Vegetation and habitat types of the Umkhanyakude Node

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Abstract

The aim of the study was to identify and classify the woodlands, bushland and grasslands of the Umkhanyakude Integrated Sustainable Rural Development Node (also known as Maputaland) into homogenous management units to assist with the natural resource audit and monitoring program initiated by the Department of Agriculture. The Node is situated in KwaZulu-Natal Province at the extreme northern border between South Africa and Mozambique. Two hundred and twenty-five surveys were conducted during March–July 2002 within 400 random plots created within ARCVIEW 3.2. Ecological data were analysed using multivariate ordination and classification techniques. Four broad plant communities within two geographically separated vegetation types were described. The Coastal Sandveld occurs on the coastal plain on recent arenaceous sediments. The Clay Thornveld occurs in the interior and is associated with a variety of terrain types and geological formations but predominantly rhyolite, basalt, shale and mudstones. Communities within the major vegetation types were differentiated based on climate (temperature and precipitation differences associated with differences in elevation and topography) and anthropogenic disturbances such as old fields, settlements and deforested plantations. The two major plant communities were subdivided into two sub-communities that can be used as management units since they have approximately the same physiognomy, grass composition and habitat characteristics. The four broad management units are the Acacia nilotica – Acacia karroo – Dichrostachys cinerea Community (Clay Thornveld); the Cissus rotundifolia – Enteropogon monostachyos (Valley Bushveld) Community; the Panicum maximum – Brachylaena discolor Community (Coastal Bushveld) and the Themeda triandra – Urelytrum agropyroides Community (Grass – Palmveld).

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1. Introduction

As an initiative to focus economic development on previously disadvantaged and impoverished areas, the South African Government has committed its development initiatives to 13 municipal regions, of which the Umkhanyakude Development Node is one of these nodes. The area is known for its high biodiversity, unique vegetation habitat types and natural beauty. It is therefore an ecologically sensitive area and is recognised as a regional centre of endemism (Van Wyk and Smith, 2001).

The main form of income in the area is subsistence farming, but due to the area’s natural resources, eco-tourism is a viable and growing industry. A number of natural parks, e.g. Hluhluwe-Umfolozi Game Reserve, Mkuzi Game Reserve, Thembu Elephant Park and Ndumu Game Reserve, have been promulgated to preserve the areas biodiversity and natural beauty. Resource degradation due to deforestation, overgrazing and urbanisation are existing threats to sustainable development as pristine natural areas are becoming fragmented and limited for conservation. Proper land use planning is therefore needed to manage the sustainable agricultural development of the region in line with current policies such as the Integrated Sustainable Rural development Strategy (ISRDS) announced by President Thabo Mbeki during the 2001 State of the Nation address (Mbeki, 2001). As part of the ISRDS program, 13 municipal nodes were identified as pilot areas to implement the strategy. One of the initiatives of the Department of Agriculture is to conduct resource audits within the nodes to obtain information for development programs and to monitor the state of resources within the node. A natural resource inventory of the Umkhanyakude Node was conducted in 2002, which assessed the vegetation habitat types, rangeland condition, alien invasion status, erosion risk and land cover usage (Ströhmenger et al., 2003).
Some ecological studies were recently conducted in the Umkhanyakude Node, which gave a background to the history of ecological studies conducted in this area. Kirkwood and Midgley (1999) did a survey on the floristics of the Sand Forest in the area. Matthews et al. (1999) described the vegetation of the Sileza Nature Reserve and classified the vegetation broadly into five vegetation types, namely Artabotrys monteiroae – Dailuim schlechteri forest, Eragrostis lappula – Helichrysum septentrionale hygrophilous grassland, Ischaemum fasciculatum – Eragrostis inamoena hygrophilous grasslands, the Leersia hexandra – Hemarthria altissima grassland and the Themeda – Salacietum M. Myre (1964) woody grasslands. Lubbe (1997) described the coastal areas of the Umkhanyakude Node using the increaser–decreaser concept to determine the veld condition assessment method.

