CHAPTER 2
STUDY AREA

2.1 Locality

This study mainly focused on the South African section of the Greater Maputaland (Figures 1 & 2), a region henceforth referred to as Maputaland, and specifically the coastal plain, a low lying region covered by Cenozoic to Recent marine deposits. The northern limits were the Mozambique border and the southern limits the northern end of Lake St Lucia, bordered by the Lebombo Mountains in the west and the Indian Ocean in the east. The core area of the southern portion of the Maputaland Centre of endemism [MC] as defined by Van Wyk (1994, 1996) and Van Wyk & Smith (2001) is congruent with the study area (Figure 1).

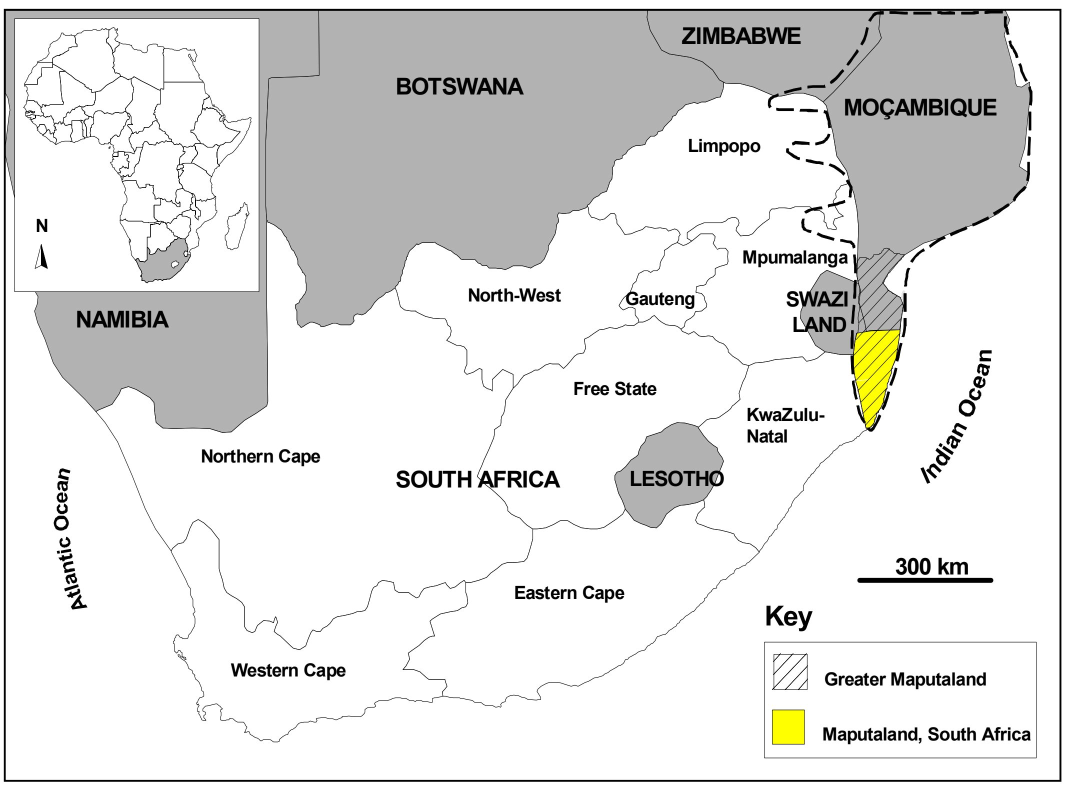


Figure 1. Location of Greater Maputaland and Maputaland, South Africa (from Smith 2001). Dashed line represents area of influence of the Maputaland Centre (Van Wyk 1994).

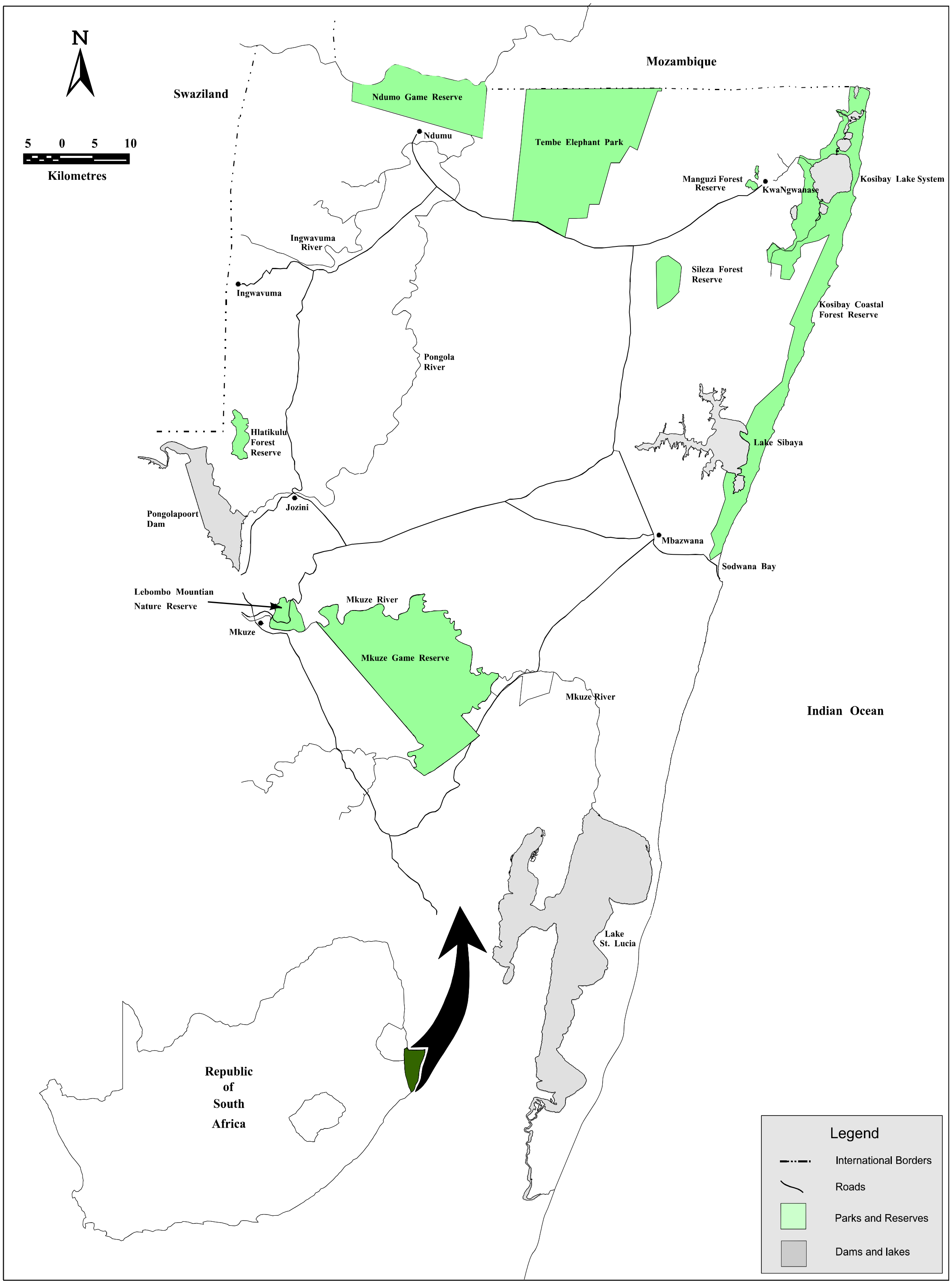


Figure 2. A simplified locality map showing main towns, parks, reserves, dams, lakes and roads of Maputaland in northern KwaZulu-Natal, South Africa as relevant to the study.

