CASE STUDY

HEAVY METALS IN LAKE BALATON

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Lake Balaton is located at the western part of Hungary. The water surface is 596km^2 with an average depth of 3.2m and a catchment area of 5775 km^2. Land use around the lake is mainly agricultural. Industry is not a significant land use (with the exception of a chemical factory). The local population in towns and villages in the lakeside communities is around 130,000. Tourism in the summer takes this figure to 800,000 people. Road and rail traffic in the vicinity of the 210km lakeshore is rather heavy (using mostly unleaded petrol). There is also an active cruise industry on the lake. Waste deposits close to the shore or in the vicinity of inflow waters are also sources of pollution, as is pollution of atmospheric origin.

Heavy metals are the most significant toxic substances in Lake Balaton. Between 1980 and 1990 regular sampling and measurement of Hg, Cd, Pb, Cu, Zn and Ni concentrations were taken from the water, sediment and aquatic animals at 5 points in the lake and at 15 main tributaries close to the inflow (Fig. 1).

Measurements were made by atomic absorption spectro-photometry as described in Salánki *et al.*, 1982. Values are given for the water in µg/l, for the sediment and animals in mg/kg dry weight. Only mean values of more than 6 samples collected in different months of the year are included in the tables, detailed data are available in research papers and reports (see references).

1. METAL CONCENTRATIONS IN THE WATER OF LAKE BALATON AND MAIN TRIBUTARIES

Soluble metal concentrations were far under permissible levels for drinking water at all locations investigated during 1988-89 as shown in Table 1. This is true even for places where metal concentrations were higher than the average (as indicated separately under "b").

2. METAL CONCENTRATIONS IN THE SEDIMENT

The level of heavy metals in the sediment was 100-10,000 times higher than in the water, however, this represents total concentrations, including insoluble metal compounds (Table 2). The metal content of the sediment is indicative of the degree of pollution. It serves as a source for solubilzation into the water depending on physico-chemical circumstances (pH, etc.) and for uptake by benthic organisms.

In some places extremely high or unusually low concentrations were detected (indicated separately with reference to sampling locations).

3. METAL CONCENTRATIONS IN THE ZOOPLANKTON OF THE LAKE

Zooplankton was collected from the open water of the lake at five locations (Fig. 1). The metal concentration was 3-4 times higher in the zooplankton than in the water, indicating a high degree of accumulation Table 3). It is remarkable that the concentrations of Hg and Pb decrease from west to eastern locations, Cu and Zn were nearly at the same level at each location, Cd varied without any rule while Ni concentrations were not detectable.

4. METAL CONCENTRATIONS IN FISH COLLECTED FROM MAIN TRIBUTARIES OF LAKE BALATON

Heavy metal concentrations in fish varied within a wide range (Table 4), however no dramatic differences were found between sampling locations. Nevertheless, in some sampling places comparatively high or low concentrations were measured. Comparison of these results with data obtained for the sediment shows that the inflow waters represented by locations E5, E6 and D2 can be considered as massive sources of metal pollution.

A more detailed analysis of data indicates that among fish organs the concentrations of some heavy metals are rather diverse: Cu is accumulated better in liver than in the gill or muscle, while Zn and Ni accumulation is much higher in the gill than in the liver or muscle. Our separate studies proved that snails accumulate better Pb than fish organs, but they are poor accumulators for Zn as compared to fish gills. In monitoring heavy metal pollution the best accumulating animals and/or organs can be recommended as biological indicators.

5. CONCLUSION

The heavy metal pollution of Lake Balaton and its tributaries is not "significant". It does not endanger aquatic life and does not hinder the use of drinking or irrigation. However, toxic metal content in the sediment is remarkable at some locations, a result of point pollution sources in the environment.

Concentrations of heavy metals in animals are low, nevertheless, if they are released from storage organs they can alter significantly basic physiological processes.

Finally there is a need to study the occurrence and concentrations of other toxic substances in the lake and its environment.

