

# Development of an Environmental Pre-Feasibility Assessment Tool for Wind Project Development in South Africa



**MSc Thesis**

**Roel van Ooij**

**4203321**

**Supervisors:**

**Prof. Dr. Martin Wassen**

**Sebastian Hirschmann**

**Utrecht University**

**Energy Science**

**GEO4-2510**

**October 2016**

## 1 Abstract

Large-scale development of wind energy in South Africa requires an Environmental Impact Assessment (EIA) for environmental authorisation by the government. An EIA is one of the last steps in the development process before realization and can have a big impact on a project. For this reason G7 Renewable Energies developed the Environmental Pre-feasibility Assessment Tool (EPAT) with the goal to resemble the outcome of a South African EIA in an early stage of wind project development. This study aims to extend EPAT with the categories Birds and Ecology, both important subjects in EIA processes. The tool is partly based on a Geographical Information System Tool (GIST) for detailed barriers and project layouts. South African avifaunal and ecological spatial data is collected and implemented in this part of EPAT. To complete EPAT, the Microsoft Excel based Detailed Site Evaluation Tool (DSET) is designed for the impact assessment of different impact categories via impact features. Legislation and guidelines applied in EIA reports were the basis for the design of impact features in DSET. The bird category is strong in observations of bird species vulnerable for wind energy development. Ecology shows a strong point in indicating drainage lines as sensitive areas despite the limited data available. Comparison of EPAT with existing EIA reports of five proposed South African wind energy development projects points out that EPAT categories Birds and Ecology are reliable in resembling EIA reports. Even though the results are good, it is recommended to apply EPAT only in combination with a site visit by an expert to check and compare the outcomes with the on-site situation as an independent validation. The quality of EPAT would benefit with the availability of more avifaunal and ecological data. With the extension of the categories Birds and Ecology EPAT becomes a complete tool covering all major subjects considered in EIAs that assists in strategic decisions on prioritizing wind energy projects.

## 2 Foreword

The MSc thesis in front of you concludes my Master Energy Science at Utrecht University. The research was conducted for the South African company G7 Renewable Energies (Pty) Ltd, based in Cape Town. I would like to thank Christi, Jyoti, Karen, Kilian, Kyle, Methuli and Nicolas of the G7 team. Their great team spirit, exciting foosball and great soccer games contributed to an unforgettable experience in Cape Town. A special thanks to my supervisor Sebastian who was always there to assist in finding solutions for the issues that showed up during the research. I also want to thank my university supervisor Martin Wassen for his flexible attitude, he was able to give very constructive feedback despite the large physical distance.

### 3 List of Abbreviations

ADU	-	Animal Demography Unit
CAR	-	Coordinated Avifaunal Roadcount
CBA	-	Critical Biodiversity Area
CR	-	Critically Endangered
DAFF	-	Department of Agriculture, Forestry and Fisheries
DEA	-	Department of Environmental Affairs
DSET	-	Detailed Site Evaluation Tool
DWS	-	Department of Water and Sanitation
EAP	-	Environmental Assessment Practitioner
EIA	-	Environmental Impact Assessment
EN	-	Endangered
EPAT	-	Environmental Pre-feasibility Assessment Tool
EWT	-	Endangered Wildlife Trust
GHG	-	Greenhouse Gas
GIST	-	Geographical Information System Tool
IAIAsa	-	International Association for Impact Assessments South Africa
IBA	-	Important Bird Area
KZN	-	Kwazulu Natal
LC	-	Least Concern
NEMA	-	National Environmental Management Act
NEMBA	-	National Environmental Management: Biodiversity Act
NEMPAA	-	National Environmental Management: Protected Areas Act
NFA	-	National Forest Act
NFEPA	-	National Freshwater Ecosystem Project Area
NPAES	-	National Protected Areas Expansion Strategy
NT	-	Near Threatened
PPA	-	Power Purchase Agreement
PV	-	Solar photovoltaics
QDGC	-	Quarter Degree Grid Cell
QGIS	-	Quantum Geographical Information System
REIPPPP	-	Renewable Energy Independent Power Producer Procurement Program
SABAP2	-	South African Bird Atlas Project 2
SAFAP	-	South African Frog Atlas Project
SANBI	-	South African National Biodiversity Institute
SARCA	-	South African Reptile Conservation Assessment
SEA	-	Strategic Environmental Assessment
VU	-	Vulnerable
WEF	-	Wind Energy Facility
WULA	-	Water Use License Application

## 4 Table of Contents

<b>1</b>	<b>Abstract</b> .....	<b>III</b>
<b>2</b>	<b>Foreword</b> .....	<b>IV</b>
<b>3</b>	<b>List of Abbreviations</b> .....	<b>V</b>
<b>5</b>	<b>Introduction</b> .....	<b>1</b>
<b>5.1</b>	<b>Background and Problem Definition</b> .....	<b>1</b>
<b>5.2</b>	<b>Environmental Pre-feasibility Assessment Tool</b> .....	<b>1</b>
5.2.1	Birds .....	2
5.2.2	Ecology .....	3
<b>5.3</b>	<b>Research Questions</b> .....	<b>3</b>
<b>6</b>	<b>Methodology</b> .....	<b>5</b>
<b>6.1</b>	<b>Background</b> .....	<b>5</b>
<b>6.2</b>	<b>Design</b> .....	<b>6</b>
6.2.1	Birds .....	7
6.2.1.1	Important Bird Areas.....	7
6.2.1.2	South African Bird Atlas Project 2 .....	8
6.2.1.3	Rivers and wetlands .....	9
6.2.1.4	Dams .....	10
6.2.1.5	Coordinated Avifaunal Roadcount .....	10
6.2.1.6	Endangered Wildlife Trust Crane Data.....	12
6.2.1.7	Cliff tool.....	13
6.2.1.8	Bearded Vulture Risk Map .....	14
6.2.2	Ecology .....	14
6.2.2.1	Vegetation.....	15
6.2.2.2	National Protected Areas Expansion Strategy .....	15
6.2.2.3	Kwazulu Natal macro ecological corridors .....	16
6.2.2.4	Critical Biodiversity Areas .....	16
6.2.2.5	Drainage lines.....	16
6.2.2.6	Frog data in NFEPA wetland dataset.....	17
6.2.2.7	FrogMAP.....	17
6.2.2.8	ReptileMAP .....	18
6.2.2.9	MammalMAP .....	18
6.2.2.10	Landscape .....	18
<b>6.3</b>	<b>Organisation and implementation</b> .....	<b>19</b>
<b>6.4</b>	<b>Validation</b> .....	<b>20</b>
<b>7</b>	<b>Results</b> .....	<b>21</b>
<b>7.1</b>	<b>Legislation</b> .....	<b>21</b>
<b>7.2</b>	<b>EPAT</b> .....	<b>21</b>
<b>7.3</b>	<b>Validation</b> .....	<b>23</b>
7.3.1	Birds .....	23
7.3.1.1	Dwarsrug wind farm.....	23
7.3.1.2	Zen WEF.....	24
7.3.1.3	Happy Valley WEF .....	26
7.3.1.4	Noupoort wind farm .....	27

7.3.1.5	Richards Bay wind farm.....	29
7.3.2	Ecology .....	30
7.3.2.1	Dwarsrug wind farm.....	30
7.3.2.2	Zen WEF .....	32
7.3.2.3	Happy Valley WEF .....	33
7.3.2.4	Noupoort Wind Farm .....	34
7.3.2.5	Richards Bay wind farm.....	36
<b>8</b>	<b>Discussion.....</b>	<b>38</b>
<b>9</b>	<b>Conclusion .....</b>	<b>40</b>
<b>10</b>	<b>References.....</b>	<b>41</b>
<b>11</b>	<b>Appendices.....</b>	<b>45</b>
11.1	Appendix A .....	45
11.2	Appendix B .....	47
11.3	Appendix C .....	48
11.4	Appendix D .....	69

## 5 Introduction

### 5.1 Background and Problem Definition

The global climate agreement of Paris in 2015 was a clear signal on ambitions to reduce emissions of greenhouse gases (GHGs). This creates opportunities for renewable energy developers to expand their activities. Renewable energy had a 13.2% share in the global energy mix in 2012, regarding limiting global warming by 2°C this share should increase by a factor 3.5 towards 2040 (IEA, 2016). Renewable energy is an effective solution to cut GHG emissions but this is not the only reason for countries to invest in renewable energy. Diversifying the energy mix reduces dependency on fossil fuel (import), thereby increasing energy security. On top of that it can fulfil a rising energy demand. Currently 145 countries have adopted policies to support renewable energy of which South Africa is one (REN21, 2015). South Africa has one of the most promising renewable energy potentials in Africa, especially wind and solar energy are considered scalable resources (Krupa & Burch, 2011).

The South African Department of Energy introduced the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) in 2011 to secure sustainable energy production and sustainable development (Greencape, 2016). The program consists of a competitive bidding process in different rounds for varying renewable energy technologies: wind, solar photovoltaics (PV) and concentrated solar power. Project bids are assigned to the most competitive project on price (70%) and economic development (30%) (Greencape, 2016). There are threshold criteria in six areas that a bidder needs to satisfy: environment, land, commercial, legal, economic development and technical. For wind developers this means among others availability of an appropriate site with twelve-month wind measurement data financed at own risk (Eberhard, 2013). The winning project is offered a 20-year Power Purchase Agreement (PPA) with Eskom, the largest electricity utility that owns the national transmission grid (Eberhard, Leigland, & Kolker, 2014). Currently 13 wind farms are fully operational with a total capacity of 953 MW, and 21 wind farms are under construction or planned (Energyblog, 2016; SAWEA, 2015). Through REIPPPP the government aims at adding 13225 MW of renewable energy to the grid in 2025, of which 6390 MW should be wind energy (Greencape, 2016; SAWEA, 2015).

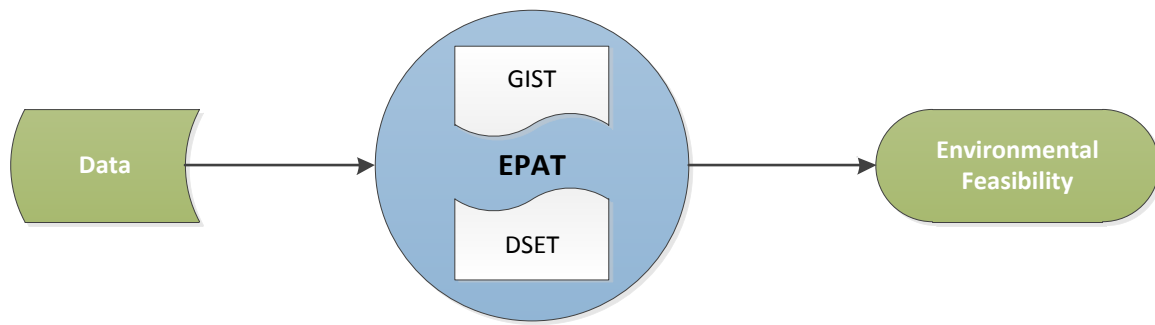
REIPPPP can be considered a success regarding cost curves of the different technologies. Compared to the first bidding round, wind energy prices have dropped with 42% in two-and-a-half year to levels below newly built coal-fired power plants (Eberhard et al., 2014; SAWEA, 2015). One of the threshold criteria mentioned in the previous paragraph is the environmental impact. Before authorisation of a project an Environmental Impact Assessment (EIA) based on the National Environmental Management Act (NEMA) is performed in order to avoid or minimise environmental impact of a project (DEA, 2015). An independent party, an Environmental Assessment Practitioner (EAP), prepares an EIA and when necessary proposes mitigation measures to avoid negative impacts. The Department of Environmental Affairs (DEA) identified eight main categories of potential environmental impacts of wind farms (DEA, 2015): visual impact, land use, impact on biodiversity, electromagnetic interference, air safety, impacts on cultural heritage and habitat fragmentation.

### 5.2 Environmental Pre-feasibility Assessment Tool

An EIA is costly for project developers and can result in unpleasant surprises that might even cancel the whole project. An EIA is usually performed after some time of research and planning that are associated with initial investment costs. G7 Renewable Energies (Pty) Ltd (hereafter referred to as G7) is a South African wind project developer covering all segments of realising a wind farm. The company is developing an in-house Environmental Pre-Feasibility Assessment Tool (EPAT) to identify potential environmental issues in an early stage of project development.

The initial development of EPAT at G7 started by Hirschmann (2012) and was continued by Starmans (2015). The current tool consists of two parts: Geographic Information System Tool (GIST) and Detailed Site Evaluation Tool (DSET), see Figure 1. GIST uses software of Quantum Geographical Information System (QGIS) version 2.14 where spatial data can be inserted that allows detailed lay-outs of environmental barriers and new project sites. DSET builds upon the data of GIST, this Microsoft Excel based part gives the possibility to incorporate scores and weight factors for defined impact categories and impact features. Also mitigation options are indicated in case of a high environmental impact.





*Figure 1 Structure of Environmental Pre-feasibility Assessment Tool (EPAT): Spatial data can be inserted in Geographic Information System Tool (GIST). The assessment in the Detailed Site Evaluation Tool (DSET), using GIST data, results in the environmental feasibility of a project.*

The previous developments of EPAT resulted in the following impact categories that are currently implemented: bats, heritage, hydrology, palaeontology and visual. Next to these categories there are more impact categories envisioned but not yet realised in EPAT: birds, fauna, flora, noise, social and soil and agriculture.

According to G7 the need for the missing categories birds, fauna and flora is the highest in EPAT. birds and other fauna are separated in compliance with the systematics in standard EIA reports because the impact of wind projects on birds is considered a major environmental concern that should be treated separately (Masden & Cook, 2016). EIA reports join the categories flora and fauna into ecology, a category that can have implications especially on micro-siting of wind turbines (CES, 2015; Hoare, 2011). This Master thesis will focus on implementing the two categories Birds and Ecology into EPAT to extend the applicability and impact of the tool. EPAT is a workable desktop tool that combines risks, impacts and mitigation options resulting in the environmental feasibility of a project. The assessment reduces investment risks because it allows prioritizing windfarm projects by providing insight in the environmental impacts in an early stage of project development. More information on EPAT can be found in the study of Starmans (2015).

### 5.2.1 Birds

The negative effect of wind turbines on birds is one of the main environmental concerns regarding wind energy (Masden & Cook, 2016). Effects are highly variable and differ with topography, habitats affected, number of birds and species present (Drewitt & Langston, 2006). Birdlife South Africa (2014) identified a list of 109 priority species in South Africa that can be considered vulnerable for wind energy development. Drewitt and Langston (2006) state three different impacts that wind energy could have on birds.

First, habitat change and losses can occur in development although habitat loss is generally small per turbine. Actual habitat loss is typically between two and five percent of the total development area (Drewitt & Langston, 2006). These effects could be larger when turbines or associated infrastructure interfere with hydrological patterns or flows on peatlands and wetlands. Increased erosion could also affect habitats (Drewitt & Langston, 2006).

As a second negative effect there is displacement, the term used for disturbance that goes further than the actual locations of the turbines and is a concern that could occur during both construction and operational phase. The scale of disturbance varies due to site- and species-specific factors and can only be assessed site-by-site. Due to a lack of before and after control impact assessments, no conclusive answer has been given. Although a maximum reliable recorded displacement distance of 600 m is widely accepted (Drewitt & Langston, 2006). An example of displacement is a powerline that restricts openness and accommodates birds of prey, causing avoidance by other species (APLIC, 2006). Also the barrier effect is a form of displacement; alteration of the flyways of migrating birds that could lead to extra energy expenditure. This effect is dependent on various factors that are partly species-dependent and relate to the type of bird movement, flight height and distance to turbines (Drewitt & Langston, 2006).

Thirdly, collision risk of birds is of most concern and depends on factors related to bird species, numbers, behaviour, weather, topography and the nature of the wind farm (Drewitt & Langston, 2006). Collision

with turbine rotors, nacelles and towers can lead to (fatal) injuries or direct mortality but associated infrastructure such as measuring masts and power lines can have the same effect (Jenkins et al., 2015). Although some state that bird mortality is not a serious problem as birds can quickly learn how to avoid obstacles (Leung & Yang, 2012), it certainly is seen as an issue in EIA reports and other scientific literature (Drewitt & Langston, 2006; Kikuchi, 2008; Krijgsveld et al., 2009; Masden et al., 2010 and others).

As stated earlier, impacts are among others dependent on species. The aforementioned priority species list composed by Birdlife South Africa (2014) takes into account different species-dependent factors such as size, aerial display, migratory and soaring behaviour and national and international conservation status. The conservation status is divided in Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN) and Critically Endangered (CR) of which the latter three categories are considered to be threatened species (Birdlife, 2016a). Particularly raptors, large terrestrial species and wetland birds are considered most vulnerable (Jenkins et al., 2015). Although the list does not take into account the important factor of flight height, it is integrated in the birds and wind energy best practice guidelines that is commonly used for EIA reports in South Africa (Jenkins et al., 2015).

### 5.2.2 Ecology

Ecology consists of flora and fauna excluding birds that are vulnerable for wind energy development. Unfortunately, scientific analysis of the impact of wind farms on ecology is scarce. The major impacts of wind energy development on ecology are considered to be habitat loss and habitat transformation (Skowno et al., 2014). Turbines have a foundation with a diameter of about 25 meter, but associated road constructions form by far the greatest threat for habitat loss: depending on project characteristics there is about 40-60 km of access roads needed between turbines (Skowno et al., 2014). Other sources of impact on ecology are changes in surface hydrology, noise from operating turbines and disturbance due to human presence.

## 5.3 Research Questions

This research will focus on expanding the in-house tool EPAT of the South African wind project developer G7. The goal is to add impact categories Birds and Ecology to the desktop tool to reduce company risk. The following research question is therefore formulated:

*How can the Environmental Pre-Feasibility Assessment Tool be extended with impact categories Birds and Ecology to be able to resemble a full Environmental Impact Assessment in these categories?*

The following sub questions will structure the research and lead to an answer of the main research question:

- *What are the current legislations in South Africa regarding birds and ecology in wind energy development?*

After a first analysis on South African legislations affecting the birds and ecology assessments, existing methodologies in assessments are examined:

- *Which methodologies for impact assessment on birds and ecology are applied and can they be implemented as new impact categories in EPAT?*

Now that the requirements and methodologies of the new impact categories have been determined, impact features can be designed that form the basis of DSET:

- *What impact features for impact categories birds and ecology should be designed to cover all important parts of an Environmental Impact Assessment?*

To differentiate between impact features, weights are assigned to each impact feature based on their importance and uncertainty:

- *What weighting factors for impact categories birds and ecology should be accounted for taking into consideration the importance and uncertainty of the impact?*

As final part of the research a test will be performed on existing projects where the assessment of impacts on birds and ecology in an official recent EIA report is compared with the assessment of the newly developed impact categories of EPAT:

- *Do the developed impact categories provide similar results as EIAs performed by specialists?*

The last step is very relevant for the success of EPAT. The publicly available EIA reports on wind project development are used to test the tool and compare it with specialist findings. The sub questions should together result in an extension of EPAT that is easy to use and give similar outputs as EIA reports executed by specialists.

