

Ugu Lwethu - Our Coast. A profile of coastal KwaZulu-Natal

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2.1 Climate

Two major sea currents surround the subcontinent of southern Africa, namely the cold Benguela and the warm Agulhas Current as explained in Section 2.3. The Agulhas Current, which flows southwards along the eastern and southern coasts, is fed by water from the tropics. The current's warm water is a major influencing factor contributing to the climate of the KZN coastal region, giving it its humid subtropical character. The climate is more formally described as mild-temperate with summer rain and an indistinct dry season.¹

The region experiences near-weekly passages of mid-latitude weather systems, which are preceded by a coastal low-pressure system. Winds first blow from the north-east, changing to mostly south-westerly as the coastal low passes. Very often, a period of warm north-westerly "berg" winds will intervene between the north-easterly and south-westerly

winds. After the coastal low, a cold front moves over the area and generally cloudy and rainy weather is experienced. A high-pressure system follows the front, pushing cooler maritime air along and over the coastline, by the predominant south-westerly winds.

Wind

In KZN, south-westerly and north-easterly winds dominate. During autumn and winter, winds from the southwest are dominant, while north-easterly winds dominate during spring and summer. Highest wind speeds are experienced during spring, with lower wind speeds usually recorded during winter. In South Africa, winds are generally stronger along the coast than in the interior; however, KZN experiences weaker winds than the remainder of the South African coastal region.

Warm weather of Durban's beachfront.



Photo: Natalie Holland



Maximum wind speeds are generally experienced in the afternoon and minimum wind speeds in the morning, with a mean difference of about 7 kph. A land breeze usually commences in the early evening and lasts until late morning the following day. Towards mid-day sea breezes often develop, especially during summer. Sea breezes are affected by Coriolis' force so that, as they strengthen by day, they are deflected increasingly to the "left", to become north-easterly winds. This phenomenon makes the distinguishing of sea breezes sometimes difficult.²

The strongest wind is commonly known as the "south-westerly buster", and is associated with the passage of a coastal low. Extreme winds of very short duration also occur during the passage of a cold front, which is frequently accompanied by embedded thunderstorms. Along the coast, the wind profile is more uniform than in the interior, with relatively small differences between wind gusts and the background mean wind speed. The highest wind gust in Durban was recorded in 1954, and measured 140 kph.

Rainfall

The KZN coastal region receives about 1 000 to 1 200 mm of rainfall per year; places receiving more than 1 200 mm are not uncommon, especially along the north coast. The annual rainfall received over the KZN coastal region is less variable compared to that received by the rest of the country. While most of the rainfall occurs in mid-summer, the winter months are not completely dry, with some rainfall occurring in June, the driest month of the year. In KZN, about 28 days per year receive more than 10 mm of rain over a 24-hour period; and this varies from four times a month in summer to once a month in winter.

The KZN coastal rainfall can be of a convective or a stratiform nature.³ The former may result in significant amounts of rainfall, sometimes accompanied by severe thunderstorms. Extreme rainfall events are also associated with occasional "cut-off low" pressure systems that cool and trap excessive moisture. While the region does experience tropical cyclones, their occurrence is infrequent. One of the most severe tropical cyclones to hit the region was Domoina, in January 1984, which caused the highest daily rainfall recorded in South Africa: 542 mm recorded at St. Lucia.

Temperature

Coastal climates in South Africa tend to be moderate. Temperatures recorded in Durban show an average high of about 28°C from January to March, a maximum record of 40°C. Average lows of about 11°C occur in June and July, the lowest dropping to 3°C. The annual range of mean monthly temperature between the warmest and coolest months is approximately 7.5°C; about half of the range experienced in the interior.

