



# Peatland Types and Tropical Swamp Forests on the Maputaland Coastal Plain (South Africa)

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## Contents

Introduction .....	1424
Geomorphological History of the Maputaland Coastal Plain .....	1424
Mire Types of Maputaland Coastal Plain .....	1426
Peat Swamp Forests .....	1428
Swamp Forest on Mineral Soils .....	1433
Threats and Future Challenges to Mires and Swamp Forests .....	1433
References .....	1434

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**Abstract**

The Maputaland Coastal Plain (MCP) is on the north-eastern seaboard of the KwaZulu-Natal Province, South Africa. It hosts a variety of wetlands and mire types that range from rare tropical swamp forest and calcareous fens to various inter-dune settings with groundwater-fed to surface water fed fens and floodplains. The MCP peatland areas are important not only for biodiversity (e.g. many endemic species) and supporting subsistence cultivation but they also host the largest and thickest peat deposits found in South Africa. The peatlands on the MCP developed in a drowned dune landscape and the peat thickness vary from 0.5 to 11 m. Threats and future challenges on the peatlands in Maputaland include the effects of land-use practices: plantations, agriculture and urbanization. Attempts to conserve swamp forests are often frustrated by the different management frameworks of provincial conservation agencies and the national government.

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**Keywords**

Groundwater · Hydrology · Mire types · Subsistence cultivation

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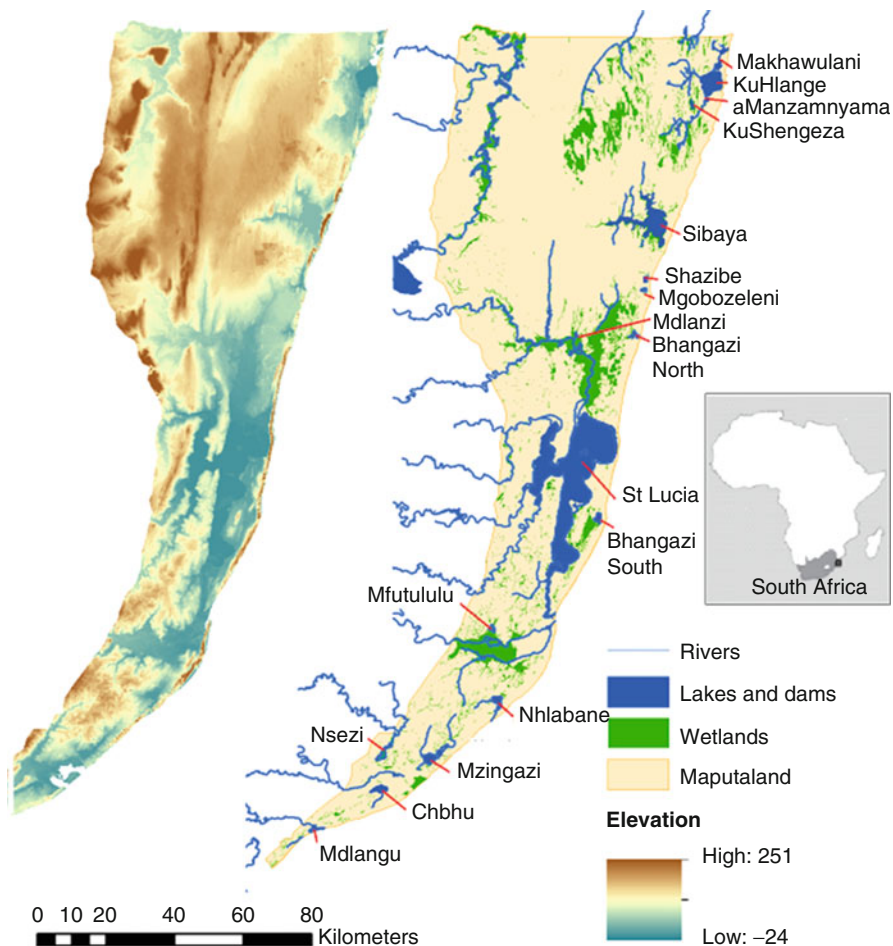
**Introduction**