## 6 Methodology

The purpose of this study was to develop an extension of EPAT with the fields Birds and Ecology that resembled EIA reports on South African wind energy projects. The methodology is divided into five different phases for each impact category individually; background, design, implementation, organization and validation. These phases can be interpreted as a circular process where feedback of the validation phase can be used to improve the tool starting at the background phase again (Figure 2). Since scientific understanding will improve, environmental legislation will change and data will be updated. This circular process can be used again after completion of this research to keep EPAT up-to-date.

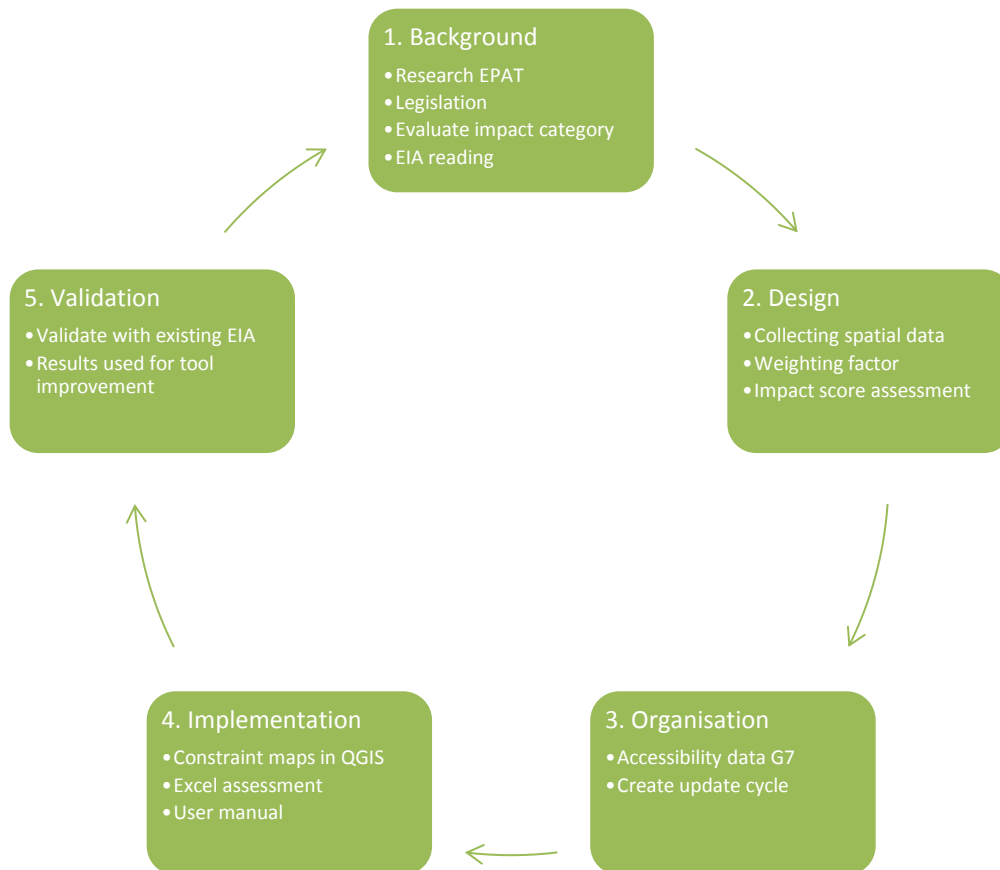


Figure 2 Circular process of methodology EPAT research for each category individually.

The extended part of EPAT and the validation thereof is seen as the result of this study while the development of EPAT is a methodological approach and therefore covered in the Methodology section of this report. The research area is limited to wind energy on the mainland of South Africa. Oversea territories and offshore possibilities will not be incorporated as G7 is only active on South African mainland and stimulation of renewable energy is primarily for onshore technologies. EPAT will consequently only be useful on the mainland of South Africa as legislation differs per country. Some features relevant for the two categories in this study such as Ramsar wetlands have already been covered by Starmans (2015) in another impact category and will therefore not be assessed again. The impact assessment for Birds and Ecology as developed here is primarily applicable on cases where a decision on the operational phase of a windfarm on a certain location within South Africa is at stake. It might also be relevant for the construction phase and different types of infrastructure projects like grid connection powerlines but this was not the focus of this study.

### 6.1 Background

The first step in this research was to study the most recent version of EPAT. This consisted of the work of Starmans (2015) and related documents such as the QGIS based GIST and Excel based DSET and their manuals. Getting familiar with EPAT was important to get into the methodology of existing impact categories.

Each new impact category (Birds and Ecology) was evaluated on registered impacts and existing South African legislation. For this purpose, scientific literature and legislative documents served to give background information that was useful in the design phase. Both new impact categories had to comply with the same environmental legislation as defined by DEA (2015):

- National Environmental Management Act (NEMA)
- National Environmental Management: Biodiversity Act (NEMBA)
- National Environmental Management: Protected Areas Act (NEMPAA)
- National Forest Act (NFA)

Few legislative standards for practical matters, such as buffer size, are currently implemented while this is very relevant in the development of EPAT. EIA reports do cover practical implementation measures based on the expertise of the author and best practices in the field. These reports were leading in the determination of impact features and scores because the results generated in an EPAT assessment should be in compliance with EIAs. To complement the current EIA practice in South Africa, scientific journals such as Environmental Impact Assessment Review were consulted for most up to date information available.

An interview with Samantha Ralston, renewable energy manager at Birdlife South Africa, was held to increase background knowledge on environmental concerns regarding birds and to locate bird data sources. It was a semi-structured interview based on Deken (2013). Consequently, the interview was structured but the interviewer was allowed to spontaneously continue on other relevant subjects that come up during the conversation. A summary of the interview can be found in Appendix A.

## 6.2 Design

The knowledge gathered in the background phase was used in the design phase to collect data and to determine potential impact features and weighting factors for each impact category. Different impact features were formulated per impact category depending on legislation and guidelines. Impact scores and weights can be allocated to each impact feature in DSET. Impact score definition and weighting can be found in Table 1 and Table 2 respectively. These impact scores are in line with earlier defined impact scores for EPAT, however, weight scores are determined with a new method. They are now dependent on importance and uncertainty. Importance of the feature is considered twice as influential as uncertainty (Table 2). Uncertainty has impact only in situations where importance and uncertainty have large contrasts. In Appendix B a simple uncertainty analysis can be found with different weight ratios between importance and uncertainty. How the weight is calculated can be explained by the following two examples:

- A feature with high importance and high uncertainty leads to a sum of a 2.00-score (high importance) and a 0.33-score (high uncertainty) to a total score of 2.33 which is rounded off to a medium (2) weight (scores with a decimal value higher than five are rounded up).
- A feature with high importance (2.00-score) and low uncertainty (1.00-score) leads to a total score of 3 which corresponds to a high weight.

Table 1 Impact score definitions of features assessed in EPAT after Starmans (2015).

Score	Potential Impact	Definition
1	Low	No impacts expected, development can continue
2	Medium	There are potential impacts but these do not directly influence the proposed project. Development can continue.
3	High	There are potential impacts that can affect the environmental feasibility of the project. Mitigation measures are recommended to lower the impacts before development can continue.
4	Very High	There are potential impacts that will most likely form a prohibitive barrier for the proposed project. Mitigation measures are necessary to lower the overall impacts before development can continue, unless there is a fatal flaw.

Table 2 Weight scores assigned to impact features. Each impact feature has certain importance and uncertainty, summed up to a total weight assigned to the feature. Note that lower uncertainty leads to higher final scores.

Importance	Uncertainty	Total Weight
0.66 (Low)	0.33 (High)	<b>1 (Low)</b>
1.33 (Medium)	0.66 (Medium)	<b>2 (Medium)</b>
2.00 (High)	1.00 (Low)	<b>3 (High)</b>

In order for EPAT to function, impact features for each impact category were created in Excel as part of DSET. These features consisted of tasks that needed to be performed by the assessor to get the potential impact score of a particular impact feature. The score of an impact feature is calculated by multiplying the weight with the impact score resulting from a project assessment. All impact features together covered all major requirements that needed to be met for an EIA.

### 6.2.1 Birds

For the impact category Birds, species vulnerable to wind energy development were identified. This was based on the earlier mentioned wind energy priority species list of Birdlife South Africa that ranked the vulnerability of bird species with different indicators (Birdlife, 2014). Several specialists, organisations and government bodies were contacted to collect bird data and to identify vulnerable areas and species in South Africa. Unfortunately, not all organizations and specialists were willing to share their data due to confidentiality. Table 3 shows the data that were retrieved from the different sources and in what impact feature the data is used.

Table 3 Data sources used for the assessment of impact category Birds in EPAT.

Data	Impact feature	Source
Important Bird Areas	Important Bird Areas	Birdlife (2016b)
SABAP2 observation data	SABAP2	SABAP2 (2016)
List of Priority Species	SABAP2	Birdlife (2014)
	CAR	
NFEPA	Rivers and wetlands	Nel et al. (2011)
Dam locations in South Africa	Dams	DWS (2016)
CAR observation data	Coordinated Avifaunal Roadcount (CAR)	McCarthy (2016)
EWT observation data cranes	EWT crane data	GBIF (2016)
Digital elevation data	Cliff tool	G7
Bearded vulture density Southern Africa	Bearded Vulture risk map	Reid et al. (2015)

Typical tools in assessing risks for birds entail habitat identification and standard survey techniques such as point bird counts and raptor nest searches (Katzner et al., 2016). Within the data collected on birds, Important Bird Areas (IBAs), river and wetland data are assumed to represent the habitat identification while observation data and the cliff tool function as survey techniques. In the sub-paragraphs 6.2.1.1 to 6.2.1.8 there is elaborated on the design of each impact feature in the Birds category. Determination and justification of the criteria per impact score for each impact feature and the weight based on importance and uncertainty is assigned. Defining the impact features forms the basis of the Excel based DSET part of EPAT.

#### 6.2.1.1 Important Bird Areas

IBAs are areas considered critical for the long-term survival of bird species by Birdlife South Africa (Birdlife, 2016b). The sites form a network spread all over South Africa and are identified through multi-stakeholder processes and standardized criteria relating to the presence of IBA 'trigger' species. Some but not all 'trigger' species are vulnerable for wind energy development (Birdlife, 2016b). Although IBAs are not related to any active legislation, they have negatively influenced at least one Environmental Authorisation for a wind energy facility by DEA (Ralston, 2016).

In their recent position statement about wind energy facilities and IBAs, Birdlife South Africa allows for development of (small) sites relatively close or in IBAs (Birdlife, 2016b). However, facilities are considered significant threats when situated relatively close or in IBAs in the absence of information demonstrating otherwise. IBAs are taken into account by specialists in EIA reports and should be

considered likewise in EPAT. As in some (exceptional) cases wind energy facilities can be allowed within IBAs, the maximum impact score is three as can be seen in Table 4. The landscape section of the Strategic Environmental Assessment used a very high sensitivity score within two km of an unofficial protected area (CSIR, 2013). Since wind project development within an IBA is not per definition a no-go, impact scores derived from this report are considered one impact category lower to adapt to the less stringent measures for IBAs. The importance of IBAs is considered medium; Birdlife attaches high value to IBAs but they are not related to any legislation. The fact that not every IBA is vulnerable for wind project development makes the uncertainty of the feature high, the total weight assigned to IBAs then comes down to medium.

Table 4 Allocation of impact scores for distance (d) to IBAs.

Important Bird Areas	Impact Score			Weight
	3	2	1	
IBA distance (km)	d<2	2≤d<5	d≥5	2

#### 6.2.1.2 South African Bird Atlas Project 2

The South African Bird Atlas Project 2 (SABAP2) is one of the major citizen science projects in Southern Africa launched by the Animal Demography Unit (ADU) and registered over eight million and counting bird observations (SABAP2, 2016). The project, started in 2007, has the goal to map the distribution and abundance of bird species in Southern Africa. Data is collected in five by five minute pentads, meaning squares of about nine by nine km, and is freely available online (SABAP2, 2016). Despite its course resolution, the atlas could give an indication of bird species occurring on a site for about 75% of South Africa (Underhill, 2016).

All up-to-date observation information is retrieved from the website. The pentad corresponding to the location of the assessed project in EPAT should be selected. As not all areas are covered by observations, neighbouring pentads can be used when necessary. It is assumed that a neighbouring pentad is representative for the project area as in general these pentads have the same biome. In addition, birds can easily move between areas, although migration or territory characteristics differ per species. If a project area is in between different pentads, the pentad that is located over the majority of the project area is selected.

According to Ralston (2016) the priority species list is leading over the IUCN red-list of endangered bird species. Therefore, only the priority species list in the SABAP2 assessment is used. The priority species list is divided into four categories: raptors, very high priority, high priority and medium priority species. The raptor category consisted of all threatened raptors of the priority list, they were separated as they are most problematic according to EIA reports as well as scientific literature (Eichhorn et al., 2012; Jenkins, 2014; Kikuchi, 2008). The very high priority, high priority and medium priority species contained the priority species ranked 1-25, 26-50 and 51-109 respectively excluding threatened raptors.

Raptors and very high priority species both are considered very vulnerable to wind energy development, therefore these categories are treated equally, see Table 5. If the number of species that occurs in the assessment area is equal to or exceeds five, the project will be red-flagged with an impact score of four. With this amount of different high impact species, major issues can be expected with the development of a wind energy facility. Observation between one and four different species creates an impact score of three; mitigation measures will probably have to be implemented to continue the project. If there are no species present in both categories, the score will be one. High and medium priority species are considered less vulnerable in line with the ranking of Birdlife South Africa, therefore the number of species that is allowed before a higher impact score is reached is slightly higher. The allocation of impact scores was determined by an iterative process of testing the tool and comparing with the results of existing projects. The importance of raptors and very high priority was considered high, high priority species medium and medium priority species received low importance. The uncertainty of SABAP2 data was considered medium as the exact location or habitat is not known, but the species have been observed in the field. This leads to high weight for raptor and very high priority species, a medium weight for high priority species and a low weight for medium priority species.

Table 5 Allocation of impact scores of SABAP2 where  $s$  is the number of species present in the research area.

SABAP2 bird categories	Impact Score				Weight
	4	3	2	1	
Raptor priority (species)	$s \geq 5$	$1 \leq s \leq 4$	-	$s = 0$	3
Very high priority (species)	$s \geq 5$	$1 \leq s \leq 4$	-	$s = 0$	3
High priority (species)	$s \geq 10$	$3 \leq s \leq 9$	$1 \leq s \leq 2$	$s = 0$	2
Medium priority (species)	$s \geq 15$	$5 \leq s \leq 14$	$1 \leq s \leq 4$	$s = 0$	1

### 6.2.1.3 Rivers and wetlands

Water bodies should be avoided for wind energy development as they potentially attract lots of birds (Andersen et al., 2007). The National Freshwater Ecosystem Project Area (NFEPA) project had the goal to assess priority areas for freshwater ecosystems in South Africa (Nel et al., 2011). The project resulted in a dataset with all rivers and wetlands of South Africa. Unfortunately, by a check of the datasets it turned out that the basic wetland dataset was not accurate. It assigned wetlands that clearly did not qualify as wetlands on satellite imagery also underlined by the Strategic Environmental Assessment (SEA) report (Jenkins, 2014). Two other wetlands datasets, wetlands with crane observations and wetland clusters, were considered reliable when checked. The river dataset was slightly modified: the smallest rivers indicated were considered drainage lines because these are likely to have a non-perennial character given the climate in South Africa. Only rivers with an order of three and higher were taken into account in the assessment, smaller rivers were not considered to attract birds on a regular basis. Third order rivers are streams where already two smaller rivers flowed into. Rivers with a higher order are the result of more than two streams joining the main river. I assumed that third order rivers were a good average between the different South African climatic conditions.

Guidelines of the Department of Water and Sanitation (DWS) advise a 100 m buffer for major rivers (Colloty, 2016), however, several EIA reports apply a no-go buffer of 200 m for rivers (Rooyen van, 2012, 2014a; Todd, 2016; Williams, 2012). From a precautionary principle, the latter buffer zone will be implemented in EPAT as shown in Table 6. Other allocation scores can be found in the table as well: over 1000 m away from a river it is expected there will be no impact on birdlife. The importance of the dataset was considered medium, the uncertainty was marked medium as well since the cut-off of river orders could be argued. This leads to a medium weight of rivers.

The wetland dataset marked wetlands that were sensitive to the very high priority species Wattled Crane, Blue Crane and Grey Crowned Crane based on observations and nest location data from the Endangered Wildlife Trust (EWT). These wetlands are considered reliable for use and a no-go buffer of 200 m is applied consisting of 150 m no-go area for a Blue Crane nest (Jenkins, 2014), topped up by a DWS advised 50 m buffer for the wetland itself as a Crane nest could be located at the edge of a wetland (Colloty, 2016). The other impact scores were in accordance with the SEA and river impact scores. The assessed cranes are all very high priority species, therefore the dataset is seen as important. The combination with a low uncertainty, data is based on crane observations by EWT, leads to a high weight.

To identify more vulnerable wetland areas, Nel et al. (2011) identified wetland clusters: wetlands that are located within one km of each other. The wetland cluster data is considered reliable after a satellite imagery check. These clusters stimulate migration in between the areas and are assumed to increase collision risk of water birds. The data already contains a 500 m buffer; this is adopted as very high impact, lower impact scores are derived from the river impact score. The importance for weight assessment was considered low as an assessment with South African renewable energy projects revealed projects that show overlap with the clusters. The uncertainty is considered high because this only covers a small part of South African wetlands leading to a low weight.

Table 6 Allocation of impact scores to the distance ( $d$ ) of rivers, crane wetlands and wetland clusters.

Rivers and wetlands	Impact Score				Weight
	4	3	2	1	
Distance rivers (m)	$0 \leq d \leq 200$	$200 < d \leq 500$	$500 < d \leq 1000$	$d > 1000$	2
Distance to wetlands with crane nests and observations (m)	$0 \leq d \leq 200$	$200 < d \leq 500$	$500 < d \leq 1000$	$d > 1000$	3
Distance to wetland clusters (m)	$d = 0$	$0 < d \leq 300$	$300 < d \leq 800$	$d > 800$	1



#### 6.2.1.4 Dams

Dams are predominantly built for agricultural purposes but the open water attracts water birds. It can support healthy wetland bird communities, particularly after wet winters (Jenkins, 2014). It is important to include these dams to cover potential risks for wind energy development. Around the edge of the reservoir resulting from the dam the same impact score allocation holds as for rivers (Table 7). The importance of dams is high as they contain water most time of the year and therefore attract birds. In addition, the uncertainty is low as all South African registered dams are covered.

Table 7 Allocation of impact scores to the distance (d) of dams.

Dams	Impact Score				Weight
	4	3	2	1	
Distance to dams (m)	0≤d≤200	200<d≤500	500<d≤1000	d>1000	3

#### 6.2.1.5 Coordinated Avifaunal Roadcount

The Coordinated Avifaunal Roadcount (CAR) programme is again a citizen science project set up by ADU in 1993 monitoring 36 species on 19.000 km of fixed South African routes (CAR, 2016). Twice a year in midsummer and midwinter all routes are covered by regular two km interval sightings. Data is available from 1993 to 2013. To optimize the usability of the data some modifications have been applied to the dataset. Routes that had no observations in the last five years were disregarded and a 20 km buffer was applied on the remaining active routes. Project sites located outside this 20 km buffer are not assessed as they are considered too far away of the observations. Furthermore, data was divided in four groups corresponding to the divisions of SABAP2: raptor priority, very high priority, high priority and medium priority species. All CAR observed species included in the medium priority group were least concern or near threatened according to the red list of IUCN which means non-threatened. These species are not expected to have a negative impact on an EIA report, so the medium priority species category is not taken into account in this assessment.