The diurnal temperature range at the coast is generally smaller than in the interior, and has less seasonal variation. While the 30-year absolute maximum temperature documented for the KZN coastal region is around 40°C, this can be even higher in the north. The lowest temperature over this period was 3°C. However, night-time temperatures can be unpleasantly high, with minimum temperatures sometimes higher than 25°C. Uncomfortably high "apparent" temperatures are common along the KZN coastal region, due to the frequent high humidity levels. Cold spells, which are defined as the number of consecutive days when the average daily temperature drops 5°C below the long-term average, are infrequent, with 5 days being the longest cold spell recorded in Durban. The lowest maximum temperature experienced in Durban was 10.5°C, during a cold snap resulting from the passage of a cold front.⁴

Sunshine and cloudiness

Less than 60% of the maximum possible amount of sunshine is received over the KZN coast due to cloud cover. The amount of sunshine varies from 70% to 80% of the maximum during winter, to less than 50% in summer. On average, more than 50 days per year can be classified as cloudy or overcast, while the number of sunny and fine days is usually around 240 per year. October and November are the cloudiest months, when about nine days per month (on average) receive 10% or less of the maximum possible sunshine.⁴ The link between ocean and climate is visually apparent on many days when looking out to sea, where a blanket of clouds can be seen lying directly over the warm Agulhas Current, which is discussed in Section 2.3.

The KZN coastal climate is subtropical with generous summer rain. Year round warm temperatures, high humidity and sunny days, contributes to its lush natural environment and popularity as a tourist destination. ■

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2.2 Geology and Geomorphology

In terms of the geology of KZN, the coast can be readily divided into two zones, separated by the Thukela River.

The southern section is made up of bedrock, with a thin cover of soft sediments. This part of the coast consists of a series of rocky headlands with intervening sandy beaches, often across the mouths of estuaries. The rocky hinterland of the southern coast rises steeply to the Drakensberg escarpment, allowing dozens of rivers to flow to the sea. North of the Thukela River, the coast is composed of soft sediments that were deposited during the past million years; hard rock is virtually absent. Consequently, the northern part of the KZN coast has beaches that extend for kilometres, occasionally broken by tidal inlets and headlands of cemented beach and dune sand.

KZN beaches

The continental shelf along the KZN coast is very narrow by world standards, varying from a few kilometres wide off Kosi Bay to a maximum of 47 km off the Thukela River. The KZN coast is also one of the most linear in the world, a factor that reflects its geological origin. KZN has a semi-diurnal (mixed), micro (0-2 m) to lower meso (2-4 m) tidal range and is swell-dominated. The coast is subject to large swells derived from cold fronts, especially cut-off low pressure systems (as discussed in *Section 2.1*) such as those of 1966 and 2007.¹

KZN beaches are generally narrow and shallow, often with bedrock occurring at less than 3 m below the surface of the sand. The pattern of increasingly sandy beaches from south to north is linked to the northward decrease in wave energy along the KZN coast.²

The northern sections of KZN's coast portray near-continuous sandy shores, which are discussed in *Section 3.2*,

