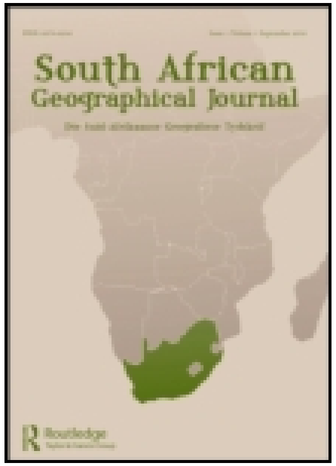


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# A STUDY OF MAPUTALAND BEACH DYNAMICS

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# A Study of Maputaland Beach Dynamics

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## ABSTRACT

The northeast coast of South Africa is a high energy, microtidal environment with a northward longshore drift and sandy beaches backed by high forested dunes. Dune morphology is influenced by longshore currents and winds and repeated transgressions and fluvial deposits. The availability and grain size distribution of sediment has a direct effect on beach and dune morphology. Analysis of grain size distributions and beach profiles provides information related to the processes that lead to the present coastal morphology and management thereof. Coarser sediment accumulates on the south side of headlands due to wave induced transport and strong southerly winds. At Mabibi, on the more sheltered north side of a headland, small grain sizes occur and the beach profile over a four year period has undergone recession that may be both seasonal, due to differences in wave energy, and long term, due to rising sea level. Through understanding coastal processes, insight can be gained as to how coastlines will respond to human impacts and environmental trends.




## Background

Sandy beaches backed by elevated dunes are a prominent feature of the Maputaland coastline. The movement of sediment at the coast by waves and wind are the major forces that create these landforms. Sediment available for reworking into coastal landforms is derived from previous transgressions, regressions and fluvial deposits. In the Maputaland region of southeastern Africa (Figure 1), variations in sea level through a number of ice age periods left an inland lake / wetland system which developed in the deeply incised river valleys behind a dune line of more recent sands. Due to most of the smaller rivers draining into these lakes or estuaries, the main source of riverine sediment is derived from the Umfolozi river just south of St. Lucia. The Agulhas Current flows southward a few kilometers offshore. It brings warm salty water creating a deep blue colour and conditions suitable for the growth of coral reefs and presence of tropical fish (see marine ecological tables in the appendix). Mean air temperatures are 20°C in winter and 27°C in summer, while sea temperatures average 25°C and help maintain the most southerly coral reefs in the world. Sea temperatures have increased nearly 1°C in the past 100 years. Surface winds are NNE-SSW and parallel to the coastline. These winds are driven by the offshore weather systems advancing toward the east. Strong NNE winds may be followed by even stronger SSW-ers and a brief spell of rain (Orme, 1973. Tinley, 1985).

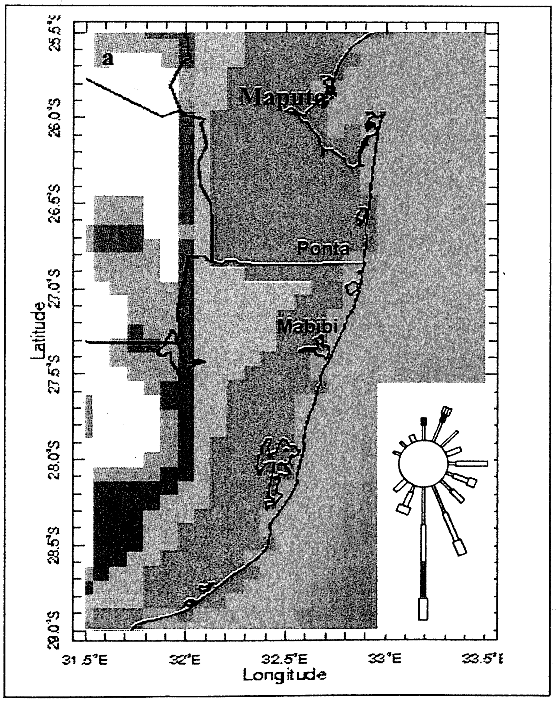
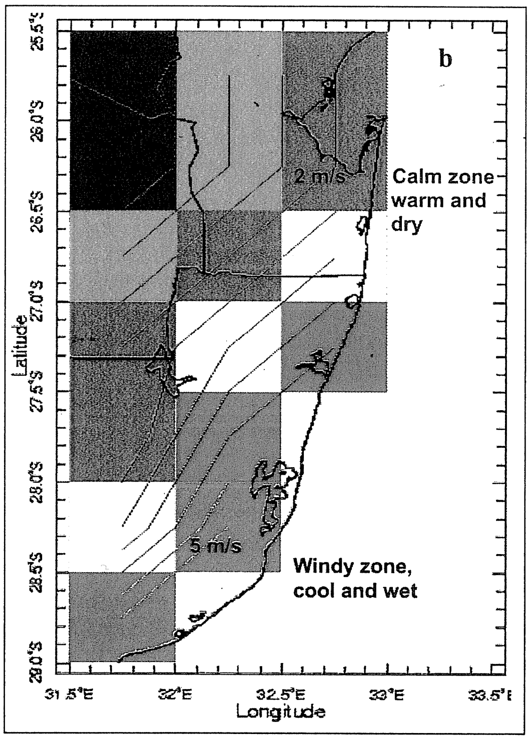
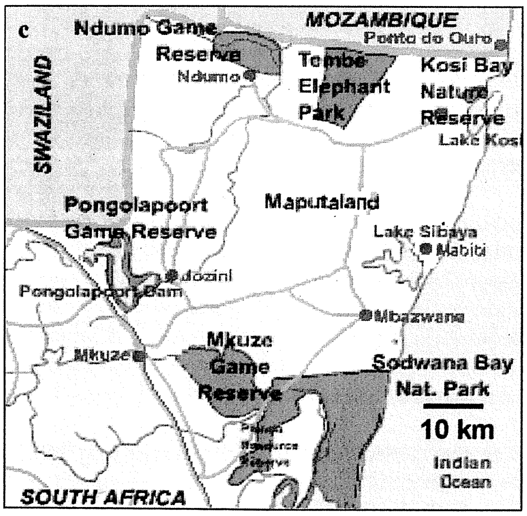



Figure 1: Topographic map of the Maputaland area (a) with swell direction and height rose inset. Mean wind speed during summer (b). (c) is a map of tourist nodes, nature reserves and road infrastructure in the study area. Blue (sea level) to brown (700 m) shading in (a) is at 100 m intervals, wind speed shading in (b) is from red (highest) to blue (lowest) with contours at 0.5 m s$^{-1}$ intervals that align with the coast.



