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The impact of effluents containing zinc and nickel metals on stream and river water bodies: The case of Chambishi and Mwambashi streams in Zambia

F.W. Ntengwe *, K.K. Maseka

School of Technology, Chemical and Environmental Engineering Department, Copperbelt University, Jambo Drive, Riverside Campus, Box 21692, Kitwe, Zambia

Abstract

Effluent from mining operations is a danger to species in the environment especially those dependent on streams and rivers. A study was conducted in Chambishi and Mwambashi Streams in Chambishi District in Zambia with an aim of establishing the impacts of zinc and nickel on the ecosystem. Samples were collected at four points at distances of 0, 1250, 2500, 3500 and 4000 m along the streams and analysed for zinc and nickel using atomic absorption spectrophotometer (AAS). The impacts on receiving environment were recorded. The analysis showed high level of zinc and nickel in water and sediment soils particularly at the discharge point where the values were found to be 0.18 mg/L of zinc and 0.73 mg/L of nickel in surface water and 0.83 mg/L of zinc and 1.36 mg/L of nickel in sediment. The impacts were found to be high upstream and low downstream of the discharge points.

Keywords: Mine tailings; Water pollution; Phytoplankton count; Water quality; Landfill; Environment

1. Introduction

Streams and rivers are a major source of fresh water in Zambia. The Kafue River, for example, is a major supplier of fresh water to most industries in the copperbelt region including the mining and chemical industries where large quantities of water are used to wash mineral ores in order to extract metals such as copper and cobalt. In the process, they generate effluent, which has potential to pollute the environment. The effluents are discharged into streams and rivers as part of conservation strategy to prevent the Kafue River from drying up but this is also done as a way of disposing of the wastewater. The wastewaters are pre-treated before discharging into streams and groundwater through percolation. Wastewater is also discharged into the atmosphere by evaporation.

Acid mine drainage, a condition created by effluents when disposed into stream and river waters, impacts on the quality of receiving waters. Tetra Tech NUS Inc. (2000) reported the impact of acid mine drainage on Ely Brook's river water quality as was determined by physical and biological factors such as metals and biota, respectively. McMenemy (2001) reported the non-survival of fish, which was cropped for one year, in Ely Brook River due to extremely poor survival and growth conditions. The effluents thus can change the ecosystems in streams and rivers if they do not meet stream and river water quality requirements. Life of species in streams and rivers and that man can be affected. Fish growth can be retarded and can even die altogether (Masters, 1974). The growth and existence of bacteria and planktons may be severely affected.

In order to protect ecosystems, waste can be treated at source and amounts discharged can be reduced. Regulations can be developed and implemented in order to control levels of pollution agents being released into the environment. The government of the Republic of Zambia

* Corresponding author. Tel./fax: +260 2 228212.
E-mail addresses: fntengwe@cbu.ac.zm (F.W. Ntengwe), masekak@cbu.ac.zm (K.K. Maseka).

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(GRZ) adopted the National Conservation Strategy in 1985 and passed the Environmental Protection and Pollution Control Act (EPPCA) in 1990 as a way of controlling and preventing pollution. This also resulted in the formation of the Environmental Council of Zambia as the enforcing agency for effluents and the National Water and Sanitation Council for enforcing the quality of drinking water (GRZ, 1990; WHO, 1993; GRZ, 1995; Katuta, 2004). Zinc (Zn), nickel (Ni), copper (Cu), iron (Fe), lead (Pb) and Sodium (Na) are among the metals that are used as parameters for monitoring water quality (GWB, 2004). On this study zinc and nickel were the metals used to assess effects or impacts of wastewater on the ecosystem comprising biota, man, fish and animals that could use water in the stream.

2. Background

The study was conducted in Chambishi District, which is about 25 km North West of Kitwe and has a population of close to 8000 inhabitants (CSO, 1990). The study focused on the levels of zinc and nickel and the impacts on the stream ecosystem comprising man, animals, fish, and biota (Planktons) (Fig. 1).

Chambishi Metals Plc is the only major mining company in the area and it operates a mine originally developed as an open pit by Zambia Consolidated Copper Mines Limited. The pit was capable of producing 24 tonnes of copper per year. In 1972, the underground mine was developed. This boosted production to 45,000 tonnes per year. Six years later, the company began to produce cobalt and sulphuric acid. The total cobalt produced per year was 23,000 tonnes. In early 1990s the company was sold to Anglova who changed the name to Chambishi Metals Plc.

The climate in the area comprises three seasons, a warm and wet season, which starts from October and ends in April, a cool and dry season, which starts in May and ends in July and a hot and dry season which begins from August and ends in October. The town lies in the medium rainfall belt of Zambia. The rain begins in October and ends in April. It is associated with the South West and North East winds. The South West Winds blow from the Atlantic Ocean to the Democratic Republic of Congo (DRC) and is the air that brings heavy rainfall to the area in the months of December, January and February. The North East Wind is associated with little or no rainfall. A large percentage of people in the study area are peasant farmers and only a few depend on mining activities for their

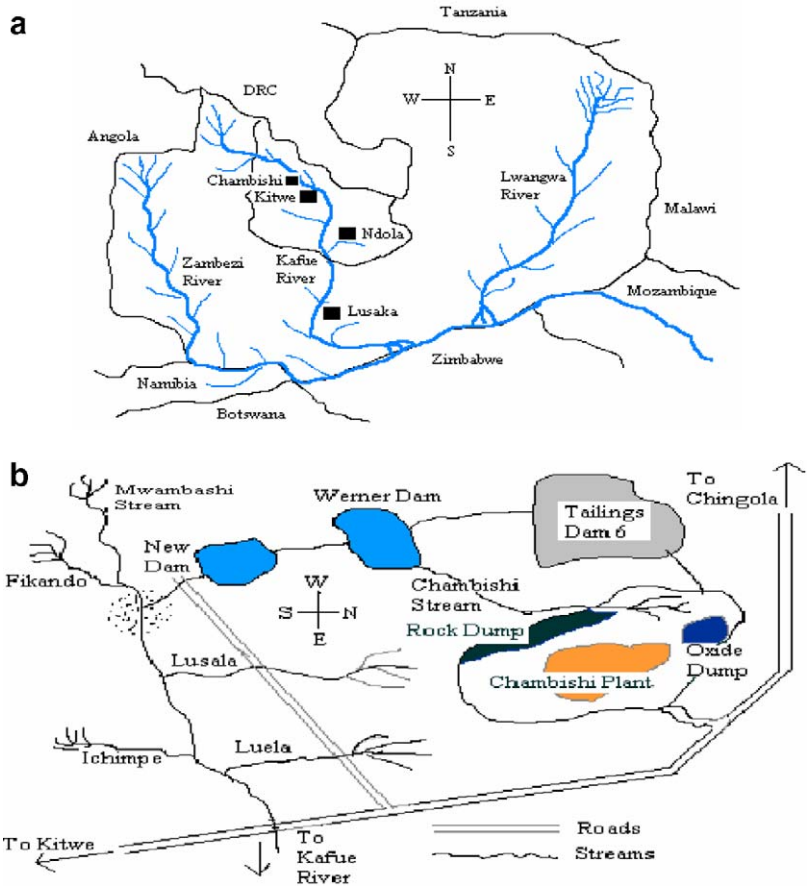

Fig. 1. The study area. (a) Zambia showing the position of Chambishi Area and (b) Chambishi Area showing the position of Chambishi and Mwambashi Streams.