The aim of this study was to identify and describe broad habitat units within the bush and grasslands of the Umkhanyakude Node to obtain a better understanding of the vegetation types of rangelands within the Umkhanyakude Node. The habitat units were also used in the assessment of the rangeland condition during the natural resource audit of the Umkhanyakude Node (Ströhmenger et al., 2003). Similar types of audit programs have been conducted for Mpumalanga (Wessels et al., 2001a) and Gauteng (Wessels et al., 2001b). Information from the audit will be used for better resource development within the node. Since wetlands and indigenous forests were not regarded viable rangelands and are generally included within conservation areas, these habitats were only noted and were not included in the studied.

This study therefore differs from previous studies in that it is aimed at holistically describing and mapping potential rangelands in the Umkhanyakude Node.

2. Materials and methods

2.1. Study area

The region is situated in the extreme north of the KwaZulu-Natal Province, South Africa. The northern part of the study area borders on Mozambique and the western part partially borders on Swaziland.

The Umkhanyakude Node is situated within the summer rainfall area (January to March being the wettest months, Fig. 1). The region has a subtropical climate. The average annual rainfall varies from 671 mm in the north to 1002 mm in the south. Climatic records indicate that potentially 50–70 days a year are rainy days. On average the daily maximum temperature is above 20 °C and the daily minimum temperature is above 10 °C (Fig. 2). The difference between the minimum and maximum temperature is seldom more than 12 °C.

The topography changes considerably from east to west and is associated with changes in the stratigraphy and lithography. The eastern region is a coastal sandy plain, originating from the continental shelf. The coastal plain is underlain with sediments, predominantly arenite and calcrete. The Josini River floodplain transects the central region from south to north and is mostly underlain by siltstone, conglomerate and alluvial sandy sediments. The western region is predominated by the Lebombo mountain range, that was formed by intrusion of felsic and intermediate volcanic rocks (Rhyolite). The southwest is mostly undulating hills underlain by basalt in the interior and mudstone, siltstone, shale and arenite in the extreme southwest (Viljoen and Reimold, 1999; Du Plessis et al., 1984; Van Wyk and Smith, 2001).

Since the study concentrated on potential rangelands, known forest areas and wetlands were excluded from the study.

2.2. Vegetation sampling

Using Geographic Information System (GIS) software, 400 sample points were allocated randomly to allow for statistically reliable statements to be made for the total area. Vegetation surveys were conducted within 225 of the 400 initially allocated points during March 2002 until July 2002 (Fig. 3) selected due to accessibility. Some sites were also subjectively chosen to obtain data from both degraded and well-managed sites. To ensure that data points were inter-
interpretable for remote sensing analysis it was essential that large, internally homogenous areas were selected that were identifiable on satellite imagery to allow for extraction of pixel values (Wilkie and Finn, 1996). Selected sites were 250 × 250 m internally homogenous and at least 250 m away from other land uses. These sites were situated at least 50 m from roads to avoid road edge effects. Vegetation surveys were then performed within a 100 × 100 m plot (1 ha) within the internally homogenous area.

Survey teams consisted of a plant ecologist and a soil scientist. All plant species were noted within the 1 ha block and relative canopy cover values were estimated for grasses, forbs and woody species. Field workers were requested to subjectively rate the grass cover, degree of soil erosion, bush encroachment, overall degradation and species change on a 1–5 scale (1 = good and 5 = poor condition). Each sample locality’s soil type, depth, texture, structure and colour were described based on the binominal soil classification system for South Africa (Soil Classification Working Group, 1991). A habitat description (land use, potential biome, slope, aspect and terrain position) of the sampling locality was also compiled.

