Cadmium in the Dnieper River: distribution, speciation and interaction with organic ligands

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With 4 figures and 2 tables in the text

Abstract

This paper summarises the spatiotemporal analysis of cadmium distribution in water of the Dnieper River. Speciation analysis was conducted using Anodic Stripping Voltammetry. Dissolved compounds (65–90% of total Cd) are the predominant form, among which complexed compounds (mainly with organic matter) represent 45–90% of dissolved Cd. Complexed compounds are formed by binding with both relatively high (> 60,000 atomic mass units) and low (< 5000 a.m.u.) molecular mass ligands. Fulvic acids play a major role, binding 65–85% of the complexed Cd.

Introduction

Cadmium is an important surface water contaminant. Its high toxicity, similar to that of mercury and arsenic, is caused by its ability to substitute for zinc in many vital enzymatic reactions, causing their rupture and inhibition. Cd accumulates mainly in the liver and kidneys of animals, owing to its active interaction with cysteine. The biological half-life of Cd is quite long (10–30 years) (MOORE & RAMAMOORTY 1987); thus the Cd content in surface water should be greatly limited. In the Ukraine the drinking water standard is 1.0 µg/l, the standard for fish breeding is 5 µg/l and for general purposes it is 10 µg/l. The negative influence of the metal on water ecosystems should not be underestimated, especially under the conditions of progressive anthropogenic loading which takes place in southern Ukraine. The chronic toxicity of Cd is a potentially serious problem in most of the heavily industrialized areas of the world, but the metal has been scarcely studied in Ukrainian surface waters.

The object of our investigation was the Dnieper River, consisting of a cascade of six reservoirs with a total volume of 44 km³ (the working storage is 19 km³). Building the cascade on the biggest river in the Ukraine has turned the Dnieper into a multi-purpose water basin which is of great importance to the Ukrainian national economy. The Dnieper provides the main source of drinking water for up to 75% of the population and irrigates more than 1 million hectares of agricultural land. Moreover it is a source of cheap hydroelectric energy and a major transportation artery.