The impact score was based on two factors: the repetition rate and the abundance of birds within the last five years of observations (Table 8 and Table 9 respectively). As the observations generally did not shift between 1993 and 2013 in geographical location, it is assumed that the five most recent years were representative for all CAR observations. The abundance of birds was considered the most important factor; a large amount of birds increases the risk of impact. However, to prevent misinterpretation of data a repetition rate is taken into account; if birds are present every year at a location, it is most likely a preferred habitat. An incidental large group of birds will be corrected by the repetition rate factor and the other way around for a smaller group that is present each year. By an iterative process of testing and adjusting, both factors were allocated impact scores. The repetition rate impact score was based on the number of unique years present per distance category and the abundance impact score was based on the number of birds per distance category. The iterative process consisted of comparison with different existing wind energy projects and their EIAs such as Haverfontein wind energy facility (CES, 2012) and the Amakhala Emoyeni facility (Mayer & Jodas, 2010).

The distance categories used in allocation of impact scores differed for the raptor group compared to the other priority groups. Raptor territories are large and therefore no-go areas in EIA reports around roosts and nest locations are larger than those for other bird species. Consequently, the distance categories where raptors experience impact of a wind project are larger leading to different impacts. The original distance categories are topped up by 1.5 km: the CAR observations are point observations along the transect roads that are covered, it is assumed that a bird can be observed within a radius of about 1,5 km from the point location.

Table 8 Allocation of impact scores for repetition rate of bird observations in the last five years for the three different priority species groups in CAR. Four different distance (d) categories receive a different impact score dependent on the number of unique years present in observations between 2009 and 2013 within the specific distance category.

Repetition impact score Raptors		Number of unique years present in the last five years				
		0-1	2	3	4	5
Distance to site (km)	0<d≤5	1	2	3	3	3
	5<d≤10	1	2	2	3	3
	10<d≤15	1	1	2	2	3
	15<d≤20	1	1	1	2	2
Repetition impact score (very) high priority groups		Number of unique years present the last five years				
		0-1	2	3	4	5
Distance to site (km)	0<d≤3.5	1	2	3	3	3
	3.5<d≤7	1	1	2	3	3
	7<d≤10	1	1	1	2	3
	10<d≤15	1	1	1	2	2

Table 9 Allocation of impact scores of abundance of birds in observations in the last five years for the three different priority species groups in CAR. Four different distance (d) categories receive a different impact score dependent on the number of observations present within the specific distance category between 2009 and 2013.

Abundance impact score Raptors		Number of birds in all observations last five years					
		0	1-4	5-8	9-12	12-15	>15
Distance to site (km)	0<d≤5	1	2	3	4	4	4
	5<d≤10	1	2	2	3	4	4
	10<d≤15	1	1	2	2	3	4
	15<d≤20	1	1	1	2	2	3
Abundance impact score very high priority groups		Number of birds in all observations last five years					
		0-10	11-30	31-100	101-150	151-200	>200
Distance to site (km)	0<d≤3.5	1	2	3	4	4	4
	3.5<d≤7	1	2	3	3	4	4
	7<d≤10	1	1	2	3	3	4
	10<d≤15	1	1	1	2	3	3
Abundance impact score high priority groups		Number of birds in all observations last five years					
		0-5	6-10	11-20	21-30	31-50	>50
Distance to site (km)	0<d≤3.5	1	2	3	4	4	4
	3.5<d≤7	1	1	2	3	4	4
	7<d≤10	1	1	1	2	3	4
	10<d≤15	1	1	1	1	2	3

As mentioned, the number of birds was considered more important than repetition rate. To create a final impact score for CAR data the following formula was used:

$$I = 0.66 * a + 0.33 * r$$

In which I is impact score, a abundance and r repetition rate. The final impact score should be rounded off to whole numbers. In Table 10 the final impact score matrix gives an overview of all possible impact scores. The ratio between abundance and repetition rate resulted from a simple sensitivity analysis available in Appendix B. The 1:2 ratio of abundance and repetition rate respectively is considered to be the middle way where repetition rate has influence on the impact score but does not disturb the outcome. The importance of the different groups was the same as at SABAP2 data; high for raptor and very high priority and medium for high priority (Table 11). The uncertainty is considered to be low as the multi-

year number of birds and the repetition rate are both available. This leads to a high weight (3) for the raptor and very high priority species group and a medium (2) weight for high priority species group.

Table 10 Final impact score matrix for CAR based on the different weights for repetition rate and abundance.

CAR Final Score Matrix		Impact score abundance			
		1	2	3	4
Impact score repetition rate	1	1	2	2	3
	2	1	2	3	3
	3	2	2	3	4

Table 11 Weights assigned to the different CAR priority groups.

CAR	Weight
Raptor priority group	3
Very high priority group	3
High priority group	2

#### 6.2.1.6 Endangered Wildlife Trust Crane Data

As part of the EWT's African Crane Conservation Programme there are observations of the Blue Crane, Grey Crowned Crane and Wattled Crane available via the Global Biodiversity Information Facility (GBIF, 2016). The data is intermittently available since 1978; for consistency with CAR observations only the years 2009 to 2013 have been used. This does not have influence on the quality of the data since the selection deletes only 600 of about 10 000 observations. In contrast to the CAR observations, the point observations of EWT contains one bird. Although not specified in the data, the location of observations seems to indicate that observations were done on road transects. This means that the observed bird is not necessarily located at the point location but in a radius of about 1.5 km around it similar to CAR observations. This extra distance is therefore taken into account in the distance categories again similar to very high priority species in CAR.

The impact score is calculated, in line with CAR observations, from abundance in number of birds and repetition rate over the years 2009-2013, see Table 12. The repetition rate of observations is identical to the CAR impact score, repetition of observations in consecutive years indicates a regular habitat. However, the number of birds in abundance that lead to the impact score is lower compared to CAR very high priority species. The reason for this is that EWT crane data has less than one third of the observations the CAR programme possesses. The numbers are based on comparing different projects with EIA reports available such as Springfontein and Aberdeen wind farms (Ajodhapersadh, Jodas, & Wood, 2012; EWT, 2014). The importance of the EWT crane data is considered high because of the very high priority Crane species. The fact that the data is observed by EWT makes the uncertainty low which results in a high weight (Table 13).

Table 12 Allocation of impact scores of repetition rate and abundance of birds in observations in the last five years for EWT crane data. Four different distance (d) categories receive a different impact score dependent on the number of unique years or observations present within the specific distance category between 2009 and 2013.

Repetition impact score EWT crane data		Number of unique years present the last five years				
		0-1	2	3	4	5
Distance (km)	0<d≤3.5	1	2	3	3	3
	3.5<d≤7	1	1	2	3	3
	7<d≤10	1	1	1	2	3
	10<d≤15	1	1	1	2	2
Abundance impact score EWT crane data		Number of birds in all observations last five years				
		0-5	6-10	11-15	16-20	>20
Distance (km)	0<d≤3.5	2	3	4	4	4
	3.5<d≤7	1	2	3	4	4
	7<d≤10	1	1	2	3	4
	10<d≤15	1	1	1	2	3

Table 13 Weight assigned to EWT Crane data.

EWT Crane data	Weight
EWT crane data	3

#### 6.2.1.7 Cliff tool

The G7 in-house cliff tool provides information of potential locations of Raptor nests on cliffs, normally Verreaux's Eagle or Booted Eagle nests. Empirical research pointed out that the majority of nests on cliffs are located at a slope angle of 35 degrees. Nest locations of those raptors are a major concern. In general, a minimal distance of 1.5 km to a nest of a Verreaux's Eagle or Booted Eagle is accepted by specialists (Todd, 2016).

The cliff tool indicates all cliffs with a slope of 35 degrees including a 1.5 km buffer. Not all of the indicated areas become a no-go area but it will give an indication of potential cliff nest locations that will be flagged by the presence of a raptor nest. A rule of thumb within G7 is that a site is still viable when 50-60 turbines are not located within the buffer area of the cliff tool, this is considered the minimum size of a windfarm to be commercially viable in South Africa. Even though the buffer of potential cliff nest locations won't cut out all wind turbines in reality, a precautionary approach is used and the impact score will have a high score as maximum. In order to run the cliff tool, two preconditions have to be met. A visual assessment with the terrain function of Google maps should indicate presence of cliffs. Or there should be an observation of a Verreaux's or Booted Eagle by SABAP2 in the area. When one of these preconditions has been met, a digital elevation map of the area with a resolution between 5 m and 25 m is needed to create a slope map.

As said, the maximum score of the cliff tool is high with less than 50 turbines left (Table 14). If this is the case, there are three options left: change the layout, (temporarily) abandon the project or invest in a field trip to check the actual nests located in the areas designated by the cliff tool. 50 to 60 turbines remaining leads to a medium impact as the project is still commercially viable. More than 60 turbines left lead to a low impact of the cliff tool on the selected project. The importance of the cliff tool is considered high since raptor nests can have serious consequences for wind farm developments. But the uncertainty is still high and a field visit is necessary to get more detailed information. The combination leads to a medium weight for the cliff tool. Collecting a digital elevation map and executing the tool is time consuming, when little time available this step can be skipped and performed in a later stadium of development.

Table 14 Allocation of impact scores for the cliff tool. The number of wind turbines (t) that are not affected by the potential cliff nest location buffer determines the impact: enough wind turbines should remain on the site for development to secure viability.

Cliff tool	Impact Score			Weight
	3	2	1	
Number of turbines not affected by the potential cliff nest location buffer	t<50	50≤t≤60	t<60	2

#### 6.2.1.8 Bearded Vulture Risk Map

The Bearded Vulture is a regional endangered raptor in South Africa and is present around Lesotho and the East of South Africa. There are major concerns about Bearded Vultures and wind energy development; the species is listed second on the priority species list (Birdlife, 2014). Spatial analysis of Bearded Vulture movements especially for wind turbine placement by Reid et al. (2015) used 21 individuals fitted with GPS tags to develop a habitat use model. This model included risk flight heights and important areas of use and resulted in a Bearded Vulture density map where the number of Bearded Vultures per km<sup>2</sup> is simulated.

The whole distribution area of Bearded Vultures is modelled in a density map and is concentrated in and around Lesotho. Due to the nature of the data, detailed information (Bearded Vultures per km<sup>2</sup>) makes it hard to define clear boundaries, therefore the same approach is used as IBA impact scores: wind energy development within the area is possible but could have a high risk of Bearded Vulture presence. Table 15 shows the allocation of impact scores, the boundaries of the density map form a wide buffer with Bearded Vulture activity and no medium impact score is allocated. A high impact score is assigned to locations within the density map and should be investigated in more detail, a project located outside of the density map is considered as low risk for Bearded Vultures. The density map covers only Bearded Vultures, therefore the assigned weight to the Bearded Vulture density map is one: low importance due to the coverage of only one species, the little detail in data make the uncertainty high.

Table 15 Allocation of impact scores for distance (d) to the Bearded Vulture density map.

Bearded Vulture density map	Impact Score			Weight
	3	2	1	
Density map distance (km)	d=0	-	d>0	1

#### 6.2.2 Ecology

For the impact category Ecology, different data sources have been consulted to establish impact assessment features. Ecological data, especially high resolution data, is limited in South Africa. The classification of IUCN in vulnerable, endangered and critically endangered species is used within this category to mark the sensitivity of plants, animals and whole ecosystems for wind energy development. From EIA reports it appears that drainage lines are important areas inside project locations with a high biodiversity and higher ecological value than surrounding areas. The different data sources used in the ecology assessment and their corresponding impact feature can be seen in Table 16.

Table 16 Data sources and impact features for the assessment of ecology in EPAT.

Data	Impact feature	Source
National Vegetation Map	Vegetation	SANBI (2016)
Vegetation map with threatened ecosystems	Vegetation	SANBI (2012)
Focus areas for protected area expansion	National Protected Areas Expansion Strategy (NPAES)	SANPARKS/SANBI (2010)
Biodiversity Sector Plan Landscape Ecological Corridors 2016	Kwazulu Natal ecological corridors	Ezemvelo KZN Wildlife/Jewitt (2011)
Drainage lines	Drainage lines	(DWS, 2015)
Critical Biodiversity Areas	Critical Biodiversity Areas	(SANBI, 2016b)
Frog data in National Freshwater Ecosystem Priority Areas	Frog data in NFEPA wetland dataset	(SANBI, 2016b)
FrogMAP	FrogMAP	ADU (2016b)
ReptileMAP	ReptileMAP	ADU (2016c)
MammalMAP	MammalMAP	ADU (2016a)

Each data source is evaluated in the following paragraphs and impact scores and weights based on literature and expert knowledge will be assigned. With all assessment features together the ecological impact of a project can be determined.

**6.2.2.1 Vegetation**

It is useful to know what kind of vegetation type can be expected in the project area, an ecology specialist can indicate features and risks that can occur at different vegetation types. The national vegetation map by SANBI (2016) shows the vegetation type of South Africa on a scale of 1:250 000 and is an update of previous versions. This feature only serves as information and does not have any impact scores. All vegetation types within the project area should be noted in the EPAT excel assessment document.

Another dataset, the vegetation map with threatened ecosystems (SANBI, 2016) was used as a headline indicator for the National Biodiversity Assessment in 2011. The ecosystem threat status informs to what degree ecosystems are intact regarding their structure, function and composition; the characteristics that determine whether an ecosystem can still provide ecosystem services. Ecosystems are divided into the categories critically endangered, endangered, vulnerable and least threatened based on the proportion of each ecosystem that remains in good ecological condition. (SANBI, 2012)

Even in ecosystems considered critically endangered wind energy projects are already approved and built, so only impact scores low and medium are assigned to ecosystems in Table 17. The least threatened ecosystems receive a score of one and threatened ecosystems receive a score of 2. Uncertainty is considered medium since the data was based on the 2006 vegetation map while newer versions have more fine scale mapping available (SANBI, 2016a). The importance is seen as low: this comes down to a low weight.

Table 17 Allocation of impact scores of threatened ecosystems.

Threatened ecosystems	Impact Score		Weight
	2	1	
Vegetation type	-	-	-
Ecosystem threat status	Vulnerable/ Endangered/ Critically endangered	Least threatened	1

**6.2.2.2 National Protected Areas Expansion Strategy**

The National Protected Areas Expansion Strategy (NPAES) is a governmental project to achieve cost-effective protected area expansion for ecological sustainability and resilience to climate change. The current protected area network falls short in reaching these goals (DEA, 2016). The collected data contains designated areas in South Africa that present the best opportunities to meet the ecosystem-specific protected area targets of NPAES. Only a part of the selected areas will be converted into actual protected areas in the future (SANBI, 2010). From a nature conservation perspective development in these areas is discouraged, but not prohibited as can be seen below.

The proposed Rietkloof Wind Energy Facility (WEF) is located within NPAES area but is not fatally flawed by its location (EOH, 2016a). As a location within NPAES is not a fatal flaw for a project, the maximum impact score is considered high as can be seen in Table 18. A high score is assigned to projects located inside a NPAES designated area, possibly extra effort or mitigation measures can be expected. Since NPAES areas have the purpose to create a network of protected areas, any location outside these areas will not form an issue. Therefore, all locations outside a NPAES area receive a low score. The importance of NPAES is considered low as not all areas will be eventually converted into protected area and have no other legislation that would protect the areas from development. For the same reason the uncertainty of this category is considered high, this totals the weight of NPAES to one.

Table 18 Allocation of impact scores for distance (d) to NPAES.

NPAES	Impact Score			Weight
	3	2	1	
Distance to NPAES area (km)	d=0	-	d>0	1

### 6.2.2.3 Kwazulu Natal macro ecological corridors

A fragmented landscape makes it difficult for animals to migrate to different places, which is especially important when climate change forces migration. For this reason, KZN Wildlife created macro-ecological corridors to link areas with each other to ease migration of species (Jewitt, 2011). Species that are able to use the corridors have a greater capacity to persist in habitats that are fragmented; the minimum corridor width was considered 100 meter (Jewitt, 2011). The corridors are not official protected areas but a strategy from KZN Wildlife to make species able to adapt to the fragmented landscape and climate change. The proposed Waaihoek WEF is partly situated within one of the corridors. Next to taking extra concern in micro-siting of turbines, electrical infrastructure and roads the location of this WEF was not considered an issue (CES, 2015).

Based on Waaihoek WEF as an example the maximum impact score is high for projects located inside the macro-ecological corridors of Kwazulu Natal. Similar to NPAES areas, the ecological relevance is only within the corridor so a low score is assigned to areas outside of the corridor. The corridors are not legislative, so importance is considered low. Uncertainty is seen as medium which leads to a low weight.

Table 19 Allocation of impact scores for distance (d) to KZN macro ecological corridors.

KZN macro ecological corridors	Impact Score			Weight
	3	2	1	
Distance to corridor (km)	d=0	-	d>0	1

### 6.2.2.4 Critical Biodiversity Areas

Critical Biodiversity Areas (CBA) have the purpose to identify areas that should be conserved and areas where development can take place without compromising biodiversity in the surroundings. The areas are planned to be incorporated in legislation in the future. CBAs can be divided in categories CBA 1, CBA 2 and CBA 3 (CES, 2015) and development of these areas is critical to meet national biodiversity targets (Turner, 2012). CBA 3 represents areas that have a high replaceability: there are more alternative sites available to reach conservation targets. CBA 2 has only a few alternative sites to reach national conservation targets and CBA 1 has no identified alternative sites for one or more biodiversity features. In this study the focus is on CBA 1 areas as it is expected that these areas have the highest impact on project development. In the obtained data there are a few limitations. Some areas in South Africa have not identified CBAs and not all identified CBAs are divided in the three categories. From a precautionary perspective all uncategorized CBAs are considered as CBA 1 areas.

The WEFs Rietkloof (EOH, 2016a) and Komsberg West (Todd, 2016) are both situated (partly) in a CBA. Based on their EIA reports it can be concluded that development within a CBA is possible. Although some extra effort in terms of a comprehensive environmental management plan, extra monitoring or mitigation measures avoiding high sensitivity areas (identified by a specialist) can be expected. Therefore, evaluating a new project the maximum score for a location within a CBA is high while for projects located outside a CBA, in accordance with NPAES and macro-ecological corridors, a low score will be assigned (Table 20). Since CBAs are not legislative the importance is considered low. Uncertainty is seen as high because of the possibility of legislation coming into effect that includes CBAs. This might change the low weight and allocation of impact scores of CBAs in the future.

Table 20 Allocation of impact scores for distance (d) to Critical Biodiversity Areas.

Critical Biodiversity Areas	Impact Score			Weight
	3	2	1	
Distance to CBA (km)	d=0	-	d>0	1

### 6.2.2.5 Drainage lines

Drainage lines function in dry areas as surface drainage channels after intense rainfall events. These drainage lines can be considered ecological linking corridors and should be observed as ecologically sensitive although they do not always have a high diversity in plant species (McDonald, 2012). Often drainage lines are recognized by denser and more green vegetation cover compared to their direct environment, reptiles and amphibians may be present at the drainage lines as well (Todd, 2016). Drainage lines often receive a buffer by specialists in EIA reports because of the important ecological function. Turbine placement, roads and underground cabling should be avoided from these areas

(McDonald, 2012). There is a possibility for roads to cross the drainage lines, although a time consuming and costly WULA license should be applied for at DWS (DWS, 2016b).