2.3. Data analysis

The floristic data were classified with TWINSPAN (Hill, 1979) in MEGATAB (Hennekans, 1996) using the WIN-DOWS 95 version. Indirect and direct ordination techniques were used to firstly elucidate environmental factors associated with identified vegetation types and secondly to identify environmental gradients. Two ordination programs, CANOCO ver. 4 (Ter Braak and Šmilauer, 1998) and PC-ORD ver. 4.21 (McCune and Mefford, 1999) were used for multivariate analysis. PC-ORD was specifically used for indirect gradient analysis using Detrended Correspondence Analysis (DCA), because PC-ORD has the capacity to overlay environmental factors over the ordination diagram. CANOCO was used for direct gradient analyses as it is more statistically orientated and provides the choice of Canonical Correspondence Analysis (CCA) or ReDundancy Analysis (RDA) (Ter Braak and Šmilauer, 1998).

3. Results

The results from the TWINSPAN analysis were strictly applied and Braun Blanquet refinements (Kent and Coker, 1994) were not made to the classification. Eight broad vegetation types were identified within two major plant communities using a TWINSPAN classification. The results from the TWNSPAN classification are superimposed within the DCA ordination diagram (Fig. 4). The two broad major communities were geographically separated. The Coastal Sandveld occurs along the coastal flats. The Clay Thornveld occurs on rolling hills and in river valleys in the interior.
The vegetation classification can be summarised as follows (symbols as indicated in Figs. 4 and 5).

1. Clay Thornveld
   1.1. *Acacia nilotica* – *Acacia karroo* – *Dichrostachys cinerea* Community
      1.1.1 *Acacia karroo* – *Lippia javanica* Sub-community (g)
      1.1.2 *Acacia tortilis* – *Themeda triandra* Sub-community (h)
   1.2 *Cissus rotundifolia* – *Enteropogon monostachyos* Community
      1.2.1 *Acacia luederitzii* Sub-community (>)
      1.2.2 *Euphorbia grandicornis* Sub-community (?)

2. Coastal Sandveld
   2.1 *Panicum maximum* – *Brachylaena discolor* Community
      2.1.1 *Eragrostis ciliaris* – *Helichrysum kraussii* Sub-community (Δ)
      2.1.2 *Acacia burkei* Sub-community (r)
   2.2 *Themeda triandra* – *Urelytrum agropyroides* Community
      2.2.1 *Syzygium cordatum* – *Phoenix reclinata* Sub-community (▼)
      2.2.2 *Eugenia albanensis* – *Parinari curatellifolia* Sub-community (†)

A DCA ordination (Fig. 4) indicates the similarity in species composition within the ordination space. The second DCA ordination axis separates the Coastal Sandveld vegetation types (groups 211–222) from the Clay Thornveld vegetation types (groups 111–122). The communities from the Coastal Sandveld occur in the upper left-hand side of the ordination diagram, whereas the Clay Thornveld communities occur in the lower left-hand side (Fig. 4). The communities identified with the TWINSPLAN classification, as described in the text, formed homogenous groups within the ordination space. The division between sub-communities, however, became less obvious and therefore further divisions to variant and sub-variant level were not warranted.

A Principal Component Analysis (PCA) of the site’s environmental variables was also performed with the different sub-communities overlain (Fig. 5). The environmental variables were strongly associated with the vegetation types. The PCA ordination (Fig. 5) divides the two vegetation types according to the percentage sand/clay content. A histogram of the clay content between the different communities confirms this tendency of correlation between environment and vegetation type (Fig. 6). The Coastal Sandveld communities have a clay content of mostly lower than 10%, whereas the clay content of the Clay Thornveld varied between 20 and 30% (Fig. 6). The sites of the Coastal Sandveld were closely clumped together, indicating that the environment was relatively homogenous regarding climate, soil and topography. The PCA ordination diagram indicates a high variability of environmental factors among sites of the Clay Thornveld. The PCA ordination diagram (Fig. 5) indicates that the *Acacia luederitzii* Sub-community (1.2.1) occurs on soil with a higher sodium content (higher exchangeable sodium percentage) (ESP) and higher electrical conductivity (EC) (Fig. 5). The sub-communities of the *Acacia nilotica* – *Acacia karroo* – *Dichrostachys cinerea* Community were also associated with soils of a higher macronutrient content (Ca, Mg and K), indicating more fertile soils. The soils associated with the *Acacia nilotica* – *Acacia karroo* – *Dichrostachys cinerea* Community are derived from volcanic rock, as well as
mudstone and shale. Elevation accompanied by differences in climate forms an important gradient from left to right in the PCA ordination. According to the PCA ordination the Acacia karroo – Lippia javanica Sub-community and the Acacia tortilis – Themeda triandra Communities occur predominantly at higher altitudes and are also associated with higher precipitation. The Acacia luederitzii Sub-community (1.2.1), the Euphorbia grandicornis Sub-community (1.2.2) and the Acacia burkei Sub-community (2.1.2) occur at lower altitudes.

