ENVIRONMENTAL MANAGEMENT FRAMEWORK

WETLAND SPECIALIST REPORT

ENVIRONMENTAL MANAGEMENT FRAMEWORK FOR THE UMGUNGUNDLOVU DISTRICT MUNICIPALITY

Institute of
Natural Resources

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1. INTRODUCTION

Accurately mapping wetlands is critical for wetland conservation and management. Equally, understanding where wetlands occur, or are like to occur, and their extent is important for guiding sustainable development. Therefore, a thorough investigation into the occurrence and extent of wetlands throughout the UMDM was undertaken to inform the EMF.

Particular focus was given to the mapping of wetlands throughout the KFAs. The process within the KFAs involved a desktop analysis of the current wetland inventory, digitizing of wetlands, limited ground truthing and the refinement and compilation of a final wetland layer. These steps are explained in detail below.

The mapping of wetlands throughout the remaining areas of the UMDM was based on three input layers:
- The wetland probability layer for KZN (Hiestermann and Rivers-Moore, 2014);
- The provincial wetland layer; and
- A digitized wetland layer (digitized wetland features along the boundary of the KFAs).

These layers provided the baseline for a refinement process, i.e. data cleaning process, that lead to the development of a refined wetland layer for the UMDM. These steps are explained in detail below.

The different methods adopted for the KFAs and the remaining areas of the UMDM resulted in varying levels of accuracy. The digitizing of wetlands provided the greatest level of accuracy in comparison to the use of the probability wetland layer and the existing provincial wetland layer. Therefore, the data should be used with the understanding that there is a variation in terms of mapping accuracy. Regardless of the method used, detailed infield wetland assessments will be required to confirm the occurrence and extent of wetlands for developments within the respective sensitivity zones in the UMDM.

2. APPROACH TO MAPPING WETLANDS FOR THE EMF

Step 1: Desktop analysis

The initial stages of the project required the acquisition, compilation and analysis of current information. The wetland probability layer and the provincial wetland layer informed this stage. The wetland probability layer for KZN was developed by Hiestermann and Rivers-Moore (2014) which utilizes remote sensing (20m resolution) and a predictive model to accurately map wetlands at a regional level. Topological and climatic variables were used in the model to predict wetlands. The accuracy threshold was tested to determine the most suitable value for this particular study. A threshold of 77 % was selected, having a predictive accuracy of 62 % for occurrence and 65 % for extent of wetlands. It was found that this layer has the tendency to overestimate wetland features whilst, the provincial wetland layer underestimates wetlands substantially. Wetlands within the KFAs were clipped out of each layer using the erase tool in the Arc Tool box. To improve the accuracy of wetland mapping in the KFAs, it was decided that these wetlands would be digitized (i.e. desktop mapping of wetlands using best available remote sensing imagery). The desktop determination of wetland occurrence and extent took into consideration the approach used in Mbona et al. (2015). In

addition, recent or ongoing wetland mapping initiatives by WWF, CSIR and SANBI were used to guide the desktop mapping of portions of wetlands within some of the KFAs, which included:

- Moor River – Spring Grove KFA (WWF); and
- Howick – Midmar, Camperdown – Baynesfield, Richmond – Indaleni, and Newhanover – Wartburg KFA (Dr Richard Lechmere-Oertel / SANBI).

The final wetland layer therefore comprised of a combination of these three layers.

Step 2: Digitizing wetlands

Google Earth Imagery and recent Local Municipality remote sensing imagery was used as the basis of the wetland mapping component of this study. The time-slider function in Google Earth was used. This was especially useful to highlight portions of the landscape (specifically wetlands) that have been transformed by agriculture and forestry. The KFA boundary layer was added to refine the mapping process. Wetlands were digitized (polygon tool) based on the 5m contour data (where available), vector rives layers from the relevant 1:50 000 topo-sheets and a visible inspection of wetland features such as vegetation and slope (based on wetland type). This layer was exported into ArcGIS 10.4 and analysed in conjunction with the wetland inventory that consists of provincial and modelled / probability layer.

Step 3: Field verification

Limited infield verification was undertaken. Only sections of the digitized layer of wetlands within some of the KFAs were verified infield by a wetland specialist. This process helped eliminate incorrectly digitized wetlands and corrected any extent errors that may have been mapped within the areas visited. Ground truthing was an important phase of the study as it also informed wetland impact and condition. On the field visit, data such as wetland impacts (clearing of vegetation, drains, pollution, sewage discharge, grazing, agriculture, etc.), existing buffers, drainage lines and wetland type were also taken into consideration. This information fed into the wetland condition assessment (Step 5). The limited infield verification restricted the accuracy of the mapping of wetlands across the KFAs.