EIA reports generally apply a buffer of 32 meter around drainage lines, this is also the minimal distance DWS advises (Levendal & Lochner, 2011; McDonald, 2012). The distribution of drainage lines and the scale of these buffers is too small to evaluate purely on the project area only. For a useful EPAT assessment, turbine locations should be known. A turbine located within the buffer area of 32 meter will result in a very high impact score as seen in Table 21, but in most cases mitigation by replacing the turbine is possible. A high impact score is assigned to turbines placed between 32 and 50 meter, between 50 and 75 meter is considered medium impact. All distances above 75 meter receive a low impact score. Since virtually every specialist report points out the importance of drainage lines, it is considered an important feature. The uncertainty is low; the location of drainage lines can be easily retrieved from inclines in the landscape. Therefore, the weight of drainage lines is high.

Table 21 Allocation of impact scores for distance (d) to drainage lines.

Drainage lines	Impact Score				Weight
	4	3	2	1	
Distance to drainage lines (m)	0≤d≤32	32<d≤50	50<d≤75	d>75	3

#### 6.2.2.6 Frog data in NFEPA wetland dataset

The NFEPA wetland dataset used in the bird evaluation also recorded IUCN threatened frog species observations and selected every wetland within 500 meter of the sighting. This results in a few wetlands across South Africa that potentially form the habitat of an endangered frog species.

Similar to the crane wetlands used in the Birds section, the frog observations within the NFEPA wetlands dataset increase the reliability of the dataset. These wetlands should be handled with care and receive a buffer of 50 m according to DWS guidelines (Colloty, 2016). As shown in Table 22 the buffer is followed by a high impact score within 100 m and up to 150 m there is a medium impact. Anything beyond receives a low impact score. The importance of endangered frogs is considered medium just as the uncertainty which results in a medium weight for this impact category.

Table 22 Allocation of impact scores for distance (d) to frog wetlands.

Frog wetlands	Impact Score				Weight
	4	3	2	1	
Distance frog wetlands (m)	0≤d≤50	50<d≤100	100<d≤150	d>150	2

#### 6.2.2.7 FrogMAP

FrogMAP is since 2010 the continuation of the Southern African Frog Atlas Project (SAFAP) and can be accessed online (ADU, 2016b). As more projects from ADU, FrogMAP is a citizen science project which aims to determine the distribution of frogs on the African continent to back-up conservation priorities (FrogMAP, 2016). The Quarter Degree Grid Cell (QDGC) system is regularly used in African Biodiversity projects (Larsen, 2009), this also holds for FrogMAP. Figure 3 shows that a QDGC divides the area between latitude and longitude degrees in four areas named A to D. For finer scale the letter squares are divided again in four; first the longitude is mentioned, followed by latitude and the two corresponding letters. This gives areas of roughly 25x25km in which FrogMAP reports frog sightings, a wide area especially for small and relative immobile animals.

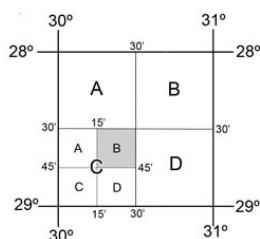


Figure 3 Quarter Degree Grid Cell is depicted by the large letters (DRDLR, 2013). FrogMAP has one more level of detail and should be noted as 3029CB in this figure.



Due to the lack of detail in frog species observations the impact score can have a maximum of high when a threatened (critically endangered, endangered or vulnerable) frog species is sighted within the area (Table 23). A medium impact is assigned for general non-threatened frog species observations and a low impact is reserved for no frog sightings available. The importance of the data is considered low: the habitat needed for a frog is probably located within already buffered areas for drainage lines, rivers or wetlands. In addition, the uncertainty is high since the area pointed out is rather large: the species could very well not be present in the project area. The outcome of the FrogMAP feature should merely be seen as an indication, a specialist in the field can give a definite answer.

Table 23 Allocation of impact scores for FrogMAP based on observed frogs and their threat status.

FrogMAP	Impact Score			Weight
	3	2	1	
Threatened/non-threatened/no species	Threatened	Non-threatened	none	1

#### 6.2.2.8 ReptileMAP

The ReptileMAP is very similar to FrogMAP, it is the continuation of the South African Reptile Conservation Assessment (SARCA) citizen science project with 120.000 records from ADU and is accessible online (ADU, 2016c). The observations are noted in the same resolution as FrogMAP.

The impact scores and allocations thereof are according to the impact score of FrogMAP (Table 24); a maximum impact score of high and a low importance and high uncertainty give a low weight. Also with ReptileMAP the outcome is only indicative and a specialist should give a definite answer.

Table 24 Allocation of impact scores for ReptileMAP based on observed reptiles and their threat status.

ReptileMAP	Impact Score			Weight
	3	2	1	
Threatened/non-threatened/no species	Threatened	Non-threatened	none	1

#### 6.2.2.9 MammalMAP

MammalMAP is again a similar project as FrogMAP and ReptileMAP in collaboration with the Mammal Research institute at the University of Pretoria. The online database provides access to near 60 000 observations in South Africa (ADU, 2016a). The impact scores and weight in Table 25 are the same as the other ADU citizen science projects above. After this indication a specialist should give a definite answer.

Table 25 Allocation of impact scores for MammalMAP based on observed mammals and their threat status.

ReptileMAP	Impact Score			Weight
	3	2	1	
Threatened/non-threatened/no species	Threatened	Non-threatened	none	1

#### 6.2.2.10 Landscape

Certain landscape features can have a specific ecological function such as rocky outcrops, they can provide a suitable habitat for reptiles and plants and can be marked as a high sensitivity area in EIA reports (Todd, 2010). There is no dataset available with rocky outcrops indicated, an alternative way is a visual assessment of the site using satellite imagery indicating locations of rocky outcrops. Next to rocky outcrops it is generally preferred from an ecological perspective that project development takes place on land that is already developed instead of natural land with minimal human disturbances. However, the Department of Agriculture, Forestry and Fisheries (DAFF) prefers that development is not taking place on agricultural land, the department wants to prevent subdivision of land in uneconomic farming units (Venzo, 2013). This forms a dilemma for project development and for this purpose, a qualitative visual satellite assessment should give an indication whether natural land or cultivated land is preferred.

A buffer of 50 m around a rocky outcrop is established, taking CES (2015) as an example. Outside of the buffer zone development is allowed, therefore only impact scores very high and low are relevant for this feature (Table 26). Rocky outcrops can be considered an important habitat so the importance is high. However, a visual satellite assessment has a high uncertainty leading to a medium weight.

The project site should be inspected on the proportion of natural land and cultivated land for the land cover impact feature. If the majority of the area is considered natural land, turbine placement on cultivated land should be assigned a medium impact, placement on natural land is considered as a low impact. If the majority of the site consists of agricultural land the impact scores are the other way around. Since this is a preference and no obligation it is assumed that the maximum impact score on this feature to be medium. The importance is considered low. Uncertainty is high as the visual inspection is very coarse and it does not give information about the ecological value of natural land or the economic potential of the cultivated land. Together this leads to a low weight for land use.

Table 26 Allocation of impact score of landscape features.

Landscape	Impact Score				Weight
	4	3	2	1	
Distance to rocky outcrops (m)	0≤d≤50	-	-	d>50	2
Land cover	-	-	Turbines on minority of land cover	Turbines on majority of land cover	1

### 6.3 Organisation and implementation

All data presented in section 6.2 should be accessible for the company to perform an EPAT assessment. Therefore, all relevant data was organised and stored in the library at G7's server. The library was accompanied by a metadata file 'Library datasets' incorporated in the DSET Excel file with type, name, description, online link, organisation, contact person, last update, update frequency, next expected update and comment section of all datasets used in EPAT. This overview should serve as an incentive to keep EPAT up to date and go through the circular methodology process. In addition, this makes the background information accessible for quick checks on methodology and original data.

The collected GIS data was modified as described in section 6.2 and implemented in the GIST part of EPAT where the new groups Birds and Ecology were added in the dataset overview panel. For each impact feature a separate sub-group was created that contained the relevant dataset(s).

The next step was to add the categories Birds and Ecology in two new spreadsheets of the EPAT Excel file of DSET. Each impact feature was inserted in a way that impact scores during an EPAT assessment can be inserted in the file. When all impact scores of a category are inserted, the file automatically calculates the final impact in this category. The impact score per impact feature is multiplied with the corresponding weight. Subsequently, together with other impact features, added up to form the impact number of a category. The range of impact numbers (lowest to highest impact number) is equally divided in four groups: low, medium, high and very high impact. There is an exception when one or more impact features have a very high impact score: it should be indicated whether this feature can be mitigated or not. If mitigation is possible, the final impact is considered high instead of very high and EPAT advises to change the layout of the project and redo the assessment. If no mitigation options are available the total impact is automatically very high and continuation of the project is discouraged independent from the number of very high impacts.

To keep the overview in the EPAT assessment a spreadsheet Total Result is added to DSET. In this part the result of every impact category is automatically added after finalization. When all impact categories are assessed, the total risk and impact is determined using the same methodology as the separate categories: division of the score range (lowest and highest impact number) in the four impacts (low/medium/high/very high). The total impact that corresponds with the impact number is assigned to the whole project. Note that only one impact feature with a very high impact and no mitigation measures already leads to a very high impact of the project.

For convenience a user manual accompanies EPAT that guides the assessor through all different steps in GIST and DSET to complete an assessment successfully. The manual should be approachable so even people without knowledge on EPAT or EIAs can perform the EPAT assessment.

## 6.4 Validation

The last step in the finalization of EPAT is the validation of the tool; running EPAT with existing proposed wind energy projects and compare EPAT results with the predicted impacts as reported in existing official EIA reports. Checking the differences and similarities between EPAT and EIA reports can identify strengths and weaknesses. These can be used to improve EPAT further by starting again at step one of the circular EPAT process. The reference projects are located in different areas of South Africa to represent different avifaunal and ecological characteristics (Figure 4). The projects that have been evaluated are:

- Zen wind energy facility
- Noupoot Wind farm
- Dwarsrug wind farm
- Happy Valley wind farm
- Richards Bay wind energy facility



Figure 4 Locations of the different wind energy facilities that are used to validate EPAT.

## 7 Results

In the result section first the most important legislation playing a role in development of wind energy will be shortly discussed, followed by the design of EPAT QGIS, EPAT DSET and EPAT user manual. The last part of this section consists of the validation of EPAT, five different existing projects will be assessed by EPAT and compared with the official EIA reports.

### 7.1 Legislation

As stated in the introduction an EIA report based on NEMA is obligated for large wind energy development projects in South Africa but this is not the only legislation relevant for environmental impacts of wind energy projects. Specific legislative acts are present for different categories such as visual impact, air safety and biodiversity. The categories Birds and Ecology are both part of the legislative term biodiversity and four different legislation acts are relevant for this term. This section is based on the EIA guideline for renewable energy projects by DEA (2015).

- NEMA

NEMA requires a basic assessment for projects between 10 and 20 MW, this is a more simplistic assessment compared to an EIA report that is obligatory for more common projects larger than 20 MW. An independent EAP should be appointed to perform the assessment and a public participation process should be included. All interested and affected parties should be kept informed and involved in the assessment and should be able to comment on any draft or final report.

An environmental management programme is required to provide goals and targets for environmental planning and regulation in the surroundings. This enforces conditional approval measures and provides a tool for the site management operating the site.

- NEMBA

The National Environmental Management: Biodiversity Act (NEMBA) of 2004 aims to provide within the framework of NEMA protection of species and ecosystems, sustainable use of indigenous biological resources and sharing the benefits from biological resources in a fair way.

- NEMPAA

The National Environmental Management: Protected Areas Act (NEMPAA) of 2003 should take care of the declaration and national management of protected areas, provide a representative network of protected areas in South Africa, promote sustainable utilisation of protected areas for the benefit of people and promote participation of local communities in the management of protected areas.

- NFA

The National Forests Act (NFA) of 1998 promotes the sustainable management and development of forests and provides protection for certain forests and trees. All natural forests are protected and certain activities in forests are regulated.

These legislations form the backbone of the environmental protection in South Africa and wind energy projects should comply with those. EPAT aims to resemble EIA reports and should also comply with the regulations above. In practice, EIA reports provide more detail than legislation. Detailed regulations on buffer distances or how to handle threatened species hardly exist. The detailed information is sometimes provided by guidelines but merely the outcome of judgement by specialists. In general, this judgement is based on specialist expertise and other EIA reports.

### 7.2 EPAT

The development of EPAT in this study is a continuation of the research of Hirschmann (2012) and Starmans (2015) adding the categories Birds and Ecology. The main part of the tool is in the QGIS environment of GIST, it contains almost all data that is used in the assessment. Each impact category has its own group and each feature is again subdivided in a group. Figure 5 shows the interface of the QGIS part of EPAT with very high priority species observations of CAR activated.

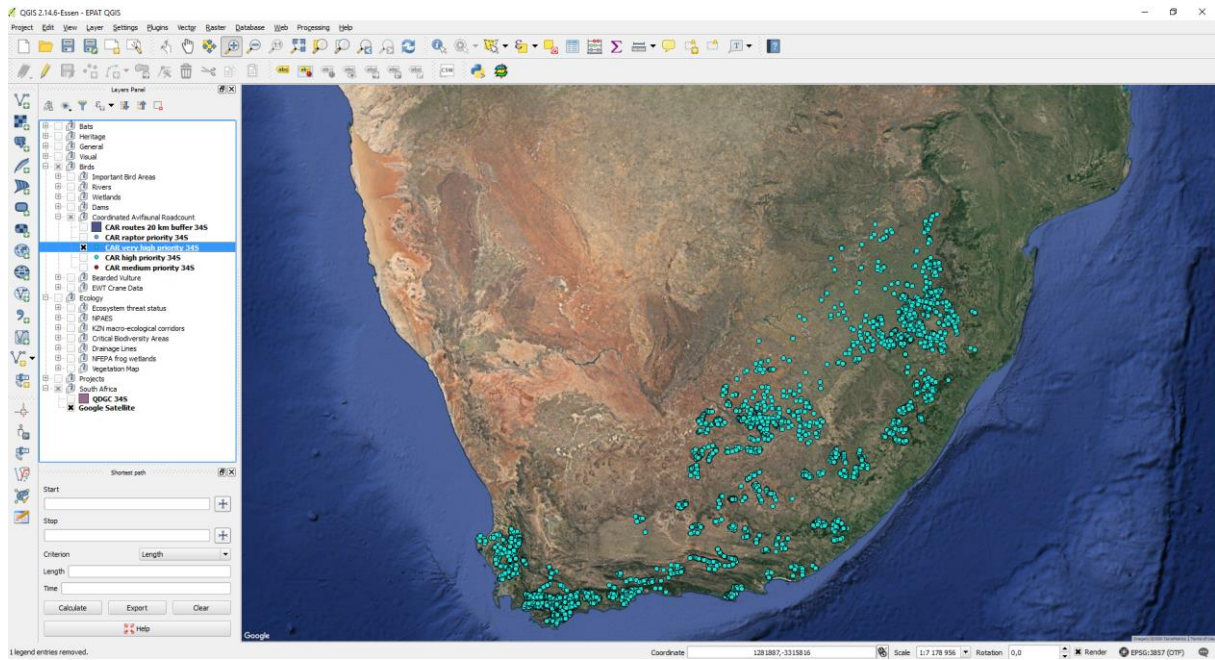


Figure 5 GIST interface of EPAT in a QGIS environment. The dots are observations of CAR very high priority feature.

The EPAT Excel file of DSET is designed to perform the assessment and determines the impact on different impact categories, see Figure 6 and Appendix D. Each impact category has its own worksheet but works in a similar way towards the impact outcome. Each impact category is divided in different steps where each impact feature can be assessed. A step consists of the title, task description, link to the used data, what the scoring criteria are based on and the associated impact scores. The outcome of the task can be entered in the file together with the impact score that is associated with the outcome. Furthermore, there is the possibility to indicate whether mitigation options are possible for the specific feature in case of a very high impact score. In addition, a comment section allows indicating irregularities or detailed information. When all categories are assessed in EPAT there is a worksheet containing all final results per category and the total impact of the project is calculated automatically identical to the individual categories.

EPAT - Birds							
<b>Step 1</b>		Feature: Task: Data used: Scoring criteria based on:	Important Bird Areas (IBA) Determine the distance to the nearest IBA <a href="#">Important Bird Areas</a> <a href="#">Avifaunal Exclusion Zones</a>				
Weighting factor	Scoring criteria		Distance (in km) to nearest IBA	Score	Fatal flaw	Possibility for mitigation (yes or no)	Comments
	Distance (in km) to nearest IBA	Score					
2	$d > 5$	1			no		
	$2 \leq d < 5$	2					
	$d < 2$	3					
<b>Step 2</b>		Feature: Task: Data used: Scoring criteria based on:	Raptors South African Bird Atlas 2 (SABAP) Determine the amount of species in the area counted by SABAP2 <a href="#">SABAP2</a> Self-developed methodology				
Weighting factor	Scoring criteria		Number of species	Score	Fatal flaw	Possibility for mitigation (yes or no)	Comments
	Number of raptor species present in the area	Score					
3	$s=0$	1			no		
	-	2					
	$1 \leq s < 4$	3					
	$s \geq 5$	4					
<b>Step 3</b>		Feature: Task: Data used: Scoring criteria based on:	Very high priority species South African Bird Atlas 2 (SABAP) Determine the amount of species in the area counted by SABAP2 <a href="#">SABAP2</a> Self-developed methodology				

Figure 6 Part of the Excel interface of EPAT Birds assessment, in total the Birds assessment consists of 15 steps.

For background information and checks there are two worksheets in EPAT Excel with information on sources (Library dataset) and information on criteria determination (Library scoring criteria). Each impact feature has a link with the source information in these worksheets.

To successfully perform and complete an EPAT assessment, a step-by-step manual is available in Appendix C to guide assessors even with minimal GIS knowledge through the EPAT process and come up with an indication of the environmental impact of a specific project.

### 7.3 Validation

In this section I used five existing wind project developments to test the quality of EPAT with locations spread across South Africa to cover the variety of the country’s landscape. For each site an EPAT assessment is performed for the categories Birds and Ecology and compared with the EIA reports of the specific site.

#### 7.3.1 Birds

A few features within birds are dependent on data coverage as not the whole country is covered by for example CAR or EWT data. This affects the reliability of this category per location. Furthermore the cliff tool is not included in the validation process because it is a time consuming process where presumably costs are involved to get the right elevation data. In paragraphs 7.3.1.1 to 7.3.1.5, each tested wind farm is discussed and compared on category birds with the existing EIA report.