A CCA ordination was conducted to investigate the association between the described communities and available environmental variables for the Coastal Sandveld and Clay Thornveld (Figs. 7 and 8). The environmental variables were selected by forward selection using a Monte Carlo Permutation test with 199 permutations.

According to the forward selection procedure between environmental variables and vegetation types of the Clay Thornveld, precipitation, elevation, old fields, percentage organic soil carbon (C), slope steepness, clay percentage, electrical conductivity (EC), pH, terrain type and average maximum temperature explained the vegetation best (Table 1). The ordination statistics indicate that the 10 environmental variables explained 14% of the variation in the species data \(1.11/8.07 \times 100\). The eigenvalues for the first two ordination axes were respectively 0.37 and 0.15. The first ordination axis related best to precipitation \((-0.6704)\) and maximum temperature \((0.7914)\), and therefore regional climate differences, whereas the second ordination axis was correlated with % clay \((0.3284)\), electrical conductivity (EC) \((0.3381)\), pH \((0.3367)\) and slope steepness \((-0.3013)\), and therefore soil differences (Table 1).

Communities were differentiated along the first axis of the CCA biplot (Fig. 7). Environmental variables associated with the first ordination axis will therefore explain the different plant communities. It can be inferred from the CCA biplot that the Euphorbia grandicornis Sub-community, situated to the right of the first ordination axis, was associated with relatively hotter and drier climates and occurs mostly on bottomlands. The Acacia karroo – Lippia javanica Sub-community was situated to the left of the first ordination axis and was therefore associated with cooler, moist climates at higher elevations. The Acacia karroo – Lippia javanica Sub-community exhibited a high variability in community composition and it seems that most old fields are affiliated to this sub-community type.

According to a CCA ordination, precipitation, pH, old fields, salinity (electrical conductivity), terrain types, percentage clay and average maximum temperature explained the
The CCA ordination statistics for the Clay Thornveld in the Umkhanyakude Node

| CCA axis 1  | CCA axis 2  | CCA axis 3  | All       |
|-------------|-------------|-------------|-----------|
| Precipitation | −0.6704    | 0.037       | 0.0914    |
| Elevation   | −0.4416    | 0.2519      | 0.0539    |
| % slope     | −0.3977    | −0.3013     | 0.1266    |
| % C         | 0.3163     | 0.0149      | 0.3436    |
| Old fields (nominal) | 0.1433      | 0.4752     | 0.0596    |
| % clay      | −0.124     | 0.3264      | 0.2738    |
| EC          | 0.157      | 0.3381      | −0.1289   |
| pH (H₂O)    | 0.3237     | 0.3367      | 0.0783    |
| Temperature | 0.388      | 0.1407      | −0.0117   |
| Maximum temperature | 0.7914     | −0.0046     | −0.1657   |

CCA statistics summary

|               |Eigenvalues   | Species–environmental correlation |Sum of all unconstrained eigenvalues|Sum of all canonical eigenvalues|Monte Carlo permutation test (199 permutations)|F-ratio:|F-ratio:|P-value:|P-value:|
|---------------|--------------|---------------------------------|-----------------------------------|-------------------------------|----------------|--------|--------|--------|--------|
|               |              | 0.372                           | 0.154                             | 0.101                          | 7.437           | 2.469  | 0.005  | 0.005  |
|               |              | 0.851                           | 0.755                             | 0.69                           | 8.07            | 1.115  |                 |        |
|               |              | 0.456                           | 0.335                             | 0.237                          | 7.018           | 1.613  |                 |        |
|               |              | 0.874                           | 0.865                             | 0.893                          |                 |        |        |        |
|               |              | 0.8087                          | −0.1254                           | −0.244                         |                 |        |        |        |

