This section should be cited as follows: Weerts, S. and Taljaad, S. *Pollution* in Goble, B.J. and van der Elst, R.P. (eds.) 2022. State of the Coast: KwaZulu-Natal - A review of the state of KwaZulu-Natal's coastal zone. KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs, Pietermaritzburg, 13-18.

2.3 POLLUTION

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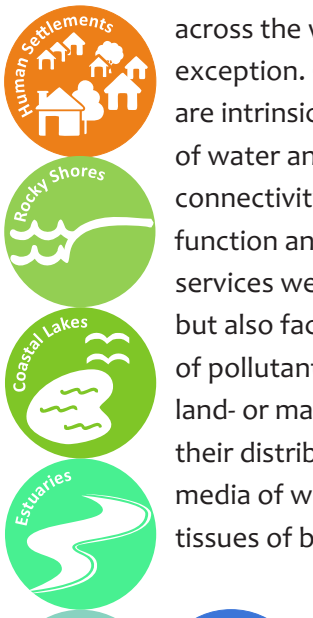
INTRODUCTION

Pollution is a crosscutting pressure impacting coastal habitats and resources across the world and KZN s no exception. Coastal environments are intrinsically connected by flows of water and sediment. This connectivity underpins ecosystem function and the goods and services we derive from our coast, but also facilitates the introduction of pollutants in various forms from land- or marine-based sources, and their distribution through the media of water, sediments and tissues of biota.



DRIVERS

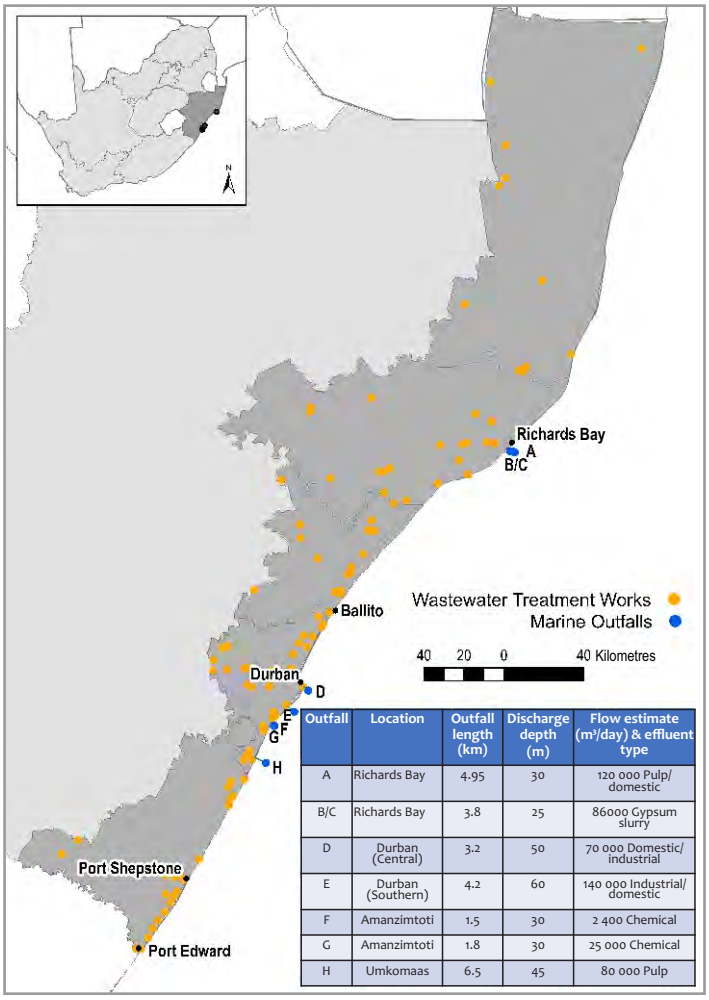
The primary driver of coastal pollution in KZN is development, fuelled by population growth and urban migration (Section 2.2). Pollution takes several forms, but water pollution is the main issue. Impacted systems include coastal lakes, rivers, estuaries, beaches, nearshore and offshore marine waters.

