

REDUCTION IN FLUORIDE LEVELS IN THE OLD WARTA RESERVOIR NEAR LUBOŃ, POLAND

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SUMMARY: Earlier reports showed that the extensive pollution of the old Warta reservoir near Luboń, Poland was caused by fluoride emissions from a nearby phosphate fertilizer plant. In this paper, we provide new determinations of fluoride levels in the reservoir. After reduction of emissions in the early 1990s, our measurements revealed that fluoride concentrations had decreased from an average of 75 mg/L in 1978 and 23 mg/L in 1984 to 2.5-2.6 mg/L in 1995-1996 with a range of 1.32 to 4.1 mg/L, depending of the season of the year and the location in the reservoir.

Keywords: Fertilizer plant fluoride, Fluoride emission, Luboń, Poland, Warta reservoir.

INTRODUCTION

Unless effectively controlled, industrial fluoride emissions, especially from phosphate fertilizer plants and the production of aluminium, iron, glass, and ceramics, are a significant environmental hazard to the biocenosis of water ecosystems. For certain life forms, even water fluoride concentrations in the 1-ppm range can be extremely damaging. Thus 1.5 ppm fluoride causes reproductive disturbances in rainbow trout,¹ and a level of 0.6 ppm inhibits long-term reproduction in *Daphnia magna*.²

Because of environmental concerns, the present study was undertaken to assess fluoride levels in the old Warta reservoir in Luboń, Poland. The reservoir is located near the chemical plant Luboń SA that was producing phosphate fertilizers. In years past, this plant was responsible for severe fluoride pollution in the Warta reservoir. In this report we present partial results of our fluoride evaluation of the biocenotic state of the reservoir as a basis for undertaking appropriate reclamation of the reservoir.

MATERIALS AND METHODS

Nature of the study area: The Warta reservoir has a total surface area of 60,000 m² and length of 900 m. The average depth is 2.5 m and the total water volume is about 150,000 m³. The average width is about 50 m. Three morphometrically different parts of the reservoir can be distinguished: northern – the shallowest (maximum depth 1.4 m), central – intermediate (maximum depth 2.5 m), and southern – the deepest part (maximum depth 5.4 m).

Owing to hydrographic, morphometric and drainage conditions of the area, the reservoir is strongly predisposed to environmental degradation. Even though there are no on-site sources of contamination, its proximity (1200 m) to the chemical plant Luboń SA, the presence of post-production

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waste dumps from the plant on the eastern bank, and the compact settlements of single-family houses on the western bank pose a serious threat to its ecosystem.

Water sampling and analysis: Water samples were collected in polyethylene bottles from three representative sites of the Warta reservoir from June 1995 through November 1996. Fluoride concentrations were determined with an ion-selective electrode (Orion 210A apparatus and TISAB IV buffer) and by capillary electrophoresis with a Kristal 310 ATV Unicam apparatus.³

RESULTS

Fluoride analyses of the water during the study period are presented in Figure 1. The highest average fluoride concentrations occurred in September 1995 and in June and July 1996, being 3.6, 3.8, and 3.4 mg/L, respectively. The overall range was 1.32 to 4.1 mg/L, depending on the sampling location and the season of the year. During the dry summer of 1995, the average fluoride levels were 1.9 to 2.1 mg/L, which increased to 3.6 mg/L after intensive rainfall in September.

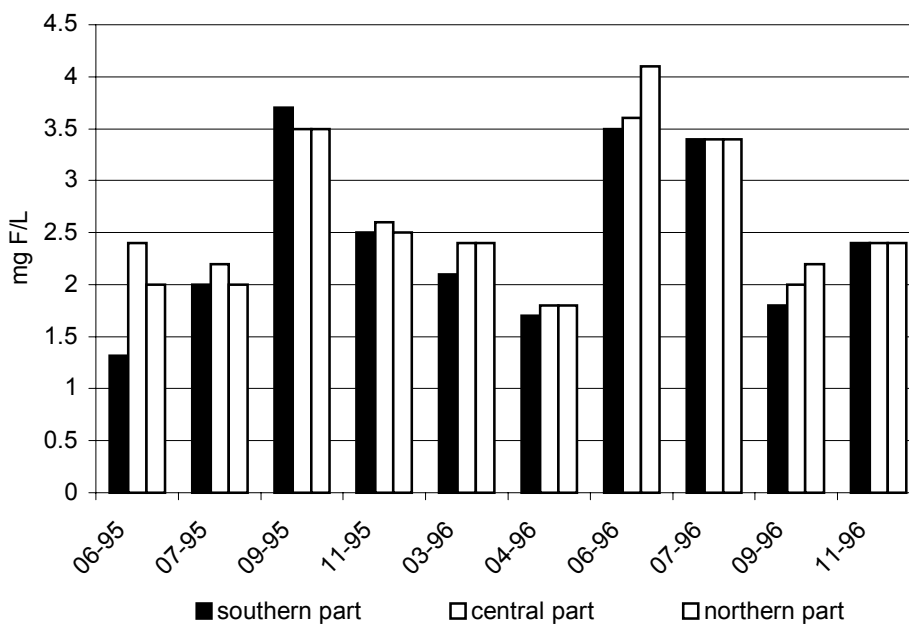


Figure 1. Seasonal changes of fluoride concentrations (mg/L) in the old Warta reservoir

The summer of 1996 had high rainfall, and the average fluoride concentration increased to 3.4-3.8 mg/L. Samples taken from different locations showed only small differences in fluoride concentration. The only exception was the low 1.32 mg/L concentration in water taken from the deepest southern part of the reservoir in June 1995.

