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Environmental Monitoring Programme in the Norwegian, Finnish and Russian Border Area

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Centre for Economic Development, Transport and the Environment for Lapland

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- The County Governor of Finnmark, Norway

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Shuonijaur. Photo Petr Terentjev.

Contents

Introduction

This report includes the results of the Pasvik watercourse monitoring program concentrating on water quality of the Lake Inarijärvi, River Pasvik, Lake Kuetsjarvi and small lakes and streams in the Norwegian, Finnish and Russian border area. Water quality monitoring is a part of the Pasvik Programme created by the environmental authorities and researches for obtaining comprehensive and current information on the changes taking place under the varying anthropogenic load in the joint border area.

Emissions from Pechenganikel industrial complex are the main reason for water quality monitoring in the Pasvik watercourse. The watercourse is impacted by direct discharges from the complex, Nikel city and other settlements, as well as atmospherically transported pollutants. In the quite recent past the emissions from the complex have been high in sulphur dioxide which causes acidification of surface waters. Toxic metals, copper and nickel in particular, are also a problem in the area as are heavy metals accumulating in the organisms, soil and bottom sediments of the surface waters.

The monitoring area covers a large part of the Pasvik catchment and the monitoring programme takes into account the specific characteristics of the area. The trilateral water quality monitoring is a joint effort based on existing national monitoring systems, supplemented where necessary with additional monitoring points and attributes.

This report is the continuation of two previous reports concerning the water quality in the Pasvik watercourse area. Previous reports were published in 2007 and 2011 as instructed by the Guidelines for the environmental monitoring programme in the Norwegian, Finnish and Russian border area.

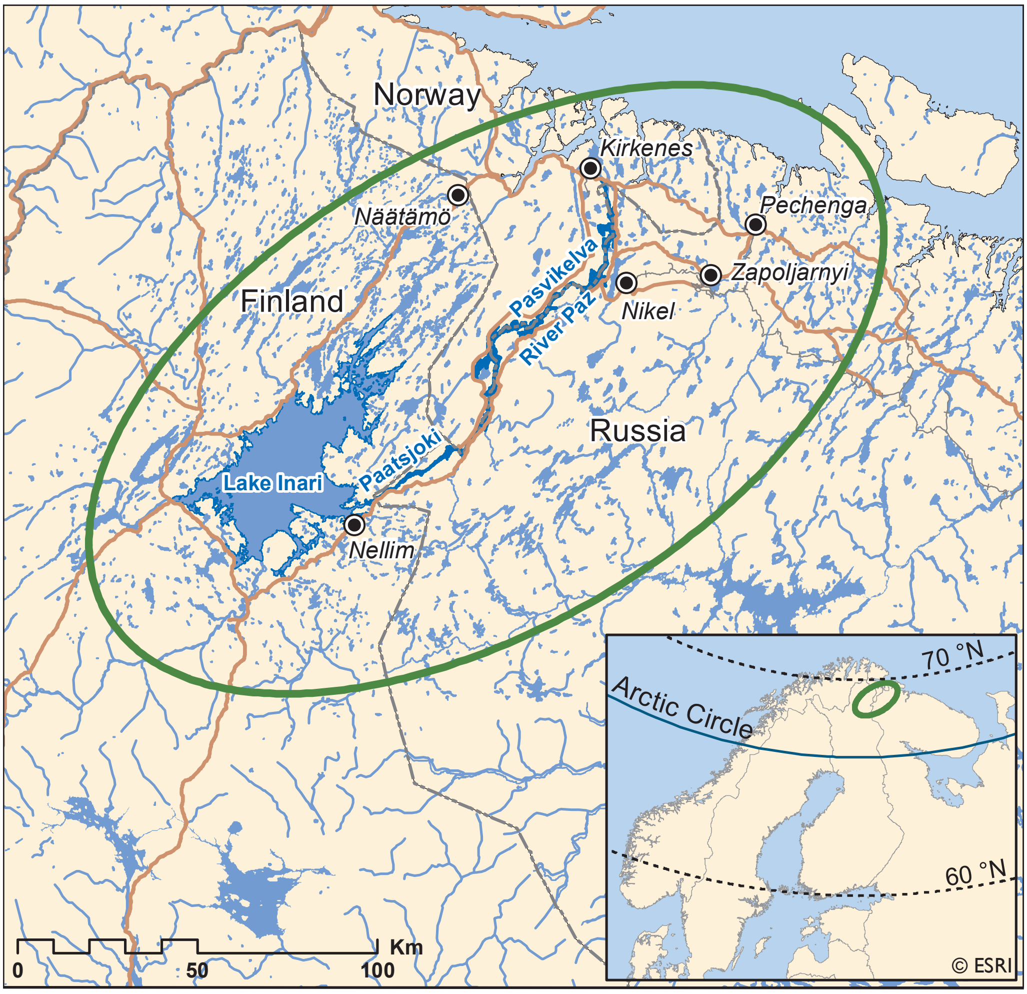


Figure 1. The area covered by the Pasvik Programme.

Water quality in Lake Inarijärvi

JUKKA YLIKÖRKKÖ

Lake Inarijärvi. Photo Annukka Puro-Tahvanainen.

Introduction

Lake Inarijärvi collects the headwaters above Pasvik River. With surface area of 1 084 km² and maximum depth of 92 m it is the largest and deepest lake in the catchment area. The region above and in the lake basin is sparsely populated and to a great extent in natural state. Pasvik River regulation inflicts moderate water level fluctuation on Lake Inarijärvi. The lake water quality is monitored in three long-term stations.

Lake Inarijärvi is free of direct industrial pollution and due to the prevailing wind direction the airborne emissions from Pechenganikel have very little effect on water quality. According to the Finnish Environment Institute's estimates c. 9 % of the phosphorus and 5 % of the nitrogen input to the lake is anthropogenic. Majority of the impact comes to the most populated southern shoreline. There is some nutrient runoff from diffuse sources, namely forestry and household sewage. Point source nutrient discharge from sewage treatment plants or fish farming accounts for a minor proportion of the anthropogenic input.

Analysis methods and sampling

Water quality monitoring network consisted of four monitoring stations (Figure 1):

- Inarijärvi – Vasikkaselkä 2000–2013
- Inarijärvi – Juutuanvuono 2000–2013
- Inarijärvi – Nuoraselkä 2004–2013
- In addition there is a station in the lake outlet in Pasvik, Virtaniemi – LAP ELY 2000–2013 (see Water Quality in the Pasvik watercourse, p. 12)

Data analyzed here are water samples taken from 1–5 meters and for oxygen content near bottom. Samples in Virtaniemi are taken from 1 m depth. Analysis methods are described in detail in Puro-Tahvanainen et al. 2008).

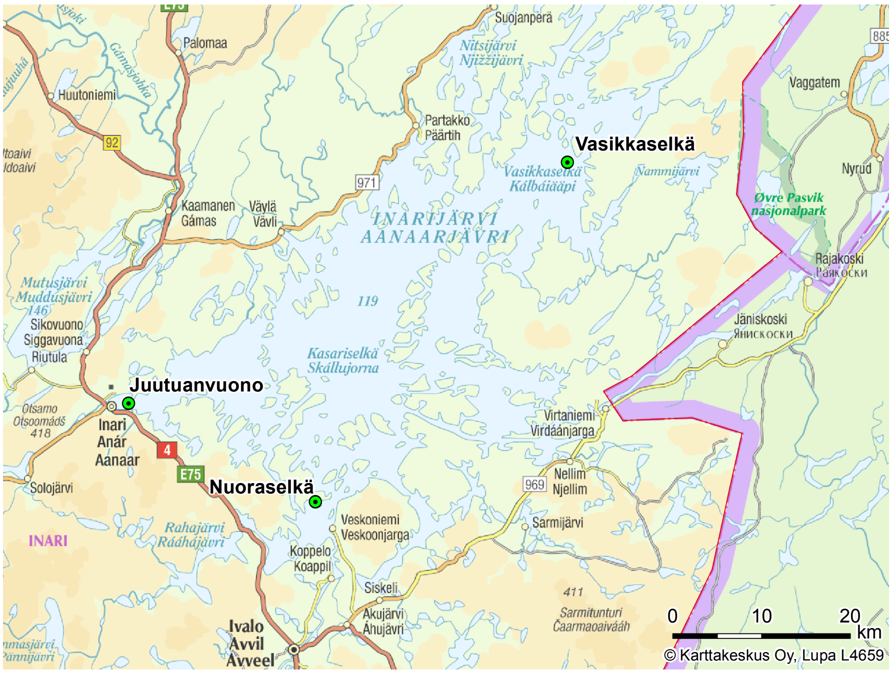


Figure 1. The water quality sampling stations in Lake Inari.

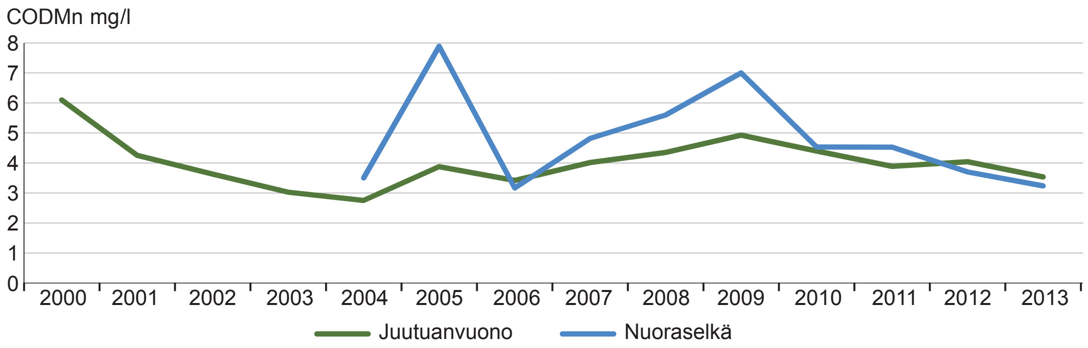
Water sampling in Vasikkaselkä. Photos: Tatu Moilanen.

Results

Organic matter

Inarijärvi is clear-watered. The average water colour in sampling stations varied from 11 Pt mg/l in Vasikkaselkä to 27 Pt mg/l in Nuoraselkä in 2000–2013. Content of organic matter is relatively low: total organic carbon 2–8 mg/l and chemical oxygen demand 2–6 mg/l on average (Figure 2a). Juutuanvuono and Nuoraselkä are located in sheltered bays near river inlets. Vasikkaselkä sampling station is the most exposed, which results in least organic matter (Figure 2b).

a



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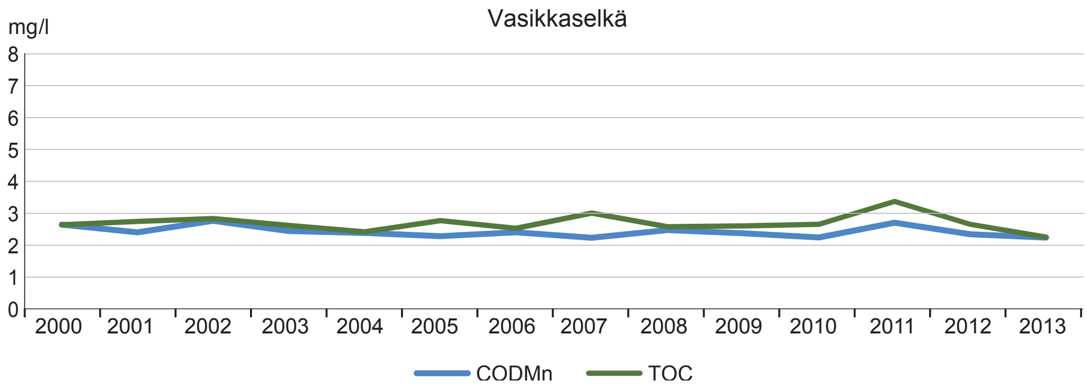


Figures 2a and 2b. Chemical oxygen demand in Juutuanvuono and Nuoraselkä (a) and Vasikkaselkä with total organic carbon (b). Samples are annual averages from 1–5 m water column for COD and whole water column for TOC.

Chlorophyll content

Chlorophyll content in the lake is low. Average growing season (June–September) chlorophyll a content during the observation period 2000–2013 has been below detection limit 1 µg/l or at most 3.1 µg/l in Nuoraselkä and 2.6 µg/l in Juutuanvuono, measured in 0–2 m water column. In Vasikkaselkä mean chlorophyll content has mostly been below detection limit or at most 1.3 µg/l.

Phosphates and phosphorus

During the years 2000–2013 average annual total phosphorus concentrations have varied from 4.6 to 10.2 µg/l in the bay stations, which locate close to the anthropogenic nutrient sources. Meanwhile in Vasikkaselkä total phosphorus has remained below 5 µg/l (Figure 3). Statistically significant trend is observed in Vasikkaselkä, where total phosphorus has been slightly decreasing in long time scale (Puro-Tahvanainen et al. 2011). For all sampling stations the annual average phosphate phosphorus was below analysis detection limit (2 µg/l).

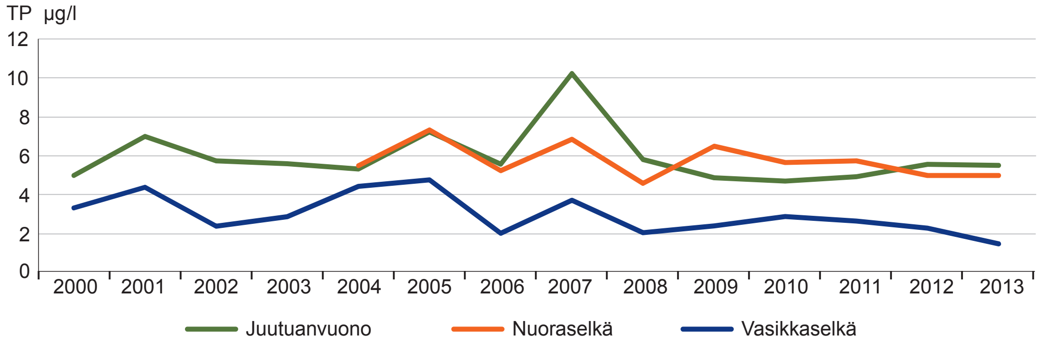
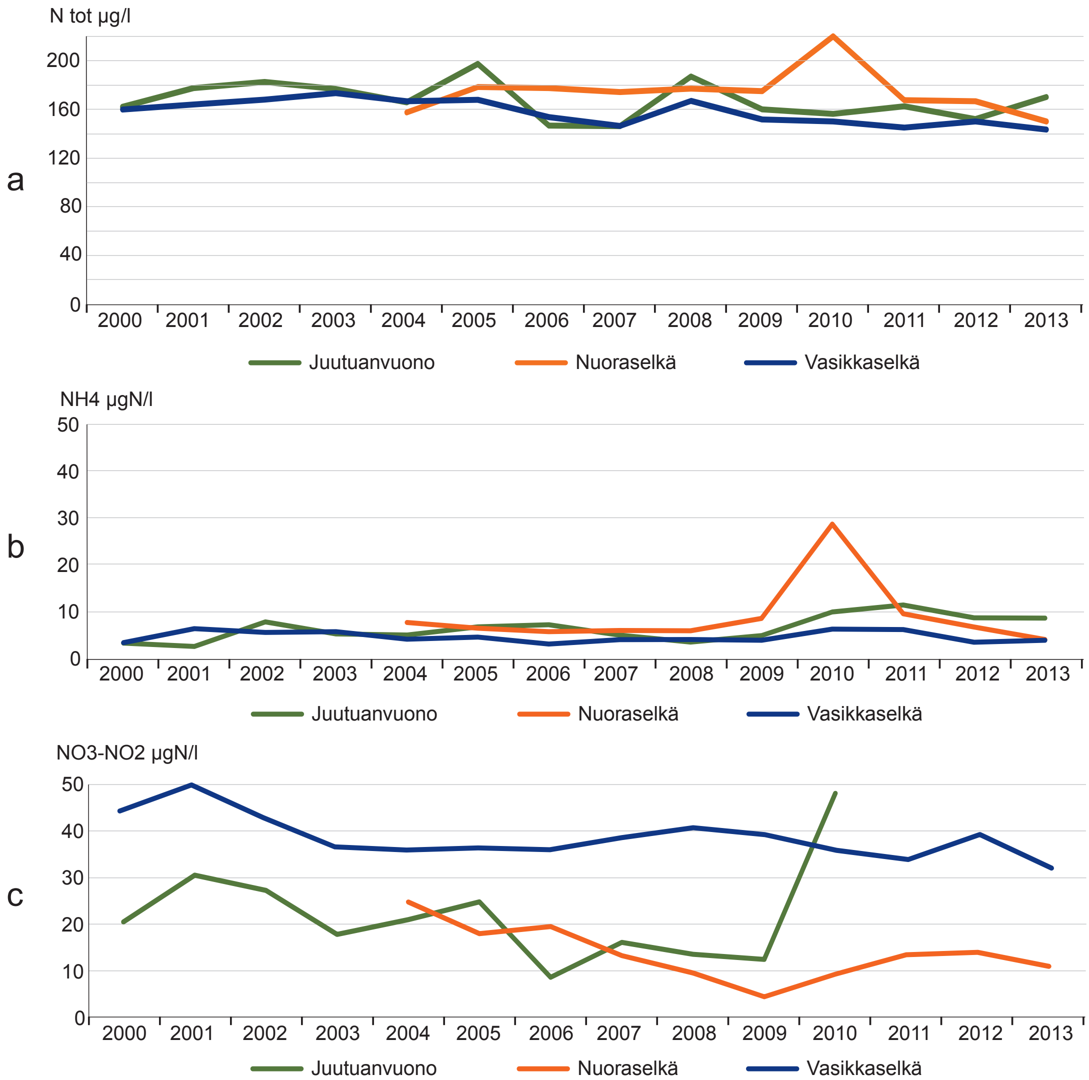


Figure 3. Total phosphorus concentrations in the three water quality sampling stations as annual averages measured from 1–5 m water column.