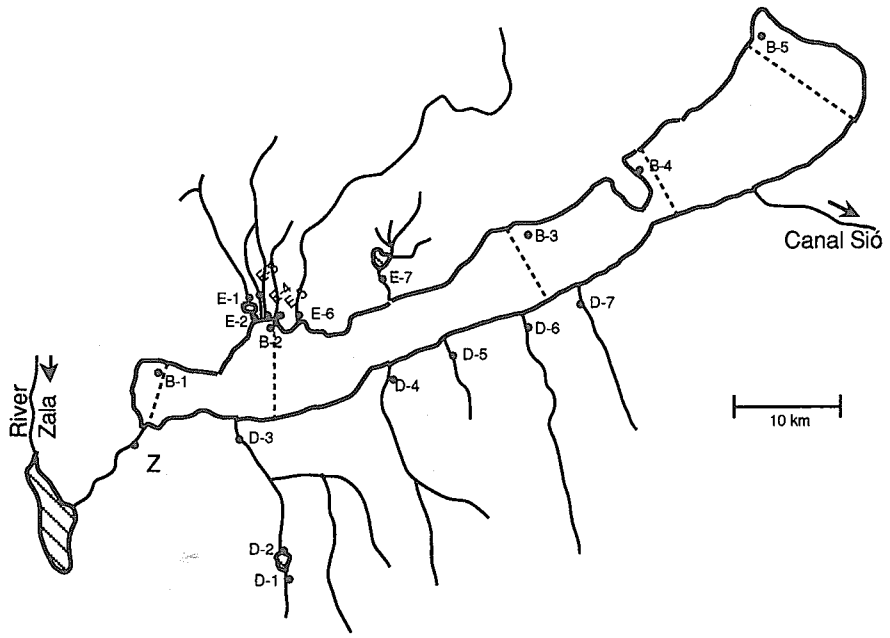

Fig. 1. Lake Balaton and sampling locations for heavy metal monitoring. E1-7: northern tributaries; D1-7: southern tributaries; Z-sampling location at River Zala; B-5: sections for sampling locations in the open water of Lake Balaton.

Table 1 Heavy metal concentrations in the water of Lake Balaton and main tributaries (µg/l)

	Hg	Cd	Pb	Cu	Zn	Ni
a	< 0.1	0.01-0.2	0.1-1.0	0.3-4.6	0.5-5.4	0.5-3.5
b		0.5-0.6	1.9-3.8	10.5	10.0-47.7	
		E7, D1	E2, D1, D3,	D7	at most places in October	

a: minimum and maximum mean values
b: markedly higher values with reference to sampling locations, according to Fig. 1.

Table 2 Heavy metal concentrations in the sediment of Lake Balaton and main tributaries (mg/kg dry weight)

	Hg	Cd	Pb	Cu	Zn	Ni
a	0.03-0.38	0.4-3.5	10.2-92.6	7.0-88.0	18.0-124.0	13.6-47.6
b	0.5-0.8	4.1-4.9	250.0		220-222	
	D1, B5	E4, E5,	E4		E1, E5	
c		0.03-0.08	2.8-8.0	1.4-3.4	8.0	1.0-2.8
		D2, B1	D2, D3	D2, D3	D2	D2

a: minimum and maximum mean values
b: markedly higher values
c: markedly lower values, with reference to sampling locations, according to Fig. 1.

Table 3 Heavy metal concentration in the zooplankton collected in the open water of Lake Balaton.

Hg	Cd	Pb	Cu	Zn	Ni
0.04-0.23	0.7-2.2	9.9-22.5	11.0-17.6	70.1-99.2	not detectable

(mg/kg dry weight, minimum and maximum mean values.)

Table 4 Heavy metal concentrations in liver, gill and muscle of fish (Esox lucius L.) collected in main tributaries of Lake Balaton (mg/kg dry weight)

	Hg	Cd	Pb	Cu	Zn	Ni
Liver						
a	0.4-0.7	1.0-4.4	1.7-5.9	11.8-37.1	95.7-187.0	2.7-8.3
b	1.3-3.6 D1,D5	6.1 E7	13.5-15.0 E1,E7			
c	0.03-0.08 E4,D2,D3,D4,					
Gill						
a	0.1-0.8	2.0-10.0	0.7-9.9	1.0-10.1	784.0-1458.0	8.6-33.7
b			17.8-51.0 D1-7	21.4 E1		
c						2.7 E6
Muscle						
a	0.3-0.7	1.1-3.1	1.3-6.2	0.3-2.8	17.7-39.0	2.3-8.5
b	1.1-1.5 E1,E6,E7,D1,		8.5-10.9 D2,D3,D4,D7,	4.2-6.6 E5,E7		

a: minimum and maximum mean values
b: markedly higher values
c: markedly lower values with reference to sampling locations according to Fig. 1.

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