Vegetation of Richards Bay municipal area, KwaZulu-Natal, South Africa, with specific reference to wetlands

by

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Declaration:

I, **Jeanine Burger** declare that the thesis/dissertation, which I hereby submit for the degree **Magister Scientiae** at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

SIGNATURE: ..…………………………..

DATE: 23 January 2009

This dissertation is dedicated to my parents Johan and Hester Burger and my sister, Surette.

“Maybe botanists live so long, I thought, because their own anxieties leach out and get lost in the intricate details of their subject…”
- Redmond O’Hanlon

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CHAPTER 1: INTRODUCTION

1.1 Basic spatial relationships surrounding Richards Bay

A variety of plant communities with a relatively high diversity of plant species occur in northern KwaZulu-Natal. With the moist-subtropical climate of this coastal area the vegetation has an exuberant appearance. The communities vary from simple aquatic, wetland and psammophitic herbaceous communities to complex wetland and dune forests. Currently though, few of these coastal plant communities still exist in a pristine state.

The coastal vegetation of KwaZulu-Natal is classified by Moll and White (1978) as comprising part of the Tongaland-Pondoland regional mosaic. The vegetation consists primarily of woody thicket and forest communities which Acocks (1988) describes as belonging to the group of Coastal sub-tropical Forests including Typical Coast-belt Forest, Dune Forest and Mangrove Forest. Other classifications of the coastal vegetation include those by Edwards (1967) and Moll (1976).

The coastal forest communities have been most thoroughly documented in terms of their biogeography (Moll and White, 1978; Tinley, 1985), phytosociology (Moll, 1969, 1978 and 1980; Macdevette and Walker, 1987; Guy and Jarman, 1969) and general ecology (Venter, 1972, 1976; Ward, 1980; Weisser *et al.*, 1982). Other plant communities are less well described.

The northern KwaZulu-Natal coast forms part of the Mozambique Coastal Plain. This area stretches from Mtunzini into the southern region of

Mozambique. Maputaland (previously known as Tongoland) is located in the north-eastern corner of KwaZulu-Natal, bordered by Mozambique to the north, the Indian Ocean to the east, the Lebombo Montains and Swaziland to the west, and the Mkuzi River and Lake St. Lucia to the south (Moll, 1977 in Lubbe, 1996).

For the size, which is approximately 26 734 km^2, the Maputaland Centre is one of the most remarkable areas of biodiversity in the world. Not only is the number of endemic species high, but they are spread over virtually the entire taxonomic spectrum. The total number of vascular plant species is at least 2500, with 225 or more species or infraspecific taxa endemic or near-endemic to the centre (Lubbe, 1996). The vegetation of Maputaland is exceptionally diverse. It consists of a mosaic of forest, woodland, grassland and swamps (Lubbe, 1996). Moll (1980) classified the vegetation of Maputaland into fifteen major types, ranging from forest on the Lebombo Mountain Range through different types of bushveld, sandforest and swamps down to the coast with coastal grassland and dune forest (Lubbe, 1996).

The diverse vegetation in the study area reflects the topographic and climatic variability of the region. The dominant primary vegetation is Coastal Forest but much of this has been destroyed or degraded by agricultural activities or industrial development. This has resulted in a complex mosaic of different fragmented communities (Weisser and Müller, 1983). With the exception of certain coastal dune areas, some wetlands and a few nature reserves, the greater part of this area has been exploited for agricultural use and forestry (Venter, 1972). This study broadly comprises a semi-quantitative study of the vegetation on the Richards Bay municipal areas, using the Braun-Blanquet method.

The Richards Bay landscape was historically comprised of a wetland environment, second only to the Greater St. Lucia Wetland Complex in size. Today the wetland environment is a fraction of its former area, but notwithstanding its reduction over time, it remains an extensive and important wetland environment. This area contains many plant and animal species at the southern limit of their tropical distribution, as well as some endemic species.

The key feature which maintain these wetlands are the large water bodies that exist today (Fig. 1.1). The position of, and linkages between these bodies can be important or useful guides for planning and development initiatives. Essentially, three large water bodies occur parallel and close to the coastline. These are Lake Mzingazi, Richards Bay Harbour and the Sanctuary Nature Reserve, which form part of the uMhlatuze River catchment (van Wyk and Bailey, 1998). The total catchment area is 4489 to 4258 km^2 (Begg, 1978). These three waterbodies recieve runoff (and subterranean water) from the immediate drainage catchment of Richards Bay. The uMhlatuze River basin area is 3670 to 3936 km^2, the main tributaries being the Nseleni River from the North-East, draining into Lake Nseze and the Mfule River. The Mthantatheni River drains into Lake Cubhu on the southern margins of the coastal flood plain. The Mzingazi River drains Lake Mzingazi on the northern margin of the coastal flood plain and several small tributaries (Mdibi, Khondweni, Payeni, Amansimyama and the

Nkoninga) discharge from the heavily urbanised and developed subcatchments surrounding the lake (van Wyk and Bailey, 1998).

These water bodies and their associated drainage systems play a key role in the functioning of the wetland environment of Richards Bay (Discussion document 2000). It therefore appears to play a key role in the management of the town, its open spaces and development areas. It is the open spaces that encompass the drainage system and the development areas that impact on the natural system and its ability to sustain itself.

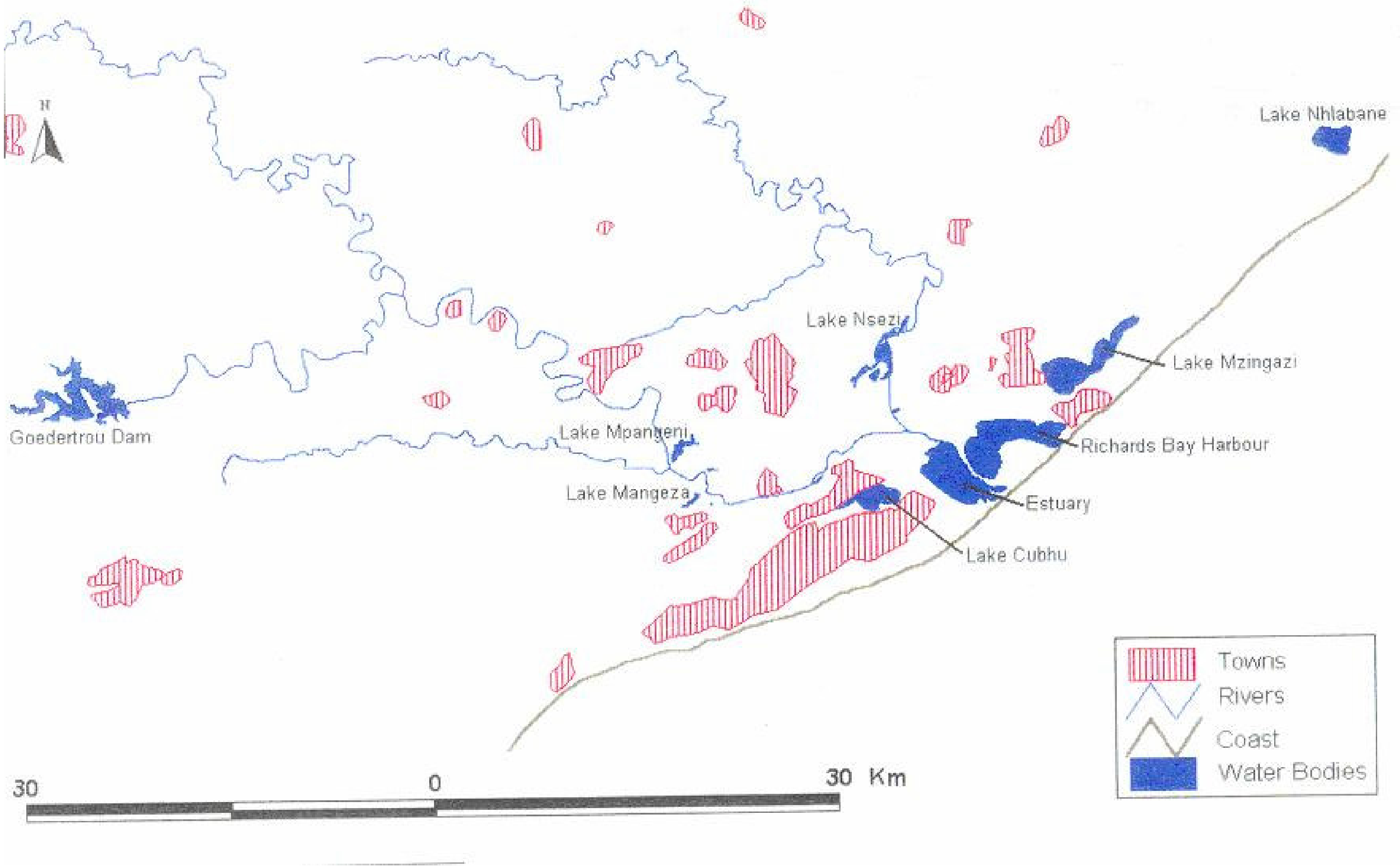


Figure 1.1: A Map of regional water resources (After Kelbe, Germishuyse, Snyman and Fourie, 2001).

1.2 General introduction to wetlands

"Wetlands" is a relatively new term used to describe the landscape that many people knew before under different names such as swamp, marsh and vlei, and indeed is used as a generic term for any ecosystem which has an aquatic base or hydrological driving force. Wetlands occur in many different climatic zones, in many different locations from the upper reaches of a catchment, down to the river mouths and estuaries and have a wide range of soil and sediment characteristics (Fig. 1.2). There are a number of definitions of wetlands in use. The following definition is a good description of the wetlands of the Richards Bay area. Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water where the depth of which at low tide does not exceed six meters. These areas may also include adjacent riparian and coastal zones. This is an intentionally broad definition to stem encroachment on habitats as diverse as mangrove swamps, peat bogs, water meadows, coastal beaches, coastal waters, tidal flats, mountain lakes and tropical river systems (Cowan and van Riet, 1998).

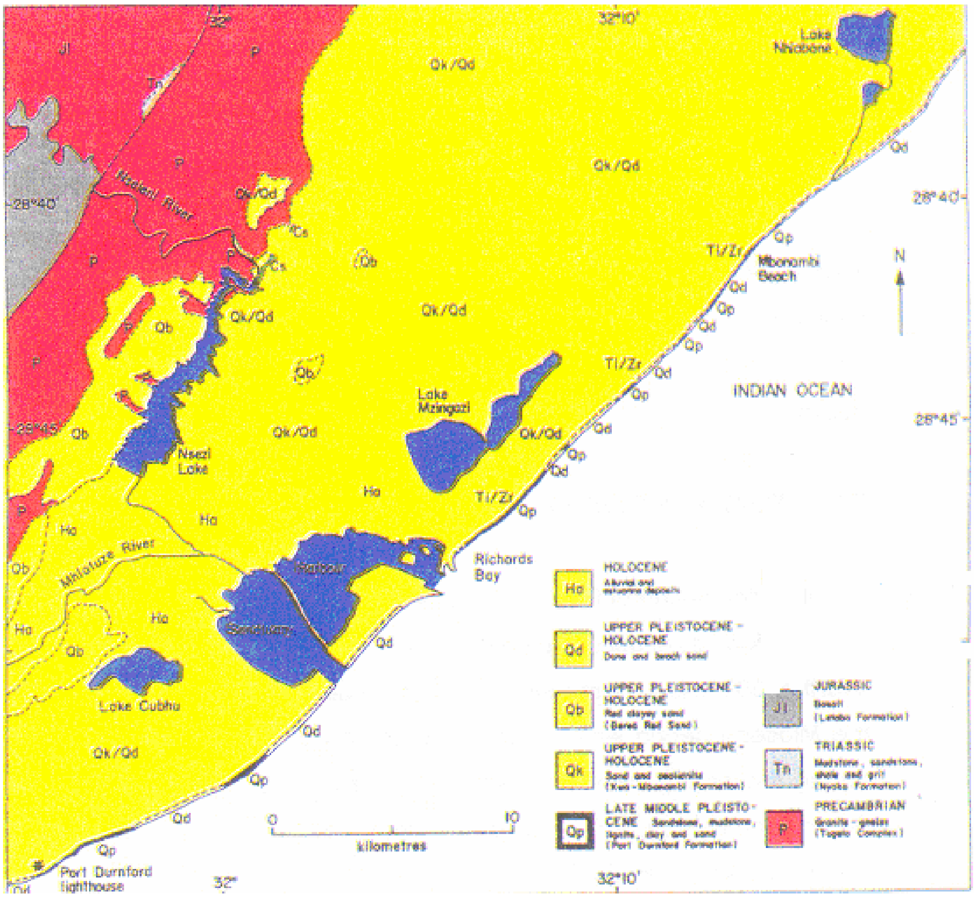


Figure 1.2: A simplified geological map of the Richards Bay region (After Worthington, 1978).

Whatever term used, the distinguishing feature of all wetlands is the interplay between the land and the water, and the consequent characteristics which reflect both. The hydrological regime may be a result of a number of different factors such as the periodic flooding of floodplains, tidal rise and fall, impeded surface flow due to geological and or geomorphological processes (such as tilting, uplift or landslip, land subsidence, deposition of sediments in estuaries or deltas), or the rising of the water table to above surface level. All these geo-morphological factors contribute to standing water, or to saturated or waterlogged soils.

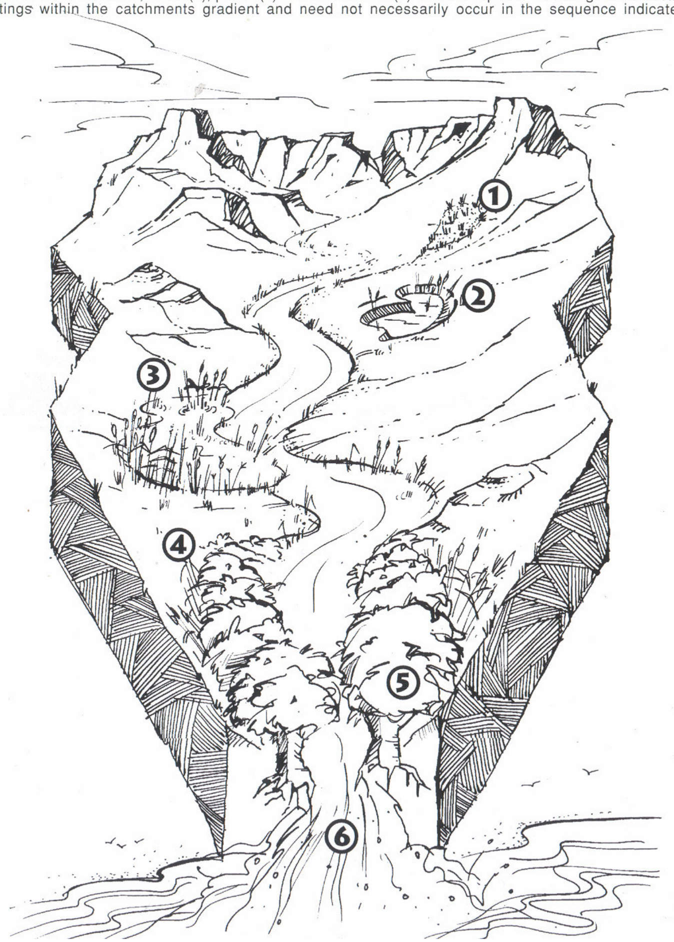
While hydrology is the most important factor in the formation of wetlands, it by no means explains their distinctiveness. Wetlands have a distinctive and characteristic vegetation, and often different to the surrounding vegetation. These plants (hydrophytes) are adapted to wet conditions, being covered by water for at least part of the growing cycle and thus temporarily deficient in oxygen.

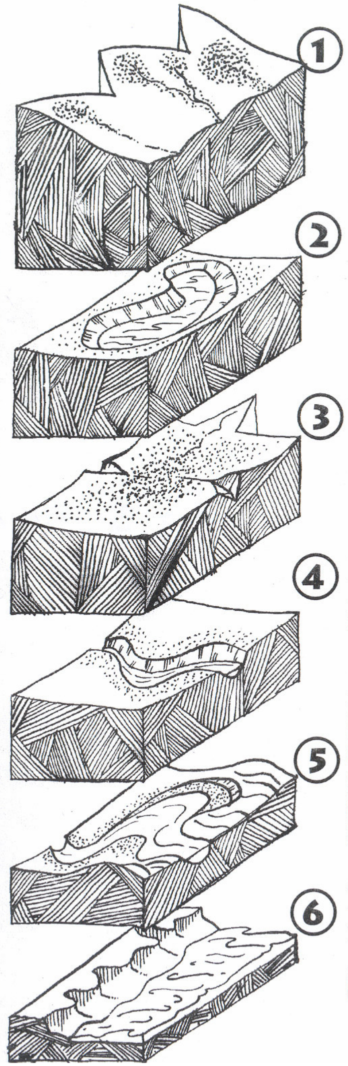
The plants decompose slowly and contribute to the process of wetland formation or maintenance by trapping silt or forming peat. Wetland animals also have specific adaptations to this environment such as the ability to breathe under water, or have developed behavioural patterns for making use of wetlands such as moulting at seasonally high water levels. Wetland soils are adapted to anoxic biochemical processes. They are physically volatile and are in constant flux with the decomposition of the vegetation and the erosion of sediments with river flow, flood and tidal shift.

The interaction between water level, sedimentation and decomposition is finely balanced, and within the soils there are biochemical processes at work as energy flows through the ecosystem leading to the transformation and trapping of nutrients. All of these factors lead to a highly diverse ecosystem which is one of the most productive in the world (Cowan and van Riet, 1998).

WHERE TO FIND WETLANDS

Vetlands occupy characteristic positions in the landscape and with a little practice it becomes relatively easy to dentify probable wetland settings from a distance.
Vhilst stream source (1) estuarine (5) and marine (6) wetlands remain fixed at their respective upper and lower ositions of a catchment; basin (2), plains (3) and streambank (4) wetlands span a wide range of landscape settings within the catchments gradient and need not necessarily occur in the sequence indicated.





1 STREAM SOURCE SETTING

The stream source spring, seepage slope or seepage plain in steeper younger valleys just below the watershed. Water inflow is diffuse and outflow can be diffuse or channelled. These settings are easily overlooked as "wetlands" and because they are often the only green "oases" in an otherwise dry landscape they can be heavily utilised as a water source and "green bite" by domestic stock and game.
Unfortunately the over use of these areas are now apparent as many of the dongas on our hillsides.
A possible future Ramsar site - The Drakensberg Park has many examples of stream source settings.

2 BASIN SETTING

The depression, fringes and open water of temporarily, seasonally, or permanently wet pans, dams and lakes. They can occur in all positions in the landscape. Pans have no obvious drainage. Pans, lakes and man-made dams are not always recognised as "wetlands" especially when temporarily or seasonally wet pans are in their dry condition. Ramsar sites that are basin settings include:- Barberspan, Lake Sibaya and De Hoop Vlei.

PLAINS SETTING

3 These have gentle gradients and can occur in all but the highest positions in the landscape. Water inflow is channelled or diffuse and can be directly linked to a stream source. Outflow is channelled, but within the site the flow can be diffuse, channelled or braided ie; a number of small channels separated by bars. Ox-bows (cut off meanders) and back-marshes often occur on the alluvial plains. Plains wetlands are some of the most recognisable of wetland systems and are commonly referred to as vleis, marshes and swamps. A Ramser site that is a plains setting is Blesbokspruit.

4 STREAMBANK SETTING

The channels, walls and adjacent riparian corridors of streams,rivers and dry water courses (including dongas) that occur throughout the catchment - connecting many wetland settings to each other thus creating a continuim of wetlands from mountain to sea.

ESTUARINE SETTING

The waterbody, fringes and peripheral wetlands around on estuary. For descriptive purposes they are sub-divided as follows:-
Estuaries - the tidal portion of river mouths
Lagoons- normally closed river mouths; and
Non-tidal open river mouths.
5 Whilst estuarine wetlands are amongst the most diverse and richest of natural habitats they are the recipients of intense local use and all up-river use and as such are the ultimate barometers of the condition of their catchments.
Ramsar sites that are estuarine settings include:- Orange River Mouth Wetland, Kosi system, De Mond State Forest, St. Lucia system, Verlorenvlei and the Wilderness Lakes.

MARINE SETTING

6 This setting includes the:-
- Inter-tidal zone - rocky and sandy marine shores -
- Sub-tidal zone - permanent marine shallow waters and coral reefs less than 6m deep at low-tide; and
- Coastal bays- coastal inlets without feeder streams or rivers.
Ramsar sites that are marine settings include:- Langebaan and theTurtle Beaches/Coral Reefs of Tongaland.

Figure 1.3: A Schematic presentation of different wetlands types (After Wyatt, 1997)

1.3 Importance of wetlands

Despite being an extremely important distinction, the functions and values of specific wetland sites often remain undefined. Indeed it has only been in recent decades that wetlands have been recognized as valuable natural resources that, in their natural state provide many important economic benefits to people and their environment.

Wetlands are very important in nature, because they constitute a unique habitat for certain aquatic plant and animal species, especially large numbers of waterfowl. Wetlands lessen the devastating effects of floods and are responsible for cleaner and healthier surface water. They act as a filter for sediment and other impurities and absorb a lot of water that may be released over time. Not many plant species grow in wetlands, but the species that do occur there are often unique (Hey and Phillipi, 1999 in Venter, 2003).

According to Joosten and Clarke (2002) the functions and values of peatland differ according to the different definitions of the word function and values. The values can be divided into three different approaches: idealistic, naturalistic and preference. The functions of a peatland are divided into five types: production functions, carrier functions, regulation functions, information functions and transformation and option functions (Venter, 2003). The production functions include functions where the peat is extracted and used for agriculture, horticulture, as a filter, for peat textiles and as bedding. Drinking water, the use of plants growing on the peatland, the use of wild animals and the uses of the peatland for agriculture are also included in the production functions (Venter, 2003).

Carrier functions include the use of the site for water reservoirs, as fishponds, as an area for urban and industrial development and for use in military exercises and defense. The regulation functions include the regulation of global and local climates, catchment hydrology, catchment hydrochemistry and soil conditions. The information functions include functions such as social-amenity and history, recreation and aesthetics (Venter, 2003).

Certain wetland plants are also used as building material, mostly *Typha* species and *Phragmites* species, or for woven products such as baskets and mats, mostly *Cyperaceae* species or *Juncus* species as well as grasses and *Typha* (Venter, 2003). The occurrence of plant species in a certain area is controlled and influenced by environmental factors (Kent and Coker, 1995). Species that are tolerant of a similar set of environmental conditions and are intolerant of another set of conditions would therefore be restricted to specific habitats and would not occur with species that favour other sets of conditions (Venter, 2003). The plant community represents an unique interaction of a specific plant species composition and a unique set of environmental variables, to form an ecosystem, which also forms a specific habitat for animal species (Bredenkamp and Brown, 2001). It is therefore important to understand that a plant community is not only an indication of the plant species that occur in an area, but also of the environmental factors and the vertebrate and invertebrate faunal species (Venter, 2003). Plant communities can therefore be used as the fundamental units for the planning of Nature Reserves (Bredenkamp and Brown, 2001).

1.4 Threats to wetlands

All classes of wetlands are threatened by organic and inorganic pollutants, which may reach the wetland either directly or indirectly from point sources or diffuse sources. With the exception of marine wetlands, all wetland classes are subject to threats due to changes in their hydrological regimes through water extraction, impoundments, inter-basin transfer and other water resource developments and afforestation. Land-use changes including afforestation, agriculture, industrial and mining developments, recreational and urban developments have both direct and indirect threats on many wetlands.

The 39 freshwater swamp forest sites and 28 peatlands listed in the Directory of South African Wetlands (Cowan and van Riet 1998), are found exclusively in the coastal plain region of Northern KwaZulu-Natal.
Peatlands are used for subsistence farming in an area of infertile sandy soils, and they are important as sources of fresh water, fodder and biomass for local communities. Poor catchment management has resulted in nutrient loading and salinization of the water as well as increased sediment loads. The introduction and spread of invasive alien biota has had a profound effect on both the functioning of wetland ecosystems and on many of their species. This is due to replacement of the indigenous flora, and disappearance of many animal species of all classes.

The vast majority of palustrine wetlands are not found in formally protected areas. This is true even for the larger wetland systems as shown by Begg (1989) who indicated that 65% of the priority wetlands of KwaZulu-Natal are privately owned.

The importance of wetlands in northern KwaZulu-Natal is recognised (Cowan and van Riet, 1998). Wetland plant communities and species composition, and their distribution patterns are still relatively unexplored. More research is definitely needed to contribute to a better understanding of these areas. It will assist in the correct management and conservation of these areas.

Palustrine wetland habitats are found in most of South Africa's Ramsar sites, and a number are found in national parks and provincial reserves. Cowardin *et al.* (1979) while separating "deep water habitats", defined wetlands as the ecosystems which occur between terrestrial and aquatic systems, where an excess of water is the dominant factor. Assuming a freshwater regime, this is possibly the best definition of palustrine wetlands, which comprise a wide range of physical situations, hydrological regimes, chemistries and vegetation types (Cowan and van Riet, 1998). Included in Dugan's (1990) classification of freshwater palustrine habitats are permanent marshes and swamps, permanent peat-forming swamps, seasonal marshes, peatlands and fens, alpine and polar wetlands, springs and oases, volcanic fumaroles, shrub swamps, swamp forest, and forested peatlands. These include both the forested and herbaceous wetlands of Denny (1996).

