Land-use impacts on the quality of groundwater in Bulawayo

E Mangore[1] and AE Taigbenu[2]*

[1] *Department of Civil and Water Engineering, National University of Science and Technology, PO Box AC 939, Ascot, Bulawayo, Zimbabwe*

[2] *School of Civil and Environmental Engineering, University of the Witwatersrand, Private Bag 3, WITS 2050, Johannesburg, South Africa*

Abstract

The impacts of land use from commercial, industrial and domestic activities in the second largest city (Bulawayo) in Zimbabwe on groundwater quality are investigated in this paper. Thirty-two boreholes that are located in the Matsheumhlope Wellfield, a basement aquifer that underlies the city of Bulawayo, were monitored during the period between August 2000 and August 2001. The results showed that the majority of the parameters (iron, manganese, copper, nitrate, fluoride, sulphate and cyanide) at most sampling stations are within the recommended and permissible limits specified in Zimbabwe drinking water standards guidelines (SAZS 560:1997). The water can therefore be used for drinking purposes. However, levels of hardness higher than the maximum allowable according to Standard Association of Zimbabwe (SAZ) guidelines were encountered. Microbiological analysis indicates that 27% of the samples showed positive total coliform and 8% positive faecal coliform with their occurrences being randomly distributed spatially and temporally. Comparison of the water quality in the industrial and residential areas revealed statistically significant differences in water quality of the two areas. The study reveals that leaks from industrial and domestic sewers, commonly being experienced due to the age of the sewer lines, are increasingly compromising the quality of the groundwater, while unusually high levels of EC encountered at two sampling stations seem to be related to the geological formation. The results from sampling groundwater within the vicinity of the landfill site in Richmond do not present a picture that is different from the other residential areas monitored, suggesting that leachate is being contained within the landfill liner and does not, as yet, pose an environmental threat to the aquifer.

Keywords: groundwater; water quality; land use; environmental impact

Introduction

Solid and liquid waste disposal and other land-use related activities constitute some of the sources of pollution to the environment on which humans depend for their sustenance. One of the consequences is the deterioration of air and water quality (both surface and groundwater). Bulawayo, the second largest city of Zimbabwe, is in the Matabeleland South region with a semi-arid climatic regime that is characterised by evapotranspiration in excess of rainfall. The region receives low and erratic precipitation with average annual rainfall of about 600 mm which ranges between 199.3 mm and 1 258.8 mm with a standard deviation of 202.3 mm. Potential evapotranspiration ranges from 1 400 mm to values greater than 2 000 mm. Rains generally fall from November to March, and October is usually the hottest month with temperatures of over 40°C being observed. The soil type of the region is closely related to the underlying lithology with grayish to reddish brown shallow to moderately deep soils that are associated with granite and allied rocks.

The city is located about 110 km from the Botswana border in the west, and plays host to a number of industries of various kinds: tanning industries (Midrion Enterprises, Wet Blue Industries), breweries (National Brewery, Ingwebu Breweries), soft drink manufacturing (Schweppes, United Bottlers), textiles (Jeans Company, Security Mills, Miller and Thomson), pharmaceutical (Datlabs, Lancaster Industrials, Zimbabwe Pharmaceutical), plastic and rubber industries (Dunlop), abattoirs and dairy processing (Kelshemar Dairies and Dairy Board Zimbabwe Limited), commercial transportation (Western Transport, Zimbabwe United Passenger Company, Super Godhlwayo), fuel storage, metallic and paint industries. It serves as the headquarters of the country's railway network (National Railways of Zimbabwe). The city derives its potable water supply from five surface water dams (Upper and Lower Ncema dams, Insiza, Inyankuni and Umzingwane) that are located some 60km south-east of the city. The supply from these dams is adequate in years of normal rains, but not in drought years that have, in recent times, shown a recurrence of 10 years (1982, 1992, 2002). These drought years have prompted the adoption and implementation of water conservation measures with consideration being given to the use of reclaimed water and groundwater as supplementary sources. Groundwater was used by the municipality of Bulawayo to supplement its water supplies during the 1992/93 drought and proved a valuable resource. Currently water from private boreholes is mainly used for urban agriculture, irrigation of lawns and parks, and general-purpose cleaning but rarely used for drinking. The aim of the present study is to evaluate and characterise the groundwater quality with the overall goal of exploring its feasibility for industrial, commercial and domestic uses. The use of groundwater has several advantages over surface water which include:

- Availability of groundwater as a naturally occurring reservoir in contrast to a specific localised surface source.
- Less susceptibility to evaporation losses and climate variability compared to surface water bodies like lakes and dams

* To whom all correspondence should be addressed.
☎+2711 7177136; fax:+270 11 3391762;
e-mail: aetaigbenu@civil.wits.ac.za
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