

A numerical assessment of research outputs on South African estuaries

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In the past, the Water Research Commission supported the publication of an estuarine bibliographic database¹ which provided an invaluable source of information for research on individual and groups of systems around the South African coast. This information has also been of use to environmental managers and private consultants undertaking work on various estuaries. The latest estuarine bibliography² has provided an opportunity to update the earlier document, to examine aspects surrounding research outputs in estuarine science over more than 100 years, and to provide a preliminary numerical assessment of progress within this field. A comprehensive review of past, present and possible future research trends in the estuarine ichthyology field were published in 2010³ and should be read in conjunction with this assessment.

Biogeographical regions and qualifying estuaries

For the purposes of this review, 280 estuarine systems were divided into three major biogeographical regions⁴: subtropical (from the Kosi Estuary in KwaZulu-Natal to the Mbashe Estuary in the Eastern Cape Province), warm temperate (from the Mendwana Estuary to the Ratels Estuary near Cape Agulhas) and cool temperate (from the Uilkraals Estuary to the Orange River mouth on the Northern Cape coast). Each estuary was placed in one of these three biogeographical categories (Figure 1).

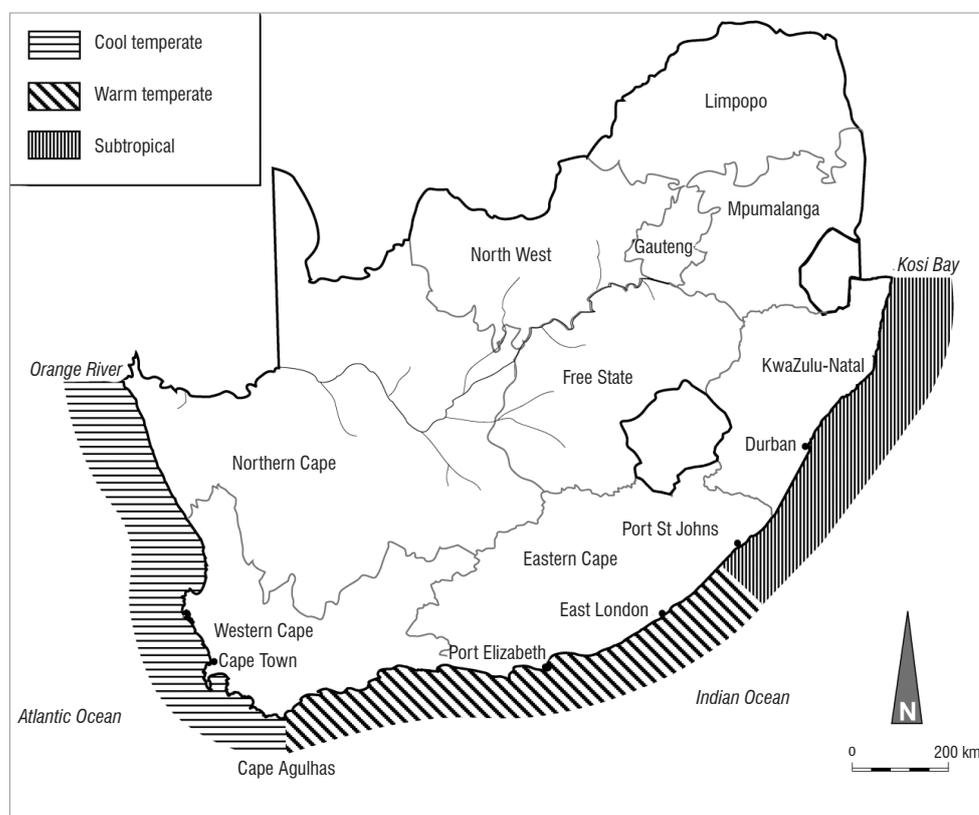


Figure 1: Map of southern Africa showing the three major biogeographical regions used in this study: cool temperate, warm temperate and subtropical.

