The effects of a single freshwater release into the Kromme Estuary. 1: General description of the study area and physico-chemical responses

UM Scharler and D Baird*
Department of Zoology, University of Port Elizabeth, PO Box 1600, Port Elizabeth 6000, South Africa

Abstract

The natural runoff from the Kromme River catchment area has been severely restricted by impoundments with storage capacities exceeding the mean annual runoff (MAR). As a consequence, freshwater input into the Kromme Estuary has been drastically reduced and the estuary itself has been labelled as 'freshwater-starved'. The annual allocation of storage water to the estuary (2 x 10^6 m^3) has been released from the Mpofu Dam as a single release. The impact on various physico-chemical parameters as well as inorganic dissolved nutrients (phosphate, nitrate, nitrite, ammonia) in the estuary has been investigated with regards to the magnitude, persistence and management of future releases. The impact on dissolved nutrient concentrations was short-lived (less than 7 d), and pre-release concentrations were quickly re-established. The release raised especially nitrate and nitrite concentrations temporarily because of elevated concentrations in the storage water, but slightly diluted phosphate concentrations in the estuary. N:P ratios indicated phosphate limitation, while ammonia showed no direct response to the release. This experiment showed no long-lasting effect on the estuary in terms of inorganic dissolved nutrients, and it is apparent that the nutrient status can only be enhanced under a continuous release strategy. Natural runoff reaching the estuary appears to be more beneficial, especially in terms of phosphate.

Introduction

The high productivity in estuaries is a result of riverine and oceanic input into these systems. Nutrients in estuaries are derived from various sources, which include *inter alia* terrigenous runoff, the sea, the atmosphere and internal nutrient (re)cycling (Webb, 1981). The riverine input is in general the most important contributor to its estuary (e.g. Aston, 1980; Funicelli, 1984), which emphasises the consequences of excessive freshwater abstraction in the catchment area. Nutrients in the estuary are exposed to biological, chemical and physical interactions (Aston, 1980; Webb, 1981; Smith et al., 1985; Eyre, 1994; 1997), including the ad-/desorption by sediments and particulate material, the utilisation by plants, and export to the sea. Estuaries can act as either a source or a sink for nutrients, depending on the amount received and the extent of internal processes (Biggs and Cronin, 1981; Pritchard and Schubel, 1981; Chapman and Thornton, 1986; Baird and Winter, 1990; Falcao and Vale, 1990; De la Lanza-Espino and Rodriguez-Medina, 1993; Eyre, 1994).

The aims of this study were to investigate the impact of a freshwater pulse on the nutrient status of the otherwise freshwater-starved Kromme Estuary with regard to the magnitude and persistence of change brought about by the release, and to comment on the feasibility of freshwater release strategies from upstream impoundments. The freshwater pulse comprised a release of 2 x 10^6 m^3 from the Mpofu Dam, which is equal to the annual allocation of water to the estuary to compensate for evaporation (Jezewski and Roberts, 1986).

* To whom all correspondence should be addressed.
☎(041) 504-2690; fax (041) 504-2317; e-mail: zladdb@zoo.upe.ac.za
Received 3 November 1999; accepted in revised form 6 June 2000.

Study area

The Kromme River, which is approximately 95 km long, originates in the Tsitsikamma mountains and drains a catchment area of approximately 936 km^2 (Reddering and Esterhuysen, 1983). The catchment is partly vegetated by fynbos and natural forest. The remaining area is utilised as farmland for stockraising and grain cultivation (Baird et al., 1992). Rainfall peaks in spring and autumn, but is low during January and February (Bickerton and Pierce, 1988). The mean annual precipitation ranges between 700 and 1 200 mm. The high mean annual runoff of approximately 105.5 x 10^6 m^3 is a consequence of the geomorphologic catchment characteristics, i.e. high relief, rocky slopes and sparsely vegetated areas (Reddering and Esterhuysen, 1983) (see Fig. 1).

Alterations to the river flow in the Kromme catchment are a result of two major obstructions that have severely reduced freshwater input into the estuary. The Kromrivier Dam (built in 1943) is situated approximately 35 km from the tidal head of the estuary and has a storage capacity of 33.3 x 10^6 m^3. The Mpofu Dam, situated only 4 km from the tidal head of the estuary, with a storage capacity of 107 x 10^6 m^3, was completed in 1982 (Bickerton and Pierce, 1988). Both dams have the combined capacity of storing ca 133% of the mean annual runoff of the Kromme River catchment.

The Kromme Estuary opens into St. Francis Bay and stretches inland for about 14 km from the mouth to the tidal head. The Geelhoutboom is a major tributary, which enters the estuary 7 km from the mouth. There are also numerous small tributaries along the entire length of the Kromme Estuary. The most prominent of these, the Sand River, drains part of a by-pass dunefield and joins the estuary 1.3 km of the mouth (Bickerton and Pierce, 1988). The estuary is a popular recreation area. A marina is situated near the mouth and numerous holiday shacks have been built further upstream. The land adjoining the estuary is used for farming to a limited extent (Reddering and Esterhuysen, 1983; Bickerton and