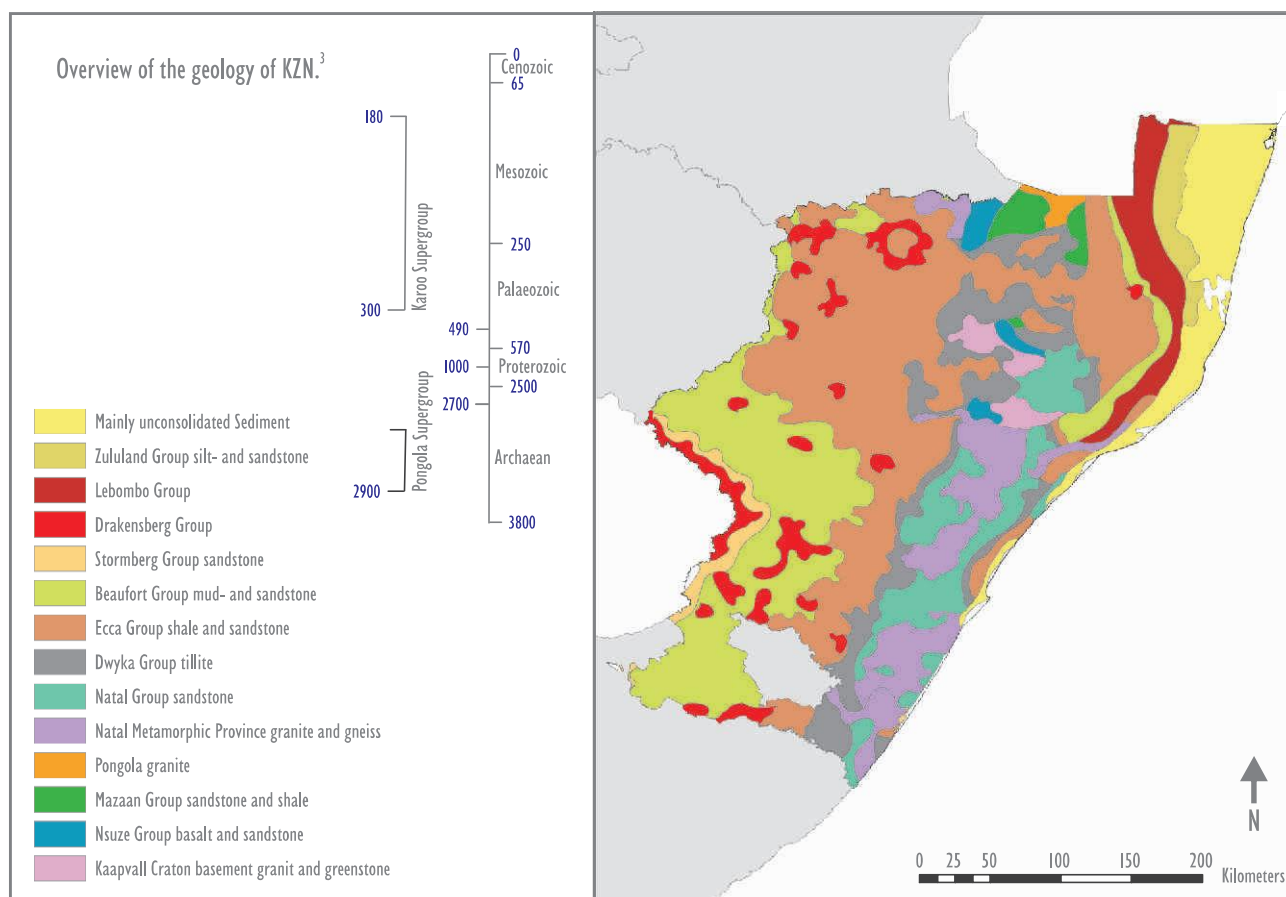
backed by high, forested dunes and locally developed fore-dunes. Occasional outcrops of beach-rock and aeolianite form headlands that cause the creation of zeta bays on their northern (down-drift) side. The coast is intercepted by a number of tidal inlets; with the inlet at Richards Bay having been modified to accommodate the port.

Around the Port Durnford area, the coast is eroding into Quaternary dunes and the sediment is dispersed along shore. This erosion is creating high erosional bluffs, which are quite unusual in KZN. North of the Thukela River, the coast is actively

Rabbit Rock, KZN north coast.



Photo: Jennifer Olbers



accumulating sediment, resulting in a series of low beach ridges.

South of the Thukela, the coast is characterised by headland bound embayments that become narrower to the south as the coast becomes more rocky. The rocky sections have a strip of sand accumulated at the base of gentle bedrock slopes. The biggest sand accumulations occur in the embayments at the mouths of small rivers.

Further south, the coast comprises a major Quaternary dune complex, the Durban Bluff Complex. Wave refraction around the Bluff has formed a large zeta bay beach that extends from Durban Harbour to Umhlanga Rocks, which is now maintained by artificial beach nourishment. In the south the coast is rocky with sandy beach accumulations in the numerous small river mouths and other small embayments.

Bedrock (Solid Rocks)

The oldest rocks on the KZN coast are the exposed granites of the Natal Metamorphic Province on the south coast, from about 1200 million years BP.⁴ They create distinctive rounded pinkish outcrops, particularly noticeable around Port Edward. Overlying these rocks are the distinctive sandstones of the Natal Group Sandstone, which are well exposed along the Mtamvuna Estuary and in the waterfall at the Vungu Estuary.

Next oldest are the Dwyka Group, a collection of sedimentary rocks that were laid down while South Africa was experiencing glacial conditions, some 300 million years ago. Outcrops of this rock are typically a distinctive grey-green mudstone with pebbles protruding; exemplified by the exposed rocks found at Zinkwazi. The cliffs around Ballito are the best place to see the overlying rocks of the Ecca Group; these ancient sedimentary rocks comprise alternating sandstones and shales that were laid down over 250 million years ago in an ancient sea. Many of the sandstones in this group were

deposited at ancient river deltas. These are presently exposed as a result of major tectonic processes in the Earth's crust during the Jurassic and Cretaceous periods, when the Natal continental margin was formed. They have been subject to millions of years of erosion and denudation since then.