The main distribution of palustrine wetlands in South Africa almost mirrors the main distribution of endorheic pans (Cowan and van Riet, 1998). Generally they are found in the areas with a mean annual rainfall greater that 500 mm. The main exceptions being those found along the main water courses, and those developed around dolomitic eyes (Skelton *et al.* 1995).

The knowledge base of palustrine wetlands in South Africa is probably the poorest of all the wetland types, and given the estimates that approximately 50% of them have already been lost, much work on these wetlands is required (Cowan and van Riet, 1998). A relatively high number of palustrine wetlands occur in northern KwaZulu-Natal and Richards Bay. Palustrine wetlands occur predominantly as peat-forming swamps, seasonal marshes and forested peatlands. At present the use of peatlands by local communities is threefold: drinking water, harvesting naturally occurring plant material and growing vegetables (Grundling *et al.* 1998). Unsustainable harvesting of plant resources and utilizing peat for vegetable gardens will lead to the degeneration of the wetlands. Consequently not only will there be a decline in the quantity and quality of potable water in KwaZulu-Natal, but also the use of wetlands for structural materials, as a medicinal and subsistence agriculture resource.

1.5 Conservation of wetlands

The conservation of wetlands within a system of protected areas is, by its very nature, extremely difficult. Being part of the hydrological system, they form links in normally linear systems, which extend beyond the protected area boundaries (Cowan and van Riet, 1998). Table 1.1 shows the number of wetlands recorded in the Directory of South African Wetlands, which are afforded varying levels of on site protection.

Table 1.1: Number of wetlands and their level of protection

Where **Total#** is the total number of wetlands in that class, **01** is no information; **02** is no legal protection; **03** is those wetlands partly or wholly included within a private nature reserve, non-hunting area or similar reserve with low level of protection; **04** is wetlands protected within a national park, provincial nature reserve, wildlife sanctuary or equivalent reserve; and **05** wetlands wholly protected within a national park, provincial nature reserve, wildlife sanctuary or equivalent reserve (Cowan and van Riet, 1998).

Protection level			**None**	**Low**	**Part**	**Full**	**% Part**	**% Full**
Class	Total #	01	02	03	04	05		
Marine	11	0	3	4	0	4	**36**	**36**
Estuarine	82	24	38	6	10	3	**19**	**5**
Lagoonal	204	20	142	10	17	15	**13**	**7**
	289	220	31	8	6	24	**5**	**8**
Riverine	208	155	18	13	9	13	**11**	**6**
Lacustrine	69	22	15	7	4	21	**16**	**30**
Palustrine	**263**	**56**	**56**	**23**	**13**	**54**	**14**	**21**
Man-made	251	187*	20	15	10	19**	**10**	**8**

NB * it can be assumed that most of the man-made wetlands for which there is no information have no legal protection;

** while these wetlands (mainly dams) are located within protected areas, their management is primarily for water resource development

CHAPTER 2: LITERATURE REVIEW OF PLANT COMMUNITIES OF NORTHERN KWAZULU-NATAL

A history of vegetation studies in northern KwaZulu-Natal

According to Venter (1972), botanical studies in northern KwaZulu-Natal are mostly related to research done on the KwaZulu-Natal province as a whole. In the 19th century a few contributions to the study of vegetation of KwaZulu-Natal were made by Kraus (1846), Plant (1852), Armitage (1854), Fourcade (1889) and Wood and Evans (1899-1912). According to Bayer (1971), J.F. Drege was the first person to collect plants in KwaZulu-Natal and collected in Zululand as far as Empangeni and Richards Bay. Bayer (1971) also mentions collectors such as William T. Gerrard and M.J. McKen and their collection safaris in Zululand in 1856.

Medley Wood though is known as the father of botany in Natal (Bayer, 1971). He collected through the whole of KwaZulu-Natal and developed the KwaZulu-Natal Herbarium in 1882 in Durban, as a center for taxonomic work. Various important botanical works, including species lists, keys and a textbook saw the light out of his work. Thode (1901) divided the vegetation of KwaZulu-Natal according to altitude into different vegetation regions. Bolus (1905) drew up a simple vegetation map of South Africa on which seven vegetation types could be differentiated. From his description of the vegetation it was clear that the eastern regions of South Africa were very poorly studied. He also noticed an interesting relationship of the vegetation with tropical vegetation and suggested the probability that the eastern region representing an extension of the tropical region.

Bews also did various works on KwaZulu-Natal. In 1912 he not only described the geology, climate and other factors of different regions within KwaZulu-Natal, but also the plant formations occurring there. In this work he gave a comprehensive description on the vegetation of the beach, coastal dunes and estuaries. In 1920 Bews published an article on the plant ecology of the coastal region of KwaZulu-Natal in which he described the different communities occurring there. Most of this description was based on information gathered in the region north of Durban between Umhloti and Port Shepstone in southern KwaZulu-Natal with only an occasional reference to Zululand vegetation. It is important to note that Bews' analyses on the vegetation in this work showed that 86% of the genera and 36% of the species indicated a tropical affinity. He also noted that more temperate, widely distributed plant types occur in earlier stages of succession, where as vegetation tends to get more tropical as succession develops further. Also Aitken and Gale (1921) mentioned the similarity of various plants with tropical vegetation on their collection and exploration trip to Kosi Bay. .

Henkel *et al.* (1936) had three short visits to Dukuduku Forest reserve close to Mtubatuba and the surrounding area. They divided the vegetation into different communities such as beach- and unestablished dune vegetation, established dune vegetation, grassveld, mangrove vegetation and stream bank forest. Pole-Evans's (1936) vegetation map of South Africa already showed a clearer concept of the common composition on the vegetation of

Zululand. He distinguished between two forest types in the coastal region of Zululand eg. Continuous "deciduous woodland and subtropical woodland" as well as discontinuous "temperate indeciduous woodland". The latter occurring around Kosi Bay and just south of Lake St. Lucia. Bayer (1938) described the vegetation of KwaZulu-Natal in detail. Though no quantitative studies were done, the descriptions testify were acute and up to present times, are seen as an important reference source on KwaZulu -Natal vegetation. He distinguished between coastal strip- and midlands-vegetation, and analysed both regions very accurately. The coastal strip vegetation he divided into coastal dune communities, coastal grassveld, coastal indeciduous bushland and woodland communities, hygrophyllous, coastal communities, mangrove vegetation and indeciduous subtropical forest.

Acocks (1953) described the vegetation of the eastern region of South Africa as "forest- and thornveld of the coastal region" and he distinguished five types. Despite the comprehensiveness of this description, it lacks information on the northern coastal dunes and wetlands, with very little mentioned of the mangrove vegetation. He admits the need for a better and more descriptive study of the coastal region, especially north of Isipingo. At a later stage a remarkable and comprehensive analysis and description of the northeastern KwaZulu-Natal vegetation was published in four reports by Tinley. In the first (1958a) he produced a report on the vegetation of Lake Sibayi. The second (1958b) dealt with the Pongolo- and Mkuze floodplains, the third (1958c) with the Kosi-lake system and the fourth on the Ndumu Game Reserve.

Huntley (1965) described the vegetation of the Ngoye Forest reserve in the Mtunzini area of KwaZulu-Natal. The description of the forest is supported with profile diagrams and histograms. He mentions the presence of common plants with physical adaptations similar to those found in tropical forest.

Venter (1966 and 1969) analysed and described the vegetation of the Ubisane valley in the Mtunzini area in a quantitative study. He studied the influence of the environment on the vegetation and also determined the productivity of grassveld species occurring in the valley.

The vegetation of the Tugela drainage basin was mapped and described by Edwards (1967) and a large part of this area he studied stretched into the borders of KwaZulu-Natal, but only a small strip of the coastal region was covered north of the Tugela River. He divides the coastal vegetation into several communities such as pioneer communities, coastal dune – shrubveld and –forest, with hygrophyllous vegetation at the river mouth. Breen and Hill (1969) made a quantitative study on the distribution and survival of mangroves after mass deaths of it occurred in the Kosi Bay estuary. Breen (1970) did another quantitative survey on the dune forest at Lake Sibayi in northern KwaZulu-Natal. This data enabled him to describe not only the composition and density of it, but also the possibility of the composition of the canopy strata in the future.

Venter (1971a) presented a preliminary overview on the vegetation of Richards Bay. In this report he gave a brief review of the different vegetation communities and dominant species. A species list of the grassveld- and wetland communities of Ngoye Forest Reserve was drawn up by Venter (1971b). This list is completive to the quantitative survey and description of the grassveld of the above mentioned reserve (Venter, 1971c).

In 1972 Venter carried out an in depth study on the plant ecology of Richards Bay. The aim of this study was to describe and analyse the vegetation of Richards Bay and to determine the influence of the environment on the vegetation and to compare the Richards Bay forests with those of Mapelane and Sibayi. Basically he distinguished between two habitat types: dune- and grass veld and swamp veld. A multi-dimensional ordination of stands according to the method of principal components analysis showed that there was a distinct difference in the centers of distribution of the species that were included in the ordination. The floristic analysis showed that the Poaceae, Asteraceae, Fabaceae and Cyperaceae were the largest families present at Richards Bay at this time. The above standing review therefore gives a clear indication of the great variety of ecological types that are still unknown and undescribed, with a special emphasis on how little quantitative work has been done.

In studies that followed though, only certain plant communities of specific areas (usually as part of impact assessments or unpublished reports), were described. Hemems *et al.* (1981), made a brief description of the vegetation surrounding Lake Nseze. They found that Lake Nseze was dominated by the southern most extensive area of *Cyperus papyrus* in Africa which continues into the lower section of the uMhlatuze floodplain. They also observed that the alien invasive, water hyacinth *Eichhornia crassipes* was widespread throughout the system, fringing most of the shoreline of the open water areas and the whole length of the river channel. They noted that the forest communities that developed around the lake outlet channel and on sections of the levees along the course of the river were of particular botanical interest and that four main forest areas are considered to be among the best remaining examples of riverine or riparian forest in South Africa.

Walmsley and Grobler (1985) described the vegetation of Lake Mzingazi briefly as part of an evaluation report. They differentiated the herbaceous vegetation into *Scirpus littoralis* communities, *Cyperus papyrus* swamp, *Phragmites australis* reedswamp, *Typha capensis* reedswamp, and sedge marsh and hygrophilous grassland. The woody vegetation they divided into shore-fringing forest, hygrophilous forest along streamlets and swamp forest. They noted that communities slightly or unaffected by high water table would be the natural areas with no or little human interference, like sand forest and areas with conspicuous human interference such as fields, mixed secondary grasslands and secondary shrubland, secondary grassland, *Acacia karoo* woodland, secondary scrub, secondary forest and afforestations.

In 1987 Weisser carried out a study on the dune vegetation between Richards Bay and the Mlalazi Lagoon and its conservation priorities in relation to dune mining. Six 1: 10 000 vegetation maps based on aerial photographs (1976) were drawn and used to assess conservation priorities with special reference to proposed dune mining. The information was summarized on three conservation-priority maps (1: 25 000). They revealed that most of the area was covered by third-priority vegetation and no major objection to mining would exist if a few areas are excluded from mining. First-priority areas were found in the Richards Bay area, at the Mlalazi

Estuary Peninsula, and some scattered patches mainly along the landward limit of the study area, and along the coast. Most of these areas were already excluded from the prospecting lease. The suggestion was also made that a KwaZulu-Natal Botanical Garden of hygrophilous forest be incorporated into the Richards Bay Sanctuary area, but to date this has not been implemented.

Schwabe (1989) carried out a preliminary ecological evaluation of the vegetation at the site of the proposed Small Craft harbour and marina in Richards Bay.

His main conclusion arising from the assessment was:
i) That the swamp forest, dune forest and marshes were threatened vegetation types and there was justifiable concern that they would have been adversely affected by development of the marina. He also noted that with the development of Richards Bay through gradual urbanisation and increased recreation, the impacts for these vegetation types would be adverse and inevitable. He realised then that the future of these areas of natural vegetation systems was uncertain.

A *CSIR report 1993* discussed and described the conservation importance analysis of the Richards Bay Borough vegetation as an aid to assit the Richards Bay Borough in the planning of the Metropolitan Open Space System (MOSS).

This study shows that the vegetation of Richards Bay has deteriorated considerably. Development has imposed greater demands on the land for agriculture, housing and recreational facilities. The natural fire regime has also been altered and this has resulted in the replacement of Coastal Forest by Dwarf Shrublands with the associated encroachment of invasive species, which at this period already started to displace the indigenous flora.

In this report the broad vegetation types occurring within the study area have been identified and allocated with botanical conservation importance ratings. Vegetation maps indicated the distribution of vegetation types and were colour coded to differentiate among different conservation categories.

The study indicates that vegetation types considered to be of high conservation importance include Mature Coastal Forest, Xeric Transitional Thicket, Grassland, the Mosiac of Coastal Forest and Swamp Forest, Swamp Forest and the Mosaics of Reedswamp, Coastal Forest and Swamp Forest and Swamp Forest and Reedswamp. It is suggested that these vegetation types should be incorporated as far as possible into the Metropolitan Open Space System, as it was considered that these vegetation types will be negatively affected by any disturbance and potential impact on the vegetation should be avoided.

Strand vegetation, Mangrove, Mosaic of Coastal Forest and Hygrophilous Grassland, the Mosaic of Coastal Forest and Swamp Forest, Primary Reedswamp and Hygrophilous Grassland were considered to be of intermediate conservation priority. Limited development could be considered in some of these areas but should be preceded by a comprehensive study aimed at the retention of as much natural vegetation as possible. It is recommended these areas be incorporated into MOSS, especially where the vegetation may adjoin other categories of high conservation importance.

The least important secondary vegetation types that were included were the Mosaics of Coastal Forest and Dwarf Shrubland, *Acacia karoo* woodland, Dredge Soil Vegetation, the Mosaics of Alien Vegetation, Dwarf Shrubland and other impacted vegetation types and Plantations, Developed Areas, Woodlands, Agriculture, Open Sandy areas and Parkland were considered to be of insignificant importance.

In the newest classification of the vegetation of southern Africa (Mucina and Rutherford, 2006), the following five vegetation types are found in the vicinity of Richards Bay:

1. CB1 – Maputaland Coastal Belt, which includes the terrestrial vegetation of the coastal plain, originally densely forested, but including dry grassland, palmveld, hygrophilous grassland and thicket. Now extreme sugar cane fields and timber plantations occur here.
2. FO a3 – Mangrove Forest at the coastal lagunes and estuaries.
3. FO z7 – Northern Coastal Forest which represents the subtropical coastal forests.
4. AZ d4 - Subtropical seashore vegetation on the seashore dunes.
5. AZ f6 – Subtropical Freshwater Wetlands, including vleis dominated by reeds, sedges as hygrophilous grasses.

CHAPTER 3: RATIONALE AND OBJECTIVES

3.1 What is a MOSS

MOSS is an acronym for Metropolitan (Municipal) Open Space System. Durban Metropolitan Open Space System (D'MOSS) defines MOSS as: "network of open spaces made up of important conservation and recreation areas linked by rivers and beaches" (Discussion document, 1998). D'MOSS draws attention to the multi-functional role which vegetation plays within a MOSS. The interaction between water level, sedimentation and decomposition is finely balanced, and within the soils there are biochemical processes at work as energy flows through the ecosystem leading to the transformation and trapping of nutrients. All of these factors lead to a highly diverse ecosystem which is one of the most productive in the world (Cowan and van Riet, 1998).

Functions of open spaces of a MOSS are however, much more diverse than merely providing opportunities for nature conservation and recreation. They also play a major role in determining and maintaining the levels of physical and psychological health of the people and animals that inhabit it (Discussion document, 1998).

3.2. Aim of MOSS

The aim of the Richards Bay MOSS is to provide all the communities of Richards Bay and its visitors with the widest choice and diversity of recreational opportunities and tourist pursuits consistent with the adequate protection of the natural and cultural resources (Richards Bay Structure Plan, 1995).

3.3 Vegetation and the Richards Bay MOSS

Vegetation can contribute to maintenance of a healthy environment through the removal of harmful substances from air and water at a fraction of the cost that would be incurred by using man-made alternatives (Discussion document, 1998).

For example: The social benefit or value of a wetland is a subjective estimate of the worth, merit, quality or importance of the wetland to mankind. This implies that a rand value can be ascribed to wetlands (Fig. 4) in terms of providing habitat for fishing, hunting, game and bird viewing, plant material harvesting, domestic stock grazing flood damage control and water cleansing, to name a few (Wyatt 1997).

These values are derived directly from the existing wetland functions. If one takes the value of a function such as flood attenuation in wetlands, the question that must be answered is: "what will it cost to replace the function?" Likewise to establish the value of the sea fish "nursery" function of an estuary it would be necessary to establish the economic dependence on fishing and tourism in the vicinity of the estuary (Wyatt 1997).

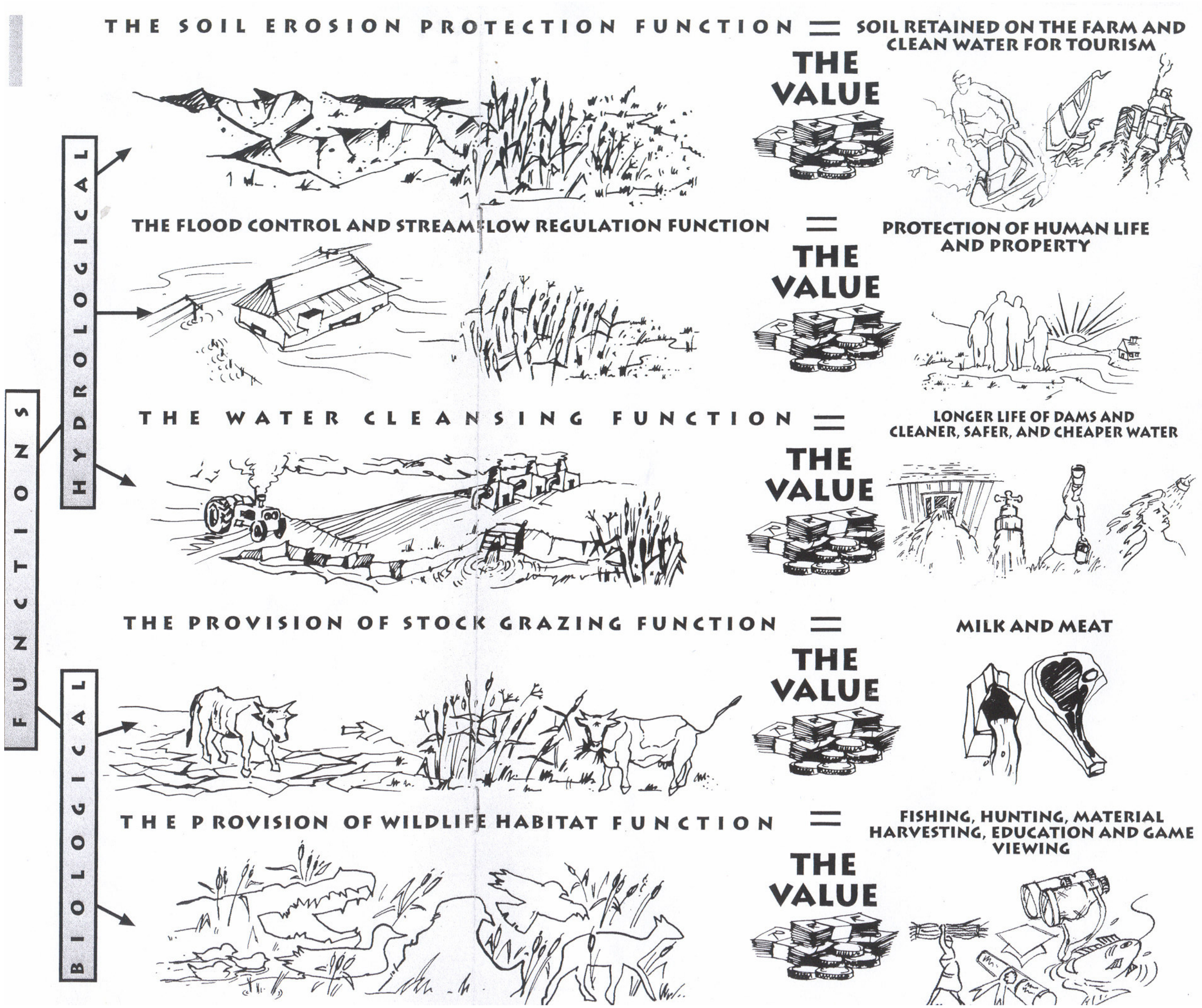


Figure 3.1: A schematic representation of wetland functions and values (After Wyatt, 1997)

The vegetation units (i.e. physiognomically and floristically distinct communities which can be distinguished on the 1:5000 scale colour aerial photographs) recognised in this research project are the major functional components of the vegetation of the Richards Bay area.

3.4 The importance of MOSS for Richards Bay and the surrounding areas

Although the Richards Bay Municipality has formalised the importance of creating a MOSS system, such a system has long been recognised by itself and environmental organisations such as the Wildlife Society of Southern Africa and the Zululand Society for the Protection and Care of the Environment (Richards Bay MOSS Report, 1994).

Richards Bay has an abundance of natural areas. Consequently, it has a tremendous advantage over many other cities in South Africa in the rich diversity of its natural areas. By harnessing these areas into a MOSS plan, opportunities, usually scarce (if not absent) in most urban context, can be created for the people of Richards Bay to benefit from a broad-based open space system offering educational and recreational outlets to these community (Richards Bay MOSS Report, 1994).

Urban growth in Richards Bay and fringe areas has resulted in increased pressure on the remaining natural or open space areas, many of which may be lost through indiscriminate development. There is, thus, a need to identify natural and particularly sensitive, areas to ensure their conservation as well as to reserve open space for future needs. Richards Bay at present lacks a linked system of open space that combines all the town's natural assets and recreational opportunities (Richards Bay MOSS Report, 1994).

Over a thirty-year period, Richards Bay's population increased dramatically, from 237 in 1960 to 28 405 in 1992. Furthermore, as people's standard of living improves, they (generally) have more leisure time at their disposal with the result that the demand for recreation facilities has grown and will continue to grow in the future, particularly with respect to outdoor recreation on the coast, the lakes, rivers and wetland areas. Richards Bay, with its outstanding scenic and natural assets, has a unique opportunity to make use of tourism as a major contributor to its economic base.

3.5 The Role of the Norwegian Programme for Development, Research and Higher Education (NUFU)

The NUFU programme's goal is to focus on the development of sustainable capacity as well as competence for research based, higher education in developing countries such as southern Africa, in terms of national development and reduction in poverty (NUFU 2007 Online).

This study formed part of a large scale project of NUFU, namely the "Biodiversity in coastal Maputaland (northern KwaZulu-Natal and southern part of Mozambique): links between geology and ecology. 1999 – 2002." The main objective of this project was to build expertise able to address intricate environmental tasks of importance to the area's management. This project initiated capacity building directed towards interdisciplinary studies in geoscience and ecology (NUFU 2007 Online). This included training programmes, staff visits to the relevant regions and countries and student participation. Master degree students from the Eduardo Mondlane University, Mozambique along with South African students were encouraged to conduct their research studies along this coastal area, supervised by scientists from the University of Natal, KwaZulu-Natal Conservation Services, the Council for Geoscience (NUFU 2007 Online).

The participating institutions were the Agricultural University of Norway, the University of Natal, Eduardo Mondlane University, Mozambique, and University of Zululand, KwaZulu-Natal Nature Conservation Service, the Council for Geoscience, South Africa and the National Directorate of Geology, Mozambique.

This programme focused on the conservation of coastal areas along the coast of Maputaland in northern KwaZulu-Natal and southern Mozambique because of the endemism of Maputaland and the well established relationship between geology and ecology in this region. Other characteristics also contributing to the selection of this specific study area are the role of the dunes and the threats to this dunes posed by development (NUFU 2007 Online).

3.6 Survey analysis of the vegetation

In this study each mapped plant community was classified according to its structure and floristic composition. The Braun-Blanquet classification system was used, that includes a number of variables such as abundance or extent of occurrence, and apparent species richness. This data can then be used to establish an importance hierarchy to identify areas of high botanical value. This strategy can indicate which plant community should receive special attention in the process of Metropolitan Open Space System (MOSS) planning.

Plant communities of high botanical importance are considered to be those that are relatively rare. Usually they include one or more threatened species, they are species rich. Wetlands are often not rich in plant species but the species that occur here, occur only here, and these habitats are rare, resulting in a rare composition of species. Therefore they are in particular need of protection from disturbance such as development.

The priority for conserving the plant communities therefore varies according to their perceived value, their ecological importance and the degree of development threat already imposed on them.

3.7 The aims of this research project are as follows;

i) The primary aim for this project was therefore to describe the different plant communities and vegetation types recognised within the area under the jurisdiction of the City of uMhlatuze Municipality.

ii) To provide an indication of the conservation importance of the vegetation types within the study area.