2.2 People of Maputaland

Maputo, the Capital City of Mozambique, and also Maputaland, is named after Chief Mabhudu of the Thonga people. He was a powerful chief at Lourenço Marques (now Maputo also formerly known as Delagoa Bay) during the 1770s and 1780s (Kloppers 2001). The Tembe people are ethnically linked to the Thonga, who occupy vast areas in southeastern Africa. The Tembe or Tembe-Thonga historically occupied the entire area from the present-day Maputo in Mozambique to the Mkhuze River in the south (Figures 1 & 2). The western boundary of the tribe's distribution was the Pongola River (Kloppers 2001). The Tembe take their name from the founder of the clan, Mthembu, who migrated from Kalanga to settle near Maputo around 1554. The word Thonga is of Zulu origin and means dawn. The Zulu used this name to refer to all the people living north of them (the Zulu people) who were not of Sotho or Nguni origin. The word Thonga also has a negative connotation to it and was used by the Zulu to denote slaves. Until recently the Maputaland region was known as Tongaland, but this name has now fallen into disuse.

The Portuguese were the first Europeans who made contact with the Tembe people. Portuguese sailors referred to the east coast of what is now known as Maputaland as 'Terra de Fumo' (the land of smoke) because of the large amount of smoke from wild fires seen. Portuguese interests in trade with Delagoa Bay (now Maputo Bay) led to the colonisation of southern Mozambique. According to Kloppers (2001), Britain also laid claim to the southernmost part of Mozambique, as did other white settlers such as the Portuguese. The issue was eventually settled in 1875 through international arbitration by the then French President, Mac Mahon. The border between Mozambique and South Africa was drawn along a straight line from Kosi Bay to the confluence of the Pongola and Usuthu Rivers, and from there along the river to the Lebombo Mountains, the exact position of the line is still today questioned by many sources (Kloppers 2001). The Tembe were not consulted and their tribal area was split in two. Today the Tembe tribal area falls in the Ingwavuma District of South Africa and in the Matutuine District of Mozambique. The Tembe Authority in Mozambique has largely been broken down during the Mozambican Civil War (September 1964–August 1974), but it still exists and has been gaining more influence since peace has been established (Lusaka Accord signed in September 1974).

By and large, environmental characteristics of Maputaland are such that it compels those who settle there to follow a particular pattern of natural resource utilisation. For example, the region is not ideally suited for keeping cattle. Considering the immense importance of cattle in Nguni

(Zulu) culture it is easy to see why the Zulu did not wish to settle here. The main source of protein available to the people is fish. The Zulu, and many other tribes in South Africa, do not eat fish except the Tembe-Thonga. These, and other ecological conditions, such as the practise of shifting agriculture in the nutrient-poor soils, made Maputaland an unattractive area for the Nguni people to settle.

Most Tembe people today still follow a traditional way of life, relying heavily on the natural resources of Maputaland for their survival. Although there are some economic developments in the area, the people still catch fish as they had always done in the fish kraals at Kosi Bay and in huge *fonyo* fishing drives in the pans around the area. Most people still collect wild fruits and many people are still involved in tapping the sap of the *ilala* palm (*Hyphaene coriacea*) to prepare the alcoholic drink called *ubusulu* (with all its intoxicating values).

However, the human population of the area has steadily increased forcing many people to over-harvest the resources. It has led many people to clear the natural vegetation to grow crops and to harvest firewood to sell to tourists and other users. This is a non-sustainable short-term solution that also impacts on the region's biodiversity. One potential long-term solution is to encourage the local people to establish sustainable eco-tourism projects and to set quotas for the sustainable harvesting of the available natural resources. However, the only way that this can be achieved is by reducing the rate of the present habitat destruction, this can only be done based on monitoring and information gathered on the biodiversity and its driving forces in the region.

2.3 Physical environment

2.3.1 Topography

With the exception of the narrow Lebombo range which rises to an elevation of some 600 m, the Maputaland Centre is a nearly flat, low-level coastal plain with a maximum elevation of about 150 m. Ancient linear north-south trending dunes, some of which may reach an altitude of 129 m, occur in the central part of the coastal plain (Wright 1997). The high coastal dune ridge along the shoreline rises to almost 200 m above sea level in places in KwaZulu-Natal, and is said to be amongst the tallest vegetated dunes in the world. The Maputaland Centre contains some extensive wetlands, particularly marshes, lakes and estuaries. In the study area there are three major natural lake systems, all of which are found in the east of the region. Lake Sibaya is the largest natural freshwater lake in South Africa and covers an approximate area of 70 km^2

(Pitman 1980; Miller 2001). The Kosi Lake system consists of four interconnected lakes, which range in salinity from close to seawater concentrations in the tidal basin, to freshwater in Lake Amanzimnyama (Wright 2002). Lake St Lucia is 40 km long, up to 10 km wide and it has an average depth of 0.9 metres. It is connected to the sea by The Narrows, a tidal channel of about 20 km that together with the lake forms the largest estuary in Africa (Taylor *et al.* 2004). There are a number of other, smaller natural water bodies in Maputaland, many of which have associated wetlands.

2.3.2 Climate

Maputaland can be described as having a warm to hot, humid sub-tropical to tropical climate. Average monthly humidity is relatively high (fluctuating between 65–85%), even in the drier inland parts of the region. Winters are drier than summers and there is a pronounced dry season (April to September), although rain is received throughout the year. A tropical to subtropical climate prevails, with no frost occurring in winter.

2.3.2.1 Moisture and rainfall

The most striking feature of the climate of Maputaland is the variation in rainfall across the region. In the east, along the coast, the annual rainfall ranges from 1000 to 1300 mm. This decreases progressively inland, so that the mean annual rainfall is approximately 500 mm at the foot of the Lebombo Mountains. Rainfall then increases with altitude with the crest of the Lebombo Mountains receiving approximately 800 mm annually (Bruton & Cooper 1980; Maud 1980; Schulze 1982). However, these annual rainfall values can vary dramatically between years. The area is subject to extreme rainfall events caused by tropical cyclones or cut-off low-pressure systems. Northeasterly and southwesterly winds predominate in the region, with the rain-bearing winds coming from the southwest.

Mist frequently occurs on the Lebombo Mountains and, through inversion, locally on the plains (particularly in winter). The relative air humidity is generally high on the plains, even away from the coast. The high relative air humidity coupled with high summer temperatures result in a high discomfort index during the summer months.

2.3.2.2 Temperature

The southern boundary of the Maputaland Centre seems to follow the 18°C mean midwinter isotherm (Poynton 1961) quite closely and thus forms the southerly tip of the Tropical Climate Region, which is characterised by the coldest month (July) having a mean temperature of above 18°C. Being in essence an ecotonal region, climatic conditions in the study areas are often referred to as tropical/subtropical. The existence of this tropical peninsula is due to the low-lying topography of the Mozambican coastal plain east of the Lebombo Mountains, and the proximity of the warm Agulhas Current (Bruton & Cooper 1980). Sea temperatures are maintained at above 21°C by this warm current that also plays a significant role in the narrow temperature range between summer and winter of the northern KwaZulu-Natal coastline.

2.3.2.3 Fire

Regular fires are a natural phenomenon in the region and are important for the maintenance of many of the vegetation types, notably the coastal grasslands. In these coastal grasslands, topography, regular fire and water table depth are key ecological determinants (see Chapter 4). The woodlands also experience fires on a regular basis, and many of the species in the woodlands are adapted to fire. The Sand Forest on the other hand, is not adapted to fire and in cases when fire has penetrated the forests it has had a detrimental impact on the intact forest patches (see Chapter 5). Dune Forest is also not adapted to fire although it can recover and re-establish itself relatively quickly after severe damage from fire.