Quaternary (Soft Sediments)

The solid rocks are overlain by the much younger sediments of the Quaternary (or Pleistocene) period. This period began about 2.58 million years ago and ended about 10 000 years ago.⁵ During this time, the Earth passed through several ice ages and intervening warm periods (interglacials). Global sea level rose and fell by over 100 m between the ice ages and interglacials. During the Quaternary period, rivers eroded sediment from the high rocks of KZN and deposited it at the coast and on the adjacent continental shelf.⁶

The coastal plain north of the Thukela is made up almost entirely of Quaternary sediments (mainly sand) deposited as beaches and coastal dunes (some of the highest in the world) during these periods of rising and falling sea level. South of the Thukela River, these sediments are less obvious because of the steep rocky basement, which left little space for sediment accumulation. Nevertheless, localised accumulations do occur, such as on the Durban Bluff, the remnants of Pleistocene dunes at Umgababa, and Port Edward's red desert. These Quaternary sediments are typically still loose sand and pebbles, but in a few places they have been transformed into rocks. The occasional headlands on the Zululand coast (e.g. Black Rock, Jesser Point) are made of cemented dunes or aeolianite and occasional outcrops of cemented former beaches and dunes can be seen at Isipingo and Reunion.⁷

Holocene

In general, sea level has been rising during the latter part of the Pleistocene and early Holocene periods (i.e. the past 17 000 years); however, the rate of rise has varied and has even been punctuated by some sea level drops. Overall, sea level in KZN has risen by 130 m^{8;9} since the close of the last ice age. The sea reached its present level about 7 000 years ago.⁹ Since then, it has been more-or-less stable, having fluctuated within two to three metres of its present position.⁹

There is good evidence of these slightly higher sea levels around Kosi Bay and St. Lucia, where former shorelines are

exposed just above the present sea level. Submerged beach and dune deposits on the seabed are evidence of Quaternary sea levels that were lower than present, for example at Aliwal Shoal¹⁰ and Sodwana Bay.¹¹

One of the results of sea level rise during the Holocene period was the truncation of KZN river drainage basins. Many of the tributaries were removed from their trunk streams (streams into which tributaries flow) and gave rise to a plethora of very short streams, particularly south of the Thukela River. This accounts for the large number of estuaries on this stretch of coast.

The geology controls the geomorphology of the KZN coast, which in turn reflects changes in the functioning of the coast, and provides valuable insight for future management of the coast. ■

