Large dams as purification systems for toxic PCDD/PCDF and dl-PCB congeners

MAGDALENA URBANIAK[1,2] **& MACIEJ ZALEWSKI**[1,2]

1 *International Institute PAS, European Regional Centre for Ecohydrology, u/a UNESCO, Tylna 3, 90-364 Lodz, Poland*
m.urbaniak@unesco.lodz.pl

2 *Department of Applied Ecology, University of Lodz, Banacha 12/16, 90-237 Lodz, Poland*

Large dams are considered as constructions with negative effects on river ecosystems' structure and functioning. According to Miller (1995), the main negative impacts of large dams on the environment are expressed as: degradation of river continuity, which influences the hydrological regime below the dam, enormous losses of water through evaporation, destruction of forestlands and croplands caused by flood and collapse, displacement of people, loss of nutrient-rich silts in downstream croplands and estuaries, and disrupted migration and spawning of some fish. Nevertheless, in the face of global climate change, dams may also play an increasingly important role in protecting water resources, contributing to human development by providing reliable sources of drinking water and irrigation, hydropower, recreation, navigation, income, and other important benefits (WCD, 2000). Moreover, they are considered as an efficient trap for sediments and, consequently, associated chemical toxins, including PCDD/PCDF and dl-PCB (Devault *et al.*, 2009). The decrease in the flow velocity and increase of flocculent settling in constructed reservoirs create perfect conditions for sedimentation and pollutant deposition. It was estimated that 97% of released PCDD/PCDF and dl-PCB in a water column were retained in sediments (DiPinto *et al.*, 1993), which serve as storage compartments for micropollutants (Knezovich *et al.*, 1987). Thus reservoirs act as a sink for dioxins and, therefore, are important in pollution studies and monitoring of ecosystem stress. The main objectives of this study are, therefore, to analyse PCDD/PCDF and dl-PCB transfer along three large reservoirs (Włocławek, Jeziorsko and Sulejów Reservoirs) located in central Poland.

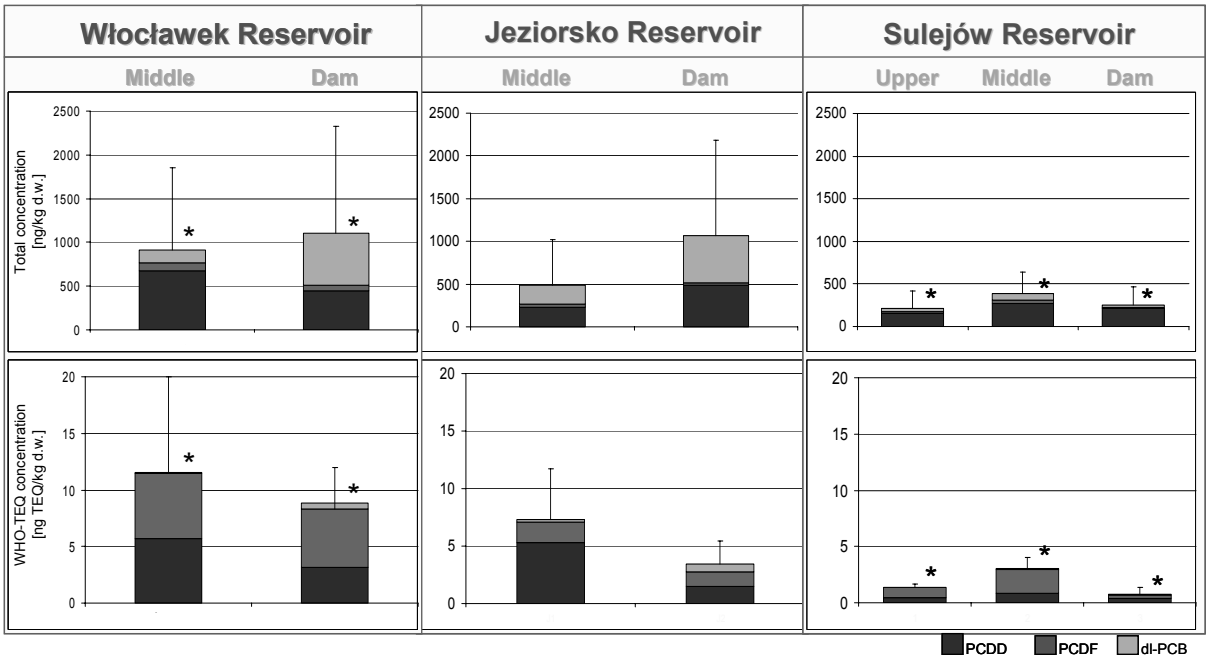

Fig. 1 Changes in PCDD/PCDF and dl-PCB concentrations during their transfer along large reservoirs (* samples significantly different, p = 0.05).

Copyright © 2010 IAHS Press

The reservoir sediment samples were collected using a gravity core sampler four times during the period of 2007 and 2008, from two stations (the middle and dam) in Włocławek and Jeziorsko Reservoirs and three stations (upper, middle and dam) in Sulejów Reservoir. PCDD/PCDF and dl-PCB congeners extractions, clean-up and analysis were performed according to US EPA 1613 and 1668 methods and PN/EN 1948: 3 2002 Norm. Identification and quantification were performed using HRGC/HRMS (HP6890, Hewlett Packard/Autospec Ultima, Micromass) with an isotope dilution method.

The results showed that 60% of analysed bottom sediment samples had elevated levels of dioxin concentration in the dam section of each reservoir, whereas the toxicity of analysed samples measured as WHO-TEQ concentration, higher in the middle section of each reservoir (67% of samples) (Fig. 1). This situation can be related to the hydraulic transport and deposition (sedimentation) of dioxins along the reservoirs, as well as to biogeochemical characteristics which determine the rate of congener transformation. The results obtained indicate that concentration and transfer of micropollutants along the river continuum may be diminished by anthropogenic retention through construction of reservoirs, in which deposition and burial of PCDD/PCDF and dl-PCB in sediments have been suggested as an important purging mechanism.

REFERENCES

Devault, D. A., Gerino, M., Laplanche, Ch., Julien F., Winterton, P., Merlina, G., Delams, F., Sanches-Perez, J. M. & Pinelli, E. (2009) Herbicide accumulation and evolution in reservoir sediments. *Sci. Total Environ.* **407**, 2659–2665.

DiPinto, L. M., Coull, B. C. & Chandler, G. (1993) Lethal and sublethal effects of a sediment-associated PCB Aroclor 1254 on a meiobenthic copepod. *Environ. Toxicol. Chem.* **12**, 1909–1918.

Knezovich, J. P., Harrison, F. L. & Wilhelm, R. G. (1987) The bioavailability of sediment sorbed organic chemicals: a review. *Water Air and Soil Pollut*. **32**, 233–245.

Miller, G. T. Jr (2005) *Environmental Science*, 5th edn. Belmont, Wadsworth, UK.

WCD World Commission on Dams (2000) *Dams and Development, A New Framework for Decision-Making*. Earthscan, London, UK.