CHAPTER 4: DESCRIPTION OF THE STUDY AREA

4.1 A Brief history or northern KwaZulu-Natal

Humans have been a constant factor in the ecosystems of KwaZulu-Natal province for a relatively long period. Archaeological records from the last quarter of the nineteenth century provided for the earliest discoveries of stone implements in South Africa (Duminy and Guest, 1989). Archaeological fieldwork conducted by Goodwin and Van Riet Lowe lead to the publication of the first comprehensive study of the South African Stone Age in the late 1920s (Duminy and Guest, 1989). The Stone Age preceded the Iron Age which was not only characterized by the introduction of metallurgy but with the introduction of agriculture, with a settled, village way of life in comparison to the nomadic patterns of the Stone Age (Duminy and Guest, 1989). Specific environments of site escavations in southern Mozambique gave specific clues of these Iron Age communities. The majority of these sites occurred on ancient dunes which have been covered by coastal forest at the time. In the St. Lucia area, sites are concentrated at the inland foot of the dunes, where these meet seasonly flooded grassland (Duminy and Guest, 1989). The sandy soils which occurred in this area are poor and leached but the accumulated forest humus would have ensured good crops for the first 2 years after it has been cleared (Duminy and Guest, 1989).

The invasion of more nations to KwaZulu-Natal caused the total disappearance of the San people, with only their rock art as memory of their presence (Venter, 1972). The Nguni people, from whom the Zulus and Xhosa people originated, apparently appeared in KwaZulu-Natal by 1400 or even earlier. The Nguni had a higher standard of civilisation than the San people and farmed with cattle, goats and sheep. Besides other food items, they also farmed with crops like sorghum and mealies (Brooks and Webb, 1967). In the early 19th century the population of northern KwaZulu-Natal was more or less 78 000 individuals (Bryant, 1929).

After the incorporation of northern KwaZulu-Natal area into the former Natal province in 1897, white people also began to settle in this region. During the late 1800s visible evidence of economical growth in KwaZulu-Natal was observed together with the changing of the physical environment (Duminy and Guest, 1989). Whole herds of animals were hunted for their skins and during the mid-1870s it was commented that no herds of game could be seen anymore, in spite of the introduction of the Colony's first game law in 1866 (Duminy and Guest, 1989). The excessive hunting of game was followed by the destruction of the natural forest and by the clearing of the land for cultivated fields. Destruction of vegetation and habitats was extensive with the effect being most noticeable in the river estuaries. Estuaries were silted up and polluted by the 1870s (Duminy and Guest, 1989).

The coastal lowlands were found to be suitable for the cultivation of sugar-cane, tea, coffee and arrowroot but sugar farming was soon to become KwaZulu-Natal's largest agricultural industry (Duminy and Guest, 1989). In

1905 the area was available for sugar-cane cultivation and after 1904 for forestry plantations (McCrystal and Moore, 1967). The sugar-cane industry expanded rapidly and by 1913 it had reached as far north as the Umfolozi River. Sugar-cane and timber plantations had the greatest impact on the vegetation of northern KwaZulu-Natal. The increase in African population from 113 000 to 169 800 in the locations from 1850s to 1881, lead to a higher demand in food, exhausting existing agricultural lands and forced encroachment onto grazing lands (Duminy and Guest, 1989). This forced indigenous vegetation to be cleared and to be altered habitats.

The draining of wetland areas is an example, as it is an important component of the ecosystem of the coastal lakes and it has many important functions. Richards Bay is named after Admiral Sir Frederick William Richards, who carried out a marine survey in 1878 along the coast of KwaZulu-Natal. Richards Bay and the surrounding area, the major wetland area, were proclaimed as public land in 1902. According to this the land could not be inhabited or cultivated and it was left undisturbed to a large extend, but this soon changed on 10th December 1969, when a local town council was established for the development of this area into a future harbour city.

4.2 Climate

Richards Bay is situated in the transition zone between subtropical and tropical climatic conditions (Weisser and Müller, 1983). The climate is humid and warm to hot with a high year-round rainfall (Schulze, 1984). The mean annual temperature at the Cape St Lucia Weather Station is 21.5ºC and the mean annual rainfall is 1 292 mm (Weisser, 1979). Most of the rainfall occurs in summer with winter being generally less humid. The region falls within the 20ºC isotherm, which is accepted as the limit for tropical vegetation (Aubert de la Rue *et al*., 1958, in Venter, 1972).

4.3 Topography

Richards Bay is located at the seaward margin of the Mozambique Coastal Plain at an altitude of less than 100 m. The Coastal Plain is characterised by an undulating surface of old dune ridges supporting shrubland and forest, swampy drainage courses and lake systems. The dune ridges were formed in an alternating sequence parallel to the present coastline by a receding Pleistocene sea with the onset of the Würm glaciation (Tinley, 1985).

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Both the shore and foreland are eroding (Tinley, 1985) and massive dune slumping occurs continually along the seaward edge. The red dune sands overlie a thick layer of clay material which influences in situ water drainage. The wetting of the clay by water percolation and the seaward drainage which occurs through lateral piping at the point of contact between the dune sand and clay zones creates unstable conditions along the dune front. This resulted in cavitational dune slumping and the formation of steep basin-shaped scars or cirques with flat floors of deep, steep-sided ravines. Because the water table becomes exposed at the cirque floor surface, these areas are usually stabilised with hygrophilous vegetation. The cirque formation is unique in that it is found at only a few localised places in South Africa (Tinley, 1985)

4.4 Geology and Soils

The geological history of the Zululand coastal plain follows the rise and fall of the sea levels. The geological sequence shown in *Figure* 4.1 is as follows.

During the Cretaceous era, marine deposits formed the Cretaceous system some 50 million years ago. The Cretaceous shore-line underlies the entire coastal plain and consists mostly of uniform siltstone with occasional thin clay lenses and thin bands of hardy limestone. It is believed that the fine silt stones make up the impermeable layer of the aquifer bottom.

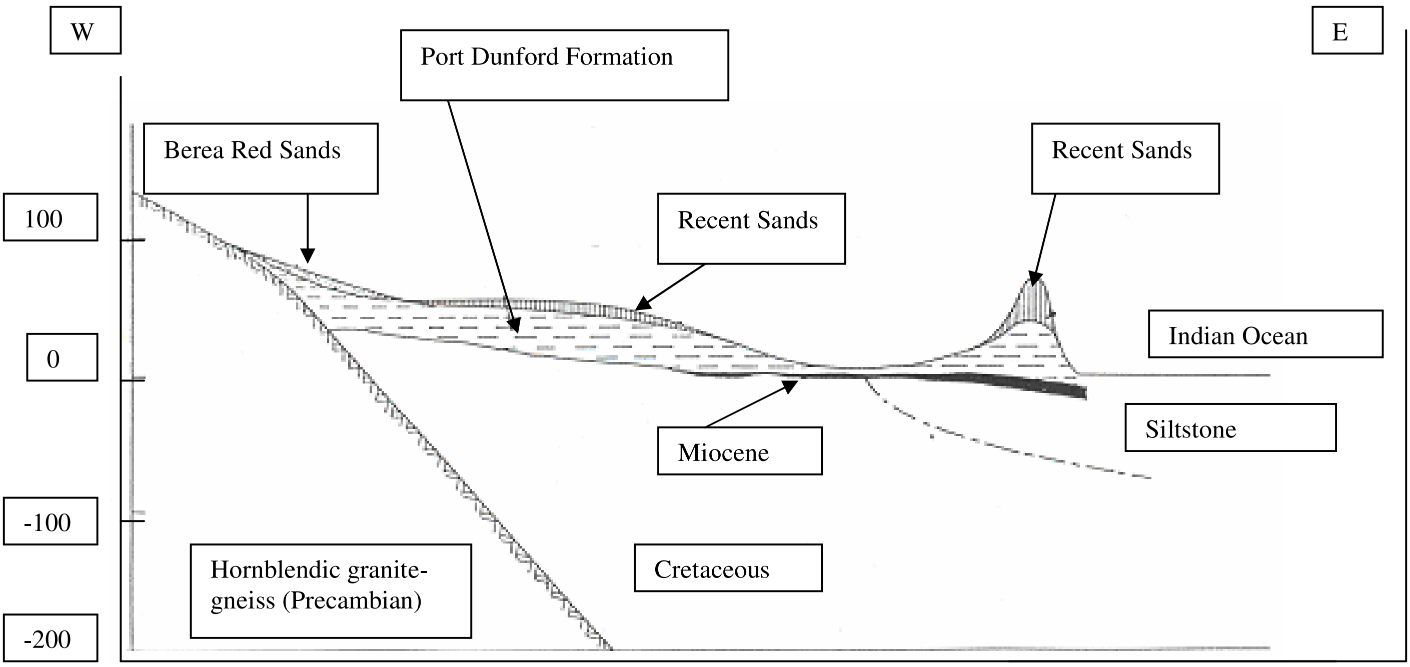

Figure 4.1 Geology of the study area (After Worthington, 1978)

In the Miocene Epoch the Cretaceous system was overlain by relatively thin Miocene deposits which are highly permeable, but not continuous. The Port Durnford system is more widespread than the Miocene deposits and is present below most of the coastal barrier complex. The Port Durnford formation is not a homogenous layer and consists of poorly consolidated fine grain sands, clays, silts and lignite. A discontinuous lignite (peat) band subdivides it into two layers.

Within the Recent Sands, the whole area is covered in a layer of unconsolidated, fluvial and aeolian sands. Geologically, the sand dunes are generally composed of beach derived sand that is blown inland. Initially a low sand dune forms a foredune which may be colonised by pioneer vegetation. This vegetation aids in the accumulation of additional sand by trapping the wind blown sand. Normally the foredunes mature, become larger and develop mature vegetation if the dunes are stable and receive adequate inputs of water as is the case along the coastline of the study area. The high coastal dunes in the study area are believed to be very young, in some places still being formed and only stable because of the vegetation cover (Germishuyse *et al*. 1998).

The more recent red, brown and grey sands that have covered the Port Durnford formation as a result of wind action have given rise to the plateau features that characterise the coastal plain. The plateau areas consist of a series of ridges approximately aligned in a north-south direction. Some of the inter-dune hollows contain accumulations of peat up to a few metres thick (Worthington, 1978).

The coastal dune barrier complex, which frequently attains heights in excess of 100 metres, is made up of sands that range in colour from creamy-white and yellow to light grey, brown and red. These sands are mainly quartzitic, fine grained, well sorted and contain rich deposits of heavy minerals such as ilemite, rutile and zircon which are being extracted commercially (Worthington, 1978). Except in the case of the older more clayey dunes, the soils are generally low to very low in natural fertility because of their high permeability and rapid leaching of nutrients (Maud, 1991).

The uMhlatuze River flood plain and channels through which the river flowed at different times contain alluvial and estuarine sediments which range in texture from sands to clays. Soft unconsolidated dark grey clays characterise the lower course of the uMhlatuze River including the harbour and the broader areas of the flood plain (Worthington, 1978). The depth to suitable foundation material is very deep in large sections of these areas with significant implications for construction costs. These areas also have an abnormally high water table with significant implications for the provision of engineering services, waste water and sewerage disposal systems.

The study area is richly endowed with building sand and stone. Course sand for concrete is mainly confined to the bed of the uMhlatuze River, while mortar sand and binder material are rare, confined to isolated deposits in the Berea Red sand and shale deposits near Mtunzini and Empangeni. Limited clay deposits, suitable for brick making, are also confined to the Empangeni area.

The narrow beach extent and local wind characteristics render the beach and dune sands highly susceptible to scour by the sea and wind erosion, emphasising the extreme sensitivity, conservation importance and need for controlled recreational use and development of the dune area.

4.5 Hydro-Geological Setting

4.5.1 General

The general groundwater flow pattern in the Zululand coastal plain is directed towards the sea. In the vicinity of the larger inland lakes, the flow deviates towards the lakes (Meyer and Godfrey, 1995). The lakes in the coastal plain play a significant role in the geo-hydrology of the area since the water levels in these lakes are an expression of the local groundwater system.

The local groundwater movement in the study area is strongly related to the topography, which is considered to be a consequence of the relatively low permeability of the Pleistocene succession (Worthington, 1978) and of relative shallow groundwater tables. The Pleistocene succession is overlain by more permeable Holocene deposits. Infiltrated water flowing towards the streams through the Pleistocene succession, having lower permeabilities, will encounter higher drainage resistance than water that flows directly from the top layers of the Holocene deposits towards the streams.

Since 1975 water level measurements in the study area show a decrease in hydraulic heads of the deep aquifereous units in east and south-east direction. This is caused by infiltration of rainfall in the higher elevated Plateau areas and discharge in the lower surface water dominated areas.

Based on the description of the geological and geo-morphological setting and the relationship with the surface water conditions, three principally different hydrological reacting regions are distinguished within the study area. These are the uMhlatuze flood plain, Lake Mzingazi and the Plateau area and are more or less the same as the geo-morphological units.

4.5.2 Surface water conditions

The higher elevated plateau area north of the lake mostly acts as a recharge area, meaning that in these areas rainwater will infiltrate into the subsurface causing replenishment of the aquifers. Lake Mzingazi and the surrounding wetlands act as a discharge area, into which the water from the Plateau areas is drained. The south western edge of the lake is part of the uMhlaluze Flood plain and acts as a discharge area for the lake. Both groundwater and surface water from the lake drain into the Mzingazi Canal (Krikken and van Nieuwkerk, 1997).

Lake Mzingazi is the main water resource of Richards Bay. The lake is threatened by possible saline intrusion from the Mzingazi Canal, which is in open contact with the sea and is in fact itself saline. In the past a weir has been built between the outflow of the lake and the Mzingazi River (Fig. 4.2 and Photo 4.1), which artificially maintains Lake Mzingazi as a freshwater zone at or above the water level in the Mzingazi Canal.

4.5.3 Groundwater recharge

In the Zululand Coastal Plain area the only major source of groundwater recharge is rainfall. The groundwater recharge is considered to represent the portion of the rainfall that reaches an aquifer after percolation through the unsaturated zone (Fig. 4.3). The net charge is defined as the total recharge minus the losses caused by evapo-transpiration from the saturated zone.

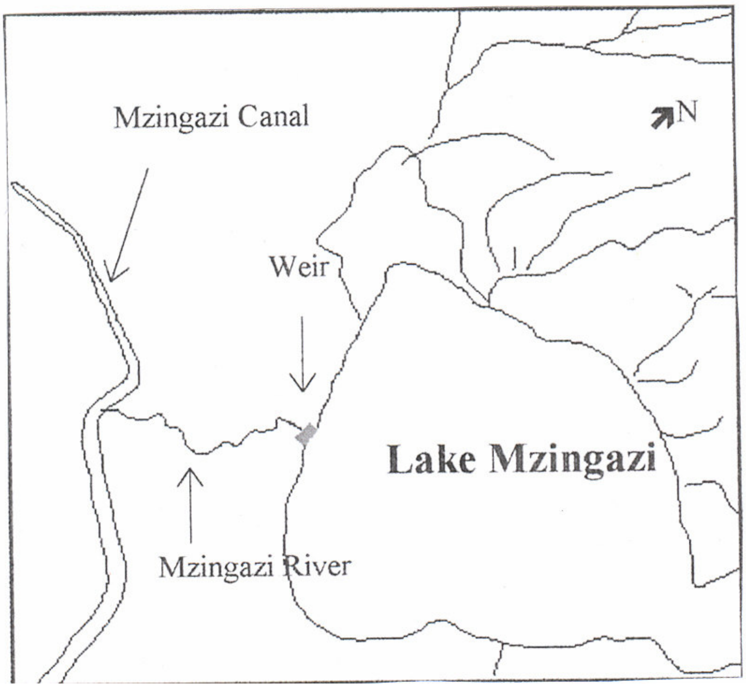

Figure 4.2: Weir against saline intrusion between Lake Mzingazi and Mzingazi River (After Krikken and van Nieuwkerk, 1997).

Photo 4.1: Weir constructed between Lake Mzingazi and Mzingazi River (February 2001).

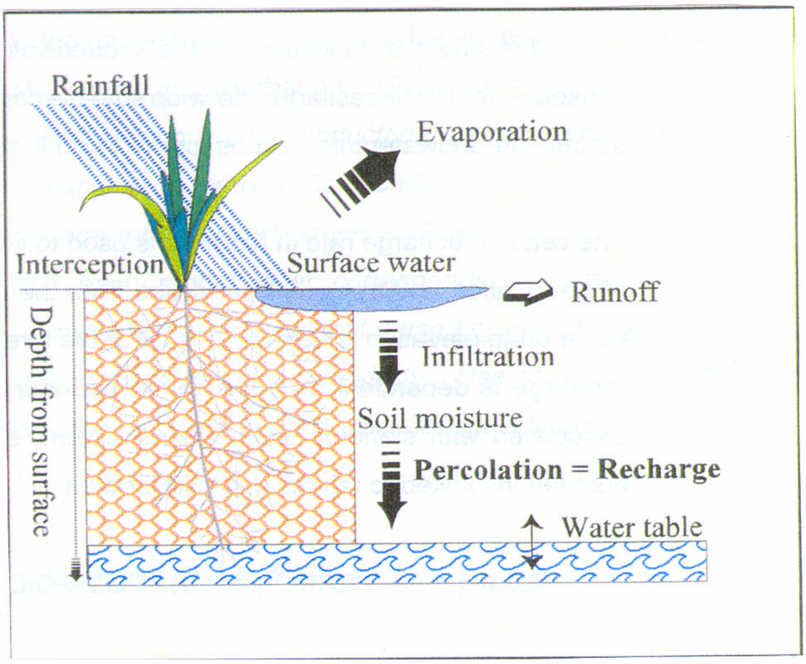

Figure 4.3: A diagrammatic representation of mechanism considered in recharge from rainfall (After Krikken and van Nieuwkerk, 1997).

The main processes which govern the losses from the total rainfall are interception by vegetation, evaporation from the unsaturated zone, soil moisture storage replenishment and evapo-transpiration from the saturated zone. These processes are assumed to be primarily controlled by the different land use types. For example a larger part of the precipitation will be lost by evapo-transpiration in a forest area than in grasslands, because of the difference in interception characteristics and rooting depth of both land use types. Four land use types with fundamentally different recharge characteristics are distinguished in Fig. 4.4.

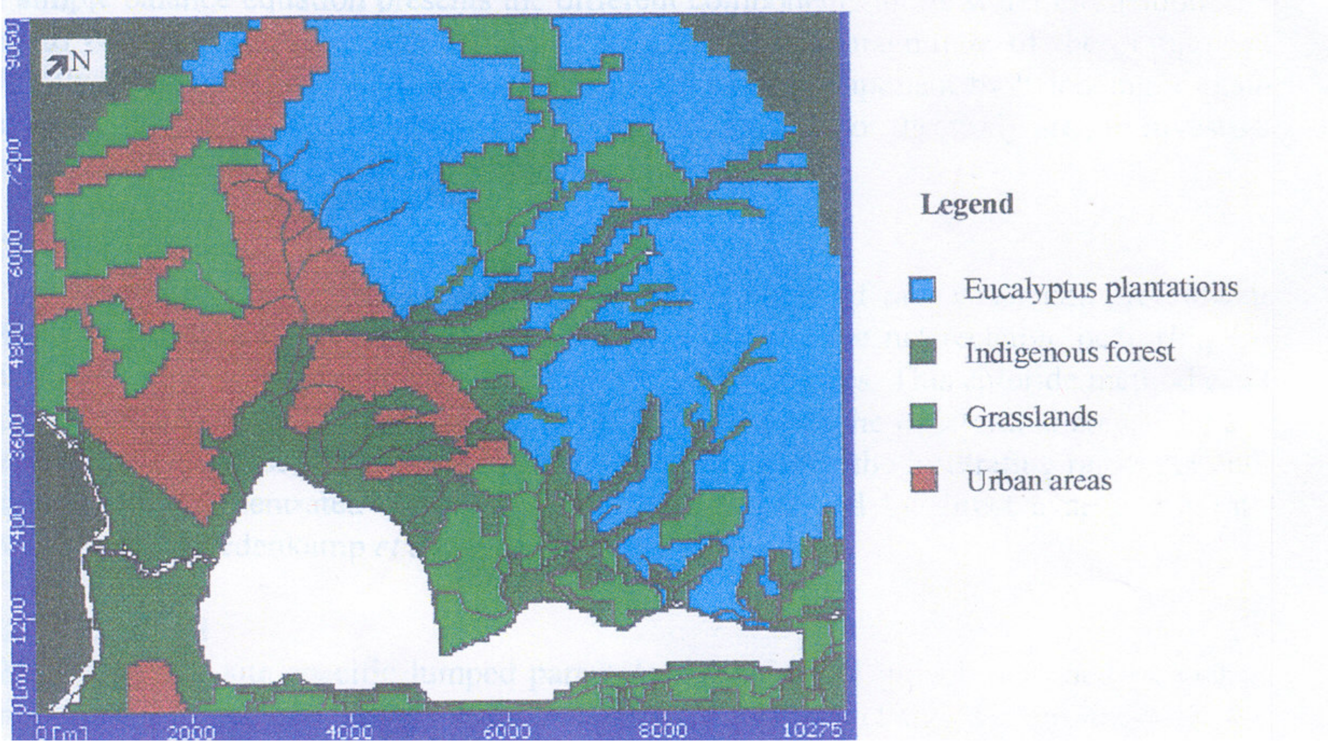

Figure 4.4: A map of different land use types in the study area of Richards Bay (After Krikken and van Nieuwkerk, 1997).

***Eucalyptus* plantations:**

Throughout the region large forests of *Eucalyptus* tree species have been planted for commercial purposes. Each plot of trees is harvested every seven years and young eucalyptus trees are put in place. Therefore, this alien plant community has the highest growth rate in the study area (Krikken and van Nieuwkerk, 1997). The rooting depth is also relatively high. Both factors account for large evapo-transpiration rates and the deep canopy of the eucalyptus trees causes large interception of rainfall.

Indigenous forest:

This land use type covered large areas of the region before humans interfered with landscape. Indigenous forest comprises trees and shrubs (indigenous plants), which have variable root depth. Indigenous trees that are old can have very deep roots (Krikken and van Nieuwkerk, 1997). The growth rate of these trees is much slower than that of eucalyptus, since these forests are not cut for commercial purposes, causing them to have a lower evapo-transpiration rate (Rawlins, Kelbe and Germishuyse, 1997).

Grasslands:

This incorporates the areas covered with grass. These areas have the lowest root depth, lowest evapo-transpiration rates and lowest interception rates of the plant communities in the study area. The land use of grasslands also comprises the wetlands surrounding the lakes. Though these land use types are not the same, the rooting depth and evapo-transpiration rate is assumed to be equal in the study area (Krikken and van Nieuwkerk, 1997).

Urban areas:

Urban areas mainly consist of buildings, roads and gardens. Most of the rain water in the study area, which falls on roads and buildings will be drained artificially, almost no water will percolate to the water table. Only in gardens and parks can rainwater infiltrate and percolate to the groundwater table. There are, however, additional recharge sources in urban areas. Krikken and van Nieuwkerk, (1997) distinguished three additional recharge sources in urban areas. Recharge can occur from leaking water mains. This can cause up to 45% of total urban recharge, though 30% is more common.

Leakage from sewers might be a source of pollution (Krikken and van Nieuwkerk, 1997).

Since the urban areas in the study area were developed very recently, using modern techniques for constructing sewers and water mains, it is assumed that these additions to the recharge are of minor importance. The third source of extra recharge is over-irrigation of gardens and parks, which contribute 20 to 40% of the urban recharge in (semi) arid areas (Krikken and van Nieuwkerk, 1997). However this factor does not apply to the study area, due to high average rainfall amounts and irrigation on a very low scale in the urban areas.

CHAPTER 5: METHODOLOGY

5.1 Selection of sites

Wetland categories such as hygrophyllis grasslands, riverine forest, swamp forest and mangrove forest as well as vegetation occurring in the dune plant communities and disturbed open spaces in the City of uMhlatuze Municipalities area (Fig. 5.1), were selected for floristic analysis and description of the recognised structural vegetation types occurring within the municipal area of Richards Bay. These areas included the main open spaces of the City of uMhlatuze Municipality area (Fig. 5.1) and the outer-lying suburbs of Esikhawini, Nseleni and Vulindlela (Fig. 5.2). In most instances these areas were also characterised by urban and industrial development. Therefore sites were randomly selected in open space areas where urban and industrial development have a relatively high environmental impact as well as in open space areas where urban and industrial impacts were less prominent.

5.2 The structural classification method

In this study each structural vegetation type was described using the structural classification according to Edwards (1983).