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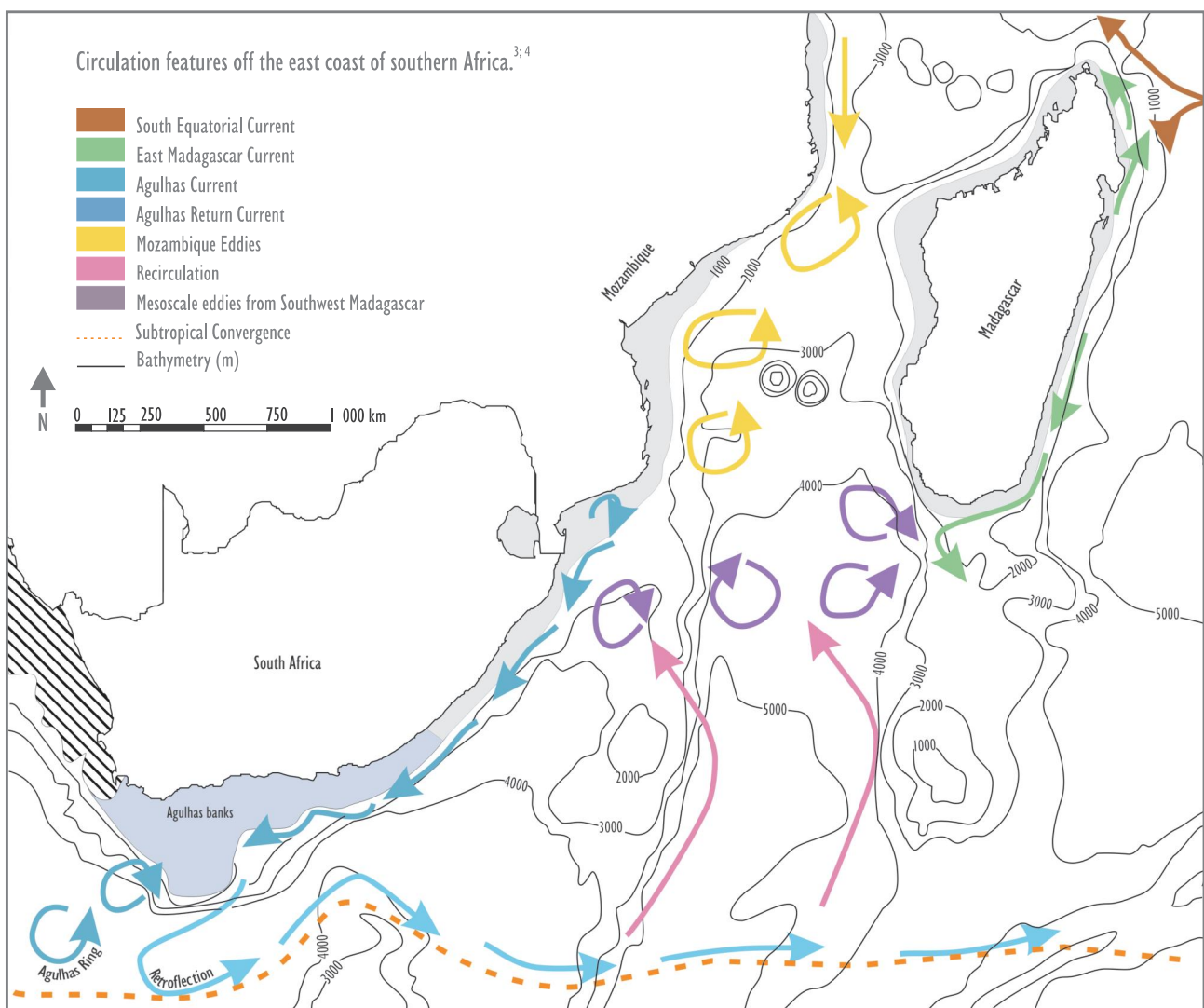
2.3 Physical Oceanography

KZN has a relatively straight, northeast trending coastline, divided into gentle bays by short, low headlands or rocky outcrops. The coast is bathed by the warm waters of the Indian Ocean, with the strong Agulhas Current flowing in a south-westerly direction, transporting warm water polewards.

Bathymetry

The east coast continental shelf of South Africa is generally steep and narrow (6-12 km), and is relatively straight, apart

from a section referred to as the KZN Bight, which extends from approximately St. Lucia in the north to Durban in the south. In this region there is an indentation in the coastline and the continental shelf widens to almost 40 km at its greatest extent, off the Thukela River. The shelf-break is approximately at a depth of 100 m off Durban and 90 m off Richards Bay and has a relatively steep gradient of up to 8°. Submarine features offshore include: the canyons off the Maputaland coast in the north (where the "fossil" fish, the coelacanth has been observed (*Section 4.5*); the depocentre of the Tugela Cone, formed by terrigenous sediments deposited by the Thukela River;² the Tugela Canyon off the shelf south-east of the Thukela River; the shallow Aliwal Shoal,



shelf south-east of the Thukela River; the shallow Aliwal Shoal, which rises from a depth of 30 m to just 6 m below the sea surface, some 4 km off Green Point;⁵ and the Protea Banks, which rise 15–25 m above the sea floor, some 8 km south of Port Shepstone. This bathymetry is an important controlling mechanism with regard to the path and features of the Agulhas Current.

