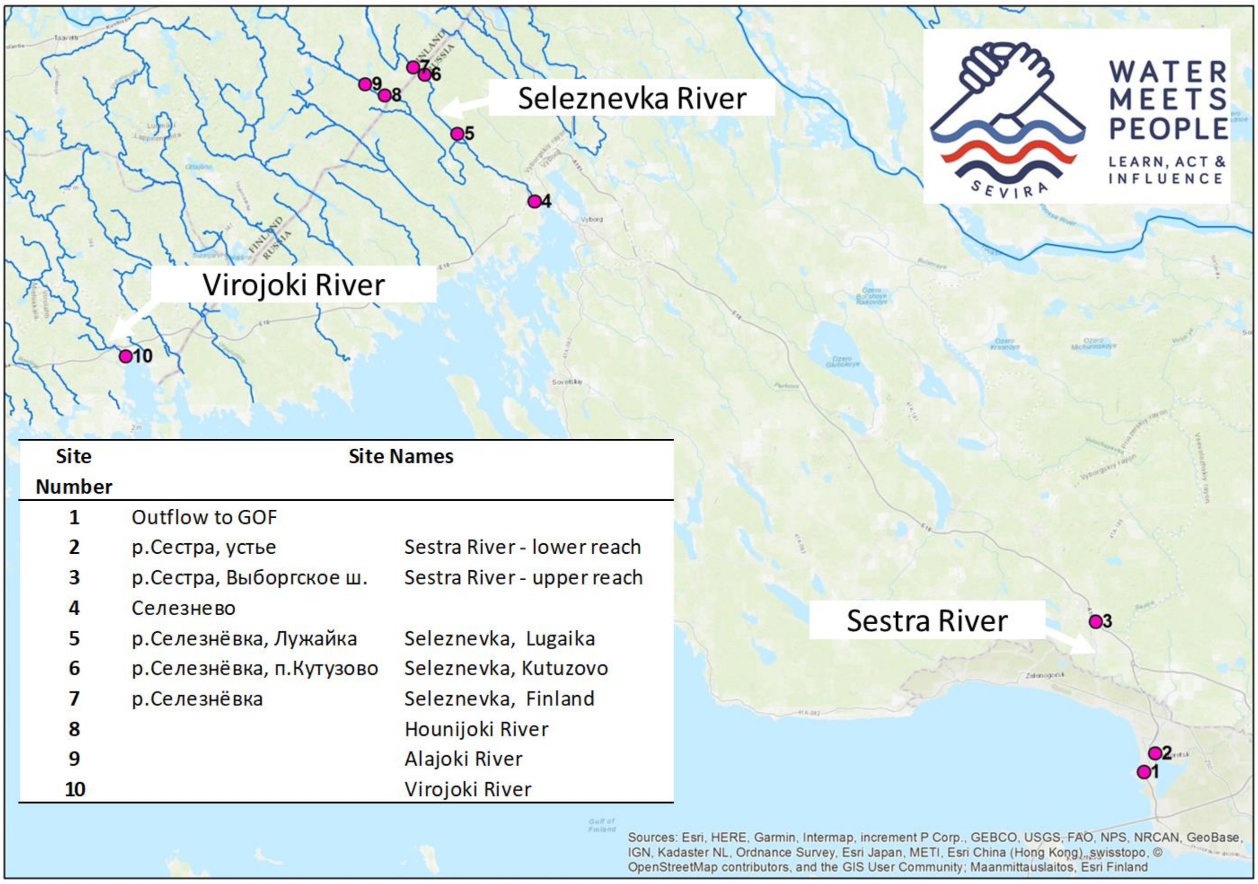
Good and bad quality of river water reflects the catchment characteristics

The SEVIRA-project has monitored water quality in three rivers discharging into the eastern Gulf of Finland: the Seleznevka (р. Селезнёвка), the Sestra (р. Сестра) and the Virojoki (Fig. 1). The transboundary Seleznevka was monitored close to the country border both in Finland (Site 7) and in Russia (Site 6, Kutuzovo), and more downstream in Lugaika (Site 5). Some samples have also been taken near the river outlet (Site 4) and from a tributary (Sites 8 and 9). The Sestra (Russia) had a monitoring station close to the river mouth (Site 2) and another in the upper reaches (Site 3). The Virojoki (Finland) was monitored only close to the river mouth (Site 10). The samples, taken about every second week in November 2018 – June 2020, have been analysed in the Finnish and Russian laboratories.



Site Number	Site Names	
1	Outflow to GOF	
2	р.Сестра, устье	Sestra River - lower reach
3	р.Сестра, Выборгское ш.	Sestra River - upper reach
4	Селезнево	
5	р.Селезнёвка, Лужайка	Seleznevka, Lugaika
6	р.Селезнёвка, п.Кутузово	Seleznevka, Kutuzovo
7	р.Селезнёвка	Seleznevka, Finland
8		Hounijoki River
9		Alajoki River
10		Virojoki River

Fig. 1 Monitoring sites in the SEVIRA-project.

Chemical status of the rivers varies from good to bad

Water quality of the rivers reflects soil properties and human activities, such as land use and wastewater loading, in the catchment. For example, nitrogen levels were clearly higher in the Seleznevka than in the Sestra and the Virojoki. Moreover, the temporal variation in the nitrogen concentrations was also the highest in the Seleznevka. The upper reaches of the river receive municipal wastewaters of the city of Lappeenranta

(Finland), and the concentrations of all nitrogen forms (total nitrogen, nitrate nitrogen and ammonium nitrogen) decreased downstream from the country border (Figs. 2–4). Ammonium nitrogen concentration peaked occasionally in the Seleznevka and in the lower reaches of the Sestra (Fig. 4). Potential reasons for the ammonium peaks include municipal effluents and agricultural runoff. High ammonia concentrations are toxic to aquatic animals, but the observed levels do not exceed e.g. the EPA recommended aquatic life water quality criteria (pdf).