Nitrogen

Average total nitrogen concentrations have been 146–220 µg/l in the bay stations, in which there is high variation between the years and no clear trend (Figure 4a). In Vasikkaselkä total nitrogen varied from 143 to 173 µg/l during the observation period and there has been slight statistically decreasing trend in long time scale.

The levels of inorganic nitrogen are generally low (Figure 4b and c). Ammonium concentrations are less than 20 µg/l, on average, with the exception of Nuoraselkä 2010. Nitrate and nitrite makes: 5–50 µg/l depending on the station and year. There is a visible decreasing trend in Vasikkaselkä (Figure 4c).



Figures 4a, 4b and 4c. Average annual total nitrogen concentrations (a), ammonium concentrations (b) and nitrate-nitrate concentrations (c) in the three sampling stations measured from 1–5 m water column.

Salinity balance

Conductivity in Lake Inarijärvi is on average below 4 mS/m (Figure 5) and represents undisturbed clear lake water. Mean sulphate levels during autumn turnover (September-October) settle between 2.0 and 2.6 mg/l in all the sampling station through the years 2000–2013.

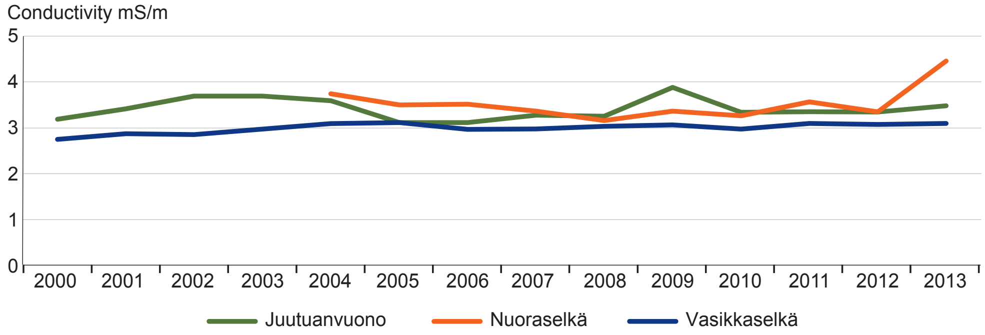


Figure 5. Conductivity in the three sampling stations as annual averages measured from 1–5 m water column.

Alkalinity and pH factor

Lake Inarijärvi has relatively good acid buffering capacity and the water is neutral: pH 7.1 on average between the sampling stations and years 2000–2013. Alkalinity means are above 0.2 mmol/l in Nuoraselkä and 0.15–0.19 mmol/l in Vasikkaselkä (Figure 6). Data from Juutuanvuono is inconsistent. The lower alkalinity values in Vasikkaselkä have been increasing and the trend is statistically significant (Puro-Tahvanainen et al. 2011).

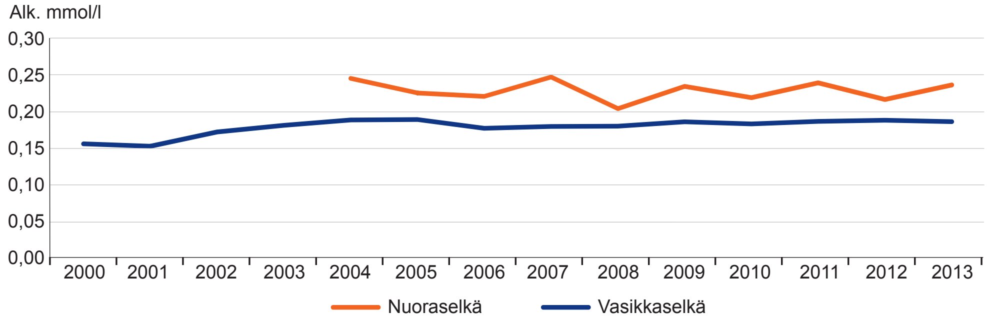


Figure 6. Average annual alkalinity values in Nuoraselkä and Vasikkaselkä measured from 1–5 m water column.

Oxygen

Winter oxygen conditions near bottom in Vasikkaselkä deep basin (93 m) are good (Figure 7). Average late winter (March-April) dissolved oxygen concentrations have been 3.6–11.4 mg/l in 2000–2013. As oxygen saturation that is 27–83 % of the full potential amount. There is no visible trend in the observed 13 years. However in the span of whole monitoring history from 1975 oxygen saturation has been decreasing (Puro-Tahvanainen et al. 2011).

Figure 7. Average March-April oxygen saturation in Vasikkaselkä near bottom (90–93 m).

References

Puro-Tahvanainen, A., Aroviita, J., Järvinen, E.A., Kuoppala, M., Marttunen, M., Nurmi, T., Riihimäki, J., Salonen, E. 2011. Inarijärven tilan kehittyminen vuosina 1960–2009. Suomen ympäristö 19/2011. 89 pp.

Puro-Tahvanainen, A., Grekelä, I., Derome, J., Stebel, K. (ed.) 2008. Environmental Monitoring programme in the Norwegian, Finnish and Russian Border Area - Implementation Guidelines. 51 pp.

Laboratory analysis. Photo Aleksandr Cherepanov.

Water Quality in the Pasvik watercourse

MARINA ZUEVA

Pasvik watercourse. Photo Jukka Ylikörkkö.

Introduction

The study of the Pasvik watercourse remains an important ecological challenge for the three countries sharing the catchment area of the river basin. In the lower course of the watercourse the load on the basin is formed by the sewage and discharge impact of the Pechenganikel mining and metallurgical complex on the Kola Peninsula. Both Russian and Norwegian hydropower plants are situated on the watercourse and also have an impact on the condition of the river. Continuous monitoring of the water quality and detection of variability in the quality parameters are necessary for the assessment of the condition of the river, its dynamics and ultimately for the measures to be taken to reduce the negative impact and to improve the state of the environment in present day conditions.

This publication continues the Pasvik River basin water quality study providing an assessment of present status and changes over the last ten years.

Pasvik watercourse flows out of Lake Inari in Finland and flows into the Bøkfjorden of the Varanger-fjord in the Barents Sea in Norway. The basin has a total area of 18 325 km^2 and includes a large number of lakes and wetlands, constituting a river-and-lake system rather typical for the Kola Peninsula. The lower course of the Pasvik river includes the Lake Svanevatn (Salmijarvi) linked by a stream with the Lake Kuetsjarvi. Kolosjoki River flows into Lake Kuetsjarvi and is affected by direct discharge of sewage from the Pechenganikel.

Pollution sources in the Pasvik River basin

The load on the waters of the Pasvik River basin comprises of industrial pollution, airborne pollution and direct discharge of waste water from the Pechenganikel smelter, the facility of mining and processing complex for copper and nickel ores belonging to Kola GMK. The Kolosjoki River serves as the main collector of the smelter's treated waste water, mine water, and household sewage of the Nikel settlement. Waste water is discharged 1.4 km upstream from the river mouth. Since 1996 the amount of discharge has decreased and the load level has been stable. In the recent years (2008–2012) there has been a decreasing trend (Figure 1). The figures of the emissions of sulphur dioxide, nickel and copper compounds are available only to the year 2010 (Figure 2).

The Pechenganikel mining and metallurgical complex is located in the Russian border towns of Nikel and Zapoliarny. The complex is a part of the OJSC Kola GMK, a subsidiary of MMC Norilsk Nickel Group. OJSC Kola GMK is making large investments into environment protection measures and facilities. The Kola GMK Environment Management System has been operating since 2004 and it is targeted to minimize and prevent negative environment impact as well as to restore the previously damaged adjacent land areas.

Pasvik watercourse. Photo: Jukka Ylikörkkö.

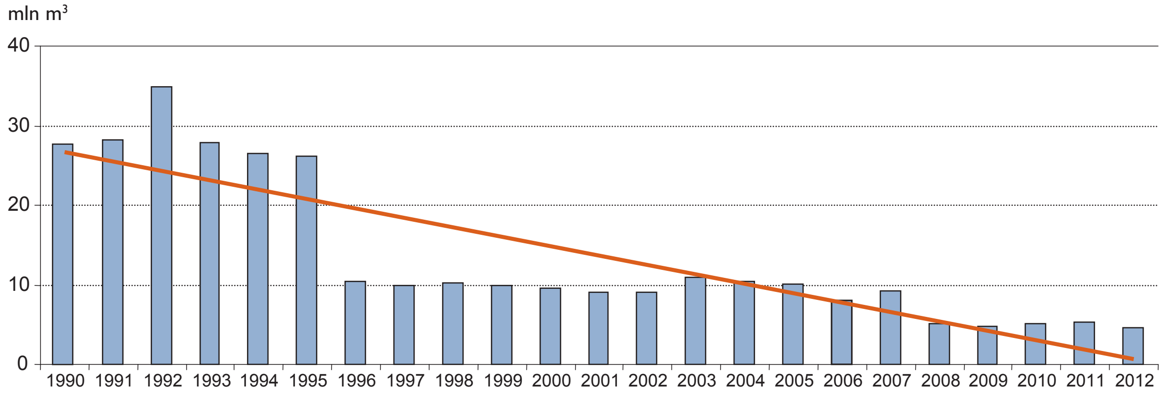


Figure 1. Wastewater discharge from GMK Pechenganikel.

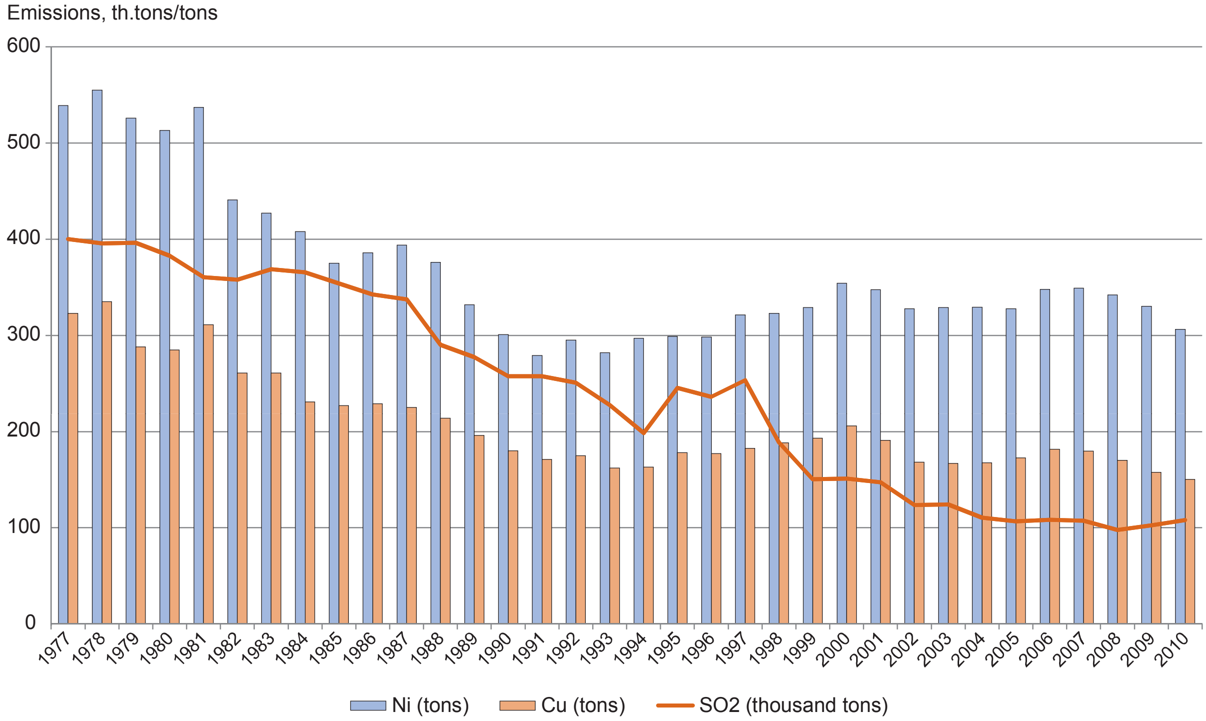


Figure 2. Emissions of sulphur dioxide (SO_2), nickel (Ni) and copper (Cu) compounds at the Pechenganikel plant.

The Kola GMK has reduced the SO_2 emissions in the last years. Also the water uptake for the processes has been reduced and the waste water treatment has improved.

According to the Kola GMK reports the emissions of pollutants, including sulfur dioxide, into the ambient air and the discharge of pollutants with waste water have been decreasing in the latest years. Also the amount of natural water uptake, both from surface and ground water sources, has been reduced.

Along the Pasvik River watercourse industrial wastewater from the Pasvik hydropower plants cascade is discharged (Figure 3). The discharge amounts to tens of thousands of tons per year, with a decreasing trend in the latest years. The discharged water is treated to the Russian standards and contains low concentrations of organic and other substances. Thus, the hydropower plants' impact is not high. However there are also negative consequences even if the amounts of pollutants are relatively small. Negative aspects include changes in the rivers' regime resulting from construction of water reservoirs, upsetting of the natural water balance because of water evaporation from the reservoirs and impact on the hydro-chemical regime of small rivers and their self-cleaning capacity.

Analysis methods and sampling

The samples collected in the Pasvik watercourse were analyzed in the laboratories of the Murmansk Department for Hydrometeorology and Environmental Monitoring (MUGMS), Institute of North Industrial Ecology

Yaniskoski hydropower station. Photo Sergey Kotov.

Table 1. Dynamics of the Kola GMK environmental impact parameters.

