Contents

Annexure 1

1. BIODIVERSITY PRIORITISATION WITHIN THE ALFRED NZO DISTRICT

Introduction

The primary aim of this analysis, as detailed in this report, was to identify those areas with high biodiversity priority.

The resulting GIS databases of biodiversity priorities will allow development planners to proactively

The analysis has limitations, being based on desktop data and aerial photographs. Much of the underlying data derived from the EC Biodiversity Plan are at a relatively coarse scale and are not suited at all to detailed planning. The use of aerial photographs to moderate the assessment results provides a significant improvement on this data, but is not able to determine range degradation associated with over-grazing, and can present a falsely optimistic picture of what is left. These limitations require that a rapid ecological integrity assessment field assessment be done to confirm decisions that have been based on the results of this desktop tool.

2. Introduction

One of the foundations to environmental management is a spatial understanding of where the main biodiversity features (species, habitats, ecosystems and services) are located, and how much of them is left. This information is ultimately expressed in the form of a summarised biodiversity priorities map that clearly demonstrates where the municipal managers need to be focusing their attention in terms of environmental management.

A limitation of the recently published EC Biodiversity Plan (Berliner & Desmet, 2007), or ECBP, was that the input data, and hence results, were at a scale too broad for management planning at the 1:50 000 scale. The ECBP identified large swathes of land as being part of various critical biodiversity areas (CBAs) and hence subject to increased conservation management and restricted development.

3. The Focus Area

The focus area for this analysis was the district boundary for the ANDM (Figure 2), comprising an area of 6,860km^2.

4. Desktop methodology

The desktop analysis was designed to be simple and robust with the specific aim of identifying those areas of the landscape that are clearly NOT contributing to biodiversity conservation due to transformation and severe and obvious degradation. Conversely, those areas that are relatively intact (i.e. have not been 'lost' to conservation) were given an elevated significance only if they are seen to be contributing towards the provincial biodiversity targets, as expressed in the Eastern Cape Biodiversity Plan (ECBP).
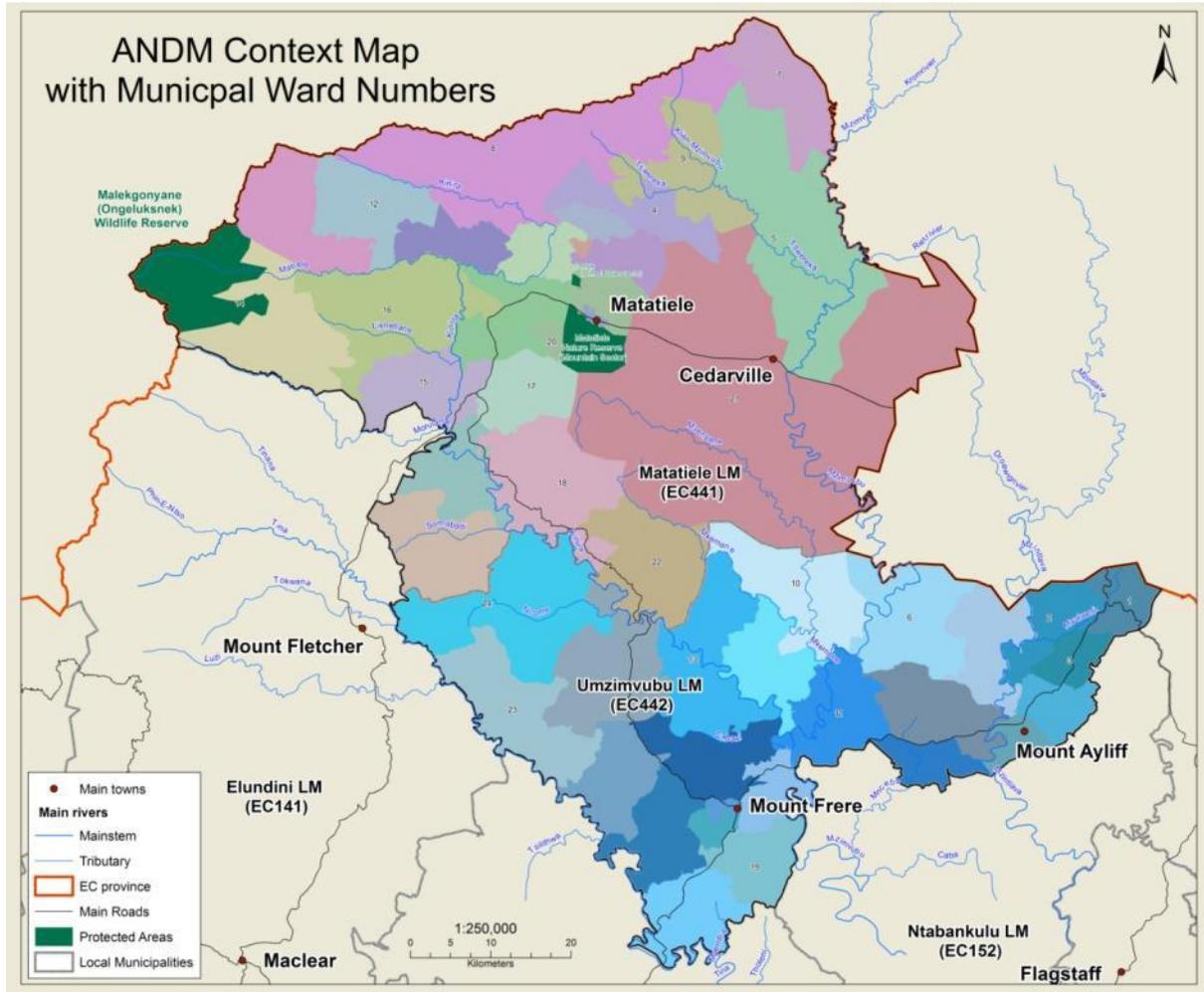
Figure 1. The Alfred Nzo DM within its context.

4.1. Software requirements and GIS project setup

The analysis was performed using ArcGIS 9.2 (SP 6) and MS Excel 2007. A biodiversity analysis add-in developed for biodiversity prioritisation within the forestry sector (Lechmere-Oertel & Benn, 2009) was used to generate biodiversity scores for all the planning units.

The following data are included in the project DVD:

NOTE:

Files with the suffix of **_wgs** are in unprojected geographic WGS1984 format. Files with the suffix **_tm27** or **_tm29** are projected into Transverse Mercator with a central meridian of 27 or 29.

- All the 1:10 000 ortho-photographs (Gauss Conform projection – Transverse Mercator with the nearest odd meridian) used in the analysis – stored in a folder: **10_photo**

- The environmental data derived from the EC Biodiversity Plan – stored in a folder: **EC_EnvData**

Data layer	Shp file name on DVD
DWAF indigenous forest layer (2005)	DWAF_forests_2005_wgs
Aquatic CBAs extracted from the ECBP, dissolved using the CBA category (1 or 2) as the dissolve field.	EC_Aquatic_CBA_tm27_diss
Estuarine CBAs extracted from the ECBP, dissolved using the CBA category (1 or 2) as the dissolve field.	EC_Estuarine_CBA_tm27_diss
Terrestrial CBAs extracted from the ECBP, dissolved using the CBA category (1,2 or 3) as the dissolve field.	EC_terrestrial_CBA_tm27_diss
Provincial biodiversity corridors dissolved using the corridor category (1 or 2) as the dissolve field.	EC_corridors_tm27_dissolve
The full ECBP dataset including the irreplaceability values used in the analysis.	ECBP_Planning_units_tm27
The woody vegetation (Protea woodlands and forest patches) derived from the Maloti-Drakensberg Transfrontier Project vegetation map.	MDTP_woody_clip_tm29
National wetlands layer version II from the Biodiversity GIS website.	National_wetlands_II_wgs
National vegetation map released by SANBI in 2006.	SANBI_veg_map_2006_wgs

- The forestry potential map (Howard 2007) and various derivatives of this layer. This data set was constricted to areas below 1700m altitude as areas higher than this are not likely to be economically suitable for plantation forestry. Stored in a folder: **Forestry_Potential**

- Various grids used in the analysis and organisation of data – stored in a folder: **Grids**

  o RSA_10000_ortho_grid_wgs (the reference grid of all orthophotos in RSA)

  o ANDM_ ortho_grid_wgs (the selection of orthophotos needed for the ANDM analysis)

  o RSA_map_50000_ wgs (the reference grid of all 1:50 000 topographic maps in RSA

  o PU_49ha_tm29 (a 700m x 700m, 49 ha, planning unit layer built specifically for this analysis)

- All the temporary intersection files derived during the analysis – stored in a folder: **Intersect**

- A collection of national and provincial contextual layers useful for map production – stored in a folder: **Context**

  o Current point locations of outstanding DWAF licence applications.

  o Main roads

  o All roads

  o Main towns

  o All settlements

  o Main rivers

  o Municipalities (district and local)

  o DWAF plantations

  o EC Provincial boundary

- All the data and shp files associated with the field verification survey – stored in a folder: **Field_Survey**

- All the data and shp files that were derived during the analysis – stored in a folder: **Analysis_results**

- The images generated from the GIS for use in presentations and documents – stored in a folder: **Map_images.**

The ArcGIS project file = ANDM_EMP.mxd

In most instances, opening this file in ArcGIS 9.x will bring up all the correct links to the files in the project. If this doesn't happen, then you will have to navigate one of the links to the file and the remainder should update automatically. The orthophotos are organised into arbitrary clusters for analysis purposes to avoid overloading the computer memory when opening the project.