The Maputaland coast in the area 26-29°S, 32-33°E, has a tidal range of ~ 1.8 m. The influence of tides along the open coast is relatively small compared to the energy generated by wind and swell-driven currents. The longshore movement of sediment by waves and nearshore currents are major forces affecting the coast. The average swell direction is from SE according to ship and lighthouse estimates (inset in Figure 1). This direction is oblique to the coast and is refracted by > 20°. The nearshore circulation is influenced by the direction of wave approach, and to a lesser extent the bottom profile, wave height and period. Longshore sand bars, 100 m offshore, are common and dissipate the wave energy. These bars create two breaker zones and are linked with rip currents that extend up to 300 m offshore. Wave data for the region testify to the high energy environment and potential sediment flux (Orme, 1973).

The coastal zone is where a large percentage of South Africa's population, growth and development are located. The coastal zone is constantly changing and cannot maintain static forms. Coastal sand dunes cover > 90% of the Maputaland coast and reach a height of 100 m. The understanding of this dynamic system is essential for effective coastal management, given increased development pressures and rising sea level.

Our beach studies focus on three locations within the Greater St Lucia World Heritage Site and Lubombo Transfrontier Conservation Area:

- Hully Point at Mabibi - a rocky headland on an extended section of dune-lined coast.
- Kosi Bay - a series of segmented lakes ending with an estuary with little human impact; and
- Ponta do Ouro just over the border in Mozambique - a prominent headland that diverts the longshore drift, with dunes of low elevation.

The objectives of this research include:

- An analysis of longshore and cross-shore variations in the coastal dunes,
- Development of a sediment budget that 'fits' theory and observations, and
- A discussion our findings as related to site-specific coastal development needs.

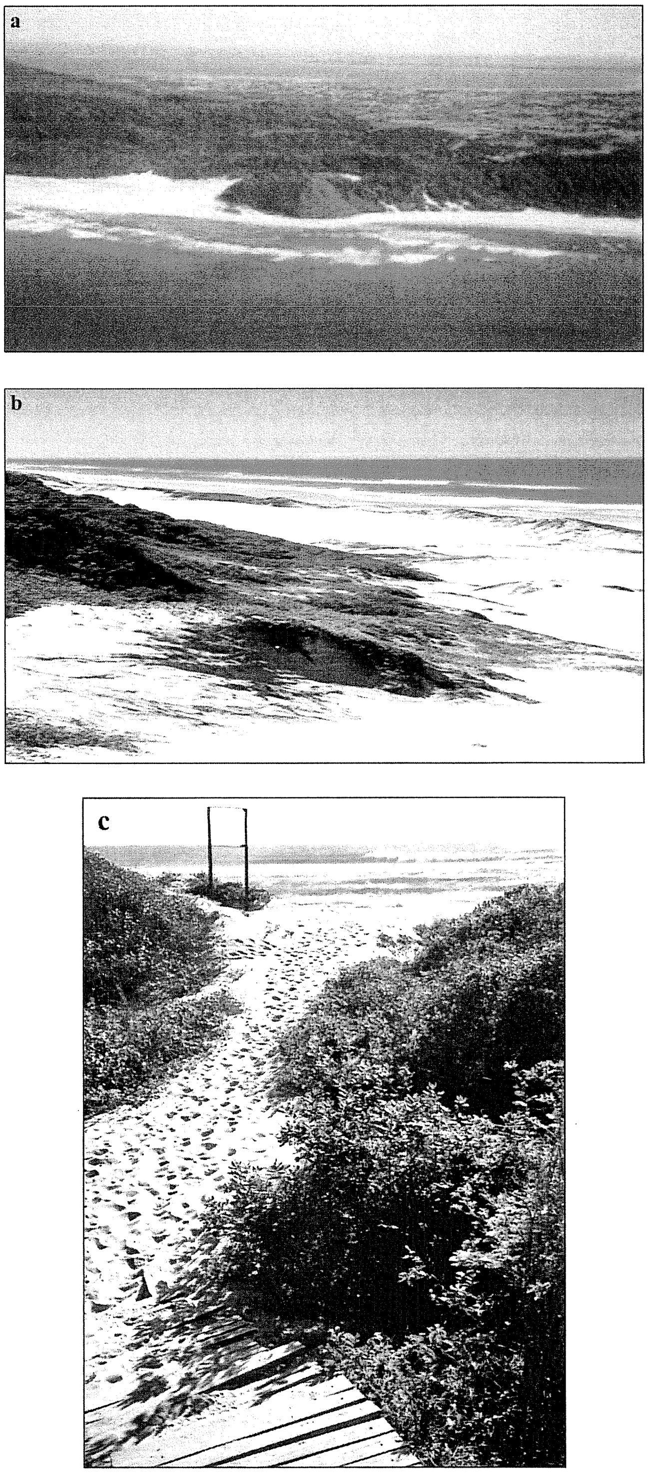
## Methods

Past and present aerial photographs of the Maputaland coast were used to identify the major landforms and coastal geomorphology. On-site reconnaissance was used to identify geographical features, coastal morphology and potential transect sites. Beach profiles were surveyed with a theodolite and staff, using geodetic references. At minor transects a tape and clinometer was used for its portability. This involves measuring the angle and distance to each change in slope, repeating while moving inland until thick vegetation is reached. Surveys were conducted on the north and south sides of headlands at low tide and photographs were taken. Cross sections were plotted to enable beach and foredune sand gradients to be analysed. Directly North and South of Hulley, point transects 2a,b and c were surveyed on a continuous basis once or twice per annum to determine profile variations through time.