The total nitrogen and total phosphorus concentrations can be used to classify the chemical status of surface waters on the basis of the guidelines used in Finland in implementing the EU Water Framework Directive. The total nitrogen levels of the Seleznevka (mean 2300–3000 µg/L) indicated bad condition for the upper and poor for the middle reaches. In the case of the Sestra, the mean nitrogen concentration indicated good water quality for the upper reaches (450 µg/L) but moderate for the lower reaches (850 µg/L), likely due to residential areas located near the coast. The chemical status of the Virojoki was moderate based on the mean nitrogen concentration 970 µg/L.

Using total phosphorus levels as the water quality criteria (Fig. 5), the monitoring results show a poor chemical status for the entire Seleznevka (three station means 58–74 µg/L) and moderate water status for the Sestra (two stations means 36 and 49 µg/L) and the Virojoki (mean 46 µg/L). These findings corroborate the conclusions presented in our first SEVIRA river water analysis report covering a shorter monitoring period (November 2018 – April 2019).

In the next stage of the project, the discharge data and concentrations will be merged to estimate nutrient loads with the aim to determine the optimum sampling strategy for the future. Based on the results a recommendation of the number and timing of samples will be produced. Too infrequent sampling results in inaccurate load estimates and biased water protection measures, while too frequent sampling increases costs rather the precision.

Sevira project analyses a large amount of water quality variables

In addition to nitrogen and phosphorus, several other water quality variables like oxygen level (Fig. 6), pH, suspended solids concentration (Fig. 7) and metal concentrations are analysed from the water samples. Timeseries and mean concentrations of manganese and nickel are shown in Figs. 8–9 as examples of metal analyses. Manganese in the Sestra is sometimes elevated and has a larger variation compared to other rivers and thus needs further attention.

The mean nickel concentrations are low in all the rivers. The detection limit of nickel is 1.0 µg/L in the Russian laboratory and 0.005 µg/L in the Finnish laboratory, which is relevant at very low concentrations if you compare analysis results from nearby stations The preliminary investigation of cadmium concentrations of the Seleznevka river showed contrasting results between the nearby stations 6 and 7, the concentration being much lower in the Finnish station. The differing results might be due to the different analysis methods. The fact that a large amount of variables are determined in different laboratories, potentially using different instruments and methods makes the multinational water quality analysis demanding but fruitful when the reasons for different results are found out.

Share of agricultural and urban areas vary within and between the catchments

The catchments of the rivers differ especially in the area and distribution of urban and agricultural land. As much as 20% of the Virojoki catchment and of the upper parts of the Seleznevka River (Kutuzovo) is agricultural land, whereas only 1–2 % of the catchment of the Sestra is under agricultural use. Residential areas occupy 11% of the catchment of Seleznevka in Finland, but the share of urban areas decreases towards the sea being 5% in Seleznevo close to the outlet. In contrast, the share of residential areas in the upper catchment of the Sestra is only 3% but increases towards the sea (9%, Peshehodniy Bridge). The Virojoki catchment is sparsely populated and residential areas account less than 2% of the catchment. Within the project it has been estimated that clayey soils cover 19% of the Seleznevka catchment whereas the share of clay soils in the Virojoki and the Sestra catchments is still to be determined.

The amount of clayey soils within a catchment typically explains several river water quality observations. Turbidity of the water increases as well as suspended solids concentration when the share of clayey soil in the catchment increases. Increased clay content may also increase concentration of total phosphorus, iron, manganese and aluminium, which can be attached in- or onto the clay particles.

A wider analysis and comparison of the water quality of the rivers is possible when additional information of the catchments is available.

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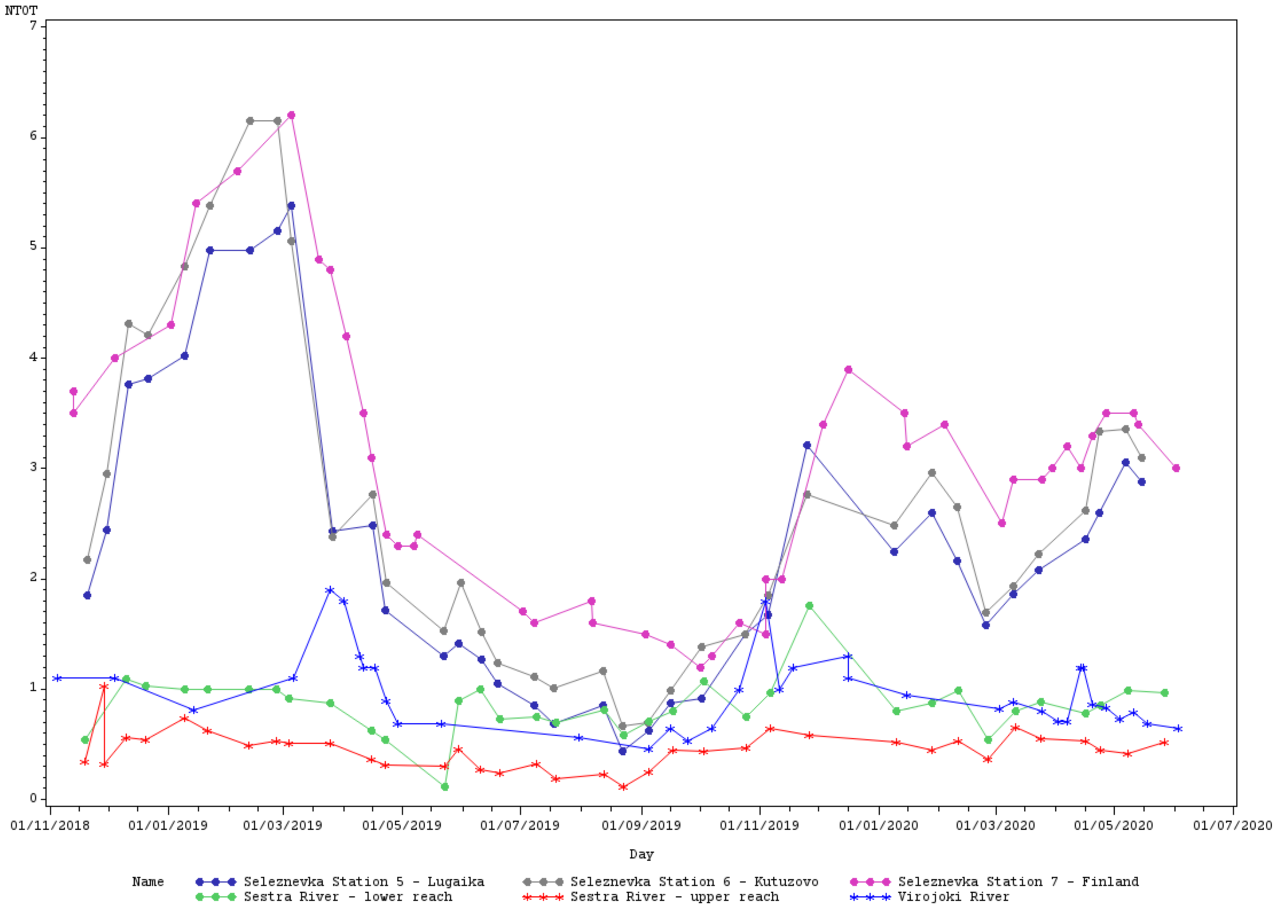
More about river monitoring in the SEVIRA pages:

- First results from river monitoring reveal differences among the rivers
- Laboratory analysis methods impact on determined riverine phosphorus concentrations
- Cross-border cooperation in on-line monitoring

Figures of river water analysis results of the SEVIRA project:



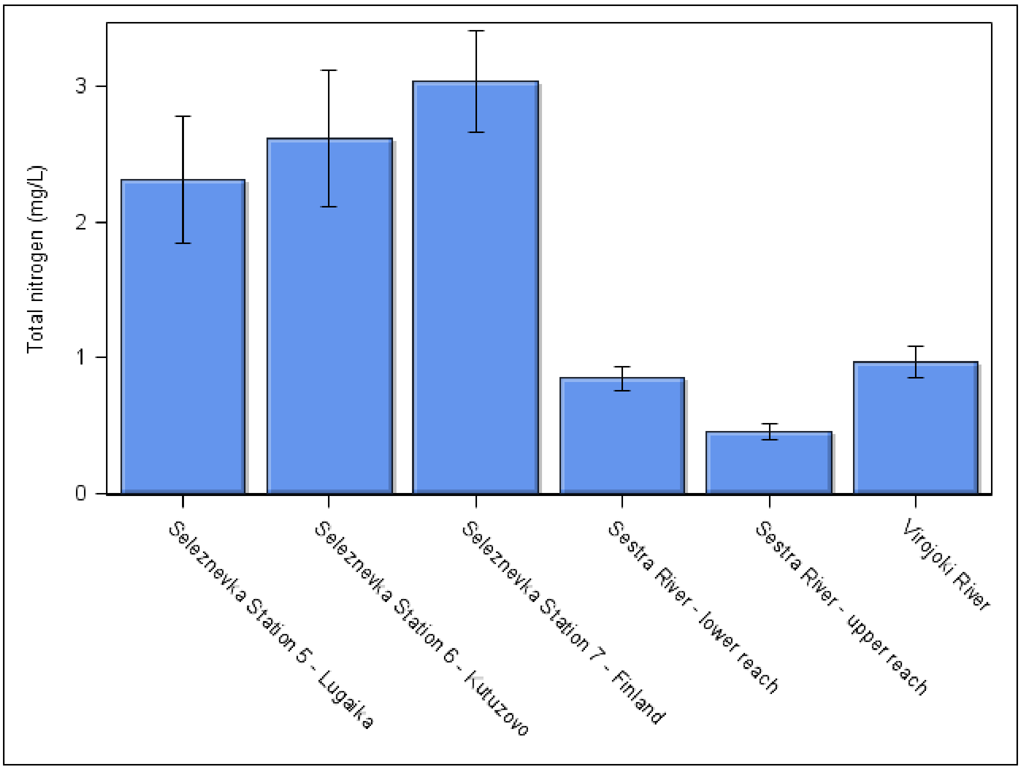


Fig. 2 Total nitrogen (NTOT) concentration (mg/L) in the rivers Seleznevka (three sites), Sestra (two sites) and Virojoki (one site) in November 2018–June 2020. The bars show the mean concentration and the whiskers its 95% confidence interval.