2.3.3 Hydrology

Water table and ground water movements play an important role in maintenance of many of the vegetation types in parts of Maputaland, as deep sand deposits cover the area. The water table varies from on the surface (Muzi Swamp and hygrophilous grassland) to depths of 60 m or more, below ground surface. The shallow water table feeds the marshes and pans in the area. The ground water is almost exclusively replenished by rainwater. After rains immediate fluctuations in local water levels can be experienced for a period of time. It was estimated by Kruger (1986) that vertical seepage rates were in the order of 0.1 m/day. Water movements through the sands were at a mean transmissivity of 20 m^2/day and a co-efficient of storativity of $1x10^{-3}$. The only other source of surface water is the seasonal pans that occur on the duplex soils. These pans are usually dry during the winter (April–September).

2.3.4 Geology

The following account of the geology of the region is based mainly on Botha (1994) and Momade & Achimo (2004). Refer to Figures 3 & 4. Parts of the Maputaland coastal plain are geologically quite recent, especially in the east where it continues to expand, chiefly as a result of sand deposition. The formation of this plain, together with the topography of the region, has had a major influence on the abiotic and biotic characteristics of Maputaland. The cover sands of the Maputaland region are mainly aeolian in origin and consist of thin veneers of sandy topsoil. The underlying geology consists of Cretaceous age siltstones unconformably overlain by sediments of Miocene and Pleistocene origin. These Cretaceous sediments are considered to comprise the hydrogeological bedrock. The overlying sediments are more permeable, with the highest values found in the Miocene deposits. The latter are however present in the form of long north-south trending ridges, possibly representing old beach terraces, and may be completely absent in some areas. The Pleistocene sediments were deposited in a back-barrier lagoonal environment. These sediments in general have a lower permeability than the Miocene sediments, and are believed to contribute to constraining the permeability for regional groundwater movement. The permeability of the cover sands is relatively high.

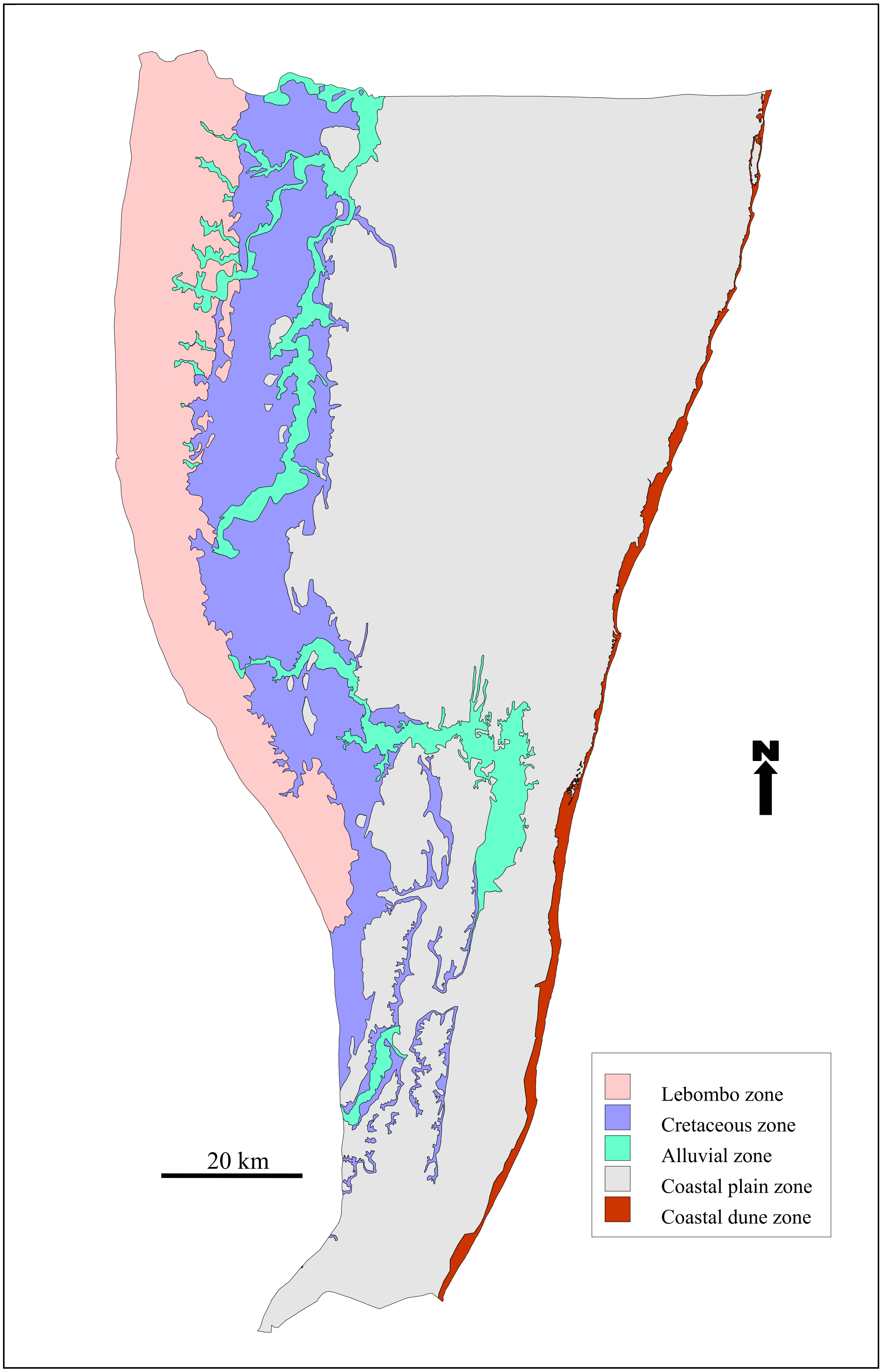


Figure 3. Main geological zones of Maputaland (Smith 2001). The study area conforms to the Coastal plain zone.

