CONCENTRATIONS AND LOADS OF METALS (V, CR, MN, FE, CU, ZN, AS, RB, Y, ZR) FROM THE CLIFF EROSION TO THE GULF OF GDANSK

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Introduction

Coastal erosion is one of the pathways through which different elements, including metals, can be introduced into the sea. It is particularly significant in the case of eroding coastlines such as polish Baltic Sea coastline which undergoes active erosion in more than a half of its length (Dubrawski and Kahlau 2006). Recent increase in the occurrence of extreme natural phenomena (for example more frequent storms) and rise of the sea level induced doubling of coastline retreat rate to 1 m a^{-1} in comparison to years 1960-1980 (Dubrawski and Kahlau 2006). The aim of this study was to estimate mean year loads of particular metals to the Gulf of Gdansk from the erosion of Orlowo Cliff.

Methods

Samples of surface sediments (0-5 cm) were collected from 7 stations. Four were located in the area of Orlowo Cliff (Gdynia, Poland): colluvial material from the cliff (C), soli above the cliff (SC), beach sand (BS) and marine sediments from the coastal zone (1 m depth) (CS(1)). Next station was located 1 km away from the cliff and marine sediments were collected there (1 m depth) (CS(2)). There were also three offshore stations. Two in the marine accumulation zone (AZ): P110 (the center of the Gulf Of Gdansk) and GG (Gdansk Deep), and one in the mouth of Vistula River (VM) (second largest river discharging into the Baltic Sea). Land samples were collected manually, marine samples – using van Veen grab sampler. Metal concentrations were analyzed using XRF spectrometer in cooperation with Institute of Oceanology of the Polish Academy of Sciences.

Results

Not in all analyzed samples every metal was above the limit of detection (LOD). In the case of As and Y there were values <LOD – in sandy sediments with very low content of fine fraction (<1%). Maximum concentrations of V, Fe, Cu, Zm, As, Rb, Y and Zr were found in accumulation zone marine sediments. Cr was highest in sediments from Vistula river mouth, and Mn in clay sediments of Orlowo Cliff.

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Table 1. Median metal concentrations [mg kg^{-1}] in surface sediments and soil in particulate stations.

station	V	Cr	Mn	Fe	Cu	Zn	As	Rb	Y	Zr
SC	18,5	57,3	135,8	7602,3	10,0	19,3	8,5	35,7	12,5	174,7
C	38,0	59,7	402,2	23963,2	18,5	39,5	7,5	78,3	21,0	148,7
BS	13,0	74,0	102,0	2872,7	8,7	10,3	<LOD	22,0	10,5	24,7
CS (1)	13,4	87,5	112,7	3133,8	8,5	9,5	<LOD	25,5	9,0	36,3
CS (2)	16,0	65,3	75,0	2630,0	8,3	12,0	<LOD	25,5	<LOD	21,3
AZ	50,5	65,0	347,0	32777,7	41,0	180,7	14,3	107,0	22,7	188,7
VM	12,0	97,9	116,5	7408,0	9,3	28,0	8,0	30,7	10,5	119,2

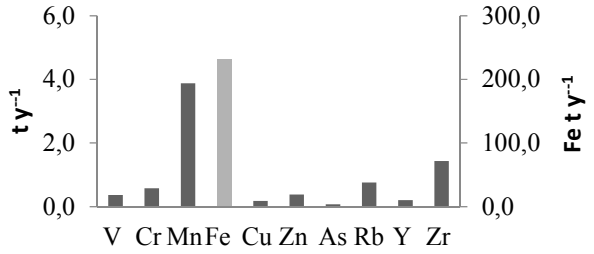

Figure 1. Estimated loads of particular metals (tonnes per year) to the Gulf of Gdansk introduced by Orlowo Cliff (Fe is on the separate axis due to high values).

Conclusion

None of analyzed metals exceeded safe, background values typical for each kind of sediment (Kabata-Pendias and Mukherjee 2006). Apart from Cr, As and Zr all metals were very strongly correlated (>90%, $p<0,05$) with fine sediment fraction (<0,063 mm) and content of organic matter both on land (C, SC, BS) and marine (CS(1)), CS(2), AZ, VM) stations. Dominant type of sediment in colluvial material of Orlowo Cliff (C) is boulder clay in which were observed higher metal concentrations than in soil above (SC), especially Fe and Mn. This cliff "print" was visible in coastal sediments (CS(1)) where values of those two metals were significantly higher than 1 km apart in the same type of sediments (CS(2)). Highest metal concentrations in the accumulation zone (AZ) are associated with fine fraction and LOI values which highest from all the stations and are 29,8 % and 15,4 % respectively. Metal loads were calculated based on median concentration values and the load of sedimentary material which is introduced to the Gulf of Gdansk by Orlowo Cliff erosion (9 647 t) (Beldowska et.al. 2016). Fe load is the highest -231 t what equals 2,3 % of the whole introduced sedimentary material. Loads of other metals varied from 0,07 t (As) to 3,88 t (Mn).

References

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