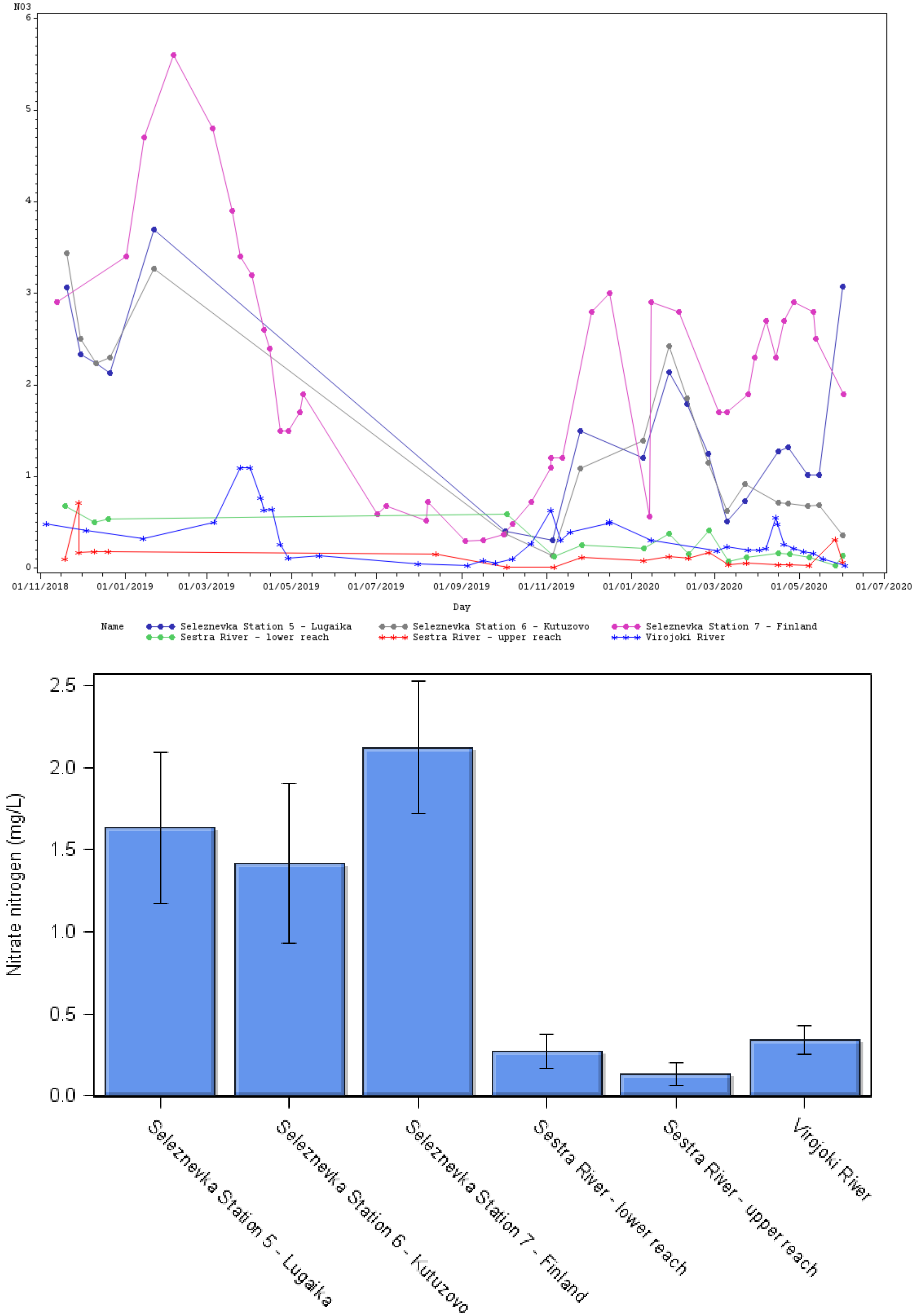


Fig. 3 Nitrate-nitrogen (NO3-N) concentration (mg/L) in the rivers Seleznevka (three sites), Sestra (two sites) and Virojoki (one site) in November 2018–June 2020. The bars show the mean concentration and the whiskers its 95% confidence interval.

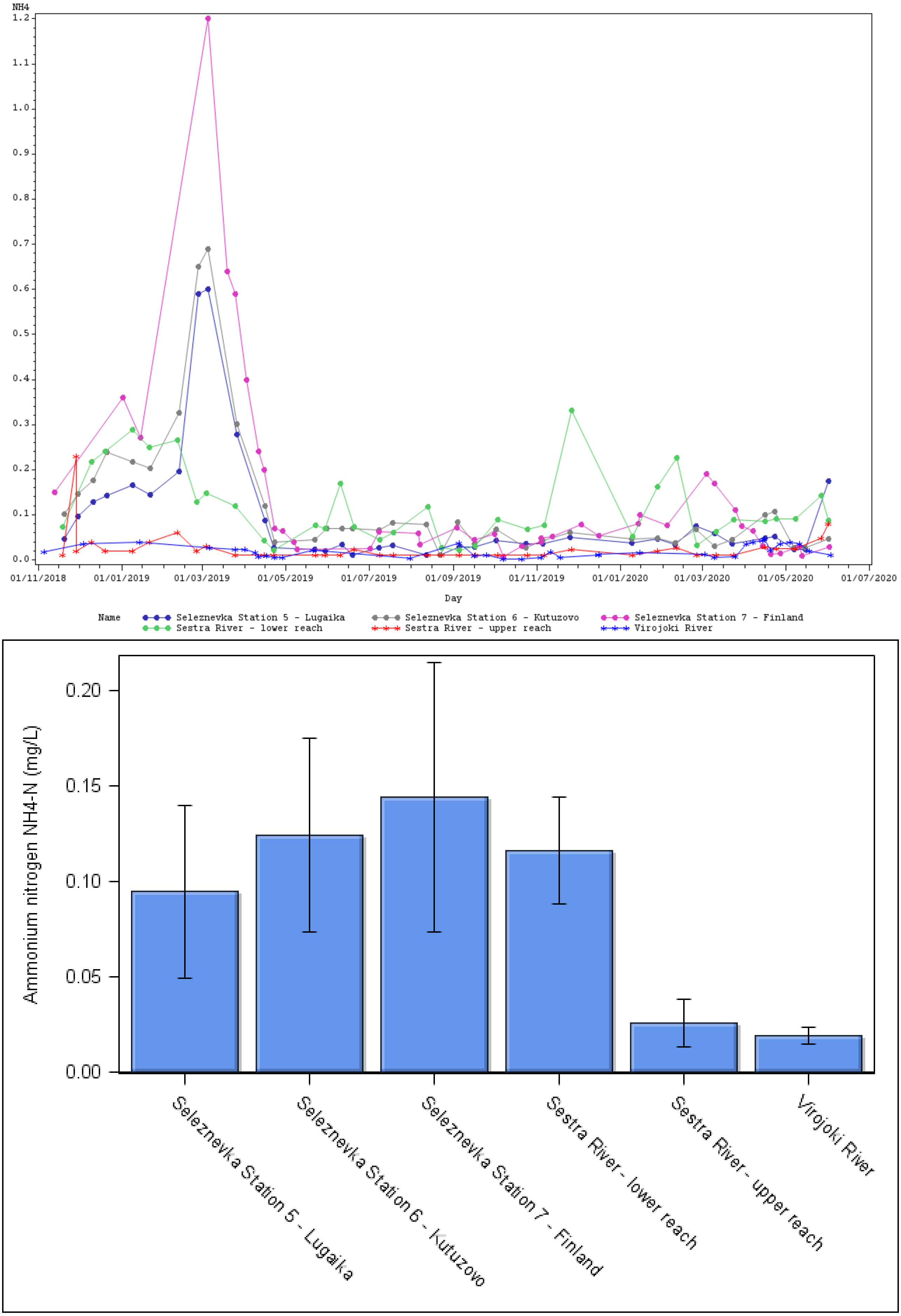


Fig. 4 Ammonium nitrogen (NH4-N) concentration (mg/L) in the rivers Seleznevka (three sites), Sestra (two sites) and Virojoki (one site) in November 2018–June 2020. The bars show the mean concentration and the whiskers its 95% confidence interval.