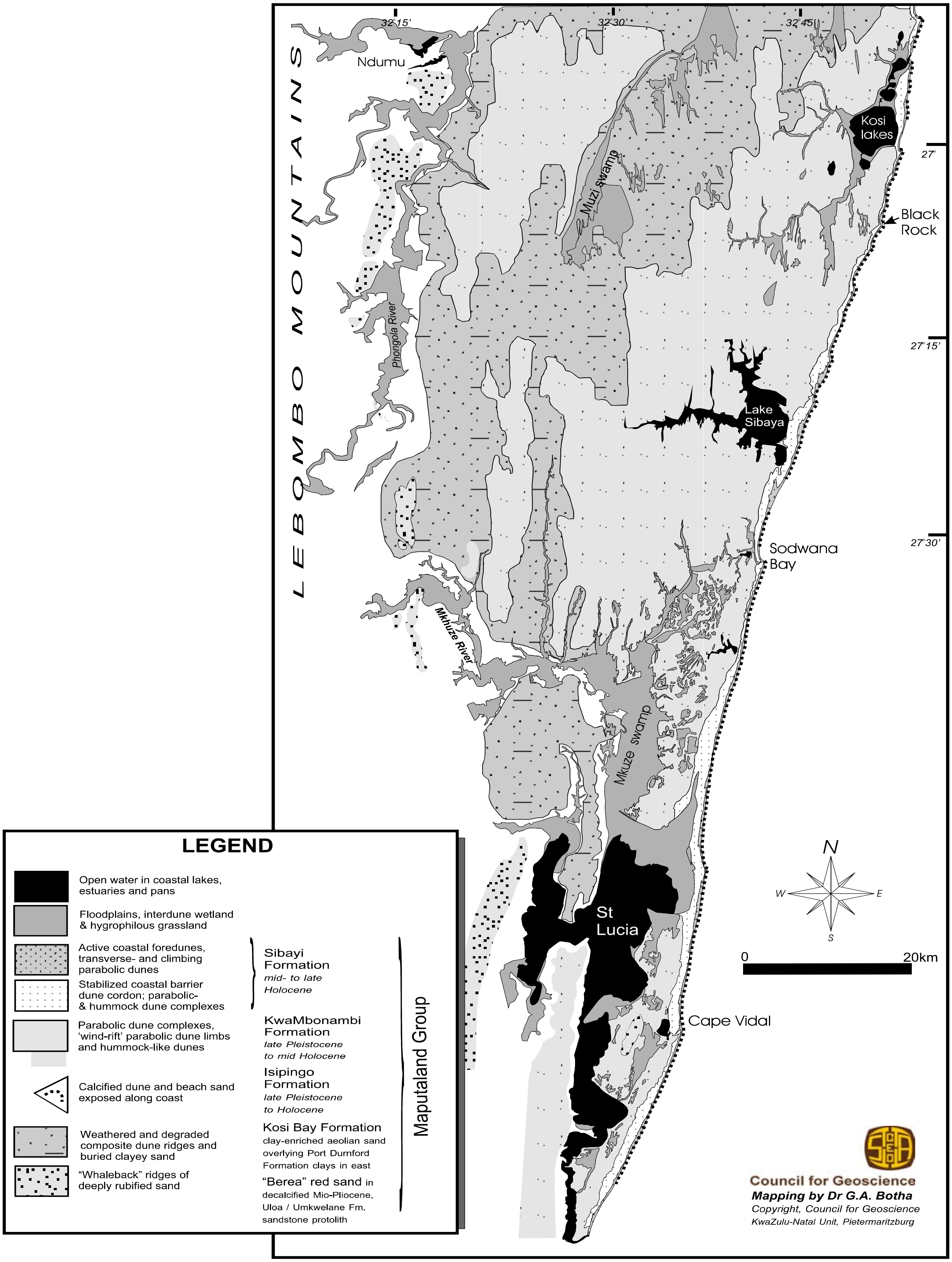


Figure 4. Geological map showing the distribution of aeolian sand stratigraphic units relative to incised drainage lines linked to coastal water bodies (Botha *et al.* 2003).

2.3.4.1 Condensed Geological history

Gondwana records

The break-up of Gondwana is an event that commenced in the Jurassic and is continuing today. There is an almost complete geological record of this period preserved in the offshore basis on the continental shelf around southern Africa (Watkeys 1997). Onshore, however, the records are sparse. Watkeys (1997) describes five stages of break-up.

The first stage, during the Jurassic (180–179 Ma), break-up in South Africa is marked by some rifting along the Lebombo mountains at the time of the Karoo vulcanism. There was an attempted continental separation as indicated by the eruption of the Jozini rhyolites (179 Ma), which now form the Lebombo mountains.

Stage two (179–155 Ma) involves the linkage and movement along a fracture system (Gastre Fault). This fracture system separated the Patagonia block from Africa and the rest of South America.

During Stage three (155–135 Ma), another fracture system developed from the Somali Basin, past the Lebombo to the Weddell Sea and the Proto-pacific Ocean. Motion along this system split Gondwana into two plates: East Gondwana (Antarctica, Madagascar, India and Australia) and West Gondwana (South America and Africa). The Msunduze Formation (consisting of conglomerates is probably part of a rift succession), Mipilo basalt and Movene basalt found in the southern parts of Mkuzi Game Reserve all formed during this stage.

Stage four (135–115 Ma) was the onset of sea flour spreading in the rift, involving the separation of South America and Africa (extraction of the Falkland Plateau which at that stage was located along the southeast coast of South Africa). Also during this time India rifted away from Australia and Antarctica. The Makatini Formation was deposited on the Maputaland platform from about 120 to 114 Ma, consisting of alluvial and fluvial deposits interfingered with estuarine and shallow marine sediments.

During Stage five (115–90 Ma), continuing extraction of the Falkland Plateau and opening of the South Atlantic occurs. Madagascar reached its present position (105 Ma) and the split between Antarctica and Australia took place. In Maputaland, the Mzinene Formation was deposited (112–

91 Ma). It consists of a general monotonous sequence of shallow marine silts and sands, which are glaucontic and locally pebbly, with sandy and shelly concretions. It is overlain by the shallow marine St Lucia Formation, rich in invertebrate fossils, which were deposited between 85 to 64 Ma.

Dune Cordons

The following account is based on Wright (2002) and refers to Figures 5 and 6a–6d. Late Cretaceous rifting associated with Gondwanaland break-up formed a shallow sea with the beach raised approximately 130 m above present sea levels. Steep gradient/short length rivers out of the Lebombo mountains formed large fluvial outwash fans which were worked into beaches by wave action (~ 65 Ma) (Zululand group: Makatini, Mzinene and St Lucia Formations). The dominant south-easterly wave direction prevails through to present times. Marine sediments are rich in fossils (e.g. ammonites, gastropods, bivalves and echinoides).

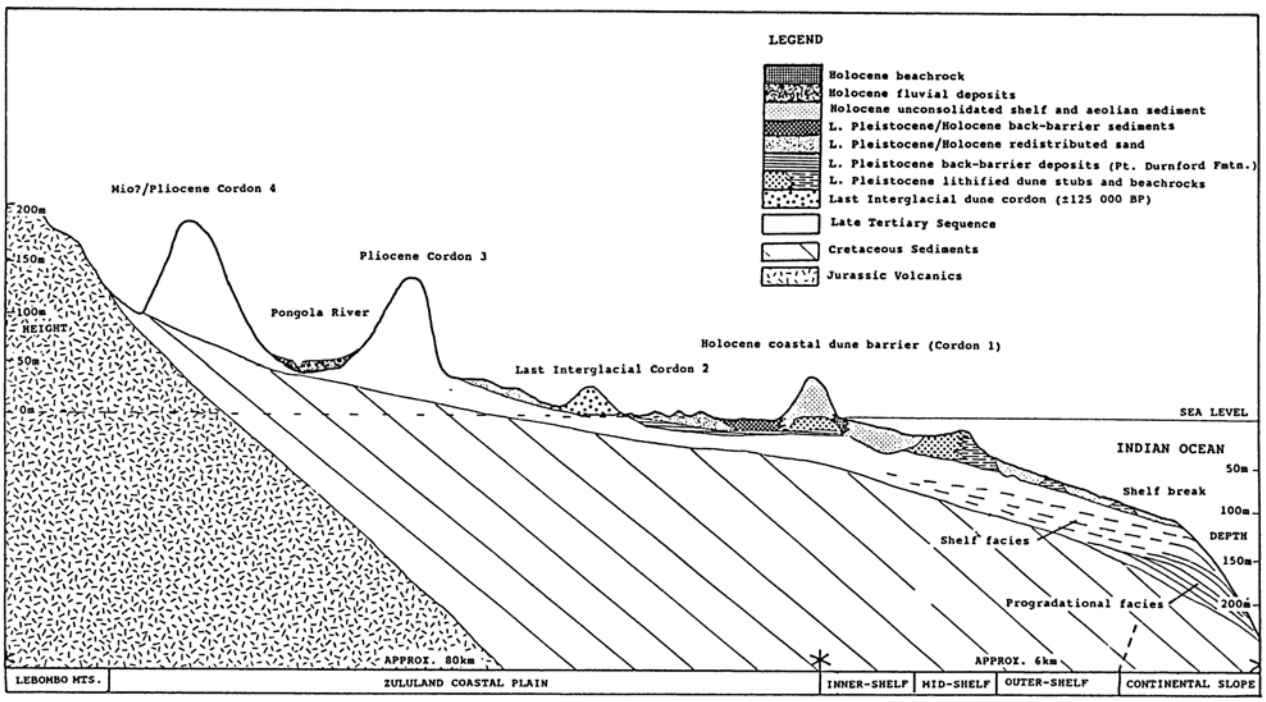


Figure 5. An idealised west to east cross-section through the northern KwaZulu-Natal Coastal Plain showing the geomorphological relationship of the different palaeodune cordons (from Wright 2002).

