Overview of the influences of mining-related pollution on the water quality of the Mooi River system's reservoirs, using basic statistical analyses and self organised mapping

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ABSTRACT

The Mooi River catchment, in particular the Wonderfonteinspruit (WFS), has been the subject of a large number of studies regarding significant pollution sources, generally attributed to mining in the area. However, very little is known about the hydrochemistry of the surface water of the Klerkskraal, Boskop and Potchefstroom Dams in the Mooi River catchment. The aim of this study was to identify any hydro-chemical changes that occurred in the water quality of Klerkskraal, Boskop and Potchefstroom Dams during the period 1995 to 2010. Self-organised mapping (SOM) of the data emphasized the influence of mining-related effluents on the quality of the freshwater resources of the Boskop Dam and Potchefstroom Damrelative to Klerkskraal Dam which is located upstream of mining-related influences and which could therefore serve as a reference site. High concentrations of SO_4 together with high electrical conductivity (EC) and total dissolved solids (TDS) values were evident in these dams as compared to Klerkskraal Dam. Concentrations of nutrients such as PO_4, NH_4 and NO_3+NO_2 were however low in all three reservoirs. In Klerkskraal Dam, which is situated above the confluence of the WFS, a strong direct relationship between EC and total alkalinity (TAL) was exhibited. This suggests that Klerkskraal Dam is still a water source displaying natural unpolluted conditions, where increases in EC, TDS and TAL can be explained by natural dissolution of the bedrock. Boskop Dam presents a dam impacted by pollutants with no direct correlation between EC and TAL. During the current study both SO_4 concentrations as well as Na^+ concentrations exhibited a decline from 1995 until 2010 in Boskop Dam. This suggests that, although Boskop Dam still carries the burden of mining pollution via the WFS, the pollution levels of the freshwater of Boskop Dam have decreased between 1995 and 2010.

Keywords: self-organised mapping, water quality, electrical conductivity, alkalinity, sulphates, Boskop Dam, Potchefstroom Dam, Klerkskraal Dam, Wonderfonteinspruit

INTRODUCTION

The Mooi River catchment includes several reservoirs, the largest of which is the Klerkskraal Dam. During the past decade the Mooi River catchment, in particular the Wonderfonteinspruit (WFS), has been the subject of a large number of studies conducted by the Department of Water Affairs and Forestry (DWAF), Council for Scientific and Industrial Research (CSIR) and Water Research Commission (WRC) (IWQS, 1999; Coetzee et al., 2002; Wade et al., 2002; Coetzee et al., 2006; Winde 2010a,b) regarding significant radioactive and other pollution sources, generally attributed to the mining in the area and the processing of gold ores rich in uranium.

A potential for downstream contamination was identified as a specific concern for the water supply of the city of Potchefstroom (Coetzee et al., 2002). Potchefstroom is located downstream of the confluence of the WFS and Mooi River. All 250 000 inhabitants of the city of Potchefstroom receive their drinking water from the Boskop and Potchefstroom Dams (Annandale and Nealer, 2011). Geohydrologically as well as hydrochemically, the WFS have been studied in detail; very little is known, however, about hydrochemistry of the surface waters of the Klerkskraal, Boskop and Potchefstroom Dams.

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When mining companies obtain prospecting permits for minerals, including gold, diamonds, uranium, tungsten, iron ore, thorium and selenium, in the Mooi River catchment area close to Potchefstroom, questions are raised regarding the future impact on drinking water quality. New mining activity may become a reality, as mining companies such as New Heights 147, Wits Gold and Miranda Mineral Holdings have already obtained prospecting permits for the area east of Boskop Dam (Louw, 2011a; Louw, 2011b).

The aim of this study was to identify any hydrochemical differences between as well as changes that have occurred in the water quality of Klerkskraal, Boskop and Potchefstroom Dams over the period 1995–2010. These results can then be used as a baseline for monitoring the impacts on water quality that may occur if proposed mining activities take place in the future. During this study we mainly concentrated on the parameters EC, TAL, pH, TDS, SO_4, Ca, Mg and Na. Kney and Brandes (2007) hypothesized that alkalinity values can be used as an index of bedrock geology and that it can be expected that, under natural conditions, a particular range of EC values will correspond to a particular range of alkalinity. Ionic pollutants from anthropogenic sources contribute to EC, however, and it is this portion of the EC that should be of primary interest to monitoring and assessment. Kney and Brandes (2007) suggest that anthropogenic impacts will result in a deviation in the relationship between EC and alkalinity and it should therefore be possible to use concurrent alkalinity and EC measurements to indicate anthropogenic impacts.

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