Systems that do not function as estuaries, using the widely accepted definition of Day⁵, were not included in this review and are individually listed in Whitfield and Baliwe². The estuarine classification system that has been used here includes permanently open estuaries, temporarily open/closed estuaries, estuarine lake systems, estuarine bays and river mouths.⁶ Langebaan Lagoon has also been included in this analysis following a motivation that the system should be classified as an estuarine embayment.⁷

Information categories and approach

Although published works in scientific journals and books usually receive the most attention, numerous reports synthesising both published and unpublished information on South African estuaries were included in Whitfield and Baliwe's report.² Much of the 'grey' literature which is readily accessible was also included in the above report but a number of documents were excluded on the basis that this type of information is not available to either scientists or managers (e.g. unpublished honours projects). Abstracts from conferences were also excluded from the

bibliographic database because these sources often cover preliminary findings which are published in detail at a later date.

In cases in which an unpublished report or progress report duplicated information provided by the same author in a published article, the former document was excluded from the analysis. Likewise, if preliminary reports were followed by final reports, which included the information given previously, then only the final document was considered. Taxonomic papers dealing exclusively with the descriptions of species were not included in the database. Selected references from both the marine and freshwater environment were included if they contained information directly relevant to estuaries or typical estuary-associated organisms.

Information available on each estuary was categorised broadly as nil, poor, moderate, good or excellent. Availability of outputs was classified as poor if there were 1–9 references for a system, moderate if there were 10–19 references, good if there were 20–39 references and excellent if there were more than 40 references.

Results and discussion

A preliminary analysis of the estuarine information database in the different biogeographical regions is shown in Table 1. Indications are that the status of information on 79% of South African estuaries could be classified as nil or poor, with 10% having moderate information and 11% having good or excellent information. One-third of the poor returns were from the former Transkei region of the Eastern Cape, where there is little or no published information for 82 out of 87 estuaries. A similar situation pertains to the former Ciskei, in which limited information is available for 10 of the 14 estuaries in this region.

Table 1: Number and percentage of estuaries in each biogeographical region for which available information ranged from nil to excellent

Estuarine information	Region							
	Cool temperate		Warm temperate		Subtropical		South Africa	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Nil	–	–	13	10	8	6	21	8
Poor	16	61	87	69	97	77	200	71
Moderate	3	12	14	11	12	9	29	10
Good	5	19	5	4	7	6	17	6
Excellent	2	8	8	6	3	2	13	5
Total	26	100	127	100	127	100	280	100

A long-term analysis of the number of references per decade over the past century revealed several interesting trends. From a low base in the 1950s and 1960s, virtually all outputs went from strength to strength until the beginning of the 1990s, after which they went into decline (Figure 2). The reason for the decline in virtually all the analysed categories after 1991 appears to be directly related to the decline in highly productive researchers in the subsequent decades. Indeed, the number of these highly active researchers declined by 50%, from 42 in the period 1972–1981 to 21 in the period 2002–2011 (Figure 3). Although the ‘brain drain’ and retirement factors may be partially responsible for the above decline, the exact reasons for this trend are unknown.

Overall, there appears to be similar outputs in terms of references from each of the major regions along the South African coast. This is

particularly the case for ‘physical and chemical’ studies. However, as far as ‘biological and ecological’ studies are concerned, outputs are considerably higher in the Eastern Cape Province and KwaZulu-Natal, when compared to the Western and Northern Cape (Figure 4).

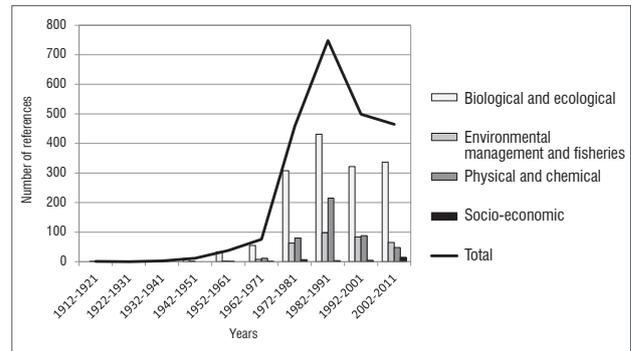


Figure 2: A decadal analysis of the number of references in different categories over the past century. The total number of publications in each decade is also shown.