Impact parameters	2012	2011	2010
Pollutants' emission into the atmosphere, total (thousand tons)	149	147	155
including			
Sulfur dioxide (thousand tons)	136	134	142
Solids (thousand tons)	10	10	10
Water discharge (million m³)	26.3	27.4	27.3
Pollutants' discharge (thousand tons)	77.5	70.5	64.7
Recycling and decontamination of waste at the company's own facility (million tons)	5	3	4
Waste disposal (million tons)	6.9	6.2	6.6

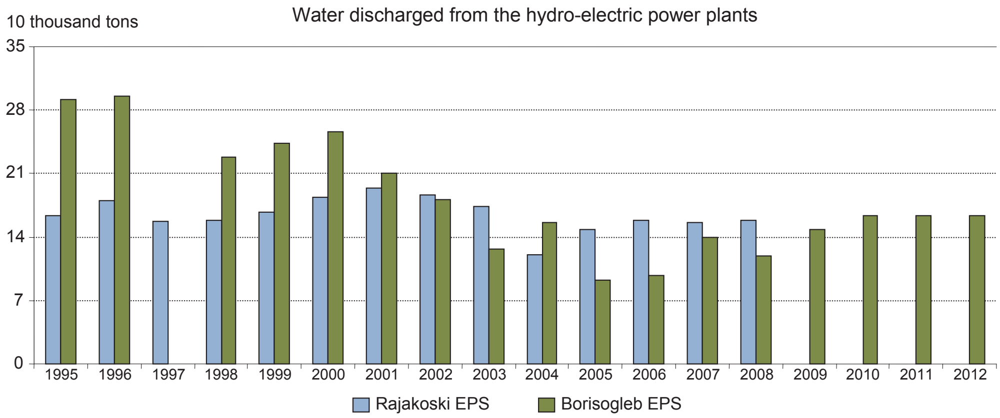


Figure 3. Discharge from Pasvik HPP.

Problems, KSC RAS (INEP) and LAP ELY using standard analytical methods. Since 1996, the laboratories have regularly participated in intercalibration exercises. However the data cannot be combined in all cases as there was some variation in the analysis results due to the use of different methodology in the individual laboratories and the modernization and improvement of the methodology over time.

The water samples were taken at the monitoring sites at the surface level at depths of 0.1–0.3 meters from the surface. Water temperature, pH and dissolved oxygen concentration were measured immediately during sampling.

Samples for determining metal concentrations were filtered through a 0,45 µm membrane filter and preserved with nitric acid. Metals and other elements were determined by flame and flameless atomic absorption spectrophotometry. Nutrient samples were analyzed using the spectrophotometry and ionic chromatography method. Samples for determining ionic composition were analyzed using the titrimetric and ionic chromatography method. Biological oxygen demand (BOD) was determined on the sampling day using the "light and dark bottle" method.

The water quality monitoring network

Water quality assessment was carried out by the partner authorities at the following stations (Figure 4):

- Pasvik, Virtaniemi – LAP ELY 2001–2013
- Pasvik, Kaitakoski – MUGMS 2001–2013
- Pasvik, Janiskoski – MUGMS 2001–2013
- Pasvik, Rajakoski – MUGMS 2001–2013
- Pasvik, Hevaskoski – MUGMS 2001–2013
- Pasvik, Jordanfossen – FMFI/Bioforsk/INEP 2002, 2003, 2005, 2008
- Pasvik, Ruskebukta – FMFI/Bioforsk/INEP 2002–2005, 2008–2013
- Pasvik, Tjerebukta – FMFI/Bioforsk/INEP 2003–2005, 2007–2008, 2010-2012
- Pasvik, Vaggatem, FMFI/Bioforsk/INEP 2002–2005, 2008–2013
- Pasvik, Melkefoss – FMFI/Bioforsk/INEP 2002, 2005, 2008
- Pasvik, Svanevatn (Salmijarvi) – FMFI/Bioforsk/INEP 2003, 2005, 2008
- Pasvik, Bjornevatn – FMFI/Bioforsk/INEP 2003, 2005, 2008
- Pasvik, Skrukkebukta – FMFI/Bioforsk/INEP 2002–2005, 2007–2013
- Pasvik, Borisoglebski – MUGMS 2001–2013
- Stream Protoka (between the lakes Kuetsjarvi and Svanevatni) – MUGMS 2001–2013
- Kolosjoki, 14,7 km from the town of Nikel – MUGMS 2001–2013
- Kolosjoki – MUGMS 2005–2013

Monitoring at the Inari, Vasikkaselkä and Pasvik, Virtaniemi stations (LAP ELY) was carried out 2–7 times a year. Monitoring at the INEP stations was carried out 2–7 times a year. The MUGMS stations on the Pasvik watercourse are all (except Kaitakoski) located below the hydropower plants, and therefore the activities of the power plants have some impact on water quality at the sampling stations. Sampling on the River Pasvik was performed 6 times a year: March, May, June, July, August and October. Monitoring was carried out monthly on the River Kolosjoki and the Stream Protoka.

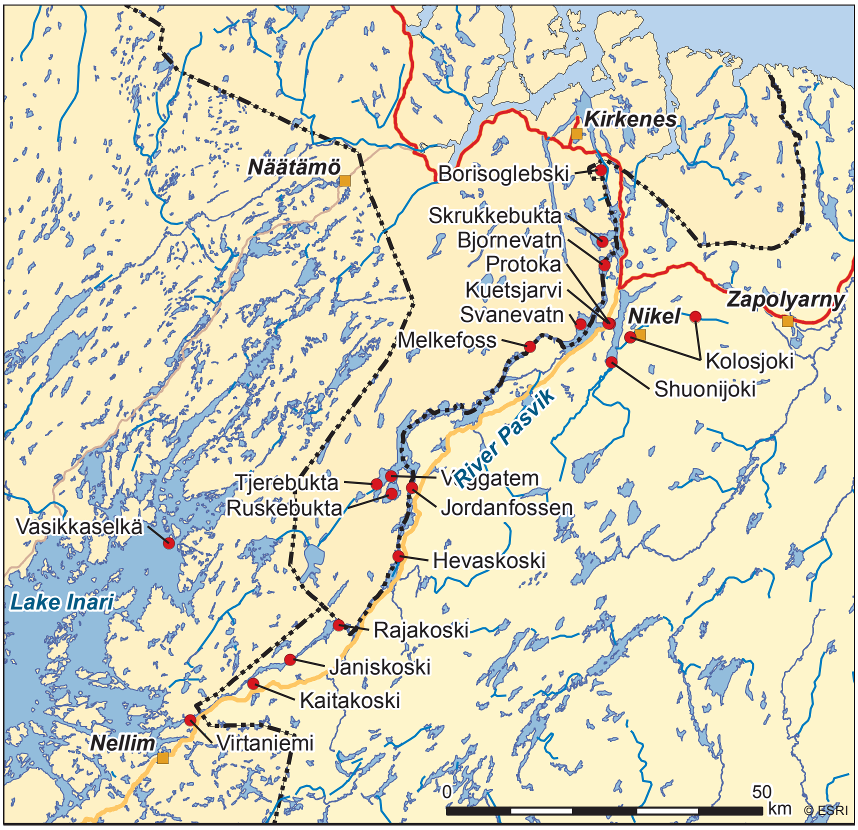


Figure 4. Monitoring stations in the Pasvik watercourse in cooperation between six different organizations.

Water quality in the Pasvik watercourse

The chemical composition of water in the Pasvik River is defined by the subsoil layer of the river bed, natural water drainage, surface run-off and deposition with rain and snow. Industrial impact includes the companies' emissions into the air and direct discharge from a pollution source into the water body. Industrial companies' impact is clearly observed in the river areas close to the Pechenganikel plant.

The report presents the status of the Pasvik River water including assessment of water quality based on the chemical composition, in particular the concentration of nitrogen and phosphorus compounds, the principle ions, and metals. The distributions of the main pollution indicators and dynamics of their changes are also considered.

Organic matter

The Pasvik River is an oligotrophic water body. The total organic carbon (TOC) amounted to ca. 3 mg/l in the clean section of the river near Virtaniemi station (LAP ELY), and 4–6 mg/l at the INEP monitoring stations. The concentration of easily oxidable organic matter at the Pasvik hydropower plants (MUGMS) is under 1 mg/l according to biological oxygen demand (BOD) and 6–8 mg/l according to chemical oxygen demand (COD) (Figure 5).

Phosphates and phosphorus

The average concentration of total phosphorus (Ptot) in the Pasvik River at the INEP monitoring stations varies within 7–38 μg/l with the highest concentrations observed at Ruskebukta station in 2011 and 2013 (34–38 μg/l) (Figure 6). Higher concentrations of organic matter have also been observed there (up and over 6 mg/l TOC). The total phosphorus concentration at Virtaniemi monitoring site was 2–3 μg/l in 2010–2012.

The average concentration of phosphate phosphorus (PH4) along the whole river course fluctuated from 0 to 3 μg/l. The maximum was measured at stations Ruskebukta and Vaggatem with concentrations of 4 μg/l, which are in line with the natural background.

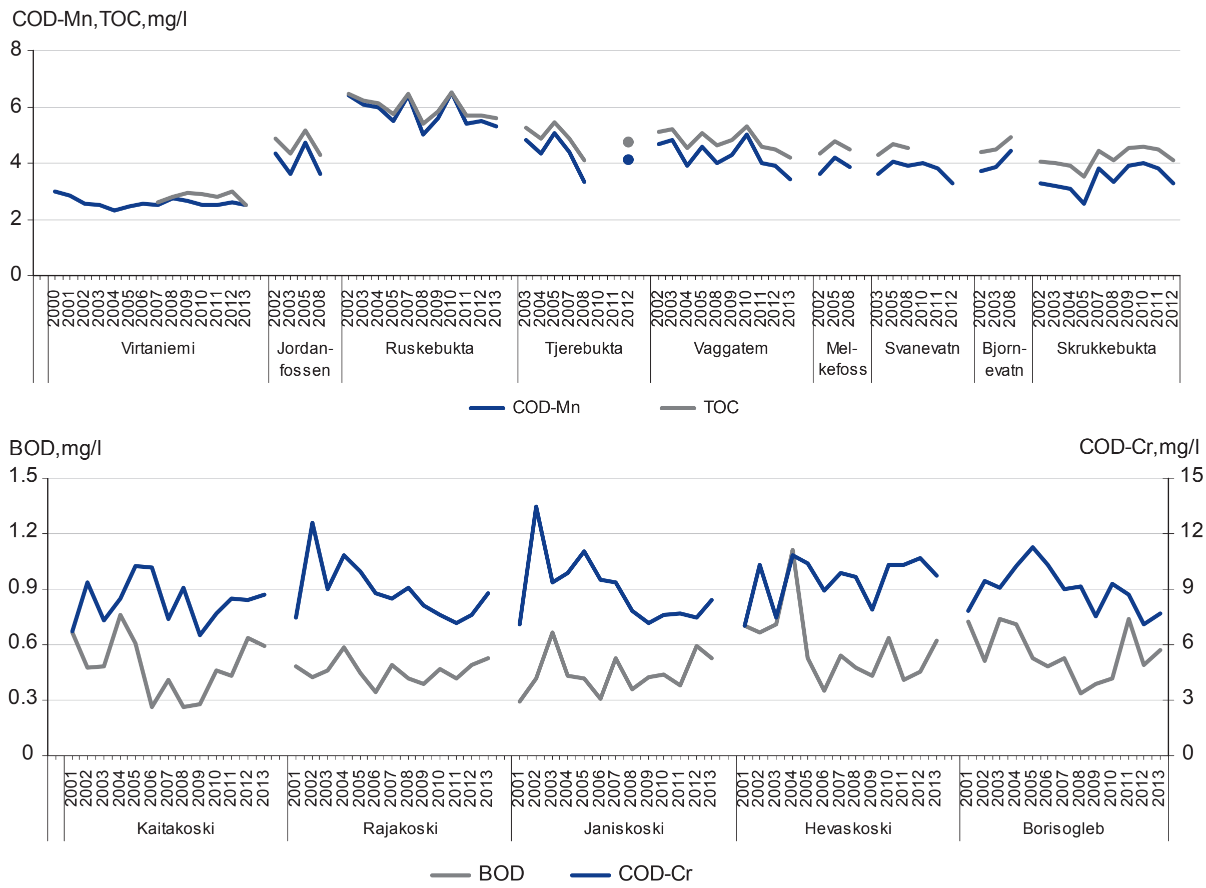
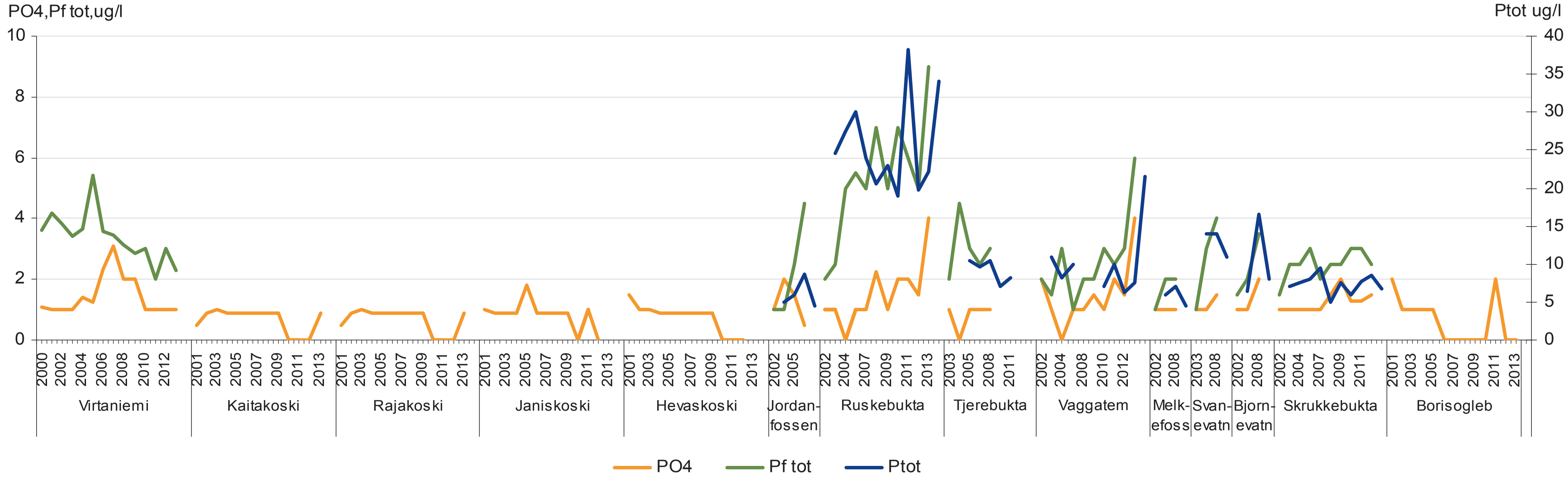


Figure 5. Organic matter distribution in the Pasvik River.



