An assessment of the impact of different land use activities on water quality in the upper Olifants River catchment

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ABSTRACT

Routine sampling of water quality was conducted at sites along a longitudinal gradient from upstream to downstream in the Olifants River to determine spatial trends in nutrient and metal concentrations and to relate these trends to changes in land use activities in the catchment. In addition, once-off sampling was conducted at a number of sites located downstream of current mining, abandoned mining, agriculture, wastewater treatment works (WWTWs) and industry. Nutrient concentrations were relatively high and a number of sites within the catchment had average N:P ratios that were indicative of eutrophic to hypertrophic conditions. Routine and once-off sampling indicated that wastewater treatment works contribute high nutrient loads to the system. Trend analysis of Department of Water Affairs (DWA) data indicated significant positive trends in ortho-phosphate at 12 of 14 stations in the catchment. An increase in sulphate concentrations from upstream to downstream indicates that mining activities have a progressively greater impact on water quality with increasing distance downstream. While dissolved metal concentrations frequently exceeded chronic and acute effect aquatic ecosystem health guidelines (particularly aluminium, copper and zinc), there was no observable trend from upstream to downstream. Once-off sampling showed high variability in water quality parameters downstream of current mining activities, and some sites showed higher metal concentrations in comparison to other land use activities. However, the contribution of current mining activities to metals is low in comparison to the contribution from abandoned mines. Hydrological data showed that acidic rivers contribute proportionally higher flow volumes in comparison to neutral rivers during the drier winter months, which may significantly impact on the lower stretches of the upper Olifants River and into Loskop Dam. A prolonged drought period will most likely result in severe impacts to the lower reaches of the Olifants River and to Loskop Dam. Improved management and maintenance of wastewater treatment works and rehabilitation and/or treatment of abandoned mines and associated acid mine drainage are crucial. Proper rehabilitation of current mining activities is essential to avoid or minimise acid mine drainage related impacts in the future.

Keywords: acid mine drainage, land use, metals, nutrients, Olifants River

INTRODUCTION

A number of land and water use activities that take place in the upper Olifants River system are of strategic importance to South Africa (e.g., mining, agriculture, power generation). These activities rely heavily on a variety of goods and services that they derive from the aquatic ecosystems in the area. The Olifants River has, however, been described as one of the most polluted rivers in southern Africa, due to the number of anthropogenic stressors that are present in the catchment (Grobler et al., 1994). These stressors include intensive coal mining activities (Hobbs et al., 2008), coal-fired power generation (Dabrowski et al., 2008), industrial activities (e.g., chemical manufacturers, chrome and steel smelters) and agriculture, combined with a general decline in the operation and management of wastewater treatment infrastructure, especially sewage treatment (DWA, 2011a).

The pollutants generated by these activities include general acidification of the system and the input or mobilisation of heavy metal ions plus sulphates and other contaminants via acid mine drainage (Bell et al., 2001; Hobbs et al., 2008); potential acid rain resulting from poor air quality (Rodhe et al., 2002); industrial effluent containing a variety of potential pollutants; excessive nutrient inputs (phosphorus and nitrogen) from agricultural activities and sewage effluent (De Villiers and Thiart, 2007; Oberholster et al., 2010a); and microbiological pollution from intensive agriculture (e.g., feedlots) and sewage effluent. Associated with these key water quality parameters are threshold concentrations which, if regularly exceeded, can result in harmful impacts on aquatic ecosystems and human health. Research and field observations indicate that these thresholds are increasingly under threat. With respect to the upper Olifants catchment, the presence of this 'cocktail' of pollutants has recently manifested in a number of critical ecological and human health concerns further downstream in the catchment, most notably in Loskop Dam. Studies performed in the upper Olifants catchment have documented the presence of various heavy metals in fish tissue (Coetzee, et al., 2002). Over the past 15 years, Loskop Dam has had a history of isolated incidents of fish mortality at different times of the year and with different durations (Driescher, 2007; Asthon, 2010). These incidents became more frequent from 2003 to 2008 and have coincided with crocodile mortalities and a population decline from ±80 individuals to a total of 4 in 2010 (Ashton, 2010). The precise cause of these mortalities is currently unknown. In 2008 a large number of crocodile mortalities were recorded in the lower Olifants River in the Kruger Park. These deaths were ascribed to pansteatitis although the exact cause of this condition in the crocodiles is currently unknown. Fish sampling in July 2009 indicated high concentrations of aluminium and iron in fish organs as well as tumour formation and severe liver necrosis

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