Figures 6a–6d. An idealised overview of the Cenozoic evolution of the northern KwaZulu-Natal palaeodune cordons (from Wright 2002).

Figure 6a.

Late Cretaceous (~65ma)

Legend

A= Lebombo Mt volcanism
B= shallow sea
C= fluvial outwash fans
D= dominant wave direction
E= Marine sediments rich in fossils

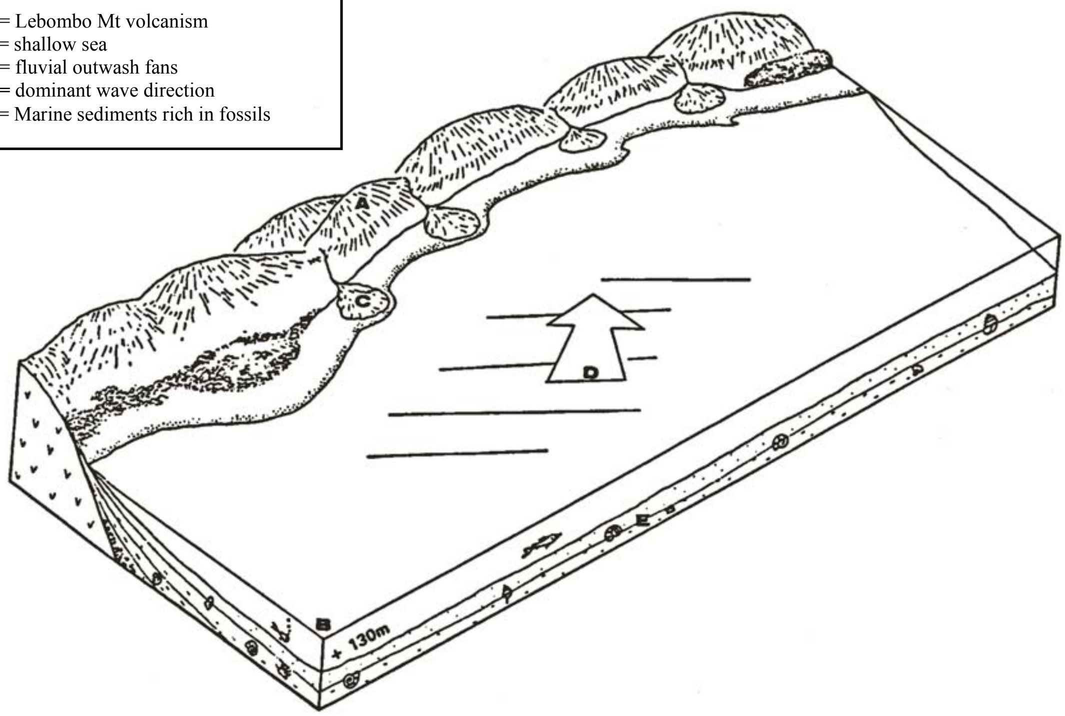
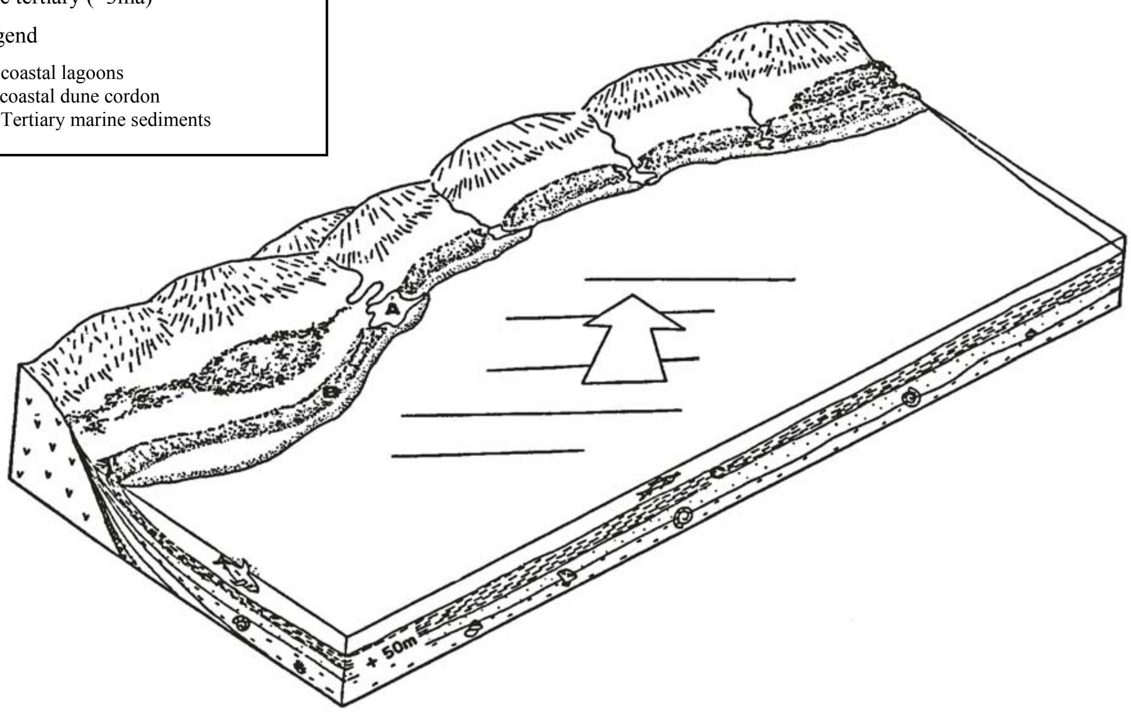


Figure 6b.

Late tertiary (~3ma)

Legend

A= coastal lagoons
B= coastal dune cordon
C= Tertiary marine sediments



Figures 6a–6d (continued). An idealised overview of the Cenozoic evolution of the northern KwaZulu-Natal palaeodune cordons (from Wright 2002).

Figure 6c.

Late Pleistocene (125 000BP)

Legend

A= shallow sea
B= tidal flats
C= coral fossil deposits
D&G&F= new coastal dune cordons
E= eroded Lebombo mountains and dune cordon