Sand samples were collected at both low tide in the surf zone and at the top of the foredune at each transect. All samples were taken on the beach and dune surface reflecting recently deposited or exposed materials. Samples were also taken in the slack between dunes in some instances and other potentially significant locations. Each sample of ~ 200 g was dated and stored with GPS coordinates.

Littoral zone currents were monitored using a drifting drogue that was launched in the surf and tracked at one minute intervals using two theodolites placed 200 m apart on the foredunes.

Figure 2: Mabibi beach from an aerial perspective (a), on-site near transect 2 (b), and near transect 2a (c). Main footpath from campsite ends near the sand profile of Fig 7.



The successive position of the ocean drifter was plotted to show the path taken by the drogue for each run. One-minute vector displacements were analysed to determine the speed and direction of the carrying current. The drifter tracking was repeated on a number of occasions to yield a frequency histogram of speed and direction.

A number of field surveys were conducted to gain an understanding of the morphology of coastal landforms, related vegetation communities and the processes that form them. One of the foci of this work is the blowouts occurring as breaks in the dune vegetation allowing wind to deposit tongues of sediment inland. The blowouts were excavated to determine the depth of dry sand and the extent of capillary action into the dunes.

Representative sand samples along selected cross-sections were dried and sieved at ranges from 1700 µm to 75 m (1.7-0.75 mm). The grainsize distribution was plotted to analyse the degree of sorting. Further analysis was done to determine the proportion of heavy minerals. Most samples underwent a full chemical analysis testing for P, Ca, K, Mg, acidity, total cations, acid saturation, pH, Zn and density. Results are reported in Table 1.

Hully Point extends ~ 200 m from the coast and is a prominent feature in the Mabibi area as seen in our photographic surveys (Figure. 2). Dunes in the Mabibi area are aligned roughly north - south, with little pattern evident. Large sheets of sand encroach onto the dune forest. Some of the highest dunes and blowouts on the Maputaland coast occur in this area. Blowouts are orientated in a northerly direction, with one almost cutting off Hully Point. Large blowouts were found to have been re-vegetated by inspection of aerial trig-survey ortho-photos made in 1938, 1958, 1978 and 1998.

The Maputaland dune system is segmented, with different landforms of different ages superimposed upon one another. The coastal barrier is relatively narrow with a decreased width translated to an increase in height. Dunes are steep and display conical peaks. Ponta do Ouro provides relatively sheltered conditions from prevailing SW winds and swells on its northern, leeward side. For the remainder, the coast is relatively exposed and the dunes average around 100 m.

## Results

*Microscale analysis*

The low tide sand samples at Mabibi had a wide grainsize distribution and could be considered 'unsorted', while dune samples were better sorted with peaks at 250 µm and 355 µm. The well sorted samples with peaks at 250 µm were all taken at the top of the dune or blowout. There is a zone of coarser sediment accumulation ~ 700 m north of the point where the wave-transported material finds its way back to the coast, after an offshore excursion. It contributes to the formation of foredunes. South of Hully point the two dune top samples are well sorted and exhibit a small peak at 250 µm (Figure 3). Dune height increases northwards of Hully Point. Higher dunes in this area often have large deflated areas of sparsely vegetated dunes between their base and foredunes.

Samples taken at Kosi Bay reveal similarities in grain size suggesting a continuity of longshore movement of material that is little affected by Kosi mouth. The sediment found inland on the side of Kosi Lake displays the same peaks as the beaches, although less sorted. The continuity of sediment characteristics North and South of Kosi suggests that the Northward drift is

Figure 3: Transect locations over an aerial ortho-photo of the Mabibi coast (a). Lower panels (b, c) are sand grain size distributions up and downstream of the headland.