##### 7.3.1.1 Dwarsrug wind farm

The Dwarsrug wind farm near Loeriesfontein in the Northern Cape province aims for 70 wind turbines and a total generation capacity of 140 MW. The site has no turbine layout available and CAR and EWT crane data are not available in the area, this reduces the level of detail in the outcome. Figure 7 shows impact scores of the Birds assessment performed with EPAT, the total impact on the impact category Birds is medium. The wetland cluster has a high impact score as it is present at the proposed site. A detailed turbine layout would give a more robust outcome for wetland clusters because of the small buffer distances involved and the impact could vary from medium to very high. The user manual indicates when a turbine layout is absent and impact features with small buffers (rivers, both wetland features and dams) are present on site, a high impact should be assigned. The features should be taken into account but are expected to be easily mitigated by micro-siting of the turbines. Often these features are only present on small parts of a site, which also justifies the allocation of high impact instead of very high impact on these features. SABAP2 has quite some observations leading to a high impact in three of the SABAP2 impact features.

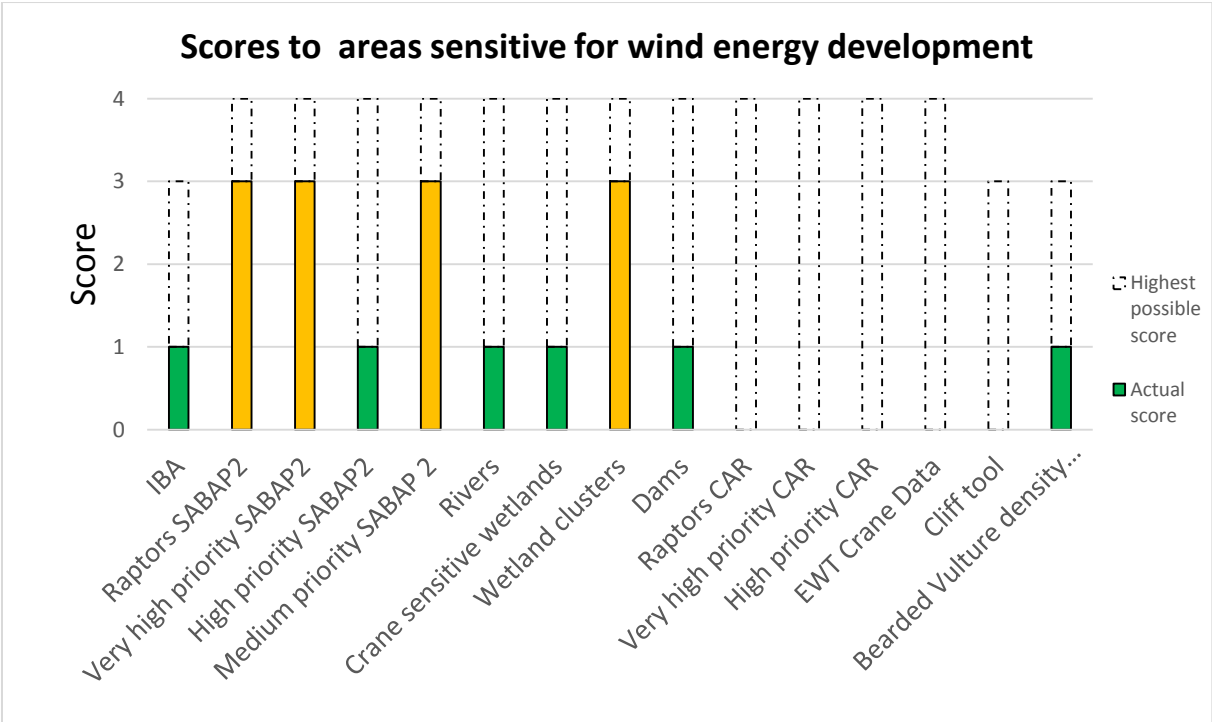


Figure 7 Scores of EPAT Birds assessment of Dwarsrug wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 27 Comparison of EPAT and EIA report of Dwarsrug wind farm on category Birds.

Feature	Outcome EPAT	EIA report
<b>Distance to IBA</b>	90 km	Not mentioned
<b>Raptor species (SABAP2)</b>	Martial Eagle, Lanner Falcon, Lappet-face Vulture	Martial Eagle, Lanner Falcon, Lappet-face Vulture
<b>Very high priority species (SABAP2)</b>	Ludwig's Bustard	Ludwig's Bustard
<b>High priority species (SABAP2)</b>	None	Red Lark, Jackal Buzzard, Kori Bustard
<b>Medium priority species</b>	Burchell's Courser, Double-banded Courser, Booted Eagle, Spotted Eagle-Owl, Southern Pale Chanting Goshawk, Greater Kestrel, Karoo Korhaan	Booted Eagle, Black-chested Snake Eagle, Southern Pale Chanting Goshawk, Greater Kestrel, Karoo Korhaan
<b>Distance to Rivers</b>	27 km	Not mentioned
<b>Distance to Crane wetlands</b>	50 km	1.6 km of closest turbine is a pan (dry wetland)
<b>Distance to Wetland clusters</b>	On site	1.6 km of closest turbine is a pan (dry wetland)
<b>Dams</b>	60 km	Not mentioned
<b>Bearded Vulture density</b>	+50 km	Not mentioned

According to the avifauna specialist report the proposed Dwarsrug wind farm will have a low to medium impact on avifauna which could be reduced in most features to low with appropriate mitigation (Rooyen van, 2014b). This is close to the impact of EPAT, which just reaches the medium category. One of the differences is the high impact for wetland clusters. It turns out that the closest turbine to the pan (dry wetland) indicated in EPAT as wetland cluster is 1.6 km away which means a low impact in EPAT. This would change the EPAT assessment from a medium to a low impact.

Table 27 shows all features of the Birds assessment and the outcomes of both EPAT and specialist report. Impact features that are located on a large distance from the site according to EPAT are not mentioned in the specialist report. All observed raptor and very high priority species have been covered by EPAT, only the high priority Jackal Buzzard, Kori Bustard and Red Lark have not been noted in EPAT but this would not have had a great impact on the total outcome of EPAT. In the medium category two species of Coursers are mentioned in EPAT, the specialist did not observe them but marks them as a high likelihood of occurrence.

Overall, EPAT resembles quite well the specialist report of Dwarsrug wind farm despite the lack of CAR and EWT data. The most important bird species are covered and other impact features also show a good resemblance. However, a turbine layout would definitely improve the resemblance with the EIA report as the wetland cluster would receive a more correct score.

#### 7.3.1.2 Zen WEF

Zen WEF near Gouda in the Western Cape province aims to install 140 MW of wind energy capacity, for this assessment also no turbine layout is available which has negative consequences on the level of detail of the impact features Rivers and Dams. EWT crane data is not incorporated into this EPAT assessment due to no availability. Figure 8 shows the outcomes of the EPAT assessment. The most striking feature is the very high priority category of CAR. This is due to abundance of Blue Cranes in the direct area and is not so easily discarded. This means that the very high impact of very high priority species in CAR cause a very high impact score on Birds for the proposed Zen WEF and continuation of the project is discouraged.

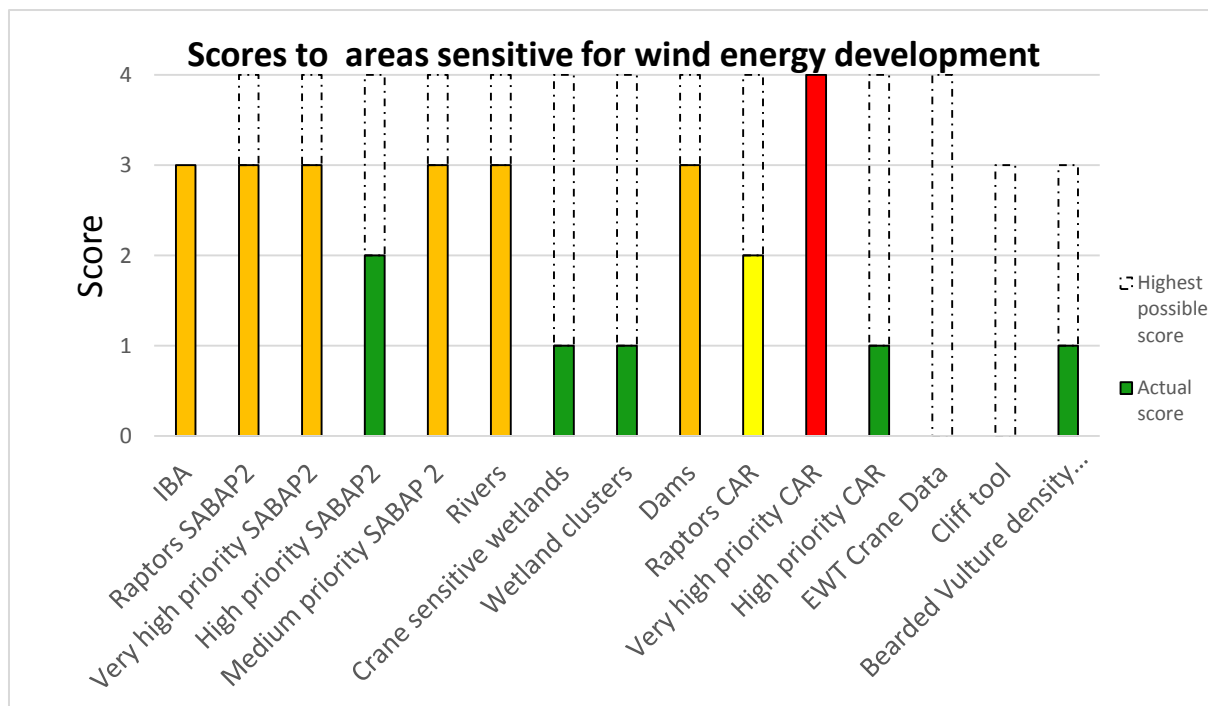


Figure 8 Scores of EPAT Birds assessment of Zen WEF. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 28 Comparison of EPAT and EIA report of Zen WEF on category Birds.

Feature	Outcome EPAT	EIA report
<b>Distance to IBA</b>	On site	Not mentioned
<b>Raptor species (SABAP2+CAR)</b>	Martial Eagle, Black Harrier	Black Harrier, Verreaux's Eagle
<b>Very high priority species (SABAP2+CAR)</b>	Blue Crane	Blue Crane, Great White Pelican
<b>High priority species (SABAP2+CAR)</b>	Peregrine Falcon, Jackal buzzard	Southern Black Korhaan, Jackal Buzzard, African Fish Eagle, Greater Flamingo
<b>Medium priority</b>	Steppe Buzzard, Booted Eagle, Black-shouldered Kite, White Stork	Steppe Buzzard, Booted Eagle, Black-shouldered Kite
<b>Distance to Rivers</b>	On site	No turbines will be placed closer than 250 m from the river
<b>Distance to Crane wetlands</b>	10 km	Three small wetlands on site
<b>Distance to Wetland clusters</b>	26 km	Three small wetlands on site
<b>Dams</b>	Two dams on site	Two dams on site
<b>Bearded Vulture density</b>	+50 km	Not mentioned

Williams (2012) states that the main area of concern is collision of birds with the rotor blades, especially Blue Cranes and Spurwinged Goose. The impact is considered medium with a substantial list of mitigation options. Personal communication with a G7 team member (S. Hirschmann, September 09, 2016) learned that the site was flawed afterwards on bird impact. This is coherent with the very high impact score EPAT gave on the CAR data.

Table 28 shows the outcomes of both EPAT and the specialist report. Some features have different outcomes, on bird observations the specialist mentioned a Verreaux's Eagle while EPAT mentions a Martial Eagle instead. Furthermore, the Great White Pelican and a few high priority species have not been observed in EPAT, but this would not have affected the impact score of these impact features. Other EPAT features except for wetlands match very well with the specialist report. In total EPAT picked



up very well the abundance of birds, especially Blue Cranes, on the site and flaws the project rightfully. A reliable dataset on wetlands would improve EPAT significantly.

**7.3.1.3 Happy Valley WEF**

The planned 30 MW Happy Valley WEF near Humansdorp is another wind energy project assessed with EPAT to validate the tool, as the previous assessed projects there is no wind turbine layout available. The presence of Denham’s Bustard and Blue Cranes cause a very high impact for the CAR very high priority feature. This impact is not easy to mitigate and might have serious consequences for the proposed project: it causes an overall very high impact on the category Birds. See Figure 9 for all individual scores assigned to Happy Valley WEF by EPAT.

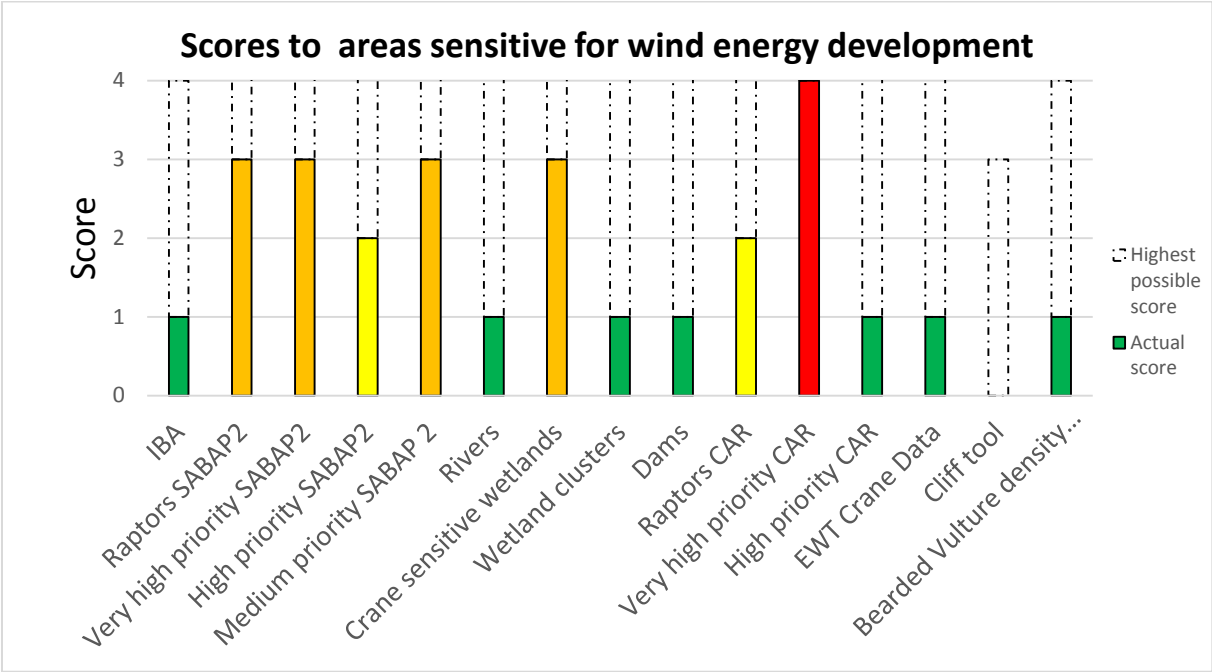


Figure 9 Scores of EPAT Birds assessment of Happy Valley WEF. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 29 Comparison of EPAT and EIA report of Happy Valley WEF on category Birds.

Feature	Outcome EPAT	EIA report
<b>Distance to IBA</b>	19 km	35 km
<b>Raptor species (SABAP2+CAR)</b>	Martial Eagle, Verreaux's Eagle, Black Harrier, Secretarybird	None. However, Martial Eagle, African Marsh Harrier, Black Harrier, Peregrine Falcon, Lanner Falcon are suspected to be present at the site according to the specialist.
<b>Very high priority species (SABAP2+CAR+EWT)</b>	Denham's Bustard, Blue Crane	Denham's Bustard
<b>High priority species (SABAP2+CAR)</b>	Jackal Buzzard	Jackal Buzzard
<b>Medium priority</b>	Steppe Buzzard, Booted Eagle, Long-crested Eagle, Spotted Eagle-Owl, Striped Flufftail, Black-shouldered Kite, Rufous-chested Sparrowhawk, White Stork, Victorin's Warbler	None. However, multiple species are suspected to be present at the site according to the specialist.
<b>Distance to Rivers</b>	25 km	Minor rivers on site
<b>Distance to Crane wetlands</b>	On site	No significant wetlands in the area
<b>Distance to Wetland clusters</b>	4.5 km	No significant wetlands in the area
<b>Dams</b>	1100 meter	Number of small farm dams in the area
<b>Bearded Vulture density</b>	+50 km	Might occur soaring in the area

The avifauna specialist report mentions that the area supports an important number of Blue Cranes and is arguably the most important area for Denham's Bustard in South Africa (Jenkins, 2012). The impact of the development on birds is considered low to medium with mitigation options implemented while in the impact statement the report says that the small WEF will probably have a detrimental effect on regionally or nationally threatened birds especially in its operational phase. In addition, it reports that the impacts should be viewed in the context of at least five other proposed wind energy projects in the same general area.

In Table 29 a comparison of the reported impacts between EPAT and the EIA report can be found. Striking is the little number of bird species observed by the specialist compared to EPAT observations, the specialist site visit was very short. This might explain the small number of species observed by the specialist, as he did expect other species also covered by EPAT to be present at the project site. In general, the avifaunal assessment is concerned about the impact of the project on birds, EPAT is more clear and gives a very high impact due to Denham's Bustard and Blue Crane presence. I was unable to find the conclusive answer for the environmental authorisation of the project so it is hard to say whether the EPAT assessment was too strict or was correct in giving a red flag on category Birds.

#### 7.3.1.4 Noupport wind farm

Noupport wind farm aims to establish a 188.6 MW wind farm, it is situated outside the coverage of CAR observation data and therefore this dataset is not taken into account. EWT Crane observations did have local observations, this even led to a very high impact score mainly due to Bleu Cranes. Other impact features can be seen in Figure 10.

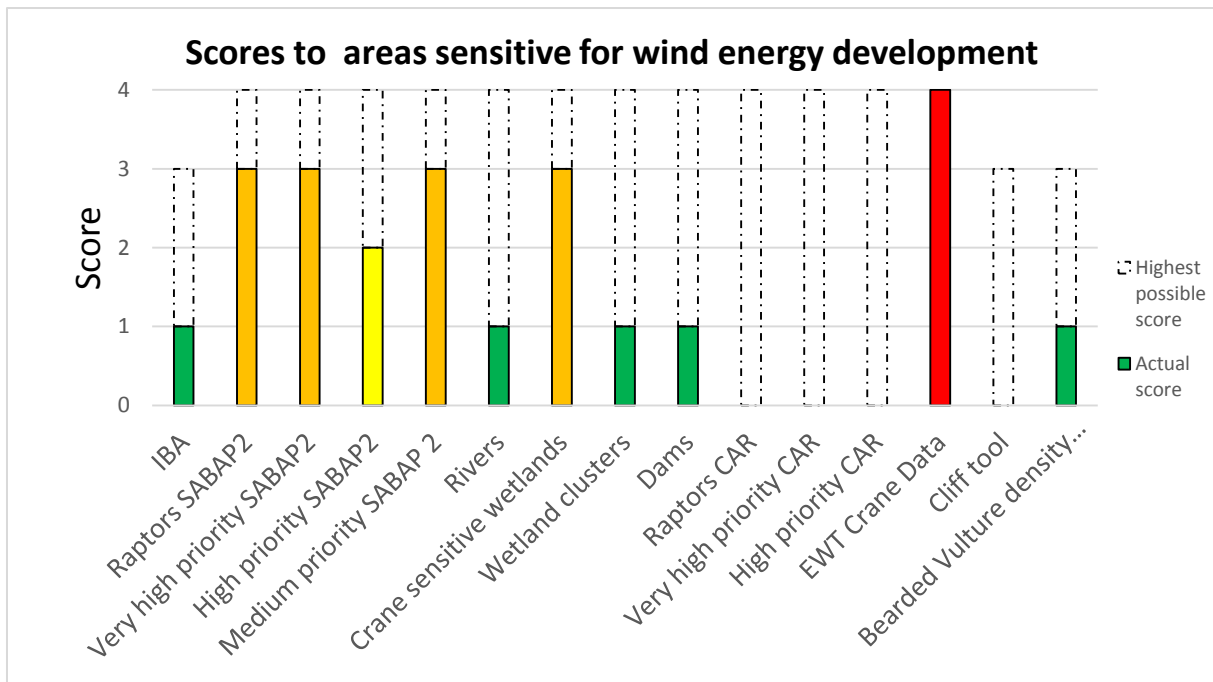


Figure 10 Scores of EPAT Birds assessment of Noupport wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 30 Comparison of EPAT and EIA report of Noupport wind farm on category Birds.