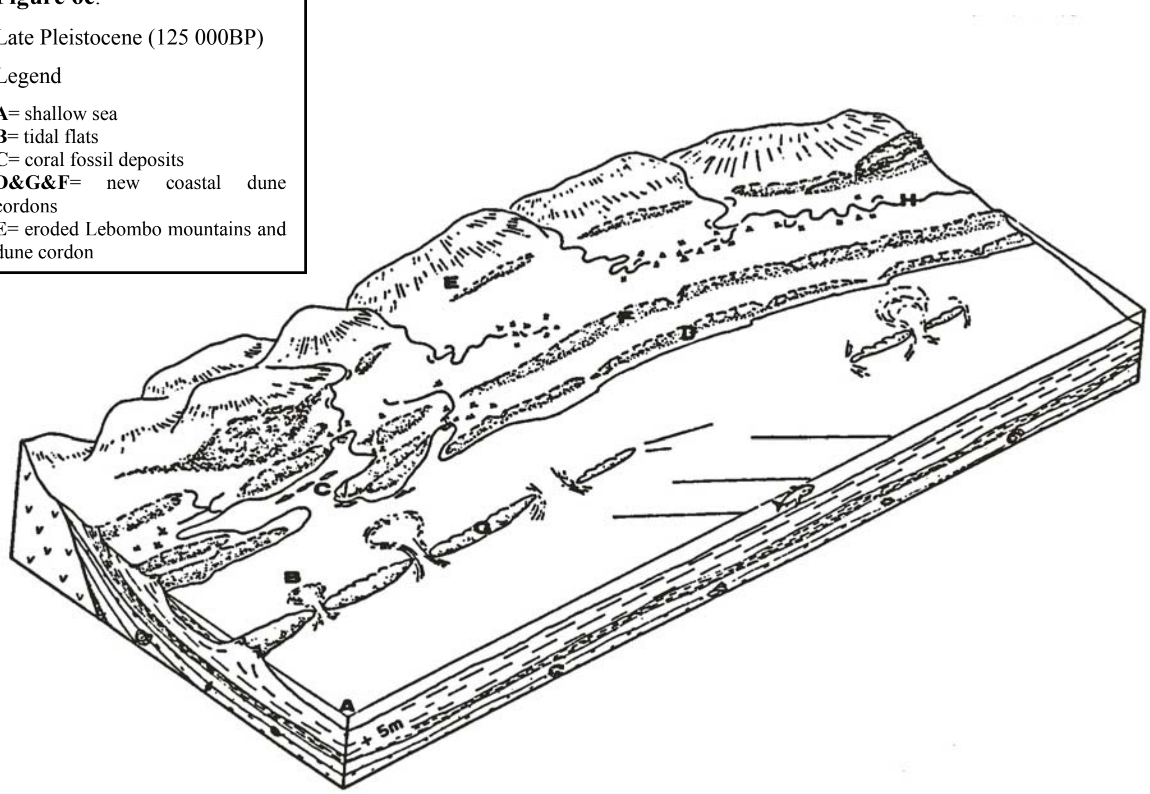
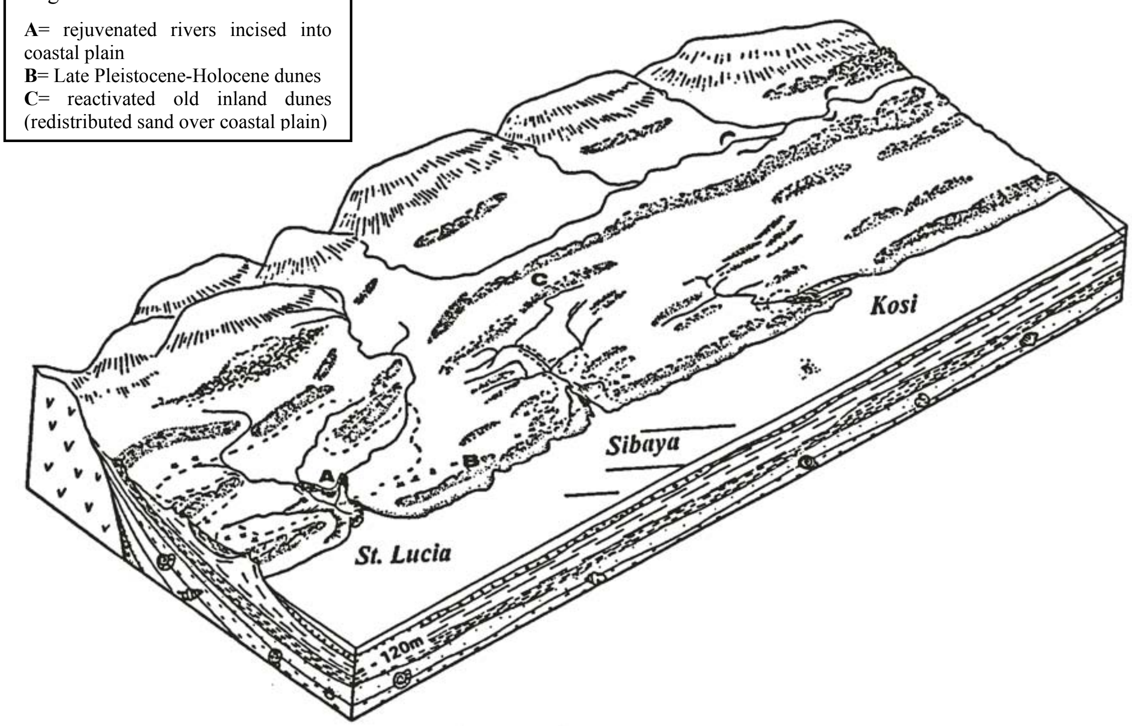


Figure 6d.

Late Pleistocene, last glacial maximum (18 000BP)

Legend

A= rejuvenated rivers incised into coastal plain
B= Late Pleistocene-Holocene dunes
C= reactivated old inland dunes (redistributed sand over coastal plain)



By the Miocene–Pliocene (~3 Ma) the mountains had eroded down and the rivers further decreased their gradients, forming lagoons at the coast (Figure 6b). Beach sediments were reworked by the prevailing winds into a large coastal dune cordon. Sediments include terrigenous and marine deposits, marine fossils and reworked Cretaceous fossils that were deposited into the shallow sea.

During the last Interglacial (~125 000 BP) sea levels had dropped approximately 125 m from a level that is 5 m above present day levels. The sea became shallower with offshore archipelagos (similar to Bazaruto in Mozambique) and tidal flats were common. Coral communities thrived leaving fossil deposits at what are now False Bay and St Lucia (Figure 6c). The Lebombo Mountains and the Miocene-Pliocene dune cordon eroded down. A new cordon (Late Pleistocene shoreline) was formed seaward of the Miocene-Pliocene dune cordon. This cordon approximates the Sihangwana dune cordon today. The archipelagos formed the basis for the more recent dune complexes. Decreasing river gradients and the formation of the barrier dune complex forced the rivers to migrate northward, resulting in the palaeo-Pongola system.

A sudden drop in sea level of 135 m (130 m below present levels) approximately 18 000 BP, rejuvenated the rivers causing them to incise into the coastal plain (Figure 6d). The very Late Pleistocene/Holocene coastal dunes formed on the old archipelagos. A change in the climate reactivated the old inland dunes, redistributing sand over the coastal plain. A rise in sea-level (130 m) to present day levels caused many of the rivers to be blocked by lagoonal barriers environments.

The precise ages of these dune cordons are still in contention. They are difficult to age, as top layers have been remobilised, possibly many times.

2.3.4.2 Main formations

Jurassic

Jozini Formation (Volcanic rhyolites): ~179 Ma.

Cretaceous

Msunduze (conglomerates), Mipilo (basalt) and Movene (basalt) Formations (155–135 Ma).

Makatini Formation (alluvial, fluvial with estuarine and shallow marine sediments): 120–

114 Ma.

Mzinene Formation (sequence of shallow marine silts and sands, locally pebbly with sand and shelly concretions): 112–91 Ma.

St Lucia Formation (rich in invertebrate fossils): 85–64 Ma.

Tertiary (65–1.8 Ma)

Miocene to Pliocene

The Uloa Formation is a source of controversy as the formation records are problematic (large time gaps present, missing records). A mid-Miocene transgression was followed by a marine regression during the late Miocene-Pliocene. A sequence of calcified conquina (cemented unsorted shelly debry, similar to conglomerate), shelly conglomerates and beach sands/gravels (Uloa Formation) and overlying aeolian calcarenite deposits (Umkwelane Formation) were deposited along the Lebombo foothills and towards the coast. A series of sea still stands during this regression are marked by remnants of dune cordons that are now deeply weathered to form Berea-type red sand e.g. Ndumo Hill.

Quaternary (1.8 Ma–0)

Pleistocene and Holocene.