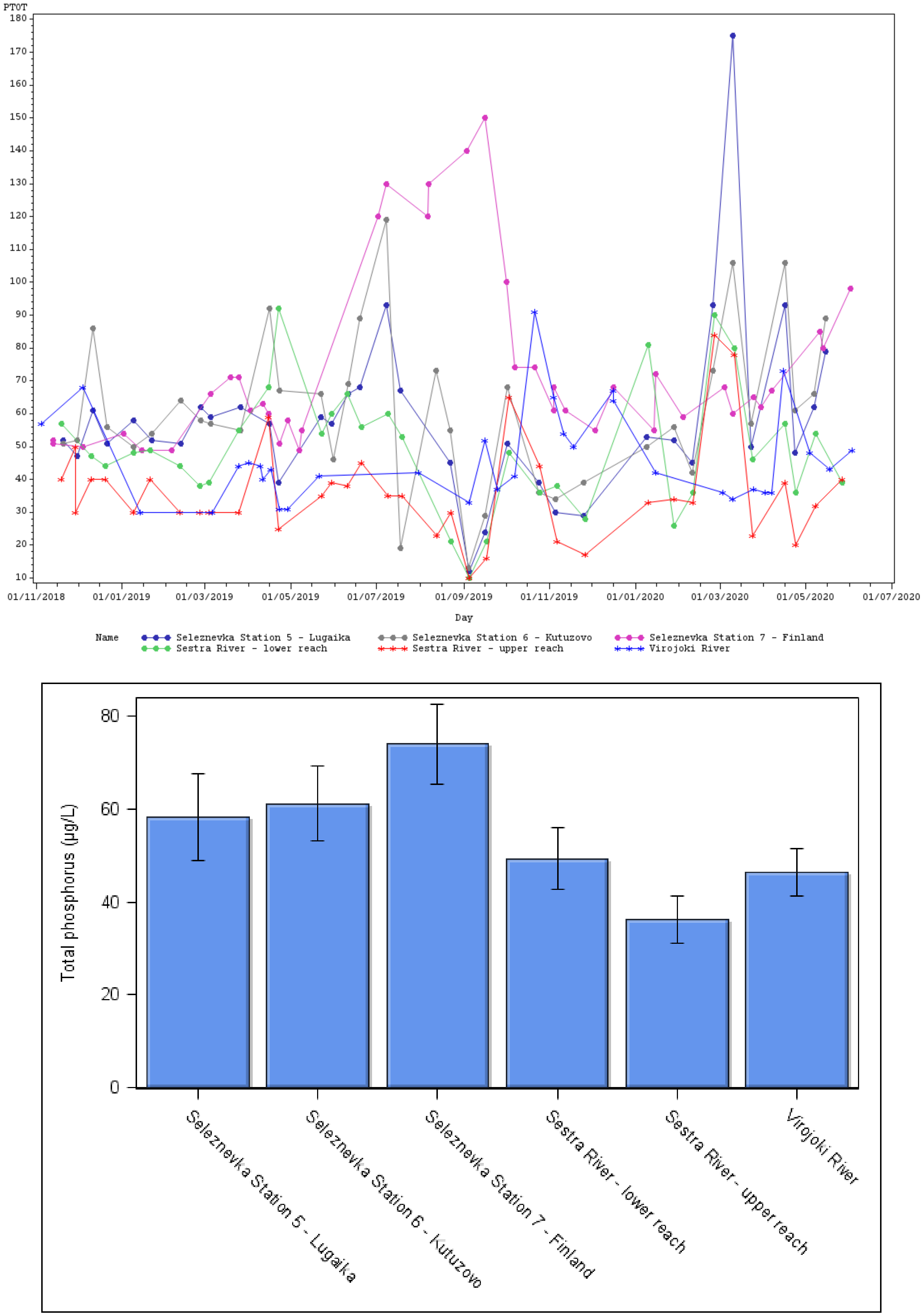


Fig. 5 Total phosphorus (PTOT) concentration (µg/L) in the rivers Seleznevka, Sestra and Virojoki. The bars stand for the mean concentration and the whiskers indicate standard error of the mean i.e. 95 % confidence interval of the mean concentration during November 2018–June 2020.