Feature	Outcome EPAT	Draft EIA report
<b>Distance to IBA</b>	22 km	Not mentioned
<b>Raptor species (SABAP2+CAR)</b>	Verreaux's Eagle	Secretarybird
<b>Very high priority species (SABAP2+CAR+EWT)</b>	Blue Crane	Blue Crane
<b>High priority species (SABAP2+CAR)</b>	Jackal Buzzard	Not mentioned
<b>Medium priority</b>	Booted Eagle, Lesser Kestrel, Melodious Lark, African Rock Pipit	Not mentioned
<b>Distance to Rivers</b>	40 km	On site
<b>Distance to Crane wetlands</b>	40 m	Wetlands on site
<b>Distance to Wetland clusters</b>	14 km	Wetlands on site
<b>Dams</b>	9 km	New constructed farm dam on site
<b>Bearded Vulture density</b>	+50 km	Not mentioned

The draft EIA report of Noupport wind farm considers the habitat to be not unique with absence of avian fly-ways (Sivest, 2012). However, the slopes are considered sensitive for soaring birds and the development may have significant detrimental effects on priority species. The impacts are considered medium impact without mitigation measures, including mitigation measures such as the avoidance of a Blue Crane nesting site the impact can be reduced to low.

Table 30 shows the comparison between EPAT and the draft EIA report, unfortunately the specialist reports were not available which decreased the level of detailed information accessible. This is especially visible in the bird observations, there are no clear lists of observed birds during the site visits. The draft EIA identified different wetlands on site which were not identified as such by EPAT but marked as drainage lines. Partly EPAT could not be well evaluated with the draft EIA report such as bird observations but other features like dams and wetlands were covered by the report. Especially the observations of Blue Cranes in EPAT causes a fatal flaw while the report does mention presence of Blue

Cranes but does not consider their presence a reason for a fatal flaw. On satellite imagery it can be seen that the Noupport farm has been realised, so the fatal flaw of EPAT was not a correct measure. However, only 35 turbines have been realised which is not enough according to G7 to have a competitive wind project in current commercial conditions (energyblog, 2016). EPAT is slightly strict in this case but looking at the fact that only 35 turbines have been realized the conservative approach of EPAT could be considered positive as this size of wind farms is not viable anymore.

### 7.3.1.5 Richards Bay wind farm

Proposed Richards Bay wind farm in Kwazulu Natal aims to develop 108 MW of wind energy capacity. The site is located outside CAR and EWT bird observation data, so these features are not included in the EPAT assessment. During a satellite imagery assessment two small dams on site were located next to the already indicated large dam at the site's border. The medium priority SABAP2 observations are just above the high impact limit and therefore the development has a very high impact on medium priority avifauna and, consequently, a very high impact on category Birds. Figure 11 shows the impact scores of all individual Birds impact features.

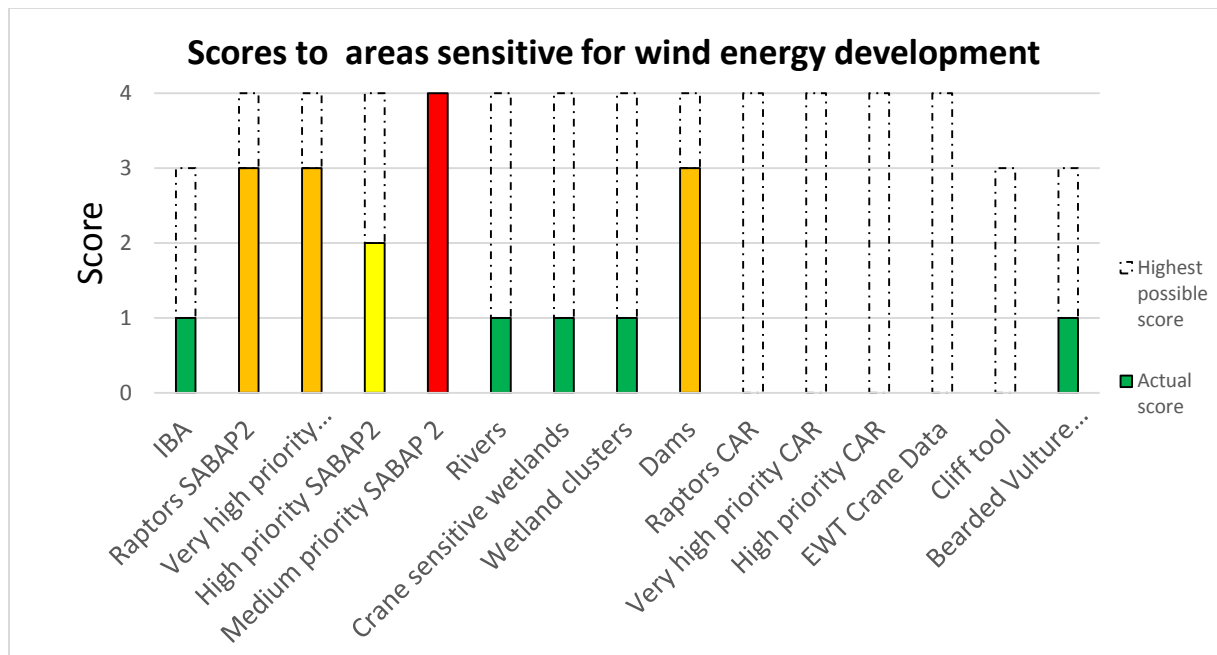


Figure 11 Scores of EPAT Birds assessment of Richards Bay wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 31 Comparison of EPAT and EIA report of Richards Bay wind farm on category Birds.

Feature	Outcome EPAT	Draft EIA report
<b>Distance to IBA</b>	17 km	Not mentioned
<b>Raptor species (SABAP2+CAR)</b>	Lanner Falcon	African Crowned Eagle, African Marsh Harrier, Lanner Falcon
<b>Very high priority species (SABAP2+CAR+EWT)</b>	Grey Crowned Crane, Southern Bald Ibis, Great White Pelican, Yellow-Billed Stork	Yellow-Billed Stork, Black Stork, Great White Pelican,
<b>High priority species (SABAP2+CAR)</b>	Jackal Buzzard, African Fish Eagle	Greater Flamingo, Lesser Flamingo, African Fish Eagle, Jackal Buzzard
<b>Medium priority</b>	Steppe Buzzard, Booted Eagle, Long-crested Eagle, Wahlberg's Eagle, Spotted Eagle-Owl, African Harrier-Hawk, Black-shouldered Kite, Black-winged Lapwing, Black Sparrowhawk, Woolly-necked Stork, Palm-nut Vulture	Woolly-necked Stork, Saddle-Billed Stork, White Stork, Black Chested Snake Eagle, Black-shouldered Kite, Booted Eagle, Steppe Buzzard, Amur Falcon, Spotted Eagle-Owl, Black Kite, African Harrier-Hawk, Black Bellied Bustard
<b>Distance to Rivers</b>	8 km	Smaller rivers on-site with a 50 m buffer instead of the usual 32 m.
<b>Distance to Crane wetlands</b>	3 km	Wetlands associated with the smaller rivers are on site with a 50 m buffer
<b>Distance to Wetland clusters</b>	9 km	Not mentioned
<b>Dams</b>	Dam at site boundary and on site	Dams on site
<b>Bearded Vulture density</b>	+50 km	Not mentioned

The EIA report of Richards Bay considers avifauna on site as low to medium sensitive for wind project development (EOH, 2016b). The Woolly-necked Stork, African Fish Eagle, African Harrier Hawk and the Jackal Buzzard are considered high risk bird species. All other species are mainly active around the large dam adjacent to the project site and will generally stay in that area. Careful planning should make it relatively easy to avoid sensitive avifaunal areas and the avifaunal specialist considers the project acceptable.

Table 31 shows the comparison of EPAT and EIA report on the impact features assessed, not all species observed by the report are covered by EPAT but this would not change EPAT impact scores. The small wetlands at the small rivers on the site have not been observed by EPAT although the small rivers are covered in the EPAT Ecology category. Despite the high number of medium priority species observed in this report the specialist doesn't consider it a big risk, in contrary to the EPAT outcome. This is due to the fact that the majority of birds tend to stay at the large dam adjacent to the project site and do not cross the site regularly. This points out the weakness of EPAT: although the observations are correct, site-specific circumstances invisible with EPAT can change the impact of a site. It emphasizes the importance of site visits by specialists.

### 7.3.2 Ecology

In this section the EPAT ecology assessment is compared with the five existing EIA reports of proposed WEFs already used for validation of category Birds. Each EPAT assessment is discussed separately on the quality of resemblance with the EIA.

#### 7.3.2.1 Dwarsrug wind farm

The Dwarsrug wind farm is evaluated without the turbine layout, which especially has impact on the drainage line feature. Drainage lines only have a buffer of 32 meter and are present on every project site including Dwarsrug. Without a turbine layout the whole project site is flagged with a very high impact even though usually micro-siting could avoid this impact easily. In line with category Birds impact features with small buffers (drainage lines, frog wetlands and rocky outcrops) in Ecology receive a high impact score when present on a site without turbine layout. The total impact score of Ecology is considered low, see Figure 12 for all individual impact scores per feature.

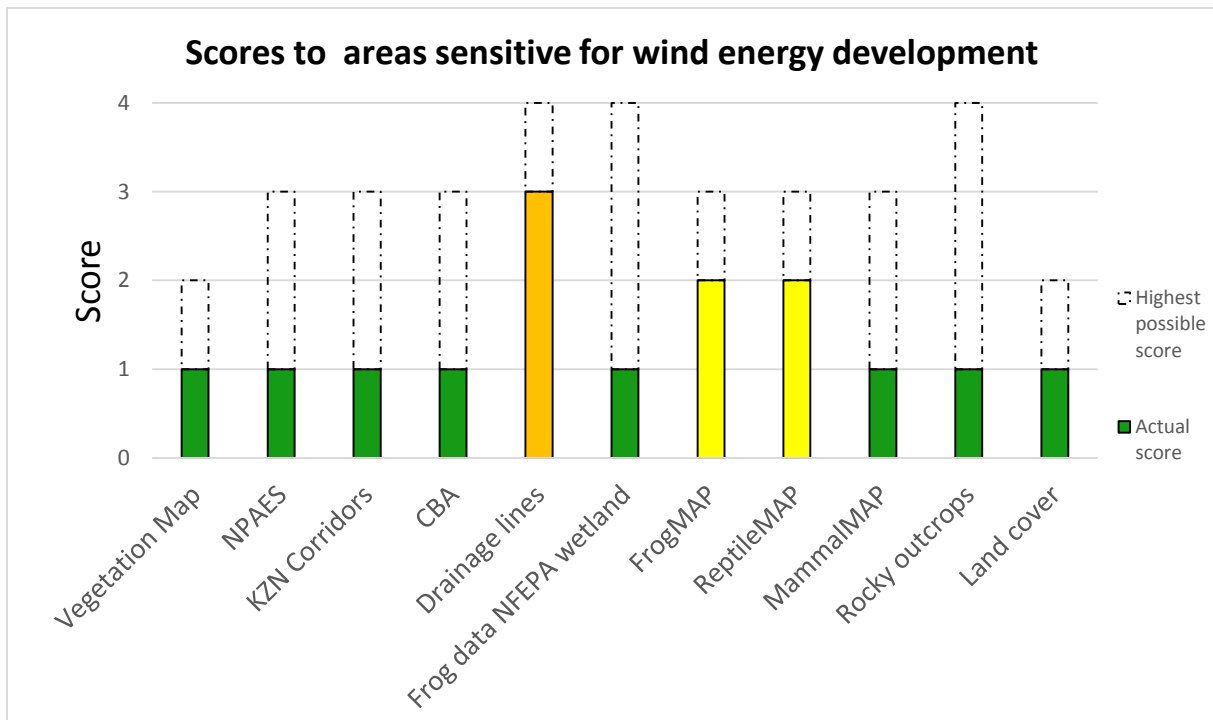


Figure 12 Scores of EPAT Ecology assessment of Dwarsrug wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 32 Comparison of EPAT and EIA report of Dwarsrug wind farm on category Ecology.

Feature	Outcome EPAT	EIA report
<b>Vegetation type</b>	Bushmanland Vloere and Bushmanland Basin Shrubland	Bushmanland Vloere and Bushmanland Basin Shrubland
<b>Threatened ecosystems</b>	Least threatened	Least threatened
<b>Distance to NPAES</b>	40 km	Not near the site
<b>In or out KZN macro-ecological corridors</b>	Out	Not mentioned
<b>In or out CBA</b>	Out	More than 10 km away
<b>Distance to drainage lines</b>	On site	There are some (high sensitivity) drainage lines on the site flowing to a pan. Construction should be avoided around them.
<b>Distance NFEPA frog wetlands</b>	>150 m	No frog wetlands, but a pan is present on the site.
<b>FrogMAP</b>	Only non-threatened species	Only six species known in the area
<b>ReptileMAP</b>	Only non-threatened species	Probably only non-threatened species
<b>MammalMAP</b>	No species	Low impact
<b>Rocky outcrops</b>	None	None
<b>Land cover</b>	Mainly extensive farming	Extensive small stock grazing

Todd (2015) concludes in the biodiversity specialist report that the overall impact of the proposed wind farm is low with a few simple mitigation measures. This coincides with the outcome of the EPAT assessment. The pan was considered a very high sensitivity area in the biodiversity report, this was not indicated in EPAT Ecology but the Birds assessment did cover this sensitive area at Dwarsrug wind farm as wetland.

In Table 32 an overview of the outcomes of EPAT and the specialist report on the different features can be found. The EPAT assessment has very similar results as the specialist report, only the detail is missing in the interpretation of the drainage lines due to the lack of a turbine layout. However, this does not influence the very good resemblance with the EIA report.

7.3.2.2 Zen WEF

The Zen WEF has a medium, nearly high, impact on ecology according to the EPAT assessment. Most striking are the location within a CBA and the presence of a frog wetland on-site. In Figure 13 all EPAT impact scores for Zen WEF can be found.

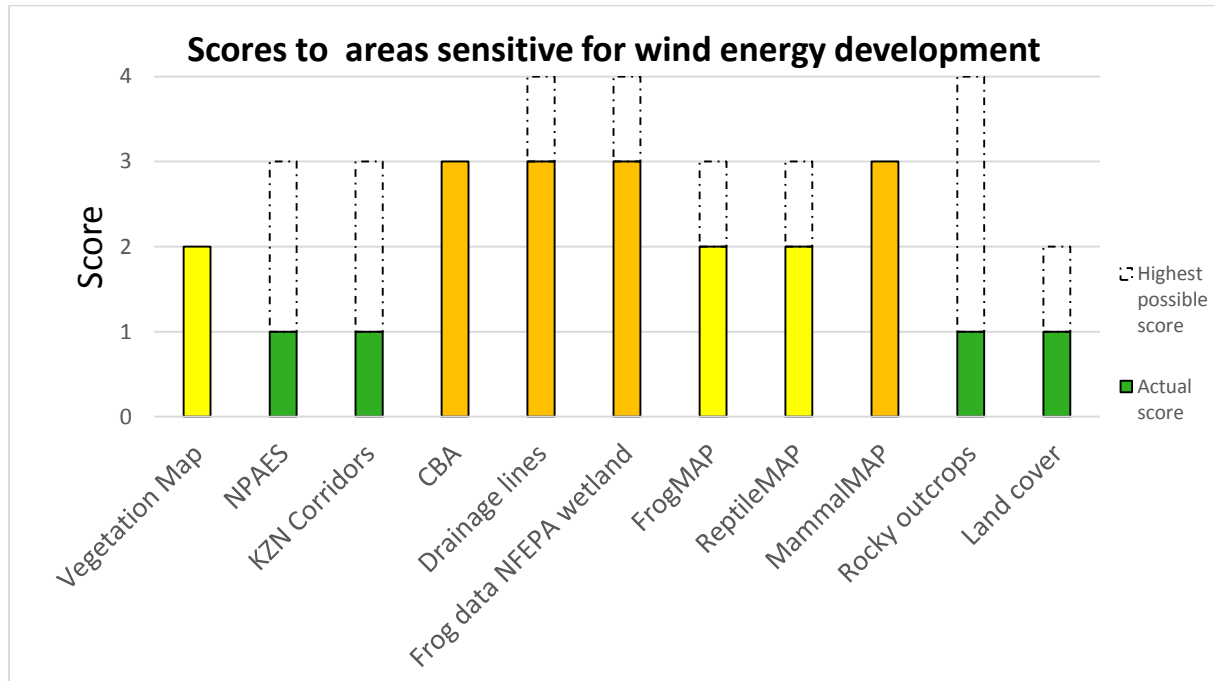


Figure 13 Scores of EPAT Ecology assessment of Zen wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 33 Comparison of EPAT and EIA report of Zen WEF on category Ecology.

Feature	Outcome EPAT	EIA report
<b>Vegetation type</b>	Swartland Shale Renosterveld, Swartland Alluvium Fynbos, Winterhoek Sandstone Fynbos	Swartland Alluvium Fynbos, Atlantis Sand Fynbos, Winterhoek Sandstone Fynbos, Swartland Shale Renosterveld
<b>Threatened ecosystems</b>	Critically endangered	Critically endangered
<b>Distance to NPAES</b>	23 km	Not mentioned
<b>In or out KZN macro-ecological corridors</b>	+50 km	Not mentioned
<b>In or out CBA</b>	CBA on site	CBA on site, but not enough detail to be reliable
<b>Distance to drainage lines</b>	On site	On site, 32-meter buffer
<b>Distance NFEPA frog wetlands</b>	River at site boundary	Not mentioned
<b>FrogMAP</b>	Non-threatened, 9 species	Potentially 13 frog species, of which 1 endangered
<b>ReptileMAP</b>	Non-threatened, 18 species	Potentially 56 species, but most likely less due to development
<b>MammalMAP</b>	1 threatened species, bontebok. 27 species total	Potentially 52 species, but most likely less due to development
<b>Rocky outcrops</b>	One outcrop on site	Numerous on site
<b>Land cover</b>	Mainly agriculture	Predominantly dry land wheat and other cereal production, but some cattle production.

The EIA report considers development at the Zen site as a medium impact on ecology without mitigation and mostly low to medium impact with implemented mitigation measures (Savannah, 2015). The site possesses a wide variety of ecological sensitivity, agricultural parts have very low sensitivity while the Renosterveld and Fynbos areas have a very high sensitivity.