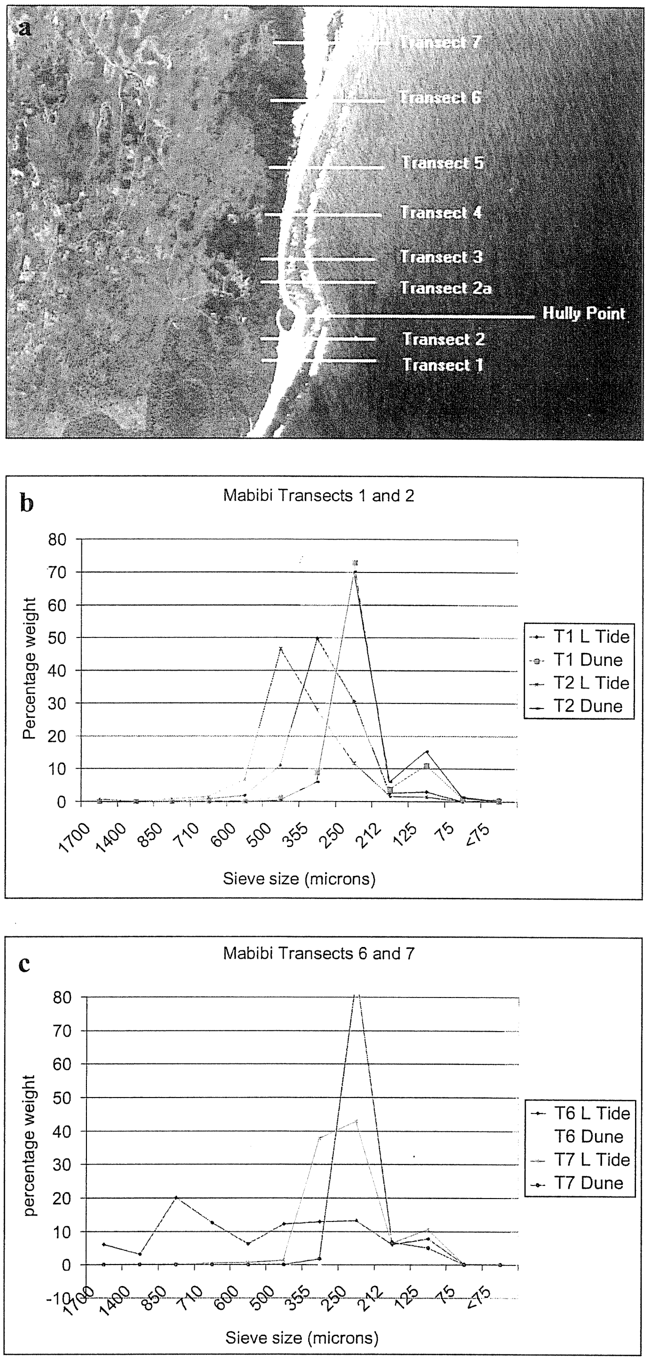



Table 1: Analysis of soil / sand samples from various Maputaland locations

| | Richards Bay T3 L Tide | Mabibi T3 Dune | Mabibi T3 L Tide | Kosi Lake A | Kosi Lake B | Kosi Lake D (s-forest) | Kosi South T3 Dune | Kosi South T3 L Tide |
|---|---|---|---|---|---|---|---|---|
| Vegetation? | N | Y | N | Y | N | Y | Y | N |
| Density g/ml | 1.49 | 1.46 | 1.28 | 1.48 | 1.52 | 0.86 | 1.41 | 1.31 |
| P | 4 | 2 | 3 | 9 | 4 | 7 | 8 | 5 |
| K | 135 | 0 | 65 | 0 | 1555 | 2450 | 0 | 110 |
| Ca | 80 | 115 | 5915 | 20 | 15 | 500 | 115 | 75 |
| Mg | 205 | 120 | 1460 | 90 | 100 | 615 | 100 | 280 |
| Acidity | 0.00 | 0.00 | 0.36 | 0.00 | 0.99 | 0.80 | 0.00 | 0.00 |
| Total Cations | 2.43 | 1.56 | 42.06 | 0.84 | 5.86 | 14.62 | 1.40 | 2.96 |
| Acid Saturation | 0 | 0 | 1 | 0 | 17 | 5 | 0 | 0 |
| pH | 9.29 | 9.48 | 5.04 | 9.36 | 4.40 | 4.53 | 9.08 | 9.23 |
| Zn | 0 | 1 | 2 | 2 | 1 | 6 | 1 | 1 |

not strongly affected by the mouth. The fact that low tide samples are better sorted than dune samples probably reflects the distance from a major sediment source in this section of the coast. This also reflects the relatively low output of the Kosi estuary, in part due to the low tidal range and wetland buffer zones that absorb surface runoff. The high degree of sorting in the swash zone also indicates the local importance of aeolian transport which is slowly eroding the beach south of Kosi. Evidence for this includes the midden now exposed in the foredunes and the steep dunes that rise rapidly from the high water mark.

There were surprising similarities in the grain size of samples from areas in different geomorphological environments within the Kosi Lakes system. What initially looked like humus in the swamp forest sample, when dried was found to be largely a mixture of organic material (Table 1) and sand exhibiting the same grain size distributions as those found on the beach and barrier dunes. The sand sample taken from a water pan had a rich brown colour, yet also had similar grain size as found on the beach.

A sample was taken of the rich dark humus in the swamp forest (Figure 4). The 125 μm peak in the swamp forest sample may be partly due to the relatively high, large leafed swamp forest trees. High trees with large leaves have greater sediment capturing ability. These particles > 90 μm can be wind-borne, with deposition taking place where sufficient turbulence and interruption of wind flow is experienced. The fine material is reworked silt carried in suspension by the streams that feed the

Figure 4: Kosi Lake swamp forest

Figure 5: Aerial views of Ponta do Ouro: downward looking orthophoto (a) and side view from aircraft (b).



lake.

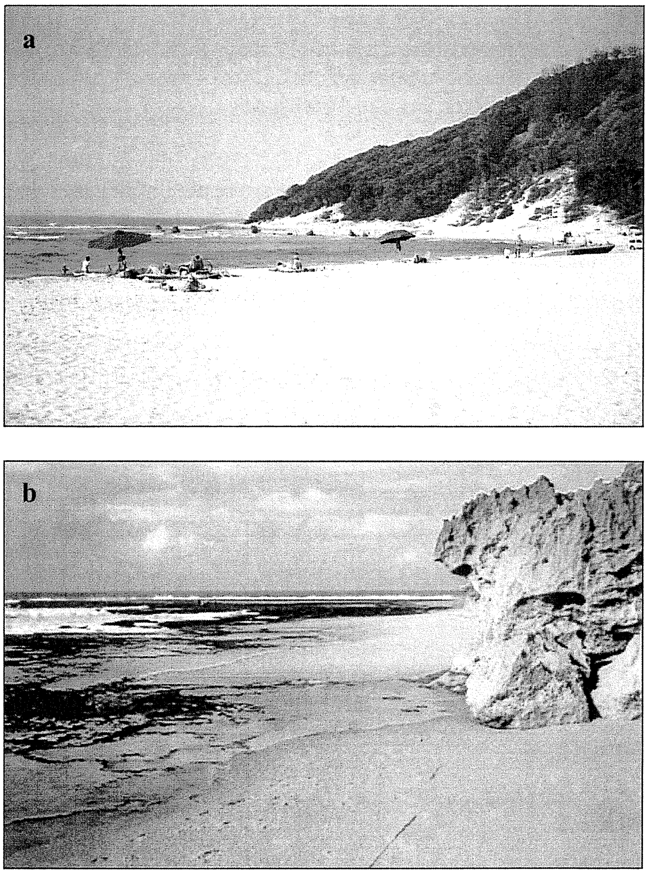
*Macroscale analysis*

Repeated marine transgressions and regressions have exposed coastal areas to aeolian processes, and reworked and homogenised the sediment of the Maputaland coast. Superimposed fluvial derived sediment provides the exception to the homogeneity, with contrasting material reflecting a past fluvial bedload.

