

Water quality of Flag Boshielo Dam, Olifants River, South Africa: Historical trends and the impact of drought

J Dabrowski^{1,2*}, PJ Oberholster^{1,3} and JM Dabrowski²

¹Department of Paraclinical Sciences, Faculty of Veterinary Science, University of Pretoria, P/Bag X04, Onderstepoort 0110, South Africa

²CSIR Natural Resources and the Environment, PO Box 395, Pretoria, 0001, South Africa

³CSIR Natural Resources and the Environment, PO Box 320, Stellenbosch, 7599, South Africa

ABSTRACT

Increasing demands for water, discharge of effluents, and variable rainfall have a negative impact on water quality in the Olifants River. Crocodile and fish mortalities attributed to pansteatitis, in Loskop Dam and downstream in the Kruger National Park (KNP), have highlighted the serious effects these impacts are having on aquatic ecosystems. Flag Boshielo Dam is a reservoir on the Olifants River, located between Loskop Dam and the KNP. It has the largest crocodile population outside of the KNP, and pansteatitis has not been reported in fish or crocodiles to date. This study evaluated comparative water quality parameters concurrent to a similar study undertaken at Loskop Dam to establish possible environmental drivers of pansteatitis. Long-term monitoring data collected by the Department of Water Affairs were analysed for trends using a Seasonal-Kendall trend test. Short-term monitoring showed that water quality in Flag Boshielo Dam was of a good standard for ecosystem health. Concentrations of dissolved Cu, Se, V and Zn were always below instrument detection limits, and Al, Fe and Mn were mostly within guideline levels for ecosystem health. A severe drought occurred between November 2002 and December 2005. Long-term monitoring showed that water quality during the drought deteriorated, with high levels of dissolved salts, especially K, Na, Cl, F, and total alkalinity. Following the drought, dissolved salt concentrations dropped, and there was a brief flush of inorganic N and P. However, between 1998 and 2011, inorganic N showed a significant decreasing trend into the oligotrophic range, while inorganic P remained in the oligo- to mesotrophic range. The inorganic N to inorganic P ratio of 5.4 after the drought was indicative of N limitation, and the phytoplankton assemblage was dominated by nitrogen-fixing species, especially *Cylindrospermopsis* sp. In contrast, further upstream, Loskop Dam has undergone increasing eutrophication, has frequent blooms of *Microcystis aeruginosa* and *Ceratium hirundinella*, and concentrations of Al, Fe and Mn periodically exceed guideline levels. The difference in trophic state, phytoplankton assemblage and levels of productivity between these two reservoirs may provide insights into the aetiology of pansteatitis, which is frequently associated with dietary causes.

Keywords: Flag Boshielo Dam, limnology, Olifants River, trend analysis, drought, nitrogen limitation

INTRODUCTION

Flag Boshielo Dam was built in 1987 for irrigation of agriculture downstream of the dam, to supply municipal water to the town of Polokwane, and to ensure dry-season water storage for mines in the area (Van Koppen, 2008). It is located at the confluence of the Olifants and Elands rivers, approximately 30 km from the town of Marble Hall in the Limpopo Province. In March 2006, the dam wall was raised by 5 m in order to secure water for mining development, and to improve supply to rural communities through the Olifants River Water Resource Development Programme (Van Koppen, 2008). The raising of the dam wall coincided with the end of a drought that lasted approximately 3 years, which provided additional motivation to increase the reservoir capacity. The drought ended in January 2006 with the first significant flows into the reservoir occurring 2 months prior to completion of construction on the dam wall.

Wide-scale irrigated agriculture along the Olifants River is the predominant catchment land use downstream of Loskop Dam, while dryland and irrigated agriculture occur in the

Elands River catchment. Upstream of Flag Boshielo Dam, Loskop Dam supplies water to the Loskop Irrigation Board, the second largest in South Africa. The irrigation board supplies 700 properties which cover an area of 16 117 ha within the Flag Boshielo Dam catchment (Oberholster and Botha, 2011). Major crops include cotton, wheat, citrus and grapes, a significant proportion of which are grown for export. In contrast to Loskop Dam, there is very little mining and industry in the catchment, although its location downstream from Loskop Dam means that Flag Boshielo Dam is susceptible to the same impacts affecting water quality in the upper catchment. Subsistence farming in the catchment has led to land degradation with extensive areas of soil erosion, and subsequent elevated suspended sediment loads in waterways. Inadequate water supply, sanitation and waste disposal systems place additional pressure on the water resources in the area (Moolman et al., 1999; Magagula et al., 2006). Not all wastewater treatment works (WWTW) in the catchment function optimally, which can result in high inputs of phosphorus-enriched effluent discharged into receiving water bodies. In particular, the Marble Hall WWTW, which discharges into the Elands River, was categorised as being in a critical state at the time of this study, scoring only 23.4% in the 2011 Green Drop report (DWA, 2011).

Recent water quality concerns upstream in Loskop Dam include eutrophication, *Microcystis* blooms, acid mine drainage related impacts, and the as yet unexplained occurrence of

* To whom all correspondence should be addressed.

☎ +27 83 2563159; fax: +27 12 8413954;

e-mail: jdabrowski1@csir.co.za

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