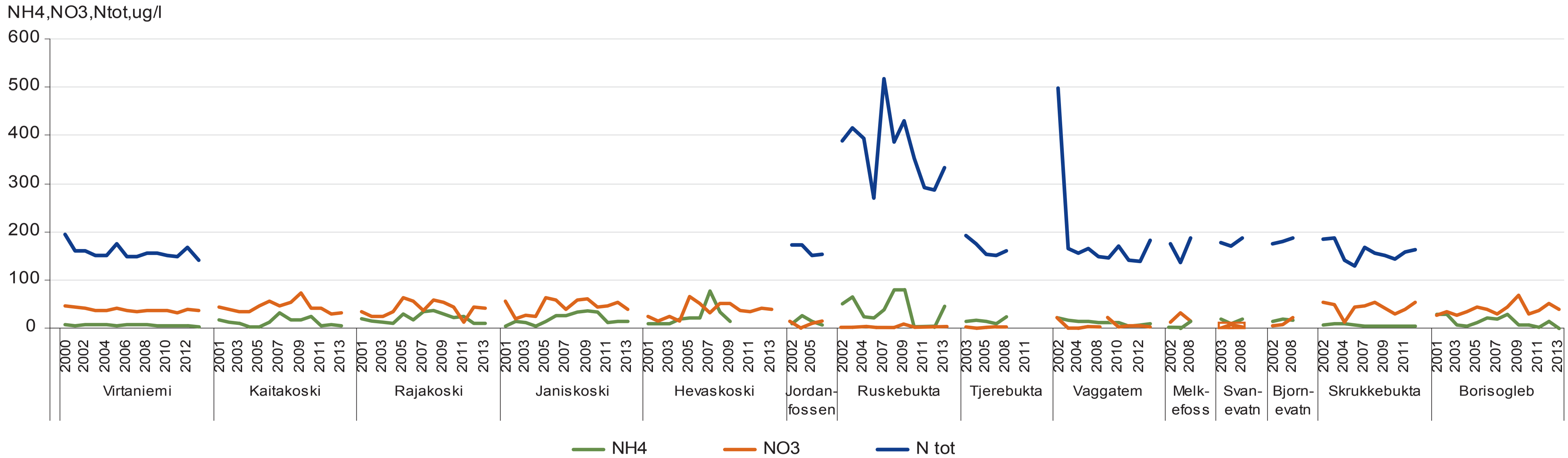


Figure 6. Distribution of phosphorus and nitrogen compounds.

Nitrogen

The annual mean total nitrogen concentration (Ntot) is increasing from 150–180 µg/l in the upper course of the Pasvik River (Virtaniemi, LAP ELY) to higher values 300–500 µg/l in the middle course (Ruskebukta, INEP) (Figure 6). The concentration of nitrates (NO_3) amounted to 0–50 µg/l and in the lower and middle course (Hevaskoski, Skrukkebukta, Borisogleb) fluctuations up to 65 µg/l were observed.

The average concentrations of ammonium nitrogen (NH_4) along the whole river course did not exceed 50 µg/l but in specific years (2008–2009) the concentration was up to 80 µg/l at the stations Hevaskoski and Ruskebukta.

Salinity balance of water

Mineralization means the sum of the mass of all ions determined during water analysis. Low mineralization of water with a low concentration of the principle ions is typical of the Pasvik River. Calcium-ions (Ca^{2+}) prevail with a share of ca. 50 % in the total mineralization and a concentration of 2–3 mg/l, in downstream Melkefoss 2–4 mg/l. The concentration of magnesium ions (Mg^{2+}) varies around 2 mg/l. Sodium ion (Na^+) concentrations over 2 mg/l are observed in the impact areas of industrial and power production companies and the concentrations of other cations are distributed similarly (Figure 7).

The water hardness is 20–25 µeq/l which is normal for river water.

In the impact areas the concentrations of sulphate ions (SO_4^{2-}) are characterized by value fluctuations and exceeding the average sulphate concentration in the water, reaching 4–5 mg/l (INEP, MUGMS). The sulphate portion among the anions amounts to 15–20 %, increasing up to 30 % in the impacted river areas. The average concentration of chlorides (Cl^-) is also increasing to 3 mg/l in the same sections of the river whereas their concentrations generally are under 2 mg/l.

Alkalinity and pH factor

The water alkalinity in the river varies within 15–25 µeq/l (Figure 8). The pH level ranges from 6.80 to 7.3; the lower values were measured in the uppermost river course and in the section from Ruskebukta to Skrukkebukta. The observed alkalinity values are typical of natural river water.

Metals

Industrial impact on the Pasvik River is clearly seen from the distribution of the metals, nickel (Ni) in particular (Figure 9). In the watercourse upstream from Lake Kuetsjarvi nickel concentrations are minimal (up to 2 µg/l) and may be regarded as background values. Downstream from the lake a considerable increase is observed. The highest concentration has reached 12–19 µg/l (Bjornevatn in 2002 and 2008, Borisogleb in 2006) and in 2010–2013 higher values (6–11 µg/l) were also observed at the same stations.

The concentration and distribution of other metals in the Pasvik River water (Fe, Zn, Mn, Pb) is close to the natural background, but higher concentrations and exceeding of the background level is observed in the river section downstream from Ruskebukta to Skrukkebukta.

Dynamics of chemical content

The dynamics of organic matter and nutrients (N, P) in the river water are shown in Figures 5 and 6 and in more detail the dynamics at some stations are shown in Figure 10. The monitoring results over the last years demonstrate certain stabilization of the Pasvik River hydro-chemical regime.

The average concentration of the principal mineral ions practically has not changed in the last years. Higher concentrations are constantly observed at the monitoring stations in the combine plant area of influence (Skrukkebukta INEP, Borisogleb MUGMS, Figures 7 and 11).

The concentrations of metals in the river are more variable both in time and at different monitoring sites because these elements are more mobile and load-dependent (Figures 9 and 12). Metals, especially copper and nickel, and sulphates serve as indicators of the negative impact of contaminated discharge and drainage from the combine plant.

The plant's impact is consistently observed during the analysis of the distributions of these substances along the watercourse. The concentrations are higher, sometimes considerably higher, in the section downstream the lake system where the discharge-contaminated river Kolosjoki flows into the Pasvik River than at the stations upstream River Kolosjoki. The concentrations decrease at the monitoring stations closer to the river estuary, however they remain at a higher level than at upstream from the plant (Figures 8, 9 and 13).

Figure 7. Distribution of main ions in the Pasvik river.

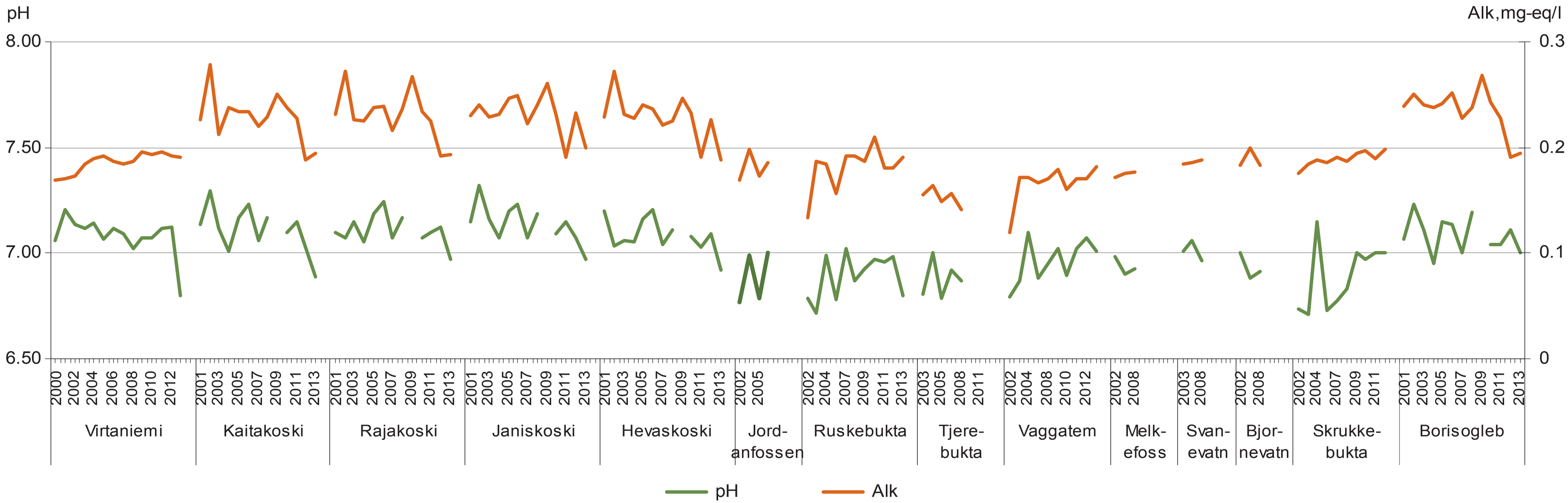
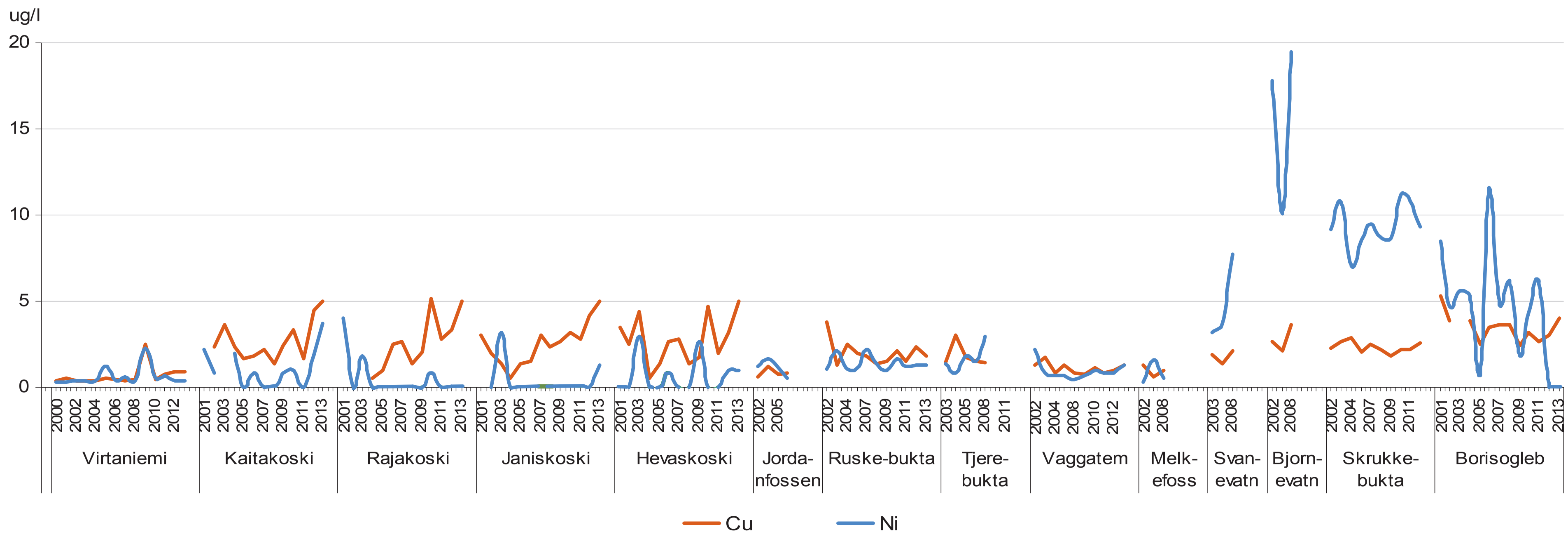


Figure 8. pH and alkalinity in the Pasvik River.



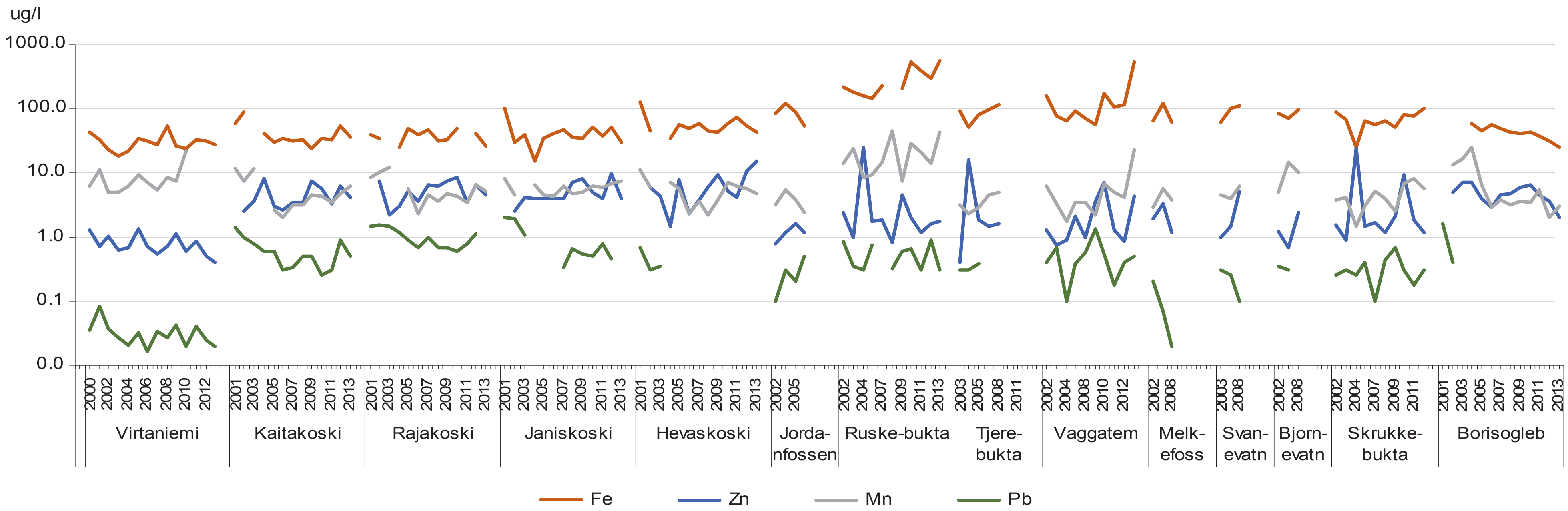


Figure 9. Distribution of copper, nickel and any other metals.

