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NICKEL AND CADMIUM IN BOTTOM SEDIMENTS OF THE SLUP AND LUBACHOW DAM RESERVOIRS (LOWER SILESIA PROVINCE)

NIKIEL I KADM W OSADACH DENNYCH ZBIORNIKÓW ZAPOROWYCH SŁUP I LUBACHÓW (WOJEWÓDZTWO DOLNOŚLĄSKIE)

Abstract: Bottom sediments from dam reservoirs: Slup and Lubachow were studied. The concentration of nickel and cadmium was determined. The bottom sediments in the Lubachow reservoir were found to have accumulated more nickel (k = 23373) and in the Slup reservoir – cadmium (k = 2259). As a general rule, metal concentrations were the lowest in the central parts of the reservoirs.

Keywords: nickel, cadmium, dam reservoirs, bottom sediments, water

The composition of bottom sediments is a resultant not only of the catchment basin structure, but also local meteorological conditions (dry and wet deposition), natural biological, chemical and physical processes, and anthropogenic factors. Metals present in dam reservoirs come from atmospheric precipitation and from inflows from direct and indirect catchment basins. In the so-called "working" dam reservoirs, where due to demand for water its flow is regulated, the bottom (bottom sediments) often comes into direct contact with atmospheric air, ie with the pollutants present in it. Water level regulation in reservoirs provided with a bottom discharge spout (the reservoirs at Slup and Lubachow) results in the outflow of the active, surface layer of the sediment and its accumulation while the reservoir is being filled. In such circumstances the quantitative composition of the sediments may be subject to change, and the quantity and the nature of its chemical compounds may vary [1].

The two reservoirs Slup and Lubachow in question are used as a source of drinking water and water used for household purposes. This was reason of chemical analysis of their bottom sediments. An attempt was also made to determine the accumulation rates for Ni and Cd in the bottom sediments.

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Materials and methods

The Lubachow dam reservoir was built in 1917 on the Bystrzyca River, 75 km from its source. The reservoir and its engineering structures are not subject to direct protection, although drinking water is drawn from here for the towns of Dzierzoniow, Bielawa and Pieszyce. The facility is also used for flood protection, power generation and recreation [2]. Its direct catchment is made up by mountains, rocky terrain, afforested areas, and recreational areas.

The Slup reservoir was built in 1986 across the Nysa Szalona river valley 8.2 km from the river source. The reservoir bowl and all of the hydro-engineering structures lie within a direct protection zone, because they are used to gather drinking water for the city of Legnica. The reservoir also performs a flood control function [3]. Its direct catchment is constituted by arable land, meadows, pastures and a small forest area. The morphometric features of reservoirs are in Table 1.

Table 1

Morphometric characteristics of the Slup and Lubachow dam reservoirs

Reservoir parameter	Slup reservoir	Lubachow reservoir
Average depth [m]	8.00	15.70
Maximum depth [m]	18.05	36.00
Length [km]	2.90	3.50
Volume [million m^3]	31.52	8.00
Area ha	408.00	51.00

Results and discussion

Nickel concentrations in the bottom sediments of the Slup reservoir ranged from 22.52 mgNi $\cdot$ kg^{-1} at site 3 to 66.32 mgNi $\cdot$ kg^{-1} also at site 3 (Table 2). The minimum concentration recorded at Lubachow amounted to 29.62 mgNi $\cdot$ kg^{-1} (site 2) and the maximum to 36.99 mgNi $\cdot$ kg^{-1} (site 1) (Table 2). The horizontal profile of the Slup reservoir showed, just like in the case of copper, an increase in nickel concentration (from 40.91 mgNi $\cdot$ kg^{-1} at site 1 to 51.38 mgNi $\cdot$ kg^{-1} at site 3), accompanied by a rising accumulation rate (k). Such trend was not noticed for the bottom sediments at Lubachow. Here the average values at individual sites were similar, and even a slight falling tendency in respect of the horizontal profile was observed. The highest accumulation rate for nickel at Lubachow was at site 1 (k = 23373); it dropped further along the water course to k = 10010 in the centre, and then grew to 18678 near the dam.

Nickel concentration in the bottom sediments of the Goczalkowice reservoir was from 3.00 mgNi $\cdot$ kg^{-1} to 170.00 mgNi $\cdot$ kg^{-1} [4–6]. A slightly narrower range was found for the Kozlowa Gora reservoir, which was studied by Pasternak and Glinski [4] and Reczynska-Dutka [7], where nickel concentration fell within the range: 5.00–28.40 mgNi $\cdot$ kg^{-1}. The corresponding figures for the Rybnicki reservoir were: 19.90–38.37

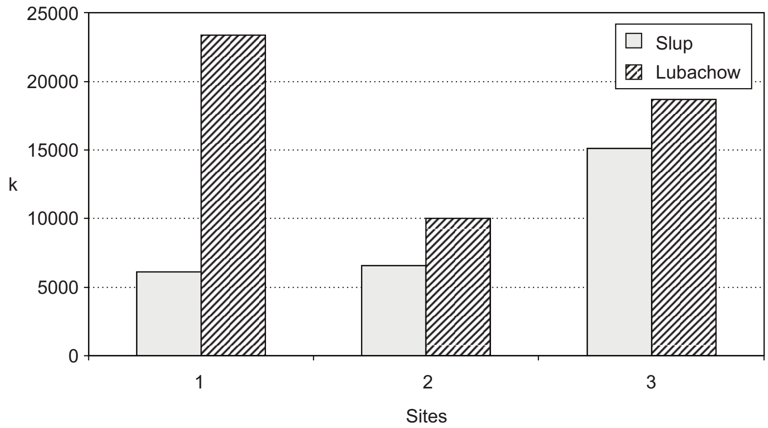

Fig. 1. Rate of accumulation nickel in bottom sediments

mgNi · kg^{-1} [8, 9]. The values were similar to those given for many years for bottom sediments from various lakes [10–12].

