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Determination of Selected Parameters/Analytes in Surface Water Samples Collected in the Surroundings of the Capital of Spitsbergen (Longyearbyen)

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Abstract. Polar regions are extremely sensitive to pollution such as harmful gases, particles or toxic substances which affect the Arctic climate and ecosystems. Spitsbergen, as well as all Arctic region, because of its geographically distant location and lack of industry sector, should be free of chemical pollution. Despite this, many pollutants could be found in the Polar environment, for example in freshwaters. Their occurrence is related with the global distillation process (Grasshopper effect) in which the contaminants from lower latitudes are transferred to the higher latitudes, resulting in the pollution of Arctic area.

The purpose of the research was to determine the selected parameters: TOC (Total Organic Carbon) and formaldehyde, phenols in samples of freshwaterwater (surface water) collected in the area surrounding the capital of Spitsbergen (Longyearbyen). The aim was to investigate the pollution of Arctic freshwater. The obtained results of detected compounds may confirm the role of transport of contaminants over large distances in pollution of Polar regions.

INTRODUCTION

Spitsbergen is the biggest island (39,000 km^2) belonging to the Svalbard archipelago (62,800 km^2) which is located 800 km north from Norway and 1100 km from the North Pole. In turn, Longyearbyen is the biggest settlement of Spitsbergen as well as the greatest administrative center of whole Svalbard. All this region should be uncontaminated, in view of its geographically distant location and lack of industry sector. However, many pollutants could be found in the Polar environment. This is related with global distillation (Grasshopper effect). During this process, the pollutants are carried by the wind from low latitudes towards high latitudes at different distances, depending on their volatility. The greater the volatility of compounds, the further they are shifted, since they are more mobile. The anthropogenic contaminants from hotter equatorial regions are moved to the temperate regions. After condensing and embedding they overwinter, for example in freshwater and soil. Under the influence of the summer sun the chemicals re-vaporize and are transferred by the air currents further to the north, where they fall to the ground once again. The cycle continues until the more volatile pollutants reach the Arctic. In colder polar regions the contaminants could no longer be lifted into the atmosphere. Thus, they remain in the Arctic environment.

The aim of this work was to determine the selected parameters and compounds in the samples of freshwater (surface water) collected in the area surrounding the capital of Spitsbergen (Longyearbyen). The samples were

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subjected to the analysis in order to measure: pH, electrical conductivity, TOC parameter, and to detect the concentration of surfactants (anionic, cationic, non-ionic), ions (cations and anions), formaldehyde and phenols. In addition, the extraction of PCBs and PAHs analytes from freshwater was performed to prepare the samples for further detection that would be continued by other researchers. The purpose of the laboratory measurements was to investigate the pollution of Arctic freshwater. Due to the fact, that in Spitsbergen the only branch of the economy is coal extraction, it could be assumed that the pollutants found in Polar region come from remote industrialized countries.

THE LOCATION OF SAMPLING SITES

The freshwater samples were collected in Longyear Valley during two time periods - Spring (the end of May, the beginning of June) and Autumn (September) in 2016. A total of ten samples were gathered, five per each term. Table 1 shows five established sampling sites.

TABLE 1. Sampling sites. The names of samples (abbreviations) with corresponding description.

No.	Name of the sample	Commentary
1	LAR	Larsbreen glacier
2	LYR1	Longyearbreen glacier
3	LYR2	Point no. 1 on Longyear River
4	LYR3	Point no. 2 on Longyear River
5	LYRU	Mouth of Longyear River

A sample called LAR contained water flowing from the Larsbreen glacier, while LYR1 - from Longyearbreen glacier. Water from both glaciers was running down to the Longyear River. Two water samples - LYR2 and LYR3 - were taken at two selected sites on the river. The last one, LYRU, was collected at the mouth of the Longyear River. Figure 1(b) presents a fragment of three-dimensional map of Longyear Valley (South view) on which sampling sites were marked out. Figure 1(a) shows the exact localization of the Valley in Spitsbergen.

