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Baseline

Status of marine pollution research in South Africa (1960–present)

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ABSTRACT

The published literature on marine pollution monitoring research in South Africa from 1960 to present was evaluated. There has been a general decline in the number of papers from the 1980s and this can be linked to the absence of a marine pollution monitoring programme in South Africa. General trends observed were that contaminant exposure monitoring of metals predominates the research conducted to date. Monitoring results indicate that there has been a general decrease in metal concentrations in South African coastal waters and concentrations of metals and most organics in mussels are lower than in other industrialised nations. This is reflected in the general pristine nature and high biodiversity of the South African coastline. The establishment of a national marine pollution monitoring framework would stimulate marine pollution research.

1. Introduction

Attwood et al. (2002) describe the South African marine environment as a rich and diverse national asset which provides economic and social opportunities. According to Taljaard et al. (2006), approximately 30% of South Africa's population reside along the coastline, which has encouraged extensive urbanisation and industrialisation of many coastal areas. This rapid transformation undoubtedly brings with it increased anthropogenic-derived waste and xenobiotics which find their way into the marine ecosystem (Greenfield et al., 2011). This, coupled with the population's reliance on the marine environment for resources, products, transportation and economic gain, has placed pressure on South Africa's marine ecosystems (Taljaard et al., 2006; DEAT, 2008). Furthermore, the sustainable use and management of these coastal resources is important to the country's future development (DEAT, 2008). While the creation of marine conservation awareness has received high priority in South Africa, the current lack of marine pollution research in South Africa hinders these efforts.

By virtue of its position at the southern tip of Africa, the seawater temperatures and therefore processes along the South African coastline are influenced by two ocean currents, i.e. the Benguela and Agulhas currents (De Villiers and Hodgson, 1999). The water temperatures divide the coastline into three climatic/biogeographic regions, i.e. along the east coast a subtropical region and warm temperate region and on the west coast a cool temperate region (Fig. 1). This gives rise to the western cold region of the coast being subjected to large scale upwelling, while the eastern seaboard contains 90% of the estuaries that drain freshwater basins to the ocean (Allanson et al., 1999). From the assessment of the west coast of southern Africa (Boyer et al., 2000) and the Indian Ocean (Sheppard, 2001), which forms part of the Seas at the Millennium series, the environmental challenges facing these regions are evidently the result of the influence of the ocean currents. The upwelling of cool, nutrient rich water is the main reason for the establishment of a large scale fishing and mariculture industry along the coast, but the region is also prone to algae blooms (red and brown tides) with consequent effects (Probyn et al., 2001). The east coast of South Africa supports a high density coastal population, with the result that waste such as nutrients (Wepener, 2007) and pollutants (Orr et al., 2008) enter the ocean through the large numbers of estuaries with consequent threats to components of the marine ecosystem such as fish populations (Whitfield and Cowan, 2010). This region is also more susceptible to global environmental issues such as climate change with resulting influences on marine ecosystems such as coral reef bleaching (Schleyer et al., 2008; McClanahan et al., 2011) and changes in marine biodiversity (Chown, 2010). Notwithstanding these challenges, the South African marine ecosystem is still regarded as relatively pristine, supporting a high degree of biodiversity (Griffiths et al., 2010). It is therefore all the more important to assess, monitor and predict the impacts that pollutants have had and may have in future on the marine ecosystem in South Africa. In this paper, we aim to provide an overview of the past, current and future status of marine pollution monitoring in South Africa.