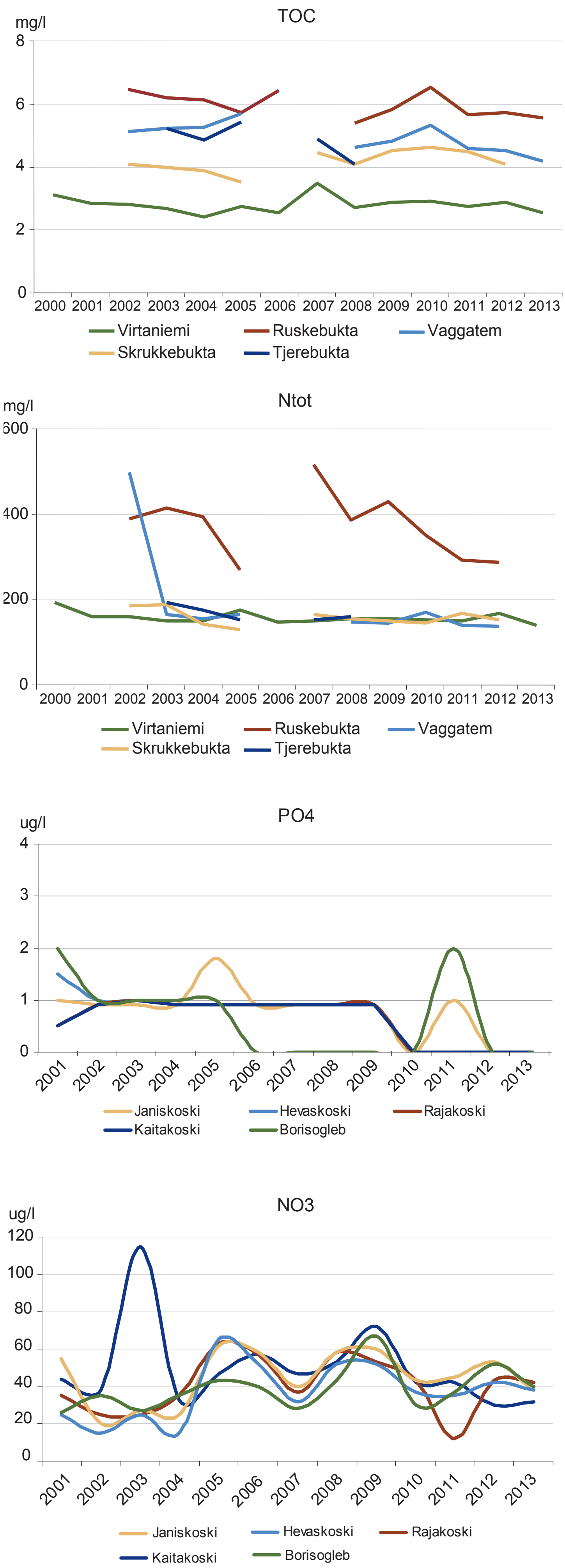
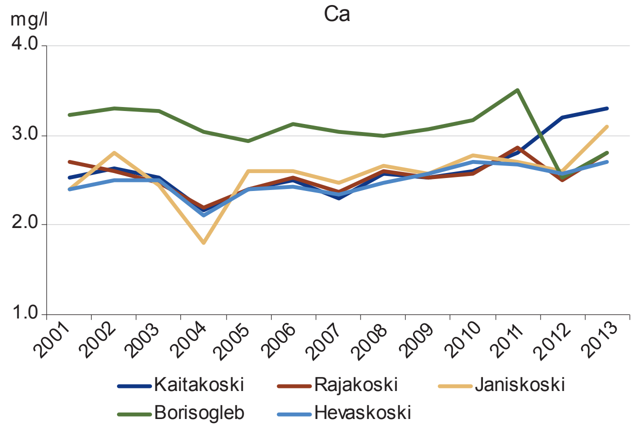
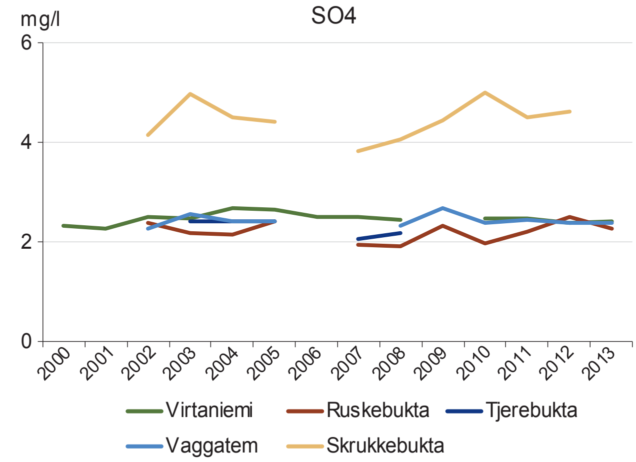
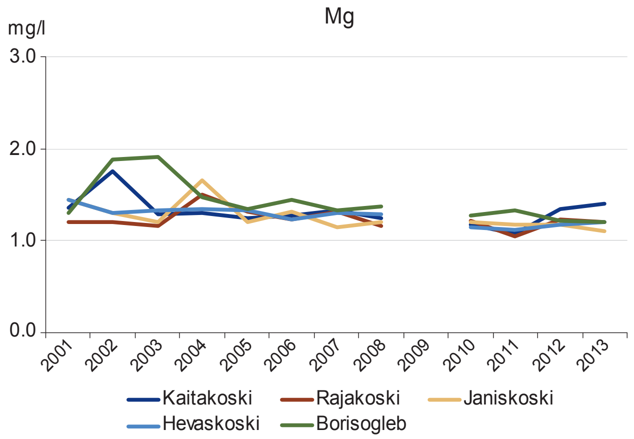
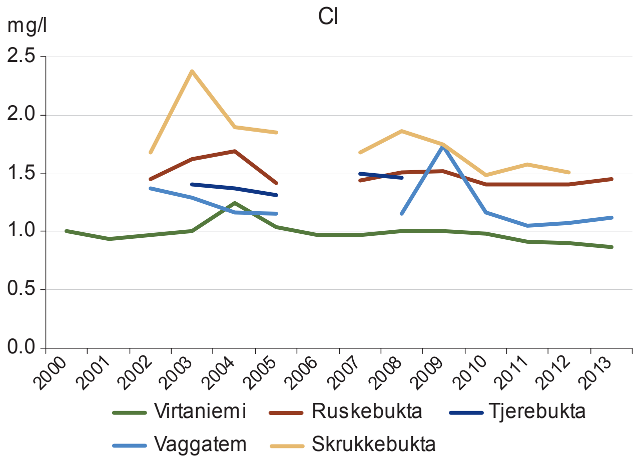


Figure 10. Dynamics of organic matter and nutrients.









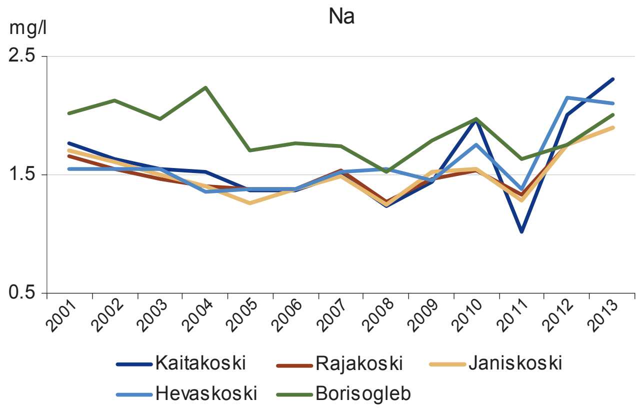
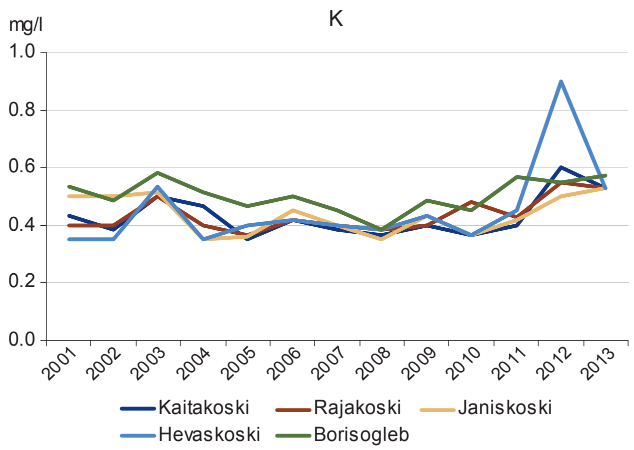


Figure 11. Dynamics of principal ions.



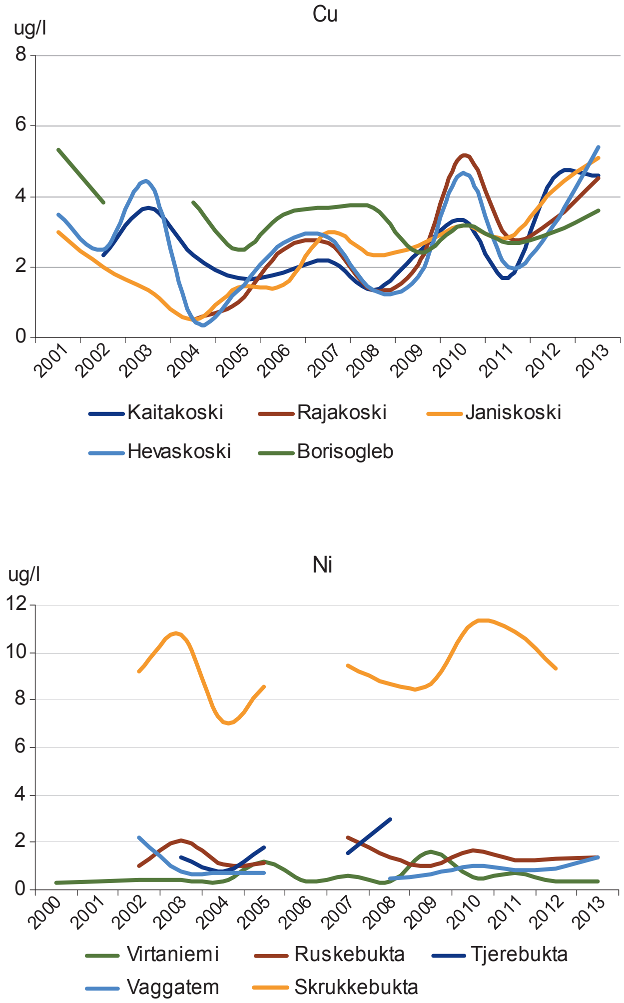


Figure 12. Dynamics of copper and nickel.

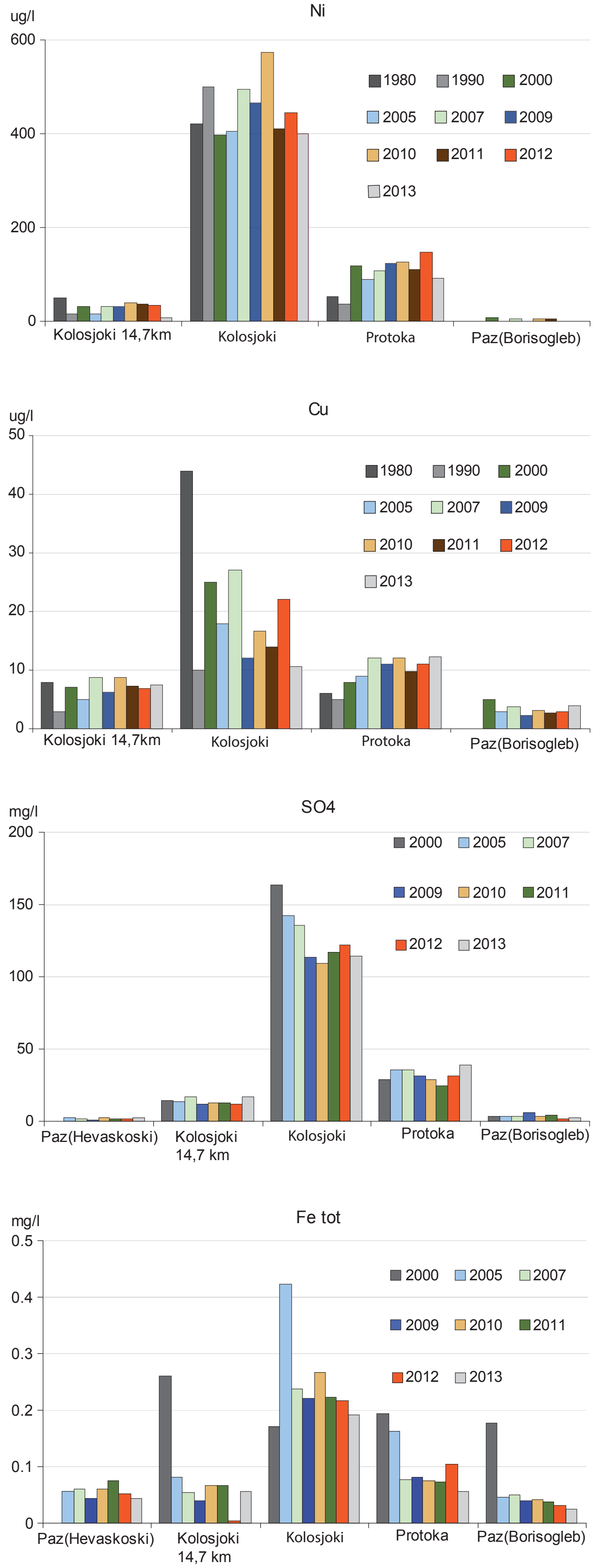


Figure 13. Impact from the sources on the Pasvik watercourse pollution.

Conclusions

The monitoring of the Pasvik River status is ongoing and this report is based on the monitoring results of 2000–2013.

Regular monitoring of the water pollution indicators – organic matter and nutrients, ion composition and concentrations of metals and microelements – is performed at more than 20 stations of 6 organizations from three countries: INEP and MUGMS (Russia), FMFI, University of Tromsø and Bioforsk Svanhovd (Norway) and LAP ELY (Finland). The samples are analyzed in the laboratories of INEP, LAP ELY and MUGMS.

The analysis of water monitoring data of the observation period confirms certain stabilization of the established hydro-chemical regime of the Pasvik River and its basin according to the concentrations levels of pollutants and pollution indicators

The monitoring data also show that pollutants are brought into the water bodies of the river basin system both directly with wastewater and by transboundary air transport.

Copper, nickel, and sulphates are the main pollutants of the basin. The most polluted water bodies in the basin are the Kolosjoki River, where the combine plant wastewater is discharged and the stream connecting the Lakes Salmijarvi and Kuetsjarvi. The concentrations of metals and sulphates in the water notably increase downstream from the Lake Kuetsjarvi.

According to the Kola GMK all possible measures are taken and in general the monitoring data confirm certain stabilization of the basin water status in the latest years.

Regular monitoring in the Pasvik River basin is necessary in the future. Joint results provide the basis for unbiased assessment of the status of the Pasvik River and thus the environment may be protected in a more efficient manner.

Water quality in Lake Kuetsjarvi

NIKOLAY KASHULIN
TATYANA KASHULINA
SERGEI SANDIMIROV


Pasvik watercourse. Photo Jukka Ylikörkkö

Introduction

Lake Kuetsjarvi water quality was monitored in 2013 at four main monitoring stations and at the lake outlet (Figure 1). Surface water was sampled also at other water bodies and watercourses (23 places altogether) at the Pasvik River in the border territories of Russia and Norway at the end of spring flood, in summer and in autumn.

Water quality

Organic matter

The Pasvik River is characterized by a quite consistent chemical oxygen demand (CODMn) value of 3.04–4.16 mg/l except for the Ruskebukta reach where COD value is 4.52–6.68 mg/l. In Lake Kuetsjarvi the CODMn value has been changing within 3.78–4.62 mg/l over the period of research and the territorial and seasonal variability in the organic matter content was insignificant.

The water color of Lake Kuetsjarvi has quite low values in spring (19–26 °Pt), summer (15–18 °Pt) and autumn (16–17 °Pt).

Phosphorus and nitrogen

The content of total phosphorus in Lake Kuetsjarvi changes within the range of 11–37 µg P/l, averaging 17 µg P/l. In the Pasvik River the total phosphorus content corresponds to natural only in the areas of Rajakoski settlement and the Skrukkebukta reach (6 µg P/l on average). Maximum values of total phosphorus are observed in near-bottom layers of Vaggatem and Ruskebukta reaches, 64 and 75 µg P/l respectively.

The content of total nitrogen normally lies within 300–700 µg N/l for oligotrophic water bodies. The concentration of total nitrogen in Lake Kuetsjarvi is changing from 156 to 337 µg N/l and averages 237 µg N/l. In the Pasvik River water it ranges from 119 to 458 µg N/l. The maximum values of total nitrogen are observed at the Ruskebukta reach in autumn.