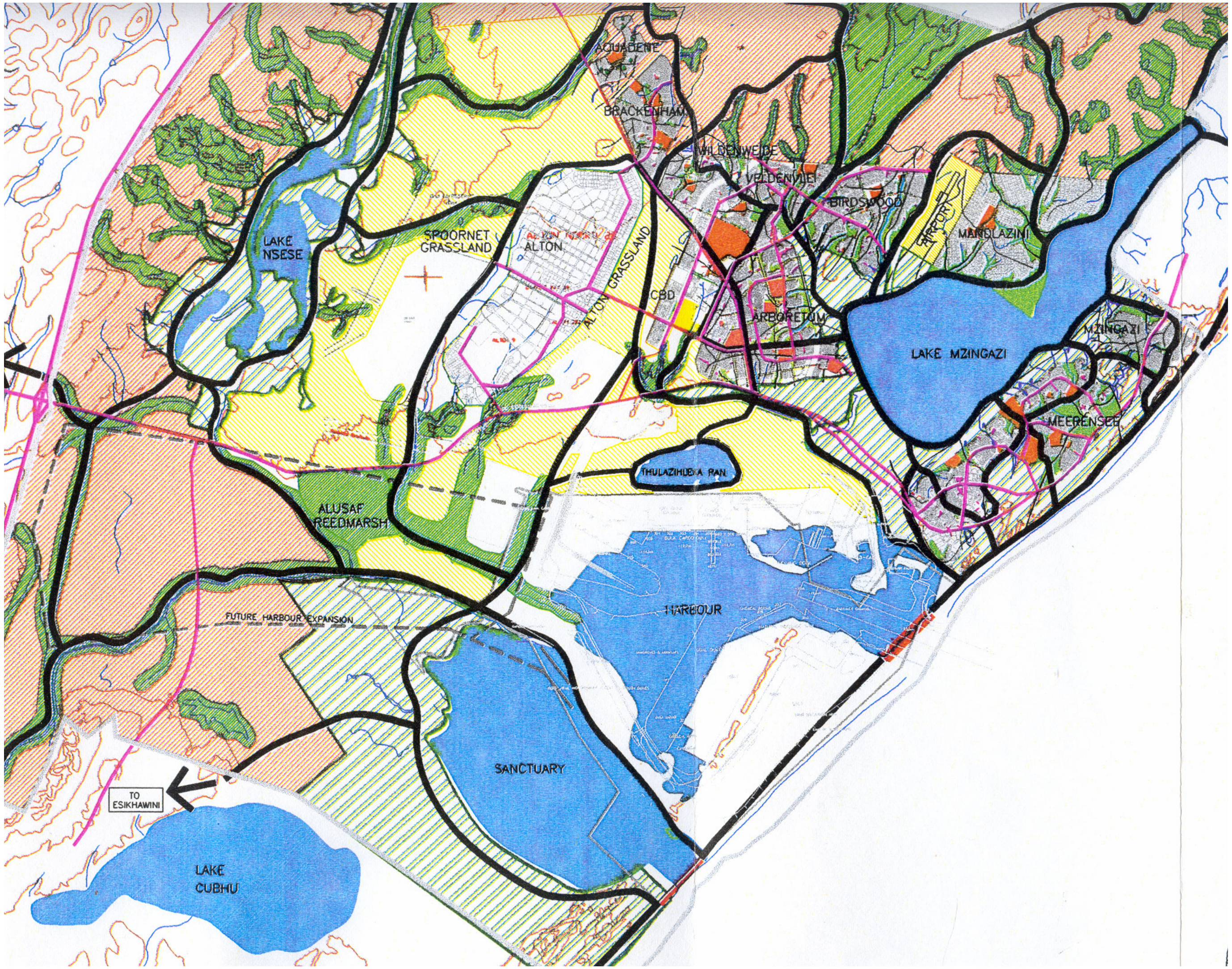

Figure 5.1: A spatial representation of Suburban Open Space Zones in the Richards Bay Municipal area (After Discussion document, 2000).

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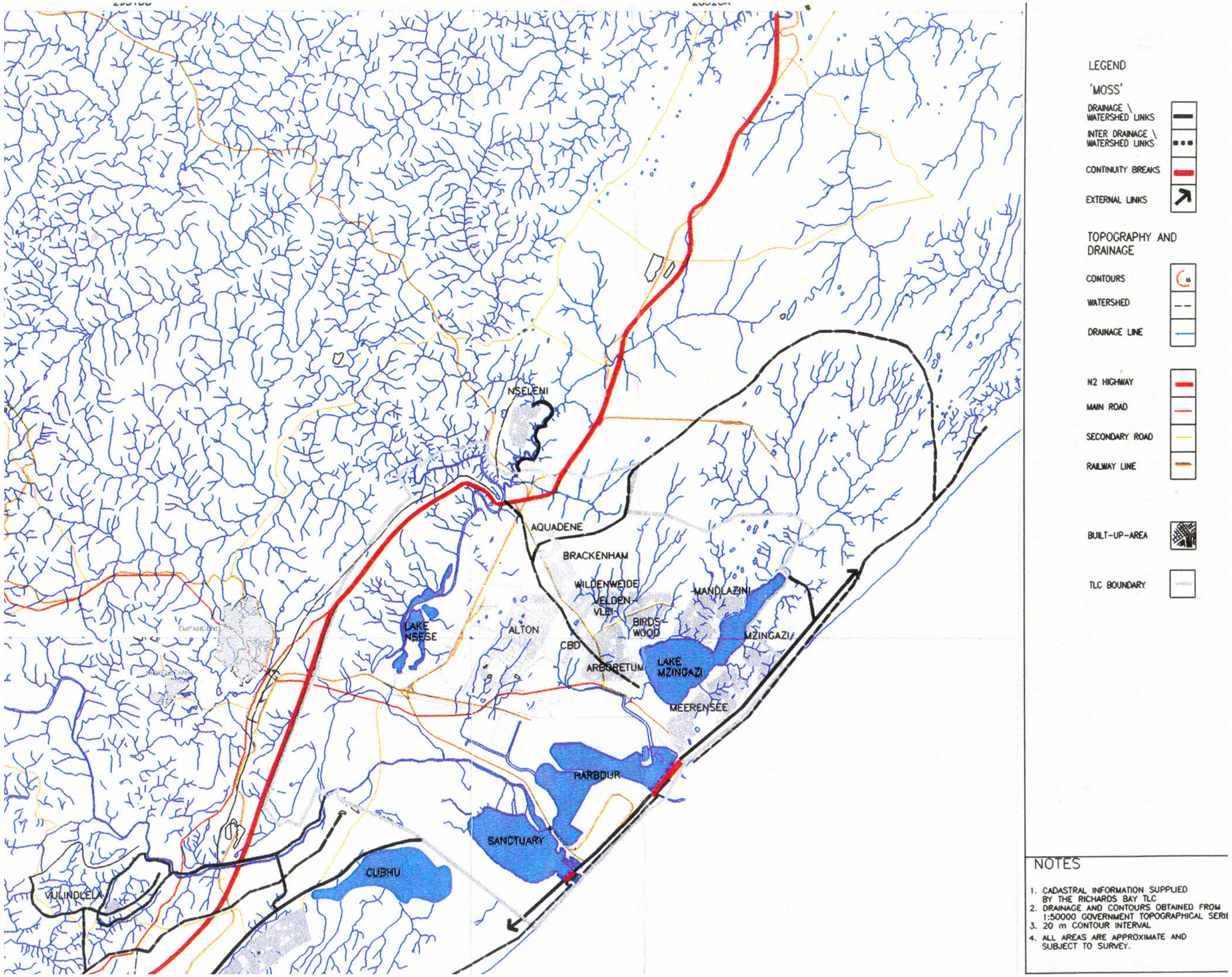


Figure 5.2: Map indicating the outer-lying suburbs of Nseleni and Vulindlela in the Richards Bay Municipal area with drainage channels and water bodies (After Discussion document, 2000).

For the broad structural classification of the vegetation in the study area, the method used in Edwards (1983) was applied. As derived from combinations of the sets of growth form, cover and height attributes, with a limited use of substratum growth form to define Thicket and Bushland and of total plant cover to define desert vegetation classes (Edwards, 1983).

The Table in Edwards (1983), being essentially a multiple entry key to the nine structural groups A to I, which are Forest and Woodland, Thicket and Bushland, Shrubland, Grassland, Herbland, Desert Woodland, Desert shrubland, Desert grassland and Desert herbland. Each structural group is then subdivided on the basis of the height of the dominant height class (Edwards, 1983). According to Edwards (1983), in terms of the criteria for classification as given by Whittaker (1980), the structural classification given here is:

i) highly accessible in that the community attributes used are simple and readily observable on the ground and from the air.
ii) the criteria are significant at the broad classificatory level in distinguishing the broad structures of vegetation and in covering the continuum from forest to desert in all combinations of primary growth form type, cover and height; and
iii) effectively at the broad scale of resolution, but also, as field trails have shown, remarkably sensitive to structural differences in vegetation at the local scale.

Table 5.1: Tabular key to structural groups and formation classes (Edwards. 1983).

Dominant height class	Total plant cover > 0.1%				Total plant cover ≤ 0.1%
	Total tree cover > 10% if >1m high **A. Forest & Woodlandf** Total tree cover				**F. Desert woodland** Trees dominant
	100-75% 0-0.1Ø	75-10% 0-0.2Ø	10-1% 2-8.5 Ø	1-01% 8.5-30 Ø	
Trees > 20 m	1. High forest	5. High close woodland	9.High open woodland	13. High sparse woodland	57. High desert woodland
Tees 10-20 m	2. Tall forest	6. Tall closed woodland	10. Tall open woodland	14. Talls sparse woodland	58. Tall desert woodland
Trees 5-10 m	3. Short forest	7. Short closed woodland	11. Short open woodland	15. Short sparse woodland	59. Short desert woodland
Trees 2-5 m	4. Low forest	8. Low closed woodland	12. Low open woodland	16. Low sparse woodland	60. Low desert woodland
	Total tree cover >1% shrub cover >10% & >1 m high **B. Thicket & Bushland** Total tree & shrub cover				
	100-10% 0-2 Ø		0-1% 2-8 Ø		
Trees 5-10 m & Shrubs 2-5 m	17. Short thicket		19. Short bushland		
Trees 2-5 m & Shrubs 1-5 m	18. Low thicket		20. Low bushland		
	Total tree cover <0.1% shrub cover >0.1% Or tree cover up to 1% & shrub cover >1 m high (closed shrublands) **C. Shrubland** Total shrub cover				**G. Desert Shrubland** Shrubs dominant
	100-10% 0-2 Ø	10-1% 2-8 Ø	1-0.1% 8.5-30 Ø		
Shrubs 2-5 m	21. High closed shrubland	25. High open shrubland	29. High sparse shrubland		61. High desert shrubland
Shrubs 1-2 m	22. Tall closed shrubland	26. Tall open shrubland	30. Tall sparse shrubland		62. Tall desert shrubland
Shrubs 0.5-1 m	23. Short closed shrubland	27. Short open shrubland	31. Short sparse shrubland		63. Short desert shrubland
Shrubs <0.5 m	24. Low closed	28. Low open shrubland	32. Low sparse shrubland		64. Low desert shrubland

	shrubland			
	Total tree cover < 0.1% shrub cover <0.1% grass cover dominant and >0.1% **D. Grassland** Total grass cover			**H. Desert grassland** Grasses dominant
	100-10% 0-2 Ø	10-1% 2-8.5 Ø	1-0.1% 8.5-30 Ø	
Grasses >2 m	33. High closed grassland	37. High open grassland	41. High sparse grassland	65. High desert grassland
Grasses 1-2 m	34. Tall closed grassland	38. Tall open grassland	42. Tall sparse grassland	66. Tall desert grassland
Grasses 0.5-1m	35. Short closed grassland	39. Short open grassland	43. Short sparse grassland	67. Short desert grassland
Grasses <.05 m	36. Low closed grassland	40. Low open grassland	44. Low sparse grassland	68. Low desert grassland
	Total tree cover <0.1% shrub cover <0.1% herb cover dominant and >0.1% **E. Herbland** Total herb cover			**I. Desert herbland** Herbs dominant
	100-10% 0-1 Ø	10-1% 2-8.5 Ø	1-0.1% 8.5-30 Ø	
Herbs >2 m	45. High closed herbland	49. High open herbland	53. High sparse herbland	69. High desert herbland
Herbs 1-2 m	46. Tall closed herbland	50. Tall open herbland	54. Tall sparse herbland	70. Tall desert herbland
Herbs 0.5-1 m	47. Short closed herbland	51. Short open herbland	55. Short sparse herbland	71. Short desert herbland
Herbs <0.5 m	48. Low closed herbland	52. Low open herbland	56 Low sparse herbland	72. Low desert herbland

5.3 The Floristic survey

For sampling to be done efficiently, the continuum of vegetation occurring in the study area must be divided into describable communities of vegetation types (Kent and Coker, 1995). A concept of particular vegetation types is formed within the study area. Representative stands of that type are found in the field, and one or more sampling plots are placed so that each sampling plot enclosed the essence of that stand. Although positioning of sampling plots is traditional non-randon in the Braun-Blanquet method, plots were placed randomly within the stratified structural units already identified. The site of vegetation description should however be a representative area of a particular vegetation type (Kent and Coker, 1995). It is also prerequisite that the relevé or sample should be uniform and homogenous in terms of floristic composition and structure. This means that the particular assemblage of species which are believed to be representative of the community type being described, should exist over a sizable local area without any detailed variations within it (Kent and Coker, 1995).

The minimal area may be determined by using the species-area curve method (Mueller-Dombois and Ellenberg, 1974). The species-area curve is compiled by placing larger and larger sampling quadrats on the ground in such a way that each larger quadrat encompasses all the smaller ones, an arrangement called nested quadrats (Fig. 5.3). As each larger quadrat is located, a list is kept of additional species encountered. A point of diminishing return is eventually reached, beyond which increasing the quadrat area results in the addition of only a very few more species (Mueller-Dombois and Ellenberg, 1974). The point on the curve where the slope most rapidly approaches the horizontal is called the minimal area (Fig. 5.3).

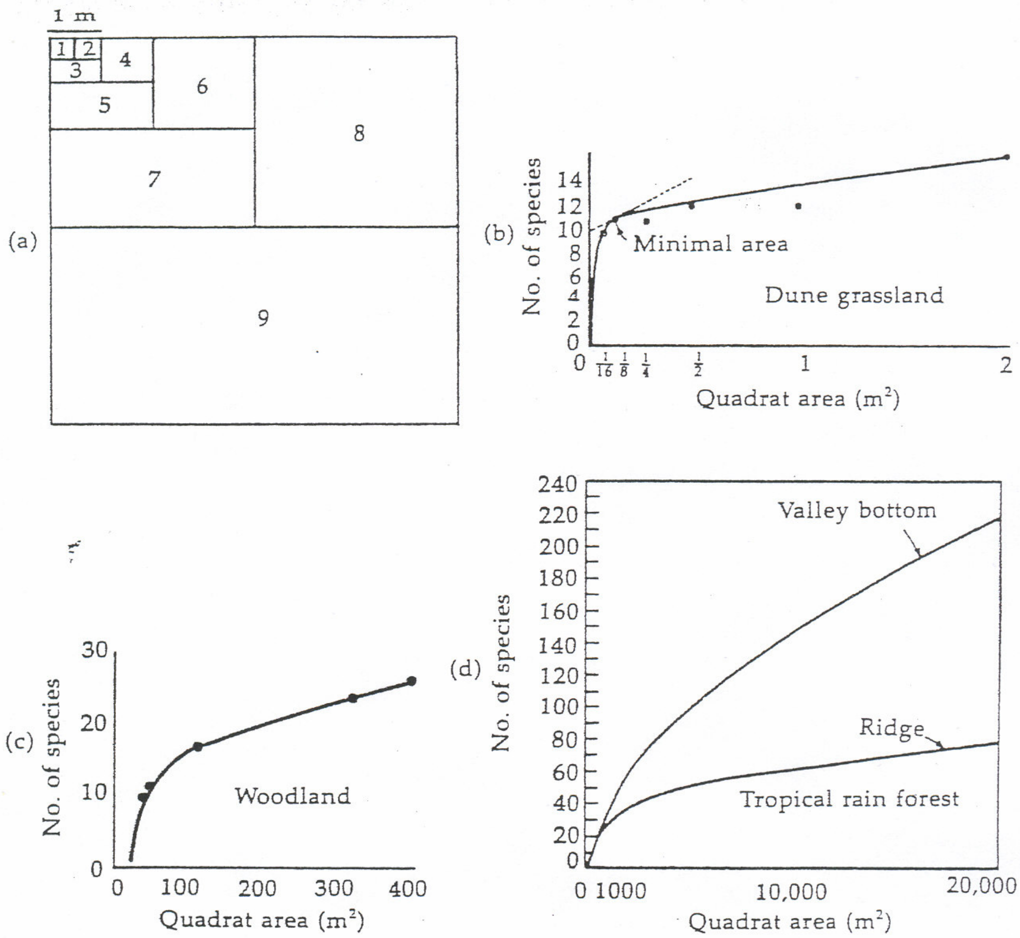


Figure 5.3 The species-area curve. (a) A system of nested plots for determining minimal area. (b) Minimal area for dune grassland. (c) Minimal area for English woodland is about a 100 m^2. (d) Minimal area for two stands of tropical rain forest in Brunei are 1000 m^2 (a ridge) and 20 000 m^2 (valley bottom) (Mueller-Dombois and Ellenberg, 1974).

Sampling plot size, shape and area are very important and will vary form one type of vegetation to another. Methods have been devised to estimate the optimum size of quadrats for a particular community type and are based on the concepts of minimal area and species-area curve. The reason is that the method is really only suitable as part of the overall Braun-Blanquet approach to subjective vegetation classification, where a vegetation sample or relevé, as it is known, is deliberately chosen as being a uniform and representative sample of the plant community being described.

Table 5.2: Suggested quadrat sizes for certain vegetation types (Mueller-Dombois and Ellenberg, 1974).

VEGETATION TYPE	**QUADRAT SIZE**
Bryophyte and lichen communities	0.5m × 0.5m
Grasslands, dwarf heaths	1m × 1m to 2m × 2m
Shrubby heaths, tall herbs and grassland communities	2m × 2m to 4m × 4m
Scrub, woodland shrubs	10m × 10m
Woodland canopies	20m × 20m to 50m × 50m (or use plotless sampling)

In this study sampling plot size for grassland and bushveld vegetation types was 100 m^2 (10 m x 10 m) as often used for South African vegetation types (Mueller-Dombois and Ellenberg, 1974).

Cover is defined as the area of ground within a quadrat which is occupied by the above-ground parts of each species when viewed from above. Cover is usually estimated visually as a percentage, but stratification of multiple layering of vegetation will often result in total cover values of well over 100%.

Table 5.3: The Braun-Blanquet cover scales (Mueller-Dombois and Ellenberg, 1974).

VALUE	BRAUN-BLANQUET
R	One individual with small cover
+	Less then 1 % cover
1	1 –5 % cover
2a	5 – 12 % cover
2b	12 – 25 % cover
2m	Less then 1 % cover but abundant in number
3	25 – 50 % cover
4	50 – 75 % cover
5	75 – 100 % cover

Sampling was undertaken during the growing season of 2001/2002.

5.4 Plant gathering, pressing, storage and identification

Plant species which could not be identified in the field during the survey were collected and identified afterwards with the use of field guides and other books (Burrows, 1990, Gibson, 1975, Tainton, 1976, Gibson, 1978, Palgrave, 1983, Pooley, 1993, Pooley, 1998, van Oudtshoorn, 1999 and Henderson, 2001). Gordon-Grey, 1995 was used to assist in identification of *Cyperaceae* species.

Species of uncertainty were verified through comparison with herbaria prototypes of the herbarium of the University of Zululand, the University of KwaZulu-Natal and the South African National Biodiversity Institute (SANBI) in Durban. Specimens taken to herbaria for confirmation were prepared according to SANBI standards.

5.5 Data processing

The aim of classification is to group together a set of individuals (quadrats of vegetation samples) on basis of their floristic composition. The end product of a classification should be a set of groups derived from the individuals where, ideally, every individual within each group is more similar to other individuals in that group than to any individual in any other group.

The purpose of the methodology of Braun-Blanquet is to construct a global classification of plant communities (Kent and Coker, 1995). The method is based on several fundamental concepts and assumptions.

The association is the basic unit of the classification system, the plant community. An association is therefore a plant community type, found by grouping together various sample relevés that have a number of species in common (Kent and Coker, 1995).

The final associations, which represent groups of similar relevés, are derived by a subjective process of tabular sorting and rearrangement of both relevés and species. Generally, sorting involves the following stages of the whole process (Fig. 5.4).

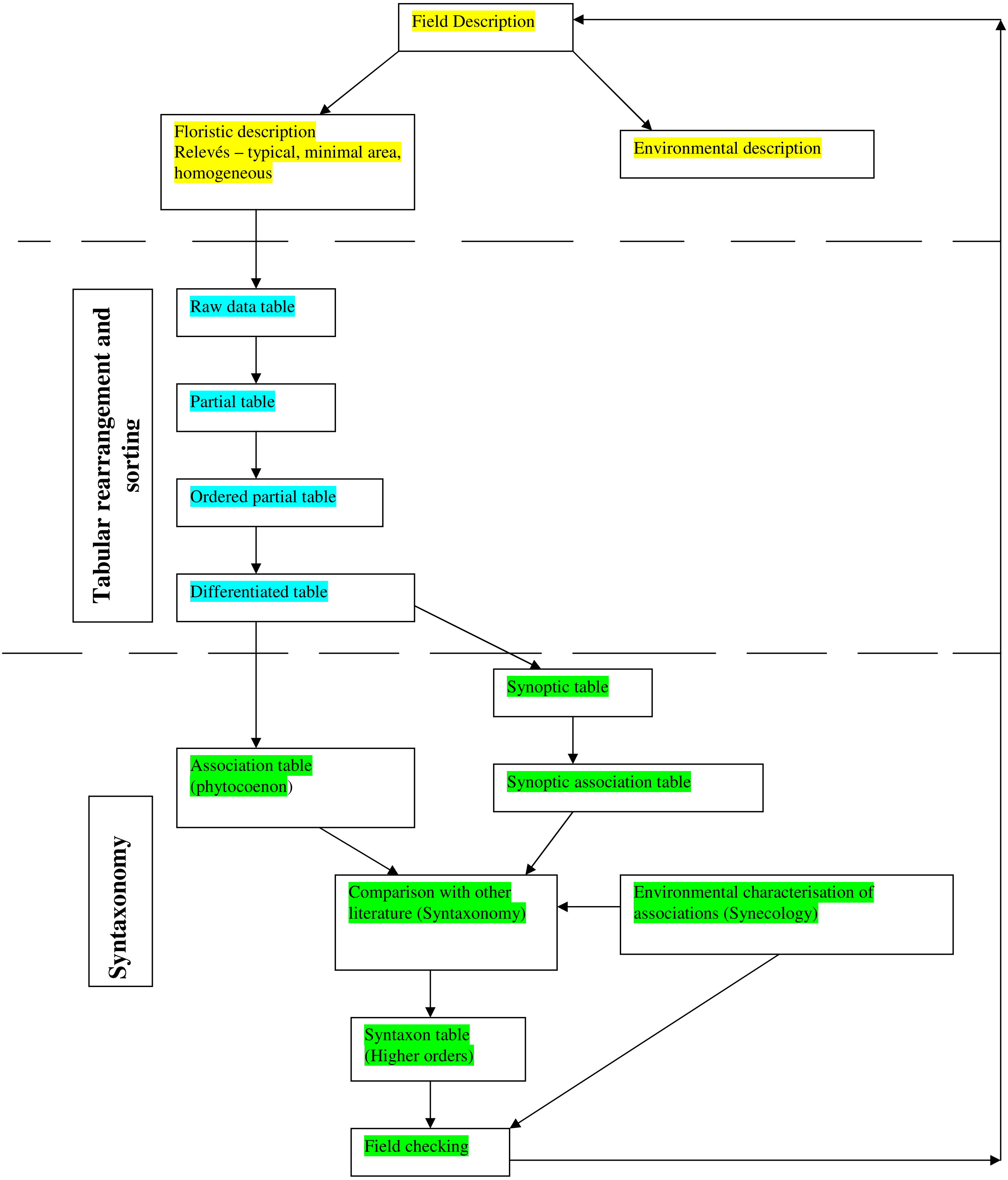
5.5.1 The TWINSPAN computerised method

The subjective nature of the process of tabular rearrangement has been reduced over the past 30 years by the writing of various computer programs to carry out tabular arrangement. Some of these programs are related to the more objective methods of numerical classification, particularly similarity analysis (Kent and Coker, 1995).

Most techniques devised over the past 25 years have been hierarchical in nature. This means that the results can be portrayed as a dendrogram. The reason why hierarchical method are more common is that such a dendrogram shows different levels of similarity or dissimilarity very clearly and the different levels displayed in a dendrogram are often very helpful when it comes to making ecological interpretations (Kent and Coker, 1995).

Methods of classification may be applied to either quantitative or qualitative data. Most methods will accept either type of data (except association analysis), and the decision on whether to use quantitative data depends on the type of problem being analysed (Kent and Coker, 1995).

Figure 5.4: A Flowchart of stages in the subjective classification of relevés using the Braun-Blanquet method (Adapted from Westhoff and Van der Maarel, 1978 in Kent and Coker, 1995).


Field Description
Floristic description
Relevés – typical, minimal area, homogeneous
Environmental description
Tabular rearrangement and sorting
Raw data table
Partial table
Ordered partial table
Differentiated table
Synoptic table
Association table (phytocoenon)
Synoptic association table
Syntaxonomy
Comparison with other literature (Syntaxonomy)
Environmental characterisation of associations (Synecology)
Syntaxon table (Higher orders)
Field checking

More recent methods, notably two way indicator species analysis (TWINSPAN), employ the idea of the pseudospecies, whereby the presence of a species at different predetermined levels of abundance is used. In TWINSPAN the percentage cover scale is often divided into six using five levels. Thus the first pseudospecies may be 1 – 2 per cent cover of the species, 3 – 5 per cent the second pseudospecies, 6 – 10 per cent the third, 11 – 20 per cent the fourth, 21 – 50 per cent the fifth and over 50 per cent the sixth. These six levels of abundance of a species are then used in presence/absence form to make the classification (Kent and Coker, 1995).

The complete Richards Bay vegetation database (320 relevés stored in TURBOVEG) was exported as a Cornell Condensed species file (cc-file) to a working directory in MEGATAB (Hennekens, 1996b). The option in TURBOVEG to distinguish between different vegetation layers a single species occupy was made inapplicable by combining all layers into one layer (no layer) (Du Plessis, 2001).

