Levels of trace metals in water and sediment from Tyume River and its effects on an irrigated farmland

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Abstract

Levels of trace metals (Cd, Pb, Co, Zn Cu and Ni) were determined in water and sediment from the Tyume River. Occurrence of these metals in vegetables and soil from a nearby farmland as a result of irrigation with the river water was also investigated. Higher levels of Cd (0.038 ± 0.004 to 0.044 ± 0.003 mg/ℓ) and Pb (0.021 ± 0.004 to 0.035 ± 0.001 mg/ℓ) were found in the river water, which may be detrimental to the "health" of the aquatic ecosystem and the rural communities that utilise the river water for domestic purposes without any treatment. Some of these metals were also detected in the soil and vegetables cultivated on the farmland which indicates a possible contribution from the river water.

Keywords: trace metals, water, sediment, farmland, Tyume River

Introduction

The presence of toxic metals such as Pb and Cd in the environment has been a source of worry to environmentalists, government agencies and health practitioners. This is mainly due to their health implications since they are non-essential metals of no benefit to humans (Tyler, 1981; Borgman, 1983). The presence of these metals in the aquatic ecosystem has far-reaching implications directly to the biota and indirectly to man. The Eastern Cape Province is noted for rural agricultural practices both for subsistence and medium-scale commercial farming.

There are no potable water supplies in some of these catchment areas, hence dependence on water sources mainly from ground- and surface waters for domestic, irrigation and livestock activities. Obviously, the chemical status of the river would have its influence on the receiving land, which might possibly reflect on the produce cultivated on such land.

Trace metals have been referred to as common pollutants, which are widely distributed in the environment with sources mainly from the weathering of minerals and soils (Merian, 1991; O' Neil, 1993). However, the level of these metals in the environment has increased tremendously in the past decades as a result of human inputs and activities (Preuss and Kollman, 1974; Prater, 1975; Merian, 1991).

Cadmium is one of the most toxic elements with reported carcinogenic effects in humans (Goering et al., 1994). It accumulates mainly in the kidney and liver and high concentrations have been found to lead to chronic kidney dysfunction. It induces cell injury and death by interfering with calcium (Ca) regulation in biological systems. It has been found to be toxic to fish and other aquatic organisms (Woodworth and Pascoe, 1982). Cadmium has been implicated in endocrine disrupting activities, which could pose serious health problems. Apart from the health implication, the metal (Cd), together with other elements, e.g. Zn form a toxic "soup" that often acts synergistically. Sources of Cd include wastes from Cd-based batteries, incinerators and runoff from agricultural soils where phosphate fertilisers are used since Cd is a common impurity in phosphate fertilisers (Stoeppler, 1991).

The United States Environmental Protection Agency has classified Pb as being potentially hazardous and toxic to most forms of life (USEPA, 1986a). It has been found to be responsible for quite a number of ailments in humans such as chronic neurological disorders especially in foetuses and children. Automobile exhaust fumes have been reported to account for about 50% of the total inorganic Pb absorbed by human beings (Mohan and Hosetti, 1998). Other inputs of Pb into the environment are from used dry-cell batteries, from sewage effluent, runoff of wastes and atmospheric deposition.

Although Zn has been found to have low toxicity to man, prolonged consumption of large doses can result in some health complications such as fatigue, dizziness, and neutropenia (Hess and Schmid, 2002). Some literature sources have also revealed that Zn could be toxic to some aquatic organisms such as fish (Alabaster and Lloyd, 1980). Certain metals such as Cu and Co are classified as essential to life due to their involvement in certain physiological processes. Elevated levels of these, however, have been found to be toxic (Spear, 1981). Copper, Zn and Co form the essential group of metals required for some metabolic activities in organisms. Toxicological effects of large amounts of Co include vasodilation, flushing and cardiomyopathy in humans and animals (Teo and Chen, 2001). Their interest in this study lies between essentiality and possible toxicity when present at elevated levels.

Nickel also is a naturally occurring element found in a number of mineral ores including Ni sulphides, oxides and silicates. It is present in the enzyme urease and as such is considered to be essential to plants and some domestic animals. The essentiality of Ni to man has not been demonstrated (Teo and Chen, 2001). Its properties such as strength, corrosion resistance, high ductility, good thermal and electric conductivity and catalytic properties enhance its commercial importance and applications. However, Ni-related health effects such as renal, cardiovascular, reproductive, and immunological effects have been reported in animals. Toxicity of Ni to rainbow trout has been reported (Pane et al., 2003). Its toxic

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