The Port Durnford Formation

These deposits comprises 20–25m succession of estuarine clays, lacustrine (lake deposits) peat and aeolian sediments. A basal sand stone is overlain by grey or black mud with sandy laminae, which contain tracks, *Ophiomorpha nodosa* (trace fossil name for mud prawn), burrows and wood fragments, as well as a variety of fossils including crustacean and fish remains, foraminifera, marine molluscs, fragments of turtles and a crocodile (Hobday 1974; Scott 1992). NOTE: This formation seems to correspond to inland water bodies, vleis, swamp forest, sediments with hippo tracks and churned-up mud, etc. A Port Durnford coastal lake may have occupied a similar perched position in the landscape relative to sea levels at different geological times.

The following deposits follow the sequence of regressions and transgressions associated with sea level changes and uplift which took place from ~130 000 – ~70 000 BP till now.

The Kosibay Formation comprises orange or grey, weathered dune sands that are widespread inland of the coastal zone. (Cross-bedded sand and local calcarenite; Mid to

Late Pleistocene: ~130 000–10 000 BP).

The KwaMbonambi Formation dune systems derived from aeolian reworking of older dune sands, and inter-dune wetland deposits (inland-stabilised dunes and redistributed sand (non-calcareous); diatomite). This formation is associated with the marine regression, rivers incisions in response to the lowering sea level (~120 m) during the cool, drier phase associated with the last glacial maximum (~18 000 BP) which exposed most of the continental shelf (exposed bedrock ~70m below current sea level).

Sibayi Formation high coastal dune cordon including the current dunes, made up of calcareous sand. The Mid-Holocene marine transgression flooded coastal valleys and lakes, with alluvial sedimentation infilling many bedrock valleys near the coast. This high sea level is recorded by beach rock along the coast beach ridges within the coastal lakes systems.

The beach rock and aeolianite outcrops (some submerged) parallel coast and coastal facies extend semi-continuously from –5 m to –95 m and delineate the Late Pleistocene palaeo-coastline events. The Pleistocene, post-last Interglacial regressions resulted in deposition and cementation of coast-parallel beach rocks and aeolianites, which defines a series of four distinct paleo-coastline episodes with possible ages between 117 000 and 22 000 years BP.

2.3.5 Sea level records

This account of sea level changes is based on Ramsy (1995, 1997) and Momade *et al.* (2004). The shelf in the Maputaland region is extremely narrow (~3 km) compared to the global average of 75 km, and is characterised by submarine canyons, coral reefs and steep gradients on the continental slope (Ramsy 1995, 1997). The shelf break occurs 3 km offshore at -65 m depth. Three submarine canyons occur off Sodwana Bay. The origins of these canyons are not related to the position of modern river mouths but can probably be linked to palaeo-outlets of the Pongola and Mkuzi River systems. It is suggested that the canyons are mass wasting features, which were exploited by paleao-drainage during regressions. These canyons seem to be associated with first, the Late Pliocene (5.3–1.8 Ma) and secondly to the Late Pleistocene (~ 18 000 BP), when a sharp fall in sea level occurred and rejuvenated rivers.

Beachrock/aeolianite is carbonate-cemented beach sand which forms on sandy beaches in tropical and subtropical climates (Miller 1997). The carbonate cement that binds the beach rocks is formed by repeated wetting and drying cycles driven by tidal activity. It is not only restricted to the tidal zone but also occurs in the supratidal zone where salt-water spray facilitates cementation. Beach rock forms during sea stillstands or during minor regression events, therefore its presence or absence can provide information regarding past sea levels and coastline morphology.

Summary of main sea level changes according to diagrams of Ramsy (1997) and a Quaternary sea level curve for southern Africa is given below. The sea levels are discussed in relation to present day sea level, taken as 0 m.

Mid Pleistocene (130 000–200 000 BP). Little is known.

Late Pleistocene (130 000–10 000 BP).

At:	+5 m	~124 000 BP.	
Dropped to	-45 m	~118 000 BP.	Last interglacial high stand
Rose to	+5 m	~106 000 BP.	
Remained at this level	0 m	~98 000 BP	(~12 000 yrs).
Slowly dropped to	-35 m	~58 000 BP.	Records between ~58 000 &
		~86 000 BP.	unclear.
Remained at this level	0 m	~44 000 BP	(for a period of ~12 000 yrs)
Dropped to	-130 m	~18 000 BP	Last Glacial Maximum
Rose sharp to	0 m	~8 000 BP	(Holocene)

Holocene sea levels according to diagrams of Ramsy (1997) are given below. Based on dating a series of Holocene beachrocks and planation (planning erosion, cutting into rock by wave action to form wave cut platforms) episodes on the southeast African coastline.

Gradual rise to	+1.5 m	~6 000 BP	
Remained at this level	0 m	~5 000 BP	
Rose sharp to	+3 m	~4 480 BP	
Dropped sharp to	0 m	~3 880 BP	
Remained at this level	0 m	~3 200 BP	
Dropped to	-2 m	~3 000 BP	Records unclear
Rose to	+1.5m	~1 610 BP	Records unclear

Dropped to	0 m	~900 BP

Remained at this level till today.

The first more relatively recent time that the sea level reach its present level along our coastline was at ca. 6 500 BP (Ramsy 1995).

2.3.6 Soils

The coastal dune sands consist mainly of quartz with local concentrations of heavy minerals such as ilmenite, rutile and zircon (Hobday 1979). Recent sands are whitish, while older sands tend to be reddish to brownish, with higher clay contents. Older dunes with stabilised woody vegetation tend to have a high humus content in the soils (Weisser & Cooper 1993).

In contrast to the infertile soils over most of Maputaland, weathering of rhyolite and basalt on the Lebombo Mountains has produced relatively fertile soils with high clay contents. Soil derived from the rhyolite and basalt to the west was deposited on the coastal plain as clayey but shallow lithosols. To the east there is a belt of rich clay-loam soils formed primarily *in situ* on the Cretaceous strata. These vary from red loamy to clayey soils on the higher-lying areas to black vertisols on lower-lying valley bottoms.

The three main soil types present on the coastal plain areas, are dystrophic regosols (Namib soil form), histosols (Champagne soil form) and humic gleysols (Soil Classification Working Group 1991; Soil Survey Staff 1996; FAO-UNESCO 1974). The regosols cover most of the region and are Quarternary sand deposits of generally low fertility (Watkeys *et al.* 1993). Dystrophic regosols are moderate to well-drained (leached) acidic sands found in elevated places such as dune crests and slopes. Histosols are acidic organic soils with an organic rich A horizon thicker than 400 mm and are found in marshy areas and pans. Humic gleysols are wet acidic sands with an abnormal accumulation of organic matter and are found in depressions where a high water table occurs. Duplex soils consisting of a clay layer beneath a sandy horizon occur in depressions, which become waterlogged in the wet season and sometimes form pans. In general, the swamps and marshes are surface expressions of the groundwater table, with little or no evidence of perched groundwater horizons occurring in the area.

2.4 Vegetation and flora

The southern boundary of the Maputaland Centre seems to follow the 18°C mean midwinter isotherm quite closely. This line also marks a zone where the fauna (and to a lesser extent the flora) changes from predominantly tropical to predominantly temperate (Poynton 1961). Plants display the same transitional pattern, although slightly more gradual. Maputaland is a transitional (ecotonal) area between tropical and subtropical climates and many plant and animal taxa find either their southern limit or their northern limit in the region.

The geological history of Maputaland suggests that the current ecosystems in the region may be of recent derivation. Many Maputaland Centre endemic plant taxa (Van Wyk & Smith 2001) comply with the concept of neo-endemics (recently developed). Thus, the Maputaland Centre comprises a unique environment in Africa in being geologically young and active with biological evolution (notably speciation) still in a very active phase. Although potential palaeo-endemics are present in the region (e.g. *Encephalartos ferox*, *Helichrysopsis septentrionale*, *Raphia australis*), many of the Maputaland Centre endemics appear to be of fairly recent diversification, an impression supported by the fact that some are differentiated at the infraspecific level only, with nearest relatives still extant. The Maputaland Centre is outstanding for its richness in neo-endemics. It is a remarkable region in which biological evolution, including speciation, appears to be particularly active amongst both plants and animals. All of these deductions would be consistent with the postulated geologically relatively recent (Quaternary) origin of the sandy, low-lying coastal plain comprising the greater proportion of the Maputaland Centre.