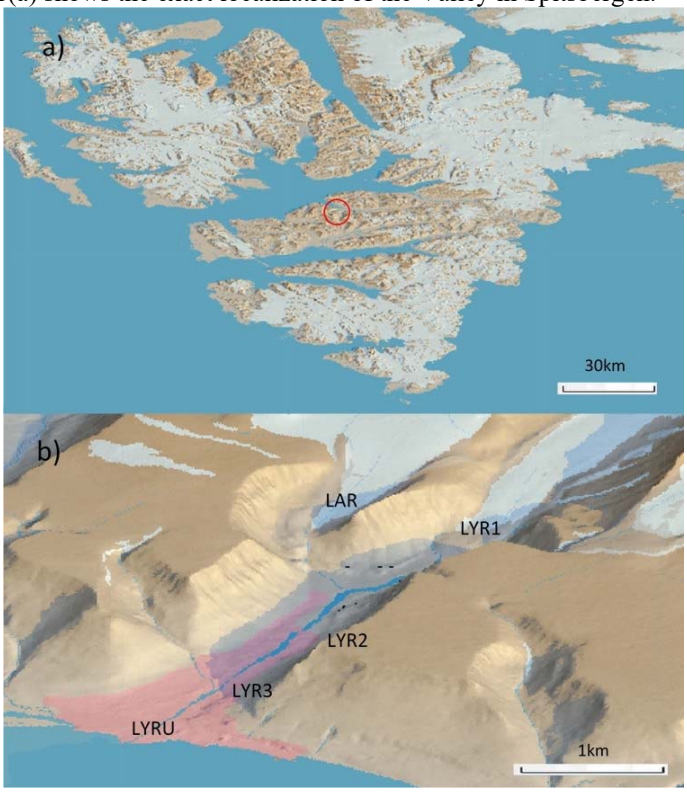

FIGURE 1. Three-dimensional map of Spitsbergen (a) exact localization of Longyear Valley, (b) sampling sites marked out on the three-dimensional map of Longyear Valley in Spitsbergen - South view
(Source: http://toposvalbard.npolar.no, Access: 29.04.2017).

RESULTS AND DISCUSSION

TOC

TOC parameter was measured in order to determine the environmental pollution, since TOC gives a full information about the content of all organic compounds in the sample. The average TOC concentration was higher in freshwater samples collected in September (0.437 mg/L) than in samples collected in May/June (0.211 mg/L). Concerning TOC concentration at particular sampling sites (as shown in the Fig. 2) in samples collected in May/June, the highest value was determined in LYR3 (point no. 2 on Longyear River: 0.367 mg/L). In turn, among samples collected in September, the highest TOC concentration was detected in LYRU (mouth of Longyear River: 0.556 mg/L) and LYR1 (freshwater from Longyearbreen glacier: 0.535 mg/L).

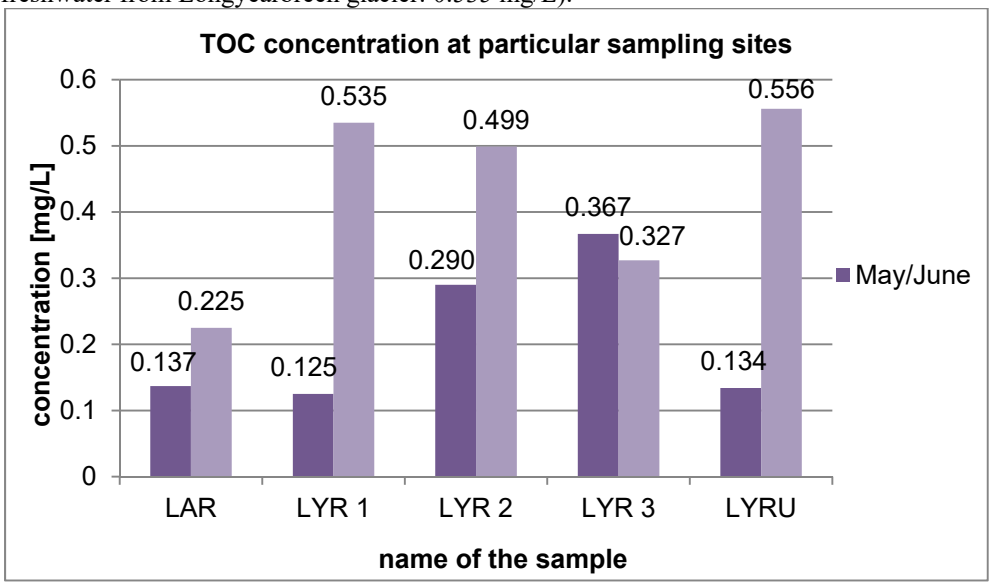

FIGURE 2. TOC concentration at particular sampling sites.

FORMALDEHYDE AND PHENOLS

The collected freshwater was also analyzed to determine formaldehyde and phenols concentration. Figure 3 presenting formaldehyde and phenols concentration at particular sampling sites in samples collected in two seasons, it could be stated that the highest concentration of both formaldehyde and phenols was in LYR1 sample (freshwater from Longyearbreen glacier) collected in September (formaldehyde: 0.710 mg/L, phenols: 0.717 mg/L). Almost the same concentration of formaldehyde as in LYR1 was detected in LYRU sample (mouth of Longyear River: 0.690 mg/L). In case of formaldehyde, its concentration in LYRU sample collected in May/June was also high (0.680 mg/L). Slightly lower results of formaldehyde amount were also obtained in LYR3 samples (May/June: 0.550 mg/L, September: 0.570 mg/L). As for phenols, the second highest concentration was detected in LYR2 sample (point no. 1 on Longyear River: 0.459 mg/L) collected in September, however the result from May/June is comparable (0.402 mg/L).

