Survey of heavy metals in the sediments of the Swartkops River Estuary, Port Elizabeth South Africa

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Abstract

Elevated levels of heavy metals in the sediment can be a good indication of man-induced pollution. Concentrations of chrome, lead, zinc, titanium, manganese, strontium, copper and tin were measured in the sediments taken along a section of the Swartkops River and its estuary. These results showed that the highest heavy metal concentrations in both the estuary and river were recorded at points where runoff from informal settlements and industry entered the system. Comparison of the results for the estuary with those obtained in a similar survey made about 20 years ago revealed some remarkable increases. This raises concern over the long-term health of the Swartkops River ecosystem.

Introduction

The Swartkops River flows through a highly urbanised and industrialised region of the Eastern Cape and forms an integral part of Port Elizabeth and the surrounding areas. It is a valuable recreational and ecological asset, but owing to the rapidly expanding urban areas, it is subject to the effects and influences of these developments.

The Swartkops River catchment contains almost the entire municipal area of Uitenhage and Kwanobuhle, Despatch and Ibhayi and also half of the Port Elizabeth municipal area. It is estimated that approximately one million people live and work presently in the Swartkops River catchment. The Swartkops catchment not only contains the greatest part of the metropolitan population, but it is also the area where the greatest diversity of urban users is found and where urban growth is most rapid. High-density, low-income housing is developing in the catchment with a concomitant increase in industry, and in the quality and quantity of stormwater runoff. These developments will also necessitate the building of further road and rail crossings over the river as well as developing more telecommunication links and power supply lines (Horenz, 1988).

The occurrence of elevated levels of trace metals especially in the sediments can be a good indication of man-induced pollution and high levels of heavy metals can often be attributed to anthropogenic influences, rather than natural enrichment of the sediment by geological weathering (Davies et al., 1991; Lord and Thompson, 1988). There can be significant temporal and spatial variability in water column concentrations of heavy metal contaminants, which leads to problems in obtaining representative samples. Sediments, on the other hand, integrate contaminants over time and are in constant flux with the overlying water column. The analysis of heavy metals in the sediments permits detection of pollutants that may be either absent or in low concentrations in the water column (Davies et al., 1991), and their distribution in coastal sediments provides a record of the spatial and temporal history of pollution in a particular region or ecosystem. Heavy metal concentrations in the water column can be relatively low, but the concentrations in the sediment may be elevated. Low level discharges of a contaminant may meet the water quality criteria, but long-term partitioning to the sediments could result in the accumulation of high loads of pollutants. It has been estimated that about 90% of particulate matter carried by rivers settles in estuaries and coastal areas (Martin and Whitfield, 1983).

Once heavy metals are discharged into estuarine and coastal waters, they rapidly become associated with particulates and are incorporated in bottom sediments (Hanson et al., 1993). The accumulation of metals from the overlying water to the sediment is dependent on a number of external environmental factors such as pH, Eh, ionic strength, anthropogenic input, the type and concentration of organic and inorganic ligands and the available surface area for adsorption caused by the variation in grain size distribution (Davies et al., 1991). Diagenetic processes in the sediments can change and redistribute these contaminants between the solid and the dissolved phases, but most of the elemental contaminants are immobilised through sedimentation (Hanson et al., 1993).

The effect of heavy metal contaminants in the sediment may be either acute or chronic (cumulative) on benthic organisms (Griggs et al., 1977). The bioaccumulation of metals in various fish and shellfish organisms is well studied (Canli and Furness, 1993; Wolfe et al., 1996), whilst the bioavailability of trace metal concentrations is controlled by many chemical, physical and biological factors (Morse et al., 1993, Morse and Rowe, 1999). Gyedu-Ababio et al. (1999) have also demonstrated that the density and diversity of nematode communities in the Swartkops River estuary are influenced by the degree of heavy metal contamination in the sediments. Many of these metals serve no known biological function in the marine environment, but can act synergistically with other chemical species to increase toxicity. Increased heavy metal concentrations and organic carbon will tend to be associated with finer-grained sediments because of their high surface to volume ratios and absorption abilities.

The objectives of this paper are to illustrate the distribution and levels of sediment contamination by heavy metals in the Swartkops River and estuary, and to compare recent data with those collected during the early 1980s.

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