Table 2

Content of nickel and cadmium in bottom sediments

Sites (number)		Slup		Lubachow	
		Ni	Cd	Ni	Cd
1	x_o	40.91	0.52	35.06	1.08
	min	30.45	0.18	31.59	0.79
	max	61.52	1.06	36.99	1.54
	x_w	0.0067	0.0004	0.0015	0.0009
2	x_o	40.82	0.54	31.03	1.31
	min	34.50	0.05	29.62	1.25
	max	49.78	0.96	31.80	1.39
	x_w	0.0062	0.0004	0.0031	0.0053
3	x_o	51.38	0.68	33.62	1.16
	min	22.52	0	29.96	0.98
	max	66.32	1.31	36.41	1.39
	x_w	0.0034	0.0003	0.0018	0.0008

x_o – mean content in bottom sediments [mg · kg^{-1}]; x_w – mean content in above bottom water [mg · dm^{-1}].

Cadmium concentrations in the bottom sediments of the Slup reservoir were from below the determination threshold at site 3 up to 1.31 mgCd · kg^{-1} also at site 3 (Table 2). Very similar figures were found at Lubachow (from 0.79 mgCd · kg^{-1} at site 1 to 1.54 mgCd · kg^{-1} also at site 1). In the Slup reservoir cadmium concentrations rose in the horizontal profile from site 1 (on average 0.52 mgCd · kg^{-1}) to site 3 (on average 0.68 mgCd · kg^{-1}). Accumulation rate also rose: from k = 1301 (site 1) to

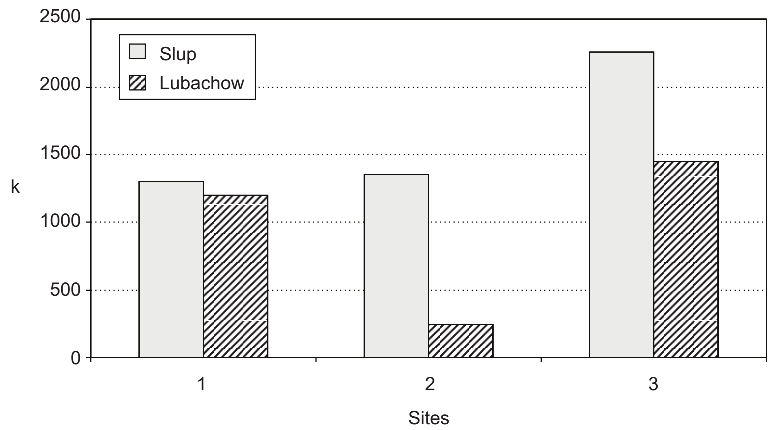

Fig. 2. Rate of accumulation cadmium in bottom sediments

k = 2259 (site 3). The changes in cadmium concentration at Lubachow, similarly to nickel, were quite small, and along the main water flow cadmium accumulated unevenly. The lowest accumulation rate (k = 247) was found in the central part of the reservoir (site 2). Of note is the fact that in both reservoirs Cd was the weakest accumulator of nickel at all sites and its accumulation rate at site 2 at Lubachow was the lowest for any metal recorded during the research.

The cadmium concentrations found by Szarek-Gwiazda [13] in the Dobczycki reservoir ranged from 0.50 mgCd $\cdot$ kg^{-1} to 1.20 mgCd $\cdot$ kg^{-1}. Cadmium concentrations at Kozlowa Gora were much higher, from 3.20 mgCd $\cdot$ kg^{-1} to 22.70 mgCd $\cdot$ kg^{-1} [7], and at Goczalkowice from 0.00 mgCd $\cdot$ kg^{-1} to 18.00 mgCd $\cdot$ kg^{-1} [5]. Similar concentrations were recorded for cadmium in the bottom sediments of the Rybnicki reservoir (from 2.75 mgCd $\cdot$ kg^{-1} to 13.10 mgCd $\cdot$ kg^{-1}) [9]. Bottom sediments sampled from numerous stagnant water reservoirs throughout Poland are characterized by concentrations similar to those found at Slup and Lubachow [7, 10, 11, 14].

Conclusions

Nickel accumulated more intensely in the Lubachow dam reservoir, whereas cadmium – at Slup. At Slup nickel and cadmium accumulated more intensely at site No. 3 in front of the dam . At Lubachow cadmium accumulated more intensely at site No. 3 and nickel at No. 1 the backwater area. Metals accumulated most weakly (the lowest accumulation rate k) in the central part of the reservoir bowls.

It should be made a regular control of level metals in bottom sediment because reservoirs are used as a source of drinking water.

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Abstrakt: Przeprowadzono badania osadów dennych zbiorników zaporowych Słup i Lubachów. Określono zawartość niklu i kadmu. Zaobserwowano większą kumulację niklu w osadach dennych ze zbiornika zaporowego Lubachów (k = 23373), a kadmu w osadach dennych zbiornika Słup (k = 2259).

Generalnie metale najsłabiej kumulowały w centralnej części zbiorników.

Słowa kluczowe: nikiel, kadm, zbiorniki zaporowe, osady denne, woda