5. Summary of approach

The following approach was adopted for this desktop assessment:

- Conduct a rapid ecological integrity assessment (REIA), using 1:10 000 ortho-photographs to identify areas that clearly DO NOT contribute to biodiversity conservation due to transformation and degradation (Section 6).
- Develop a 49 ha (700m x 700m) planning unit (PU) grid for the focus area (Section 7).
- Intersect the PU grid with the forestry potential, ECBP, corridors and REIA shape files so that each planning unit is attributed with these data (Section 8).
- Design a network of connectivity corridors that link up intact areas, focusing on the provincial-scale corridors (Section 8.3).
- Export the PU attribute data to a spreadsheet prioritisation model and then re-import the results back to the GIS for final mapping (Section 9).
- Identify areas of Good or Moderate forestry potential and high biodiversity importance (i.e. probably conflict areas) and use these as the basis for field verification (Section **Error! Reference source not ound.**).

6. Rapid Ecological Integrity Assessment (REIA)

Ortho-photographs (1:10 000 scale, Gauss Conform projection) were used as the basis for a rapid assessment of ecological integrity. The underlying principle was that significant portions of any landscape that are assumed to be contributing to biodiversity conservation (as designed at a provincial scale) are probably not doing so because they have been transformed or degraded in some way. For example, an entire mountain slope may be prioritised for biodiversity conservation at a provincial scale, but over 50% of the slope may be being used for arable agriculture. This finer-scale information significantly alters the implementation of biodiversity conservation and whether 'competing' landuses are allowed or not.

REIA done from aerial photography is significantly different from a field survey as there is a limit to what can accurately be predicted at that resolution. A simplified REIA scoring system was developed with the express purpose of identifying those portions of the landscape (1:10 000 scale) that are OBVIOUSLY NOT contributing significantly to biodiversity conservation. The following landtype classes were used (

Table 1):

Table 1. The desktop Rapid Ecological Integrity Classification system used for aerial photography interpretation

Class Name	Class No.	Description
Potentially Intact (Figure 2).	0	Land that appears to be functional grassland, but is probably exposed to some level of grazing pressure. It is unknown to what degree the full biodiversity spectrum is still present on the landscape, but this land is probably reasonably functional as a natural system.
Urban (Figure 3)	1	The urban centres, but not their outer-lying villages.
Peri-urban / Villages. (Figure 4)	4	The scattered rural settlements on the outskirts of the urban centres and in the outer-lying rural areas. The delineation includes both the houses / huts and their associated gardens, but excludes the larger arable fields.
Arable fields (Figure 4)	5	Existing arable fields. Many of these may be abandoned or lying fallow for various reasons.
Plantations (Figure 5)	6	Existing commercial plantations owned either privately or by government departments or communities. Some of these are now derelict and receive no management.
Obvious gulley and sheet erosion (Figure 6)	2	There are portions of the landscape that have been subject to such intense and prolonged rangeland pressures that they are now very obviously damaged. The primary evidence discernable at the 1:10 000 scale is the presence of large erosion gulleys and surrounding sheet erosion (white surface). These areas are also characterised by a high density of animal paths indicating that livestock are regularly accessing the area.
Alien Invasive Trees (Figure 7).	3	Some areas have become dominated by large stands of alien invasive trees, primarily wattle. These infestations stand out clearly against the surrounding grasslands. It is less easy to discern them from neighbouring indigenous bush and forests, but in some cases you can distinguish them by the uniformity in their canopy.

Polygons were drawn around each of the features (1-3) using on-screen digitising functions with ArcGIS 9.2 and attributed with the relevant class value. Once completed, the digitised layer was joined (using the Union function) to the outer boundary of the focus area and the unclassified area was attributed with class 0. The final layer was dissolved (disallowing multipart features) so that neighbouring polygons with the same REIA classification were joined. The dissolved area and perimeter were calculated for each dissolved polygon.

The shape file for this part of the analysis = *ANDM_final_reia_tm29*

Figure 2. Example of REIA Class 0: *Potentially Intact*

Figure 3. Example of REIA Class 1: *Urban*

Figure 4. Example of REIA Class 2: *Peri-Urban / Villages* and of Class 3 *Arable landuse*

Figure 5. Example of REIA Class 4: *Plantations*
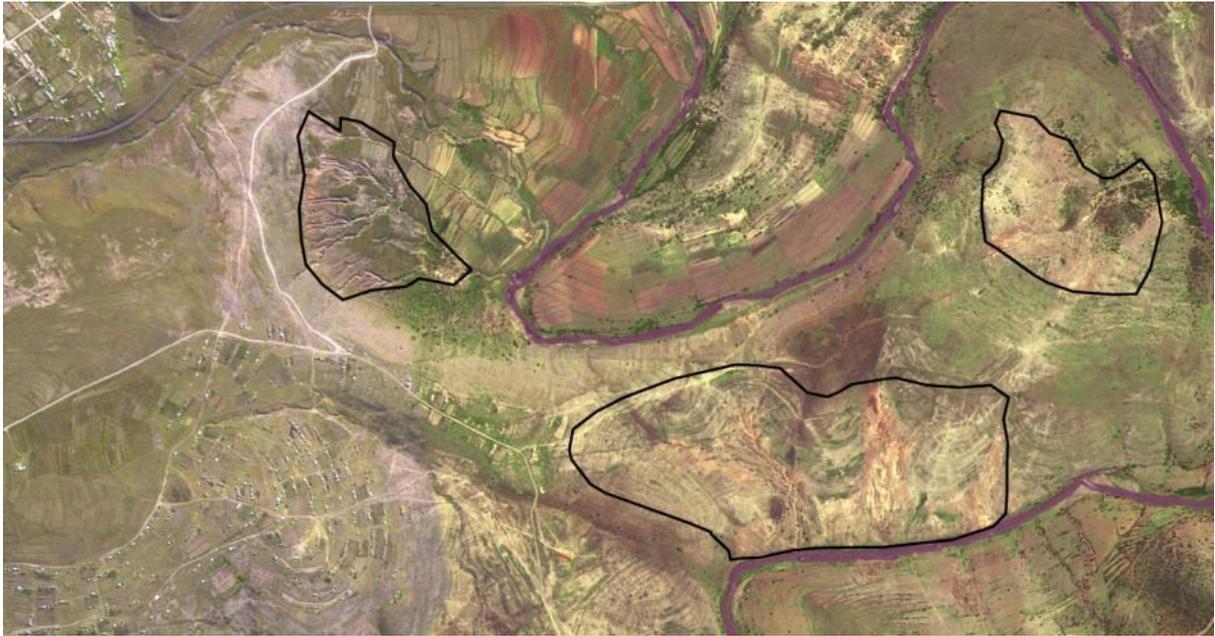
Figure 6. Example of REIA Class 5: *Extensive sheet and gully erosion*

Figure 7. Example of REIA Class 6: *Alien Invasive Tree Infestation*

7. Planning Unit Grid

A 700m x 700m (49ha) grid was generated for a rectangle that covered the extent of the focus area using HawthsTools (ArcGis 9.x). Each of the PUs were given a unique identification code (FID+1). This PU layer was clipped to the boundary of the focus areas using the 'Select by Spatial Area' option.

Overall PU grid shp file (Grids folder) = *PU_49ha_tm29*

8. GIS Shape file Intersections

A copy of *PU_clipped_to_focus_area_tm29* shp file was made and called *PU_Working_tm29* (Intersect folder). Once an intersection was conducted, the resulting data field was attributed back to this working shp file. This file is the repository of all the environmental data, and became the basis of the analysis.

8.1. EC Biodiversity Plan's Critical Biodiversity Areas (CBAs) and corridors

The ECBP identified various types of CBAs and two types of corridors (Table 2), each having a different conservation implication (Berliner & Desmet, 2007). The CBAs were identified for terrestrial, aquatic and estuarine environments. The CBA and corridor types were separated into individual shape files (
Figure 8, **Error! Reference source not found.**,
Figure 9, Figure 10), and then dissolved into multipart features.

The PU grid was intersected with each of these separate CBA and corridors shape files, and the area of the resulting intersected polygons calculated. These new polygon areas were calculated as a percentage of the 49ha grid cell and then joined back to the PU layer using the unique ID code as the join field. A field was added to the PU attribute table for each CBA and corridor type (*e.g.* AquCBA1, TerrCBA2, etc), and this was attributed with the percentage area of each of those CBA's for each grid cell.