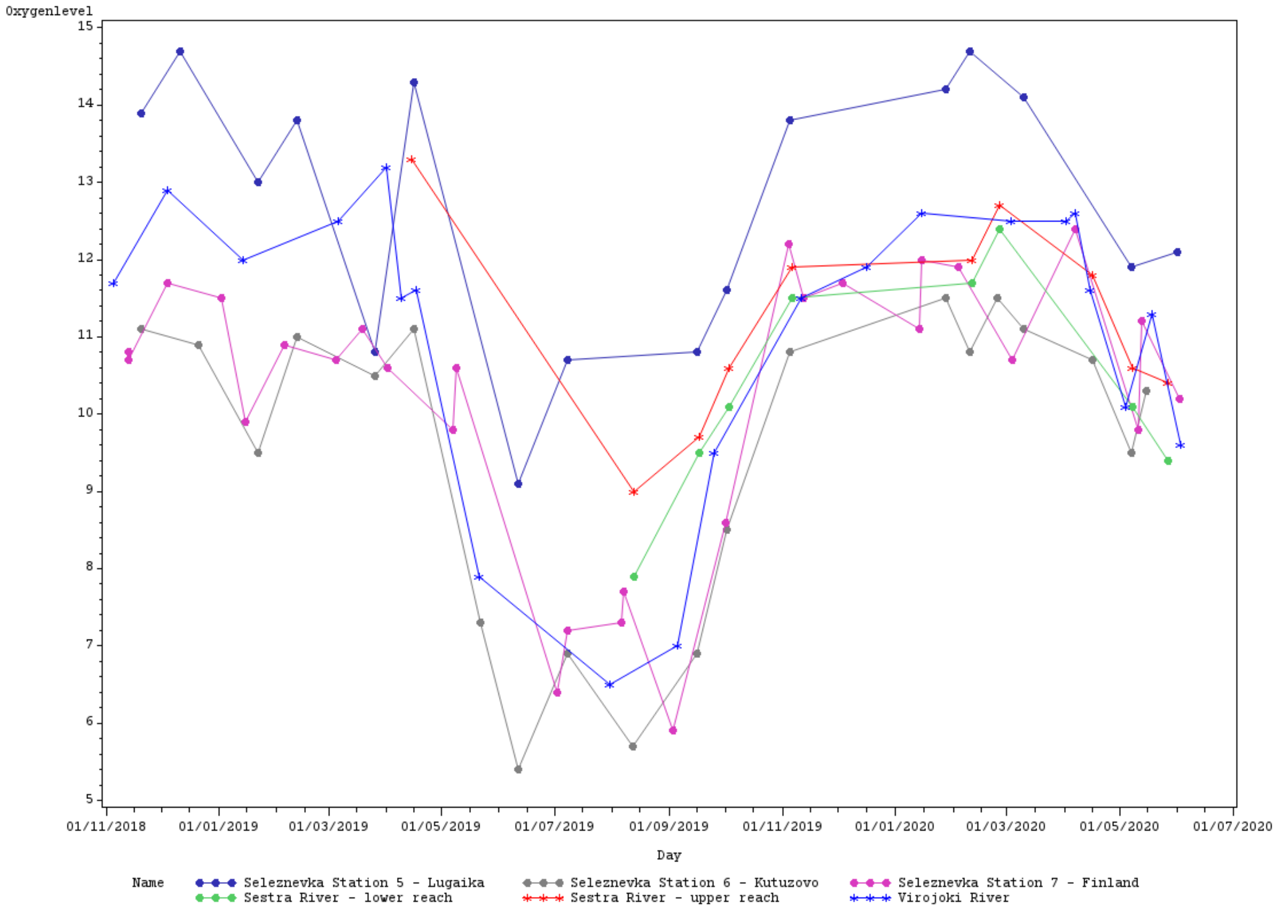
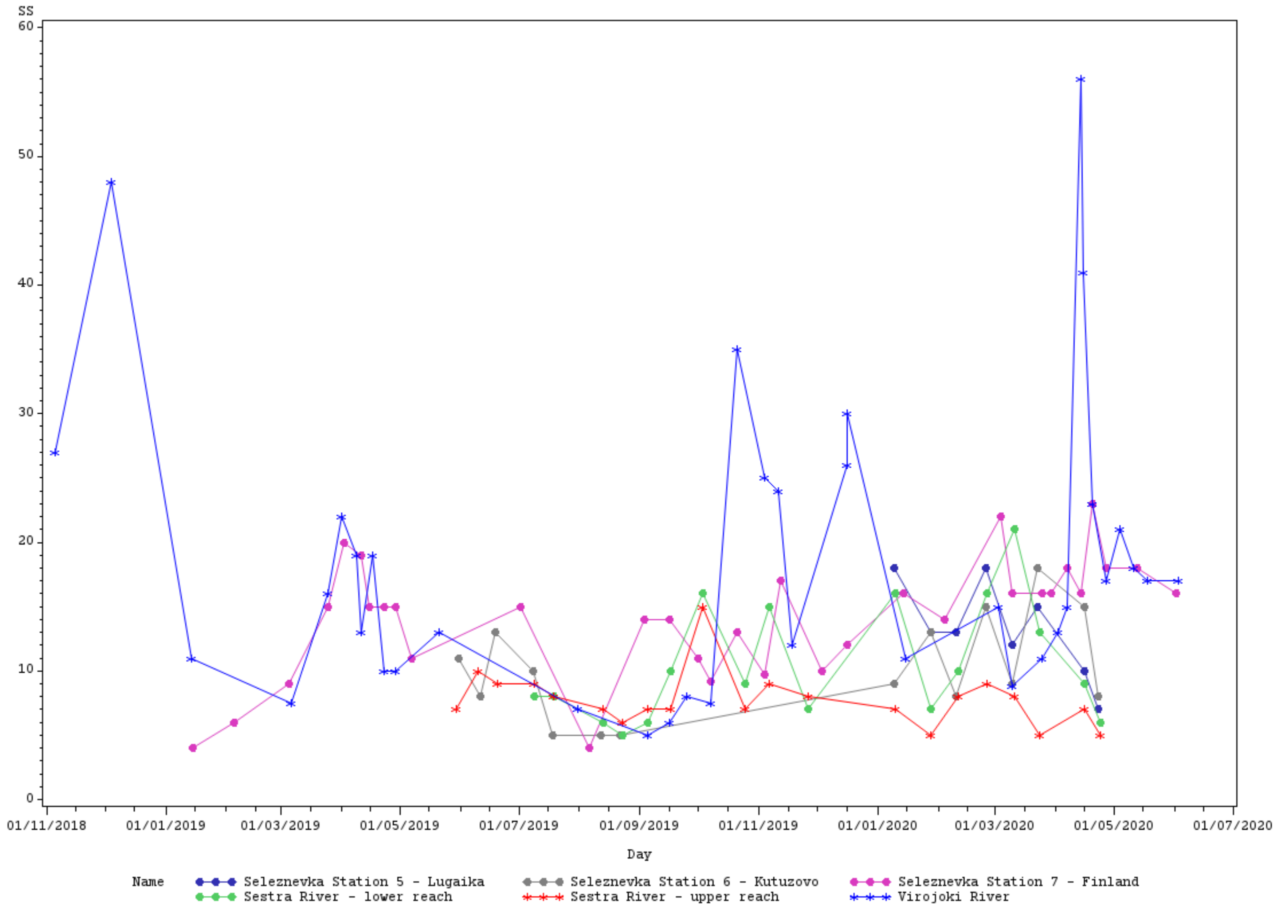


Fig. 6 Oxygen level (%) in the rivers Seleznevka, Sestra and Virojoki.