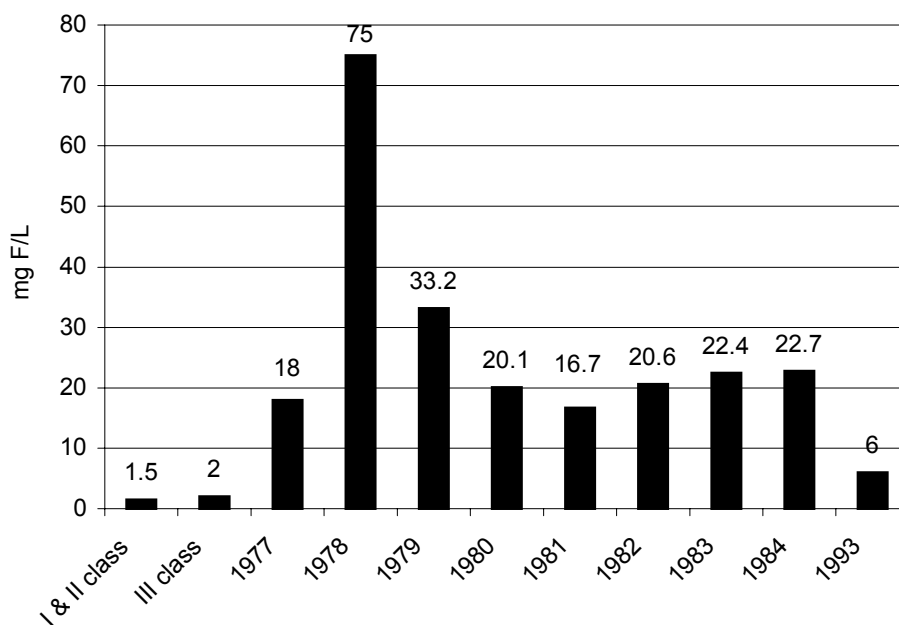


Figure 2. Average fluoride contents (mg/L) in the old Warta reservoir water (1977-1993) in comparison with Polish Standards^{5-7,9}

DISCUSSION

For many years, the chemical plant Luboń SA has been emitting pollutants such as NO_x, SO₂ and fluorides to the neighboring area, causing destructive effects not only in the soil and vegetation but also on the ecosystem of the Warta reservoir.⁴

As seen in Figure 2, fluoride concentrations in the water averaged 75 mg/L in 1978 and 23 mg/L in 1984.^{5,6} By the early 1990s the concentrations had decreased to 6 mg/L as a result of a four-fold decrease in the production of phosphate fertilizers and installation of improved emissions control

equipment.^{7,8} The levels we found in 1995-1996 are even lower (2.5-2.6 mg/L) but are still higher than desirable.

By comparison, the fluoride content of the water in the various lakes of Wielkopolski National Park located about 8 km southwest from the Chemical Plant Luboń SA ranges from 0.2 to 0.46 mg/L.⁸ Therefore the concentration of fluoride in the Warta reservoir must be regarded as high, exceeding both the Polish Standard I and II class (1.5 mg/L) and the Standard III (2.0 mg/L) for water quality.⁹

REFERENCES

- 1 Ellis MM, Westfall BA, Ellis MD. Determination of Water Quality Research Report 9. Fish and Wildlife Service, Department of Interior, Washington DC 1938 p. 81-2.
- 2 Dave G. Effect of fluoride on growth, reproduction and survival of *Daphnia magna*. *Comp Biochem Physiol* 1984;78c:425-31.
- 3 Kristal 310 ATV UNICAM Manual.
- 1 Zbierska J. Content of microelements and fluorine in the soil and the undergrowth of grassland in region of phosphorus fertilizer plant in Luboń. *Pr Kom Nauk Roln Kom Nauk Leśn PTPN WNRiL* 1996;81:227-34.
- 5 Zbierska J. Concentration of fluorine compounds in surface and ground waters near phosphate fertilizers plants. *Rocz AR Pozn* 1981;31(133):89-98.
- 6 Zbierska J. Effect of pollution emission from phosphate fertilizers plants on the concentration of fluorine in surface and ground water. *Pr Kom Nauk Roln Kom Leśn PTPN* 1986;61:287-95.
- 7 Zerbe J, Sobczyński T, Kabaciński M. Analysis of the Warta old riverbed water in Luboń. *Biuro Usług Konsult-Tech Poznań (Expert report)* 1993, [In Polish].
- 8 Zerbe J, Elbanowska H, Gramowska H, Adamczewska M, Sobczyński T, Kabaciński M, et al. Appraisal of effect of fluorine and other pollutants emission on the waters, vegetation and soils in the area of the Wielkopolski National Park and its protective zone. In: *Geocosystem of the Wielkopolski National Park as the protected area under anthropopressure*. Bogucki Wydaw Nauk Poznań 1994. p. 89-135 [In Polish].
- 9 Regulation act by the Minister of Environmental Protection, Natural Resources and Forestry of 5 November 1991 on classification of the water. Annex no.1, *The Governmental Gazette (DzU) No.116, pos.503, 1991* [In Polish].