Longshore wave-induced northward drift is pronounced around Ponta do Ouro headland (Figures 5 and 6). There is a picturesque bay that extends ~ 300 m north of the point that is sheltered from the prevailing SE waves and wind. A sand bar extends from the point in a NW direction, providing an offshore conveyer belt by which the longshore drift process can continue. After leaving the point, sediment follows this path to rejoin the beach > 1 km downstream and continue northwards. North of Ponta, low tide samples decrease in average grain size, and remain poorly sorted.

Dune samples on the south side of Ponta do Ouro were an order of magnitude coarser than on the north side and poorly sorted. Modest peaks appear at 850 and 500 um and are < 30% by weight. The wide seaward excursion of the current around the Ponta headland seems to have limited its affect on beach – dune coupling on the north side.

Figure 6: The bay (a), headland and reef (b) at Ponta do Ouro.



*Dune dynamics*

Dune development is most significant on flat, dissipative foreshores where large volumes of sand of suitable grain size are exposed at low tide. Foredunes are usually poorly developed on reflective beaches where the beach face is steep and the area of sediment exposed at low tide is minimal. The width of beach affects its dune building capability (Carter 1988) as do wind, temperature, solar radiation and slope (Psuty, 1992). An abundance of non-uniform sediment on the beach indicates that material is available for transport by the wind. In the high energy environment of South Africa, larger grains are set in motion (according to the cube of the wind speed,) that impact smaller grains with the potential of building dunes. Dunes tend to exhibit smaller grain sizes and better sorting when compared to adjacent beach samples.

The Maputaland coast displays one of the largest sequences of coastal dunes in the world, with wave (and wind) energy more important than tidal range. Sand transported from the compacted windward slope to the cascading leeward slope results in dune migration (Pethick, 1984), more so for dry sun-facing slopes. Strong winds in the dry seasons induce the period of greatest aeolian transport, locally in spring – August to November. Wind often removes the fines in aeolian suspension, leaving behind coarser, better sorted material that forms into dunes.

The interaction between wind and vegetation is essential for coastal dune growth. Woody stems and leaves provide an open flexible obstacle to wind driven sand. The drop in wind velocity around the vegetation canopy, combined with the dune shape, results in a convergence of flow and a deposition of sand. Burial by sand stimulates further plant growth up through the deposited sand and in this way the Maputaland dunes grow to elevations exceeding 100 m. The pioneer plant *Scaevola thunbergii* initiates this process.

Vegetation of the Maputaland coastal zone is rich in biodiversity (Govender, 2001) with little human disturbance. Large quantities of moisture and nutrient-rich sea spray are carried a short distance onshore by prevailing winds and encourage a year-round sub-tropical microclimate (Tinley, 1985, Govender, 2001). A few of the coastal headlands have had their indigenous vegetation supplemented with exotic *Casuarina*. Exotic vegetation alters the environment to favour some species at the expense of others.

Limited vegetation and poorly sorted grain sizes enhance the airborne movement of sediment (Paton *et al.*1995). Blowouts, gaps in plant cover breached by wind, are cumulative in nature. Once breaching occurs, plants that are less salt tolerant are smothered in the advancement, paving the way for further blowouts. Blowouts can be initiated by footpaths inappropriate siting of access roads onto beaches or the clearing or disturbance of dune forests. The axes of blowouts in Maputaland align with the southerly winds (Tinley, 1985) produced during stormy frontal weather. Around and north of Mabibi, the size and frequency of blowouts increases. Many blowouts there appear steep, compacted and damp. This may be due to hydraulic pressure from Lake Sibaya that lies ~ 20 m above sea level a short distance inland. Water flow is directed seawards beneath the dunes.

There are no major offshore reefs to cause the refraction and dissipation of wave energy north of Hully Point. The result is the formation of back-beach berms and cliffed foredunes. Coarsest beach material consists of gravel, shells and coral fragments, concentrated in nodes intermittently along the beach. The beach on the north side of the headland is gradually retreating according to profiles analysed in Figure 7.

Further evidence for retreat includes sandstone concretions exposed on the dune faces at Hully Point, a larger area of reef exposed in recent surveys, cliffed foredunes and large pieces of exposed beach rock. The beach profile varies seasonally from constructional swells in summer to destructional storm waves in winter. The predominantely northward currents along the beach (Figure 8) suggest a through-flow of sediment. South of the headland, the dune face is steepening.

Figure 7: Evolution of the sand profile at Mabibi beach over a four year period. Beach and dunes are on the right and the swash zone is on the left. Numbers indicate years, indicating slight recession.

