Impact of river runoff on heavy metal concentrations in bottom sediments of West Spitsbergen fjords in the era of climate change

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Introduction

Although **the Artic** is considered to be a pristine area, not impacted by industrial activities, it turns out that a significant amount of **pollutants** get there, from the sources than can be even thousands kilometers away. Antropogenic heavy metals are transported to the Arctic by direct (eg. sea currents, atmospheric circulation, river runoff and sea-ice drift) and indirect pathways - **secodary sources** (melting of ice, glacier and snow cover, permafrost thawing, increased discharge of river runoff or extensive coastal)

In the winter of **2016** and **2018** the surface temperature in the Arctic was **6°C** higher than the average from 1981 to 2010.

The freshwater supply to Hornsund from tidewater glaciers is of **257 ± 82 Mt a^{-1}** (with as much as **39% - 986 Mt a^{-1}** from glaciers meltwater runoff and **28% - 634 Mt a^{-1}** from frontal ablation of tidewater glaciers.

For every **2°C** increase in, there will be a **22%** increase in the sediment supply by the rivers to Spitsbergen fjords.

Objective

Measure historical distribution of heavy metals (**Cu, Zn, Pb, Cd**) in the bottom sediments of three West Spitsbergen fjords

Hypothesis

The riverine runoff is one of **the most important** transport route for heavy metals to enter the Spitsbergen fjords ecosystem.

Methods

Fig. 1 Dicksonfjorden

Fig. 2 Sassenfjorden

Fig. 3 Van Mijenfjorden

Svalbard, Spitsbergen

Sampling

In 2019, 14 bottom sediment cores were collected in three West Spitsbergen fjords. The stations were located near the rivers mouth and in the central part of the fjords.

Laboratory analyses

The sediment layers were dated using the ^{210}Pb method. The concentrations of heavy metals were analysed on the ICP-MS (Perkin-Elmer Sciex ELAN 9000 and AAS. The concentrations were normalized with the concentrations of Al and Fe.

Analysis

A database containing all research results was created. Statistical calculations were in the STATISTICA 6.0 licensed program.

Results

Van Mijenfjorden [µg g^{-1}]
Cu: 20.9-47.8
Zn: 53.3-133.1
Pb: 13.4-28.9
Cd: 0.01-1.0

Dicksonfjorden [µg g^{-1}]
Cu: 13.4-25.5
Zn: 96.9-109.4
Pb: 24.1-35.3
Cd: 0.03-0.2

Sassenfjorden [µg g^{-1}]
Cu: 18.8-43.2
Zn: 67.0-131.8
Pb: 8.3-18.9
Cd: 0.02-1.2

The **natural background** for each element was as follows:

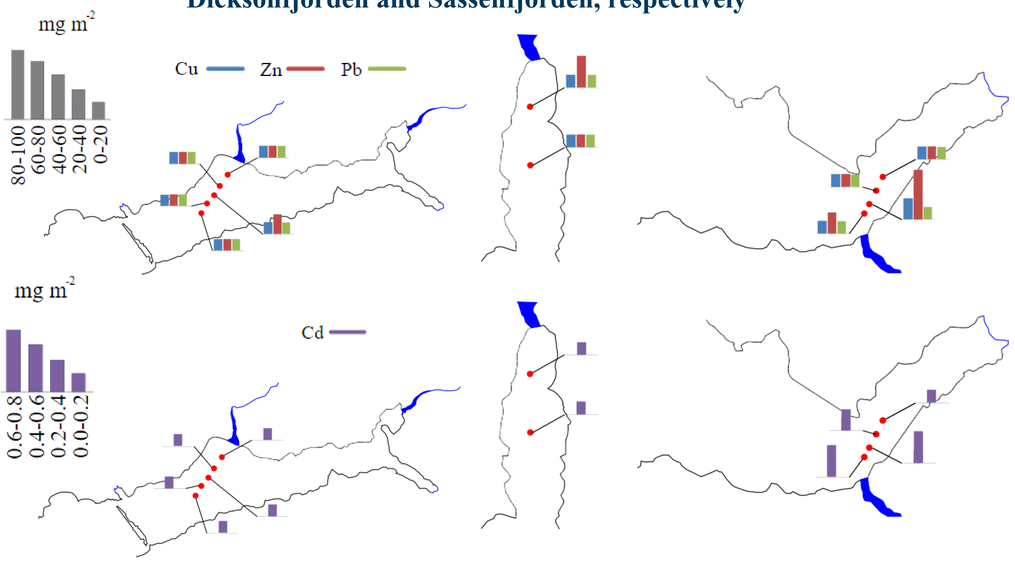
- **Cu: 20 µg g^{-1};**
- **Zn: 58 µg g^{-1};**
- **Pb: 11 µg g^{-1};**
- **Cd: 0.1 µg g^{-1}.**

Mass sediment accumulation rates [mg cm^{-2} yr^{-1}]

Van Mijenfjorden	Dicksonfjorden	Sassenfjorden
6.70 - 127.08	11.16 - 226.74	7.30 - 218.25

Fig. 4

The anthropogenic fluxes of selected heavy metals to Van Mijenfjorden, Dicksonfjorden and Sassenfjorden, respectively



Conclusion

Conclusions

No increased heavy metals concentrations were observed near the rivers mouth. However, due to the **high sediment accumulation rates** in the points located near the rivers mouth **increased loads of heavy metals** can be observed (especialy for Zn in Dicksonfjorden and Sassenfjorden and for Cd in Sassenfjorden). However, these loads are several times lower than those recorded near glaciers in previous studies, suggesting that glaciers may be a much more significant source of pollution to fjords seawater.

Future directions

So far, no monitoring focused on the release of heavy metals from secondary sources has been conducted. The studies will be continued, additional sediment cores in 7 other Svalbard fjords influenced by glacier meltwater and riverine discharge have been collected.

References

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