The interpretation of the current geographical range of a species is much more complex than just the climatic variables which determine the broad vegetation types in the region. To explain individual floristic patterns of distribution, a complex combination of biotic and abiotic factors may be taken into account including those present today and those from the past.

The general vegetation of the study area was broadly classified by Acocks (1953, 1988) as Coastal Forest and various Thornveld and Lowveld savanna veld types. The Coastal Forest and Thornveld was subdivided into the Typical Coast-belt Forest (1), Zululand Palm Veld (1b), Dune Forest (1d) and Mangrove Forest. According to Low & Rebelo (1996) the vegetation of Maputaland is part of both the Savanna and Forest Biomes. Savanna vegetation types recognised by them in the area are Sweet Lowveld Bushveld and Natal Lowveld Bushveld, and Coastal Bushveld-Grassland. The Sand Forest and Coastal Forest belong to the Forest Biome.

At least fifteen broad vegetation types were described for the KwaZulu-Natal portion of Maputaland by Moll (1977, 1980). However, with the exception of the pioneering work of Myre (1964) on the vegetation of southern Mozambique, very little detailed work has been done on the phytosociology of the region's sand-associated vegetation types. Myre's vegetation classification concentrated on the grasslands, with only superficial descriptions being given for woodland and associated communities. Tinley (1971, 1976, 1985) did some pioneering work on the vegetation along the coast including mapping much of the southern Mozambique vegetation. Detailed vegetation descriptions have, however, been published for Ndumo Game Reserve (De Moor *et al*. 1977) and Mkhuzi Game Reserve (Goodman 1990) but these areas are not chiefly on sand. Klingelhoeffer (1987) did some work on the vegetation of the Tembe Elephant Park, but this was a broad-scale study related to elephant in the area. Lubbe (1996) completed a comprehensive vegetation study of the coastal strip from the Mozambique border down to Sodwana Bay, and included all the estuarine and lake systems in this area. Kirkwood & Midgley (1999) analysed the floristics and structure of Sand Forest.

2.4.1 Unique plant communities

Two noteworthy vegetation types, Sand Forest and Woody Grassland occur in Maputaland and are considered endemic to the Maputaland Centre. In this study emphasis was put on Sand Forest specifically as there are many intriguing aspects and management questions related to this Forest type. For example it is the forest type in the Maputaland Centre with the highest number of plant and animal types that are endemic to the Maputaland Centre, many of which are rare plants and animals. Sand Forest is the habitat for rare types of animals such as suni (*Neotragus moschatus*), four-toed elephant shrew (*Petrodromus tetradactylus*), Neergaard's sunbird (*Nectarinia neergaardi*), bluethroated sunbird (*Anthreptes reichenowi*), African broadbill (*Smithornis capensis*) and many different species of butterfly. Sand Forest shows low regenerating capabilities and certain of the large tree species like *Newtonia hildebrandtii* seem only to occur as mature plants. There are also management questions about the impact that elephants have on Sand Forest in Tembe Elephant Park. The Woody Grassland also has relatively high numbers of plant and animal types that are endemic to the Maputaland Centre, many of which are rare plants and animals. Intriguing aspects of this habitat is the suffrutex growth form that is so prevalent among many of the woody plant species.

2.4.1.1 Sand Forest (also named Licuáti Forest)

This forest type occurs in both South Africa and Mozambique. Sand Forest, also known as Licuáti Forest in Mozambique, is a very distinctive forest type with a unique combination of plant and animal taxa. This vegetation type is more or less restricted to ancient coastal dunes in northern KwaZulu-Natal and the extreme southern portion of Mozambique (Maputaland). Sand Forest harbours many rare and unusual types of plant and animal, including several Maputaland Centre endemics. Because of its restricted occurrence and unusual species complement, Sand Forest is one of the most important habitat types in the Maputaland Centre. It occurs in patches from False Bay in the south to just south of Maputo in Mozambique (Myre 1964; De Moor *et al*. 1977; Moll 1978; Moll & White 1978; Goodman 1990; Matthews *et al*. 1991, 2001; Everard *et al*. 1995; Lubbe 1997; Kirkwood & Midgley 1999; Siebert *et al*. 2002). The biggest stand of Sand Forest (perhaps best described as thicket in this area) is found in southern Mozambique (north of Tembe Elephant Park) ~ 25 km long and ~8 km wide (Siebert *et al*. 2002; Izidine 2003).

Structurally Sand Forest is from 5 to 12 m tall and forms a dense vegetation with different strata. The forest is generally low-grown, with a closed canopy of *Cleistanthus schlechteri, Dialium schlechteri* and *Hymenocardia ulmoides*. *Newtonia hildebrandtii* is one of the tallest species emerging above the forest canopy. *Croton pseudopulchellus*, *Pteleopsis myrtifolia, Drypetes arguta, Uvaria lucida* and *Cola greenwayi* are the most common shrubs in the understorey; while *Eragrostis moggii* is the most abundant grass species. The emergent trees are covered in places by epiphytic plants such as orchids and lichens. These forests have a relic character showing links to the tropical forest flora further north. The patches of Sand Forest are characterised by very sharp boundaries towards the surrounding vegetation (generally sandy woodland) and a distinct surrounding 'fringe’ of thicket-like vegetation. In most cases the forests are delimited by narrow zones of sparse grass-vegetated or bare-sand areas directly adjacent to the forest margin, and these in turn are surrounded by open woodland communities.

The word “Licuáti” is a Mozambican (Ronga word) term that locally (locally referring to southern Mozambican areas, Maputaland) refers to thick bush that in most cases is what on the South African side is known as Sand Forest. Myre (1964) was the first to use the term “Licuáti Forest” formally to refer to a type of forest of which the composition corresponds closely with what is now called Sand Forest. A distinction has been made between so-called tall and short sand Licuáti Forest. Izidine (2004) referred to the short, dense form of Sand Forest and proposed to call it Licuáti Thicket, based on Edward's (1983) structural classification of vegetation. The 14 000 ha of the Licuáti Forest Reserve, Mozambique, is a fine example of this form of Sand Forest. The tall form continues to be referred to as Licuáti Forest.

2.4.1.2 Woody Grassland

This unique grassland type is endemic to the Maputaland Centre, and is shared by South Africa and Mozambique. The Name Woody Grassland is applied to an unusual type of grassland characterised by the abundance of dwarf woody plant species with annual or short-lived woody shoots sprouting from a massive perennial underground system (so-called geoxylic suffrutices). The Woody Grassland is characterized by the dwarf shrubs *Parinari capensis* subsp. *incohata*, *Eugenia albanensis, Ancylobotrys petersiana*, *Diospyros galpinii, Gymnosporia markwardii*, *Eugenia capensis* (suffrutex form) and *Salacia kraussii*. Grass species include *Themeda triandra, Cymbopogon plurinodis, Diheteropogon amplectens, Trachypogon spicatus* and *Urelytrum agropyriodes*. This rather uncommon growth-form appears to be best developed in Africa, with the greatest concentration of such taxa occurring in the Zambesian Region (White 1976, 1983). These dwarf woody plants can be compared with extremely stunted trees, a fact which led White (1976) to refer to them as the "underground forests of Africa". Woody Grassland is found widespread on the dune crests and slopes elevated above the low-relief plains. It also occurs in open areas on sandy soils in woodlands and the Palmveld of Moll (1978).