Response of micro-algae in the Kromme Estuary to managed freshwater inputs

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Abstract

The Kromme is a permanently open estuary that receives little freshwater input because the capacity of the dams is equivalent to the mean annual runoff from the catchment. The estuary is marine dominated and phytoplankton chlorophyll *a* is low because of the low freshwater pulses that introduce nutrient-rich freshwater. Water released (2 x 10^6 m^3) from the Mpofu Dam in 1998 produced little micro-algal response in the estuary. The study reported here addresses further runoff scenarios to see which might be beneficial in stimulating microalgal production. Recent surveys together with past research were used to describe the present state and reference condition of the estuary. Average intertidal chlorophyll *a* was 12.9 ± 2.5 $\mu g \cdot g^{-1}$ of sediment and 4.9 ± 0.4 $\mu g \cdot g^{-1}$ of sediment during November 2003 and July 2004. These concentrations are relatively low but comparable to those found in intertidal sediments in other South African estuaries and might indicate that intertidal microalgal biomass is not severely limited by low freshwater inputs. Average water column chlorophyll *a* concentrations have ranged from 0.6 ± 0.1 to 5.6 ± 0.3 $\mu g \cdot \ell^{-1}$. Present state conditions can thus be described as those where water column chlorophyll *a* seldom exceeds 5 $\mu g \cdot \ell^{-1}$ and small flagellates (3.5 µm x 2.8 µm) dominate the phytoplankton. The diatoms introduced via freshwater have been lost. Under reference conditions before the Mpofu Dam was built, baseflow would have been greater than 1 $m^3 \cdot s^{-1}$ for approximately 8 months of the year. The flocculation of fine particles associated with the mixing of fresh and saline waters would have resulted in phytoplankton peaks (chl *a* >10 $\mu g \cdot \ell^{-1}$) in the middle reaches of the estuary. A more suitable habitat might also have been present for the epipelic (mud associated) benthic microalgae. An assessment of the future runoff scenarios indicated that the most beneficial for the microalgae would be a flow release from the Mpofu Dam of 5 x 10^6 m^3 in October and then again in January. This would stimulate a 25 to 33% increase in phytoplankton chlorophyll *a* and a doubling in intertidal benthic chlorophyll *a* for a period of two months following the releases.

Keywords: phytoplankton, microphytobenthos, freshwater inflow, salinity, present state, dam releases

Introduction

The Kromme Estuary is located in the Eastern Cape Province, 80 km west of Port Elizabeth. The estuary is relatively narrow with an average width of approximately 80 m, and extends for 14 km from the permanently open mouth to a rocky sill that forms the tidal head of the estuary. Its major tributary is the Geelhoutboom River which enters 8 km from the mouth. The catchment area and length of the Kromme River are approximately 1 000 km^2 and 100 km respectively. The rainfall in the catchment occurs throughout the year, with bimodal maxima in autumn and spring. January and February tend to have the lowest rainfall (Bickerton and Pierce, 1988).

There are two dams above the estuary and their combined holding capacity (Mpofu Dam 107 x 10^6 m^3 and the Churchill Dam 33.3 x 10^6 m^3) exceeds the mean annual runoff (MAR) of the Kromme River (estimated to be in excess of 105 x 10^6 m^3) (Reddering, 1988). This has resulted in the water becoming saline towards the head of the estuary. In addition to reduced river flow, the dams have also affected the frequency and magnitude of flood events, and the availability of riverine material replenishing the estuarine nutrient pool (Scharler et al., 1997). A release policy, which provides 2 x 10^6 m^3/a (EMATEK (CSIR) 1994), was proposed to account for the evaporative loss of the estuary (Jezewski and Roberts, 1986). However, flow records and personal communications with the Mpofu Dam managers indicate that very few or no releases have been made for a number of years (2002 to 2005). The construction of farm dams and abstraction of water for agriculture have significantly reduced the flow of water from the Geelhoutboom River.

A freshwater release study in 1998 (Bate and Adams 2000; Snow et al., 2000a) indicated that a release of 2 x 10^6 m^3 had little beneficial effect on the estuary and that a consistent baseflow was probably necessary to maintain water column production. The results reported in this study were a component of a Department of Water Affairs and Forestry comprehensive Ecological Reserve study on the Kromme Estuary. The response of the micro-algae to different runoff scenarios was investigated to compare which would be most beneficial to micro-algal production.

The aims of this study were to document the present state of micro-algae (phytoplankton and microphytobenthos) in the Kromme Estuary, determine how this has changed from the reference condition (before anthropogenic influences) and then to predict changes in response to varying freshwater inflow scenarios. The present status assessment was based on two recent surveys and past research results. The freshwater inflow scenarios considered were:

- 5 x 10^6 m^3 release from the Mpofu Dam during November
- 5 x 10^6 m^3 release during November and another in January
- Maintain present flow in the Kromme but increase flow in the Geelhoutboom Tributary
- 5 x 10^6 m^3 release during November and increased flow from the Geelhoutboom Tributary
- 7.5 x 10^6 m^3 release over a two-month period (October-November).

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