The comparison in Table 33 shows that EPAT resembles the assessment quite well, the number of frogs, reptiles and mammals is smaller than indicated in the EIA but the numbers in the report are potentially occurring species and not actually observed and do not influence the impact scores of EPAT. The final impact score of EPAT is medium and the EIA impact score is low to medium which is again an acceptable EPAT result.

**7.3.2.3 Happy Valley WEF**

The ecological impact on Happy Valley WEF by EPAT is considered medium, nearly high. Drainage lines and rocky outcrops are the most influential high impact features stimulating a higher total ecological impact, also the location within a CBA and presence of a threatened mammal contribute to the impact score as can be seen in Figure 14.

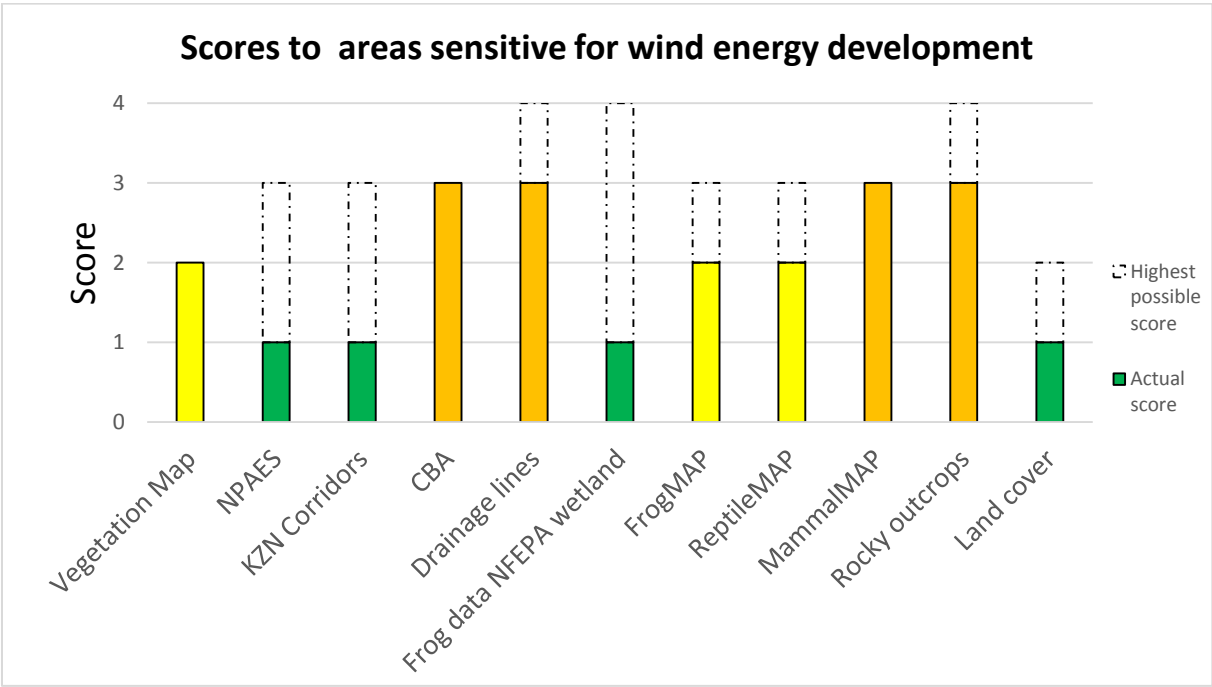


Figure 14 Scores of EPAT Ecology assessment of Happy Valley wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.



Table 34 Comparison of EPAT and EIA report of Happy Valley WEF on category Ecology.

<b>Feature</b>	<b>Outcome EPAT</b>	<b>EIA report</b>
<b>Vegetation type</b>	Humansdorp Shale Renosterveld, Kouga Grassy Sandstone Fynbos	Humansdorp Shale Renosterveld, Kouga Grassy Sandstone Fynbos (dominant)
<b>Threatened ecosystems</b>	The Renosterveld area is endangered	The Renosterveld area is endangered
<b>Distance to NPAES</b>	17 km	Not mentioned
<b>In or out KZN macro-ecological corridors</b>	+50 km	Not mentioned
<b>In or out CBA</b>	On site	CBA 1 and CBA 2 on site. CBA 2 is dominant.
<b>Distance to drainage lines</b>	On site	On site
<b>Distance NFEPA frog wetlands</b>	>150 m	No endangered frog species
<b>FrogMAP</b>	11 non-threatened species	Non-threatened species
<b>ReptileMAP</b>	6 non-threatened species	Non-threatened species
<b>MammalMAP</b>	4 non-threatened species, vulnerable Bontebok present	Non-threatened species
<b>Rocky outcrops</b>	Multiple outcrops in the area	Outcrops present
<b>Land cover</b>	Mainly natural land	Mainly natural land

The ecological specialist report is concerned about the infrastructure in the area that contributes with its high biodiversity to valuable ecosystem goods and services in the surrounding landscape (Hoare, 2011). Without mitigation measures the impact is considered medium to high, while with considerable mitigation measures the impact can be reduced to medium or low. But even with the mitigation impacts development could lead to long-term negative impacts on the ecology of the project site.

Table 34 shows the comparison between EPAT assessment and EIA report outcomes for Happy Valley WEF. EPAT results agree with the outcomes of the specialist report without the mitigation options and lead to a similar impact on ecology. However, in the EIA report little attention is given to rocky outcrops while they are present in large parts of the site. Apparently, the specialist was not concerned about the outcrops and potential biodiversity present or the turbine layout in possession by the specialist was not near rocky outcrops. Even though the absent turbine layout has a high influence on some impact features, EPAT still gives a good comparison result with the EIA report.

#### **7.3.2.4 Noupoot Wind Farm**

Drainage lines and outcrops form two influential components with a high impact of the Noupoot wind farm EPAT assessment, another issue might be that almost the total project site is situated in an NPAES area. The total impact on ecology of Noupoot wind farm is considered medium by EPAT. Other individual impact features (Figure 15) have no extreme impact scores except for the threatened African White-tail Rat observation.

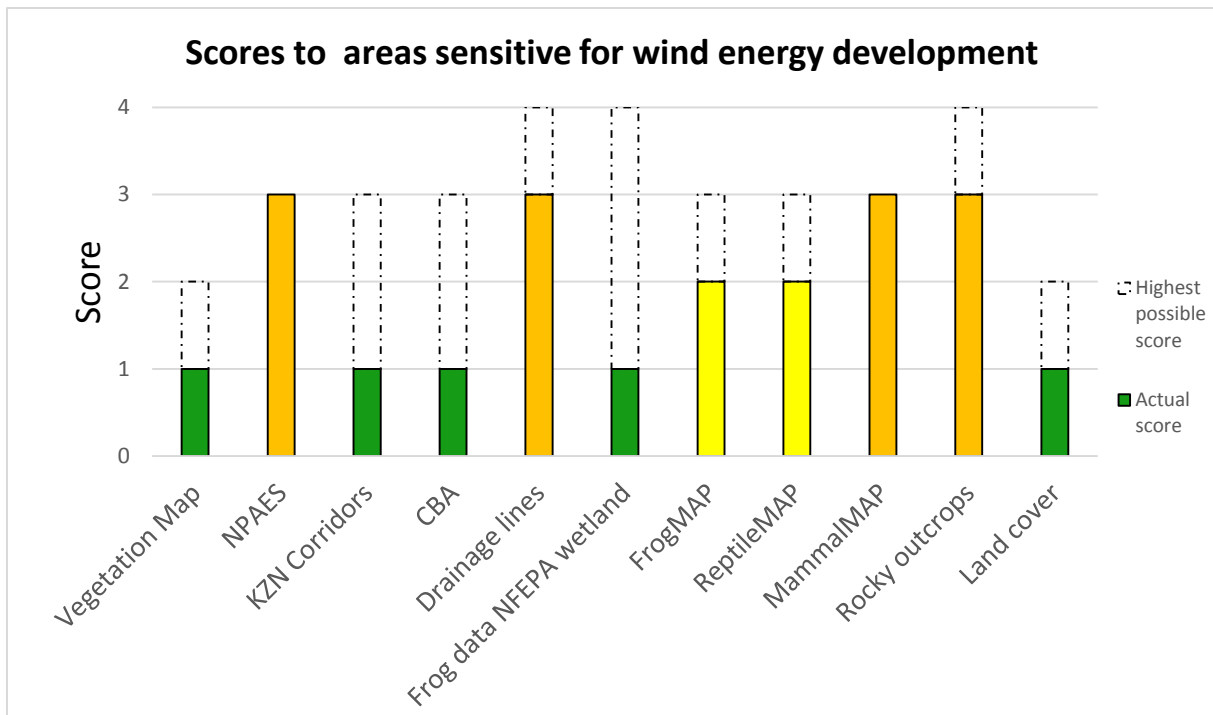


Figure 15 Scores of EPAT Ecology assessment of Noupport wind farm. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 35 Comparison of EPAT and EIA report of Noupport wind farm on category Ecology.

Feature	Outcome EPAT	EIA report
<b>Vegetation type</b>	Karoo Escarpment Grassland, Tarkastad Montane Shrubland, Eastern Upper Karoo	Karoo Escarpment Grassland, Tarkastad Montane Shrubland, Eastern Upper Karoo
<b>Threatened ecosystems</b>	Least threatened	Least threatened
<b>Distance to NPAES</b>	Almost the whole site is NPAES	Not mentioned
<b>In or out KZN macro-ecological corridors</b>	Out	Not mentioned
<b>In or out CBA</b>	Out, 9 km distance	Not near
<b>Distance to drainage lines</b>	On site	On site, sometimes widen into small seasonal wetlands
<b>Distance NFEPA frog wetlands</b>	>150 m	Not mentioned
<b>FrogMAP</b>	3 non-threatened species	Possibly 10 non-threatened species
<b>ReptileMAP</b>	6 non-threatened species	Possibly 21 non-threatened species
<b>MammalMAP</b>	18 species, endangered African White-tail Rat	Several species present, also some threatened species.
<b>Rocky outcrops</b>	On site	On site, marked as sensitive
<b>Land cover</b>	Mainly natural land	Mix of natural veld and unimproved grassland. Recommended that proposed development does not influence agricultural area.

The biggest biodiversity concern in the draft EIA report is habitat loss of species (Sivest, 2012). The impact is considered low to medium without mitigation measures and low with implemented mitigation measures.

Table 35 shows the comparison between EPAT and the draft EIA report of Noupport. EPAT is quite well in line with the draft EIA report. Interestingly, the draft EIA does not mention the NPAES areas at all. Possibly the area was not marked as NPAES at the time the report was written. Furthermore, there are potentially more animal species present at the site than EPAT mentioned. EPAT results are sufficient to be considered a reliable risk assessment for this site.

7.3.2.5 Richards Bay wind farm

Richards Bay shows, as all other test locations, high sensitivity for drainage lines on site because of the absence of a turbine layout. Furthermore, FrogMAP, ReptileMAP and MammalMAP show a high number of observed species which could indicate a high biodiversity in the area although in each feature only one species is marked as threatened. The overall impact on ecology is considered medium, all individual impact scores of Richards Bay WEF Ecology category can be seen in Figure 16.

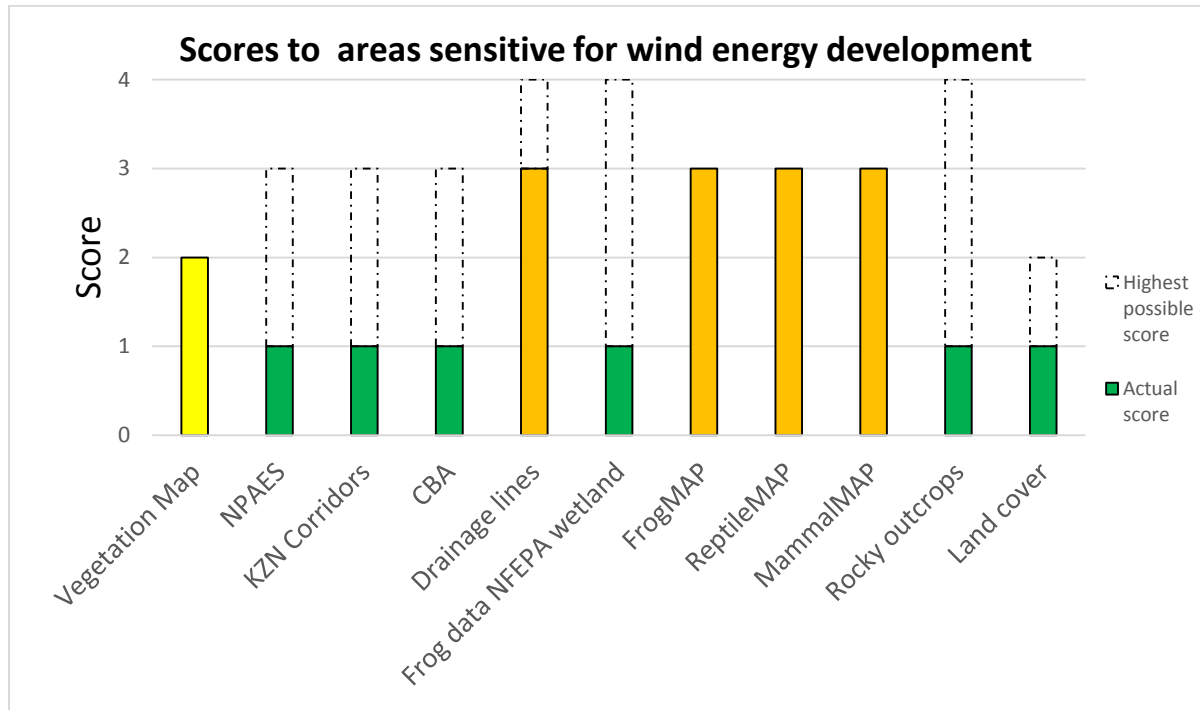


Figure 16 Scores of EPAT Ecology assessment of Richards Bay WEF. The coloured bars (green, yellow, orange and red) represent the actual score, the white bars represent the highest possible score.

Table 36 Comparison of EPAT and EIA report of Richards Bay WEF on category Ecology.

Feature	Outcome EPAT	EIA report
<b>Vegetation type</b>	Maputaland Coastal Belt, Subtropical Alluvial Vegetation, Zululand Coastal Thornveld	Maputaland Coastal Belt, Zululand Coastal Thornveld
<b>Threatened ecosystems</b>	Zululand Coastal Thornveld is endangered	Zululand Coastal Thornveld is endangered, patches of high sensitivity present on site
<b>Distance to NPAES</b>	17 km	Not on site
<b>In or out KZN macro-ecological corridors</b>	13 km outside	Not on site
<b>In or out CBA</b>	3.2 km outside	Only a small area of CBA 3
<b>Distance to drainage lines</b>	On site	On site
<b>Distance NFEPA frog wetlands</b>	>150 m	Wetlands are on site
<b>FrogMAP</b>	32 species, vulnerable Spotted Shovel-nosed Frog	Not mentioned
<b>ReptileMAP</b>	29 species, vulnerable Nile Crocodile	Not mentioned
<b>MammalMAP</b>	46 species, vulnerable Blue Duiker	Potentially 55 species, vulnerable Blue Duiker and endangered White-tailed Mouse
<b>Rocky outcrops</b>	No rocky outcrops	No rocky outcrops mentioned
<b>Land cover</b>	Mainly Agriculture	Mainly agricultural, residential or industrial

The EIA report considers the site from an ecological perspective highly transformed due to agricultural activities, only small patches of indigenous vegetation are left and no species of special concern were identified on the site (EOH, 2016b). The specialist concludes that the site is of low significance from an ecological perspective.

Table 36 shows the comparison between the EPAT assessment and the EIA report of category Ecology. Although wetlands are not marked on the map, drainage lines cover the same area as the wetlands indicated in the EIA report. Other outcomes of the EPAT Ecology assessment agree with the statements of the EIA report. Although the overall impact score is estimated higher by EPAT, it is still an acceptable result.

Next to the outcome, it is also important that the EPAT assessment can be executed quickly. On average, the Birds category tests take 45 minutes to perform. The availability of observation data has a large influence on the time needed to complete the exercise. Note that in none of the test assessments the cliff tool was used, this would significantly increase the time needed since data needs to be collected and several GIS data alterations need to be done. The Ecology assessment is a little shorter with an average time of 30 minutes. Both categories can be assessed rather quick to give an indication of the expected environmental impacts, it should be mentioned that a person new to EPAT could take some more time to complete the exercises.

## 8 Discussion

Scientific literature on environmental pre-feasibility tools for wind energy in particular is scarce. The approach of Aydin et al. (2010) is close to the one of EPAT with a GIS-based decision support tool for wind energy in Turkey. The tool integrates wind energy potential maps with environmental objectives including corresponding buffers based on scientific literature and Turkish legislation to mark areas suitable for wind energy development.

To assess potential collision impacts of wind turbines on birds, ten avian Collision Risk Models (CRM) are described in scientific literature (Masden & Cook, 2016). Most of the models take into account the probability of collision per bird and a measure of the number of birds within the risk window to estimate the number of collisions per time frame. In the UK these models are frequently used although they have some major limitations (Masden & Cook, 2016). One of those limitations is the amount and detail of data needed. Data such as number of birds passing per hour, flight path and flights within the risk window are very specific data that cannot be determined from available datasets in EPAT. Therefore, no CRM was used to assess the collision risk in EPAT. It is assumed that this does not have implications for the quality of the EPAT research as South African EIA reports do not use CRMs as well. It is beyond the scope of this study, but it would be interesting to look into possibilities to improve South African EIA processes by the use of CRMs. For EPAT however, CRMs are not an option because of the limits on data availability.

Impact on birds is also one of the environmental objectives of Aydin et al. (2010), within this objective are wildlife conservation areas, nature reserves, wetlands and bird migration pathways. South African data on migration pathways is not available in EPAT but it is also less relevant since the country is the most southern part of the continent and seasonal migration is not seen as an issue in South African wind energy development (Ralston, 2016). Bird observations are an important aspect of EPAT, but the availability of detailed bird observations can be an issue. Ideally all priority species vulnerable for wind energy development should be monitored across South Africa. This would not only improve knowledge on distribution, but also give more insight in the actual vulnerability for wind energy development. Included observations in EPAT form a big advantage on the tool of Aydin et al. (2010) which does not contain information on actual avifaunal conditions at a given location. To improve data availability in South Africa there was a call during a conference of the International Association for Impact Assessments South Africa (IAIASa) to bird and ecology specialists and EAPs to publish recorded data for EIA purposes in the citizen science projects of ADU such as SABAP2 (Underhill, 2016). Publishing the data improves availability of observation data which can further improve, next to EPAT itself, species specific knowledge on wind energy vulnerability and could lead to an improvement of the priority species list of Birdlife South Africa. Despite bird data do not cover the whole country, the bird observations are very well in line with observations by specialists in the field.

In the ecology part of EPAT most of the impact features do not have clear boundaries, there is for example a clear desire to have no developments within CBAs or threatened ecosystem areas but in practice it turns out that these areas are used for wind energy development. It is therefore challenging to process these features correctly in EPAT. The semi-official character of CBAs and other impact features play a role in this situation, DEA plans to incorporate CBAs into legislation and this might influence the impact score of CBAs in EPAT in the future.