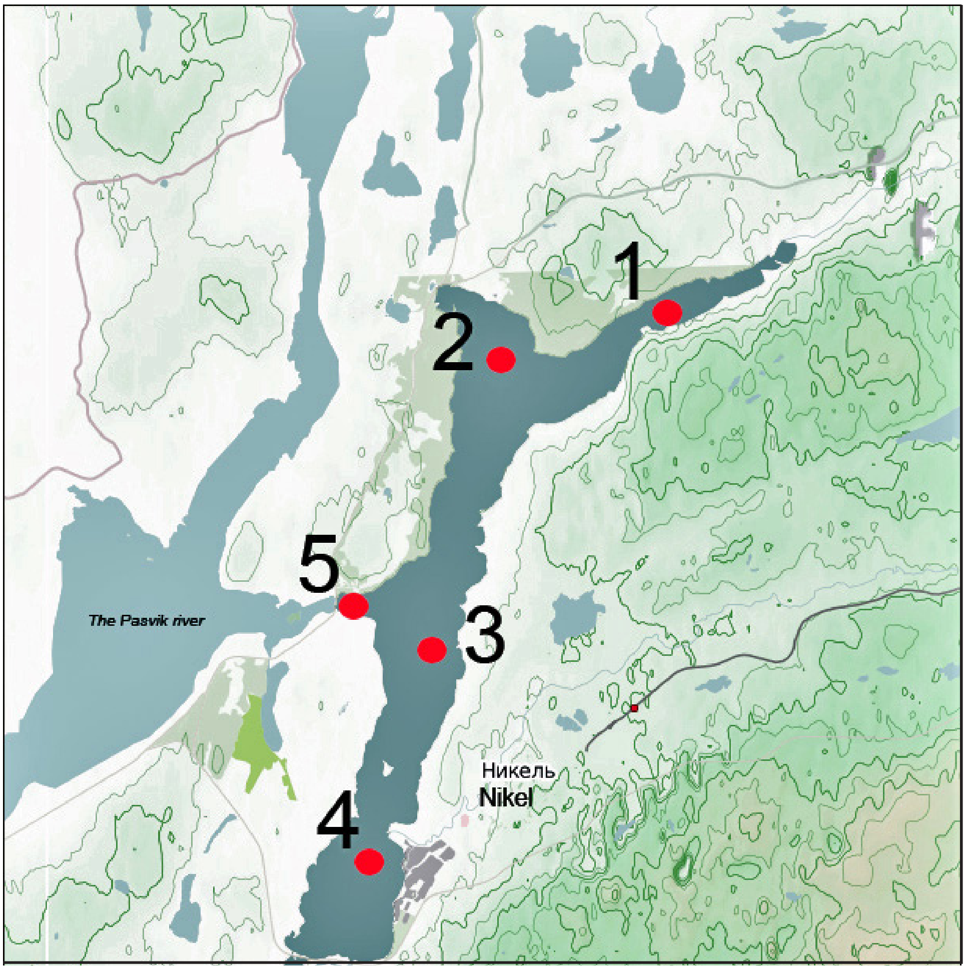


Figure 1. Lake Kuetsjarvi and monitoring stations:
1. Bely kamen
2. Golfstream
3. Salmijarvi
4. Kolosjoki
5. lake outlet

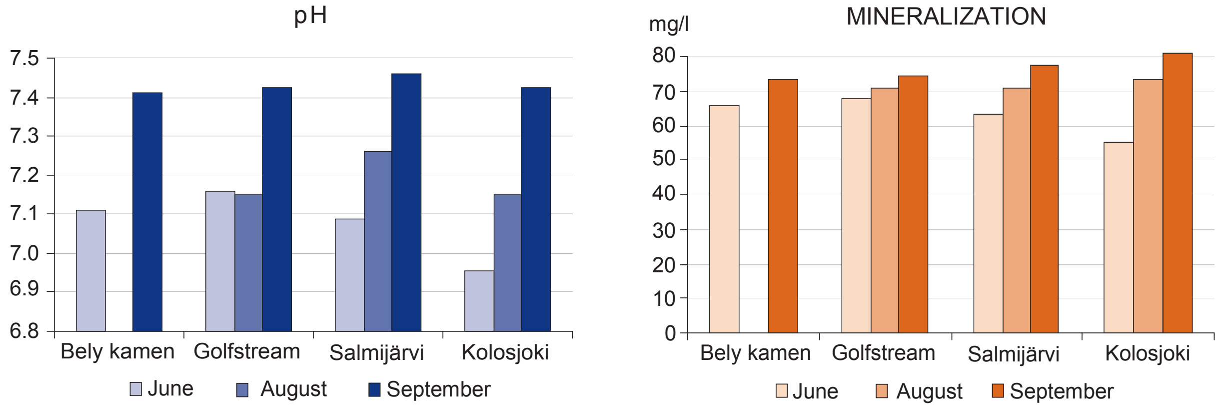


Figure 2. Seasonal changes of pH and total mineralization in different sampling points in Lake Kuetsjarvi (2013).

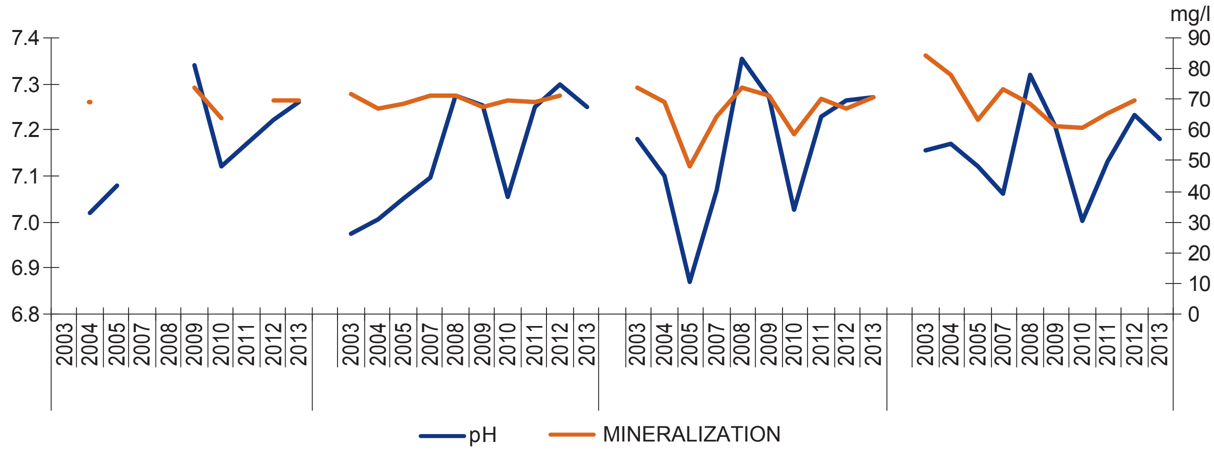


Figure 3. The dynamics of pH and mineralization in different sampling points in Lake Kuetsjarvi.

pH and mineralization

In general the water of the Pasvik River is neutral (pH 6.65–7.11). The water of Lake Kuetsjarvi is closer to being slightly alkaline with pH values of 6.86–7.48). In early summer the pH is lower due to the run-off of more acidic melt-water from the catchment territory (Figure 2). No significant changes of water pH in Lake Kuetsjarvi, which is polluted with waste water, have been observed when compared to natural values.

In 2013 the average mineralization, the sum of the mass of all ions, in Lake Kuetsjarvi amounted to 70.4 mg/l which is caused by waste water discharge from industrial enterprises into the lake for the past 10 years (Figure 3). The lowest values were noted in spring and summer in the southern area of the lake in the mouths of the Shuonijoki and the Kolosjoki rivers due to the delivery of low mineralized melt-water. Natural mineralization of water was noted in the Pasvik River (18.8–27.2 mg/l), which is characteristic of the majority of the lakes in the Kola Peninsula.

The Pasvik River corresponds to the natural order of distribution of principal ions for the waters of the Kola North: HCO_3^- > SO_4^{2-} > Cl^-; Ca^{2+} > Na^+ > Mg^{2+} > K^+ and belongs to the hydrocarbonates class. In the upstream Pasvik River the amount sulphates in anion composition is 16 % and in downstream 25 % on average. Over the latest years from 2003 till 2012 this ratio has remained at the same level, only changing on average by 4–5% in some years. In Lake Kuetsjarvi the amount of sulphates in anion composition is 59 % due to the delivery of waste water from the Pechenganikel integrated plant. Comparison of contents of cations shows that the predominant cation at all the sampling stations at Lake Kuetsjarvi is calcium, which averages out to 56 % in cation composition.

Metals

Nickel and copper are the main components in the waste water from the copper-and-nickel Pechenganikel integrated plant. Waste water flows into Lake Kuetsjarvi which is located in the downstream Pasvik River. From there the pollutants are carried by water current further down the river.

The background content of nickel is 1 μg/l in the water bodies located in the territory of the Kola Peninsula. The highest concentrations of Ni were noted in Lake Kuetsjarvi where the content ranges from 110 to 161 μg/l and averages 133 μg/l (Figure 4). In the Pasvik River upstream from Lake Kuetsjarvi the average content of Ni ranges in average from 0.9 μg/l (Rajakoski settlement) to 1.4 μg/l (Vaggatem), which is comparable to conventional background values. Downstream from the lake the nickel content is 5.7–22.0 μg/l which exceeds the background concentrations.

The background content of copper for the water bodies of the Kola Peninsula is 1 μg/l. The average concentration of Cu in Lake Kuetsjarvi (14.5 μg/l) and in the downstream Pasvik River (3.1 μg/l) exceeds this. Over the period of research the content of Cu in Lake Kuetsjarvi ranged from 10.4 to 22.0 μg/l, decreasing towards autumn (Figure 4). In the upstream Pasvik River the concentration of Cu ranged from 0.3 to 3.1 μg/l, averaging 1.4 μg/l.

In the last years of the research period of 2003–2013 there were no significant changes in the concentrations of Ni and Cu in the Kuetsjarvi Lake (Figure 5).

Aluminum and iron are dicharged into Lake Kuetsjarvi with the waste water from industrial plants and settlements. Maximum concentrations of Al in are observed in late spring flood period in near-bottom layers -up to 101 μg/l in the Salmijarvi area and up to 113 μg/l in the Kolosjoki River. The most even

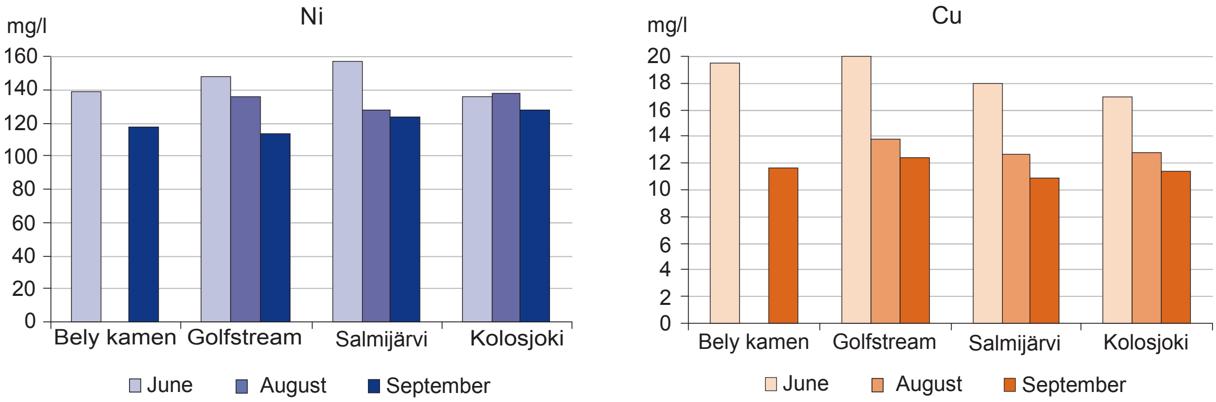


Figure 4. Seasonal changes of Ni and Cu content in different sampling points in Lake Kuetsjarvi (2013).

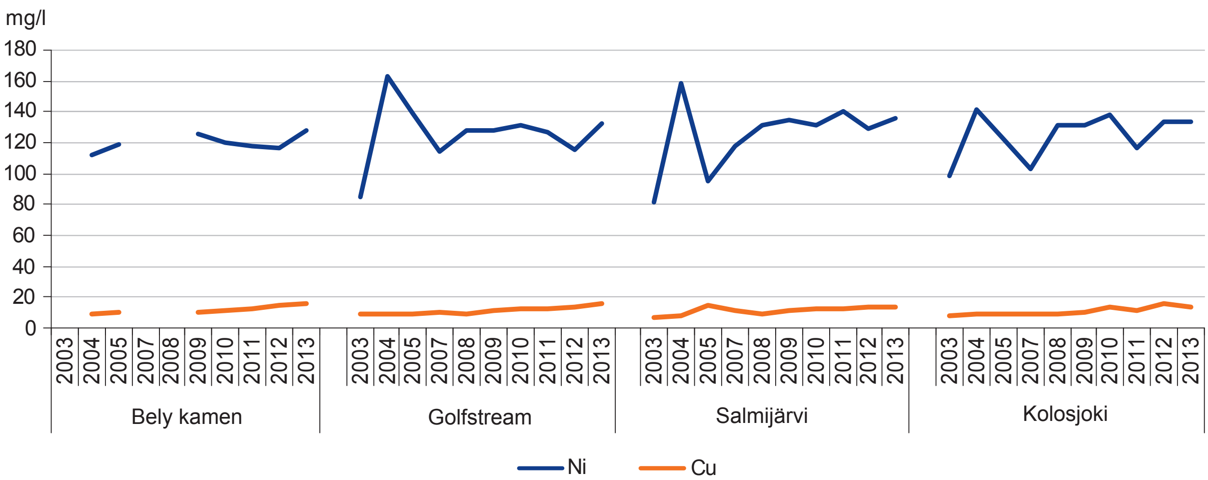


Figure 5. The dynamics of Ni and Cu content in different sampling points in Lake Kuetsjarvi.

distribution of Al throughout the water area of Lake Kuetsjarvi was noted in autumn, 24–36 µg/l, which corresponds to conventional background values for the Kola North (< 30 µg/l). The average concentration of Al in the Pasvik River is 73 µg/l in spring and 21 µg/l in autumn.

The content of Fe in the Pasvik River varies a lot spatially. Upstream in the area of Rajakoski settlement the concentration is 40–41 µg/l. The maximum concentrations of Fe were noted further downstream in the Vaggetem and Ruskebukta reaches, up to 99–1 000 µg/l. Further downstream in the Skrukkebukta reach the Fe concentration decreases and ranges from 24 to 108 µg/l. In Lake Kuetsjarvi the maximum concentrations of Fe were noted in spring in the Salmijarvi area and near the mouth of the Kolosjoki River, up to 212 and 238 µg/l, respectively. In summer the concentrations of Fe decrease to 60–83 µg/l.

The background contents of manganese and strontium in the water bodies of the Kola Peninsula are 5.5 µg/l and <26 µg/l, respectively. In the Pasvik River the average content of manganese is 21.2 µg/l and of strontium 16.9 µg/l. The largest concentrations of Mn in the Pasvik River are observed in the Ruskebukta reach (up to 90 µg/l in the near-bottom layer). The content of Mn in Lake Kuetsjarvi varies within the range of 17–50 µg/l, averaging 37 µg/l. The content of Sr in Lake Kuetsjarvi in all research periods ranges from 51 to 72 µg/l.

The contents of cobalt (Co), zinc (Zn), lead (Pb), chromium (Cr), and cadmium (Cd) are low and do not exceed the conventional background values for the Kola Peninsula and the maximum allowable concentrations in Russia.

Conclusions

The Kuetsjarvi Lake was sampled at 5 monitoring stations and the water quality results were compared to those of the Pasvik River. Salinity in Lake Kuetsjarvi is high which is caused by the long-term wastewater discharge from the Pechenganikel combine plant into the lake. The main components of the wastewater are copper and nickel, the concentrations of which are quite elevated in the lake and have not changed in the observation period of 2003–2013. The concentrations of several other metals were also higher compared to Kola Peninsula natural background values or the concentrations measured in the Pasvik River.

Water quality of small lakes and streams in the Norwegian, Finnish and Russian border area

JUKKA YLIKÖRKKÖ

Jarfjord Borsevatn. Photo Helén Andersen.

Introduction

This is a follow-up report of Finnish, Norwegian and Russian joint small lake and stream water quality monitoring, previously reported in Puro-Tahvanainen et al. (2011). The studied water bodies (Figure 1) receive aerial sulphur dioxide and heavy metal depositions in amounts relative to their location in terms of the Pechenganikel industry. As far as possible the previously applied parameters and methods were used to observe the current water quality and detect possibly changes through the monitoring period 2000–2013.

Methods

As in Puro-Tahvanainen et al. (2011), the data were surface samples (≤1 m) from July–October. Values below the reliable detection limit are calculated as half of the detection limit. Lampi 114 in Vätsäri was excluded, because its monitoring ended in 2006.