A Twinspan classification (Hill, 1979b), incorporated in MEGATAB, was used to obtain a first approximation of the plant communities occurring in the area. This classification was used to compile a table using the Braun-Blanquet method (Werger 1974, Westhoff and Van der Maarel 1978) in the data editor program MEGATAB (Hennekens 1996b). These results showed three major plant communities, which were then separated into three different tables. The data in each of the parts were classified separately, using TURBOVEG (Hennekens 1996), TWINSPAN (Hill, 1979b) and MEGATAB, to clearly indicate the different communities and the differences between the sub-communities within the major communities.

The communities and their sub-communities were then described, according to their diagnostic species, dominant species and associated species. The final three phytosociological tables indicate the different plant communities, as well as the floristic variation within each community and the relationship between communities (Venter, 2003).

The classification of vegetation types in terms of their floristic composition using the Braun-Blanquet classification technique with the use of the two way indicator species analysis (TWINSPAN) computerised method for numerical classification as well as the hierachical technique where the results are potrayed as a dendrogram, also known as a tree of linkage diagram (Kent and Koker, 1995).

To facilitate the task of refining a phytosociological table containing more than 300 relevés and almost 500 species, a synoptic table was constructed directly from the TWINSPAN table as an option in MEGATAB (Du Plessis, 2001).

5.6 Field mapping and verification of wetlands and other vegetation

One of the aims of this study was to establish the occurrence and distribution of the Richards Bay plant communities. Information on the plant communities was obtained from colour aerial photographs, taken in May 1998. The plant communities were identified principally on the basis of colour and structural variation portrayed by the aerial photographs. Where identification was uncertain because of poor photographic resolution, identification was on the basis of apparent similarity to other clearly recognised vegetation types.

The potential and limitations of aerial photo interpretation for vegetation studies are discussed in the literature (For example, Edwards, 1972; Weisser, 1979 and Jarman *et al*., 1983). While mapping, the aerial photos were realigned as soon as a deviation of corresponding points and areas could be observed. Inaccuracies owing to distortions and mapping difficulties though, are at a level that will not impair main conclusions.

Ground truthing of the vegetation was carried out in the growing season of 2001/2002, during which the general species composition, apparent species diversity and overall condition of plant communities, within their communities was assessed over their distribution ranges.

CHAPTER 6: RESULTS:
PLANT COMMUNITIES OF THE DUNES

The result of the floristic analysis of the vegetation of the dunes is given in Table 6.1. All references to species groups in this Chapter refer to this Table. Four communities were recognised, but these may be grouped into two major communities. The classification of these communities is as follows:

6.1 Classification

1. *Carprobotus dimidiatus – Gazania rigens* Dune vegetation.
1.1 *Gazania rigens – Scaevola plumieri* Foredune community.
1.2 *Cynanchum natalitium – Carprobotus dimidiatus* Mid-dune community.
2. *Chrysanthemoides monilifera – Casaurina equisetifolia* Dune Scrub
2.1 *Chrysanthemoides monilifera – Carpobrotus dimidiatus* Dune Scrub
2.2 *Chrysanthemoides monilifera – Brachylaena discolor* Backdune Scrub Thicket.

Description of Dune vegetation

1. *Carprobotus dimidiatus – Gazania rigens* Dune vegetation

This vegetation is characterised by species group C. The diagnostic species are the succulent creepers *Carprobotus dimidiatus* and *Ipomoea pes-caprae*, the shrub *Helichrysum kraussii* and the herbaceous creepers or forbs *Gazania rigens*, *Arctotheca populifolia* and *Launaea sarmentosa*.

Few other species may be present, including *Chrysantehmoides monilifera*, *Eugenia capensis* and the alien tree/shrub *Casuarina equisetifolia*.

The dune and strand vegetation occurs on unconsolidated loose sand of the sand dunes north and south of Richards Bay harbour. Analysis on the sand indicated that the sand's water holding capacity is generally low and that it is almost uniformly alkaline with a pH as high as 8.7 (Venter, 1972). This vegetation on the frontal dunes is subjected to high concentrations salt spray and consequently only species tolerant to these conditions establish in this habitat (Venter, 1972).

Carprobotus dimidiatus is a perennial, trailing succulent. It grows in sand on the coastal strip and will grow down as far to the high tide mark on beaches (Pooley, 1998). This species generally forms large mats on open sand as observed in the study area. *C. dimidiatus* forms a good ground cover as well as a sand stabilizer and is tolerant to salt spray conditions (Pooley, 1998).

Gazania rigens is a creeping perennial herb which is a common sand coloniser, which is distributed from southern Cape to Mozambique (Pooley, 1998).

Two communities were recognised under the *Carprobotus dimidiatus* – *Gazania rigens* Dune vegetation:

1.1 *Gazania rigens* – *Scaevola plumieri* Foredune community.

This vegetation is characterised by species group A. The only diagnostic species is *Scaevola plumieri*, however the diagnostic species of the *Carprobotus dimidiatus* – *Gazania rigens* Dune vegetation (species group C) are also present, and especially *Gazania rigens* is prominent. Dense stands of *Scaevola plumieri* and *Gazania rigens* were very common on sand dunes north of the bay mouth and Richards Bay harbour.

Scaevola plumieri is an evergreen succulent shrublet and form large colonies on coastal sand dunes (Pooley, 1998). *Gazania rigens* is more widely distributed as a pioneer species throughout the front dunes and backdunes which are exposed to wind and salt spray. *S. plumieri* is however more restricted and forms more dense stands on the frontdunes than the back dunes.

1.2 *Cynanchum natalitium – Carprobotus dimidiatus* Mid-dune community.

This vegetation is characterised by species group B. The diagnostic species include the scrambling vine *Cynanchum natalitium*, the shrub *Maytenus procumbens*, the forbs *Canavalia bonariensis*, *Senecio macroglossoides* and *Hibiscus trionum* and the sedge *Mariscus solidus*.

Cynanchum natalitium is a vine occurring in dune forest or scrub. The stems are woody and bark corky (Pooley, 1998).

This vegetation occurs on the mid-dune areas, and is transitional between the foredunes and the backdunes. This is indicated by the presence of species from species group C, and especially species group E.

2. *Chrysanthemoides monilifera – Casaurina equisetifolia* Dune Scrub

This major dune scrub community is characterised by species group E. Diagnostic species are the shrubby *Chrysanthemoides monilifera* and the alien tree *Casaurina equisetifolia*.

Chrysanthemoides monilifera grows in the form of a shrub or small tree which can reach heights between 1 to 6 meters and can be found from coastal dunes to the Drakensberg escarpment in KwaZulu-Natal and Transkei (Pooley, 1993). Maximum heights of 3.5 meters were observed for this species on the back dunes of the northern shores area of Richards Bay as well as in the open spaces of the Meerensee suburb of Richards Bay where soils were still sandy.

Casaurina equisetifolia is an alien tree species used to stabilise shifting sands at the coast, now naturalised in Transkei, KwaZulu-Natal and Mozambique (Pooley, 1993). This alien species forms part of a community occurring in dense stands on the northern and southern bounderies of the bay mouth. Littoral drift sands that originated on the beach formed tongues into the vegetated dunes (Weisser and Muller, 1983). Many drift sands were too small to be mapped, however, the position of the drift sand along the coast was reasonably constant through the years (Weisser *et al*., 1983).

By comparing 1937 and 1976 maps, a reduction in size and number of coastal drift sands was found. This was most probably a consequence of the protective management (e.g. reduction of grazing and fire) carried out by the Department of Forestry and of their drift sand rehabilitation programme using *Casaurina equisetifolia* (Weisser *et al*., 1983). Three main inland drift sands were found on the 1937 photographs. On the 1976 photos they were found to have stabilized mainly through the plantings of *Casaurina equisetifolia* (Weisser *et al*., 1983).

Less frequent species occurring in the back dune communities include: *Imperata cylindrica*, *Carissa macrocarpa, Helichrysum areum, Cymbopogon validus, Phoenix reclinata, Momordica foetida* and *Rhus chirindensis*.

Photo 6.1: *C. equisetifolia* one of the diagnostic species of the Backdune Vegetation Community viewed from the harbour to the south (March 2002).

Table 6.1: Plant communities of the dunes

Releve number	269	270	263	264	265	266	267	268	257	260	254	271	272	273	274	278	35	39	249	250	252	255	256	258	259	261	262	275	276	277	279	280	281
Species Group A																																	
Scaevola plumieri	m	1	b	b	1	b	b	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group B																																	
Cynanchum natalitium	.	.	.	.	.	.	.	.	b	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.
Maytenus procumbens	.	.	.	.	.	.	.	.	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Canavalia bonariensis	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio macroglossoides	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus trionum	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Mariscus solidus	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group C																																	
Ipomoea pes-caprae	+	+	.	+	.	.	.	+	+	+	.	+	+	+	+	+	.	.	b	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Gazania rigens	+	1	.	+	+	+	+	1	.	+	b	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carpobrotus dimidiatus	+	.	+	.	.	.	.	.	1	1	+	+	+	+	b	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	1
Helichrysum kraussii	.	+	+	1	.	.	.	.	.	.	1	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arctotheca populifolia	1	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Launaea sarmentosa	+	+	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group D																																	
Brachylaena discolor	.	.	.	.	.	.	.	.	+	b	.	.	.	.	.	.	.	.	1	4	3	3	m	m	m	3	.	1	.	1	1	1	1
Eugenia capensis	.	r	.	.	.	.	.	.	.	.	b	1	.	.	.	.	.	.	.	.	+	1	1	1	3	m	.	r	r	r	.	1	+
Strelitzia nicolai	.	.	.	.	.	.	.	.	r	1	.	.	.	.	.	.	.	.	1	1	1	1	1	+	1	r	b	.	.	.	.	.	.
Sideroxylon inerme	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	m	m	1	3	4	1	.	1	1	.	.	.	.	r	.
Microsorium scolopendrum	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	+	.	+	1	.	.	.	.	.	.	.	+	.
Chromolaena odorata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	1	.	1
Species Group E																																	
Casuarina equisetifolia	.	+	.	r	.	.	.	.	r	+	.	1	r	b	1	3	4	4	.	.	.	r	.	3	.	1	.	4	3	b	5	5	5
Chrysanthemoides monilifera	.	.	1	r	.	.	.	.	b	1	3	3	+	4	b	b	.	.	3	1	.	b	.	1	+	1	b	.	1	m	.	.	.
Infrequent Species																																	
Imperata cylindrica	.	.	.	.	.	.	.	.	+	.	a	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	+	.	.
Carissa macrocarpa	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	+	.	+	.	.	.	.	.	.	.	.	.	.
Helichrysum aureum	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	+
Cymbopogon validus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Rhus nebulosa	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	m	.	.	.
Phoenix reclinata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	.	+	.	.	.	.	.	.
Abrus precatorius	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.
Isoglossa woodii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Tagetes minuta	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Passiflora subpeltata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Allophylus africanus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b	.	.	r	.	.	.	.	.	.	.	.	.
Momordica foetida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.
Smilax anceps	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.
Rhus chirindensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	b	.	.	.	.	.	.	+	.
Acacia karroo	.	.	.	.	.	.	.	.	.	.	.	b	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	b	.	.	.	.
Cyperus rupestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Helinus integrifolius	. . . .	. .	. . . . . .	. . . . + ...
Acacia robusta	. . . .	. .	. . . . . .	. . . . + ...
Cryptocarya myrtifolia	. . . .	. .	. . . . . .	. . . . + ...
Blechnum australe	. . . .	. .	. . . . . .	. . . . + ...
Eulophia horsfallii	. . . .	. .	. . . . . .	. . . . . . r . . . .
Acalypha sonderiana	. . . .	. .	. . . . . .	. . . . + ...
Catunaregam spinosa	. . . .	. .	. . . . . .	. . . . 1 . . . .
Lablab purpureus	. . . .	. .	. . . . . .	. . . . . . + ...
Tricalysia lanceolata	. . . .	. .	. . . . . .	. . . . r .
Erythrina lysistemon	. . . .	. .	. . . . . .	. . . . r . . . .
Syzygium guineense	. . . .	. .	. . . . . .	. . . . r
Chironia baccifera	. . . .	. .	. . . . . +	. . . .
Echinochloa pyramidalis	. . . .	. .	. . . + . .	. . . .
Asparagus falcatus	. . . .	. .	. . . . . .	. . . . + ...
Lantana camara	. . . .	. .	. . . . . .	. . . . +
Halleria lucida	. . . .	. .	. . . . . .	. . . . + ...
Allophylus natalensis	. . . .	. .	. . . . . .	. . . . . . + ...
Oplismenus hirtellus	. . . .	. .	. . . . . .	. . . . + ...
Digitaria eriantha	. . . .	. .	. . . . . +	. . . .
Aristida junciformis	. . . .	. .	. . . . . +	. . . .
Dactyloctenium australe	. . . .	. .	. . a . . .	. . . .
Pinus elliottii	. . . .	. .	. . . . . .	. . . 1 . . . .
Senecio tamoides	. . . .	. .	. . . . . .	. . . . + ...
Cissampelos mucronata	. . . .	. .	. . . . . .	. . . . . . + ...
Trichilia dregeana	. . . .	. .	. . . . . .	. . . . b . . . .
Zehneria parvifolia	. . . .	. .	+	. . . .
Maytenus nemorosa	. . . .	. .	. . + . . .	. . . .
Grewia pondoensis	. . . .	. .	. . . . . .	. . . . + ...
Ipomoea cairica	. . . .	. .	. . . . . .	. + ...
Panicum repens	. . . . . 1 . .	. .	. . . . . .	. . . .
Commelina erecta	. . . .	. +	. . . . . .	. . . .
Senecio madagascariensis	. . . + ...	. .	. . . . . .	. . . .
Helichrysum aureonitens	. . . + ...	. .	. . . . . .	. . . .
Bulbostylis hispidula	. . . .	. .	. . . a . .	. . . .
Canavalia rosea	. . . .	+ .	. . . . . .	. . . .
Indigofera spicata	. . . .	. .	. . . . . +	. . . .
Pycreus macranthus	. . . .	+ .	. . . . . .	. . . .
Hydrocotyle bonariensis	. . . .	. .	+	. . . .
Helichrysum auriceps	. . . .	. .	+	. . . .
Paspalum distichum	. . . .	. .	. . . . . .	. . . . + ...
Vigna unguiculata	. . . .	. .	. . . . . .	+ . . . .
Diospyros natalensis	. . . .	. .	. . . . . .	. . . . r . . . .
Rubia cordifolia	. . . .	. .	. . . . . .	. . . . . . + ...
Zehneria scabra	. . . .	. .	. . . . . .	+ . . . .
Trema orientalis	. . . .	. .	. . . . . .	. . . . r . . . .

CHAPTER 7: RESULTS:
FOREST COMMUNITIES

The results of the floristic analysis of the forest vegetation are given in Table 7.1. All references to species groups in this Chapter refer to this Table. Four communities were recognised. The classification of these communities is as follows:

1. *Isoglossa woodii – Macaranga capensis* Tall Closed Forest
2. *Chromolaena ordonata – Melia azedarach* Short Woodland and Forest
3. *Barringtonia racemosa – Ficus tricopoda* Tall Swamp Forest
4. *Avicia marina* Short Mangrove Forest

Description of Forest Communities

1. *Isoglossa woodii – Macaranga capensis* Tall Closed Forest.

This forest community occurs north and south of the bay mouth and forms an extensive part of the coastal forest vegetation (Venter, 1972).

This vegetation is characterised by species group A. Species considered to be diagnostic include the trees *Macaranga capensis*, *Trichillia emetica*, *hibiscus* tiliaceus, Mimusops *caffra*, *Psychortria capensis* and *Strelitzia reginae*, the shrub *Isoglossa woodii,* the lianas *Asparagus falcatus, Senecia tamoides* and the alien invasive *Ipomoea purpurea, the geophyte Scadoxis multiflorus* subsp. *katharinae* and the fern *Cheilanthes viridis*.

Macaranga capensis is a tall deciduous tree, found in low altitude forests, usually in wet areas (Pooley, 1993). It is mainly distributed along lake banks and also occurred frequently on river and stream banks. Most trees observed were mature trees differing in height from 9 to 20 meters. *Isoglosa woodii* is a shrub which can grow up to 4 meters and usually grow in colonies in forest understoreys (Pooley, 1998). It appears to be the dominant species occurring within the understorey of the forest community within the study area. *Asparagus falcatus* is a robust climber also associated with forest margins and thickets and has a wide distribution from Eastern Cape to tropical Africa (Pooley, 1993)

Species that are often found in these forests (species group C) include the trees *Strelitzia nicolai*, *Acacia karroo*, *Trema orientalis*, *Rhus nebulosa* and *Brachylaena discolor* and the prominent forb *Asystacia gangetica*, while the alien invader tree *Psidium guajava* and alien liana *Passiflora subpeltata* may also be present.

Other species encountered include (species group F) the trees *Tricalysia capensis, Albizia adianthifolia* and *Phoenix reclinata*, the lianas *Smilax anceps* and *Cissampelos torulosa* and the climbing fern *Stenochlaena tenuifolia*.

Strelitzia nicolai occurred scattered through out the open grassveld and became more evident in denser stands with higher cover abundance in closed forest areas. *Strelitzia nicolai* rarely reached heights above 3 meters and formed part of the sub-crown stratum of coastal dune and sand forest. *Trema* *orientalis* is a common pioneer tree or shrub (5 to 15 meters) high and is usually found on forest margins, disturbed soils, water courses in warm, fairly high rainfall areas (Pooley, 1993). *Asystacia gangetica* is a spreading herb and is commonly found growing in woodland and forest where it occurs predominantly in shady areas as groundcover (Pooley, 1998). The species has preference to shady and moister conditions within the forests of Richards Bay area. Within the more open grassveld patches with more direct exposure to sunlight, *Asystacia gangetica* occurs less prominently.

As mentioned, this community also has the alien invasive species *Psidium guajava*. This species is a small tree, found in the scrub forest, riverine vegetation and on roadsides and although an exotic from tropical America, it is now naturalised along the KwaZulu-Natal coastal areas (Pooley, 1993). Results (7.1) indicate that *P. guajava* and *L. camara* has invaded the greater parts of the Richards Bay municipal area. It was also observed during this study that erosion was visible in this study area and that open eroded patches were colonised by *Psidium guajava* and *Lantana camara*.

As observed by Venter (1972) *Acacia karroo* may form a community on the outer bounderies of the forest communities where it separates the grassveld from the rest of the forest community. This species may occur in loose standing stands within other forest communities, as shown in species group C (Table 7.1). Previous observations of active *A. karroo* encroachment into adjacent grassveld and dune wetland areas, where sufficient moisture conditions exists (Venter, 1972 and Matsau, 1999) could be supported with observations of this study.

2. *Chromolaena ordonata – Melia azedarach* Short Woodland and Forest

This vegetation is degraded woodland or more open degraded forest where alien species invaded and became very prominent. The community is characterised by species group B. Diagnostic species are often alien invader species, e.g. the woody *Chromolaena ordonata*, *Melia azedarach*, *Lantana camara* and *Eucalyptus grandis*. Other diagnostic species include the tree *Rhus chirindensis*, the grasses *Oplismenus hirtellus* and *Paspalum distichum* and the reed *Phragmites australis*.

Other species that are often encountered include (species group C) the trees *Strelitzia nicolae*, *Acacia karroo*, *Trema orientalis*, *Rhus nebulosa* and *Brachylaena discolor* and the prominent forb *Asystacia gangetica*, while the alien invader tree *Psidium guajava* and alien liana *Passiflora subpeltata* may also be present. Other species present include (species group F) the trees *Albizia adianthifolia* and *Phoenix reclinata*, the lianas *Smilax anceps* and *Cissampelos torulosa* and the climbing fern *Stenochlaena tenuifolia*.

Chromolaena ordonata is a scrambling, sparsely hairy shrub up to 4 metres or higher, often forming dense thickets. This species originally cultivated as an ornamental plant, is now found as an invader of forest margins, savanna, plantations as well as along water courses and roadsides (Henderson, 2001). The species is usually associated with growing in disturbed places and is regarded as a serious threat to South Africa's natural vegetation (Pooley, 1998).

Melia azedarach is a deciduous, spreading tree up to 23 meters high. It was cultivated for ornamental, shade providing trees, but now invades savanna, roadsides, urban open spaces, wasteland and riverbanks (Henderson, 2001). This species appears to be distributed mainly along riverbanks and the man made drainage channels as well as roadsides in the study area of Richards Bay municipal area. This species was declared as a category 3 invader, which is not allowed to occur within 30 meters of a 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland (Henderson, 2001).

Photo 7.1: *Chromolaena ordonata* invading riverine, Swamp and Dune forest Vegetation (February 2002).

Photo 7.2: *Psidium guajava*, alien invasive species encroaching in woodland and Grassland areas (June 2002).

Lantana camara is another alien invasive species observed in this community and was first introduced as an ornamental plant from central and South America, which now became a noxious invasive weed in southern Africa and also known to be poisonous to cattle (Pooley, 1998).

Eucalyptus grandis is a tall evergreen tree which was originally cultivated for timber, shelter, firewood and a honey source (Henderson, 2001). This species invades forest gaps, plantations, watercourses and roadsides. It is a declared category 2 invader. This species are only allowed to grow in areas demonstrated to primarily serve a commercial purpose, use as a woodlot, shelter belt, building material, animal fodder, soil stabilisation, medicinal or other beneficial function (Henderson, 2001).

The presence of the species listed in species group C occur in both the *Isoglossa woodii – Macaranga capensis* Tall Closed Forest and the *Chromolaena ordonata – Melia azedarach* Short Woodland and Forest. This may indicate a floristic and ecological relationship between these two communities. It may also indicate that the *Chromolaena ordonata – Melia azedarach* Short Woodland and Forest is a degraded form of the *Isoglossa woodii – Macaranga capensis* Tall Closed Forest, totally invaded by alien species. This could indicate that pristine coastal forest will change to a degraded forest type dominated by alien species if not protected against human caused impacts.

1. *Barringtonia racemosa – Ficus tricopoda* Swamp Forest

Freshwater Swamp Forests grow along the coast of northern KwaZulu-Natal. These small communities of *Barringtonia racemosa – Ficus tricopoda* Swamp Forests grow mainly in localised groups on the shores of Lake Mzingazi along drainage lines. In some areas, especially towards the Mdibi River in the north of the lake, *Barringtonia racemosa* is extensively harvested for building material by locals and several other species uses as traditional medicines by the Zulu community (Reavell, Maseko and Matsau, 1998*)*. *Barringtonia racemosa* is one of some trees having a broad tolerance to a range of hydroperiods and soil moisture, whereas *Ficus tricopoda* is more confined to wetter areas (Reavell, *et al*. 1998).

This Swamp Forest is characterised by species group D and the diagnostic species are *Barringtonia racemosa*, *Ficus tricopoda* and *Ficinia trichodes*. Other species that may be present (species group F) include the tree *Phoenix reclinata*, the liana *Smilax anceps* and the fern *Stenochlaena tenuifolia*.

Barringtonia racemosa is a small to medium sized tree, found fringing coastal swamp forest, estuaries and rivers from the KwaZulu-Natal south coast to Mozambique (Pooley, 1993). This species previously formed large continuous communities as indicated by Venter (1972). However, in the study area *Barringtonia racemosa* and *Ficus tricopoda* dominated swamp forests have been reduced to relatively small patches occurring within the Richards Bay municipal area. These trees usually occur in association with each other and are restricted to the back swamps of Lake Mzingazi, Lake Nzeze and on the river banks of the Mzingazi river and other streamlets and drainage channels. A possible decline in *Barringtonia racemosa* over the years could be a result of the harvesting of this species by local people in the areas of Lake Mzingazi for fence and hut building and those areas where trees are removed are usually invaded by species like *Chromolaena odorata* (Maseko, 1996).

Photo 7.3: *Barringtonia racemosa* Swamp Forest on the banks of Lake Mzingazi. Dead *B. racemosa* trees in the front (May 2002).

Photo 7.4: Swamp Forest mosaic vegetation invaded by *Eucalyptus grandis* (May 2002).

Photo 7.5: Clearing of Swamp Forest vegetation for agriculture and building material on lake shores such as Lake Chubu and Mzingazi (June 2002).

2. *Avicenia marina* Mangrove Forest

Avicenia marina occurred as the only species within this mangrove community (species group E) and formed dense stands on the northern banks of the bay and as far to the west as the Mhlatuze River. Dense stands with cover abundance scales of 3 to 5 were often observed, especially closer to or on the banks of the estuary and in areas that are more protected to direct wave action than those stands occurring in more open waters.

Avicenia marina is a small to medium sized and pioneer mangrove, found in estuaries and intertidal area in KwaZulu-Natal and Eastern Cape coastlines (Pooley, 1998). The largest trees were observed in the dense stands where the species reached heights of up to 9 – 10 meters. Although *Avicenia marina* is usually associated with *Brugeuiera gymnorrhiza*, the only species recognised in the sub-crown stratum of this community, was *Avicenia marina*. *Brugeuiera gymnorrhiza* was not recorded in the sample plots in the mangrove forest community of Richards Bay area. If *Brugeuiera gymnorrhiza* still occurs it is to a much lesser that was observed by Venter (1972).

Other studies indicated that different age groups were recognised in the mangrove forest that developed after the construction of a harbour in the

Umhlatuze Estuary in 1976 (Bedin, 2001). The rate of progress was high during the first period, varying until 1982. Thereafter there was a small decrease in the total area, and progress has been 5.4 ha per year over 13 years. The difference in stem densities was also observed and higher densities were found in youngest stands (Bedin, 2001). Stem densities became significantly lower in older stands. This suggests that the mangrove progression has slowed down and that the system was settling down (Bedin, 2001).