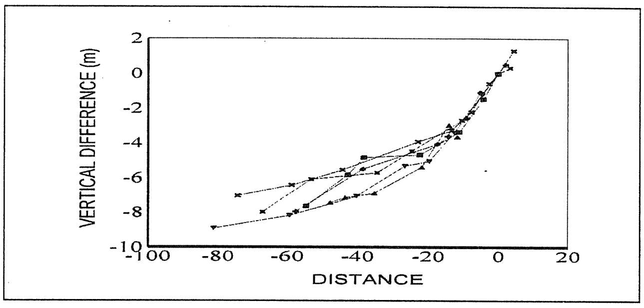
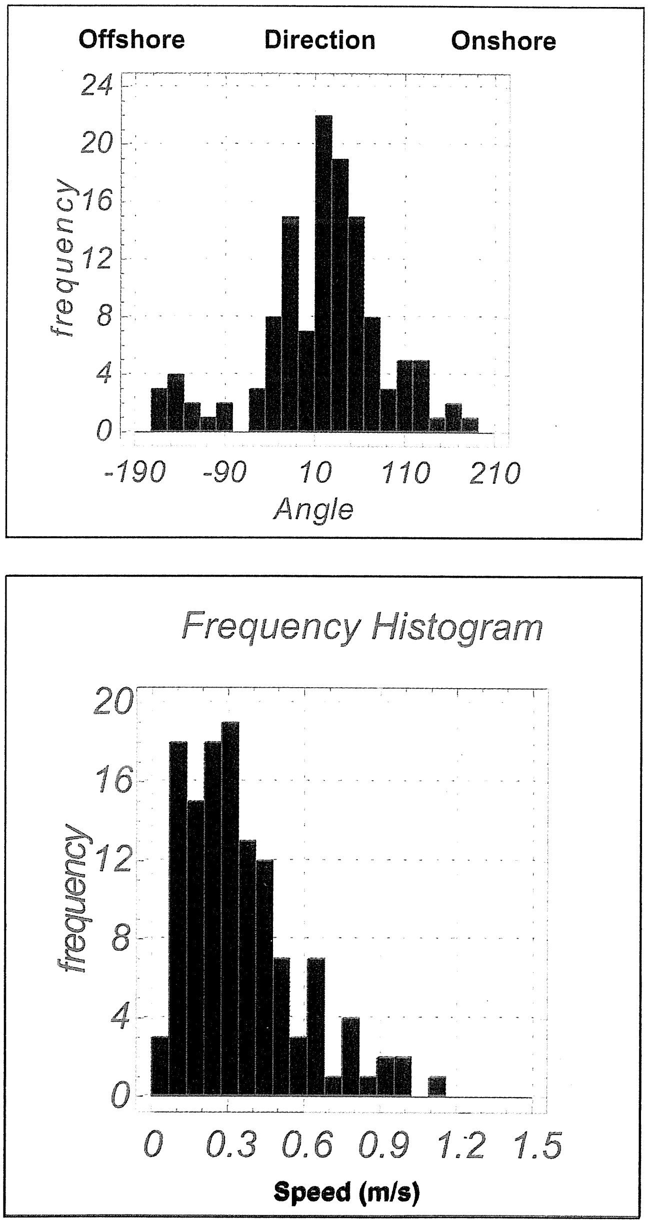



Figure 8: Summary of drifter track results for direction (a) and speed (b). Currents are mainly longshore (eg. angle of 0 to 10) and toward the north.



The dunes south of Ponta do Ouro form large conical peaks that are relatively uncommon. Their increased height and slope corresponds with a diminished foredune. Ecological studies have indicated that biodiversity is closely related to elevation, so the over-topping of vegetation and subsequent dune growth is critical to the coastal biota (Govender, 2001). Continued scientific monitoring will be valuable in devising ways to best utilise an eroding coast where ecotourism development is planned.

*Sediment budget*

Physical environmental parameters that determine coastal transport processes include wave and wind climates, nearshore currents and water levels, storm influences and sediment grain size. These data are available from climatological atlases and project site-specific information. Tidal currents are small along the Maputaland coast and have a minor influence on coastal processes. The tidal range is about 2 m and storm surges are typically 2 m about once a year. At low tide, the longshore wave driven currents shift to the offshore bar (about 100 m seaward), while at high tide longshore currents are less obstructed by headlands and flow strongly near the coast. More than 90% of wave driven sediment transport takes place in 0 - 2 m water depths (Aijaz and Treloar, 2003). There are few rivers in the area, so sediment discharge from heavy rain events is minimal.

The wave climate is an important component of the sediment budget. Data on swell height and direction are taken from SADCO ship data based on a 30 year period. The swell rose (see inset in Figure 1) provides a graphical representation of the climatology. The Maputaland coast receives large swells throughout the year, mainly from the south in the winter and the southeast in the summer. Mean swell conditions vary seasonally; in January: 140° direction, 1.6 m height, 6.5 s period; in July: 170° direction, 1.9 m height, 7.8 s period. The southerly swells of winter are strongly refracted and produce the observed northward nearshore currents, while dissipating their energy. Open ocean wave heights exceed 4 m more than 10% of the time according to CSIR wave-rider statistics from Richards Bay, a short distance to the south. About 1% of the time, storms swells exceed 6 m and take considerable volumes of sediment offshore, more so in winter. The statistics mask the *strongly pulsed* character of longshore drift. At about weekly intervals, storm systems moving up from the Cape bring southerly incoming swells for a period of 2-3 days. Northward currents then reach almost 1 m $s^{-1}$ in the surf zone whereas, during the anticyclonic interval lasting 3-5 days, currents subside.

The mean wave energy flux is calculated as: $\int \boldsymbol{p}[H^2\,T\,\phi] / \boldsymbol{p}[H^2\,T]$; where $\boldsymbol{p}$ is the probability distribution, H is wave height, T is wave period, and $\phi$ is wave direction (relative to the coast). Here the mean period is taken as 7 seconds. The marine wind climatology is available from SADCO ship data. Records indicate that for speeds > 10 m $s^{-1}$ capable of mobilising sand of 0.3 mm grain size: directions from S-SW yield a 12% occurrence, from the N-NE 15%. Observations at Mabibi indicate a persistent northward current > 0.2 m $s^{-1}$ except during strong N-NE winds.