Temporal regional-scale trends were studied using regional Kendall test, which is an application of the non-parametric seasonal Kendal trend test for time series. The p-values measure the probability of a monotonic trend in regionally summarized data series. The direction (+/-) and the strength of the trend is indicated by "Thiel-Sen" estimator, which estimates the median slope through sample points. Data analysis was performed with R Software (R Core Team 2013), package "wq" by Jassby & Cloern (2013).

It should be noted the selected methods are robust and time series from Vätsäri and Pechenga had missing data. Certain Vätsäri lakes had 3–9 years of no sampling and Pechenga lakes lacked 3 years of data. Both the regional Kendal test and Thiel-Sen estimator assume the data points are independent. In practise, many variables showed autocorrelation, which would lead to slight overestimate of the trend and test significance. Test results significant at 95 % confidence level with slope at least magnitude of 0.01 will be discussed.

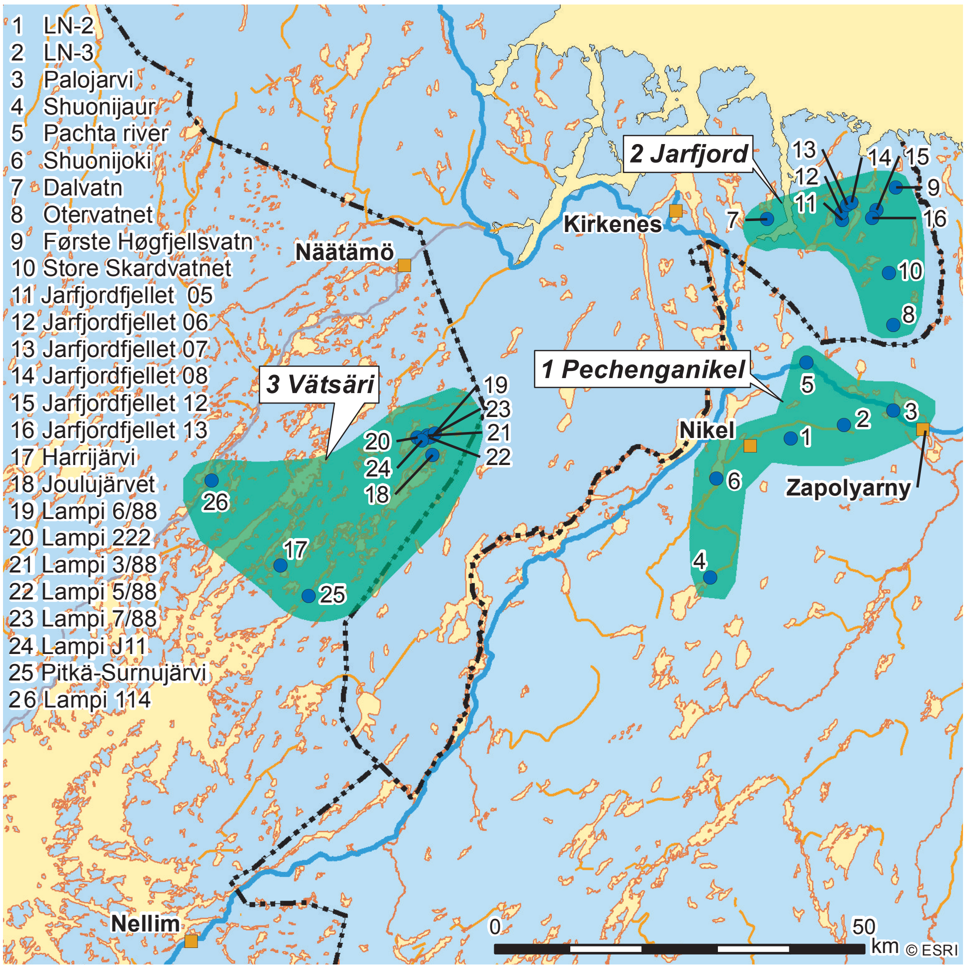


Figure 1. Location of the monitored lakes and rivers and the three sub-areas. The monitoring in Lampi 114 ended in 2006.

Vätsäri from above. Photo Jukka Ylikörkkö.

Jarfjord. Photo Helén Andersen.

Results and discussion

Overall water quality

There are no major changes in nutrients or total organic carbon (TOC) during the last three years.

In Vätsäri the cyclically fluctuating total phosphorus now exhibits a slow decreasing trend through the 14-years (Table 1, Figure 2).

Acidification

Certain lakes in Jarfjord remain acidic with annually measured pH below 6.0 (Figure 3). For comparison, pH minimum in Vätsäri lakes was 5.9–6.8 during 2000–2013. Other parameters, alkalinity, acid neutralizing capacity (ANC) and non-marine base cation content (BC*), have varied within previously observed ranges in Jarfjord and Vätsäri during the four recent years (Figure 4). In Pechenga area, pH, alkalinity and base cation content have been notably higher since 2011.

In Puro-Tahvanainen et al. (2011) an increasing trend in alkalinity and pH was observed in Vätsäri and Jarfjord. In the current 14 year time series a moderate rising trend in alkalinity was detected in all three areas (Table 2). For pH a slow trend is significant in Jarfjord and Pechenga areas.

Rising ANC in Jarfjord and Pechenga are new verified trends in the longer time series. Also non-marine base cation content is in rapid rise in Pechenga (slope 3.7). The new trends in Pechenga are largely due to increasing calcium concentrations in Lake LN-2, Lake LN-3 and the two river stations. Non-marine base cations in Vätsäri appear decreasing.

Annual non-marine sulphate concentrations in Pechenga were the highest, ranging between 2 128–2 468 μeq/l in Lake LN-2 and 61–351 μeq/l in other lakes during 2010–2014. The corresponding ranges for Jarfjord and Vätsäri were 45–87 μeq/l and 29–37 μeq/l. No uniform trend was observed in Pechenga area, whereas in Vätsäri and Jarfjord sulphate concentrations continue the moderate decrease (Table 2).

Time series in annual median values for above parameters are presented in Figure 4.

Table 1. Areal trends for total organic carbon (TOC), total phosphorus (P tot.) and total nitrogen (N tot.) in years 2000–2013: Theil-Sen median slopes representing trend direction and strength and regional Kendall p-values. Significant results bolded.

		Total organic carbon (TOC)		Total phosphorus		Total nitrogen	
	n	p	slope	p	slope	p	slope
Vätsäri	9	0.900	0	**<0.001**	**-0.111**	0.475	0
Jarfjord	10	0.443	0	0.545	0	0.519	-0.222
Pechenga	6	0.911	+0.002	0.759	0	0.676	-0.500

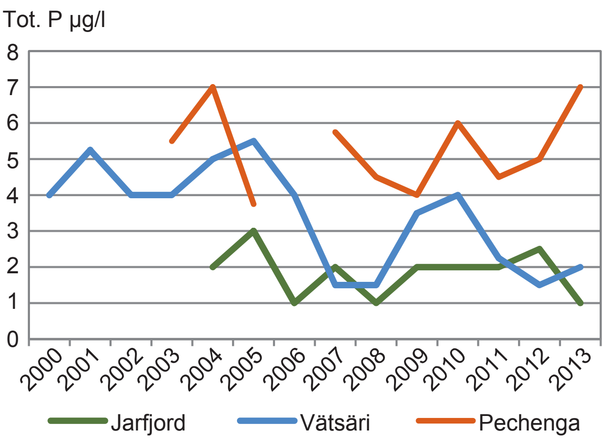


Figure 2. Median total phosphorus in the three areas in years 2000–2013.

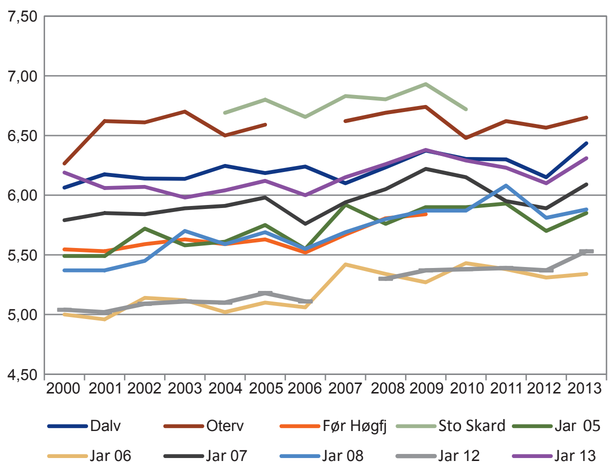
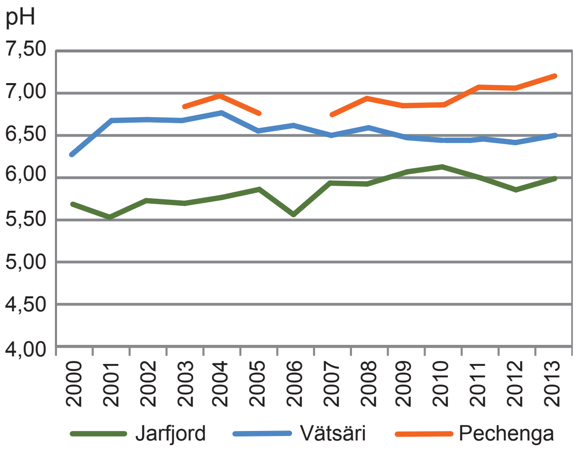
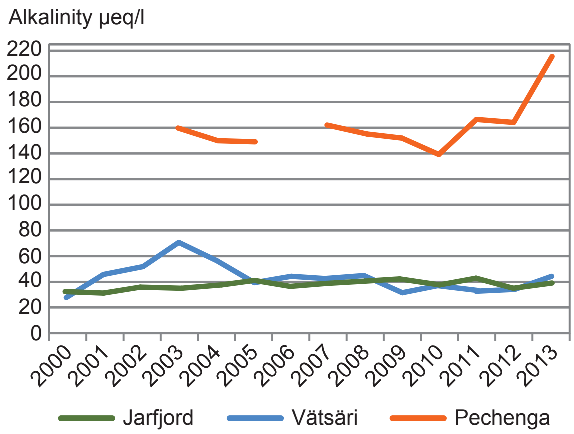
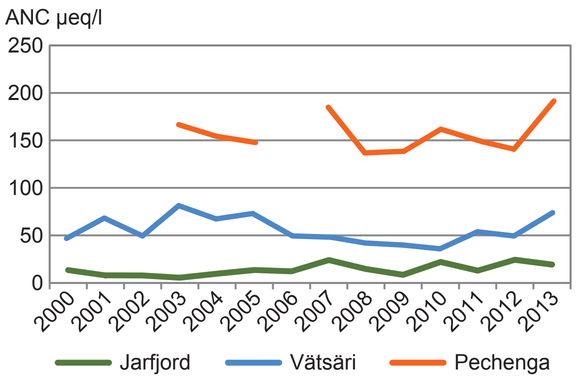
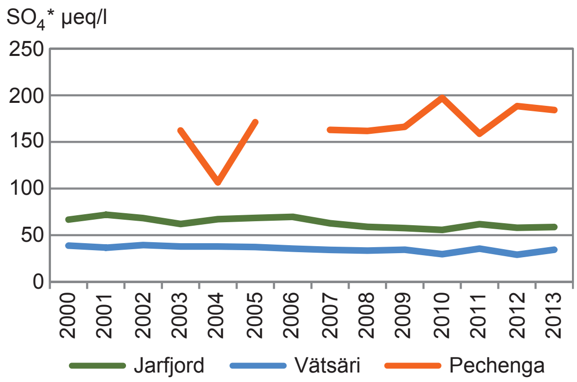


Figure 3. Annual pH values in Jarfjord lakes.









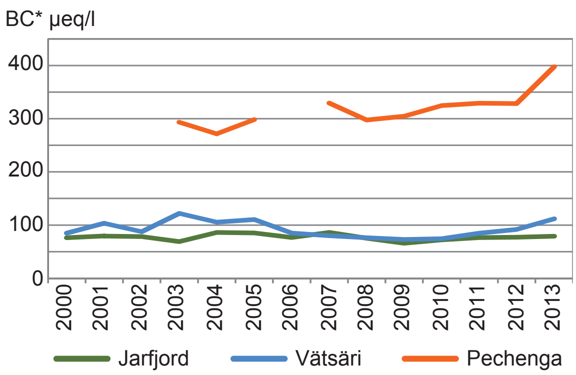


Figure 4. Median annual pH, acid neutralizing capacity (ANC), alkalinity, non-marine sulphate (SO_4*) and non-marine base cation (BC*=Ca*+Mg*+Na*+K*) values in the three areas in years 2000–2013.

Table 2. Areal trends for alkalinity, pH, ANC, SO_4* and BC* in years 2000-2013: Theil-Sen median slopes representing trend direction and strength and regional Kendall p-values. Significant results bolded.

		Alkalinity		PH		ANC		SO_4*		BC*	
	n	**p**	**slope**	**p**	**slope**	**p**	**slope**	**p**	**slope**	**p**	**slope**
Vätsäri	9	**0.002**	**+0.400**	0.104	-0.006	0.493	-0.305	**<0.001**	**-0.429**	**0.016**	**-0.543**
Jarfjord	10	**<0.001**	**+0.500**	**<0.001**	**+0.026**	**<0.001**	**+1.128**	**<0.001**	**-0.967**	0.705	+0.053
Pechenga	6	**0.001**	**+1.191**	**<0.001**	**+0.023**	**0.004**	**+1.782**	0.081	+0.980	**<0.001**	**+3.697**

Metals

The main metal emissions from Pechenganikel industrial complex, copper and nickel, were most evidently increasing in Pechenga area. The same finding was reported in 2011 by Puro-Tahvanainen et al. Other findings of the previous analysis were decreasing trends for aluminum in all the areas and for lead in Vätsäri and Jarfjord.

In 2010–2013 the regional median metal concentrations have fluctuated, but mostly within the previously observed ranges.

In the time series 2000–2014 moderate decreasing trend in total and labile aluminum was still true in Jarfjord area (Table 3). Elsewhere the trend could not be statistically verified.

Jarfjord Gardsjoen. Photo Helén Andersen

Annual copper concentrations show slight increase in the past 4 years (Figure 5). Observing through the whole time series there is a moderate growing trend in Jarfjord (slope +0.10) and Pechenga area (slope +0.23). Also in Vätsäri the trend was now significant, but slow (slope +0.04). Copper concentration above 3 µg/l is reported to affect zooplankton viability (USEPA 2007). This level is exceeded in several places in Jarfjord and Pechenga.

There has been a drop in regional nickel concentrations in Pechenga after 2009 (Figure 6). At the moment only one monitoring site is clearly increasing in nickel. Observing through the whole time series the regional nickel concentration show moderate rise in Jarfjord (slope +0.43) and Pechenga (slope +0.66). The rate of increase appeared to be settling comparing to somewhat higher slopes reported earlier. Nickel toxicity to plankton shows from 10 µg/l upwards in soft water (USEPA 1986). At the moment all Jarfjord and Pechenga sites are above this level. In Pechenga area the nickel level occasionally exceeded 50 µg/l. This level may directly weaken fish viability.

Lead concentrations show diminutive negative trends, significant only for Jarfjord area. Also the previously observed negative trends were weak.

As concluded in Puro-Tahvanainen et al. (2011) cadmium trend in Vätsäri is likely an artefact of lowered detection limit. Zinc concentrations in Jarfjord showed a weak negative in 2000–2013 time series.

All annual metal median values are presented in Figures 5 and 6.

Table 3. Areal trends for metals in years 2000–2013: Theil-Sen median slopes representing trend direction and strength and regional Kendall p-values. Significant results bolded.