Table 2. Descriptions of the Critical Biodiversity Areas and Corridors from the EC Biodiversity Plan

Terrestrial Critical Biodiversity Areas (T-CBAs)	
1	• National critically endangered vegetation types (ecosystems): The Amount of remaining intact SA vegetation type is less than representation target. • STEP critically endangered vegetations types. • National Forest Assessment critically endangered forest patches. • 80-100% irreplaceable planning units: Areas definitely required to meet representation targets for biodiversity features (SA vegetation types, expert mapped areas). • KZN C-Plan minset R1 & R2 minset display categories. • Important forest clusters as identified in the forestry planning process as critical.
2	• Endangered SA vegetation types. The area of intact vegetation remaining of a vegetation type is within 15% of the set representation target. • Endangered STEP vegetations types. • Endangered forest patches. • All expert mapped areas less than 25 000ha in size. Includes expert data from this project, STEP birds, SKEP, Wild Coast, Pondoland and marine studies. • All other Forest Clusters (with 500m buffers). • 1km coastal buffer (forests are not added to this as these are captured elsewhere). • Ecological corridors and/or named macro-ecological corridors from existing studies (i.e. from STEP, Wild Coast/Pondoland, SEA, etc.) and expert mapped. • Ecological corridors identified in this project using an integrated corridor design for the whole province.
3	• Vulnerable SA vegetation types. • Vulnerable STEP vegetation types.
Aquatic Critical Biodiversity Areas (A-CBAs)	
1	• Irreplaceability river sub-catchments for Eco-region level 2 representation, endemic fish, terrestrial priorities and estuaries. • Critical estuaries. Highest importance estuaries (conservation rank of 10) as identified by Turpie 2007.
2	• Important sub-catchments – supporting zone required for preventing degradation of A1 rivers. Require moderate or high protection. Defined as all remaining areas within the designed river catchment network not in A-CBA1. • Free flowing rivers/ fish migratory systems. Mapped at the Quaternary catchment level based on data from CSIR/DWAF assessment. • All important estuaries not in E1 (Turpie 2007 ranks 4-9).
3	• Hydrological primary catchment management areas for E1 estuaries. Highest priority management area. Focus on management of activities that have a direct impact on the physical estuary (e.g. MAR, erosion, pesticides). Limit total transformation of catchment to less than 10%. MAR reduction 15%. • Hydrological primary catchment management areas for E2 estuaries. Focus on management of MAR to sustain functioning of important estuaries in Zone. Limit total transformation of catchment to less than 15%. MAR reduction 25%.

|	
Estuarine Critical Biodiversity Areas (E-CBAs)	
1	• Critical estuaries. Highest importance estuaries (conservation rank of 10) as identified by Turpie and Clark (2007).
2	• All important estuaries not in E1 (Turpie and Clark, 2007 ranks 4-9)
Provincial corridors	
1	• Ecological corridors and/or named macro-ecological corridors from existing studies. This layer merges mapped biodiversity corridors identified by: o STEP o Wild Coast study o Pondoland study o WMA12 SEA o Garden Route Conservation Plan o Greater Addo – Baviaanskloof Conservation Plan o ECBP Expert mapping.
2	• This layer represents a network of ecological corridors identified as part of the systematic conservation assessment (see Section 7). It represents an integrated corridor design in that it considers all terrestrial and aquatic features and biodiversity targets used in the assessment whilst attempting to minimize conflict (cost) with existing production landscapes. • Nodes within the corridor network are dictated by existing protected areas and/or identified centres of biodiversity importance within the province. The linkages between nodes (north-south, coast-inland, coastal, escarpment, etc,) were based on recommendations made by the experts consulted as part of this project as well as the existing corridor network (Corridor1) where they aligned with terrestrial and/or freshwater priority (CBA level 1) areas. • The design of the corridor network used the sub-catchment planning units developed for the freshwater conservation assessment as these form intuitive ecological units within the landscape.
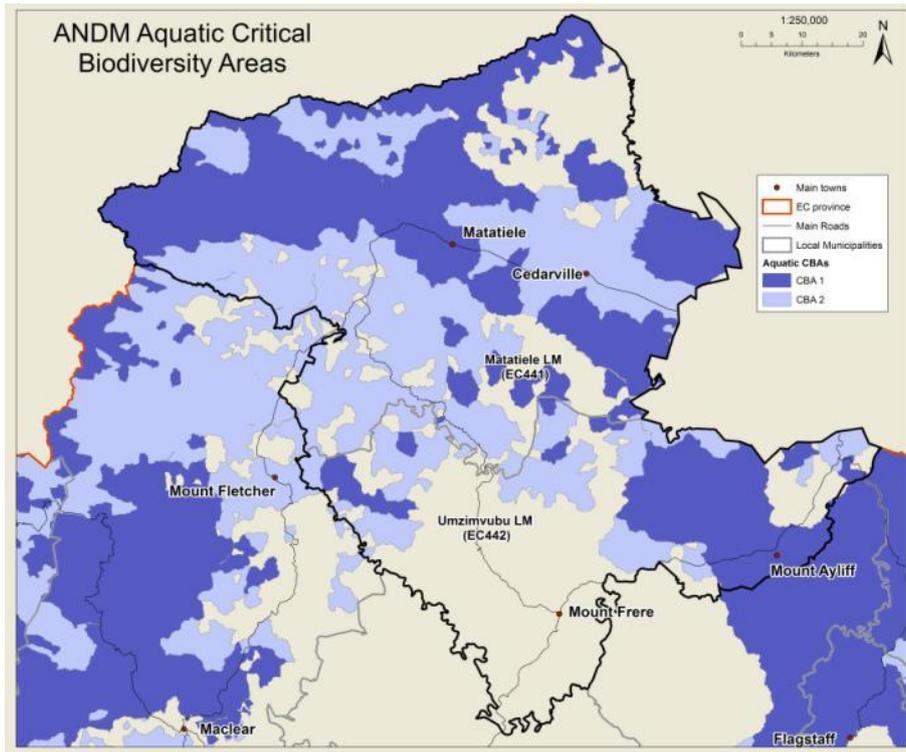
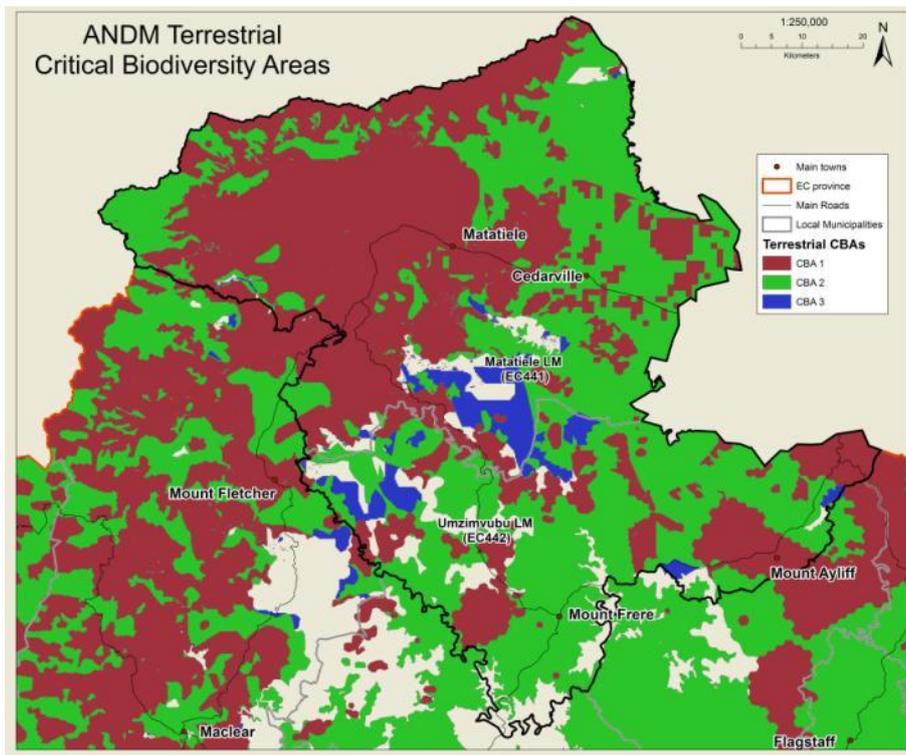Figure 8. ECBP Aquatic Critical Biodiversity Areas in the ANDM.

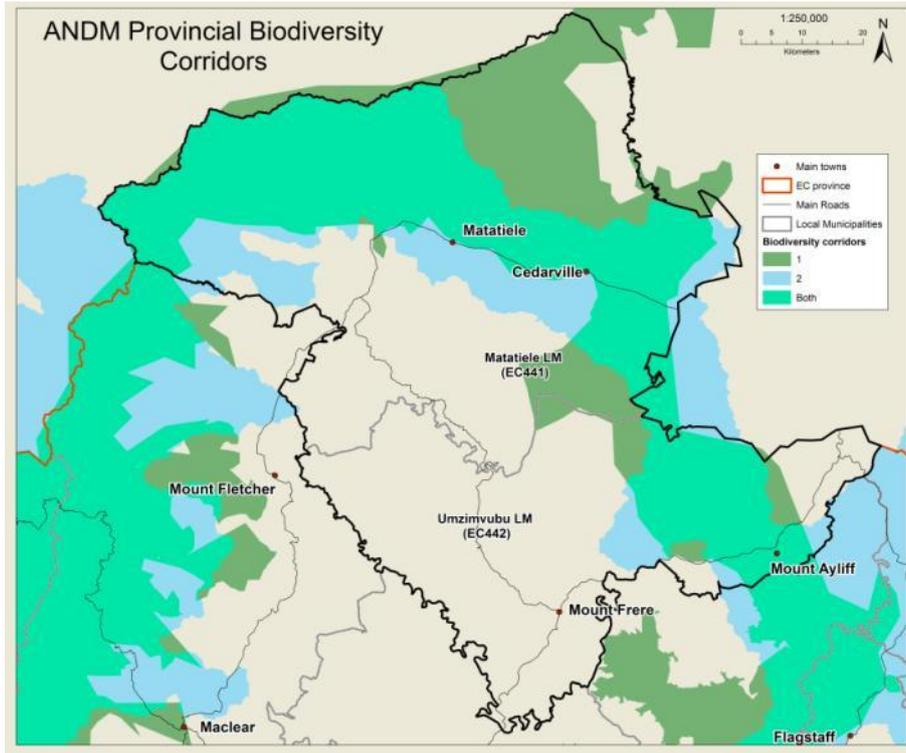Figure 9. ECBP Terrestrial Critical Biodiversity Areas in the focus area