The Maputaland Coastal Plain (MCP) is one of the wetter areas in South Africa with a mean annual precipitation of 900–1,000 mm. It hosts the most extensive wetlands and best developed peat deposits in South Africa and has a high biodiversity with many endemic species (Grundling et al. 1998; Smuts 1992). Maputaland, the southern tip of the Mozambique Coastal Plain (Fig. 1) in South Africa's KwaZulu-Natal Province, contains 60% of the known peat resources in South Africa, ranging in size from a few to thousands of hectares of wetland (Grundling et al. 1998). Approximately 266 peatlands occur within the MCP with peat thickness varying from 0.5 to 11 m (Grundling et al. 2000). The highest concentration of peatlands occurs close to the coast where the precipitation is highest, but larger peatlands also occur towards the western edge of Lake Sibaya (Grundling 1994) and the tributaries of the northward flowing Futi (Mkuzi-North) stream, where the rainfall varies between 600 and 800 mm pa (Grundling et al. 1998). The tropical peat swamp forests of Maputaland form about a third of the peatlands in Maputaland and are one of the most unique and rare wetland types in southern Africa (Moll 1980; Wessels 1997). Various land use practices impact negatively on the peatlands in Maputaland, including plantation, cultivation and urbanization (Grundling et al. 2013a).

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**Geomorphological History of the Maputaland Coastal Plain**

The original rivers of this area flowed from west to east, i.e., approximately at right angles to the present coastline (Fig. 1). Most had estuaries, controlled partly by coastal sand bars, partly by a rise in sea level. Periods of transgression have resulted



**Fig. 1** Landscapes (high 250 m.a.s.l and low <50 m.a.s.l), rivers, lakes and wetlands and major peatlands of the Maputland Coastal Plain, on the Indian seaboard of South Africa (With permission from Grundling et al. 2014)

in the drowning of the coast-parallel dune valleys allowing low energy, low-sedimentation regimes to prevail. Peat deposits have developed in this drowned dune landscape (Smuts 1992), often in association with the lakes, which are the result of damming and diversion of rivers by belts of sand dunes. These dunes originate from beach deflation (Hart 1995).

The shape of the lakes is controlled by the topography of the drowned dune landscape. Some of these lakes, such as Lake Sibaya, are up to 35 m deep (Wright et al. 2000). Some lakes are isolated and their river mouths closed by dunes up to 180 m high (northern part of the study area). Lake Sibaya and Lake Bhangazi were formed in this way (Hart 1995). Excess water from the lake seeps through the dune to

reach the ocean in the form of fresh-water beach springs (Taylor et al. 2006). Lake Sibaya is the largest natural fresh water body in South Africa and 29 groundwater-fed peatlands (fens) are directly related to this lake (Grundling et al. 2000).

Lake St. Lucia represents a composite diversion of several river systems, such as the Mkuze and the Hluhluwe (Hart 1995). The diversion in the case of Lake St. Lucia has been for a distance of 80 km. The St. Lucia wetland system hosts the largest and the thickest peatlands in South Africa. They are respectively the Mkuze Delta (a floodplain with papyrus, reed and peat swamp forest) with an aerial extent of 8,800 ha and the Mfabeni Mire with a peat thickness of 10 m (Grundling et al. 2013b). The genesis of lake associated peatlands is interpreted to be related to a rise in sea level and with high groundwater levels in adjacent dune systems (Grundling et al. 2000; Grundling et al 2013b). This rise in sea level has reduced the sediment carrying capacity of the rivers. Consequently the rivers deposit the sediment within their valleys, many kilometres before reaching the sea shore. During floods, the rivers flow out of their normal river courses onto the floodplain. In many instances, these flood waters spread wide enough to submerge the lower reaches of smaller tributaries of the main rivers (Grundling et al. 2000; Ellery et al. 2012). The sediment build-up on the main floodplain, in some instances, has further dammed the lower reaches of the local tributaries, resulting in the formation of more lakes in the lower portions of these tributaries. About 15% of the peatlands in Maputaland are associated with these lakes.

