Some factors governing the water quality of microtidal estuaries in South Africa

BR Allanson
Institute for Water Research, Rhodes University, Grahamstown 6140, South Africa

Abstract

The role of coastal geomorphology and Man-made alterations, including reduced river flow through dam construction, determines, at least in part, the water quality of South African microtidal estuaries. To offer increased understanding of the manner in which these features may modify water quality, a short description of the biogeochemical processes in estuaries is provided. Comment on the present limitations of modelling some of the estuarine processes in South African investigations is given.

Nomenclature

aeolian transported by wind
DO dissolved oxygen
DOC dissolved organic carbon
DON dissolved organic nitrogen
DIN dissolved inorganic nitrogen
DOP dissolved organic phosphorus
DIP dissolved inorganic phosphorus
EFR estuarine flow requirement - pertaining to required river flow
Eh redox potential expressed in millivolts
MAR mean annual rainfall
MSL mean sea level
N:P normally the value of the ratio of total soluble nitrogen to total soluble phosphorus in the water column
ppt parts per thousand - with respect to seawater, meaning kg of salts per kg of solution.
POC particulate organic carbon
POM particulate organic matter
PON particulate organic nitrogen
SRP soluble reactive phosphate
TDL theoretical dilution line which represents a linear dilution of a solute as it passes through the estuary - such solutes are termed 'conservative'.

Introduction

The earliest synthesis which described the water quality of South African estuaries was prepared by Day (1981). It showed that while the principles of estuarine chemistry established in the Northern Hemisphere were applicable to southern African estuaries, there were sufficient differences in the hydrodynamic features of these estuaries which could influence water quality and the like. It is the purpose of this paper to examine those features of coastal geomorphology which define (at least in part) the hydrodynamic properties of the estuaries, and how they may affect the water quality of a number of representative estuaries along the South African coast.

☎ (044) 384-0658; fax: (044) 384-0658; e-mail: ba11@pixie.co.za
Received 12 June 2000; accepted in revised form 23 March 2001.

This approach has been adopted in order to highlight those geomorphological features which should be incorporated into the management strategies for estuaries in South Africa. In so doing, we become increasingly aware of the ecological and socio-economic linkages which are undergoing both spatial and temporal co-evolution (Crooks and Turner, 1999). It is also necessary to recognise that upon this morphological template changes due to varying coastal processes are imposed which may further alter both structure and hydrodynamics and, therefore, water quality.

The influence of Man-made alterations on estuarine structure and hydrodynamics, brought about by bridges and dams, and the likely impact of the transfer of impounded water between catchments are described. Further, and in view of the overwhelming importance of inter-tidal wetlands in the carbon, nitrogen and phosphorus metabolism of estuaries, the general principles of these pathways are described, and their role in South African estuaries, particularly with respect to handling soluble wastes of human origin, are commented upon.

Some geomorphological features

Recent studies in South Africa have demonstrated the modulating influences brought about by geomorphological processes in shaping the coastal scenery since the Pleistocene (Cooper et al., 1999). Of particular significance was the substantial fall in sea level at the height of the Flandrian glaciation (18 000 BP) which exposed the Agulhas Bank to the edge of the continental shelf. This, coupled with the strengthening of onshore winds across the exposed coastal zone due to the increasing differential between sea and land temperature (Hobday, 1979), brought about substantial aeolian transport which built up extensive dune cordons. In KwaZulu-Natal the dune cordons from Mtunzini northward into Mozambique constitute one of the largest persistent cordons in the world (Hobday, 1979). Dunes with crests elevated to 200 m are rarely interrupted by estuaries, but lakes formed by sealing of the palaeo-estuaries are common, and the largest of these is Lake Sibaya, South Africa (27° 22' S : 32° 41' E).

Along the southern coastal rim-land, the geomorphology is dominated by the ancient Cape Fold Mountains, which lie parallel to the coast, resulting in a series of inward-moving rain-shadow areas of increasing severity. The rim-land has been subject both to uplift and to the later effects of variation in Pleistocene sea level. The consequences of sea level regression and subsequent