The log-spiral shape of the Mabibi coast is typical of many headlands in South Africa. Sediment transport varies along the log-spiral. The south side of the headland receives greater swell energy and nearshore currents are stronger. Sand often bypasses the 'leeward' recessed beach, where longshore currents remain further offshore. Sand grain sizes (Figure 3) vary from 0.25 to 0.5 mm from swash zone to foredune. Littoral transport is estimated from the Engelund - Fredsoe equation as applied by Aijaz and Treloar (2003). For bed load: $Q_b = \Phi \sqrt{(s-1)\, g\, D^3}$ where $\Phi$ is related to current and wave driven particle movement and viscosity, $s$ is specific gravity of the sediment, and D is median grain size. For suspended load: $Q_s = \int^{D}_{2d} V(z,t)\, C(z,t)\, \partial z$ where z is height above bed, V is mean current, D is water depth, d is particle size and C is concentration of suspended sediments. The main finding from the above analysis is that > $10^5$ $m^3$ / yr is mobilised in the nearshore zone, mostly during winter storms. Hence, a 'river of sand' flows northward in the surf zone along this stretch of coast. On the headland we presume that the continual input of sediment from the south balances the outflow toward the north (the beach profile is stable). However in the bay, a small deficit occurs due to sand bypass. Observations of the Mabibi beach profile (Figure 7) reveal a 'small' loss of ~ 10 $m^3$ / yr. Here, we have not explicitly resolved aeolian transport, nor can we determine whether the losses are seasonal, part of a long-term trend, or due to increased human activity.

## Conclusions and recommendations

Understanding how the coast functions is central to effective management (Glavovic, 2000). Almost all geomorphologists and ecologists would agree that dunes are dynamic systems. On the other hand, many planners, policy makers and the public in general, view dunes as stable or static features. These conflicts can be solved with information on coastal processes - to balance public access with ecological protection in an environment characterized by a strongly pulsed longshore drift of sand (McLachlan and Erasmus, 1983).

South Africa's warm east coast is home to a great diversity of marine and terrestrial organisms. Around 10 million people live within 10 km of the coast from Maputo, Mozambique to Durban, South Africa. There has been a coastward shift in economic activities over the last 30 years. Coastal resources play an ever-increasing role in the economy. The estimated annual value of direct benefits obtained from coastal goods and services is ~R168 billion, amounting to ~35% of South Africa's GDP (in 2000), with indirect benefits amounting to ~R134 billion. Much of this productivity is in the service sector which does not extract resources, but uses the coast as a scenic amenity. As an example, the annual turnover from the dive industry at Ponta do Ouro is estimated to be in excess of R 20 million.

There are significant longshore variations in dune morphology despite the northward drift on the east coast. The rocky reef at Mabibi extends a few hundred metres seawards and shelters a significant shallow-water coral reef that serves as a tropical fisheries habitat (Tables 2 and 3). There is increasing anthropogenic pressure on the marine resources and coastal dunes from local residents and tourists. Both groups catch shellfish and fish. Some control is implemented by a permit system, but this is not strictly enforced. There is some debate on beach travel by vehicle and in 2003 a ban was put in effect. Vehicles compact the sand and impact on fauna that inhabits the interstices. A compromise solution would be to limit vehicular traffic to less sensitive areas during the holiday season, leaving the rest of the year for recovery. The high rate of northward sand transport in the surf-zone and lower beach makes recovery more likely.

Development pressures at Mabibi will increase, as it is a popular snorkeling location. The more accessible recreation areas to the south are becoming crowded. There are already blowouts around Hully Point that have been initiated by footpaths. Additional tourism development such as the new Thonga Beach Lodge, could add to environmental pressures whilst providing much needed income to local communities. A boardwalk system along the foredune would help control erosion.

Table 2: Fish species, Mabibi tidal pool, November 2001

| Species Name | | Common Name | Notes |
|---|---|---|---|
| Abudefduf | sparodies | false eye damsel | |
| Abudefduf | leucozona | coral fish | |
| Abudefduf | natalensis | four bar damsel | may be confused with A. sexfasciatus the sissor tail sergeant or Acanthus triostegus. |
| Abudefduf | vaigiensis | sergeant major | |
| Abudefduf | sordidus | spot damsel | juvenile. Uses rock pools as nurseries |
| Acanthurus | triostegus | lancet fish, tang, banded surgeon | v. common, 2 dots on tail distinguishing feature forms large shoals. |
| Acanthurus | lineatus | blue banded surgeon | outer reefs, not rare, vibrant colours. |
| Amanses | sandwichinensis | | Little information see smith, variable colour |
| Anthia | squamipinnis | sea goldies | often in schools. Type of rock cod. Most common of the 30 sp. |
| Chaetodon | lunula | half moon butterfly fish | widely distributed. Eyespot on dorsal fin only present in juv. |
| Congiopodus | spinifer | race horse, seahorse | |
| Coris | formosa | queen coris | |
| Coris | gaimand | | Juv. Widely distributed but nowhere abundant. in shallow waters. |
| Epinephelus | tauvina | garrupa, rock cod, sea bass | |
| Epinephelus | morrhua | rock cod | |
| Gymnothorax | favagineus | honey comb moray eel | common |
| Halmablennis | dussimieri | rock skipper | colours fairly constant |
| Kuhlia | mugil | barred flagtail | five barred stripes on tail uses rocky reefs as nurseries. |
| Labroides | dimidiatus | blue streak cleaner wrass | unmistakable small fish. Colours incl. pink, yellow and dark blue |
| Lycodontis | tessellata | moray eel | |
| Pempheris | adusta | dusky sweeper | body shape unmistakable. found in shoals under over-hangs. Swims with sweep of tail. |
| Plectorhinchus | chubbi | dusky rubberlip | occurs in deeper reefs but also inv shallow reefs as nurseries. |
| Pomacanthus | imperator | emperor angelfish | Juv. V. distinctive but may be other P. juveniles especially P. semicirculatus. |
| Pseudochromis | dutoiti | dutoiti | Small |
| Pterois | miles | indian lion fish, devil fish | common unmistakable |
| Rhinecanthus | rectangulus | masked trigger fish | Pattern unmistakable, especially yellowish V on tail. |
| Stegastes | nigricans | black damsel fish | white bar from eye to pectoral fin is a distinguishing mark. |
| Thalassoma | purpureum | rainbow or surge wrass | Colours and markings are variable and change. Pink markings behind eyes. |
| Torpedo | sinuspersci | marbled electric ray | Difficult to identify as buried in sand. Yellow with small blue spots on back. |
| Trachinotus | blochii | snub nose or fin pompano | orange tinted fins, may have golden colour on ventral surfaces. |
| Tylosurus | crocodilus crocodilus | crocodile needle fish or garfish | a more common species in the area |

