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The ecohydrological biotechnology (SBFS) for reduction of dioxin-induced toxicity in Asella lake, Ethiopia

M. Urbaniak (1,2), Y. Zerihun Negussie (3), M. Zalewski (1,2)

(1) International Institute of Polish Academy of Sciences European Regional Centre for Ecohydrology, 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, (3) Ministry of Water and Energy of Ethiopia, Haile G/Silassie, P.O. Box 5744, Addis Ababa, Ethiopia, (4) Nofer Institute of Occupational Medicine, Teresy 8, 91-348 Lodz, Poland

The transfer of dioxins along river continuum is a well know process which indicated permanent increase of their content in the river sediments. Despite this, there is still lack of empirical data highlighting the role of lakes and reservoirs in dioxins transfer along river continuum. Using the ecohydrology as a framework for water problem solving, the reduction of dioxins bioaccumulation in aquatic food chain should be based on two steps: 1) a reduction of dioxins emission to the water ecosystems and 2) an understanding of the role that the factors determining dioxins accumulation, transportation and transformation in the river and lake/reservoir system play for implementation of ecohydrological biotechnologies and system solutions. From limnological perspective lakes and reservoirs are considered as traps for organic and mineral sediments and bounded with them nutrients and other polluting substances. As effect of long term ecological succession the amount of sedimented matter, nutrients and loads and concentrations of pollutants usually increases. Such situation was observed in Asella lake, located in the Arsi zone of the Oromia region about 175 kilometers from Addis Ababa, Ethiopia. As the results of above processes the high concentration of dioxin concentrations in the sediments was observed, inducing decline in the water resources use.

During this study the spatial pattern of dioxins concentration and toxicity (measured as WHO TEQ concentration) in the sediments of Asella river and lake taken before (in 2009) and after (in 2010) construction of Sequentional BioFiltering System (SBFS) were compared. The determination of dioxin concentrations were followed according to US EPA 1613 and 1668 Methods.

Among the samples collected in the 2009 year, the contamination of lake sediments amounted for 127.65 ng kg^{-1} dry weight (d.w.), whereas concentration of dioxins in samples taken at the lake outflow decreased to the value of 26.65 ng kg^{-1} d.w. The WHO-TEQ concentrations also showed declining tendency along the river-lake system with the highest value in the inflow (2.32 ng TEQ kg^{-1} d.w.), middle in the lake (1.09 ng TEQ kg^{-1} d.w.) and the lowest at the lake outflow (0.55 ng TEQ kg^{-1} d.w.). Samples collected after one year of SBFS implementation showed 70% reduction of sediment toxicity in the lake indicating positive role of such ecohydrological solution on the quality of lake ecosystem and in consequence on the human health.

The obtained data indicate that the reduction of dioxins contamination in the upper part of the river by construction of the SBFS is fundamental to the improvement of the quality of the lake and lower part of the river. Implementation of such system reduced the input of dioxins to the lake through sedimentation and possibly due to acceleration of photo- and biodegradation processes and in consequence improve the quality of the whole river-lake system.

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