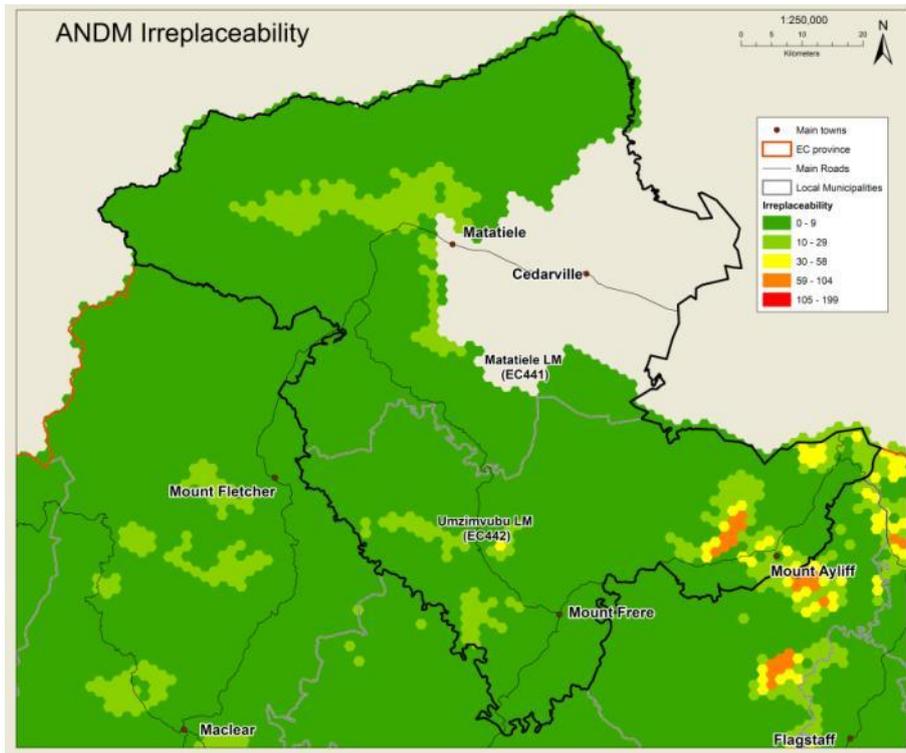Figure 10. ECBP Biodiversity Corridors in the focus area

Figure 11. Irreplaceability map from the Eastern Cape Biodiversity Plan

8.1. Irreplaceability

The PU layer was intersected with the ECBP hexagon layer (
Figure 11) that was attributed with Irreplaceability values. The areas of the new intersected polygons were calculated as a percentage of the 49ha grid cell. All polygons with a percentage > 10 were selected and summarised for maximum irreplaceability. The summary table was joined back to the PU attribute table using the unique ID code, and a new field called *MaxIrr* was attributed with the maximum irreplaceability.

8.2. Habitats (Vegetation types & wetlands)

The PU grid was intersected with the SANBI Vegetation Map layer (2006), and the area of the resulting intersected polygons calculated. The percentage this new polygon area was calculated of the original PU grid (49ha) and then joined back to the PU layer using the unique ID code. The dominant and sub-dominant vegetation types (based on the area per 49ha PU) were identified. A field was added to the PU attribute table for these, and were attributed with the percentage area of the respective vegetation types.

The PU grid was intersected with the DWAF indigenous forest layer (2005) (Figure 12), and the area of the resulting intersected polygons calculated. The percentage this new polygon area was calculated of the original PU grid (49ha) and then joined back to the PU layer using the unique ID code. A field was added to the PU attribute table for DWAF forests, and this was attributed with the percentage area of each of those CBA's for each grid cell. A separate field was added with the count of forest patches per PU.

The same procedure was applied to the Maloti-Drakensberg Transfrontier Project woody vegetation (2007) layer and the national wetlands 2010 layer (
Figure 13).
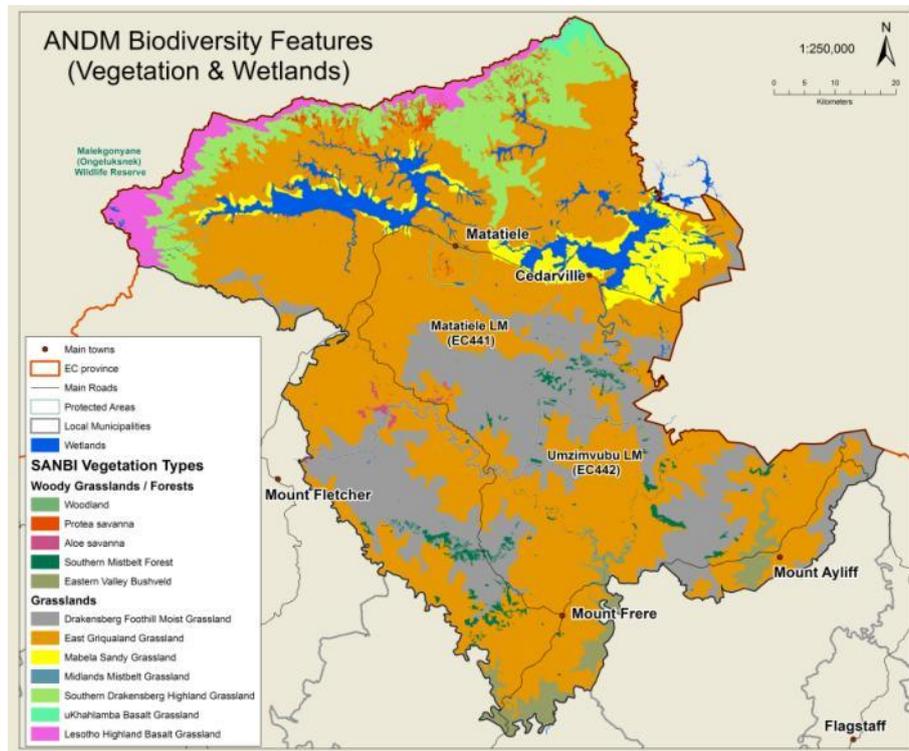
Figure 12. The indigenous forests and other woody vegetation types used in the analysis.
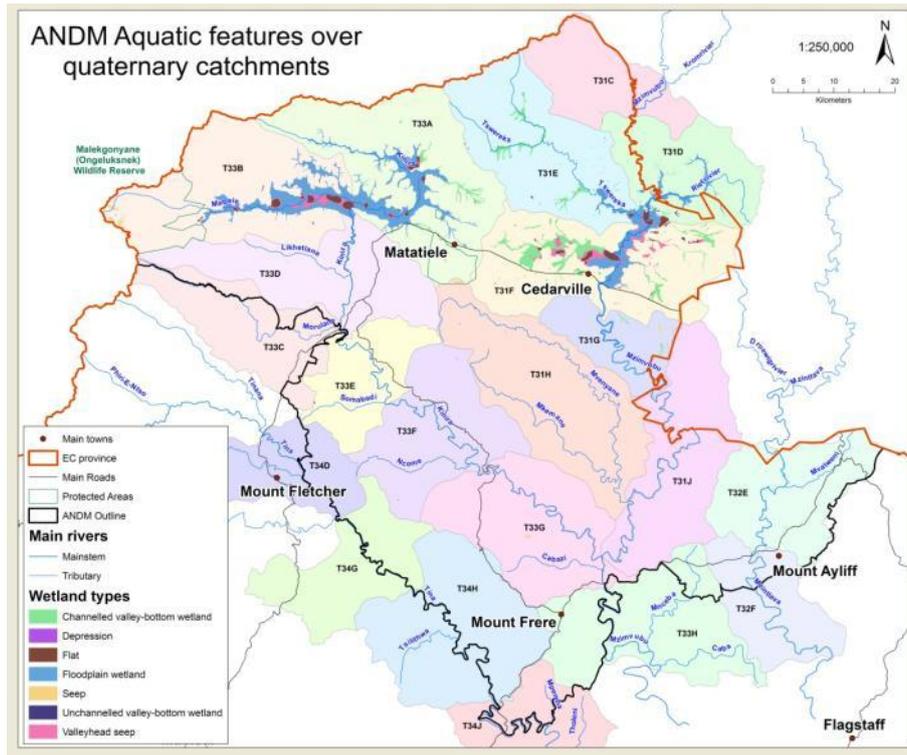
Figure 13. The aquatic features used in the analysis.