URBANISATION AND TOURISM

Coastal populations have grown disproportionately compared to inland areas, with most of this growth in urban centres. In KZN these include the eThekwini Metropolitan Municipality and the District Municipalities of uMhlathuze, KwaDukuza and Ray Nkonyeni (Section 2.2). Stormwater runoff along with overflows and leakage from municipal wastewater systems is a source of water pollution. Large areas of informal settlement with poor access to waste services invariably results in contaminated runoff into surface waters (coastal freshwaters and estuaries). Human waste, faecal bacteria and viruses are carried by stormwater into coastal waters, along with nutrients, soaps, oils, organic matter and pharmaceuticals. Solid waste (litter) is the most conspicuous component of stormwater runoff and is omnipresent in waters and on beaches, abundantly so after rainfall events. It comprises a wide variety of materials of different buoyancies: cigarette butts, glass bottles, tin cans, cardboard and nappies are common, but the most significant contributor is plastic which persists in the aquatic environment, and as it breaks down into smaller pieces, can be spread over large areas.

INDUSTRY

Industrial development has occurred primarily near the ports of Durban and Richards Bay. Wastewater from industry is typically handled via municipal sewerage infrastructure after being treated at source to meet a required standard. This wastewater can contain a wide range of potential contaminants, from high suspended



Outfall	Location	Outfall length (km)	Discharge depth (m)	Flow estimate (m³/day) & effluent type
A	Richards Bay	4.95	30	120 000 Pulp/ domestic
B/C	Richards Bay	3.8	25	86000 Gypsum slurry
D	Durban (Central)	3.2	50	70 000 Domestic/ industrial
E	Durban (Southern)	4.2	60	140 000 Industrial/ domestic
F	Amanzimtoti	1.5	30	2 400 Chemical
G	Amanzimtoti	1.8	30	25 000 Chemical
H	Umkomaas	6.5	45	80 000 Pulp

Figure 2.3: Wastewater treatment works and marine outfalls along the KZN coast.

solids to heavy metals and synthetic chemicals. There are four areas on the KZN coast where industrial wastewater is discharged directly to sea (Figure 2.3). Two marine outfalls at Durban, and two at Richards Bay discharge industrial and domestic wastewater. On the south coast, two outfalls at Amanzimtoti and one at Umkomaas discharge industrial effluent to sea (Figure 2.3).

MINING

In KZN, mining on the coast has historically been limited to heavy minerals (Section 8.7). This activity and its associated residue dams and processing plants have clear impacts on coastal environments in terms of habitat destruction and water use. Sand mining occurs on smaller individual scales, but cumulatively over a larger area (Section 8.8). It is poorly regulated and controlled, and pollution impacts are likely more severe, including increased suspended solids and contaminants such as metals.

AGRICULTURE AND AQUACULTURE

Sugarcane farming and forestry are prominent land uses in catchments along the KZN coast (Section 8.4). These activities rely on the application of a wide variety of pesticides, including toxic synthesized organic chemicals which are carried in "return flows" by surface runoff into coastal waters. While progress has been made in the development of pesticides that degrade relatively quickly in the environment, many are persistent and have the propensity to bioaccumulate and biomagnify in food chains. Fertilisers widely applied in agriculture are also carried in return flows to coastal waters where they contribute to nutrient pollution.

Aquaculture is not widely practised in KZN (Section 8.3). However, pollution impacts include water and sediment quality deterioration by various contaminants, including pharmaceuticals. Biological pollution can occur in the form of pathogens that proliferate in captive stocks being lost to surrounding natural waters, affecting wild biota. Alien invasive species introductions occur as escapees of either non-indigenous farmed stock or associated biota that are inadvertently introduced (e.g., snails on aquarium plants).

PORTS AND SHIPPING

The ports of Durban and Richards Bay contribute to pollution through various activities. However, water quality in these ports is primarily impacted by surrounding city catchments. There are clear hotspots of sediment contamination in both ports that can be ascribed to bulk cargo handling, ship repair activities and drainage from urban catchments. Underwater hull cleaning is a growing pressure that will add to contamination

of waters and sediments in both ports. Contaminants include antifouling agents that are used in paints applied to ships, and toxicity impacts in port sediments occur. Waste from ships in port is discharged to port reception facilities which, in most categories are regarded as satisfactory in both ports (APWC 2020). Dredging is carried out at both ports with dredged material being disposed at registered open water sites. This has the potential to release plumes of fine sediment as well as contaminants to port and offshore waters, and to pollute the seabed in the vicinity of the dumpsites.

The origin of most waste on beaches is from land-based sources (Ryan 2020). However, there is good evidence that waste, including plastic, is dumped by ships at sea (Ryan *et al.* 2021). Bilgewater discharge, often contaminated with oil is difficult to track and regulate. Shipping accidents can also be significant sources of pollution - oil spills are typical examples.

ENERGY

The energy sector is not a major contributor to KZN coastal pollution, but with growing interest in oil and gas (Section 8.10) this may change. An imminent issue is that of powerships proposed at the Port of Richards Bay. These have the potential to contaminate water as well as introduce light and noise pollution.