Origin of the Agulhas Current and water properties

The source of the Agulhas Current is complex.³ However, evidence suggests that the current forms off the northern KZN/southern Mozambique coast, from the confluence of waters that follow complex trajectories south of Madagascar and in the Mozambique Channel.^{4; 6; 7; 8} Mesoscale anticyclonic eddies move southward down the Mozambique Channel and a series of mesoscale dipole (paired cyclonic and anticyclonic) eddies, generated south-west of Madagascar, move westward to contribute to the flow, combined with recirculation from the Agulhas Return Current and the South-West Indian Ocean sub-gyre.⁹ The waters coalesce to form a strong western boundary current off the east coast of South Africa. The section of the Agulhas Current along the KZN coast falls within what is termed the northern Agulhas Current, which extends from approximately 27°S (Kosi Bay) to 34°S (Port Elizabeth). South-west of Port Elizabeth the current behaves quite differently, owing to the controlling feature of the Agulhas Bank and the current here is termed the southern Agulhas Current.

Temperature and salinity characteristics indicate that the surface and shelf waters off the KZN east coast generally have a tropical to sub-tropical origin.¹⁰ Salinity within the Agulhas Current is relatively high, usually greater than 35.5 parts per thousand (‰); however this can decrease to around 35.0‰ in summer, as a result of fresh water input following summer rains. Lower salinities are recorded on the shelf off the major river mouths, e.g. the Thukela, Mkomazi, Mzimkulu and Mfolozi Rivers, particularly during summer, with a minimum of 33.3‰ being recorded off the Thukela River in January 2010. However, even lower values are possible in the surf zone after any period when there has been significant rainfall, with a salinity of 30‰ 1 km off the Mkomazi River and a minimum of 20‰ 500 m from the river mouth having previously been recorded.¹¹

Surface temperatures of the Agulhas Current are warm, varying seasonally from 22–28°C,¹² with temperatures decreasing southwards along its trajectory. There is no

apparent seasonal temperature variation at depth.¹⁰ Inshore water is generally cooler than offshore; the core of the Agulhas Current is evident by the warmer water and higher salinity concentrations some 40–60 km from the coast. There is a regular decrease in vertical temperature with increasing depth and waters are usually well mixed; there is no pronounced thermocline i.e. a narrow layer of water that marks a sudden decrease in temperature with depth. At depths of approximately 300–800 m, water of South Indian Central Ocean origin is found. Occasionally this central water is upwelled onto the shelf, resulting in cooler temperatures.¹⁰

The Agulhas Current waters are described as oligotrophic, i.e. low in nutrients but often high in dissolved oxygen. This means that the open ocean waters do not sustain an abundance of marine life. However, various upwelling mechanisms are capable of bringing cooler, nutrient-rich water from depth onto the shelf, which is important for sustaining marine life. Topographically induced upwelling¹³ caused by the Agulhas Current shearing from the shelf edge between St. Lucia and Richards Bay brings this nutrient-rich water from greater depths onto the shelf by a process known as Ekman veering. The St Lucia upwelling cell results in cooler water (18–19°C) and increased chlorophyll-a phytoplankton concentrations inshore, and is an important source of nutrients and primary productivity for the KZN Bight.¹⁴ A small, semi-permanent cyclonic eddy caused by the Agulhas Current leaving the shelf edge at the southern end of the KZN Bight, south of Durban¹⁵ is also responsible for the advection of colder water from depth, resulting in a localised increase in nutrients and primary productivity.

Current speeds, direction and volume transport

The Agulhas Current is regarded as the strongest western boundary current in the world.^{4; 16; 17} The current is generally 70–100 km wide¹⁸ and extends to a depth of approximately 1 500 m.¹⁹ The current flow is controlled by the bathymetry and the core of the current flows along the shelf-break; this results in relatively stable flow.^{16; 20} The Agulhas Current transports some 70 million tons of warm water per second^{21; 22} south-westward, along the east coast of South Africa, with current speeds in the current core attaining 2 m.s⁻¹. Even faster speeds of up to 2.5 m.s⁻¹ (approximately 5 knots) are attained south of KZN, off the Transkei coast. The current is intense and narrow and has sometimes been described as a “river” in the ocean. It is characterised by strong velocity gradients and a central warm core where the temperatures are highest and



current speeds are fastest. The core is generally just offshore of the shelf break. There is no distinct seasonal variation in the volume flow or current speed,^{16;23} and day-to-day variability is probably greater than any seasonal variability.^{15;23} Temperature variations are also greater over the day-to-day than seasonal period, with nearshore current reversals (mainly associated with meanders and eddies) and upwelling events being the main contributing factor to these shorter term variations.