8.3. Local corridors

Working within the provincial corridors, the 'potentially-intact' Class of the REIA was used to identify a network of connectivity corridors at a 1:50 000 scale. This was done by 'eye' and is thus a professional opinion. Local corridors were aimed to be at least three PU's wide (2.1km) and to link across the focus area within the provincial corridor network. PUs that were selected to be part of the local corridor network were attributed with a score of 100 (
Figure 14).
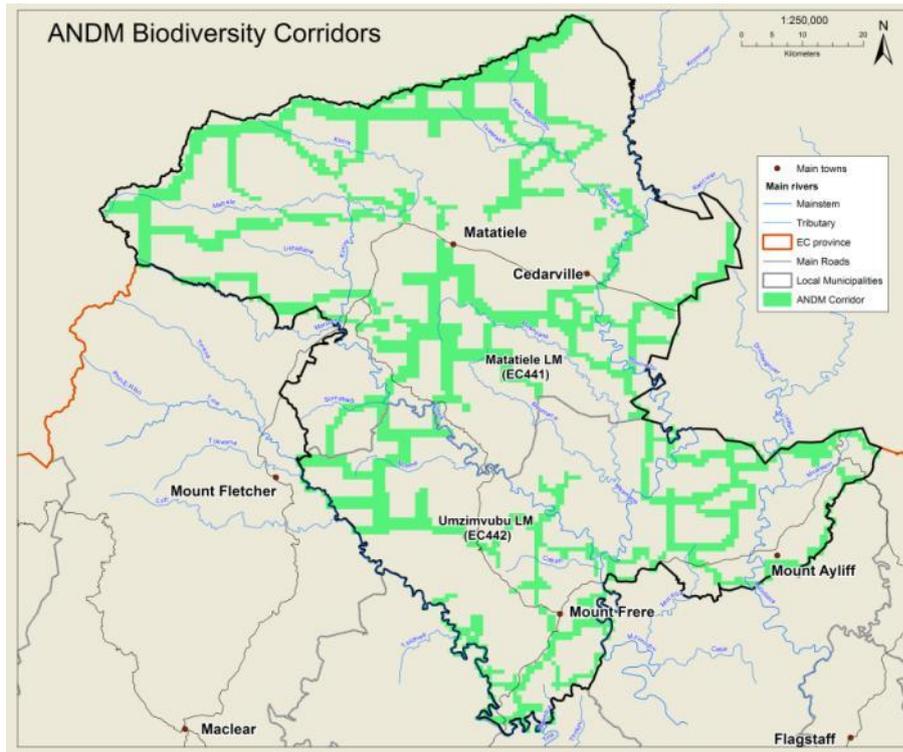
Figure 14. The local biodiversity connectivity corridor network.

8.4. Final Attribute Table for Excel Analysis

Once the intersections had been performed, the data for each environmental layer was attributed back to the working PU layer. The final attribute table (Table 3) from the GIS was exported to Excel for further prioritisation analysis using a modified add-in developed for the Grasslands Programme (Lechmere-Oertel & Benn, 2009). Not all the data in the attribute table is used in the analysis, but is kept there for reference purposes if a user is looking up what is important about a site.

Table 3. Example of the final GIS attribute table exported to Excel for analysis.
Note: Only three rows of data are presented. The green column headers have been cut and pasted to fit onto a page.

Id	Est_CBA1	Est_CBA2	EST_CBA	Aqu_CBA1	Aqu_CBA2	AQUA_CBA	Ter_CBA1	Ter_CBA2	Ter_CBA3	TER_CBA	ProvCor1	ProvCor2
473	0	0	0	0	0	0	0	0	0	0	0	0
474	0	0	0	0	0	0	0	0	0	0	0	0
475	0	0	0	0	0	0	0	0	0	0	0	0

Id	PROVCORR	LocCorr	Irrepl	DomVeg	DomVegHa	SubVeg	SubVegHa	
473	0	0	1	Amathole Montane Grassland	49	None	0	
474	0	0	1	Amathole Montane Grassland	49	None	0	
475	0	0	1	Amathole Montane Grassland	49	None	0	

Id	Adj_PA	For_Cnt	For_Ha	For_P49	mdtp_cnt	mdtp_Ha	mdtp_P49	FORHAB	Wet_Cnt	Wet_Ha	Wet_P49	REIA_0
473	0	0	0.000	0	0	0	0	0	0	0	0	49
474	0	0	0.000	0	0	0	0	0	0	0	0	49
475	0	0	0.000	0	0	0	0	0	0	0	0	47.6

Id	REIA_1	REIA_2	REIA_3	REIA_Tot	Pot_Good	Pot_Mod	Pot_None	DA_Rel	APR_Rel	VeldCond	WeedScore	PU_Ha
473	0	0	0	49	0	0	49	100	93	100	0	49
474	0	0	0	49	0	0	49	100	93	100	0	49
475	0.0	0	0	48	0	0	49	100	93	99	0	49

8.5. REIA analysis

The final REIA layer was separated into individual shape files for each of the four REIA classes (0-3), and each of these was dissolved into multipart features.

The PU grid was intersected with each of these separate REIA Class shape files, and the area of the resulting intersected polygons calculated. The percentage these new polygon areas were calculated as a percentage of the 49ha grid cell and then joined back to the PU layer using the unique ID code. A field was added to the PU attribute table for each REIA Class, and this was attributed with the percentage area of each REIA Class for each grid cell.

9. Biodiversity Prioritisation Analysis in Excel

The Excel analysis is conceptually quite simple. The user sets a relative weighting for each of the biodiversity variables. These weightings are a measure of the relative importance or ranking of the variables against each other. The model multiplies the variable value by the weight for each grid cell to give a score for that variable in that grid cell. The scores for all the variables within a grid cell are summed and then multiplied by the ecological integrity score to give the intrinsic biodiversity score (IBS) for the grid cell. The IBS value is then multiplied by the weed infestation score to give an Adjusted Biodiversity Score (ABS)

Once the intrinsic biodiversity score (IBS) has been calculated for all the grid cells, the results are re-imported into the GIS and linked back to the attribute table using the unique ID column. The GIS is used to generate maps showing the biodiversity importance in colour shading. The user can click on an area to ID what biodiversity features are making the area important.

IMPORTANT NOTE:
The Eastern Cape biodiversity data were quite complex and the number of biodiversity variables exceeded the capacity of the prioritisation tool (nine variables). This was overcome by running two separate analyses, one for provincial variables and one for more local variables. The Intrinsic Biodiversity Score (IBS) result of the aquatic analysis was included in the terrestrial analysis as a variable. This is explained in more detail later. The two analysis spreadsheets are denoted with the suffix _A and _B.

9.1 Technical detail and Installation

The prioritisation tool has been developed as an Excel Add-In which, when installed, adds a new Menu Item to the Excel interface. The process for installing the tool is the same as that used to install any Excel add-in. The Add-in is provided as a file with an *.xla extension, and is located in the **Documents** folder.

The tool has been written in Microsoft Visual Basic for Applications (VBA) 6.5, and makes use of standard Excel operations to carry out the required functions. The add-in will not work in the various Open Office spreadsheets. In the majority of instances, use of the tool's functions is identical in Excel 2003 and 2007.
The Add-In code has been password protected. Should you desire to modify the tool in any way, please contact Grant Benn (grant@geocline.co.za).

Installation process (Excel 2003/7)

Excel 2003	Excel 2007
Save the extension into a location where it can easily be found again (*e.g.* C:\Program Files\Microsoft Office\Office12\ADDINS).	
Open Excel 2003 On the **Tools** Menu, click **Add-Ins**.	Open Excel 2007 Click on the Office Button icon (top left). Select Excel Options. Select the Add-Ins tab on the left panel. Ensure the 'Manage:' tab is set to 'Excel Add-Ins' Click on the 'Go…' tab.
The **Add-Ins** dialog box will be opened, click on **Browse**. Browse to the location of the add-in file (*.xla) provided, and click **OK**. A new tool called **Biodiversity Assessment Tool** will be added to the list. If the tick box to the left of the tool name is not checked please do so and click **OK**.	
A new Menu Item called **Assess Biodiversity Priority** will be added to the interface.	The Biodiversity tool will now be found under the Add-In tab in the menu ribbon.

Key procedures in the Excel Add-In

- The tool provides the following procedural functions:
- Loading of input data for assessment of biodiversity priority scores.
- Updating of data for single variables.
- Validation of loaded input data.
- Loading/Adjusting of Intended Purpose values.
- Loading/Adjusting of Variable Weights.
- Loading/Adjusting of Relative Priority Classes.
- Assessment of biodiversity priority indices at two spatial scales.
- Generation of summary results.
- Exporting of results.

The Excel analysis using the tool will take approximately 60 mins in total from loading the data to exporting the results, with the core analysis taking approximately 45 minutes of processing time, depending on the number of records. Initial tests indicated that tool functions took longer to complete in Excel 2007. This has been widely reported to be a common issue with various Excel operations.

9.1. Loading Full Dataset

The Biodiversity Assessment Tool provides functionality to load the data produced using the GIS techniques outlined above. The tool places the input data into an Excel worksheet in the required format for analysis with the tool. The input data **MUST** be loaded through this tool; otherwise the analysis may not operate correctly.

The tool does allow for the user to load data from more than one spreadsheet table. However, if data is loaded from more than one table it is important that each table **has all records present** (i.e. all *uniqueIDs* must exist in all tables) and that each table is **sorted in ascending order on the *UniqueID* field**.