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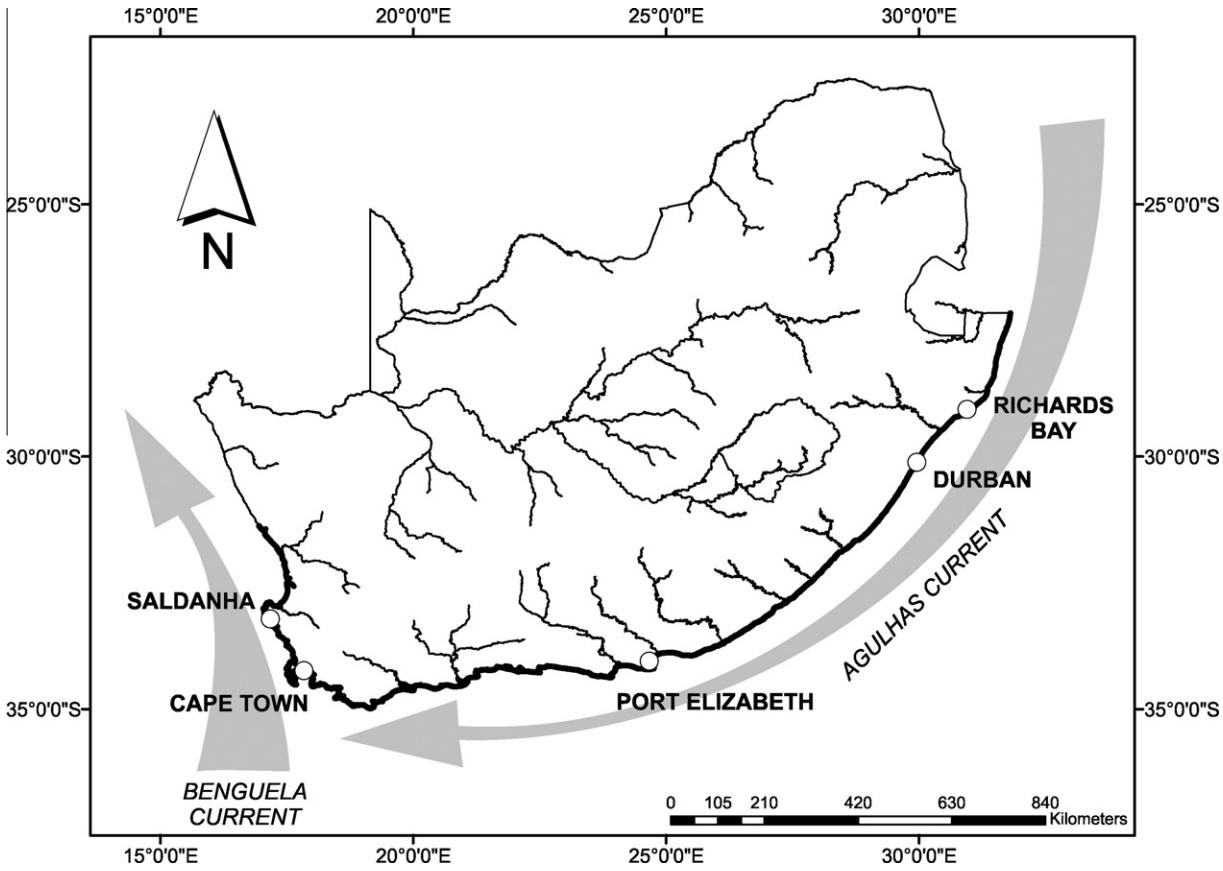

Fig. 1. Map showing the distribution of the three climatic/biogeographical zones along the South African coastline based on water temperatures.

2. Approach

Primary data for this review were sourced in the same manner described by O'Donoghue and Marshall (2003) who undertook an extensive review of available literature on marine pollution studies in South Africa between 1960 and 2003. To supplement the existing literature data base, the scientific literature and readily available grey literature were searched from 2003 to present, using SCOPUS and Current Contents search engines. The same key terms used by O'Donoghue and Marshall (2003), i.e. South Africa marine, estuarine, coast, pollution, chemical, storm water, outfall, sediment, sewerage, nutrients, microbial, bacterial, metal, zinc, mercury, cadmium, copper, lead, tin, radioactive, nuclear, thermal, litter, organics, oil, petroleum, DDT, dieldrin, PCB, organochlorine, bioaccumulation, biomonitoring, bioindication and ecotoxicology were applied for this study. Wildcard characters with truncated aspects of the keywords were used to capture all variations of the required search terms. In addition to the original 284 references a surprisingly small number of additional references (38) were added to the database. Information on the type of pollutant, the region in which the monitoring was undertaken, the type of monitoring (i.e. exposure or effects monitoring) and the year monitoring was undertaken were recorded for the purposes of this review.

3. History of marine pollution monitoring in South Africa

A meta-analysis of the literature provided by O'Donoghue and Marshall (2003) and for this study revealed that marine pollution monitoring in South Africa spans a period of 40 years during which the initial years are characterised by a bloom period during the 1970s–1980s, followed by a 20 period where pollution studies were largely neglected (Fig. 2). The majority of the initial studies that were undertaken between 1960 and 1980 can be regarded as exposure assessments, which were related to the determination of levels of contaminants in sediments and biota along the South African coastline. From the 1980s onwards just under 50% of the studies dealt with some form of biological effects measurement relating exposure to biological responses.

A large array of different contaminants has been measured, with the earlier literature (1960–1980) dealing with the lesser known contaminants such as thermal, plastic debris, radioactivity and microbiology (O'Donoghue and Marshall, 2003). The three main classes of contaminants that have been monitored are discussed in more detail.

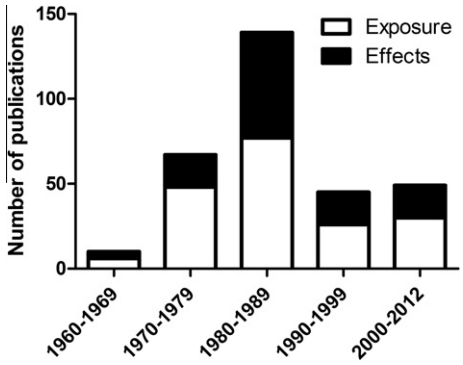

Fig. 2. Distribution of the number of published papers and available grey literature on marine pollution research between 1960 and 2012. A distinction is made between papers on contaminant exposure and contaminant effects.