PRESSURES

Pollution pressures on the KZN coast arise from an array of sectors which contribute to a diverse range of pollutants (Table 2.1). Rapid urbanisation has put considerable pressure on authorities to provide waste and sanitation services. Although non-sewered, on-site sanitation technologies are being trialed in Durban's informal settlements (Sutherland *et al.*

Table 2.1: Key pressures and associated pollutants.

KEY PRESSURE SECTORS AND ASSOCIATED ACTIVITIES	POLLUTANTS														
	Thermal pollution	Discolouration	Solid waste (litter)	pH	Biodegradable organic matter	Suspended/ settable solids	Inorganic nutrients	Microbiological contaminants	Toxic inorganic pollutants	Metals	Petrochemicals	Agrochemicals	Pharmaceuticals	Other persistent organic pollutants	Harmful organisms
URBANISATION & TOURISM															
Stormwater runoff			●	●	●	●	●	●	●	●	●	●	●	●	
Municipal wastewater				●	●	●	●	●	●	●			●	●	
Solid waste			●		●										
INDUSTRY & MINING															
Chemical		●		●	●	●			●	●				●	
Paper & pulp	●	●		●	●	●			●					●	
Coastal mining						●				●					
AGRICULTURE, FORESTRY & AQUACULTURE															
Agricultural return flows					●	●	●	●				●			
Aquaculture					●	●	●						●		●
PORTS & SHIPPING															
Port activities			●		●	●	●	●		●	●				
Ship repair & hull cleaning		●				●				●				●	●
Ballast water discharge															●
Dredge spoil disposal					●	●				●	●			●	
Ship waste at sea			●								●				
Oil spills						●					●				

2021), centralised sewerage systems remain the primary focus. These comprise a network of pipes that deliver water-borne sewage to wastewater treatment works, where it is treated to a permitted standard and discharged as effluent to surface waters.

Marine outfalls deliver a range of potential contaminants into the marine environment that are specific to the industries being served. They also have the potential to impact some of the basic physico-chemical properties of seawater. Salinity is an obvious example (waste is typically carried in freshwater), but some of the industrial effluents are discharged at temperatures well above, and at pH levels well below ambient seawater. In some cases domestic and industrial effluent is diluted with clean seawater prior to discharge, but fundamentally these outfalls rely on the high assimilative capacity of the KZN offshore environment to dilute and disperse contaminants to levels which pose little or no risk to human health and the natural environment as quickly as possible, impacting only an area designated as a mixing zone.

Blue Lagoon, Durban
Photo: Omar Parak

STATE

The coastal waters of KZN are showing clear signs of pollution. In urban areas, rivers and estuaries are significantly impacted by municipal wastewater. This is manifest in elevated nutrient loads and bacteriological contamination, which extends to adjacent surf zones and beach waters. Bacteriological contamination is evident in all 16 estuaries in eThekwini (Forbes and Demetriades 2008). This is not limited to the central coast; faecal bacteria have historically been reported from systems along the whole KZN coast (Begg 1984). Recent years have seen an increase in both the frequency, duration and levels of contamination. Sewerage infrastructure failures result in repeated and prolonged raw sewage overflows into many systems, including the iKongeni Estuary (Margate), Durban Bay and uMngeni Estuary with consequent closure of swimming beaches.

Data on cases of waterborne diseases in beach users are not available but increases in gastrointestinal and respiratory illness, and skin, eye, ear, nose, throat infections are commonly reported, especially after rainfall events. At least two cases of flesh-eating bacteria infections have been reported in the last 15 years. Such water quality issues significantly impact the tourism value of the coast (Nahman and Rigby 2008).

In addition, stormwater runoff and municipal wastewater inflows have led to elevated nutrients and organic matter loads in many KZN estuaries. There are clear signs that many of our estuaries are suffering consequences of nutrient overload. This is evident in periodic phytoplankton and macroalgae blooms. Over the

last five years, serious overflows of untreated sewage and/or fish kills have been recorded in over 20 KZN estuaries. Many systems between the iSiphingo and the uThukela (including Durban Bay) have suffered repeated fish kills. Further south, beaches at Margate and Uvongo have frequently needed to be closed to protect bathers from sewage outflows.

Solid waste (litter) is another major category of pollution. In KZN, beaches most affected are between Durban and Richards Bay. Most of this litter is plastic. An estimated 60-90% of plastic from land-based sources ends up on beaches, where most is buried (Ryan 2020), but some invariably remains afloat in coastal waters.

