Preliminary investigation of seasonality in the Great Berg Estuary

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Abstract

The hydrodynamics and water quality of the Great Berg Estuary were studied under river flow conditions typical of the winter and summer seasons. Results reflect a strongly seasonal regime with the estuary exhibiting fluvial dominance during winter and marine dominance under the low-flow conditions of summer. Limited renewal of esiuarine water occurs over the summer period with the result that a plug of characteristically estuarine water is formed. Tidal influence extends 69 km upstream of the mouth in summer, while salinities in excess of 5 x 10^{-3} occur 37 km from the mouth. The role of river flow in counterbalancing the upstream dispersion of salt during the summer season is highlighted. The relevance of these findings in the preliminary assessment of the freshwater requirements of the Great Berg Estuary is addressed.

Introduction

Published information on the hydrodynamics and water quality of the Great Berg Estuary is limited to salinity records (FISCOR, 1973), preliminary observations of water chemistry (Cloete and Oliff, 1976), a summary by Day (1981). chemical studies undertaken in 1975 and 1976 by Eagle and Bartlett (1984) and preliminary results of this study and a concurrent modelling investigation (Taljaard and Slinger, 1992; Huizinga et al., 1993; CSIR, 1993). Supplementary hydrodynamic and water quality information is obtainable from ecological and biomonitoring investigations undertaken on the estuary (Gaigher, 1979; Kalejta and Hockey, 1991; Ninham Shand Inc., 1993; Adams and Bate, 1994; CSIR, 1994).

Large seasonal variations in salinities, temperatures and water chemistry were observed in the earlier studies (FISCOR, 1973; Eagle and Bartlett, 1984). The penetration of seawater into the estuary was limited during the wet season (April 1976), but by early summer (October 1976) saline water extended more than 6 km upstream. A salinity of 9 x 10^{3} was recorded at Kersefontein, 45 km from the mouth, in February 1979 (Day, 1981).

The need for more detailed information on the hydrodynamics and water quality characteristics of the Great Berg Estuary, particularly with regard to seasonal variation, was evident, especially as further exploitation of the water resources of the upper and middle catchment is proposed (Ninham Shand Inc., 1993). The investigation subsequently described was launched in an effort to meet this need.

Study area

The Great Berg River flows northward from its source in the Great Drakenstein Mountains near the town of Franschoek, draining a catchment of approximately 7 715 km^2 (CSIR, 1988) before entering the sea at St Helena Bay (34°46'S, I8°09'E) on the west coast of South Africa {Fig. 1). Streamflow in the 294 km long river is seasonal with high flows occurring in winter (May to August) and low flows in summer (November to February). Two major impoundments are located on the river, the Voëlvlei Dam and the Wemmershoek Dam with storage capacities of 164.1 x 10^{6} m^3 and 58.5 x 10^{6} m^3, respectively. The present mean annual runoff is 693 x 10 6 m^{1} (Berg, 1993).

In 1966, entrainment of the mouth of the Great Berg Estuary occurred, owing to problems encountered by fishing vessels attempting to enter the sheltered harbour at Laaiplek (US, 1963). A new mouth was cut through the sand dunes and fixed in position about 1 km north of the original mouth position. The original mouth has since silted up completely and now forms a blind side-arm or lagoon running parallel to the coast (Eagle and Bartlett, 1984). The main channel of the estuary is about 250 m wide and 5 m deep in the vicinity of the mouth, generally becoming narrower and shallower with distance upstream. The average width and depth of the estuary are 150 m and 3 m, respectively. The estuary meanders through flat terrain, rising only I m in the first 50 km. Extensive floodplains, which are seasonally inundated, lie adjacent to the channel and support a rich bird population.

Material and methods

Field expeditions were undertaken from 17 to 20 September 1989, 29 January to 1 February 1990 and on 20 March 1990. Salinities, temperatures and current velocities were measured at hydrographic stations located along the length of the estuary (Fig. 1), providing quasi-synoptic pictures ofthethermohaline structure and circulation on flood- and ebb-tides. Salinity and temperature were measured at 0.25 m depth intervals using a Valeport Series 600 MKIICTDS Meter (accuracy 0.2 x l0 -3 0.2°C, 0.1 m), while current velocities were measured at 0.5 m depth intervals with an NBA DNC-1 MK III Current Meter (accuracy 0.02 ms^{-1}).

On 4 occasions, namely the flood-tides of 18 September 1989 and 29 January 1990 and the ebb-tides of 19 September 1989 and 30 January 1990, surface and bottom water samples were collected at hydrographic stations in the lower and middle reaches of the estuary. These were analysed for pH, dissolved nutrients (nitrite, nitrate, total ammonia, reactive phosphate, reactive silicate), dissolved oxygen, chlorophyll *a*, trace metals and faecal bacterial numbers. Whereas pH was measured in the field using a Radiometer Model 29, the dissolved nutrient samples were filtered through 0.45 µm Millipore filters, frozen in 4 *ml* vials, and later analysed on a Technicon Auto Analyser using a modified version of the methods described by Mostert (1983). Dissolved oxygen levels were obtained by the method of Winkler (Watling, 1981).

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