Step 4: Final wetland layer

Field data informed the wetland refinement process, by realigning wetland boundaries and in some instances removing or including new features. The digitized wetland layer for the KFAs now required to be merged with the provincial and probability layers. In order to do so all layers needed to be in the file type (vector). Therefore, the only raster layer, the probability layer, was reclassified using the reclassify tool in Spatial Analyst, into two classes as seen in the table below.

Table 1: Reclassification criteria

Classification	Class
0 - 76 %	No Data
77 - 100 %	Wetland

Thereafter, the layer was converted into vector format using the Conversion tool in Arc Tool box. To avoid the creation of many small polygons the initial raster layer was 'buffered' by 0.5m to allow for a more integrated wetland layer. Multi part polygons where then exploded and all polygon's smaller

than 500m^2 were eliminated. In addition, converting a layer from raster to vector has the disadvantage of creating polygons with a large number of points. These points needed to be reduced to limit the size of the wetland layer. Points were reduced to 10m apart, which still allowed for a smooth edge effect. Another disadvantage was the creation of doughnut holes, which are considered as "parts of polygons" within the polygons of the new layer (see Figure 1). These needed to be filled using the Eliminate polygon part tool under the Data Management tab in Arc Tool box. The condition of elimination (of contained parts only) is set to an Area of 15 000 000m^2 which was necessary to fill a maximum number of holes.
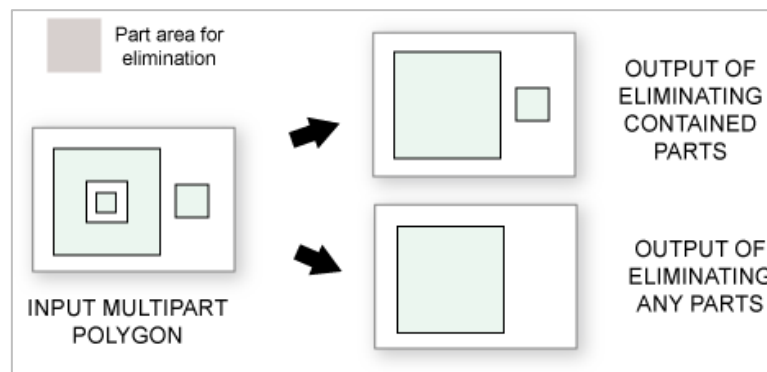

Figure 1: Elimination of part polygons (http://desktop.arcgis.com/en/arcmap/10.3/tools/data-management-toolbox/eliminate-polygon-part.htm)

An analysis of the vector layer highlighted roughly 59 000 wetlands, of which not all were accurate representations, making it difficult to manage. This needed to be cleaned / "thinned out" into a more accurate format, which could be achieved by eliminating random / outliers. This was done in four different ways namely: by majority filter, river buffer, land use and the exclusion of the Msunduzi municipality which already has an EMF.

Majority filter

The layer was converted back into raster format (setting the environment to the original extent - snap raster) and using the Majority Filter tool in Spatial Analyst which replaces cells based on the majority of their contiguous neighbouring cells. In this case the kernel of the filter was set to 8 of the nearest neighbouring cells. This tool was run twice, reducing wetland features to less than 28 000, after vectorization.

River Buffer

The most common wetland types found in the UMDM, based on topology are valley bottom systems. This concept motivated the next step of 'thinning' out the data, assuming that the majority of wetlands found in the area would occur along drainage lines. The 1: 50 000 river topo-sheet was clipped to the UMDM boundary and buffered by a 30m zone. All wetlands that intersected the river buffer were selected (Select by Location), and reserved to the final layer. Of the wetlands that weren't selected (inverse selection), those comprising of less than 1800m^2 (equivalent to 4 pixels) were deleted and the balance added to the final layer. This reduced the total to 23 000 features.

Land Use (Sugarcane and Commercial Forestry)

Analysing the current layer in conjunction with the regional land use layer (EKZNW) highlighted wetlands that were likely to occur throughout sugarcane fields and commercial forestry plantations

(see Figure 2). The primary aim of mapping wetlands for the EMF was to identify functional intact wetlands throughout the UMDM. Thus, where wetlands were likely to occur within sugarcane fields and commercial forestry plantations it was decided to exclude these areas as they were unlikely to be functional systems, from a habitat perspective, given the extent of disturbance resulting from the planting of sugarcane and timber. It was decided to eliminate wetland features less than 1800m^2, that occur completely within these land use types (Select by Location) as well as features that occur completely within the land use types and do not intersect the river buffer. This eliminated 540 wetlands.
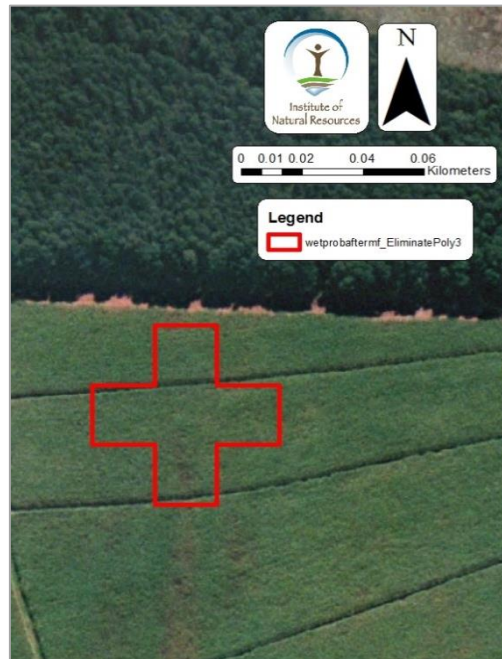

