

# The continued influence of organic pollution on the water quality of the turbid Modder River

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## Abstract

The Modder River is a relatively small river which drains an area of 7 960 km<sup>2</sup>, in the central region of the Free State Province, South Africa, and has a mean annual runoff of 184 x 10<sup>6</sup> m<sup>3</sup>. Botshabelo is a city which was developed in the catchment area of the river and treated sewage is released into the Klein Modder River. This study determined seasonal and spatial patterns in the system as well as the continued influence that Botshabelo's treated sewage outflow has on the water quality of the river. It was determined that the Modder River and Klein Modder River follow distinctive seasonal patterns in terms of algal growth and physical factors. There were periods when the waters of the Modder River and Klein Modder River are of acceptable quality; however, outflows from Botshabelo have a detrimental effect on the water quality, in terms of nutrient concentrations and algal biomass. The inflow of the Klein Modder River into the Modder River caused on average, 112% increase in phosphate-phosphorus (PO<sub>4</sub>-P), 171% increase in nitrate-nitrogen (NO<sub>3</sub>-N) and a 50% increase in chlorophyll-*a* concentration in the Modder River. The long-term detrimental effect of Botshabelo on the system can clearly be seen by comparing predicted nutrient increases with measured values.

## Introduction

South Africa is well endowed with natural resources, except for water. The total surface runoff in South Africa is only 51 x 10<sup>9</sup> m<sup>3</sup>/a (Koch et al., 1990). Only 11% of the total rainfall reaches the rivers. The remainder is lost to evaporation and groundwater sources.

Due to ignorance by the major mines and factories, in spite of effluent quality regulations pollution, is having a negative impact on the quality of drinking water (Koch et al., 1990). Because the demand for potable water is increasing in South Africa, more research is needed to determine the best possible way to use, reuse and conserve freshwater.

The Modder River is a relatively small river which drains an area of 7 960 km<sup>2</sup>, in the central region of the Free State Province, South Africa, and has a mean annual runoff of 184 x 10<sup>6</sup> m<sup>3</sup>. Water from this river is stored in the Rustfontein, Mockes, Mazelspoort and Krugersdrift Dams (Grobler and Toerien, 1986; Grobbelaar, 1992). About 60% of the potable water supply of Bloemfontein is provided by the Modder River. The rest is pumped from the Caledon River which is about 150 km south-east of Bloemfontein (Grobbelaar, 1992). The Modder River is also a very turbid system, (modder means mud), for example the average sediment yield at Sannaspos was calculated to be 304 t/km<sup>2</sup>-a (Rooseboom, 1978). The Modder River can be dry for long periods, particularly during the winter months and the impoundments are the only permanent sources of water (Grobbelaar, 1991). However, the river never ran dry during the study period, although the water levels were sometimes very low.

Botshabelo was founded in the 1970s and developed in the catchment of the Modder River, about 60 km east from Bloemfontein. The total population in 1995 was 243 855 (Pretorius and Viljoen, 1997). The majority of the residents reside in informal settlements and sanitation services are minimal. The sewage treatment facility

at Botshabelo releases about 5 Mℓ treated effluent per day into the Klein (meaning small) Modder River. This may add contaminant concentrations of micro-organisms, minerals and nutrients to the Modder River system.

Grobler and Toerien (1986) conducted a study to predict the impact of Botshabelo's treated effluent on the river system by means of a simulation model. They concluded that the discharge of treated effluent into the Klein Modder River could result in undesirable eutrophic conditions in Mockes Dam and the Mazelspoort Barrage. To comply with the 1 mg/ℓ standard required for 95% of the time, an average concentration of 0.4 mg P/ℓ in the effluent would be required (Grobler and Toerien, 1986). They predicted that problems could arise before 1990, if a 1 mg/ℓ P standard for effluents was not enforced.

At present there is limited limnological information on the Modder River. Grobbelaar (1985; 1989) reported on the primary production and Jagals and Grabow (1996) on the effect of pollution on human health. Grobler and Toerien (1986) reported on some of the chemical characteristics of the river.

Using information from the literature, comparisons between different lotic ecosystems (for example a turbid system like the Barwon-Darling River in Australia and a polluted system like the Vaal River in South Africa) were made to put relationships between environmental variables and phytoplankton responses measured in the Modder River into perspective and to determine whether common characteristics could be found among the different systems. Because of limited availability, only some information regarding the Orange and the Caledon Rivers was given to gain a perspective on differences, if any, between rivers in the same catchment area.

The present study serves to determine whether Botshabelo has a detrimental effect (eutrophication and/or salinisation) on the water quality of the Modder River and what the self-purification potential of the river is. It also elucidates seasonal and spatial changes in the physical, chemical and biological characteristics of the water. The final objective is to contribute towards the limnological knowledge and resource management of the Modder River.

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