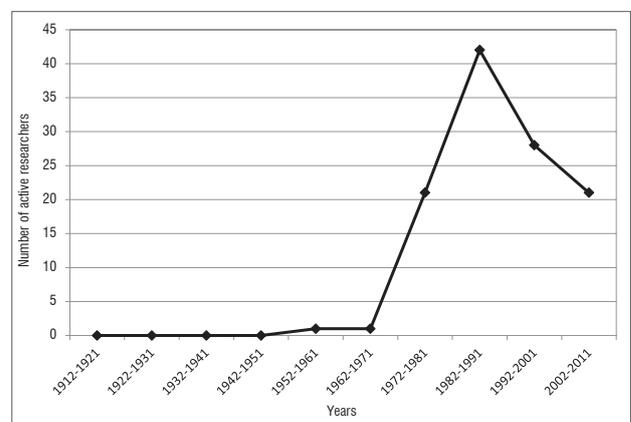


Figure 3: Number of highly active researchers per decade as obtained from the first author of referenced publications, reports and theses. To qualify as an active researcher in a particular decade, a minimum of five senior authored outputs had to be produced by that individual in the decade.

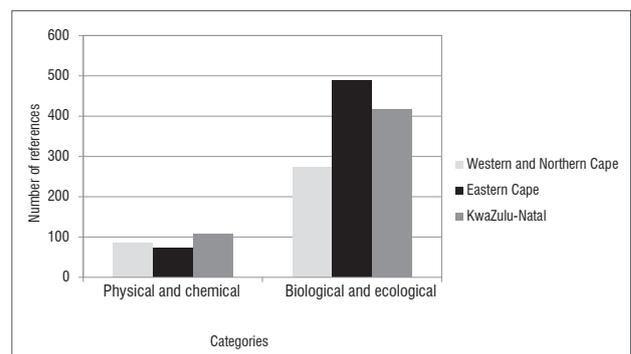


Figure 4: Diagram illustrating the number of estuarine-related references in two categories from three major regions along the South African coast.

A total of 241 Masters and PhD theses on South African estuaries have been produced, with the overwhelming majority (166) covering ‘biological and ecological’ topics (Figure 5). The second and third largest categories were the ‘physical and chemical’ and ‘environmental management and fisheries’ categories with 50 and 19 theses, respectively. Only six theses over the past century had a primary focus on ‘socio-economic’ issues.

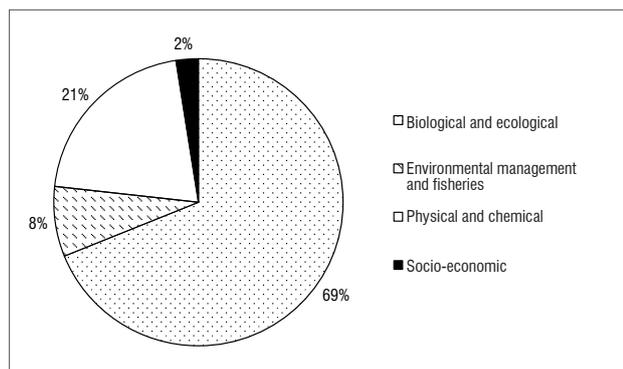


Figure 5: Percentage of theses in each of four categories of research related to South African estuaries.

The graduation of Masters and Doctoral students in South African estuarine studies was dominated by four coastal universities – Nelson Mandela Metropolitan University (with 36% of graduates), University of KwaZulu-Natal (28%), Rhodes University (13%) and the University of Cape Town (12%). Together these four universities accounted for almost 90% of all degrees awarded in the estuarine research field, with the remaining 12 universities responsible for just over 10% of graduates within this field. The reasons why the four coastal universities have dominated the supervision of postgraduate students in this field is linked to the location of the universities, their infrastructure and funding resources, and, perhaps most of all, the research interests of lecturing staff at these institutions. Certain staff members at these universities have been responsible for training a large number of students during their careers and in many cases were succeeded by lecturers with similar interests to their own, thus continuing the tradition of estuarine research at that particular university. In other cases, collaboration within and between universities and research institutes created teams of researchers who worked together on estuarine programmes to the benefit of both the science and students at these institutions.

The presence of research institutes such as the Institute for Coastal Research at the then University of Port Elizabeth, the South African Institute for Aquatic Biodiversity associated with Rhodes University, and the Oceanographic Research Institute associated with the University of KwaZulu-Natal, also contributed to the relative strengths of estuarine research at these universities, when compared to others where such collaborative links were absent. The importance of a university's location in determining whether estuarine studies are a feature of these institutions (or not) can be gauged from the minimal student contribution to estuarine research by the large universities of the Witwatersrand and Pretoria. Conversely, the Walter Sisulu University is located relatively close to a large number of important estuaries in the Eastern Cape Province but has not fully utilised the training opportunities provided by these systems. The reasons for this mismatch can be traced back to the historically disadvantaged nature of this university and the pressures on graduating students to seek employment once a Bachelor's degree has been obtained.