Systematic coastal water quality monitoring is not performed, but annual monitoring of waters and the seabed in the vicinity of marine outfalls is conducted, and in most cases, includes surveys of areas at some distance away to serve as reference sites. This monitoring indicates that there are pollution impacts but these are limited to close proximity (generally < 1 km) of the outfall diffuser areas. Outfalls discharging in shallow water, close to shore or discharging dense rather than buoyant effluent have been problematic. For example, the industrial outfall at Umkomaas has been extended twice since it was first commissioned in 1967, in part to deal with nearshore water quality issues (foaming). Diffuser blocking and deposition of non-soluble gypsum on the seafloor at Richards Bay has necessitated the installation of a third industrial line (Retief and Fijen 2008). In general, however, these outfalls are well managed and working to their required engineering specifications, with expected, but limited environmental impact.

In South Africa, most marine outfalls were designed by applying the "receiving water quality objective and fitness for use" approach (DEA 2014). This requires that the treatment and disposal of wastewater must consider the receiving environment. Following this approach, if operations are within design limits, marine outfalls are not expected to have a major impact beyond a pre-defined mixing zone. In contrast, discharge of wastewater to rivers, estuaries and surf zones has historically been licenced based on a "uniform effluent standard" approach. Volumes and chemical compositions of these discharges have not been based on the assimilative capacity of the receiving environment, but rather on uniform legal standards. In KZN, malfunctioning or overloaded treatment facilities no doubt contribute to adverse impacts in estuaries especially, but wastewater discharges, even if their compositions comply with current standards (legal limits), have simply become too large for these systems waters to assimilate.

Disposal of dredge material to sea for port operations is licenced under the ICMA and appears to be conducted at levels that are sustainable and do not result in lasting or widespread pollution. While regular monitoring of offshore dredge disposal sites is not performed, periodic monitoring before, during and after large-scale capital works indicates impacts are limited to close proximity of the disposal sites and recovery is rapid once dredge disposal ceases.

In addition to the persistent inflow of pollutants, the frequency of large-scale pollution events that have recently occurred is a concern. This is well illustrated by the massive agrochemical spill from the United Phosphorus Ltd (UPL) warehouse into the uMhlanga River during the July 2021 riots, which will have long-lasting pollution impacts. Others include the fire at Sun Oil Refineries resulting in hundreds of thousands of litres of firewater and edible vegetable oil spilling into Durban Bay (March 2015), a fire at a Transnet

warehouse resulting in firewater and tons of wax entering the Durban Bay (March 2017), a shipping accident which spilled 49 tonnes of plastic pellets into Durban Bay (October 2017) (Schumann *et al.* 2019), a massive spill of oil into the Umbilo River and Durban Bay from a Transnet pipeline (October 2020), two major sewage overflow events into the Port of Durban (May 2019, November 2021), and a more recent one into the uMngeni Estuary (January 2022). A multitude of smaller fire events have also occurred, several in the Durban south area, including those at the SAPREF refinery, as well as fires in the Durban central business district (the most recent, the burning of the China Emporium).

IMPACT

Eutrophication of KZN estuaries significantly reduces the biodiversity and nursery value of these systems, with fisheries and tourism impacts. Pollutants impacting estuaries also flow into the sea, affecting beaches and nearshore waters by bacteriological contamination and solid waste. The most pressing impacts of pollution by sewage are those associated with human health. Solid waste on beaches has obvious implications for recreational beach value and tourism.

Ingestion of microplastics by various biotic assemblages has been demonstrated, e.g., estuarine fishes (Naidoo *et al.* 2020), crabs and rocky shore invertebrates (Iwalaye *et al.* 2020). Actual impacts of this have not been studied locally, but from international literature range from physical damage in digestive tracts affecting feeding, development, growth and reproduction, uptake in tissues and organs, and toxicological impacts from leached plastic additives or pollutants adsorbed from seawater, causing carcinogenesis and endocrine disruption (Wright *et al.* 2013). Entanglement, choking and digestive tract impacts of larger plastics have been documented locally in sharks (Cliff *et al.* 2020) and turtles (Mann-Lang *et al.* 2020).

By and large, offshore marine water quality off KZN remains good, despite the presence of marine outfalls discharging domestic and industrial wastewater directly into these waters. This is mainly attributable to the dynamic nature and high assimilative capacity of these waters. Rivers and estuaries are far more susceptible to accumulation of persistent pollutants. Metals, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) are widespread in port and estuarine waters in eThekwini (Newman *et al.* 2015). Fish and mussels in Durban Bay, uMngeni and iSiphingo estuaries have been found to accumulate metals, PAHs and PCBs in their tissues at concentrations high enough to pose a potential risk to human health *(acknowledging limitations in data - notably on consumption rates of local recreational and subsistence fishers)* (Newman *et al.* 2015). While limited research of pharmaceutical contaminants has been conducted, they are known to occur in waters in the lower uMngeni catchment, either because of incomplete removal, or inflows of untreated wastewater (Agunbiade and Moodley 2014; Segura *et al.* 2015).