- Open Excel with a blank spreadsheet.
- On the **File** Menu click **Open** and select the table/s containing the input data. If opening a dbf or other format file, save it as an Excel sheet before proceeding.
- On the 'Assess Biodiversity Priority Menu', select 'Map Required Input Variables' and click on the 'Load Full Dataset' option. The **Map Input Variables** dialog box will open.

Up to 17 variables can be used in the analysis (Table 4). There are eight pre-determined variables, and nine optional variables. The user must ensure the nine optional variables, which have no name, link correctly to the variable weightings.

Select data ranges for each variable by clicking on the input box next to each variable and then selecting the relevant data range.

- Do not select column headings if present.
- If no data are available for any variable, click on a blank cell in the input table; do not simply ignore that variable (this includes the optional variables).
- A short cut to avoid jumping back and forward into the sheet to highlight columns of data is to copy the range reference from the first variable and then just change the column letters accordingly.
- Once the data ranges for all variables have been selected, click **OK**.
- The tool will now load in all the input data and place it into a new worksheet called **InputData**.
- Save the spreadsheet with a new name using the **Save As** option from the **File** Menu.

IMPORTANT NOTE:
The tool does no unit conversions on the area variables (Dissolved Polygon Area and Original Polygon Area). Area units must be consistent for all records: the data are used as loaded.

Table 4. The variables from the GIS used in the Excel analyses with their descriptions and weightings.

Analysis A – Provincial Data

Variable name	Type	Description	Field Name	Weight
UniqueID	Numeric	The unique polygon identifier from the GIS	UniqueID	-
Range Name	Text	Municipality	LocalMun	-
Intended Purpose	Text	Not used in this initial analysis		
Weed Score	Num 0-1	Included in Analysis B	WeedPerc	n/a
Original Polygon Area	Numeric	The original area of the polygons (m^2).	OrigArea	-
Dissolved Area	Num 0-100	The dissolved area of unfragmented intact land relativised to a 0-100 scale.	CLIA_Rel	7.3
Dissolved PA ratio	Num 0-100	The dissolved area:perimeter ratio of unfragmented intact land relativised to a 0-100 scale.	APR_Rel	5.5
Ecological Integrity	Num 0-1	Included in Analysis B	PercIntact	n/a
1	Num 0-100	The percentage of the cell that falls into Estuarine CBA category 2	Est_CBA2	2.7
2	Num 0-100	The percentage of the cell that falls into Aquatic CBA category 1	Aqu_CBA1	5.8
3	Num 0-100	The percentage of the cell that falls into Aquatic CBA category 2	Aqu_CBA2	2.7
4	Num 0-100	The percentage of the cell that falls into Terrestrial CBA category 1	Ter_CBA1	7.3
5	Num 0-100	The percentage of the cell that falls into Terrestrial CBA category 2	Ter_CBA2	3.5
6	Num 0-100	The percentage of the cell that falls into Terrestrial CBA category 3	Ter_CBA3	2.7
7	Num 0-100	The percentage of the cell that falls into Provincial Corridor category 1	ProvCor1	3.0
8	Num 0-100	The percentage of the cell that falls into Provincial Corridor category 2	ProvCor2	2.8
9	Num 0-100	The maximum irreplaceability value in the planning unit	Irrepl	5.3

Analysis B – Local Data

Variable name	Type	Description	Field Name	Weight
UniqueID	Numeric	The unique polygon identifier from the GIS	UniqueID	-
Range Name	Text	Municipality name	LocalMun	-
Intended Purpose	Text	Blank		-
Weed Score	Num 0-1	The proportion of each planning unit that is NOT infested with alien trees (0 = 100% free, 1 = 100% infested).	WeedScore	n/a
Original Polygon Area	Numeric	The original area of the polygons (m^2).	OrigArea	-
Dissolved Area	Num 0-100	Included in Analysis A	CLIA_Rel	
Dissolved PA ratio	Num 0-100	Included in Analysis A	APR_Rel	
Ecological Integrity	Num 0-1	The proportion (0-1 scale) of each planning unit that is potentially intact.	PercIntact	n/a
1	Num 0-100	A Yes (100) / No (0) value defining whether a polygon comprises part of a district corridor	ANDM_Corr	5.7
2	Num 0-100	A Yes (100) / No (0) value defining whether a polygon is within 1000m of a Protected Area	Adj_PA	13.5
3	Num 0-100	The percentage of the polygon that comprises forests delineated in the SANBI, MDTP or DWAF forests layers	IndigFor	12.6
4	Num 0-100	The percentage of the polygon that comprises wetlands (as per national wetlands 2010)	Wetland	14.3
5	Num 0-100	The percentage of the polygon that comprises MDTP Protea savanna	Prot_Sav	5.2
6	Num 0-100	The intrinsic biodiversity score (IBS) from Analysis A	Anal_A	1
7	Num 0-100	Blank		-
8	Num 0-100	Blank		-
9	Num 0-100	Blank		-

9.2. Updating Single Variables

The tool also provides functionality for the updating of individual variables. Again, the data for the updating of variables must include records for **all** *UniqueID'*s sorted in ascending order on this field. This functionality can only be used once the Full Dataset has been loaded, and is provided to update data records for single variables if values have been updated.

- Open the spreadsheet/s containing the updated input data. On the Assess Biodiversity Priority Menu, select 'Map Required Input Variables' and click on the 'Update Single Variable' option. The Map Selected Input Variable dialog box will open.
- Select the variable to be updated by clicking on the variable name in the left-hand list box (only one variable can be selected).
- Select the data range for the updated variable, and click **OK**. Again do not select column headings in the data range if present.

The tool will now load in the updated data into the relevant column in the **InputData** worksheet. If further variables need to be updated, this function can be run as often as required.

9.3. Data Validation

The tool provides functionality to validate the input data to ensure that critical requirements for the analysis are adhered to in the input data. The functionality highlights problem records to allow for easier location of problem records.

The following potential data errors are checked for by the tool:
- Records with blank internal land holding names.
- Intended purpose codes that are not text fields or not one of the allowed options, i.e. Cons, Aes, FP, Maint, Util or Unknown.
- Numeric values for those variables with a theoretical maximum of 100 do not exceed this value.
- Numeric values for those variables with a theoretical maximum of 1 do not exceed this value.

On the Assess Biodiversity Priority Menu, click on the 'Validate Loaded Data' option. If the tool finds no problems in the input data (as contained in the InputData worksheet), a dialog box indicating it is finished will appear. Click **OK**. However, if the tool encounters inconsistent data entries, it will report the number and nature of these inconsistencies, as well as how these have been highlighted in the InputData worksheet. Locate the inconsistent data entries in the source data worksheet and correct these, and then run the Updating Single Variables for the corrected variable(s), and re-run the data validation tool again to ensure that all errors have been corrected.

9.4. Loading and Adjusting Intended Purpose Values

This option was not used in this analysis.

The tool allows user to adjust the values assigned to the set of Intended Purpose codes. These are the values used in the analysis to determine the biodiversity priority indices. The tool creates a new worksheet which shows the values being used.

On the Assess Biodiversity Priority Menu, click on the 'Load/Adjust Intended Purpose Values' option.
- The 'Verify or Adjust Intended Purpose Values' dialog box will open.
- To select the indicated default values simply click **OK**.
- If other values are required for one or more of the Intended Purpose codes then simply enter the new value into the relevant input box, and click **OK**.

- The tool creates a new worksheet called **IntendedPurpose** which gives the Intended Purpose values selected. This worksheet is locked and must not be edited.

The Intended Purpose values can be updated at any time, but if updated all the analyses and derivations of summary results which have been completed will need to be re-run. The tool will provide a reminder of this every time the Intended Purpose Values are updated.

9.5. Loading and Adjusting Variable Weightings

The tool allows user to adjust the weights assigned to the set of variables used in the determination of the biodiversity priority scores. These weightings are used to adjust the scores provided in the input data for each variable (PU value x weighting). The tool creates a new worksheet which shows the weight values being used.

The tool allows user to adjust the weights assigned to the set of variables used in the determination of the biodiversity priority scores (Table 4). These weightings are used to adjust the scores provided in the input data for each variable (PU value x weighting). The tool creates a new worksheet which shows the weight values being used.

> *IMPORTANT NOTE:*
> *In this analysis, the weightings were calculated using a Pairwise Comparison statistic where each variable was rated against all the others using the following categories:*
>
> *1   Equally important*
> *2   Slightly more important*
>   *Moderately more*
> *3   important*
> *4   Much more important*
>
> *The calculation is included in the spreadsheets attached. In the case of Analysis_B, which used the intrinsic biodiversity score from Analysis_A as a variable, the weighting was set to 1, which essentially keeps the weightings of the variables used in Analysis_A.*

On the Assess Biodiversity Priority Menu, click on the 'Load/Adjust Variable Weightings' option. The 'Verify or Adjust Variable Weightings' dialog box will open. To select the indicated default values simply click **OK**. If other values are required for one or more of the variable weights then simply enter the new value into the relevant input box, and click **OK**. The tool creates a new worksheet called **Weights** which gives the Variable Weight values. This worksheet is locked and must not be edited. The Weight values can be updated at any time, but if updated all the analyses and derivations of summary results which have been completed will need to be re-run. The tool will provide a reminder of this every time the Weight Values are updated.