Coastal Sandveld best (Table 2 and Fig. 8). The seven environmental variables explained 23% of the variation (1.613/7.018*100) in the species data. The first CCA ordination axis was best explained by average maximum temperature (0.8087) and clay content (0.4021). The second ordination axis was explained best by precipitation (0.7391) and the nominal variable; old fields (0.5539) (Table 2).

Table 2
The CCA ordination statistics for the Coastal Sandveld in the Umkhanyakude Node

|               |CCA axis 1  |CCA axis 2  |CCA axis 3  |All       |
|---------------|-------------|-------------|-------------|-----------|
|Precipitation  | −0.348      | 0.7391      | 0.1698      |
|pH (H₂O)      | −0.1628     | −0.2794     | 0.1973      |
|Old fields    | −0.0844     | 0.5539      | −0.1755     |
|Terrain types | −0.0209     | −0.2259     | −0.0508     |
|EC            | 0.328       | 0.2179      | 0.5333      |
|% clay        | 0.4021      | 0.2069      | 0.633       |
|Maximum temp. | 0.8087      | −0.1254     | −0.244      |

CCA statistics summary

|               |Eigenvalues   | Species–environmental correlation |Sum of all unconstrained eigenvalues|Sum of all canonical eigenvalues|Monte Carlo permutation test (199 permutations)|F-ratio:|F-ratio:|P-value:|P-value:|
|---------------|--------------|---------------------------------|-----------------------------------|-------------------------------|----------------|--------|--------|--------|--------|
|               |              | 0.456                           | 0.335                             | 0.237                          | 7.018           | 1.613  |                 |        |
|               |              | 0.874                           | 0.865                             | 0.893                          |                 |        |        |        |
|               |              | 0.8087                          | −0.1254                           | −0.244                         |                 |        |        |        |

The Eragrostis ciliaris – Helichrysum kraussii Sub-community, Acacia burkei Sub-community and Eugenia albanensis – Parinari curatellifolia Sub-community occur to the left of the CCA ordination axis along the first ordination axis (Fig. 8). From the ordination diagram it can be inferred that these three sub-communities were associated with a cooler climate and sandier soils. The second CCA axis can best be described as a precipitation and disturbance gradient (Fig. 8). The Eragrostis ciliaris – Helichrysum kraussii Sub-community and a few sites of the Acacia burkei Sub-community were situated at the top of the second ordination axis and associated with old fields and higher precipitation.

3.1. Description of the communities

The following section contains a floristic description of the plant communities from the TWINSPAN classification result. Indicator species were identified with a DCA ordination by plotting the species abundance in the ordination diagram.

Clay Thornveld

The Clay Thornveld occurs in the interior of the Umkhanyakude Node. As indicated in Fig. 6 the clay content in the A-horizon is highly variable, but on average higher than the Coastal Sandveld. The vegetation is dominated by Acacia shrubs and trees as well as the shrubs of the Croton menyharti and Euclea species (Table 3). The vegetation structure is mostly woodlands except where bush clearing has taken place. In the case of old fields, small Acacia shrubs frequently occurred together with shrublets such as Lippia javanica.

The following four sub-communities were identified within two communities of the Clay Thornveld from the TWINSPAN classification.