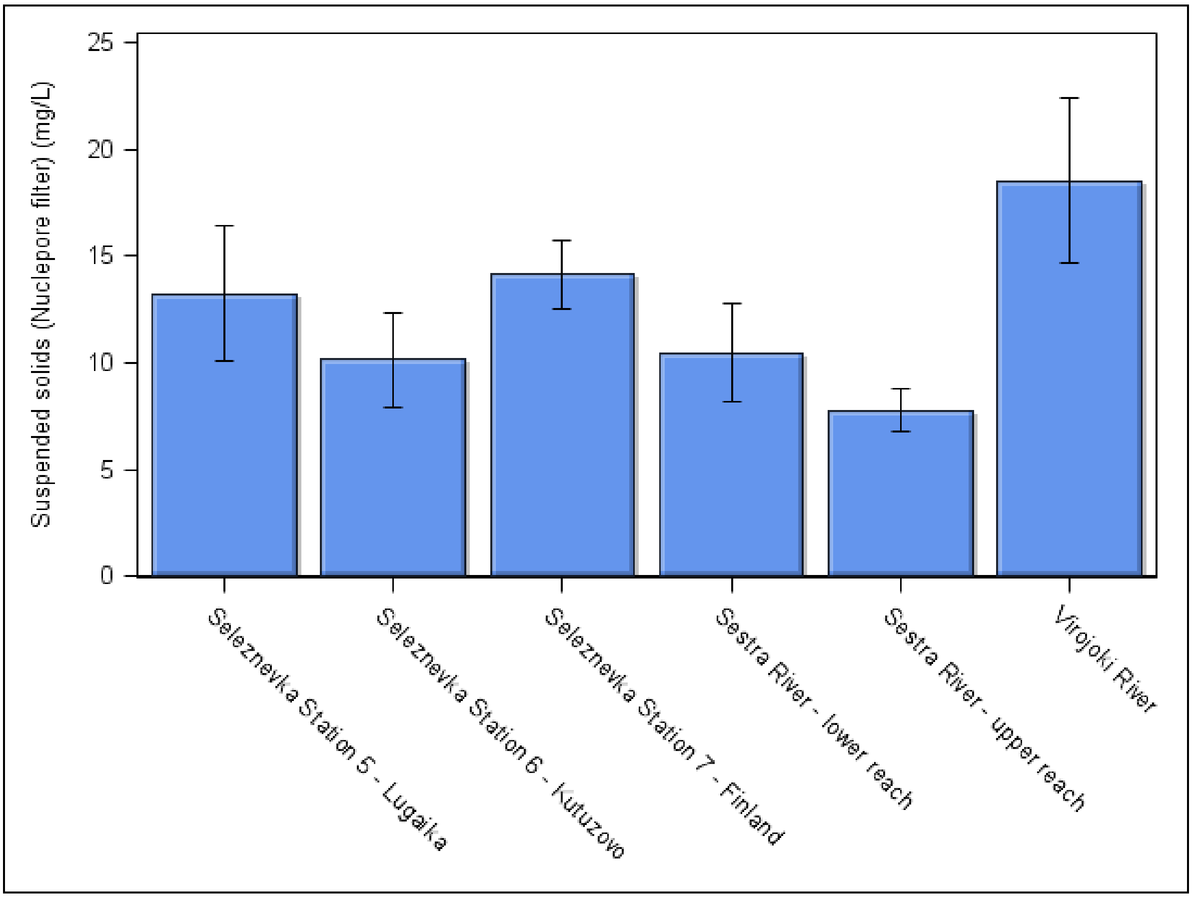


Fig. 7 Suspended solids (SS) concentration (mg/L) in the rivers Seleznevka, Sestra and Virojoki. The bars stand for the mean concentration and the whiskers indicate standard error of the mean i.e. 95 % confidence interval of the mean concentration during November 2018–June 2020.