9.6. Loading and Adjusting Relative Priority Classification Ranges

The tool can classify the polygons based on their relative importance within the landholding being analysed. For example, it can identify those polygons that fall into the top 10% of the analysis. It is important to note that this classification is relative to the polygons in the analysis and is of less importance than the intrinsic biodiversity value. The model calculates this value by taking the polygon's intrinsic biodiversity value as a percentage of the maximum biodiversity score for all polygons in the analysis.

The user can adjust the value ranges for the priority classes. These are the percentage ranges used to assign each record into one of four priority classes (Very High, High, Moderate, Low). The tool creates a new worksheet which shows the Relative Priority Ranges being used. On the Assess Biodiversity Priority Menu, click on the 'Load/Adjust Priority Class Values Ranges' option. The 'Verify or Adjust Priority Class Ranges' dialog box will open.

To select the default ranges simply click **OK**. If other values are required, enter the new values into the relevant input boxes, and click **OK**. If the entered ranges are valid, the tool will creates a new worksheet called **PriorityClasses** which gives the class ranges selected. This worksheet is locked and must not be edited.
However, if the one or more of the range values are invalid (e.g., outside of the 0-100 range, or ranges overlap) the tool will return an error message indicating the reason for the ranges being invalid and highlight the offending value/s.

The default values were used in this analysis (
Table 5).

Table 5. The relative priority classification used in the analysis

Relative Priority Class	Range of percentage scores
Very High	80-100
High	60-80
Moderate	40-60
Low	<40

The Priority Class ranges values can be updated at any time, but if updated all the analyses and derivations of summary results which have been completed will need to be re-run. The tool will provide a reminder of this every time the Priority Classification Ranges Values are updated.

9.7. Assessing Biodiversity Priority Status

The tool allows for the analysis to be conducted at two spatial levels. The difference only applies to the relative priority score classification, and does not affect the Intrinsic Biodiversity Scores.
- The **Full Land Holding Level** assesses the biodiversity priority status of each open area relative to **all** open areas in the analysis.
- The **Internal Land Portion Level** assesses the biodiversity priority status within a particular grouping of PUs (using the Range Name to indicate different groupings; in this analysis the quaternary catchments were used). The scale here is irrelevant, and any internal classification can be used.

It is important to note that the intrinsic biodiversity score will not be different between these two levels of analysis; only the priority classification will change. This function produces a new worksheet which gives the various biodiversity priority indices for each record, as well as assigning each into one of the four priority classes.

Full Land Holding Level
On the Assess Biodiversity Priority Menu, select 'Assess Biodiversity Priority' and click on the 'Full Land Holding Level Analysis' option. The tool will then present a check dialog asking whether key inputs for the analysis have been completed. If these have been done, click **Yes**. If not, click **No** and then undertake the relevant functions to complete the required inputs before continuing. Once the analysis is complete the tool will popup a message box indicating that if summary analyses have been undertaken on the data previously these will need to be re-run to ensure that the summary results are correct. Click **OK** to remove the dialog box. The tool presents the analysis results in a worksheet called **FullHoldingAnalysis**. This worksheet is locked and must not be edited.

Internal Land Portion Level
On the Assess Biodiversity Priority Menu, select Assess Biodiversity Priority and click on the Internal Land Portion Level Analysis option. The tool will then present the dialog popup asking whether key inputs for the analysis have

been completed. If these have been done, click **Yes**. If not, click **No** and then undertake the relevant functions to complete the required inputs before continuing. Once the analysis is complete the tool will present a message box indicating that if summary analyses have been undertaken on the data previously these will need to be re-run to ensure that the summary results are correct. Click **OK** to remove the dialog box. The tool presents the analysis results in a worksheet called **InternalHoldingAnalysis**. This worksheet is locked and must not be edited.

9.8. Generating Summary Results

The tool allows for the generation of summary results for analyses conducted at both the Full Holding and Internal Land Portion levels. This function provides a set of summary indices of the priority indices, as well as a chart showing the distribution of priority values. For the Internal Land Portions, the tool allows users to select the particular Land Portion for which summary results are required. This function produces a summary worksheet.

Full Land Holding Level

On the Assess Biodiversity Priority Menu, select 'Generate Summary Results' and click on the 'Full Land Holding Level Summary' option. The tool will then present a check dialog asking whether the Full Holding Level Analysis has been run. The generation of the summary results requires that this has been done. If the analysis has been done, click **Yes**. If not, click **No** and then undertake the Full Land Holding Level Analysis before continuing. Once the summary analysis is complete the tool will present a message box indicating that the analysis is complete. Click **OK** to remove the dialog box. The tool presents the summary results in a worksheet called **FullHoldingSummary**. This worksheet is locked and must not be edited.

Internal Land Portion Level

On the Assess Biodiversity Priority Menu, select Generate Summary Results and click on the Internal Land Portion Level Summary option. The tool will then present a check dialog asking whether the Internal Land Portion Level Analysis has been run. The generation of the summary results requires that this has been done. If the analysis has been done, click **Yes**. If not, click **No** and then undertake the Internal Land Portion Level Analysis before continuing.

The tool then presents a dialog box allowing the user to select the Internal Land Portion for which summary results are required. Select the required Internal Land Portion name and Click **OK**. Once the summary analysis is complete the tool will present a message box indicating that the analysis is complete. Click **OK** to remove the dialog box. The tool presents the summary results in a worksheet called with the name of the selected Internal Land Portion as the prefix followed by the word **Summary**. This worksheet is locked and must not be edited.

Important Note:
The areas reported in the Summary Reports are in the units of the loaded Original Polygon Area data.
Exporting Results from Excel and Importing back to GIS

9.9. Export the results for use in GIS

The tool allows for the analysis results to be exported into CSV format for importing into GIS software, thus allowing for the results to be viewed spatially. The tool allows for both the Full Land Holding and Internal Land Portion Level analysis results to be exported.

Full Land Holding Level

On the Assess Biodiversity Priority Menu, select 'Export Assessment Results' and click on the 'Export Full Land Holding Level' Results option. Use the **Export Full Holding Analysis Results** dialog box to indicate the output file name and the folder where the file must be saved. If no name is given, the tool will save the results in a file called FullHolding Results.csv. The tool will then present a dialog box asking whether the user wants to view the exported file before continuing. Clicking on **Yes** will open the exported file.

Internal Land Portion Level

On the Assess Biodiversity Priority Menu, select 'Export Assessment Results' and click on the Export Internal Holding Analysis Results dialog box to indicate the output file name and the folder where the file must be saved. If no name is given, the tool will save the results in a file called InternalHolding Results.csv. The tool will then present a dialog box asking whether the user wants to view the exported file before continuing. Clicking on **Yes** will open the exported file in Excel.

9.10. Incorporating the results back into GIS

Any of the export files generated from the Excel analysis above can be linked back to the original data files used in the GIS based on the *UniqueID* field. The attribute table of the PU_data shp file should be opened and the following fields added (Table 6) and populated by joining the export csv file to it using *UniqueID* as the join field. Use the field calculator to set these new fields equal to the equivalent in the csv table. Remove the join when finished.

Table 6 Results fields to be added to the OAW table.

Field	Data
IBS_Score	The Intrinsic Biodiversity Score calculated by Excel, ignoring any weed infestation.
IBS_Status	The category of importance based on the cut-offs set in the Excel model. These categories reflect the RELATIVE importance of one polygon against the others as a percentage of the maximum IBS_Score.
ABS_Score	This is the IBS_Score multiplied by the Weed score (0-1 scale) to give an Adjusted Biodiversity Score (ABS).
ABS_Status	The category of importance based on the cut-offs set in the Excel model. These categories reflect the RELATIVE importance of one polygon against the others as a percentage of the maximum ABS_Score.

9.11. Visualising the results

The results are best represented by using a graduated colour symbology on the Intrinsic Biodiversity Score (IBS) field using a Jenk's Natural Breaks classification (the default in ArcGIS). **The IBS results are best used if there is low confidence in the completeness and reliability of the weed data.** The Adjusted Biodiversity Score (ABS) is better if the weed data are current and accurate. Use a graduated colour symbology classification that relates to the relative priority classification cutoffs from the Excel model.

The difference between the score and status is that the score is the calculated value that results from the analysis (and is thus comparable with any other prior analysis that used the same variable weightings) while the status shows the importance of each polygon **relative** to the other polygons (calculated as a percentage of the maximum score of that particular analysis run).

Important Note
Please ensure you understand the difference between the IBS and ABS results, and the use of the score versus the relative status, as the visual picture can be quite different.