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## Mire Types of Maputaland Coastal Plain

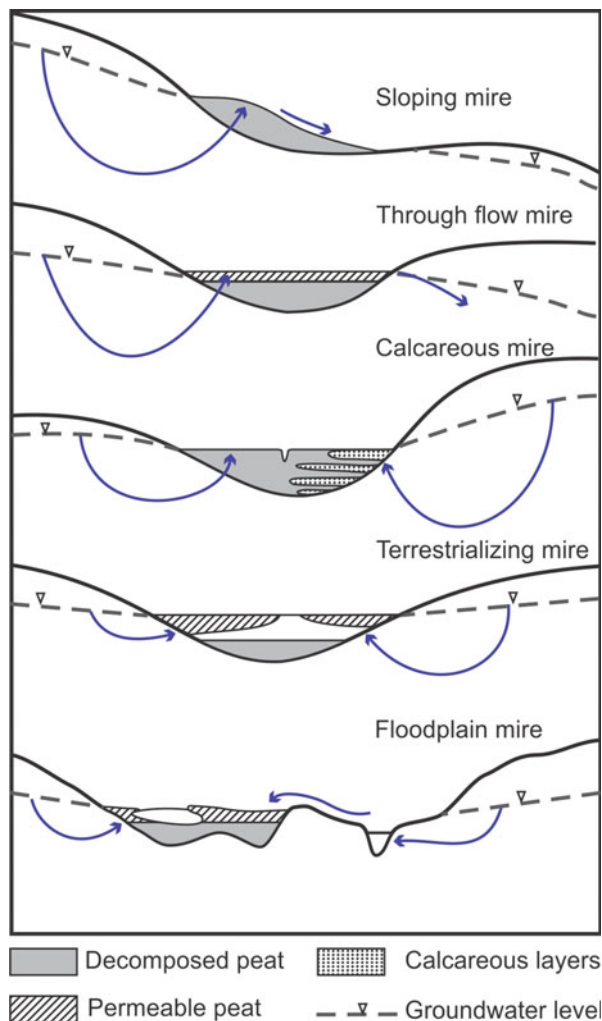
A variety of mire types, all fens as they are all groundwater-fed or surface water fed, can be found on the MCP, of which the following are distinguished (Fig. 2):

*Sloping mires* (Fig. 3) are fed by groundwater from a larger plateau that is discharging groundwater on its slopes (i.e., through seepage) to a low lying area. Usually these systems are associated with geological faults or deeply incised valleys, where erosion has exposed an aquifer. In Maputaland these are usually associated with perched aquifers formed by impermeable clay layers, or occur closer to the coast where the regional water table is intersected by incised valleys. Slope or spring mires are often associated with swamp forest components (Grundling et al. 2014).

*Through flow mires* (also called percolation fens) (Fig. 4) have groundwater flowing through the shallow peat layers, or more often passing over the surface of the peat. Such fens are also relatively flat and can contain both groundwater and rainwater on the surface. The peat layers can be quite thick (up to 11 m). These isolated inter-dunal mires are quite common in northern Maputaland and are usually covered by reeds and sedges. They are orientated parallel to the Pleistocene dune ridges and hydrologically linked to coastal lakes with an estuary. Examples are Siyadla, the Muzi North system in Tembe Elephant Park and the Mfabeni Mire (Grundling et al. 2013b).

*Calcareous mires* (Fig. 5) have deposited calcite on the peat, thus creating a very alkaline and nutrient-poor environment. The calcite originates from supersaturated

**Fig. 2** Conceptual models of hydrological functioning of some Maputaland mire types (© Rights remain with the authors)



groundwater, which precipitates  $\text{CaCO}_3$  when exposed to the air (Grootjans et al. 2012). Only one example of a calcareous mire has been found on the MCP (the Muzi North system in Tembe Elephant Park). Chalk (marl) deposits were observed in the peat profile where it borders a through flow mire (Grundling 2014).

*Terrestrializing mires* (Fig. 6) are flat and float on surface water. Peat formation can proceed because such mires do not dry out. They are mainly fed by lake water, but groundwater may also reach such fens. The floating mat mostly consists of papyrus (*Cyperus papyrus*), reeds (*Phragmites australis*) and sedges (*Fimbristylis longiculmis*, *Cladium mariscus*) and during the last stage of terrestrializing, swamp forest (dominated mainly by *Ficus trichopoda*, *Syzigium cordatum* and *Voacanga thouarsii*) colonizes the mire. Terrestrializing mires are the most common type of peatland in the Maputaland area.