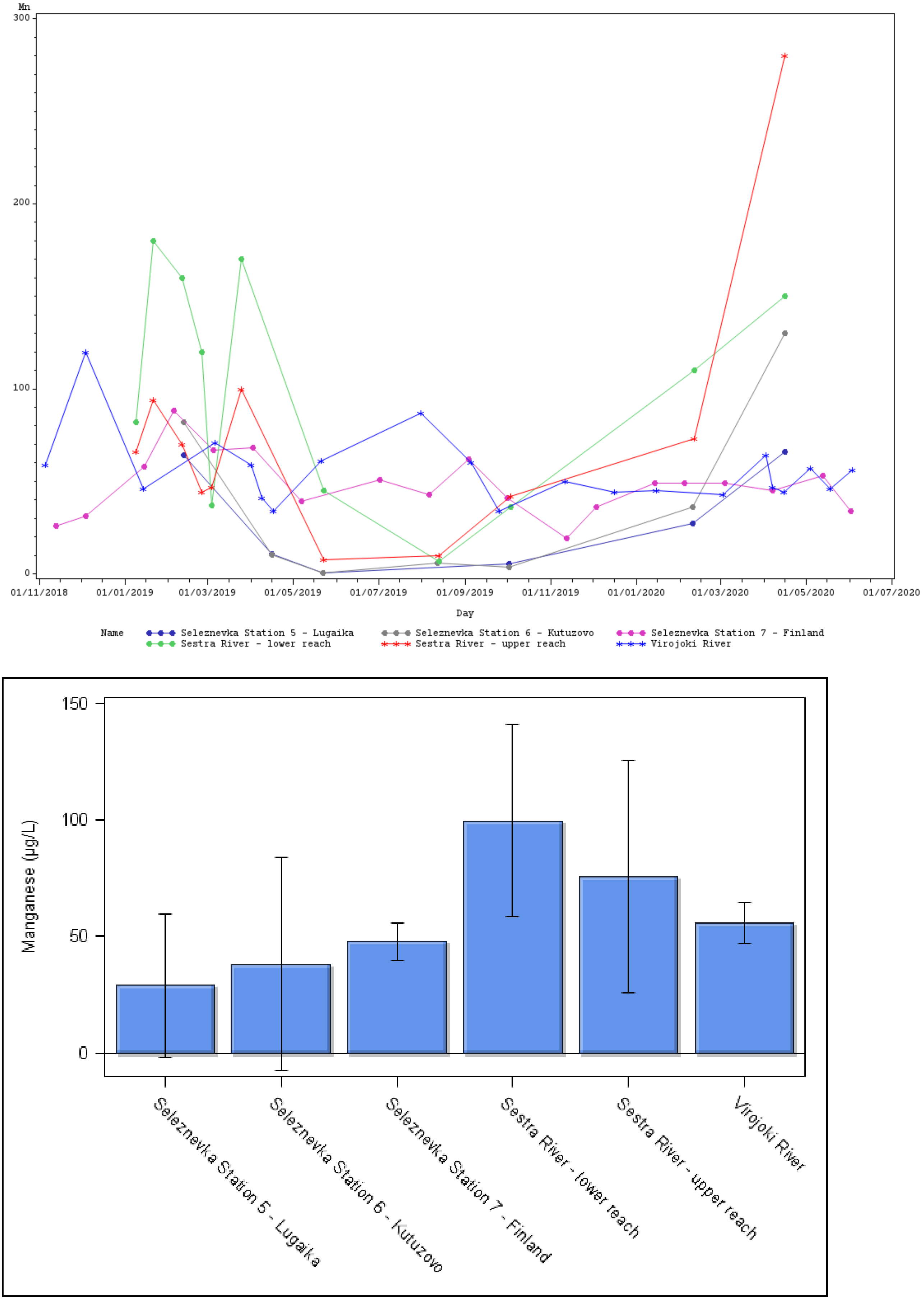


Fig. 8 Manganese (Mn) concentration (µg/L) in the rivers Seleznevka, Sestra and Virojoki. The bars stand for the mean concentration and the whiskers indicate standard error of the mean i.e. 95 % confidence interval of the mean concentration during November 2018–June 2020.

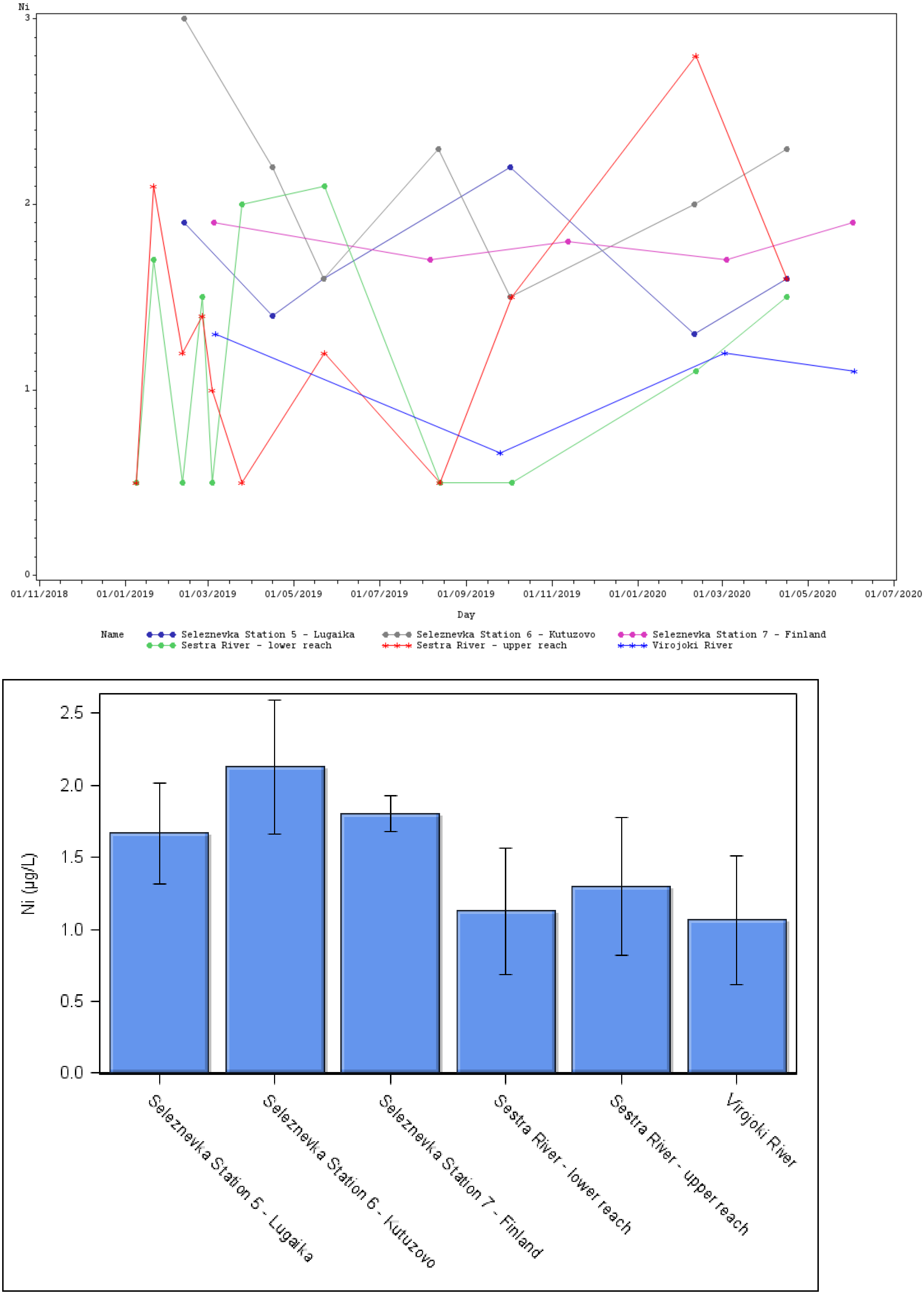


Fig. 9 Nickel (Ni) concentration (µg/L) in the rivers Seleznevka, Sestra and Virojoki. The bars stand for the mean concentration and the whiskers indicate standard error of the mean i.e. 95 % confidence interval of the mean concentration during November 2018–June 2020.