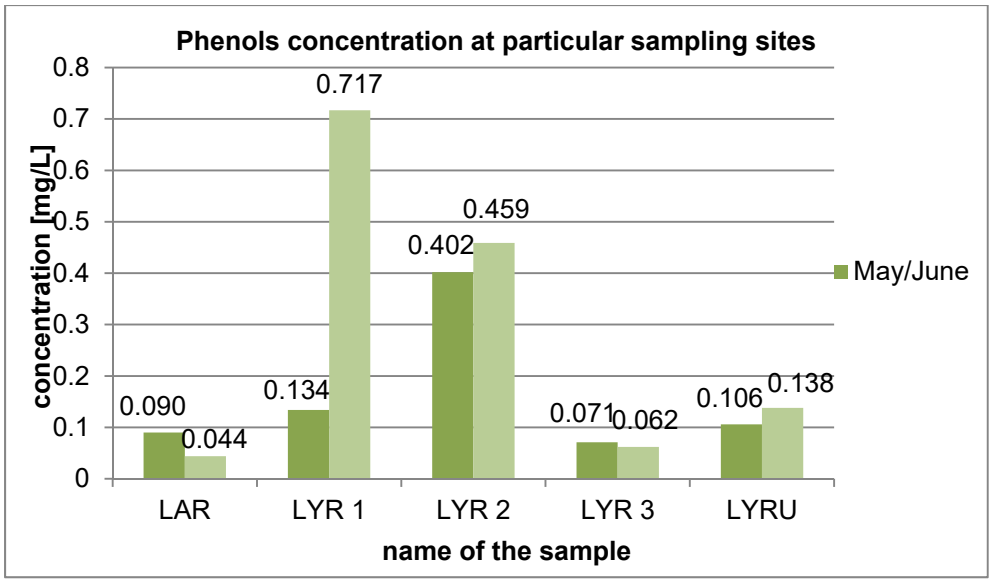

FIGURE 3. Phenols concentration at particular sampling sites.

SUMMARY

The aim of this work was to determine the selected parameters and compounds in the samples of freshwater (surface water) collected in the area surrounding the capital of Spitsbergen (Longyearbyen). Ten samples were subjected to the analysis to measure TOC parameter, and to detect the concentration of formaldehyde and phenols.

The purpose of all laboratory measurements was to investigate the pollution of Arctic freshwater, which because of its distant location far from industrial areas, should be free of chemical pollution. Due to the fact, that in Spitsbergen the only branch of the economy is coal extraction, it could be assumed that the pollutants found in Polar region come from remote industrialized countries. The pollutants are transferred by the global distillation process (Grasshopper effect) from lower to higher latitudes. It also could be established that the global migration of pollutants has adverse effect on the quality of Arctic freshwater, as well as on living organisms (animals).

The TOC parameter was measured additionally for the determination of the degree of environmental pollution. It may be implied that as the level of contamination increases, the concentration of TOC is higher, since TOC gives full information about the sum of all the organic compounds present in the analyzed sample. However it does not provide the detailed information on the type of the individual organic compounds. The maximum value of TOC was determined in LYRU sample (mouth of Longyear River: 0.556 mg/L) collected in September and in LYR1 (freshwater from Longyearbreen glacier: 0.525 mg/L) collected in the same time of sampling.

The highest formaldehyde concentration determined in all freshwater samples was 0.710 mg/L, while the highest concentration of phenols equaled to 0.717 mg/L. The presence of these compounds in tested samples may confirm the role of transport of contaminants over large distances in the pollution of Polar regions. In addition, high concentration of formaldehyde and phenols from sampling site called LYR1 (freshwater from Longyearbreen glacier) may suggest that part of pollution was derived from glacier meltwater.

In general, comparing the two periods of sampling, it could be noticed that the concentration of most of the detected compounds was higher in freshwater samples collected in September than in the samples collected in May/June. The time difference between two seasons of sampling was small, however it could be stated that the tendency of increasing concentration of pollutants occurs. Therefore, it is significant to conduct the research concerning the monitoring of Arctic area. It is also important to develop the analytical techniques serving to study of Arctic environmental samples. The concentration of various contaminants should be regularly detected and the parameters should be measured, since even low levels of contaminants may be an indicator of the pollution of considerable part of the Polar region.

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