Community 1.1: Acacia nilotica – Acacia karroo – Dichrostachys cinerea Community. The Acacia nilotica – Acacia karroo – Dichrostachys cinerea Community is typically thornveld dominated by Acacia spp. and Dichrostachys

Table 3
Characteristic trees and shrubs of the Clay Thornveld in the Umkhanyakude Node

| Characteristic species | Growth form |
|------------------------|-------------|
| Acacia species (A. nilotica (L.) Willd. ex Delile, A. tortilis (Forsk) Hayne, A. hederitzii Engl., A. karroo Hayne) | Tree |
| Berchemia zeyheri (Sond.) Grubov | Tree |
| Croton menyharti Pax | Tree |
| Euclea divinorum Hiern | Tree |
| Euclea racemosa Murr. | Tree |
| Lippia javanica Spreng. | Shrub |
| Gymnosporia mossambicensis Loes. | Tree |
| Rhus spp. (R. gueinzii Sond., R. pentheri A. Zahlbr., R. rehmanniana Engl.) | Tree |
| Sideroxylon inerme L. | Tree |
cinerea (L.) Wight and Arn. trees and shrubs. The vegetation is mostly associated with the southern areas in the Hluhluwe-Umfolozi Game Reserves extending northwards into the Lebombo Mountains. The Acacia nilotica – Acacia karroo – Dichrostachys cinerea Community is similar to the Natal Lowveld Bushveld (Low and Rebelo, 1998) and secondary woody vegetation of the Coastal Bushveld – Grassland (Low and Rebelo, 1998), of which Acacia species forms an important component.

Sub-community 1.1.1: Acacia karroo – Lippia javanica Sub-community. The Acacia karroo – Lippia javanica Sub-community has a variable physiognomical structure from pure grassland to closed woodlands. If the classification of Edwards (1983) is followed, the sub-community can be grouped into three physiognomic sub-variants: Closed Wood/Shrubland, Open Wood/Shrubland and Sparse wood/Shrubland or Grassland.

The tree cover was mostly dominated by Acacia karroo, Dichrostachys cinerea, Acacia nilotica, Euclea racemosa and Sclerocarya birrea Hochst. subsp. caffra (Sond.) J.O. Kokwaro. The shrub layer was dominated by Acacia karroo, Acacia caffra Willd., Dichrostachys cinerea, Diospyros lycioides Desf., Lippia javanica and Gymnosporia senegalensis Loes. The grasses Bothriochloa insculpta (A. Rich.) A. Camus, Chloris gayana Kunth, Eragrostis curvula (Schrad.) Nees, Sporobolus fimbriatus Nees and Themeda triandra Forsk. dominated the herbaceous layer. The grasses Chloris gayana and Hyparrhenia hirta (L.) Stapf are characteristic of this sub-community. The declared invaders, Chromolaena odorata (L.) R.M. King and H. Rob. and Lantana camara L., occur as dominant herbaceous shrubs.

This sub-community occurs predominantly to the south in the vicinity of Hluhluwe-Umfolozi Game Reserves (Fig. 3). The vegetation type occurs on a variety of geological rock types, predominantly basalt of the Lebombo Group as well as sandstone, shale and mudstones of the Beaufort and the Ecca groups.

Sub-community 1.1.2: Acacia tortilis – Themeda triandra Sub-community. The Acacia tortilis – Themeda triandra Sub-community can be described as a closed woodland. The height of the woody cover is highly variable, becoming shrubby in places. The tree layer is mostly dominated by Acacia nigrescens Oliver, Acacia nilotica, Acacia tortilis and Dichrostachys cinerea. A few broad-leaved trees, such as Combretum apiculatum Sond., Sporostachys africana Sond., Ziziphus mucronata Willd. and Sclerocarya birrea may also dominate in places. The shrub layer is dominated by Dichrostachys cinerea, Acacia nilotica, Euclea divinorum and Gymnosporia senegalensis. The grass layer consists predominantly of Bothriochloa insculpta, Panicum deustum Thunb, or P. maximum Jacq., Themeda triandra and Setaria sphacelata (Schumach.) Moss. The declared invader Chromolaena odorata also occurs predominantly as a soft shrub. This sub-community is mostly found from the north of Hluhluwe-Umfolozi to the Mkuzi Game Reserve. The vegetation type occurred on similar geological formations to the Acacia karroo – Lippia javanica Sub-community.