A temporal breakdown of the relative contributions by the different universities towards the production of Masters and Doctoral theses is shown in Figure 6. The important role of Nelson Mandela Metropolitan University in the training of postgraduate students in estuarine work from the 1970s to the present is most apparent. Similarly, Rhodes University and the University of KwaZulu-Natal have made important contributions over the same period, although the latter university seems to have faltered during the 1990s before increasing its outputs following the turn of the century. Again, these trends can be traced back to the changing staff composition in various departments at this university.

There appears to be a strong disjuncture between the peak in thesis production during the period 2002–2011 (Figure 6) and the continued overall decline in published papers and reports in various disciplines during the same period (Figure 2). The reasons for this mismatch are obscure but may be related to a change in emphasis by lecturers and

scientists towards the training of new Masters and Doctoral students, together with a reduced focus on the publication of results from these theses. This hypothesis does, however, run counter to the pressures on supervisors to generate publications for their universities and institutes for subsidy and researcher rating purposes, although it is also true that government subsidies for postgraduate students graduating with these higher degrees have also increased considerably within the last decade.

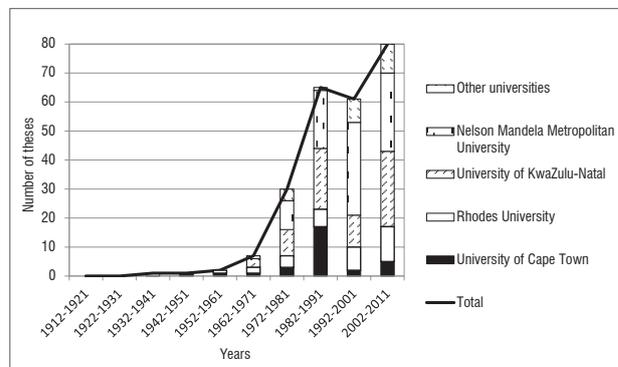


Figure 6: Decadal diagram illustrating the production of Masters and Doctoral theses by students conducting South African estuarine studies at various universities.

Another reason for the decrease in published documents during the past two decades could be the curtailment of report outputs during this period, which declined from more than 200 in the period 1981–1992 to less than 80 in the period 2001–2011 (Figure 7). This decline is not only attributable to the 50% decrease in highly active researchers over the same two periods (Figure 3) but may also be linked to decreased government funding being directed at estuarine studies. For example, a number of substantial estuarine contracts between the Department of Environmental Affairs and the Council for Scientific and Industrial Research came to an end towards the end of the 1980s and led to a major drop in national report outputs from this source in the 1990s and beyond.

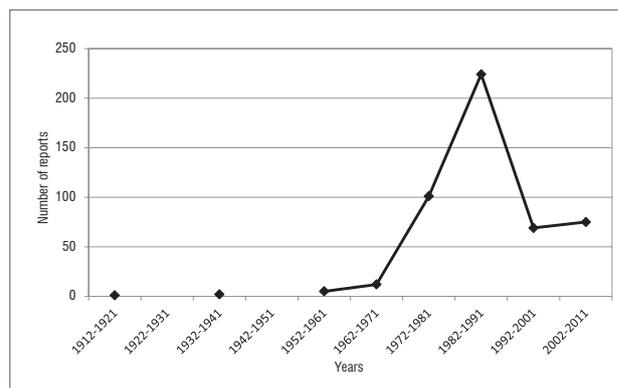


Figure 7: Number of estuarine reports produced per decade between 1912 and 2011.

In conclusion, it would appear that our knowledge of South Africa's estuaries, particularly the larger systems close to major coastal cities, has grown considerably over the past 50 years. This growth applies particularly to the biology and ecology of the biota in these estuaries, with considerably fewer studies having been devoted to the physico-chemical and socio-economic aspects. Although increasing numbers of postgraduate students appear to be acquiring the necessary skills to conduct research on South African estuaries, there needs to be a concerted drive for these students to publish their findings in the primary literature and to actively pursue professional careers in estuarine studies through both the public and private sector.

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