Photo 7.6: Aerial view of the *A. marina* Forest south of Richards Bay Harbour (March 2002).

Photo 7.7: *Avicenia marina* (White Mangrove) stands of the Mangrove Swamp Forest vegetation (March 2002).

Photo 7.8: *A. marina* saplings (March 2002).

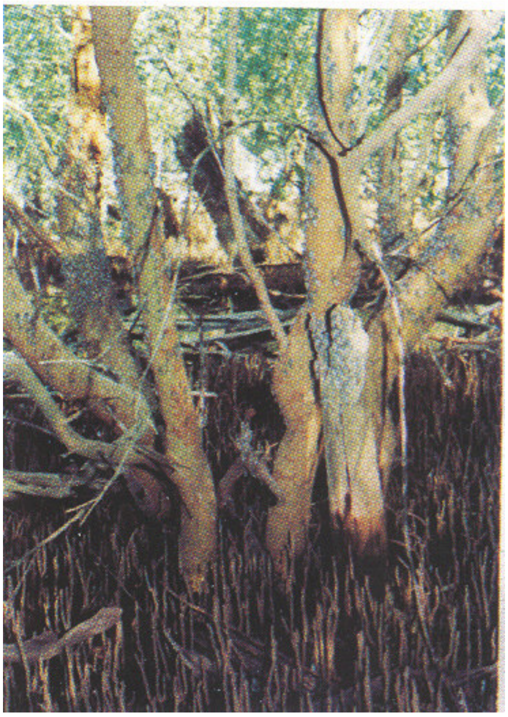


Photo 7.9: Aerial roots of *A. marina* (March 2002).

Table 7.1: Forest plant communities

Relevé nr			
	34 49 71 72 85 86 123 124 129 131 140 154 155 168 170 171 174 175 176 177 178 179 183 184 185 225 226 228 239 240 245 246 247	52 57 58 73 75 77 87 88 91 92 94 96 125 142 147 148 149 152 158 159 160 162 163 165 166 182 186 187 194 190 191 194 202 210 217 222 224 238 241 248 159 253	214 220 227 89 90 95 130 144 153 167 172 173
Species Group A			
Isoglossa woodii	. . + . . + + . 1 . . 1 . . m b 1 . b 3 m 1 4 3 3 + + + m m 3 3 m	. . . . + ... 1 . 3 . . . . 1 . . 1 1 . .	. . . .
Macaranga capensis	. . . . b . . 4 b . . 3 . m 3 4 b b . . . . m b . + . . .	. . . . 3 . . 1 . . . . r	. . 1 . . . .
Asparagus falcatus	. + ... + . . + + . + + + . + . . + + . + + + + . + . . .	. . . . + ... + ...	+ . . . . +
Trichilia emetica	. . 1 . . . 1 1 3 . 4 . . . . + b 3 4 . . . . 1 . 1	. . . 1 . + ...	. . . .
Ipomoea purpurea	. + ... + . . . + . + + + . . + ...	. . . . . . b . . . . + ...	. . . . + ... + .
Hibiscus tiliaceus	. . . . b . . . . m 3 b . 1 . . . . 1	. . . . . . m	. . . .
Mimusops caffra	. . . . . m . . . . . b . . . . . . 1 . . . . . . 1 1	. . . . + ...	1 . . . .
Psychotria capensis	. . . . m . . . . 3 b . m . . . . . m	. . . .	. . 1 . . . .
Scadoxis multiflorus katharinae	. . . . + + . + . . + + ...	. . . .	. . . r . + ...
Senecio tamoides	. . . . + ... + ... + +	. . . . +	. . . .
Cheilanthes viridis	. . . + ... 1 . + ... 1 . . . . m	. . . . + ...	. . . .
Strelitzia reginae	. . + ... + ... + r . . . . r	. . . .	. . . .
Species Group B			
Chromolaena odorata	. . + ... b 3 . + . + . .	. . . . . 1 . . . b . . . . . m 1 . . . . b . 3 m 3 b b 4 b b . 4 b 4 m b b 3 . 1	3 + ...
Melia azedarach	. . . . 1	. . . . . 4 4 4 m m . . b . . . b 3 1 3 1 3 . 1 m . 1 . . . r . . . . . 1 . . . 3 .	. . . 1 4 . . . .
Lantana camara	. . + ... 1	4 1 . + b b 3 1 . . . 3 . . . r . + ... r . . . + 1 + . 1 + . . . 3	. . . .
Rhus chirindensis	. . . . . . 1 1	+ . . . . . m m 1 . . . 4 1 b + . m . . . . 1 + ... + . + . 1 + . m	. . + ...
Oplismenus hirtellus	. . . . + . . + + . . . + ...	. . . b m 1 + ... + ... + . . . + + . . . + . . + . . + . . . + . + .	. . . .
Eucalyptus grandis	. . . .	. . . . 4 3 . . . 4 . . . b 4 . + . . . m . . m . . 1 . . . . . . 3	. . . .
Paspalum distichum	. . . . + +	. . . . + ... a a . a . . . . a . + . +	. . . .
Phragmites australis	. . . . +	. . . . . . 1 . . . . b . . . + ... + . 1 + . + ...	. + ... + ...
Species Group C			
Asystasia gangetica	. . . + ... m . + . . . m + 1 . 1 1 1 m 1 m + . . + 1 + . +	. r + ... + 1 m 1 3 m + . . + + 3	. . . . + . .
Strelitzia nicolai	. . . + ... 1 + . . 4 . . . . b 1 . . . . . . + . 1 .	. + + + + . . . b + . 1 . + ... 4 3 . b 3 . 3 . . . . 3 + 1 . + . 3 .	. . . + ...
Acacia karroo	. . . . b . . . 1 . . . . . . + . . 1 . 3 . . + . m 1 . 4	. . . . 1 . . . 1 . 4 . . . b 1 3 . . . . b . m . . 1 + . 1 . . b 1 1 . . 1	+ + ...
Commelina africana	. . . . 1 . . 1 1 b 1 . . . . 1 . . 1 b . . . 1 + + . . 1	. . . . + ... 1 + 1 . . . . 1 . . . . b 1 + . + ... 1 . . r . + . .	. . . .
Psidium guajava	. b . . 3 . 4 m . . . . b . . . . . 1 3 m 4 .	m + ... b . . . b . . . . b 4 + 1 + . 1 . 1 . 4 1 . 4 . . 4	. . . .
Trema orientalis	. . . . + . + + + . + ... + ... + . . +	. . . 1 b . . . + ... + + + + + . + . + ... + . . + + .	. . . .
Rhus nebulosa	. . + . . 1 . . . . + + ... 1 . + ...	+ . . . . b . + ... + 1 . 1 . + . 1 . . . . r . . + . . . 1 . .	. . . .
Passiflora subpeltata	. . . . 1 . . . . 3 4 3 b b . . . 4 . . . 1	. . . . . . 3 m b . . . 1 b . . . . . 3 . . . . 1 . . . . b 3 .	. . . . m . . . .
Commelina erecta	. . . . 1 . . . . . m . . . 3 . . . . . 1 1 + + . . b	. . . . b + ... 1 . . . . m m r m . . 1	. 1 . . . .
Brachylaena discolor	. . 1 + . . . 1 . 1 . m . . . . 1 . + ... m .	. . . . 1 . m + b . + ... + ...	. . . .
Centella asiatica	. . + ... + + . + ... + ... + .	+ . . + . + + + . + + ... + ...	. . . .
	. . . . + ... + 1 . . . . . + ... + .	. . . + ... + ... + . + . + . . + ... + ... + + ...	. . . . + .
	. . . . . 3 1 . . . b . . . . + 1 . . 1 . . . . + . . .	. . . . b 1 . . . . m . . . . + b . . 1	. . . .
Microsorium scolopendrum	. . . . + ... + . + . . + . + + . . .	. . . . + ... + + . . + + ... + ...	. . . .
Ficus sur	. . . . 1 . . . . 1 b . . . . . r	. r . . . . m . . . . . b . . . m . . . . r	. r . . . .
Species Group D			
Barringtonia racemosa	. . . . 3 m . b . . 1 1 . . 1 . . . . . . m . m	. . . . + m . . . 3 . . b . . 1 b . . . . b	3 3 4 4 4 5 5 4 5 4 . 4
Ficus trichopoda	. . . . m . b	. . r	. . . b 4 b . . . . . b
Ficinia trichodes	. . . .	. . . .	. . . . 3 3 .

Species Group E
Avicenia marina

Species Group F

Smilax anceps	. . + ... + b + + ... + . + + . . + . . + + + . + . . +	. + . + + ... + . . + + + . + . ar . . + + ... + + + + + + + + . + + + . .	. + + ... + . . . +
Phoenix reclinata	+ + + 1 m . b + m b b + b + + + . 1 1 + 1 + ... + + . .	. . . . 1 . r + + ... 3 . 1 . . + . 1 . .	+ b + ... + .
Stenochlaena tenuifolia	. . . . 1 . . . . 1 . m . . m	. + + ... + b . . . . + . . + 4	. . . 3 b + . . . + 1 +
Albizia adianthifolia	. . 1 . . . . . 1 + ... + 3 . . + . + ... m	. . . . 1 . . . . m . m . . . . b 1	. . . . + . . 1 . . . .
Cissampelos torulosa	. . . . + + . + . . . + ... + + . + + ...	. . . . + . + ... + . . + . . + ...	. . . + ... + .
Senecio macroglossoides	. . . . + . + ... + ... + ...	. . . . + + . . + ... + ... + . +	. . . + ... + +
Cissampelos mucronata	. . . . + . . + ... + . . + + . .	. . . . + . + + ... + ... + ... + . .	. . . . +
Tricalysia capensis	. . . . . . b . . b . 1 . . 1	. . . . . + ... 1 . . + ...	 3
Ipomoea alba	. . . . + ... + . .	. . . . + . 1 . . . . + + ...	. . + ... + .
Dalbergia armata	. . . . 1 . . . . m b . . . . + ...	. . . . m 1 . m	. . . .
Dichrostachys cinerea	. . . . b . . . . + + ...	. . . + ... + ... 1 . . . . r	. . . .
Pisonia aculeata	. . . . + ... 1 1 r	. . . . 1 . . 1 . . . . 1 . .	. . . .
Abrus laevigatus	. . . . + + . + . + .	. . . . + + ...	. . . .
Solanum panduriforme	. . . . + ...	. . . . + + ... r r . . + ...	. . . .
Zanthoxylum davyi	. . 1 . . . . 1 . . . 1 . . . 3 . 3	. . . r	. . . .

CHAPTER 8
RESULTS: GRASSLAND AND WETLAND COMMUNITIES

The results of the floristic analysis of the forest vegetation are given in Table 8.1. All references to species groups in this Chapter refer to this Table. Five communities were recognised. The classification of these communities is as follows:

1. *Phragmites australis – Typha capensis* Tall Closed Hygrophilous Grassland
2. *Pycreus polystachyos – Schoenoplectus senegalensis* Short open Hygrophilous Sedgeland
3. *Pycreus polystachyos – Cyperus rotundus* Short Open Hygrophilous Sedgeland
4. *Imperata cylindrica – Sporobolus fimbriatus* Temporary Hygrophilous Grassland
5. *Paspalum distichum – Eragrostis chloromelas* Temporary Hygrophilous Grassland

Description of Grassland and Wetland Communities

1. *Phragmites australis* – *Typha capensis* Tall Closed Hygrophilous Grassland

This community dominated by the diagnostic reed *Phragmites australis* is characterised by species group A. *Typha capensis* is a further diagnostic species. The widespread species of species groups F, G and H are however mostly absent in this community.

Very few other species occur, though some species (species group H) may be found scattered in this community. The alien woody invader *Psidium guajava* is often found in these reed communities, while species such as *Ipomoea cairica* and *Microsorium scolopendrum* can also be present.

This community usually grows in or close to water sources like rivers or wetlands where it forms dense stands. Although it has very little grazing value it does play an important ecological role. It protects soil from flooding and acts as a water purifier by filtration. It also provides habitat for various animals and birds (Van Oudtshoorn, 1999).

In comparison to findings of a predominant importance value of 66.1 % (Venter, 1972), *Phragmites australis* occurs to a much lesser extend during 2001. Although widely distributed throughout the Richards Bay area it only occurred locally in dense stands. Although another reed species, *Phragmites mauritianus* was recorded in previous studies (Venter, 1972), as a species occurring in wet sand beds, none were encountered in sampling plots of this study. This was verified according to specified differences between *Phragmites australis* and *Phragmites mauritianus* (Gordon-Gray and Ward, 1970).

The disappearance or decreased occurrence of *Phragmites mauritianus* surrounding Lake Mzingazi was linked to an abrupt rise in lake level in 1984 (Weisser *et al.* 1985). Furthermore, the pond weeds *Potamageton schweinforthii* and *Potamageton pectinatus* disappeared from Lake Bhangazi South (Hart and Appleton, 1997), the wilderness Lakes and Swartvlei in the Eastern Cape (Taylor 1983, Whitfield, 1984). This was attributed to severe lake level fluctuations (Weisser *et al.* 1985).

Phragmites australis was widely spread throughout the area of Richards Bay and covered almost all of the wetland and marsh areas around the bay and the wetlands between the dunes (Venter, 1972). The species' habitat was almost constantly covered with standing or at least slow flowing water. It survived in areas of salt water on the banks of the bay and in clay and saline in comparison to stands growing in sandy and alkaline soils between the dunes (Venter, 1972). For this species to decrease to the extent it did from 1972 to 2001, it can be assumed that a drastic change in habitat must have occurred. The possibility of extensive drainage for development of the Richards Bay municipal area over the years might have lowered the water table to such an extent that *Phragmites australis* no longer had optimal conditions for growing.

Phragmites australis forms part of the dominant vegetation on the periphery of most perennial water bodies and in some swamp areas. These swamps includes the extensive *Papyrus* stands that fringe onto open-water and *Phragmites* reed-beds, which often occur adjacent to Swamp Forest. Reedswamps consist of dense, often monospecific *Cyperus papyrus* communities up to 3 metres tall. No sample plots were placed in *Cyperus papyrus* communities.

Photo 8.1: *Cyperus papyrus* beds occurring in the back swamps of large water bodies such as Lake Chubu, Nsezi and Mzingazi (April 2002).

Photo 8.2: *C. papyus* stands with *E. grandis* invasion at the back
Of the Mdibi Swamp area at the northern shores of Lake Mzingazi (April 2002).

Typha capensis is a perennial herb which is wide spread along water courses in marshy areas and can reach heights up to 2.5 meters (Pooley, 1998).
Phragmites australis and *Typha capensis* seldom grow together, but they form more or less monospecific stands (Table 8.1). In wetland areas the two species will frequently occur in separate stands next to each other, but seldom mixed. This was also noted by Venter (1972).

Cyperus prolifer is a perennial herb which also occurs in colonies along the KwaZulu-Natal coast as well as in well aerated water of streams and marshes (Pooley, 1998). No sample plots were placed in this community, described by Venter (2003), from Mfabeni swamp at St Lucia.

2. *Pycreus polystachyos* – *Schoenoplectus senegalensis* Short open Hygrophilous Sedgeland

This wetland community is found scattered throughout the study area, mainly in bottomland situations adjacent to small streams. It is characterised by species group B, which is rather poorly defined. The widespread species of species group F are however mostly absent in this community. Diagnostic species include the sedges *Schoenoplectus senegalensis* and *Bulbostylis hispidula* and the grass *Andropogon eucomis*.

The sedges *Cyperus rotundus* and *Pycreus polystacyous* and the grass *Digitaria eriantha* (species groups G and H) are also present in this wetland community.

Cyperus rotundus is a perennial sedge growing between 60 to 150 mm. The species grows in moist and usually disturbed places. The species is also widely used as traditional medicine around the world. This species as well as *Cyperus esculentus*, is reputed to be one of the most formidable weeds in KwaZulu-Natal and most of the world, spreading rapidly by means of small tubers (Pooley, 1998).

Pycreus polystachyos is a perennial sedge ranging from 0.6 to 1 metre in height. This species is common in moist areas including slightly saline conditions and warm temperate regions throughout the world (Pooley, 1998).

Schoenoplectus senegalensis is distributed through Maputaland. The species is tufted, glabrous annual sedge (Gordon-Grey, 1995).

3. *Pycreus polystachyos – Cyperus rotundus* Short Open Hygrophilous Sedgeland

This wetland community also occurs scattered thoughout the study area in bottomland situations where water accumilate during the rainy season. The community is characterised by species group C. Several diagnostic species were recognised, including the tree *Syzygium cordatum*, the shrubby *Chrysanthemoides monilifera* and *Helichrysum kraussii*, the grass *Setaria sphacelata*, the sedge *Carex zuluensis*, the fern *Cheilanthes viridis* and the forb *Hydrocotylebonariensis*.

Several other more widespread species from species groups F, G and H may also be present in this community. The most frequently found species include the grasses *Imperata cylindrica* and *Paspalum distichum*, the sedges *Cyperus rotundus* and *Pycreus polystachyos*, the forbs *Ludwigia octovalvis* and *Commelina erecta* and the woody alien invader *Psidium guajava*.

Imperata cylindrica usually grows in poorly drained soil such as wetlands and river banks where it can form dense stands. It does grow in other habitat types in regions with high rainfall (Van Oudtshoorn, 1999). It is poorly utilized by animals due to the general hardness of the leaves. It is however an important soil stabiliser in many tropical regions of the world (Van Oudtshoorn, 1999). *Imperata cylindrica* may form the predominant plant species in some area (Table 8.1). Venter (1972) indicated that *Imperata cylindrica* may form communities which may invade moist grassland.

Syzygium cordatum is a medium sized evergreen tree species occurring in wooded grassland, forest and along watercourses in KwaZulu-Natal and Eastern Cape, and sometimes found in groves (Pooley, 1993). *Syzygium cordatum* is distributed throughout this wetland community. This species starts occurring more frequently in wetter grassland areas of Richards Bay. Localities where *Syzygium cordatum* was recorded were all in the vicinity of Lake Nzeze and Lake Mzingazi, where various man-made drainage channels and natural streamlets were observed.

Helichrysum kraussii is an aromatic shrublet which occur in colonies of the coastal grassland and open woodland (Pooley, 1998). *H. kraussii* was observed in drier and elevated grassland open spaces where soil water content was lower due to water leaching out to lower laying grasslands suppressions in Richards Bay area.

Old lands, Secondary Mixed Dune Grassland and Dwarf Shrubland covered the largest area of Richards Bay in 1937 (Weisser and Müller, 1983). This was the result of destruction of the original forest by humans, through fire, clearing of forest for cultivation and grazing (Weisser and Müller, 1983). In these areas grasslands were dominated by grasses such as *Imperata cylindrica* and dwarf shrubland with species such as *Chrysanthemoides monilifera* and *Helichrysum* kraussii (Weisser and Müller, 1983).

Table 8.1: Grassland and Wetland Communities

Community 1

Releve nr	40	42	44	45	46	67	108	119	128	161	206
Species Group A											
Phragmites australis	3	5	+	+	5	+	4	a	a	4	b
Typha capensis	+	.	5	5	+	+	.	+	a	.	.
Species Group B											
Schoenoplectus senegalensis	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis hispidula	.	.	.	.	.	.	.	.	.	.	.
Andropogon eucomus	.	.	.	.	.	.	.	.	.	.	.
Species Group C											
Cheilanthes viridis	.	.	.	.	.	.	.	.	.	.	.
Hydrocotyle bonariensis	.	.	.	.	.	.	.	.	.	.	.
Setaria sphacelata	.	.	.	.	.	.	.	.	.	.	.
Syzygium cordatum	.	.	.	.	.	.	.	.	b	.	.
Chrysanthemoides monilifera	.	.	.	.	.	.	.	.	.	.	.
Carex zuluensis	.	.	.	.	.	.	.	.	.	.	a
Helichrysum kraussii	.	.	.	.	.	.	.	.	.	.	.
Species Group D											
Sporobolus fimbriatus	.	.	.	.	.	.	.	.	.	.	.
Chromolaena odorata	.	.	.	.	.	.	.	.	.	.	.
Centella asiatica	.	.	.	.	.	.	.	.	.	.	.
Lantana camara	.	.	.	.	.	.	.	.	.	.	.
Bridelia micrantha	.	.	.	.	.	.	.	.	.	.	+
Panicum repens	.	.	.	.	.	.	.	.	.	.	.
Aristida junciformis	.	.	.	.	.	.	.	.	.	.	.
Schinus terebinthifolius	.	.	.	.	.	.	.	.	.	.	.
Crotalaria natalitia	.	.	.	.	.	.	.	.	.	.	.
Abildgaardia ovata	.	.	.	.	.	.	.	.	.	.	.
Schistostephium rotundifolium	.	.	.	.	.	+	.	.	.	.	.

Community 2

Releve nr	27	30	43	50	61	65	69	70	76	102	103
Species Group A											
Phragmites australis	.	.	.	.	.	+	.	3	.	.	.
Typha capensis	.	.	.	.	.	1	.	.	.	.	.
Species Group B											
Schoenoplectus senegalensis	.	.	.	.	.	.	1	a	.	+	.
Bulbostylis hispidula	+	a	.	.	.	+	.	.	.	.	.
Andropogon eucomus	.	.	b	.	.	.	+	+	.	.	.
Species Group C											
Cheilanthes viridis	.	.	.	.	.	.	.	.	.	.	.
Hydrocotyle bonariensis	+	.	.	.	.	1	.	.	.	.	.
Setaria sphacelata	.	.	.	.	.	.	.	.	.	.	.
Syzygium cordatum	.	.	.	.	.	.	.	.	.	.	.
Chrysanthemoides monilifera	.	.	.	.	.	.	.	.	.	.	.
Carex zuluensis	.	.	.	.	.	.	1	.	.	.	.
Helichrysum kraussii	.	.	.	.	.	.	.	.	.	.	.
Species Group D											
Sporobolus fimbriatus	.	.	.	.	.	.	+	.	.	+	.
Chromolaena odorata	.	.	.	.	.	.	.	.	.	.	.
Centella asiatica	.	.	.	.	b	.	.	.	.	.	.
Lantana camara	.	.	.	.	.	.	.	.	1	.	.
Bridelia micrantha	.	.	.	.	.	.	.	.	.	.	.
Panicum repens	.	.	.	.	.	.	.	.	.	.	.
Aristida junciformis	.	+	.	.	.	.	.	.	.	.	.
Schinus terebinthifolius	.	.	.	.	.	.	.	.	.	.	.
Crotalaria natalitia	.	.	.	.	.	.	.	.	.	.	.
Abildgaardia ovata	.	.	.	.	.	.	1	+	.	.	.
Schistostephium rotundifolium	.	.	.	.	.	.	.	.	.	.	.

Community 3

Releve nr	104	105	106	107	109	110	112	113	118	127	133	134	145	146	151	156	157	169	180	181
Species Group A																				
Phragmites australis	a	a	b	a	a	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.
Typha capensis	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.
Species Group B																				
Schoenoplectus senegalensis	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis hispidula	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon eucomus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group C																				
Cheilanthes viridis	+	+	.	.	r	+	.	.	+	+	.	.	.	1	+	.	1	5	.	.
Hydrocotyle bonariensis	.	.	.	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+
Setaria sphacelata	.	.	.	.	.	.	.	.	.	.	+	a	+	.	.	.	.	.	+	+
Syzygium cordatum	1	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	b	.	.
Chrysanthemoides monilifera	+	m	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex zuluensis	.	.	.	.	.	.	.	+	.	+	.	.	.	a	.	a	.	.	.	.
Helichrysum kraussii	.	.	b	.	.	.	.	.	b	.	.	+	.	.	.	.	.	.	.	.
Species Group D																				
Sporobolus fimbriatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chromolaena odorata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centella asiatica	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Lantana camara	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Bridelia micrantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum repens	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Aristida junciformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schinus terebinthifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria natalitia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Abildgaardia ovata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schistostephium rotundifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Community 4

Releve nr	188	189	195	196	197	198	199	200	201	203	204	205	208	209	211	212	213	215	216	223	229	230	231	232
Species Group A																								
Phragmites australis	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
Typha capensis	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group B																								
Schoenoplectus senegalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis hispidula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon eucomus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group C																								
Cheilanthes viridis	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hydrocotyle bonariensis	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.
Setaria sphacelata	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Syzygium cordatum	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
Chrysanthemoides monilifera	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Carex zuluensis	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Helichrysum kraussii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.
Species Group D																								
Sporobolus fimbriatus	+	.	+	+	+	.	.	+	.	+	.	+	.	.	+	+	+	+	.	.	+	+	.	.
Chromolaena odorata	1	+	+	b	+	b	.	.	b	r	4	.	3	4	.	m	.	+	.	.	.	.	.	.
Centella asiatica	.	+	+	+	+	.	.	+	+	+	.	+	.	.	+	.	+	.	.	.	+	+	.	.
Lantana camara	+	+	.	.	.	+	3	.	.	.	.	+	+	m	.	.	.	.	.	.	.	.	.	+
Bridelia micrantha	.	r	.	.	.	+	.	.	+	.	r	.	.	.	.	.	.	r	.	.	.	.	1	1
Panicum repens	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	+	a	+	.	.	.
Aristida junciformis	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.
Schinus terebinthifolius	.	3	+	.	1	m	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria natalitia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	+	+	.	.
Abildgaardia ovata	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	a	.	.	+	.
Schistostephium rotundifolium	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.