RESPONSE

While it is convenient to regard waste assimilation as one of the ecosystem services that coastal waters provide, it must be recognised that there are limits to what the sea can absorb. In the last 30 years, pollution has emerged from being a relatively minor pressure on the KZN coast to a grave concern. Estuaries are under extreme threat, which is a serious warning. Direct consequences for human health, livelihoods and economies are

now clearly emerging. South Africa's legislation pertaining to coastal and marine pollution is guided by several international conventions. Implementation is supported by a range of norms and standards. As with many other pressures on coastal and marine resources, management is constrained not by a lack of legislation, but rather by poor enforcement and compliance (Taljaard *et al.* 2019; Table 2.2).

Pollution of estuaries and beaches by municipal wastewater and stormwater runoff is the most significant pollution issue demanding management response:

- Resources must be allocated to the development and maintenance of sewerage infrastructure, and systems put in place to monitor wastewater treatment works. The latter can be achieved via the *Green Drop* programme.
- Regular, systematic monitoring of receiving waters should be performed, for example, as used to be the case for eThekwini Municipality State of Rivers Reporting. This provides information on the condition of waters, allowing the identification of pollution hotspots, problem stormwater inflows and failing sewerage infrastructure. Estuaries are the most polluted of all coastal habitats in KZN and they should be included in long-term monitoring programmes. These programmes can be expensive, but if well designed they can be rationalised and implementable to provide valuable information to manage pollution pressure.
- The national lack of analytical laboratory capacity to measure known and emerging pollutants needs to be addressed by investment in marine laboratory capability.
- Litter boom projects and beach cleanups, often community-led, play a significant role in reducing solid waste pollution but *preventing* waste entering coastal waters is the ultimate solution. Society must adopt a paradigm shift in its generation and disposal of solid waste. The Sihlazimvelo programme (led by eThekwini) provides a template to stimulate shift. It is a community-based stream management programme, creating jobs and working to reduce flooding through removing blockages in streams from solid waste.
- In the case of plastics, government policy intervention is needed either in terms of bans, pricing mechanisms or recycling initiatives.
- Persistent and emerging pollutants in coastal waters and their human health impacts need

Table 2.2: Status of legislation, available norms and standards, levels of enforcement and compliance for KZN coastal pollution (●= good, ●= fair, ●= poor, *two symbols imply mixed status. E.g., 'good' in some areas, while still in a 'poor' state in other areas*). Modified from Taljaard *et al.* 2019.

SECTOR	KEY ISSUE	STATUS OF LEGAL LANDSCAPE & IMPLEMENTATION		
		Legislation	Norms & Standards	Enforcement & Compliance
Biodiversity	Control of alien & invasive species	●	●/●	●/●
Mining	Mineral mining (heavy minerals)	●	●	●
	Sand mining	●	●	●
Water	Environmental flows	●	●/●	●
	Sewage treatment	●	●	●/●
Land-based pollution	Stormwater runoff	●	●	●
	Municipal wastewater disposal	●	●	●/●
	Industrial wastewater disposal	●	●	●/●
	Agricultural runoff	●	●	●
	Solid waste	●	●	●/●
	Dredge spoil disposal	●	●	●
Shipping	Pollution from ships	●	●	●/●
	Ballast water	●	●	●/●
Tourism	Safe recreation	●	●	●/●

to be investigated better. Information on fish consumption rates in local communities is required to contextualise this risk for KZN.

- Recycling technologies should be developed and trialed for commercial feasibility. These should consider the current socioeconomic setting and provide opportunities for local community involvement and job creation.
- Technologies for the sustainable collection and management of plastic are being investigated, and an integrated seawater desalination and wastewater reuse demonstration project is being conducted at Durban. This could and should be grown to other waste categories.

Data Requirements

Sufficient information is already available to prioritise and guide an informed response to address coastal pollution issues we face. We need action rather than more data. Data will be useful in monitoring the success of management actions. Human health issues are an exception. There are signs that in some systems fish and shellfish are contaminated to levels that may pose a risk to human health. This needs to be investigated, and data collected on consumption rates of local recreational and subsistence fishers to contextualise this risk for the KZN setting.