Coastal Sandveld

The Coastal Sandveld is associated with the coastal plains and dunes. The soils consist of leached and regic sands. The species characteristics of the Coastal Sandveld are listed in Table 4. The vegetation is a mixture of grasslands, palmveld and mixed bushveld with variable degrees of affinity to sand forests. Sand forests were excluded from the study and are therefore not described in this paper.

Community 2.1: Panicum maximum – Brachylaena discolor Community

Sub-community 2.1.1: Eragrostis ciliaris – Helichrysum kraussii Sub-community. The Eragrostis ciliaris – Helichrysum kraussii Sub-community is associated with disturbed areas such as old fields in original sand forests or...
recently cleared plantations. The vegetation therefore consists mostly of pioneer grasses and forbs. Characteristic species included the grasses *Eragrostis ciliaris* and *Melinis repens*, the sub-shrub *Helichrysum kraussii* and the small tree *Sapium integerrimum* (Hoehst. ex Krauss) J. Leonard. Lubbe (1997) identified a similar community, the *Helichrysum kraussii* – *Melinis repens* (Wild.) Ziaka subsp. *reps* coastal grasslands, that was found in the proximity of human settlements and trampled areas.

**Sub-community 2.1.2: Acacia burkei Sub-community.** Sub-community 2.1.2 is a woodland community mostly dominated by the trees *Terminalia sericea*, *Acacia burkei* Benth. and *Strychnos madagascariensis*, the shrubs *Eugenia capensis*, *Dichrostachys cinerea* and *Hyphaene coriacea* Gaertn. and the grasses * Panicum maximum*, *Dactyloctenium aegyptium*, *Perotis patens*, *Pogonarthria squarrosa* (Licht.) Pilg. and *Themeda triandra*.

All of the sites in the Tembe Elephant Park form part of this sub-community (Fig. 3). The communities of the *Acacia burkei* Sub-community occur as outliers within the *Acacia tortilis* – *Themeda triandra* Sub-community. They are geographically associated with the *Euphorbia grandicornis* Sub-community (Fig. 3). The *Acacia burkei* Community is associated with the Sub-humid Lowveld Bushveld. Outliers of the *Acacia burkei* community occur within the coastal Bushveld, as well as in the Natal Lowveld Bushveld (Low and Rebelo, 1998).

**Community 2.2: Themeda triandra – Urelytrum agropyroides Community.** The *Themeda triandra* – *Urelytrum agropyroides* Community was previously described by Myre (1964) as the *Themeto – Salacietum* M. Myre (1964). Matthews et al. (1999) described this vegetation type as wood grassland associated with relatively dry sands with a deep water table on dune crests and slopes. The *Themeda triandra* – *Urelytrum agropyroides* Community occurs exclusively in the Coastal Bushveld grassland described by Low and Rebelo (1998).

**Syzygium cordatum – Phoenix reclinata Sub-community.** The vegetation of the *Syzygium cordatum* – *Phoenix reclinata* Sub-community can be regarded as an open to semi-closed woodland dominated by the trees *Syzygium cordatum* and *Strychnos madagascariensis* and the shrubs *Phoenix reclinata*, *Parinari curatellifolia* and *Hyphaene coriacea*. The grass layer is dominated by *Themeda triandra*, *Tristachya leucothrix* Nees and *Urelytrum agropyroides* (Hack.) Hack.

The *Syzygium cordatum – Phoenix reclinata* Sub-community occurs throughout the Coastal Sandveld. Lubbe (1997) described this vegetation type as part of the *Syzygium cordatum – Hyperthelia dissoluta* Woodland.

**Sub-community 2.2.2: Eugenia albanensis – Parinari curatellifolia Sub-community.** The *Eugenia albanensis* – *Parinari curatellifolia* Sub-community can be regarded as the only true grassland community in the Coastal Sandveld. A number of sub-shrubs are present in the grassland, of which *Parinari curatellifolia* and *Eugenia albanensis* Sond. are dominant. The grass layer is dominated by *Themeda triandra* and *Eragrostis curvula*.