Community 5

Releve nr	233	234	235
Species Group A			
Phragmites australis	.	.	.
Typha capensis	.	.	.
Species Group B			
Schoenoplectus senegalensis	.	.	.
Bulbostylis hispidula	.	.	.
Andropogon eucomus	.	.	.
Species Group C			
Cheilanthes viridis	.	.	.
Hydrocotyle bonariensis	.	.	.
Setaria sphacelata	.	.	.
Syzygium cordatum	.	b	.
Chrysanthemoides monilifera	.	.	.
Carex zuluensis	.	.	.
Helichrysum kraussii	.	.	.
Species Group D			
Sporobolus fimbriatus	.	.	.
Chromolaena odorata	.	.	.
Centella asiatica	.	.	.
Lantana camara	.	.	.
Bridelia micrantha	.	.	.
Panicum repens	.	.	.
Aristida junciformis	.	.	+
Schinus terebinthifolius	.	.	.
Crotalaria natalitia	.	.	+
Abildgaardia ovata	.	.	.
Schistostephium rotundifolium	.	.	.

Species					
Species Group E					
Dissotis canescens	. . . . . + ...	. . . .	. . . .	. . . .	+ + .
Eragrostis chloromelas	. . . .	. . . .	. . . .	. . . .	. . a
Chloris gayana	. . . .	. . . .	. . . .	. . . .	. . +
Pycnostachys reticulat	. . . .	. . . .	. . . .	. . . .	+ . .
Species Group F					
Imperata cylindrica	. . . .	. . . . + a	. + a 1 . + + 1 + ... + ...	. a . + . . + . a . . a	. . .
Ludwigia octovalvis	. . . . +	. . . .	m 1 . . . . b . . . . . b 1 + . b	. . . . + . 1 . . . 1 . . . . . . + ... + .	. . .
Paspalum distichum	. . . .	. . . . + ...	. . . . a . . + a a	a . . . . a . . . a	a a a
Species Group G					
Cyperus rotundus	. . . . + . .	. . 3 + . . 1 . . + .	. + + + . . + . + + . + . a + + + + + +	. . . . . a . . . . . + . a + . + . + a + + + +	a 1 +
Digitaria eriantha	. . . .	. + . . . + + . . + +	. . . . . . + ...	+ . . + + . . + ... + ...	. . .
Species Group H					
Pycreus polystachyos	. . . . . + . + + . .	a b . . a 1 b 1 + a +	+ . + + + . . . + . + + + a . + + + + +	. . . + . . . + . + a + + . + . + . . . + + a .	+ + .
Psidium guajava	+ . . . . . . b . . .	. . . .	1 1 1 . . 1 + . . 1	1 . + 1 . 1 1 . + r + + + . 1 . 3 . . . + r . +	. . r
Commelina erecta	. . . . . . + . + . .	. . . . . . + + . + .	. + . + + + . . + + + ... + . + . .	+ . . . + + ... + . . + ... + . . . +	. . .
Microsorium scolopendrum	. + . . + 1 . . 3 . b	. . + ...	. . . . 1 b . . + b . . . 1	. + + . b + ... + ...	+ . .
Ipomoea cairica	. . . . + . + +	. . . .	. . . . + ... + + + . +	+ . . . . + ... + . .	. . +
Rare Species					
Cyperus prolifer	. . . .	+ 1 . . . . . + . . .	+ . . . . + ...	. + ... + ... + ...	. . .
Commelina africana	+ . . + ... + . .	. . . . . + . . . + .	. . . . + .	. . . . . . + ... +	. . .
Dactylocteni australe	. . . .	. . + . . . + ...	. . . . + . . .	. . + ... + . + ...	. . .
Smilax anceps	. . . .	. . . . b . .	. . . . + . . . + . . . + .	. . . . + ... + ...	. . .
Tagetes minuta	. . . .	. . . . r . + ...	+	. . . . + ... + ...	. . .
Panicum maximum	. . . .	. . . .	. . . . . . + . . . + ...	. . . . + + + ...	. . .
Cymbopogon validus	. . . .	. . . .	. . . . + . . + ...	. . . . . + . + + ...	. . .
Rhus chirindensis	+	. . . .	. . . . 1 . . . 1 .	. . + ... + . .	. . .
Hibiscus surattensis	. . . . 1 . . .	. . . .	. . + . . + . . . + ...	. . . . + ...	. . .
Fimbristylis obtusifol	. . . .	. . . . + +	. . + a . . . . + ...	. . . .	. . .
Melinis repens	. . . . + . .	. . . . . . + ...	. . . .	. . . + ... +	. . .
Asystasia gangetica	. . . .	. . . .	. . . . + ... + . .	. . . . + ... + ...	. . .
Pycreus macranthus	. . . .	. 1	. . . . + ...	. . . . + . a	. . .

Cyperus papyrus	. . . . + 1 .	. . . .	. . . .	. . . . 3 . b	. . .
Conostomium natalense	. . . .	. . . . +	. . . .	. . . . + . + .	+ . .
Sida cordifolia	. . . + . + ...	. . . .	. . . . . . 1	. . . . + ...	. . .
Phoenix reclinata	. . . .	. . . .	. . . . 1	. . . . 1 . m . . . . r . . .	. . .
Eucalyptus grandis	. . . .	. . . .	. . . . . . + ... 1	. . 4 . m	. . .
Rhus nebulosa	. . . .	. . . .	. . . . 3 . . . . . b	. . . . + ...	. . .
Fimbristylis complanat	. . . . . + ...	. . . . 1 . . .	. . . .	. . . .	+ . .
Helichrysum aureum	. . . .	. . . .	+	. . . + ... + . .	. . .
Lactuca indica	. . . .	+	. . . .	+ + ...	. . .
Indigofera spicata	. . . .	. . . . + . . .	. . . .	. . + . . . + ...	. . .
Helichrysum auriceps	. . . .	. . . .	+	. . . . . + + ...	. . .
Rubus fruticosus	. . . .	. . . .	. . . . 1 .	. + . . . + ...	. . .
Carex cognata	. . . .	. . . .	. . . . + . . + . .	+	. . .
Desmodium incanum	. . . .	. . . .	. . . .	. . . . + + . . + ...	. . .
Alinula paradoxa	. . . .	. . + a	. . . .	. . . . + ...	. . .
Hypoxis angustifolia	. . . .	. . . .	. . . .	. . + + ...	. . +
Eriosema psoraleoides	. . . .	. . . .	. . . . + ...	. . . . 1 . . . . +	. . .
Persicaria serrulata	. . . . + . +	. . . .	. . . . + ...	. . . .	. . .
Eragrostis ciliaris	. . . .	. . . .	. . . .	. . . . + . + ... +	. . .
Bidens biternata	. . . .	. . . . . + ...	. . . .	. . + ... +	. . .
Cuscuta campestris	. . . .	. . . .	. . . . + ...	. . . . + ...	. . .
Chamaecrista mimosoide	. . . .	. . . . + ...	. . . .	+	. . .
Melia azedarach	. . . .	. . . .	. . . . 1	 1	. . .
Ipomoea purpurea	. . . .	. . . . . . + ...	. . . . + ...	. . . .	. . .
Hibiscus tiliaceus	. . . .	. . . .	. . . 1 . . . . 1	. . . .	. . .
Asplenium monanthes	. . . .	. . . .	. . . . 1	+	. . .
Senecio deltoideus	. . . .	. . . .	. . . . + .	. . + ...	. . .
Diheteropogo amplecten	. . . .	. . . . b . . .	. . . .	. . . . + ...	. . .
Gomphocarpus physocarp	. . . .	. . . .	. . . .	. + + ...	. . .
Helichrysum aureoniten	. . . . . + ...	. . . . + .	. . . .	. . . .	. . .
Trema orientalis	. . . .	. . . .	. b	. . . . . + ...	. . .

Acacia karroo	....	....	....	.....+1.................	...
TRIHANN0	....	....	...........+........	.................+......	...
Ipomoea obscura	....	....	....	+.....+.................	...
Crotalaria natalensis	....	....	....	...........+............	+..
Hewittia species	....	....	......+.............	..+.....................	...
Dicliptera clinopodia	....	....	....	...+...........+........	...
Zantedeschia aethiopic	..........+	....	....	....+...................	...
Crotalaria macrocarpa	....	....	...................b	.........+..............	...
Oxalis corniculata	....	....	....	.................+...+..	...
Sutera floribunda	....	....	....	.......+.........+......	...
Barleria meyeriana	....	....	....	.........r+.............	...
Cyanotis speciosa	....	....	13	....	...
Brachylaena ilicifolia	........+..	....	.........+..........	....	...
Pteridium aquilinum	....	....	...+......+.........	....	...
Oxygonum dregeanum	....	.......+..+	....	....	...
Ethulia conyzoides	.....+.....	.......+...	....	....	...
Eragrostis gummiflua	.....+.....	....	....	............+...........	...
Dumasia villosa	....	.....+.....	................+...	....	...
Desmodium dregeanum	....	..........+	....	..................+.....	...
Desmodium setigerum	....	....+......	....	..+.....................	...
Ischaemum fasciculatum	....	....	...1a...............	....	...
Oldenlandia herbacea	....	+....+.....	....	....	...
Gnidia kraussiana	....	.....+.....	..+.................	....	...
Nidorella undulata	....	....+......	..r.................	....	...
Lycopodium cernuum	.....+.....	a..........	....	....	...
Eleocharis limosa	....	.........+.	....	...................a....	...
Juncus kraussii	....	....	+.......+...........	....	...
Themeda triandra	....	.........++	....	....	...
Lobelia coronopifolia	....	+..........	........+...........	....	+..
Strelitzia nicolai	....	........+..	....	.................r......	...
Ficus sur	....	....	.....b............1.	....	...
Pinus elliottii	....	....	...1................	....	...
Ficus trichopoda	....	....	....	..........r.............	...
Pergularia daemia	....	....	....	..........+.............	...

Passiflora subpeltata	. . . .	. . . . . . + ...	. . . .	. . . .	. . .
Crocosmia aurea	. . . .	. . . . + . .	. . . .	. . . .	. . .
Tricalysia capensis	. . . .	. . . .	. . . .	1	. . .
Senecio tamoides	. . . .	. . . .	. . . . + ...	. . . .	. . .
Cissampelos mucronata	. . . .	. . . .	. . . . + ...	. . . .	. . .
Strychnos spinosa	. . . .	. . . .	. . . .	. . . . + ...	. . .
Pisonia aculeata	. . . .	. . . .	. . . .	. . . . . 1	. . .
Rubus flagellaris	. . . .	. . . .	. . . . + ...	. . . .	. . .
Laportea peduncularis	. . . .	. . . .	. . . .	. . . . . . + ...	. . .
Ipomoea congesta	. . . .	. . . .	. . . .	. . . . + ...	. . .
Pleurostylia capensis	. . . .	. . . .	. . . .	. . . . + ...	. . .
Eugenia natalitia	. . . .	. . . .	. . . . + . .	. . . .	. . .
Ipomoea alba	. . . .	. . . .	. . . .	. . . . + ...	. . .
Senecio madagascarie	. . . .	. . . .	. . . .	. . . . + ...	. . .
Scleria poiformis	. . . .	. . . .	. . . .	. . r	. . .
Thelypteris dentata	. . . .	. . . .	. . . . 3	. . . .	. . .
Canthium inerme	. . . .	. . . .	. . . .	. . r	. . .
Cyperus dives	. . . .	. . . .	. . . .	. . . . + ...	. . .
Uvaria caffra	. . . .	. . . .	. . . .	. . + ...	. . .
Xymalos monospora	. . . .	. . . .	. . . .	. . . . + . .	. . .
Pinus species	. . . .	. . . .	. . . .	. . . . + ...	. . .
Eucalyptus camaldulens	. . . .	. . . .	. . . .	. . . . b	. . .
Cnestis polyphylla	. . . .	. . . .	. . . . + . .	. . . .	. . .
Asparagus setaceus	. . . .	. . . .	. . . . . . + ...	. . . .	. . .
Strychnos madagascarie	. . . .	. . . . 1 . .	. . . .	. . . .	. . .
Justicia campylostemon	. . . .	. . . .	. . . .	. . . . + .	. . .
Ranunculus multifidus	. . . .	. . . .	. . . .	. + ...	. . .
Pavetta lanceolata	. . . .	. . . .	. . . .	. . . . + ...	. . .
Rumex sagittatus	. . . . . + ...	. . . .	. . . .	. . . .	. . .
Pavonia burchellii	. . . . + . . .	. . . .	. . . .	. . . .	. . .
Manilkara discolor	. . . .	. . . .	. . . .	. . . . r	. . .
Myrica serrata	. . . .	. . . .	. . . .	. . + ...	. . .
Scleria angusta	. . . .	. . . .	. . . . a	. . . .	. . .
Abutilon grantii	. . . .	. . . .	. . . .	. . . . + ...	. . .

Vangueria infausta	. . . .	. . . .	. . . .	. . . . r	. . .
Coleotrype natalensis	. . . .	. . . . + . .	. . . .	. . . .	. . .
Acacia nilotica	. . . .	. . . .	. . . .	. . . . + ...	. . .
Senecio polyanthemoi	. . . .	. . . . + ...	. . . .	. . . .	. . .
TRIHPIL0	. . . .	. . . .	. . . .	. . . . + ...	. . .
Rhoicissus tridentata	. . . .	. . . .	. . . .	. . . + ...	. . .
Hibiscus vitifolius	. . . .	. . . .	. . . .	. . . . r	. . .
Solanum retroflexum	. . . .	. . . .	. . . .	. . . . + ...	. . .
Scleria dregeana	. . . .	. . . .	. . . .	. . . . + ...	. . .
Indigofera micrantha	. . . .	. . . .	. . . .	. . . . + ...	. . .
Ursinia tenuifolia	. . . .	. . . .	. . . .	. . . . + ...	. . .
Euclea crispa	. . . .	. . . .	. . . .	. . . . + ...	. . .
Lotononis corymbosa	. . . .	. . . .	. . . .	. . . . + ...	. . .
Lagynias lasiantha	. . . .	. . . .	. . . .	. . . . + ...	. . .
Acacia niloti s. kraus	. . . .	. . . .	. . . .	. . . . 1	. . .
Asclepias albens	. . . .	. . . .	. . . .	. . . . + ...	. . .
Argemone mexicana	. . . .	. . . .	. . . .	. . . . r	. . .
Strychnos henningsii	. . . .	. . . .	. . . .	. . . . + ...	. . .
Rhynchosia caribaea	. . . .	. . . .	. . . .	. . . . + ...	. . .
Solanum nodiflorum	. . . .	. . . .	. . . .	. . . . + ...	. . .
Becium obovatum	. . . .	. . . .	. . . .	. . . + ...	. . .
Rhynchosia monophylla	. . . .	. . . .	. . . .	. . + ...	. . .
Rabdosiella calycina	. . . .	. . . .	. . . .	. . + ...	. . .
Hibiscus pusillus	. . . .	. . . .	. . . .	. . + ...	. . .
Berkheya setifera	. . . .	. . . .	. . . .	. . + ...	. . .
Pennisetum clandestinu	. . . .	. . . .	. . . .	. . . m	. . .
Senecio napifolius	. . . .	. . . .	. . . .	. + ...	. . .
Schinus molle	. . . .	. . . .	. . . .	+	. . .
Cyathea dregei	. . . .	. . . .	. . . .	+	. . .
Canthium setiflorum	. . . .	. . . .	. . . . + . .	. . . .	. . .
Arundo donax	. . . . 1 .	. . . .	. . . .	. . . .	. . .
Helictotrich turgidulu	. . . .	. . . .	. . . . + ...	. . . .	. . .
Melanthera scandens	. . . .	. . . .	. . . . + ...	. . . .	. . .

Hibiscus calyphyllus	....	....	..........1.........	....	...
Cycnium racemosum	....	....	..........+.........	....	...
Ficinia laciniata	........+..	....	....	....	...
Nidorella auriculata	.......+...	....	....	....	...
Cynanchum obtusifolium	.......+...	....	....	....	...
Indigofera dimidiata	....	....	........+...........	....	...
Scabiosa columbaria	....	....	....	.................+......	...
Monocymbium ceresiifor	....	....	.......+............	....	...
Gnidia calocephala	....	....	......+.............	....	...
Teucrium kraussii	....	....	.....+..............	....	...
Schoenoplect scirpoide	....	..........+	....	....	...
Paspalum scrobiculatum	....	.........r.	....	....	...
Ipomoea ficifolia	....	.........+.	....	....	...
Aristea juncifolia	....	.........+.	....	....	...
Indigofera velutina	....	.........+.	....	....	...
Tephrosia grandiflora	....	....	....	........+...............	...
Strychnos decussata	....	........+..	....	....	...
Premna mooiensis	....	........r..	....	....	...
Canthium kuntzeanum	....	........+..	....	....	...
Canna indica	....	........+..	....	....	...
Cyperus obtusiflorus	....	.........+.	....	....	...
Justicia flava	....	.......+...	....	....	...
Chamaecrista plumosa	....	.......+...	....	....	...
Agrost barbul v. barbu	....	.......+...	....	....	...
Rhinacanthus gracilis	....	......+....	....	....	...
Ornith tenuif s. tenui	....	......+....	....	....	...
Justicia protracta	....	......+....	....	....	...
Eragrostis cilianensis	....	......+....	....	....	...
Leersia hexandra	.....+.....	....	....	....	...
Eragrostis superba	....	.........+.	....	....	...
Pycreus pelophilus	....	.....+.....	....	....	...
Miscanthus capensis	....	.....1.....	....	....	...
Catharanthus roseus	....	.....+.....	....	....	...
Bidens pilosa	....	.....+.....	....	....	...

Lippia javanica	....	....	....	.................+......	...
Hyparrhenia cymbaria	....	.........+.	....	....	...
Berkheya speciosa	....	....	......+.............	....	...
Buchnera species	....	....+......	....	....	...
Pavetta bowkeri	....	....+......	....	....	...
Monopsis stellarioides	....	....+......	....	....	...
Andropogon appendicula	....	....m......	....	....	...
Pentanisia prunelloide	....	....	....	....	+..
Urochloa panicoides	....	....	....	....................+...	...
Senecio inornatus	....	....	....	+.......................	...
Androcymbium eucomoide	....	....	.....+..............	....	...
Hibiscus aethiopicus	b..........	....	....	....	...
Utricularia livida	....	+..........	....	....	...
Panicum ecklonii	....	1..........	....	....	...
Mariscus dubius	....	+..........	....	....	...
Chironia purpurascens	....	+..........	....	....	...
Gnidia burchellii	....	..........+	....	....	...
Helichrysum decorum	..........+	....	....	....	...
Wahlenbergia grandiflo	....	....	........+...........	....	...
Rhus discolor	....	.r.........	....	....	...
Verbena bonariensis	....	....	.......1............	....	...
Setari sphace v. seric	....	....b......	....	....	...
Senecio macroglossoi	....	....	...............+....	....	...
Mariscus solidus	....	....	.+..................	....	...
Brachylaena discolor	....	.....r.....	....	....	...
Casuarina equisetifoli	....	...1.......	....	....	...
Isoglossa woodii	.......+...	....	....	....	...
Halleria lucida	....	.....r.....	....	....	...
Oplismenus hirtellus	....	....	...............+....	....	...
Stenochlaena tenuifoli	....	...+.......	....	....	...
Rubia cordifolia	....	....	....	....	...

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CHAPTER 9: GENERAL DISCUSSION

The study area of the Coastal Forest or Thornveld (Low and Rebelo, 1998), was observed as a mosaic of vegetation types, which occur from just above sea level to about 300 meters in altitude. This mosaic of vegetation types was also mentioned in previous publications (Low, and Rebelo, 1998). The area is more or less flat to gently undulating terrain with slope gradients rarely steeper then 8 degrees. However, the region is also deeply dissected by the many rivers and streams which drain eastwards across KwaZulu-Natal.

The primary aim of this research project was to delimit and describe the different plant commuities recognised within the area under the jurisdiction of the Richards Bay Municipality and providing an indication of the relative conservation importance of these plant communities.

The study identified three major vegetation types which comprised 3 floristically distinct plant communities.

1. The Dune or Strand vegetation containing four plant communities
2. The Forest vegetation containing four plant communities
3. Grassland and Wetland vegetation containing five communities.

Dune vegetation

The Dune vegetation was classified into four plant communities (Table 6.1).

The *Carprobotus dimidiatus – Gazania rigens* Dune vegetation, also known as the Strand Community, although many authors refer to it as the Dune Pioneer community (Donnely and Pammenter 1983; Weisser and Backer 1983). Breen (1979) however, differs in opinion and notes that this community represents a stage of succession of dune forest.

Barbour, Burk and Pitts (1980) states that the dune pioneer community forms part of a toposequence, where different distances from a stress, in this case salt spray, influence the topographical distribution of plants. Strong winds causes salt spray and form new dunes, which expose or cover beach pioneer plants. The beach sand of northern Kwazulu-Natal consists of silica quartz and has a high salt content (Tinley 1985). The sand also has a high infiltration rate and rapidly dries out after rain and due to full sun exposure also experiences high extremes of temperatures.

It is reasoned that the pioneers do not extend further into the more sheltered areas of the back dune communities and adjacent shrub thickets because of their adaptation to extreme environmental conditions or that they are unable to compete with species occurring in these communities (Lubbe 1996).

The species composition of the Dune vegetation shows many similarities with those found in previous studies (e.g. Weisser 1978, Weisser and Marques 1979, Weisser *et al.* 1982), especially with the vegetation occurring on the foredunes.

The species composition recorded in the study area is, for example, similar to that found in studies done on beach pioneer communities in the Mhlalazi – Richards Bay and Mtunzini areas to the south (Weisser and Müller, 1983) and studies done to the north (Lubbe 1996).

Scaevola plumieri is the main colonizer on the foredunes. This species is also said to be the most efficient sand binder in these communities, but its efficiency and ability to colonize the beachfront seems to be declining south of the Fish River Mouth in the Eastern Cape (Weisser and Müller, 1983) indicating a more tropical affinity.

The dune pioneer community does not have high species diversity, but fulfils a very important function in the stabilizing and formation of dunes. It acts as a barrier providing some protection to the dune scrub community. Behind the foredune and dune pioneer community, the salt spray and sand deposition decreases and it is in this area where a change in vegetation can be observed on the mid-dune areas where dune scrub community becomes more prominent (Donnelly and Pammenter, 1983). In this study this vegetation is represented by the *Cynanchum natalitium –Carprobotus dimidiatus* Mid-dune community and even the *Chrysanthemoides monilifera – Carpobrotus dimidiatus* Dune Scrub

Behind these foredunes, on the backdunes, dune scrub communities occur. These are described as *Chrysanthemoides monilifera – Casaurina equisetifolia* Dune Scrub.

These results compare well with results found by Weisser and Backer (1983) in the Mtunzini area. However, the *Passerina* sp. Scrub zone, which occurs between the coastal scrub thicket and the dune pioneer communities in the Mtunzini and Mhlalazi – Richards Bay area (Weisser and Müller, 1983; and Weisser and Cooper, 1993), seems to be absent within the current study area. This trend was also observed by Lubbe (1996), who noted that the coastal scrub thicket in the Kosi Bay Forest reserve, bordered directly on the pioneer community. The absence of the *Passerina* sp. Scrub community might be attributed to a lack of space or suitable habitat (Lubbe, 1996).

In the case of the *Chrysanthemoides monilifera – Casaurina equisetifolia* Dune Scrub, *Casuarina equisitifolia* an alien a pine-like angiosperm, which dispersed seeds and occurs naturally on Indo-Pacific Islands, became established. It is not an aggressive invader, but dense growth, shade and heavy leaf litter inhibits succession of natural forest (Tinley, 1985). Few other plants grow in *Casuarina* stands (Table 6.1). The reason that this species was planted in the study area was to bind the sand as to prevent local destruction of coastal dune forest by being covered with sand (Lubbe, 1996). Management of these stands can include the felling of these trees in order for drift sands to re-assume its natural geomorphic functions and to allow natural vegetation to re-establish in the study area.

Forest

The second vegetation type occurring within the study area is Forest. Four forest communities were identified.

Swamp and riparian forest are widespread in the Zambezian region, but limited to specific habitats, while in the eastern half of Africa, afromontane and coastal forests have a localised and fragmented distribution (White, 1980).

The *Isoglossa woodii – Macaranga capensis* Tall Closed Forest is the best example of primary coastal forest within the study area. Many fine examples of forest trees occur here, though a degree of degradation resulted in the presence of alien invader species, notably *Psidium guajava.*

A severely degraded form of the coastal forest is represented by the *Chromolaena ordonata – Melia azedarach* Short Forest, where several alien species invaded, e.g. *Chromolaena odorata,Melia azedarach, Lantana camara* and *Eucalyptus grandis*. This could indicate that pristine coastal forest will change to a degraded forest type dominated by alien species if not protected against human caused impacts.

The natural climax grasslands of the areas within which the three outlying suburbs occur, would, according to Acocks (1953), have formed part of the Coastal Forest and Thornveld One variation of this veld type, Typical Coast-veld Forest would have occurred in the study area (Discussion document, 1998). Acocks also stated that when this forest is removed, it becomes replaced with Thornveld. The dominant species of thorn tree is *Acacia karroo* while the grass component includes species such as *Aristida junciformis, Eragrostic* spp., *Sporobolus* spp., *Hyperrhenia* spp., and occasionally *Themeda triandra.*

As observed by Venter (1972) *Acacia karroo* may form a community on the outer bounderies of the forest communities where it separates the grassveld of the blowsand from the rest of the forest community. This species may occur in loose standing stands within other forest communities, as shown in species group C (Table 7.1). Previous observations of active *A. karroo* encroachment into adjacent grassveld and dune wetland areas, where sufficient moisture conditions exists (Venter, 1972 and Matsau, 1999) could be supported with observations of this study.