**Fig. 3** The Mfabeni sedge fen (*foreground*), an 11-m deep peatland with a sloping mire (the Nkazana swamp forest) comprising its western edge (*middle ground*) (Photo credit: Piet-Louis Grundling © Rights remain with the author)

*Floodplain mires* (Fig. 7) are fed by surface water (floods from rivers) and also by groundwater. Due to the high energy conditions experienced during flood events, much sediment is deposited on these mires. Consequently, they are more productive than the former fen types and covered by papyrus, reeds and sedges. The peat is often formed by floating mats with the peat layers practically always containing grey clay particles or thin grey clay laminae. The clay observed in this peat is deposited in the papyrus mats when the floodplain back-floods into the off-channel lakes during flood events. Some swamp forests occur in these settings as well. These peatlands are usually found at the fringes of large floodplains, where they are supplied with groundwater from the surrounding plateaus or dunes. Good examples are mires in the vicinity of the Pongolo, Mkuze, Hluhluwe, Umfolozi and Mhlatuzi rivers.

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## Peat Swamp Forests

Peat swamp forests (Fig. 8) are fresh-water forested wetlands that are established on peat and require a high water table with periodic saturated conditions, as a result of inundation, that creates a favourable hydrological regime for peat development (Sliva 2004). Most swamp forests occur in the proximity of lakes (Table 1) within inundated (flooded) inter-dune valleys (Grundling et al. 2000). Other important settings are seep zones, inter-dune valleys and drainage lines underlain by low-permeability sediments (Sliva 2004), whereby groundwater seepage elevates the water table sufficiently to promote peat accumulation in which the long-term annual average biomass production exceeds decay (Clymo 1983). The MCP hosts 75% of South Africa's swamp forests (Lubbe 1997) with 59% of all South African swamp forest protected within the iSimangaliso Wetland Park (Wessels 1997).



**Fig. 4** A through flow mire in an inter-dune setting in the iSimangaliso Wetland Park. Below is a close-up of the gardens (Photos credit: Althea Grundling © Rights remain with the author)



**Fig. 5** Aerial view of the Muzi peatland, Tembe Elephant Park – a calcareous mire. Note the elephants in the mire (Photo credit: Piet-Louis Grundling © Rights remain with the author)



**Fig. 6** Terrestrializing mires (Photo credit: Retief Grobler © Rights remain with the author)





**Fig. 7** Floodplain mires. *Above*, aerial view with meandering river (Photo credit: Piet-Louis Grundling © Rights remain with the author). *Below*, the Pongolo Floodplain (Photo credit: Althea Grundling © Rights remain with the author)



**Fig. 8** Peat swamp forest at Twamansi (Photo credit: Retief Grobler © Rights remain with the author)

**Table 1** Lakes associated with peatlands on the Maputaland Coastal Plain

Lake	Isolated, floodplain or open ended	No of peatlands	Peat thickness (m)	Peat area (ha)
Manzamnyama	Open ended	1	0.65	3.5
Bhangazi North	Isolated	16	6.2	66.5
Bhangazi South	Open ended	1	11	1460
Cubhu	Open ended	3	2	30
KuHlange	Open ended	6	6.1	46.5
KuShengeza	Isolated	2	1.1	16
Makhawulani	Open ended	3	4.7	21
Mdlangu	Open ended	1	1.65	4
Mdlanzi	Floodplain	3	4.7	248
Mfutululu	Floodplain	1	6.5	87.5
Mgobozeleni	Open ended	4	2.4	131
Mzingazi	Open ended	5	3.5	715
Nhlabane	Open ended	3	3.2	23
Nsezi	Floodplain	1	5.9	324
Shazibe	Open ended	2	2.85	150
Sibaya	Isolated	29	5.5	400
St Lucia	Open ended	7	5.9	7650
<b>Total: 17</b>		<b>88</b>		<b>10 732.5</b>

## Swamp Forest on Mineral Soils

It has been noted extensively throughout the whole study area that swamp forests or riverine forests that are dominated by *Barringtonia racemosa* do not contain peat. Only some organic, sandy clay or dark clay material is present. *B. racemosa* only dominates parts of swamp forest peatlands where there is concentrated surface water flow. Under these conditions the heavy seed pod of *B. racemosa* can be transported. However, much of the organic material that may have accumulated is flushed out of the system at the same time. Therefore, the presence of *B. racemosa* could be an indicator of wetlands with low peat accumulation potential (Grundling et al. 2000).