		Vätsäri	Jarfjord	Pechenga
	n	9	10	6
Total aluminum (TAl)	p	0.071	**<0.001**	0.823
	slope	-0.89	**-1.00**	-0.05
Labile aluminum (LAl)	p		**<0.001**	
	slope		**-0.71**	
Arsen (As)	p	0.817	0.269	
	slope	0	0	
Cadmium (Cd)	p	**<0.001**	0.672	0.474
	slope	**-0.001**	0	0
Cobolt (Co)	p	0.005	0.767	0.175
	slope	-0.01	-0	0
Chromium (Cr)	p	<0.001	0.094	0.104
	slope	0	0	0
Copper (Cu)	p	**<0.001**	**<0.001**	**<0.001**
	slope	**+0.04**	**+0.10**	**+0.23**
Nickel (Ni)	p	0.499	**<0.001**	**0.019**
	slope	0	**+0.43**	**+0.66**
Lead (Pb)	p	0.072	**<0.001**	0.466
	slope	-0	**-0.01**	-0
Zinc (Zn)	p	0.650	**0.001**	0.07
	slope	0	**-0.04**	-0.07

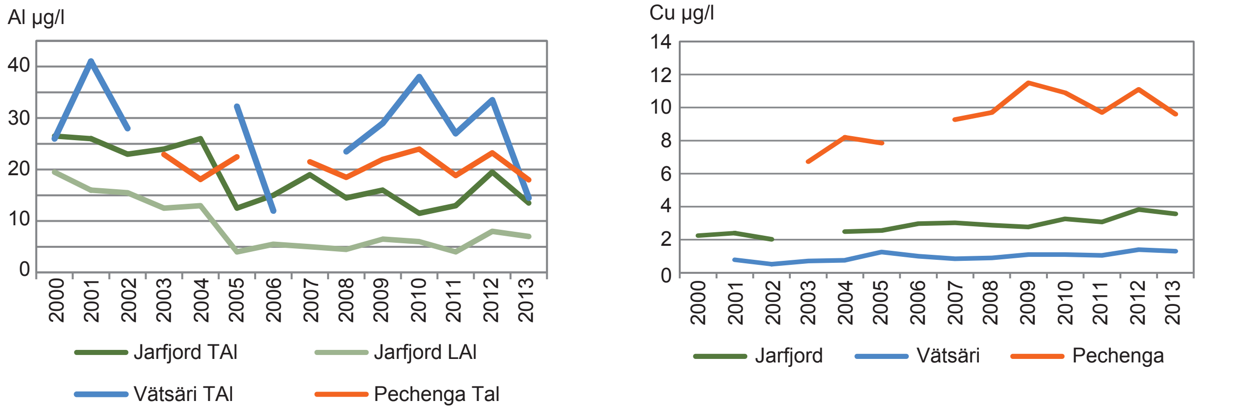


Figure 5. ”Annual median values for the three areas for total aluminum (TAl) and labile aluminum (LAl) (left) and copper (Cu) (right).

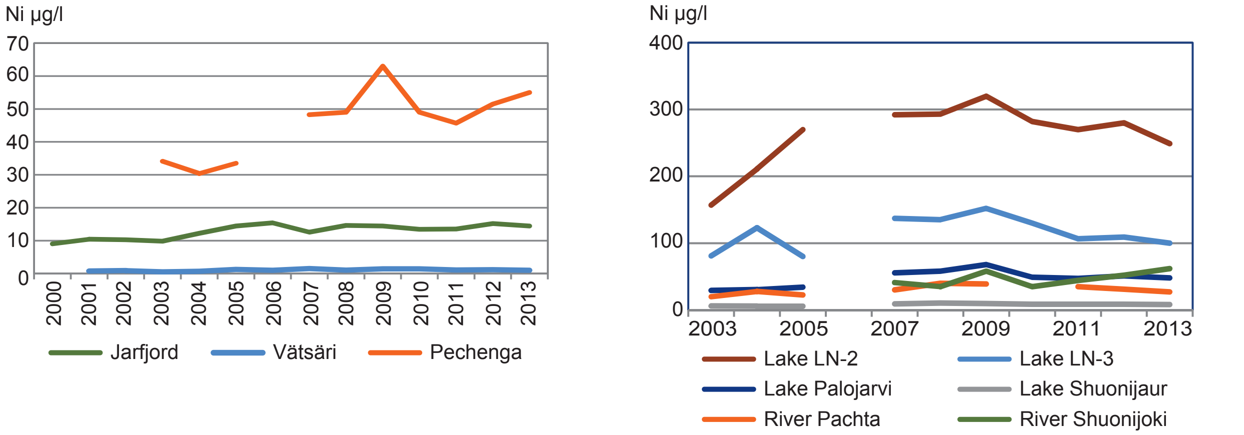


Figure 6. Annual median values of nickel for the three areas in 2000–2013 (left) and annual average values for Pechenga monitoring stations in years 2003–2013 (right).

Conclusions

Recovery from acidification in Vätsäri and Jarfjord is still evident in the scope of the 14-year time series. Non-marine sulphates continue to decrease in the two areas. This shows in slow but significant increasing pH in both areas as well as in increasing alkalinity and acid neutralizing capacity in Jarfjord. It should be noted that the Jarfjord lakes are slightly acidic naturally due to local bedrock and catchment quality. As noted in earlier studies (Puro-Tahvanainen et al. 2011, Stebel et al. 2007), Pechenga area has high buffering capacity and the sulphur deposits there do not show as acidification in water systems. Currently some water bodies in Pechenga have increasing amounts of base cations, namely calcium, which most likely originates from the industry.

Nickel and copper concentrations were rising through the first decade of monitoring. During 2010–2013 their concentrations have fluctuated but remained on clearly elevated level in Jarfjord and Pechenga areas.

Copper concentrations have been slightly rising in the recent years and observed through the whole monitoring history it also shows an increasing trend. Now the trend for copper is increasing in the Vätsäri area as well. The increasing trend of nickel and copper levels in the water samples are supported by recent findings from air monitoring and from a new sediment study in 48 lakes in the Pasvik border (Rognerud et al. 2013). Similar findings can be done observing the Lake Kuetsjarvi water quality.

There is great variance in Pechenga area nickel concentrations during the last four monitoring years. Nickel in some places is decreasing but the regional trend through whole time series is still positive. Also rising trend in nickel in Jarfjord lakes is still observed but the lower regional median slope indicates at least to slowing rate of nickel increase.

The time-series provide the tool for observing the ongoing changes in water quality in the three country border area. It is essential to maintain the monitoring. Monitoring sites with continuous time-series should be placed as priority. There are also new sets of larger lakes introduced for Norway and Russia in ENPI TEC (2012–2014) project Activity 5, which add up to the information from the border area.

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Jarfjord sunset. Photo Helén Andersen.

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Author(s)
Jukka Ylikörkkö
Marina Zueva
Nikolai Kashulin
Tatyana Kashulina
Sergei Sandimirov
Guttorm Christensen
Elli Jelkänen

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Abstract

The Pasvik monitoring programme was created in 2006 as a result of the trilateral cooperation and with the intention of following changes in the environment under variable pollution levels. Water quality is one of the basic elements of the programme when assessing the effects of the emissions from the Pechenganikel mining end metallurgical industry (Kola GMK).

In this report temporal trends of the water chemistry during 2000–2013 are examined on the basis of the data gathered from lake Inari, River Pasvik and directly connected lakes, Lake Kuetsjarvi and 25 small lakes in three areas: Pechenganikel (Russia), Jarfjord (Norway) and Vätsäri (Finland). The lower parts of the Pasvik watercourse are impacted by both atmospheric pollution and direct wastewater discharge from the Pechenganikel smelter and the settlement of Nikel. The upper section of the watercourse and the small lakes and streams which are not directly linked to the Pasvik Watercourse only receive atmospheric pollution.

Lake Inari is free of direct emissions from the Pechenganikel and the water quality is excellent.

In River Pasvik and the directly connected lakes copper, nickel, and sulphates are the main pollutants. The most polluted water body is the Kolosjoki River as well as the stream connecting the Lakes Salmijarvi and Kuetsjarvi. The concentration of metals and sulphates in the water notably increases downstream the river lower Lake Kuetsjarvi. In Lake Kuetsjarvi copper and nickel concentrations are clearly elevated and have changed insignificantly in the last years of the research period

In the small border area lakes recovery from acidification in Vätsäri and Jarfjord is evident. Nickel and copper concentrations have fluctuated but remained on clearly elevated level in Jarfjord and Pechenga. Copper concentrations have been slightly rising in the recent years. In Pechenga area nickel concentrations during the last four monitoring years are decreasing in some places but the regional trend through whole time series is still positive.

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Environment, monitoring, water quality

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(Paatsjoen vedenlaatu vuoteen 2013; Ympäristönseurantaohjelma Norjan, Suomen ja Venäjän raja-alueella)

Tiivistelmä

Suomen, Norjan ja Venäjän välinen yhteistyö loi vuonna 2006 Paatsjoen seurantaohjelman, jotta voidaan seurata ympäristön muutoksia päästötasojen vaihdellessa. Vedenlaatu on yksi ohjelman peruselementtejä arvioitaessa Petšenganikelin kaivos- ja metalliteollisuuden päästöjen vaikutusta ympäristöön.

Tässä raportissa tarkastellaan Inarijärven, Paatsjoen ja siihen liittyvien järvien, Kuetsjärven ja 25 Petšengan, Jarfjordin ja Vätsärin alueella olevan pienen järven vedenlaadun kehitystä vuosina 2000–2013. Paatsjoen alajuoksun tilaan vaikuttavat sekä ilmansaasteet että suorat jätevesipäästöt Petšenganikelin sulatosta ja Nikel-taajamasta. Paatsjoen yläjuoksu sekä järvet ja purot, jotka eivät suoraan liity jokeen, kärsivät vain ilmansaasteista.

Inarijärveen ei kohdistu suoria päästöjä Petšenganikelistä ja sen vedenlaatu on erinomainen.

Paatsjoessa ja siihen liittyvissä järvissä kupari, nikkeli ja sulfaatit ovat keskeisimmät haitta-aineet. Kuormittuneimmat vesistöt ovat Kolosjoki ja Salmijärven ja Kuetsjärven yhdistävä salmi. Metallien ja sulfaattien pitoisuudet ovat korkeimpia Kuetsjärveltä alavirtaan. Kuetsjärvellä kupari- ja nikkelipitoisuudet ovat korkeat eivätkä ne ole muuttuneet seurantajakson aikana.

Pienissä järvissä Vätsärin ja Jarfjordin alueella on havaittu toipumista happamoitumisesta. Nikkeli- ja kuparipitoisuudet ovat vaihdelleet mutta pysyneet selvästi korkeina Jarfjordin ja Petšengan alueilla. Kuparipitoisuudet ovat nousseet hieman viime vuosina. Petšengassa nikkelipitoisuudet ovat laskemassa joissakin paikoissa viimeisen neljän seurantavuoden aikana, mutta koko tutkimusjakson mittakaavassa alueen nikkelipitoisuudet ovat kuitenkin kasvamassa.

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Авторы
Юкка Юликёрккё
Марина Зуева
Николай Кашулин
Татьяна Кашулина
Сергей Сандимиров
Гутторм Кристенсен
Элли Елкянен

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Environmental Monitoring Programme in the Norwegian, Finnish and Russian Border Area

(Отчёт по качеству воды Пасвик

Программа мониторинга окружающей среды в приграничном районе Норвегии, Финляндии и России)

Резюме

Программа мониторинга Пасвик разработана в 2006 году в рамках трехстороннего сотрудничества с целью наблюдения за изменениями окружающей среды при различных уровнях загрязнения. Качество воды является одним из ключевых элементов программы при оценке воздействия выбросов горно-металлургического комбината «Печенганикель» Кольской ГМК.

В настоящем отчете представлены тенденции изменения химического состава вод озера Инари, реки Паз и непосредственно сообщающихся с ней озёр, озере Куетсъярви, а также 25 малых озёр в трех районах: «Печенганикель» (Россия), Ярфьорд (Норвегия) и Вятсяри (Финляндия). Река Паз в нижнем течении подвержена воздействию как атмосферного переноса загрязняющих веществ, так и непосредственного сброса сточных вод комбината «Печенганикель» и поселка Никель. Верхняя часть реки, малые озера и ручьи, не сообщающиеся непосредственно с рекой Паз, загрязняются только атмосферными выбросами.

На озеро Инари выбросы комбината «Печенганикель» не оказывают прямого воздействия; качество воды отличное.

Основными загрязняющими веществами в реке Паз и непосредственно сообщающихся с ней озерах являются медь, никель и сульфаты. Наиболее загрязненным водоемом является река Колосйоки, а также протока, соединяющая озера Салмиярви и Куетсъярви. Более высокое содержание металлов и сульфатов в реке Паз наблюдается вниз по течению от озера Куетсъярви. В озере Куетсъярви концентрации меди и никеля высокие, их уровень не изменился за период наблюдений.

Происходит восстановление от закисления малых озёр в районах Вятсяри и Ярфьорд. В Ярфьорде и Печенгском районе уровень концентраций никеля и меди остаётся по-прежнему повышенным. За последние четыре года наблюдений концентрации никеля в Печенгском районе снижались на отдельных участках, но в целом наблюдается повышающийся тренд содержания никеля.

Ключевые слова:
Окружающая среда, мониторинг, качество воды

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Environmental Monitoring Programme in the Norwegian, Finnish and Russian Border Area

Vannkvalitetsrapport – Pasvik inntil 2013; Overvåkningsprogrammet i grenseområdet mellom Norge, Finland og Russland

Sammendrag

Overvåkingsprogrammet for Pasvikområdet ble etablert i 2006 som et resultat av de tre berørte lands samarbeid innen miljøovervåking. Programmet har som mål å avdekke endringer i miljøet under vekslende forurensningsbelastninger. Overvåking av vannkvaliteten er et av de grunnleggende elementer i programmet for å vurdere effektene av utslipp fra Petsjenganikel kombinatets gruvedrift og metallurgiske industri (Kola GMK).

Rapporten angir tidsbestemte trender i vannkjemien for årene 2000–2013 med bakgrunn i data innsamlet fra Enaresjøen, Pasvikelva og innsjøer i direkte tilknytting til den, samt 25 små innsjøer i følgende tre områder: Petsjenga (Russland), Jarfjord (Norge) og Vätsäri (Finland).

De nedre delene av Pasvikvassdraget er påvirket av både luftbåren forurensing, av direkte utslipp fra smelteverket og av avløp fra Nikel by. De øvre delene av Pasvikvassdraget, de små innsjøene og bekker som ikke er direkte tilknyttet Pasvikelva mottar forurensingen via luft og nedbør.

Enaresjøen er ikke i direkte tilknytning til smelteverket og har en god vannkjemisk tilstand.

De innhentede data bekrefter at kobber (Cu), nikkel (Ni) og sulfater er de sentrale forurensningskomponentene. De høyeste nivåene ble funnet nærmest smelteverkene, elven Kolosjoki, som kobler sammen innsjøene Svanevatn og Kuetsjarvi er den mest forurensede. Nikkel og kobber konsentrasjonene er variert noe, men er ligger stabilt på et forhøyet nivå. Konsentrasjonen av kobber har en økende trend.

Konsentrasjonene av metaller og sulfater i Pasvikelva er høyere nedstrøms innsjøen Kuetsjarvi enn oppstrøms. Det har ikke vært noen reduksjon i forurensingsnivået i Pasvikvassdraget gjennom de siste 10 årene.

Gjennom de siste ti årene ser man en forbedring i forsuringssituasjonen i de undersøkte små innsjøene i Jarfjord og Vätsäri området.

Konsentrasjonen av nikkel og kobber har variert noe, men ligger på et klart forhøyet nivå i Petsjenga og på Jarfjord. Konsentrasjonene av enkelte metaller, spesielt kobber har økt i løpet av overvåkningsperioden. I Petsjengaområdet har nikkelkonsentrasjoner også variert noe i løpet av den siste overvåkningsperioden. Konsentrasjonen av nikkel synkner enkelte steder og området i sin helhet, gjennom hele tidsserien, er positiv.

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