Fires in these vegetation types are rare and restricted to occasional extreme fire weather conditions (Van Wilgen *et al*., 1997). Dry or deciduous forests have a canopy, which is near – continuous and multi – layered, dominated by deciduous trees. These types of forests occur in areas where there is a two to three month dry period in the year. Dry forest would be more prone to fire than evergreen forests, and would therefore burn periodically because of the accumulation of fuel in the form of dry leaf and twig litter (Van Wilgen, *et al*., 1997).

Swamp Forest

Another Forest community is *Barringtonia racemosa – Ficus tricopoda* Tall Swamp forest community which forms small dense stands along rivers, drainage channels and on the shores bordering Lake Mzingazi. This community is severy impacted on by urban development in the Richards Bay and surrounding area. Some human settlements that have been developed on the borders of the small remaining stands of this community caused a decrease of the species, especially due to slash and burn cultivation, which also increased the size of canopy gaps. This enabled other woody species to invade and regenerate, increasing the numbers and density of climbing plants (Reavell, *et.al.*, 1998). Alien invasive species like *Chromolaena odorata* also invaded into these open gaps.

Reavell *et al*. (1998) identified the environmental impact of urban and rural development on Richards Bay Swamp Forest. It was noted that 24 species of angiosperms were removed for use in traditional medicine, by slash and burn cultivation practices and for building material. This could lead to the disappearance of this plant community and the habitat for its associated animals. This also led to an increase of alien invader plants such as *Chromolaena odorata*.

The drainage and dessication of the hydromorphic peat due vegetable gardening also had an impact on turbidity levels in Lake Mzingazi. From June to July 1996 there was evidence of an eight fold increase in turbidity and a fifty fold increase in soluble reactive phosporus in the Mdibi River channel after heavy rainfall (Reavell, *et.al.*, 1998). If this process continues it could smother submerged macrophytes in Lake Mzingazi. Excess nutrients, such as phosphorus, being washed into the lake will also cause eutrophication of the lake water, which may cause increases in water treatment and associated costs.

Mangrove Forest

The fourth forest vegetation type recognised is the *Avicennia marina* Short Mangrove Forest with stands dominated by a single mangrove species, namely *Avicennia marina,* which is restricted to areas south of Richards Bay harbour.

Mangrove forests with more than one mangrove species have been described in very few areas in South Africa. The Kosi Bay Forest Reserve to the north of Kwazulu-Natal coast has six mangrove species (Lubbe, 1996). These species included *Acrostichum areum, Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Lumnitzera racemosa* and *Rhizophora mucronata* (Steinke, 1995, Lubbe, 1996). In the current study of Richards Bay only *Avicennia marina* was recorded in the sample plots.

Mangroves fulfill important functions as breeding and feeding grounds for marine fauna species and also protect shorelines against erosion and flooding. Mangroves also provide a source of reduced carbon in the form of leaves, wood and other litter that falls from the trees and contributes to detritus-based food chains in estuaries (Steinke, 1995). Management of the mangrove community would therefore include controlled utilization as well as the maintenance of the natural hydrolocical processes occurring in the study area.

The ecological importance of mangrove swamps in the tropics and sub-tropics has not been widely recognised. Roughly one-fourth of the world's coastline is dominated by mangroves. Evidence indicates that mangroves are highly productive ecosystems and are responsible for the production of large quantities of organic matter, the export of this organic matter and particularly fallen leaf material, from under the mangroves into surrounding deeper water (Hasler, 1975). Mangrove communities are also responsible for the transformation, as it decays, of the leaf material into detritus particles covered with bacteria, micro-algae and protozoans and permeated with fungi. The utilization of mangrove detritus particles as food by a large group of consumer organisms contribute to mangrove communities' ecological functionality (Halser, 1975).

The importances of Swamp Forest are set out in unpublished report (1998) as follows:

- This vegetation type provides deep-rooted stabilization to hydromorphic soil.
- Together with other wetland plants, assists in removing nutrients such as nitrates and phosphates from runoff, preventing eutrophication of freshwater sources.
- Contributes to the filtering properties of wetland systems, which are able to reduce levels of micro-organisms such as the bacteria, *E. coli*.
- Contributes to the maintenance of very scarce habitats which is required by various species of fauna, such as amphibians and birds.
- Although Swamp Forest plant species are mostly intolerant of fire, it does create an effective firebreak.

Wetlands

The third vegetation main type is the Grassland and Wetland vegetation. Five communities were recognised, the first three being wetlands and the last two represent moist grasslands.

The mosaic of Coastal Forest and Hygrophilous Grassland still occurs where the water table is raised in the proximity of coastal forest, which creates an environment that is suitable for hygrophilous grass species to establish and occupy the herbaceous layer within the vegetation mosaic (CSIR report, 1993). These communities are influenced by the topography of the study area, which plays a major role in the origin and the maintenance of these grassland communities. With topography, slope and water table depth being some of the most important environmental factors by which grassland was differentiated. The absence of trees and shrubs and the dominance of grasses distinguish the grasslands from the forests, thickets and woodlands. A low water table depth differentiates the coastal grasslands from the hygrophilous grasslands, which has a high water table (Lubbe, 1996).

Photo 9.1: *Phragmites australis - Typha capensis* Tall closed Hygrophilous Grassland community with *P. guajava* encroachment fringing (June 2002).

The *Phragmites australis* – *Typha capensis* Tall Closed Hygrophilous Grassland is quite unique with either *Phragmites australis* or *Typha capensis* dominant and very few other species present.

The large Reedswamp community occurs along water courses and the backswamps of the fresh water lakes. Reedbeds can also play an important role in the successional development of Swamp Forest by impeding the flow of flood waters and causing the deposition of silt (Moll, 1976). Once the ground surface has risen above the permanent water level, Swamp Forest is able to develop. Swamp Forest trees are found growing on the periphery of most of the reedbeds in the study area and within major drainage channels. Reedswamps are important in that it is a unique vegetation type and create a buffer between open water and the terrestrial environment (Unpublish report, 1993).

The *Pycreus polystachyos* – *Schoenoplectus senegalensis* Short open Hygrophilous Sedgeland and the *Pycreus polystachyos* – *Cyperus rotundus* Short Open Hygrophilous Sedgeland are both wetland communities within the study area, dominated by the sedges *Pycreus polystachyos* and *Cyperus rotundus*.

Permanent wetlands (excluding the seasonally – wetted hydromorphic grasslands) make up a small fraction of the southern hemisphere African landscape. *Phragmites* – dominated reedbeds are associated with most rivers and burn frequently (two to five years), whereas the peat – producing *Papyrus* swamps burn once every century or more (Van Wilgen *et al*., 1997).

Marshes and other wetlands in which there is a profuse growth of aquatic plants are common in many parts of the Richards Bay Municipal area. There is a certain flux of nutrients to the marsh from groundwaters, surface flow, and direct precipitation and gas exchange. Wetlands are often considered low – value land since in their normal condition they cannot be used for most agricultural activities or urban development, and increasing pressure exists to drain marshes to provide higher – value land for suburban development (Hasler, 1975).

Hygrophilous grassland communities composed of hygrophilous grass species also occur within depressions in the study area, where the water table is relatively near to the soil surface. These depressions are seasonaly flooded after heavy rains and may occasionally become waterlogged. The community growth appears to be maintained by fire, but due to the moist environment, fires burn at lower temperatures than the surrounding Shrublands. Here the state of the water table inhibits succession towards a woody community.

The importance of wetlands are set out as follows (Unpublished report, 1998):

- Wetland communities attenuate high velocity runoff.
- These communities retain large quantities of nitrates and phosphates.
- By retarding runoff wetland communities cause deposition of silt, thereby enhancing the life of rivers and other large water bodies.

- Wetlands are habitats for economically important plants such as *Juncus kraussii* (Ncema grass), which is used for the making of baskets and mats.
- Wetlands are habitats for a variety of birds and other fauna playing vital roles on the ecology of the system.

Grassland

The *Imperata cylindrica – Sporobolus fimbriatus* Temporary Hygrophilous Grassland and the *Paspalum distichum – Eragrostis chloromelas* Temporary Hygrophilous Grassland are both moist grassland types.
The latter community is severely encroached by alien woody species, indicating a degraded form of grassland in the area.

Moll and White (1978) and White (1983) distinguished two broad types of grassland in the Tongaland-Pondoland Regional Mosaic, namely edaphically controlled grassland associated with scattered palms on poorly drained soil and secondary fire-maintained grassland that has replace anthropogenically destroyed coastal dune forest. There is a rather abrupt change from coastal dune forest to coastal grassland. No obvious environmental changes occur in this area and it is therefore difficult to explain this abrupt transition from forest to grassland (Lubbe, 1996), except for clearing by man. Tinley (1982) described the grasslands of the Mozambique plain as sour, occurring on leached sands, in contrast to the calcicole trees and shrubs found in the coastal dune forest on calcareous sands.

The differences in the sand are probably caused by the different impact that grassland and forest has on the soil. The grasslands of the dune systems of

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Abstract

The vegetation of Richards Bay municipal area, KwaZulu-Natal, South Africa, with specific reference to wetlands

by

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A vegetation survey was conducted at plant community level within the boundaries of Richards Bay Municipal area during 2001 to 2002. Relevés was randomly selected and floristic information was recorded for 310 sample plots and was referenced by GPS. The data were captured in TURBOVEG data base, for vegetation data and classified using the TWINSPAN numerical classification algorithm. Phytosociological tables were compiled using the MAGATAB computerized table management program. Thirteen plant communities were identified, described and characterized by diagnostic and dominant species occurring in them. The study in general showed that vegetation in the Richards Bay Municipal area has deteriorated considerably over the last 30 years. The study indicated that wetland communities occupy a relatively small area and has become relatively degraded within the study area. It is recommended that Richards Bay Town Council plan the Metropolitan Open Space System (MOSS) bringing the ecological areas

of importance into consideration and that all new developments in the Richards Bay area be subjected to proper ecological investigation as part of the Environmental Impact Assessment process.

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Kwazulu-Natal were classified as secondary grasslands created by the clearing of coastal forest and maintained by regular fires and grazing (Conlong and Van Wyk, 1991). Grasslands occurring on dunes between Richards Bay and the Mfolozi River also seem to be secondary, originating from forest clearing by local inhabitants (Weisser, 1978).

Although more than one factor was probably involved in the formation of coastal grasslands, fire has certainly played a major role (Lubbe, 1996). It was also suggested that before Early Iron Age settlement, the extent of marshlands and alluvial flats were less extensive, with larger expanses of open water (Hall, 1981). This could therefore made it possible that grasslands or woodlands formed after the water table dropped and were maintained by fires either induced by man or lightning (Lubbe, 1996).

Edwards (1967) states that it is unlikely that fire was a major limiting factors on the vegetation, due to the high rainfall and humid climate of the area, which lacks a pronounces dry season and large fuel load accumulation. If this is correct it would be difficult to explain the adaptations to fire that are displayed by the vegetation (Lubbe, 1996).

Syzygium cordatum, one very common woody species occurring in the grasslands of the Richards Bay study area as well as in the Kosi Bay Forest Reserve is very resistant to fire (Lubbe, 1996). Other common species like *Phoenix reclinata* also occurring in the grasslands of the Richards Bay study area shows quick recovery after fire in the Kosi Bay Forest Reserve (Lubbe, 1996). Other fire-maintained woody plants include *Brachylaena discolor,* *Strychnos spinosa, Strychnos madagscariensis* and *Garcinia livingstonei* (Lubbe, 1996).

The high occurrence of geoxylic suffrutices or dwarf shrubs in the coastal grassland, also suggests a long period of exposure to fire. Suffrutices seem to be most abundant in areas with a high frequency of less intense fires. Further evidence indicates that fires must have had a long history of occurrence in the coastal grasslands, is the presence of 5 endemic suffrutice species in the coastal grasslands of the Kosi Bay Forest Reserve (Lubbe, 1996).

This therefore suggests that the grasslands of this study area have been subjected to frequent fires over a long period of time, enabling the development of taxa with suffrutex habit (Lubbe, 1996).

The grasslands in the study area of Richards Bay Municipal area however are not maintained by fire. Here fire is usually prevented or extinguished due to high residential settlement and industrial development in the study area. Some large scale industries such as the Bayside and Hillside *Aluminium* is supplied with electricity by high voltage overhead powerlines also running through some patches of grassland, contributing to the control of fire underneath or close to the powerlines.

Coastal grassland is one of the most threatened vegetation types in Maputaland. The destruction of coastal grassland, mainly through afforestation and other agricultural activities has diminished coastal grassland considerably in Maputaland (Lubbe, 1996). In the Western Shores area of St Lucia a 56% decrease in grassland has been estimated, from 1937 to 1975 (Conlong and Van Wyk, 1991). This reduction in grasslands due to indigenous bush encroachment is ascribed to change in management. Weisser and Marques (1979) ascribe an 86% decrease in grassland in the area between Richards Bay and the Mfolozi River from 1937 to 1974, as being due to afforestation and the protection of these grasslands against fire by conservation authorities.

Grazing has a detrimental effect on communities with little history of grazing, but is necessary to maintain communities with a long history of grazing (Nevch and Whittaker, 1980). This may be interpreted in two ways:

i) grazing is a disturbance for the former system, but not for the latter:
ii) grazing is by definition, a disturbance and the former system is disturbance-prone while the latter is disturbance-dependent (Van Andel *et al.*, 1987).

Plant populations are dynamic entities, their genetic structure responding to various types of disturbance. The rate and form of the response will, of course, depend both on the nature of the disturbance, and on biological attributes of the species, e.g. life history characteristics and ecological tolerance (Snaydon, 1987). As a result, it may be very difficult to distinguish between change, which constitutes disturbance, and change which is an inherent part of the system; as Van Andel and Van den Bergh (1987) point out, the status of the change can only be determined by studying the response of the system and comparing it with an undisturbed control (Snaydon, 1987).

CHAPTER 10: CONCLUSIONS

The general trend observed in this study compared to other similar projects of the past is that the vegetation of Richards Bay is deteriorating and becoming more disturbed. This is mainly caused by the influence of development in the Richards Bay Municipal area. Urban development is increasing rapidly along with an expansion in a variety of industrial developments. Informal settlements and surrounding township area are also expanding and due to small scale and commercial agricultural activities there is an increasing pressure on open spaces with natural vegetation.

The study in general showed that the vegetation in the Richards Bay Municipal area has deteriorated considerably in comparison to results of a study done approximately 30 years earlier by Venter (1972). This decline in natural vegetation and plant species diversity can mainly be ascribed to the demand that development imposes on the land for agriculture, housing and recreational facilities.

The natural fire regime has also been altered and this has resulted in the recruitment of invasive species, which are now displacing the indigenous flora. The occurrence of fire in natural vegetation is dependent on several factors: enough fuel of the right kind has to be present to support a fire, the vegetation providing the fuel for fires is a product of both the soil and the prevailing climate (Van Wilgen *et al.* 1997). Vegetation growing under almost any climate regime can burn under certain conditions, but the occurrence of fires is strongly dependent on the weather. For a fire to occur, sufficient fine dry fuels must be present. There is much evidence that fire has an important and usually beneficial role in maintaining the bio-diversity, structure and function of African grassland ecosystems (Frost 1984, 1985). Fire is also one of the key factors in maintaining the competitive balance between trees and grasses in savannas (Van Wilgen *et al*., 1997). The vegetation types of southern Africa have traditionally been mapped and described on the basis of the species that they contain also known as a floristic classification, rather than on the basis of their physical structure. The floristic approach results in a large number of classes with no clear association to their fire-related properties (Van Wilgen *et al*., 1997).

Plantations which also occur to a great extend in the area of the Richards Bay Municipal area, which consist of non – indigenous trees; predominantly species of *Pinus* and *Eucalyptus* are actively defended against fire, with varying degrees of success. In South Africa, an average of 6430 ha (0.5% of the planted area of 1.3 million hectares) per annum was burned over the period 1986 – 1993 (Van Wilgen, *et al*., 1997). Forest and savanna mosaics can be edaphic or anthropogenic. Anthropogenic mosaics are usually created in areas which were formally forested, particularly through the process from regeneration by frequent fires or by continuous harvesting of woody re-growth (Van Wilgen, *et al*., 1997).

It should be noted that according to the Conservation of Agricultural Resources Act (Act No. 43 of 1982, as ammended in 2001) all Category 1 alien plants are prohibited and must be controlled, while Category 2 plants (usually commercially used plants) may be grown in demarcated area providing that there is a permit and that steps are taken to prevent their spread (Henderson 2001).

Encroachment of *Helichrysum kraussii* and other woody species such as *A. karroo, P. guavaja* and *L. camara* into grassland and wetlands were observed. The general conclusion is drawn that fire *per se* favours the development and maintenance of a predominantly grassland vegetation by destroying the juvenile trees and shrubs and preventing the development of more mature plants to a taller, fire-resistant stage (Huntley and Walker, 1982).

In order to prevent further degradation of the remaining intact natural vegetation future developments should be carefully planned and located if possible in the least sensitive areas. Important vegetation types should be conserved and incorporated into the MOSS of the Richards Bay Municipal area and therefore this study could play a role in meeting the conservation objectives.

The species composition in Forest vegetation has changed in some of the Forest communities occurring in the study area of Richards Bay. The *Acacia karroo* Woodland community that was observed in a study by the CSIR (1993) is now incorporated in the *Isoglossa woodii – Macaranga capensis* Tall Closed Forest and the *Chromolaena odorata – Melia azedarach* Short Forest. The large extend of alien invasive species occurring in the latter community, gives an indication of extensive clearance of Dune Forest and Swamp Forest vegetation. Alien invasive species and other woody schrubs started to encroach such gaps in forest canopies and out compete original vegetation species.

The *Barringtonia racemosa – Ficus tricopoda* Tall Swamp Forest community is becoming smaller in the study area in comparison to studies done by Venter (1972) and Weisser *et. al.* (1995). The Swamp Forest community of Richards Bay study area is now represented by small stands of *B. racemoca* occurring along the shores of the four freshwater lakes of Mzingazi, Nzesi, Chubu and the Estuary. This plant community also occurs along rivers and drainage channels surrounding these waterbodies. Because of the ecological function these communities have on these waterbodies their conservation as a buffer zone is important. A total clearance of these plant communities for rural and urban development purposes will have severe impact on the turbidity of these waterbodies leading to the siltation and eutrophication of these fresh water sources. *Brugueria racemosa* and *Ficus tricopoda* are also listed as endangered and protected tree species by South African legislation. All stands of these forests should be protected.

Swamp Forest was once common along drainage channels and rivers in the eSikhawini township area, but has now been severely invaded by *Psidium guajava* (Guava trees), *Lantana camara* (Lantana shrub) and *Melia azedarach* (Syringa tree). The township of Vulindlela shows a serious *Schinus terebinthifolius* (Brazilian pepper tree) as well as a severe *Psidium guajava* invasion. All these alien species should be eradicated.

The Mangrove Short Closed Forest community is also still represented by large homogenic stands of *Avicenia marina*. Mangrove communities not only support a highly nutrient rich environment in the Estuary but also play a key role in providing a suitable habitat for a high diversity in fauna in and around the estuary. These large stands also play an important role in flood attentuation. All stands of these forests should be protected.

Wetland communities occupy a relatively small area and are vulnerable to disturbance and have become significantly degraded within the study area. It is recommended that Grassland and Wetland communities should be excluded from all development options.

It is recommended that the Richards Bay Town Council plan the Metropolitan Open Space System (MOSS) bringing the ecological areas of importance into consideration. These vegetation types and its plant communities usually support a larger system. This would be areas where Sand Dune or Strand vegetation, the Mangrove Forest vegetation and the Mosaics of Swamp Forest vegetation and its associated fringing *Papyrus* and Reedswamps, occur.

It is strongly recommended that all new developments in the Richards Bay area be subjected to a proper ecological investigation as part of the Environmental Impact Assessment process, as prescribed and outlined in terms of sections 24 and 24D of the National Environmental Management Act, 1998 (Act No. 107 of 1998), listed activities in the Schedule under the Environmental Impact Assessment Regulations, 2006, made under section 24(5) of the Act and published in Government Notice No. R. 385 of 2006.

In particular, we need to distinguish between variation in space and time, but also such aspects as the pattern of change in space or time, and the rapidity with which change occurs in it.

In an ecological context, the term "disturbance" indicates change in the condition of an organism, population or community caused by an external agency, often man. Such changes usually imply a shift towards sub-optimal conditions, since we can usually assume that the organisms were previously adapted to the existing environmental conditions (Van Andel and van den Bergh, 1987).

After the sudden change in management (disturbance as an event) the grassland communities diverged. However, after a certain stage, the management treatment can no longer be considered "disturbance" since the community adapts to the new regimes (Van Andel, *et al.*, 1987). The succssional pathway of a community also determines the chance of reversibility. The successional rain' (Klötzli, 1981) is particularly important. Dispersal of diaspores, either in space or in time (seed bank), of species that disappeared is a prerequisite for recovery (Van Andel, *et al.*, 1987).

The importance of Grasslands (Discussion document, 1998):

- Grasses provide an effective and tenacious vegetation cover over the soil, thereby protecting it from erosion.
- If mown, grassland can be maintained as low-cost sport fields and playgrounds.

Problems associated with Grasslands (Discussion document, 1998):

- Most abundant grass species are of very limited value for maintaining domestic grazing animals.
- Low level of richness in indigenous species makes these grasslands of very low priority for nature conservation.
- Taller-growing grasses, especially *Hyparrhenia* spp. offer screening which encourage dumping of rubble and litter.

General

Vegetation plays various important roles in the Richards Bay MOSS and the surroundings (Discussion document, 1998).

- Vegetation can contribute to maintenance of a healthy environment through the removal of harmful substances from air and water at a fraction of the cost that would be incurred by using man-made alternatives.
- If properly managed plant communities will function indefinitely barring the occurrence of some natural disaster;
- Vegetation can contribute to suppressing noise
- Vegetation can screen unsightly features.

Photo 8.3: Overgrazed hygrophilous grassland with secondary sand dune forest at the back (June 2002).

4. *Imperata cylindrica – Sporobolus fimbriatus* Temporary Hygrophilous Grassland

This grassland community is mostly found in moist places along rivers or wetland situations. The community is characterised by species group D, containing several diagnostic species. These species include the woody *Bridelia micrantha*, but most diagnostic woody species are aliens e.g. *Lantana camara*, *Chromolaena odorata* and *Schinus terebinthifolius*. Diagnostic grass species are *Sporobolus fimbriatus, Aristida junciformis* and *Panicum repens,* while diagnostic forbs species include *Centella asiatica, Schistostephium rotundifolium, Crotalaria natalitia* and *Abildgaardia ovata.*

Sporobolus fimbriatus usually grows in moist places next to rivers, drainage channels and along roadsides as well as in the shadow under trees (Van Oudtshoorn, 1999). The species also grows in well drained soils. The species is also widely distributed throughout southern and east Africa (Van Oudtshoorn, 1999).

Aristida junciformis already occurred as the predominant species in the Coastal Bushveld – grassland as observed in the early seventies (Venter, 1972). *Aristida junciformis* commonly grows in open grassveld. This species is also associated with high rainfall areas as well as wetter areas like wetlands (Van Oudtshoorn, 1999). Although *Aristida junciformis* may generally occur within most soil types it is more characteristically to poor and stony soil types and clay soils in wetland areas (Van Oudtshoorn, 1999). This species is an unpalatable grass for grazing and provides very little nutritional value for grazing purposes. In areas where selective overgrazing occurs, *Aristida junciformis* will tend to increase, where-after it will form dense dominant stands in grassveld (Van Oudtshoorn, 1999).

Aristida junciformis occurred mainly in sampling plots where overgrazing was observed. If grazing activity is not better managed and regulated it is possible that *Aristida junciformis* may become dominant, replacing most other species in this kind of community.

Panicum repens grows in or close to temporary or permanent water sources and is also associated with sandy and saline soils. *Panicum repens* is regarded as a good grazing grass (Van Oudtshoorn, 1999). Where *Panicum* *repens* occurs it may indicate a healthy and good grazing grassveld, which occurred in some areas of the Richards Bay municipal area in the past.

5. *Paspalum distichum* – *Eragrostis chloromelas* Temporary Hygrophilous Grassland

This grassland occurs in disturbed moist areas within the study area. It is characterised by species group E, with the grasses *Eragrostis chloromelas* and *Chloris gayana* and the forbs *Dissotis canescns* and *Pycnostachys reticualtus* as the diagnostic species.

Other prominent species are *Paspalum distichum*, which is the dominant grass, and *Cyperus rotundus.*

Paspalum distichum grows in or close to water. The species may be regarded as a weed in crop fields occurring in areas with high rainfall. The species grows in a variety of soil types from sand to clay (Van Oudtshoorn, 1999). *Paspalum distichum* is regarded as a palatable grazing grass that can withstand heavy grazing. Although when this species becomes established in an area, it is very difficult to eradicate (Van Oudtshoorn, 1999). The species is originally from tropical Africa and America, but is distributed today throughout the tropics, worldwide (Van Oudtshoorn, 1999).