## Threats and Future Challenges to Mires and Swamp Forests

*Pinus* and *Eucalyptus* plantations both on a commercial and a woodlot scale, has severe impacts on peatlands and swamp forests on the MCP (Blackmore and Mulqueeny 1996). Since swamp forests are largely groundwater dependent the lowering of the water table by forest plantations of exotic species results in desiccation of the peat profile and eventually degradation of the swamp forest, often with accompanying peat fires (Grundling and Blackmore 1998). Soils of the coastal plain of north-eastern South Africa are very sandy, leached and low in nutrients (Watkeys et al. 1993; Sliva 2004), resulting in their low agricultural potential. The low-lying peatland areas, however, are relatively fertile, mostly swamp forests (Grundling et al. 2000). Consequently, the expansion of cultivation is the most significant land-use pressure in swamp forest of the MCP (SANBI 2006; Grundling and Grundling 2007), threatening both the ecosystem and the soil resource itself (Grundling et al. 1998). The relatively fertile peat soils with high water-holding capacity are very suitable for crops such as bananas, madumbe (taro), cassava and sweet potato as well as a variety of vegetables; these crops are instrumental in the local food supply, economy and social structure (Sliva 2004). However, the productivity of subsistence cultivation on swamp forest peat is threatened by soil degradation associated with drainage, especially carbon loss through soil oxidation and peat fires. Since the type of crop and farming practice influences water use and soil carbon store (Robinson and Alberts 1989; Jones 2006), a sustainable swamp forest use strategy is important to maintain ecological condition and prolongs productive use, essential for building food security and easing pressure on the remaining pristine systems. Sustainable management actions include the blocking of drains to maintain high water tables to reduce desiccation, oxidation and collapsing and burning of the peat. The increasing population, which is one of the most impoverished in the country (Morgenthal et al. 2004), is partly constituted by illegal cross-border migration and depends mainly on subsistence living (Grobler et al. 2004) derived primarily from swamp forest cultivation. Degradation of the swamp forest is a key symptom of complex socio-economic and ecological processes that constitute a 'difficult and complex problem' for stakeholders across the wider socio-political terrain (Van Bueren et al. 2003).

Rainfall patterns dictate the distribution of the human population in Maputaland and most communities are located on the fertile floodplains of the Pongola, Mkuze and

other rivers in the western parts of Maputaland or close to the higher rainfall areas along the eastern coastal dune corridor. The higher population densities associated with the higher rainfall thus also result in more pressures on coastal swamp forests.

Evidence of abandoned raised garden beds (described as fossil gardens by Grundling 1996, Fig. 9) in seasonal wetlands in Maputaland highlights the unpredictable inundation of wetlands dependent on variable rainfall patterns. Local groundwater tables vary as much as 3 m within a season responding to large rainfall events after extensive drier periods. The stable water sources associated with swamp forests are thus another important consideration when selecting cultivation plots, which leads to greater pressure on the swamp forests. The pattern and expansion of cultivation in swamp forests is directly linked to road access and distance to informal markets (KwaZulu-Natal Top Business 2009; Grundling et al. 2013a).

Roughly 4,000 ha of peat swamp forest occurs on the coastal plain, much of which is still unclassified due to its remoteness and inaccessibility (Wessels 1997), although Sliva (2004) recognized swamp forest sites as either “pristine”, “recently disturbed”, “long-time recovering” or under “active gardening”. Some swamp forests have been designated as Ramsar Sites, recognizing their unique character and settings. However, such attempts to conserve swamp forests are often frustrated by other management frameworks operating within different socio-spatial, political and resource jurisdictions (Sliva 2004).

The Maputaland Coastal Plain hosts a variety of mires ranging from calcareous fens to swamp forest that developed in an array of hydrogeomorphic settings. Not only do these mires contribute to the rich biodiversity of the region, they also provide the basis for subsistence farming and the only means of survival for many families. Conserving and making wise use of these systems is therefore of importance, and research to understand how they function and the need for sustainable management should be promoted.

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