Levels of Cd, Hg and Zn in some surface waters from the Eastern Cape Province, South Africa

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Abstract

Total trace metals levels – Cd, Hg and Zn, which may affect human health and the "health" of the aquatic ecosystem, were determined in the Umtata, Buffalo, Keiskamma and Tyume Rivers and in the Sandile and Umtata Dams. These elements were also determined in sediment samples from some of these surface waters. Normal levels of the metals were detected in water samples from the Umtata River and the Umtata Dam but samples from Buffalo, Keiskamma and Tyume Rivers contained elevated levels of Cd. Generally the levels of Hg and Zn were normal in samples from all the surface waters. The probable sources of the metals in the rivers are diffuse, originating from rural and urban runoff and from agricultural runoff in the catchments although there could be contribution from natural and point sources.

Keywords: heavy metals, water, sediments, atomic absorption spectrometry

Introduction

The accumulation of metals in an aquatic environment has direct consequences to man and the ecosystem. Interest in a metal like Zn, which is required for metabolic activity in organisms, lie in the narrow "window" between their essentiality and toxicity (Skidmore, 1964; Spear, 1981). Its study is also important because of its synergistic reaction with cadmium in the aquatic systems. Other metals like Cd and Hg exhibit extreme toxicity even at trace levels (Merian, 1991; DWAF1996a-c).

Cd, Hg and Zn are common environmental pollutants, which are widely distributed in the aquatic environment. Their sources are mainly from weathering of minerals and soils (Merian, 1991); atmospheric deposition from non-ferrous metal mines, smelters and refineries, coal combustion, refuse incineration and iron and steel industries (Merian, 1991); industrial effluents (Asami, 1974; Prater, 1975); domestic effluents (Preuss and Kollman, 1974); urban storm-water runoff (Field and Lager, 1975) and spoil heaps (Heitfield and Schottler, 1973).

Extensive literature on the aquatic toxicity of Zn and especially its toxicity to fish has been reviewed by Alabaster and Lloyd (1980) and by Spear (1981). Zn is unusual in that it has low toxicity to man, but relatively high toxicity to fish (Alabaster and Lloyd 1980).

Cd has been found to be toxic to fish and other aquatic organisms (Rao and Saxeena, 1981; Woodworth and Pascoe, 1982). Effect of Cd toxicity in man includes kidney damage (Friberg, et al., 1986a; Herber et al., 1988) and pains in bones (Itai-itai disease) (Tsuchiya, 1978; Kjellstroem, 1986). Cd also has mutagenic, carcinogenic and teratogenic effects (Fischer, 1987; Friberg et al., 1986b, Kazantzis, 1987).

Hg is a metal of major concern because of its potentially harmful effects on human health and the environment. Its major pathway to man is commonly accepted to be ingestion of aquatic organisms, particularly fish. Hg is the only metal, which indisputably magnifies through the food chain. In addition, unlike most other metals, Hg is efficiently transformed into its most toxic form (methyl mercury) in the aquatic environment. These facts make Hg exposure to the target population potentially serious, even in remote areas. All of the above observations suggest that the effects of environmental exposure to Hg may be insidious, difficult to detect, and potentially widespread (Harrison, 1983). Hg is a potential cellular toxin and is known to decrease neurotransmitter production, disrupt important processes within the nerve cells, and decrease important hormones such as thyroid and testerone. In the aquatic system, it may affect the fitness of fish species in terms of health and behaviour and in terms of the fitness of the fish flesh for human consumption (DWAF, 1996d).

The pH of a water body determines the chemical species of many metals and thereby alters their availability and toxicity in aquatic environment (DWAF, 1996b). Metals like Cd and Zn are most likely to have increased detrimental environmental effects as a result of lowered pH (DWAF, 1996b).

Temperatures at which a sample is collected and at which physico-chemical measurements are made are important for data correlation and interpretation purposes. For domestic use high temperature may increase the toxicity of many substances such as heavy metals in waters. In addition to microbial activities within an aquatic medium, temperature and pH are two important factors that govern the methylation of elements such as Pb and Hg (Van Loon, 1982; Dojlido and Best, 1993).

Electrical conductivity (EC) is a useful indicator of the mineralisation in a water sample. It correlates with the total dissolved solids (TDS) of that sample. The SA guideline for EC in water for domestic use is 70 mS/m but health effects of EC occur only at levels above 370 mS/m. The effects of high EC may include disturbances of salt and water balance, adverse effects on certain heart patients and individuals with high blood pressure, adverse effects on individuals with renal disease and laxative effects where elevated concentrations of sulphate are present (DWAF, 1998).

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Received 30 April 2003; accepted in revised form 24 June 2003.