10. Desktop Results

10.1. Land cover assessment

The desktop land cover assessment (Figure 15) showed that approximately 44.5 % of the landscape assessment is transformed by peri-urban / arable, severe erosion or alien tree infestations (assessment. Table). The remaining 55.5% is considered relatively intact, although much of this is exposed to heavy grazing and incorrect fire management and would have lost elements of its biodiversity. Most of the transformed land is centred around the urban areas and concentrated in the valley floors and lowlands. As expected, the high-lying areas remain relatively intact due to access and other development constraints.
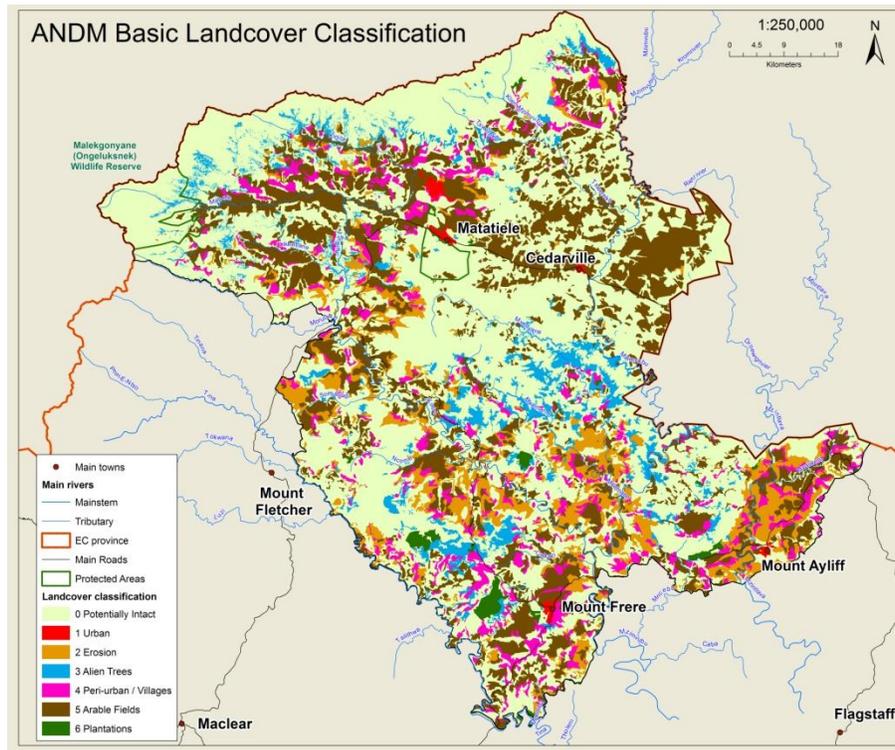

Figure 15. The Land cover classification map for ANDM

Table 7. Area summary per category resulting from the desktop Land cover assessment.

Class	Name	Area (ha)	% of ANDM
0	Potentially Intact	380,539	55.5
1	Urban	2,594	0.4
2	Severe erosion	60,023	8.8
3	Invasive alien trees	37,636	5.5
4	Peri-Urban / Rural Village	46,618	6.8
5	Arable fields	152,562	22.3
6	Plantations	5,430	0.8
	TOTAL	685,402	100.00

These spatial data are provided in the **Analysis_results** folder of the DVD:
- *ANDM_Landcover_tm29.shp*

10.2. Excel biodiversity prioritisation analysis

The completed Excel analysis (.xlsx) and the exported results (.csv) are provided in the **Analysis_Results** folder:

- *ANDM Biodiversity Prioritisation Analysis.xlsx*
- *Excel analysis results for GIS.csv*

Over the six scenarios, there was not a lot of difference in the summary statistics of the Intrinsic Biodiversity Scores (**Error! Reference source not found.**). This suggests that the model and data are not very sensitive to the cenarios. The exception may be scenario 2, which had the highest maximum, average and median scores of all the scenarios. Importantly, the median score is considerably lower than the maximum score, indicating that the majority of the PUs have relatively low biodiversity importance, and a few are highly important. Such a spread of results makes it easy to identify priority areas.

Table 8. The summary results of the desktop assessment per priority category

Relative Priority Class	PU Count	Area	% of Total Area
Very High	9	441	0.06
High	211	10,334	1.51
Moderate	808	38,950	5.68
Low	13,522	636,165	92.75
Totals	**14,550**	**685,891**	**100**

9.3 GIS interpretation of the analysis results

Presenting the results in GIS allows the user to identify areas that stand out as sensitive from a biodiversity perspective (Figure 16). At a regional-scale, the results are useful for developing a proactive planning approach for plantation development by ANDM. However, due to small size of the planning units (49 ha), it is possible to zoom into an area using GIS tools for more detail assessment for proactive planning purposes or to evaluate a development application at a desktop level to decide what level of field work will be required for a decision. Because the attribute table of the analysis results contains all the under-lying biodiversity data, it is possible to generate summary results of the biodiversity features within a polygon, or at a point. This can either be done using the Information button, or using the Summarise feature of the attribute table.

The analysis can be also used to highlight areas that are considered important for forestry potential, but that have been prioritised for biodiversity value, i.e. the areas of potential conflict (**Error! Reference source not found.**). This ort of overlay is useful for regional development planning as it allows development to be planned in areas that are unlikely to conflict with biodiversity priorities.
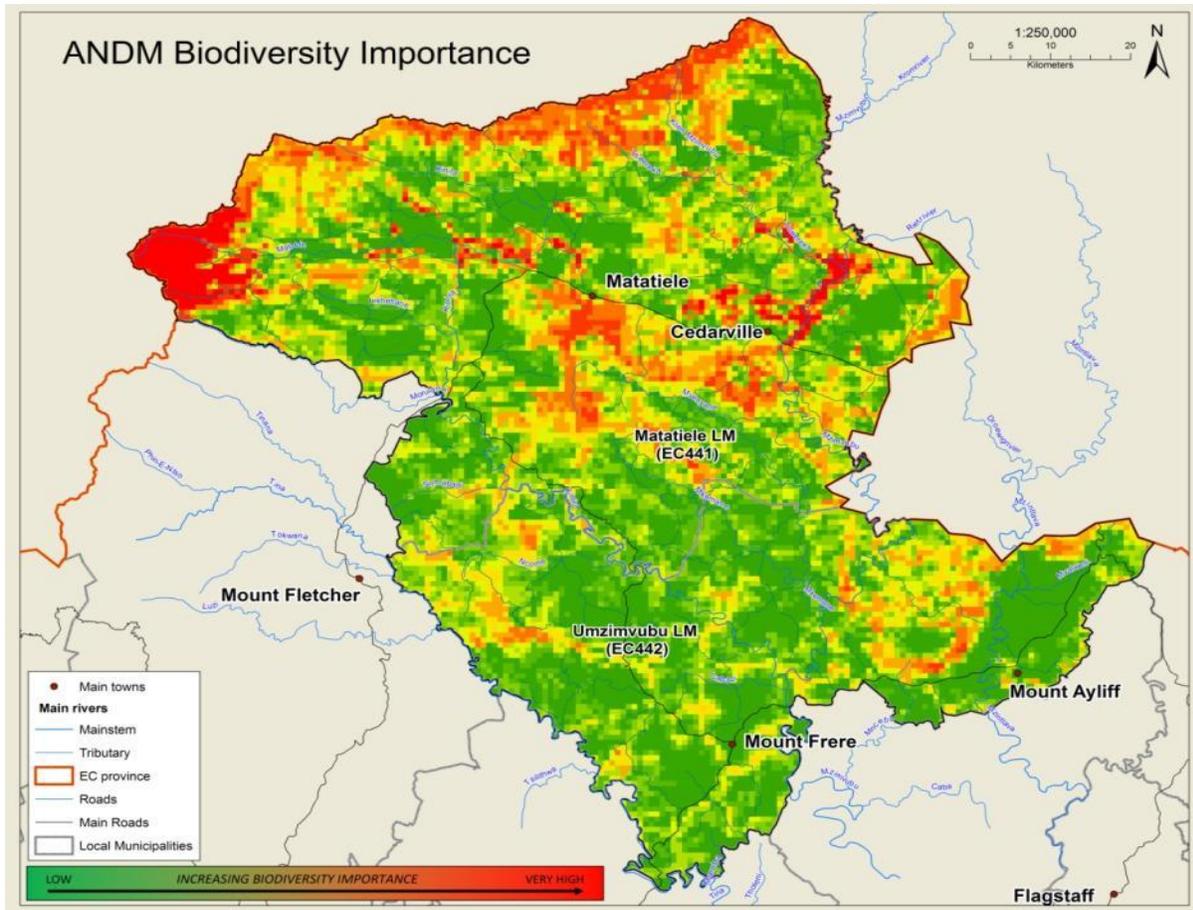
Figure 16. Biodiversity Importance map produced from the analysis.

11. Conclusions

This desktop biodiversity assessment for pre-screening land under consideration for plantation forestry development has proved to be a useful exercise. The resulting GIS database of biodiversity priorities allows for development planners to proactively avoid areas that are likely to have a high biodiversity priority, which could lead to complications during the EIA stage of the application process. Furthermore, the GIS tools will assist decision-makers in their evaluation of plantation applications.

The analysis has limitations, being based on desktop data and aerial photographs. Much of the underlying data derived from the EC Biodiversity Plan are at a relatively coarse scale and are not suited at all to detailed planning. The use of aerial photographs to moderate the assessment results provides a significant improvement on this data, but not without limitations. The interpretation of aerial photography is not able to determine range degradation associated with over-grazing, and can present a falsely optimistic picture of what is left.

These limitations, relevant of any desktop assessment, require that at rapid ecological integrity assessment field assessment be done to confirm the results of desktop proactive planning or decision-making using this tool.

12. References

Berliner D. & Desmet P. (2007) Eastern Cape Biodiversity Conservation Plan: Technical Report. Department of Water Affairs and Forestry Project No 2005-012, Pretoria. 1 August 2007.

Lechmere-Oertel, R.G. & Benn, G.B. (2008). Biodiversity prioritisation for unplanted lands in the forestry sector. Unpublished model, SANBI Grasslands Programme.