A series of Acoustic Doppler Current Profiler (ADCP) current metre moorings, deployed for a period of 18 months on the KZN Bight as part of the ACEP II research programme, has provided improved insight into the currents off the KZN coast. An ADCP mooring deployed offshore, in the core of the Agulhas Current as it passes Durban shows predominantly south to south-westward flow, with the highest frequency of currents flowing to the south-south-west, at a rate ranging between 76–114 cm.s⁻¹. Currents flowed south to south-westward 77% of the time. The highest current speed measured was 185 cm.s⁻¹, flowing to the south-west. The occasional shifts to other directions were associated with low current speeds and were usually due to a Natal Pulse, which typically results in weak currents off Durban, as the core of the Agulhas Current is deflected further offshore. By contrast, a second current meter deployed inshore showed currents that flowed predominantly in a northerly to easterly direction for some 53% of the time, mostly at speeds of between 14–70 cm.s⁻¹. Current speeds were generally lower than at the offshore location in the Agulhas Current, although some high speeds were recorded; e.g. a maximum current speed of 135 cm.s⁻¹ was measured flowing to the north-east. The nearshore north-eastward current, counter to the predominantly south-westward flow of the Agulhas Current offshore, is related mainly to the presence of the semi-permanent Durban Eddy.

Variability in the Agulhas Current: the Natal Pulse and Durban Eddy

While the flow of the Agulhas Current is known to be fairly stable,^{4;16} there are occasional, irregular perturbations that can alter the flow. Anticyclonic eddies offshore and upstream of the Agulhas Current can initiate a meander when they interact with the mean flow of the current,²⁴ forming what is locally known as the Natal Pulse. The KZN Bight appears to be a key region for the development and growth of these instabilities.²⁵ The meander is evident throughout the water column and grows in amplitude as it passes south of the KZN Bight,

sometimes reaching 200 km offshore, off East London. Using satellite altimetry data, it has been calculated that, on average, 1.6 Natal Pulses per year reach as far south as Port Elizabeth.²⁵ However, previous estimates have put the number at 4–6 per year.^{4;26} The Natal Pulse migrates south-westward down the coast at a speed of approximately 10–20 km.day⁻¹, although propagation speeds of 23 km.day⁻¹ have been reported,²⁷ and with a lifespan of some 50–70 days.²⁵ The resultant cyclonic vorticity and cold core that develops, facilitates enhanced primary production and may be important for the retention of eggs and larvae and concentration of plankton (food).²⁷

Semi-permanent cyclonic (clockwise) eddies develop on the inshore region of the southward-flowing Agulhas Current, especially in the lee of large coastal offsets along the coastline.^{16;28} One such eddy is the Durban Eddy, a semi-permanent cyclonic eddy circulation that exists off the south coast of KZN in the lee of the southern end of the KZN Bight, between Durban in the north and Sezela in the south. The Durban Eddy is a mesoscale feature with a size range of approximately 40–50 km wide and 60–90 km long. The eddy is caused by the strong Agulhas Current moving offshore of the regressing shelf edge, south of Durban.¹⁵ The clockwise rotation of the eddy causes north-eastward flowing currents to occur near the coast, opposite to the main south-westward Agulhas Current flow further offshore. The occurrence of counter currents off Durban and the south coast of KZN is well known and has been exploited by mariners for centuries. Off Durban, a northward movement of mobile submarine dune fields has suggested a more dominant north-east trending counter-current at depth, and the persistence of the lee eddy in this region.¹⁴ Examination of 18 months of current meter records and satellite imagery indicates that the eddy occurs approximately 55% of the time and is a major contributing factor to the frequent current reversals inshore, landward of the core of the Agulhas Current. The spread of data at the inshore mooring shows the predominantly north-eastward flow associated with the eddy, but with a secondary peak in the south to south-westerly direction occurring between eddy events. The Durban Eddy is highly variable in occurrence, strength and downstream propagation speeds.¹⁵ The average lifespan is 8.6 days, with a range of 3–19 days, and an average time between eddy events of 7.7 days.²⁹