Figure 2: Predicted wetland on cultivated sugarcane

Msunduzi District Boundary

The final means of elimination occurred by referring to the terms of reference which excludes all wetlands in the Msunduzi District. The last step in finalizing a wetland layer for UMDM was to merge the provincial, probability and digitized layer using the Union tool in Geoprocessing tab. The total number of wetlands for the UMDM was approximately 25000.

Step 5: Condition assessment

In addition to providing a useable wetland layer for the UMDM a condition assessment for wetlands within the KFAs was also conducted to provide a baseline for wetland condition. This data was added to the attribute table of the final wetland layer. The methodology to assess wetland ecological condition based on land-cover type (Kotze, 2016) was applied. The method was adapted to allow for the assessment of ecological condition of wetlands based on identifying land-cover types in the wetlands and a 200m 'zone of influence', and inferring impacts from the particular land-cover types present.

Wetland condition was determined using the Excel tool developed by Kotze (2016). It determines the impacts to the different land uses (represented by a percentage of the total area) within a wetland by assigning them an overall impact score and combines it with a score developed in the

same manner for the catchment upslope of the wetland. Land use percentages were extracted per wetland using a script developed in model builder, combining the tabulate area and iterate tools. The total magnitude of the score is adjusted based on the presence and condition within the zone of influence. The combined overall magnitude score related to a Present Ecological State (PES) (see Table 2 for categories and descriptions). The method requires a level of ground truthing of all wetlands assessed. However, only limited infield data relating to impact to wetlands in some of the KFAs was available for consideration (Note: only partial infield data was collected during the ground truthing exercise in Step 3).

Table 2: Overall impact score categories and corresponding Present Ecological State (PES) categories (modified from MacFarlane et al., 2008).

Overall impact score range	Impact category	Description	PES category
0-0.9	None	No discernible modification or the modification is such that it has no impact on wetland integrity.	A
1-1.9	Small	Although identifiable, the impact of this modification on wetland integrity is small.	B
2-3.9	Moderate	The impact of this modification on wetland integrity is clearly identifiable, but limited.	C
4-5.9	Large	The modification has a clearly detrimental impact on wetland integrity. Approximately 50% of wetland integrity has been lost.	D
6-7.9	Serious	The modification has a clearly adverse effect on this component of habitat integrity. Well in excess of 50% of the wetland integrity has been lost.	E
8.0-10	Critical	The modification is present in such a way that the ecosystem processes of this component of wetland health are totally / almost totally destroyed.	F

3. ASSUMPTIONS AND LIMITATIONS

- The refining / cleaning of the probability wetland layer was required largely to reduce the size of the wetland layer to make it 'useable' for the development of the EMF.
- The digitizing of wetlands was to a large degree a subjective process (i.e. interpreting features throughout the landscape).
- While the wetland layer digitized for the KFAs allowed for an improved understanding of the occurrence and extent of wetlands, an infield wetland delineation must still be undertaken by an accredited wetland specialist for all proposed developments within the regulated area (i.e. 500m from the edge of a wetland).
- The wetland layer generated for the remaining areas of the UMDM (i.e. outside of the KFAs), has a lower level of accuracy in comparison to the digitized layer. Interrogation of the wetland layer in these areas must be used with caution. The layer is a good guide for informing sustainable development. However, it is essential that further investigation be carried out to verify the occurrence and extent of wetlands. This could be in the form of digitization of wetlands, where large areas require verification. Current and future wetland mapping assessments throughout the UMDM could be used to improve portions of this wetland map. Ultimately infield assessments to verify wetland extent, i.e. wetland delineations, must be undertaken by a suitably qualified and experienced wetland specialist.
- The condition scores provided for the wetlands within the KFAs where determined primarily at a desktop level. The method developed by Kotze (2016) highlights the need for infield verification. Therefore, the condition scores should be used with caution. These scores provide an indication of the likely condition. Infield assessments of condition will need to be undertaken for all developments within the regulated area around wetlands.

4. REFERENCES

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