Table 3: Coral species, Mabibi tidal pool, November 2001

| Species Name | Type | Confidence 1=Good 3=Reconfirm | Notes |
|---|---|---|---|
| Anomastrea irregularis | cn | 1 | Forms low small mound like colonies up to about 20cm in height. The septal pattern is reduced and corallites are small (3-5mm across) and arranged irregularly in a brown honeycomb pattern. |
| Astreopora myriophthalma | cn | 2 | Colonies are encrusting (3 mm across) or form plates or bulbous, hemispherical mounds. The coralites are well defined, slightly conical 2 mm across with twelve vertical spines around the edges. Cream - yellow - pale bluish brown |
| Dictyospheria cavernosa | w | 2 | Young specimens are sub globular and hollow, stiff brittle and composed of macroscopic cells 1-3 mm in diameter; in older specimens – cup-like structures; green. Epibenthic, in lower and sub littoral zone. Syn Valonia ventricosa |
| Favia stelligera | cn | 2 | Polyps are plocoid e.g.. each one has a separate wall with a gap between adjacent coralites. Large domed colonies with numerous lobes each 10 - 20 mm across with corallites 2-6 mm. Visible at the surface. Pale yellow. |
| Lobophytum sp. | s | 2 | A conspicuous genera, forming soft encrusting colonies. Dimorphic, with feeding polyps and smaller polyps lacking tentacles. Self-promoting water circulation within the colony. Zooxanthellate. Over 15 species recorded. Blue colour |
| Montipora aequituberculata | cn | 3 | Colonies consist of thin plates often growing in tiers. The upper surface is papillate and usually cream to khaki brown in colour with pale margins. |
| Palythoa natalensis | a | 2 | Polyp diameter 7-10 mm. Sand encrusted colonies forming clusters of small, discrete nodules or extensive sheets covering large areas. Polyps immersed in thick coenenchyme. Pale to dark brown. |
| Palythoa nelliae | a | 2 | Polyp diameter 5-10 mm, expanded disk and tentacles to 3 cm. Colonies heavily sand encrusted. Polyps open during the day, joined at base by stolons / coenenchyme. |
| Physogyna lichtensteni | cn | 3 | Large polyps extend enlarged, grape like vesicals during the day but these are retracted during the night. Light skeleton which has a petal-like septa. Coralites meandering. |
| Sancophyton trocheilophorum | s | 3 | Colony up to 50 cm across, each 5 mm in diameter. White interior and grey to light green upper surface. When disturbed, the autozooids of this species retract. |
| Sporolithon ptychoides | ca | 3 | Reddish, thalli strongly attached, flat to lumpy. Tetrasporangial sori forming raised patches on the surface, old sori buried in rows in the thallus. Syn Archaeolithothamnion erythraeum. |
| Zoanthus natalensis | a | 1 | Polyp diameter 3 - 6 mm expanded disk and tentacles to 1 cm; height of 3 cm. Extensive sheets with polyps immersed in coenenchyme. Pale blue or green. Free standing, crown opened by day, smooth body wall. Shallow reefs. |

Coral types, a = anemones, cn = cnidaria - hard corals, s = octocorals - soft corals, w = sea weed

Kosi is the largest and best example of a segmented lakes system on the coast and is already part of a nature reserve. Visitor access is limited by permit and local population densities are relatively low. Exotic *Casuarina* species planted to stabilise the southern shore of the estuary were removed in 2002 resulting in a reef in the estuary mouth being inundated by sand. Large scale removal of exotic vegetation species, particularly *Casuarinas* on the coast, is being implemented. Care needs to be taken to replace exotic vegetation with indigenous vegetation as soon as possible after removal to minimise disturbance.

Ponta do Ouro in southern Mozambique is a headland large enough to provide shelter from the prevailing southerly swells and winds. It is the only site on the coast that supports water-front development. Many houses are built in the foredunes, some providing facilities for guests and camping. Development there is at risk of erosion and damage during tropical cyclones and major storm surge events. Offshore waters are warming at rates above the global trend, thus impacts are likely in future. A means of protecting the low-lying dune vegetation is recommended, using fencing to control walkways around the campsite and dive camps.

Dive boats are launched and retrieved by 4 x 4 vehicles in the bay almost every day in support of dive tourism that attracts the majority of visitors to Ponta. Although divers are generally environmentally aware and appreciate the underwater scenery, the associated infrastructure impacts significantly on the coastal zone. Following a long period of stagnation, there is renewed interest and increased tourism numbers since 1998, when the new Faraleza border-post was opened. Hence coastal resources at Ponta are under increasing pressure and a system of local government needs to be put in place to control tourism activities. Environmental education will increase awareness of the fragile nature of coastal resources and help involve local community members in tourism services on this beautiful and dynamic coast.



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