### Table 4

| Characteristic species                  | Growth form |
|----------------------------------------|-------------|
| Bridelia                               | Tree        |
| Corchorus junodi N.E.Br                | Shrub       |
| Eleuca natalensis A.DC.                | Tree        |
| Eugenia capensis Harv.                 | Tree        |
| Helichrysum kraussii Sch. Bip          | Shrub       |
| Landolphia kirki Dyer                  | Tree        |
| Parinari curatellifolia Planch. ex Benth. | Tree      |
| Perotis patens Gand.                   | Grass       |
| Phoenix reclinata Jacq.                | Tree        |
| Strychnos species (S madagascariensis Poir., S spinosa Lam.) | Tree |
| Syzygium cordatum Hochst. ex C. Krauss | Tree        |
| Terminalia sericea Burch. ex DC.       | Tree        |

### Figs. 9 and 10

Fig. 9. Estimated percentage woody covers for the eight sub-communities described in the Umkhanyakude Node. Vegetation types are as described in the text and Figs. 4 and 5.

Fig. 10. Average estimated herbaceous cover for the eight different sub-communities described in the Umkhanyakude Node. Vegetation types are as described in the text and Figs. 4 and 5.
Umfolozi-Hluhluwe Game Reserve as well as the foothills of the Lebombo Mountain Range. These include:

- Acacia nilotica – Acacia karroo – Dichrostachys cinerea
- Themeda triandra – Urelytrum agropyroides

With exception of the Cissus rotundifolia – Enteropogon monostachyos Community, the Acacia burkei Sub-community and the Eragrostis ciliaris – Helichrysum kraussii Sub-community, the herbaceous cover for the rest of the communities was similar (≈80% herbaceous cover). A negative relationship existed between the herbaceous cover and woody cover. Herbaceous cover was on average lower in sub-communities with a woody cover higher than 40% (Figs. 9 and 10).

4. Discussion

According to the vegetation classification obtained from this study, the vegetation of the Umkhanyakude Node (Maputaland) can be split into two major vegetation types mainly based on geology and soil (clay content). The coastal region, although relatively homogenous in soil and topography, has heterogeneous vegetation consisting of a spectrum of forests, bushveld, palm bushveld and grassland. Differences in the vegetation types of the Coastal Sandveld could probably be related to differences in micro-relief and microclimate. The results of this study indicated similarities between this classification and the classifications of Lubbe (1997) and Matthews et al. (1999).

The vegetation of the inland areas was mostly associated with hills and mountains of the Lebombo Mountain Range and the alluvial pediments of the Pongola River valley. The Acacia nilotica – Acacia karroo – Dichrostachys cinerea Community was particularly associated with the hills of the Umfolozi-Hlulhule Game Reserve as well as the foothills and mountains of the Lebombo Range. The Cissus rotundifolia – Enteropogon monostachyos Community was particularly associated with river valleys of the Pongola and Mkuze river flood plains.

The results from the study were further used in the resource audit to draw a habitat map based on percentage clay, precipitation and elevation (Ströhmerger et al., 2003). The vegetation classification was then used to determine the veld condition based on gradients analysis, incorporating observations such as the level of over grazing, erosion, bush encroachment, vegetation cover and perceived species change within these broad homogeneous groups.

Four habitat types were delineated for further veld condition assessment studies. These include:

a) Acacia nilotica – Acacia karroo – Dichrostachys cinerea Management Unit: Thornveld
b) Cissus rotundifolia – Enteropogon monostachyos Management Unit: Valley Bushveld
c) Panicum maximum – Brachylaena discolor Management Unit: Coastal Bushveld
d) Themeda triandra – Urelytrum agropyroides Management Unit: Grass-palmveld

These management units are important for land use planning since they describe vegetation that is phytosociologically similar.

Most of the differences between habitat units were described on the shrubs and tree composition. Although specific grass species were associated with specific habitat types the relationship was also largely influenced by disturbance effects or was associated with a number of vegetation types.

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