Whereas the Natal Pulse gains momentum and grows in amplitude offshore as it migrates southwards along the coast with the Agulhas Current, the Durban Eddy flattens against the coast and dissipates as it detaches from the Durban area and migrates southwards.¹⁵ Only 41% of Durban Eddies were

evident passing through Sezela, and the percentage of breakaway eddies evident downstream decreases further south. Upwelling along the shelf and in the cyclonically rotating Natal Pulse and eddies facilitates the upward transport of nutrients and primary production, as evidenced by higher values of chlorophyll *a*. Thus these systems play an important role in the ecosystem functioning of the KZN shelf and in the Agulhas Current waters downstream. In addition, it has recently been found that the total suspended solids washed into the sea from the Thukela River are a very important source of organic matter. This nutrient input controls the food web structure and production of the benthic communities of the KZN Bight, stretching from the shallow Thukela Bank to the deep sea floor.³⁰

Tides

The KZN coastline is subjected to semi-diurnal tides, meaning that there are two high tides and two low tides per day. Tidal levels are measured with reference to a mean level called the chart datum (CD), which is based on the level of the lowest astronomical tide (LAT). The LAT is the lowest level that can be predicted to occur under average conditions in a 19 year cycle, at a given location. Along the KZN coast, the tidal range generally varies from 0.8 m during neap tides to 1.8 m during spring tides, with the highest astronomical tide (HAT) of 2.3 m (in relation to the CD) for Durban. The tidal range is generally larger during equinoxes than during solstice periods.

Wave regime and littoral drift

The KZN coastline is dynamic and subject to large swells, particularly in autumn and winter. Based on a combined CSIR/Transnet waverider buoy dataset for Richards Bay and Durban for the 18-year period from 1992-2009, the average significant wave height (Hs) for Durban is 1.65 m, with an average swell direction of 130°. ³¹ Swells from the south-south-east (SSE) dominate the spectrum, particularly in autumn, winter and spring. The SSE swells are generally long period swells generated by cold fronts (refer to *Section 2.1*) that form in mid-latitudes and propagate from west to east, accompanied by intensified winds from the south-west. These systems are generally stronger in the winter months. Although many of the cold fronts are deflected southwards of the KZN coast by a strengthened interior high pressure system (anticyclone) during winter, the swells associated with these systems nevertheless propagate up the coast. While the open

ocean swells generated by the frontal systems are originally from the south to southwest, they are refracted as they approach and cross the continental shelf to become SSE to south-easterly. The prevailing SSE swells result in a predominantly south-to-north net littoral drift along the coast. The swell pattern changes to an increased easterly component in summer; these are generally shorter period easterly swells associated with the South Indian Ocean Anticyclone and an increased frequency of north-easterly winds (see *Section 2.1*). The cold fronts are usually weaker during this time, meaning that swells associated with these systems have less of an influence. The easterly swells can cause a temporary reversal in littoral drift from north-to-south.³²

There are two additional weather systems that may cause extreme wave events along the KZN coast, sometimes with disastrous consequences (see *Section 2.1*), viz. tropical cyclones and cut-off low pressure systems. Tropical cyclones occur over the tropical South West Indian Ocean, mainly during the austral summer to autumn, with peaks in occurrence during January to March.³³ Although these systems seldom reach the KZN coast, the associated east to east-south-east, long period swells can realise great heights, e.g. Tropical Cyclone Imboa (1984), where an extreme swell height of Hs 9 m was attained off Richards Bay.³⁴

Cut-off low pressure systems can occur at any time of year, but are generally more prevalent during March to November³⁵ and when these systems are confined to being over the ocean and their eastward passage is blocked by a dominant South Indian Ocean Anticyclone,³⁴ significant swells can be generated, e.g. 21 March 2007 where an Hs of 8.5 m and Hs maximum of 12.4 m³¹ was generated off Richards Bay. Large (extreme) wave events most frequently occur during autumn off the KZN coast³¹ and these are associated mainly with tropical cyclones and cut-off low pressure systems. The effects are exacerbated when they coincide with spring and/or equinoctial tides, storm surge and low atmospheric pressure.

The Agulhas Current flows offshore parallel to the KZN coast, transporting warm water from tropical and sub-tropical regions south-westward. However, circulation over the inshore continental shelf areas is more variable, characterised by occasional meanders in the current, eddies and counter currents. Knowledge of the current circulation is important for shipping, fishing, siting of offshore infrastructure and pollution dissipation. ■