Aydin et al. (2010) uses three criteria in its ecology part: ecological sensitive areas, water bodies and areas of ecological value. It remains unclear whether these criteria are well defined. EPAT provides some more detail with the inclusion of drainage lines and fauna observations of frogs, reptiles and mammals. These observations however, are very coarse and more detail would allow a better assessments on fauna observations in EPAT. Despite the low level of detail, improvement of data presumably has at most influence on micro-siting of turbines.

DSET offers a spreadsheet where all results of the different impact categories are presented and a total impact score is calculated by adding up all impact scores. With the current method of calculating the total impact, the category with the most impact features has the largest influence. Categories with the most impact features are in general the more important ones covering more topics. Due to time constraints the current method was not evaluated or adapted. An evaluation of the total impact method should determine the need of a revision. An alternative that would be equal for all impact categories would be that the impact categories should first be normalised before a total impact is calculated.

Testing of EPAT showed a majority of agreements with EIA reports, some differences however, were also present. All tested projects had no turbine layout available and caused more uncertainty in the impact scores for impact features with small buffers such as rivers, dams and drainage lines. When assessing real projects this problem should not arise since turbine layouts should be included. The biggest diversion of EPAT results compared to an EIA report was at Richards Bay WEF. The high number of medium priority bird species of SABAP2 caused a fatal flaw of the project in EPAT while the EIA report did not find a very high impact by these bird species. This has to do with the large dam adjacent to the project area which attracts lots of water birds. These birds however, do not fly over the proposed wind farm and cause no environmental risk in the development of the wind project. This points out the indicative character of EPAT, it is important to do site visits to confirm outcomes of EPAT before deciding to go further with a project.

Despite some data limitations EPAT is compared to the tool developed by Aydin et al. (2010) more sophisticated in the number of categories and the detail in those categories. More availability of data and dataset updates would improve EPAT even more. After Aydin et al. (2010), a useful future step in the development of EPAT would be the integration of South African wind data to be able to determine quickly low risk and high yield wind areas.

## 9 Conclusion

The purpose of this research was to extend the environmental assessment tool EPAT by G7 with the impact categories Birds and Ecology in order to resemble South African EIA reports in an early stage of wind project development to decrease company risk. By analysing legislation and specialist reports of existing EIAs, necessary data was identified and collected when available. Collected data was implemented in QGIS to make a spatial assessment possible. On the basis of the data different impact features were designed where legislation and mainly EIA guidelines are integrated in Excel into an impact score with four different impact categories: low, medium, high and very high.

All impact features of a category together determined the total impact score of this category. The four impact scores were evenly divided between the lowest and highest impact score of a category. A very high impact score of any of the features leads to a discouragement of the project, although the possibility of mitigation measures can lower this impact to high. A user manual also suited for persons without background knowledge on QGIS and EIAs accompanies the tool. The last phase of the research was comparing EPAT with existing projects to test the reliability of the designed tool.

The validation of EPAT was done by assessing Ecology and Birds for five proposed wind energy development projects across South Africa and compares the results with the actual EIA outcomes of those projects. The EPAT results of Birds were reliable in resembling the EIA specialist reports of the five projects assessed, EPAT turned out to be a solid tool to indicate avifaunal risk in an early stage of wind project development. Often, the most important bird species were picked up by the observations in SABAP2 or CAR and integrated well into scoring criteria that determine the development impact despite that these datasets did not cover the whole country. Other landscape features indicating bird activity were also well implemented except for wetlands where no reliable dataset was available. Different very high impact scores have been assigned in the testing process of which Richards Bay WEF shows a pitfall of EPAT Birds. A high amount of medium priority species was observed by SABAP2 and led to a very high impact score, mainly due to water birds attracted to the large dam adjacent to the project area. In the specialist report it turned out that those birds did not fly over the project property and development did not pose a risk to birds in the area. A specialist on site can only conclude this, so it is advised to always send a bird specialist on site before continuation of a project towards a next phase.

Ecology has the challenge of limited data available in both amount and scale of the data. In EIA reports ecological impact can often be mitigated by micro-siting of turbines and associated infrastructure, therefore the absence of turbine layouts in the tested projects was not ideal. Despite the lack of data and the absence of turbine layouts in the validation part, the Ecology category of EPAT was reliable in resembling EIA reports and gave a good indication on the challenges on ecology on a specific site. Especially drainage lines were a consistent factor in EPAT and EIA reports that make up an important part of the ecological impact. Validation on ecology by a specialist is strongly recommended as available data is coarse and does not necessarily reflect the conditions on site.

With the added categories Birds and Ecology EPAT is a complete environmental assessment tool including the most important subjects featured in EIA reports and is ready to be used for new wind energy projects by G7. EPAT can give in an early stage of development a proper indication of the environmental risks involved in the development of wind energy in a specific area anywhere in South Africa. It can help in strategic decisions on which projects should be prioritized. Due to the circular character of the methodology it is possible to adjust EPAT to changing insights and legislation and new available or updated datasets. All the features together make EPAT a useful and reliable tool in South Africa for current and future wind energy development that contributes to a better assessment of potential environmental risks and impacts.

## 10 References

- ADU. (2016a). Virtual Museum of African Mammals. Retrieved August 15, 2016, from [http://vmus.adu.org.za/vm\\_metadata.php?database=vimma&prj\\_acronym=MammalMAP&db=vimma&URL=http://mammalmap.adu.org.za/&Logo=images/vimma\\_logo.png&Headline=Virtual Museum of African Mammals&Use\\_main\\_filter=0&User\\_id=&Full\\_name=&serve\\_sp\\_list=1&drop\\_down\\_li](http://vmus.adu.org.za/vm_metadata.php?database=vimma&prj_acronym=MammalMAP&db=vimma&URL=http://mammalmap.adu.org.za/&Logo=images/vimma_logo.png&Headline=Virtual%20Museum%20of%20African%20Mammals&Use_main_filter=0&User_id=&Full_name=&serve_sp_list=1&drop_down_li)
- ADU. (2016b). VM FrogMAP. Retrieved July 21, 2016, from [http://vmus.adu.org.za/vm\\_metadata.php?database=safap&prj\\_acronym=FrogMAP&db=safap&URL=http://adu.org.za/frog\\_atlas.php&Logo=images/frogmap\\_logo.png&Headline=Frog Atlas of Southern African&Use\\_main\\_filter=0&User\\_id=&Full\\_name=&serve\\_sp\\_list=1&drop\\_down\\_li](http://vmus.adu.org.za/vm_metadata.php?database=safap&prj_acronym=FrogMAP&db=safap&URL=http://adu.org.za/frog_atlas.php&Logo=images/frogmap_logo.png&Headline=Frog%20Atlas%20of%20Southern%20African&Use_main_filter=0&User_id=&Full_name=&serve_sp_list=1&drop_down_li)
- ADU. (2016c). VM Reptile Atlas of Southern Africa. Retrieved July 21, 2016, from [http://vmus.adu.org.za/vm\\_search.php?database=sarca&prj\\_acronym=ReptileMAP&db=sarca&URL=http://sarca.adu.org.za&Logo=images/reptilemap\\_logo.png&Headline=Reptile Atlas of Southern Africa&Use\\_main\\_filter=0&User\\_id=&Full\\_name=&serve\\_sp\\_list=1&drop\\_down\\_list=](http://vmus.adu.org.za/vm_search.php?database=sarca&prj_acronym=ReptileMAP&db=sarca&URL=http://sarca.adu.org.za&Logo=images/reptilemap_logo.png&Headline=Reptile%20Atlas%20of%20Southern%20Africa&Use_main_filter=0&User_id=&Full_name=&serve_sp_list=1&drop_down_list=)
- Ajodhapersadh, R., Jodas, K., & Wood, G. (2012). *DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT PROPOSED MAINSTREAM SPRINGFONTEIN WIND ENERGY FACILITY*. Retrieved from [www.savannahsa.com](http://www.savannahsa.com)
- Andersen, R., Sanders, S., Flint, S., & Sterner, D. (2007). *CALIFORNIA GUIDELINES FOR REDUCING IMPACTS TO BIRDS AND BATS FROM WIND ENERGY DEVELOPMENT*. Retrieved from <http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF>
- APLIC. (2006). *Suggested Practices for Avian Protection On Power Lines: The State of the Art in 2006*. Avian Power Line Interaction Committee.
- Aydin, N. Y., Kentel, E., & Duzgun, S. (2010). GIS-based environmental assessment of wind energy systems for spatial planning: A case study from Western Turkey. *Renewable and Sustainable Energy Reviews, 14*(1), 364–373. <http://doi.org/10.1016/j.rser.2009.07.023>
- Birdlife. (2014). *Wind Energy Priority Bird Species list South Africa*.
- Birdlife. (2016a). Birdlife International Country Profile South Africa. Retrieved April 25, 2016, from <http://www.birdlife.org/datazone/country/south-africa>
- Birdlife. (2016b). *Position Statement on the development of Wind Energy facilities in Important Bird and Biodiversity Areas*.
- CAR. (2016). CAR website.
- CES. (2012). *Environmental impact assessment proposed Haverfontein wind energy project*.
- CES. (2015). *Proposed Waaihoek Wind Energy Facility, Ecological Report*.
- Colloty, S. (2016). *Brandvalley wind energy facility aquatic assessment*. Port Elizabeth.
- CSIR. (2013). Strategic Environmental Assessment Section 2 Landscape, (January), 1–30.
- DEA. (2015). *EIA Guideline for Renewable Energy Projects*. Pretoria. Retrieved from [https://www.environment.gov.za/sites/default/files/legislations/EIA\\_guidelineforrenewableenergyprojects.pdf](https://www.environment.gov.za/sites/default/files/legislations/EIA_guidelineforrenewableenergyprojects.pdf)
- DEA. (2016). National Protected Areas Expansion Strategy, Department of Environmental Affairs. Retrieved July 19, 2016, from [https://www.environment.gov.za/documents/strategicdocuments?q=content/strategic\\_docs/national\\_protectedareas\\_expansion\\_strategy](https://www.environment.gov.za/documents/strategicdocuments?q=content/strategic_docs/national_protectedareas_expansion_strategy)
- DEAT. (2004). *Strategic Environmental Assessment*. Pretoria. Retrieved from [https://www.environment.gov.za/sites/default/files/docs/series10\\_strategic\\_environmental\\_assessment.pdf](https://www.environment.gov.za/sites/default/files/docs/series10_strategic_environmental_assessment.pdf)
- Deken, F. (2013). *The Qualitative Research Interview, research interview training*. Delft.
- DRDLR, D. of R. D. and L. R. (2013). SA Mapsheet Referencing. Retrieved May 30, 2016, from <http://www.ngi.gov.za/index.php/what-we-do/maps-and-geospatial-information/41-sa-mapsheet-referencing>
- Drewitt, A. L., & Langston, R. H. W. (2006). Assessing the impacts of wind farms on birds. *Ibis, 148*(SUPPL. 1), 29–42. <http://doi.org/10.1111/j.1474-919X.2006.00516.x>



- DWS. (2015). *Drainage lines South Africa*.
- DWS. (2016a). Department of Water and Sanitation Dam Safety Office; Overlay for registered dams, February 2016. Retrieved June 15, 2016, from <https://www.dwa.gov.za/DSO/Publications.aspx>
- DWS. (2016b). Water Use License Application. Retrieved August 22, 2016, from <https://www.dwa.gov.za/war/licenceprocess.aspx>
- Eberhard, A. (2013). *Feedin Tariffs or Auctions? Procuring Renewable Energy Supply in South Africa*.
- Eberhard, A., Leigland, J., & Kolker, J. (2014). South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons, (May), 1–56. Retrieved from <http://www.ee.co.za/article/south-africas-reipp-programme-success-factors-lessons.html>
- Eichhorn, M., Johst, K., Seppelt, R., & Drechsler, M. (2012). Model-based estimation of collision risks of predatory birds with wind turbines. *Ecology and Society*, 17(2). <http://doi.org/org/10.5751/ES-04594-170201>
- energyblog. (2016). Noupoot Mainstream Wind. Retrieved October 24, 2016, from <http://energy.org.za/knowledge-tools/project-database/noupoot-mainstream-wind>
- Energyblog. (2016). Project Database. Retrieved March 15, 2016, from [http://energy.org.za/knowledge-tools/project-database?art\\_title=&programme=Other&status=&project\\_type=Onshore+Wind&province=&cck=project&search=project\\_lookup&task=search](http://energy.org.za/knowledge-tools/project-database?art_title=&programme=Other&status=&project_type=Onshore+Wind&province=&cck=project&search=project_lookup&task=search)
- EOH. (2016a). *Draft EIA for the proposed Rietkloof wind energy facility*.
- EOH. (2016b). *Proposed Richards Bay wind energy project Environmental Impact Assessment report*.
- EWT. (2014). *Aberdeen Wind Energy Facility: Pre-construction bird monitoring and avifaunal assessment*.
- FrogMAP. (2016). About FrogMAP. Retrieved July 21, 2016, from <http://frogmap.adu.org.za/>
- GBIF. (2016). Global Biodiversity Information Facility. Retrieved August 15, 2016, from <http://www.gbif.org/>
- Greencape. (2016). 2016 Market Intelligence Report. <http://doi.org/10.1017/CBO9781107415324.004>
- Hirschmann, S. (2012). *Development of a Desktop Tool for the Assessment of the Potential Environmental Risks And Impacts of Wind Energy Power Plants in South Africa*. HAW Hamburg.
- Hoare, D. (2011). *Happy Valley WEF: Ecological impact assessment*.
- IEA. (2016). Renewable Energy. Retrieved March 5, 2016, from <http://www.iea.org/aboutus/faqs/renewableenergy/>
- Jenkins, A. (2012). *Happy Valley Wind Energy Facility: Avian impact assessment*.
- Jenkins, A. (2014). *Strategic Environmental Assessment: Appendix A5 Birds Scoping Assessment Report*.
- Jenkins, A., Rooyen van, C., Smallie, J., Harrison, J., Diamond, M., Smit-Robinson, H., & Ralston, S. (2015). *Birds and Wind Energy Best-Practice Guidelines*.
- Jewitt, D. (2011). The Macro-Ecological Corridors of KZN. Retrieved from [http://www.dargleconservancy.org.za/documents/Macro Ecological Corridors of KZN Conservancies AGM.pdf](http://www.dargleconservancy.org.za/documents/Macro%20Ecological%20Corridors%20of%20KZN%20Conservancies%20AGM.pdf)
- Katzner, T., Bennett, V., Duerr, A., Braham, M., & Hale, A. (2016). Wind energy development: methods for assessing risks to birds and bats pre-construction. *Human-Wildlife Interactions*, 10(1), 42–52.
- Kikuchi, R. (2008). Adverse impacts of wind power generation on collision behaviour of birds and anti-predator behaviour of squirrels. *Journal for Nature Conservation*, 16(1), 44–55. <http://doi.org/10.1016/j.jnc.2007.11.001>
- Krijgsveld, K. L., Akershoek, K., Schenk, F., Dijk, F., & Dirksen, S. (2009). Collision Risk of Birds with Modern Large Wind Turbines. *Ardea*, 97(3), 357–366. <http://doi.org/10.5253/078.097.0311>
- Krupa, J., & Burch, S. (2011). A new energy future for South Africa: The political ecology of South African renewable energy. *Energy Policy*, 39(10), 6254–6261. <http://doi.org/10.1016/j.enpol.2011.07.024>
- Larsen, R., Holmern, T., Prager, S. D., Maliti, H., & Røskaft, E. (2009). Using the extended quarter degree grid

- cell system to unify mapping and sharing of biodiversity data. *African Journal of Ecology*, 47(3), 382–392. <http://doi.org/10.1111/j.1365-2028.2008.00997.x>
- Leung, D. Y. C., & Yang, Y. (2012). Wind energy development and its environmental impact: A review. *Renewable and Sustainable Energy Reviews*, 16(1), 1031–1039. <http://doi.org/10.1016/j.rser.2011.09.024>
- Levendal, M., & Lochner, P. (2011). *Final Environmental Impact Assessment Report BioTherm wind energy project Excelsior*.
- Masden, E. A., & Cook, A. S. C. P. (2016). Avian collision risk models for wind energy impact assessments. *Environmental Impact Assessment Review*, 56, 43–49. <http://doi.org/10.1016/j.eiar.2015.09.001>
- Masden, E. A., Fox, A. D., Furness, R. W., Bullman, R., & Haydon, D. T. (2010). Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. *Environmental Impact Assessment Review*, 30(1), 1–7. <http://doi.org/10.1016/j.eiar.2009.05.002>
- Mayer, J. von, & Jodas, K. (2010). *Draft EIA report Proposed Amakhala Emoyeni Wind Energy Facility*.
- McCarthy, A. (2016). Personal communication on CAR dataset 09-05-2016.
- Mcdonald, D. J. (2012). Botanical Scoping for Pofadder Renewable Energy Facility , Northern Cape Province, (July).
- Nel, J. L., Murray, K. M., Maherry, A. M., Petersen, C. P., Roux, D. J., Driver, A., ... Downsborough, L. Nienaber, S. (2011). *Technical Report for the National Freshwater Ecosystem Priority Areas project*.
- Ralston, S. (2016). Personal communication 20-04-2016.
- Reid, T., Krüger, S., Whitfield, D. P., & Amar, A. (2015). Using spatial analyses of bearded vulture movements in southern Africa to inform wind turbine placement. *Journal of Applied Ecology*, 52(4), 881–892. <http://doi.org/10.1111/1365-2664.12468>
- REN21. (2015). *Renewables 2015 Status Report*.
- Rooyen van, C. (2012). *Bird Impact Scoping Report July 2012 Pofadder WEF*.
- Rooyen van, C. (2014a). *Bird Impact Assessment Report for the Proposed Wind Energy Facility and associated infrastructure for Waaihoek Energy Facility*.
- Rooyen van, C. (2014b). Dwarsrug Wind Energy Facility Bird Impact Assessment Report December 2014, (December).
- SABAP2. (2016). Home page SABAP2. Retrieved June 10, 2016, from <http://sabap2.adu.org.za/>
- Saidur, R., Rahim, N. A., Islam, M. R., & Solangi, K. H. (2011). Environmental impact of wind energy. *Renewable and Sustainable Energy Reviews*, 15(5), 2423–2430. <http://doi.org/10.1016/j.rser.2011.02.024>
- SANBI. (2010). *GIS Metadata detailed report NPAES*.
- SANBI. (2012). *South African National Biodiversity Institute Ecosystem Threat Status NBA 2011*.
- SANBI. (2016a). 2012 Vegetation Map of South Africa, Lesotho and Swaziland - Biodiversity BGIS. Retrieved August 24, 2016, from <http://bgis.sanbi.org/Projects/Detail/60>
- SANBI. (2016b). SANBI BGIS data portal. Retrieved October 18, 2016, from <http://bgis.sanbi.org/Search?searchterm=cba>
- Savannah. (2015). *Proposed Zen WEF near Saron amended Final EIA*.
- SAWEA. (2015). Rocket Launch After a Long Countdown - The Rise of South Africa's Wind Industry. Retrieved March 15, 2016, from <http://sawea.org.za/images/Wind Stats and facts November 2015.pdf>
- Sivest. (2012). *Proposed Noupoot wind farm Draft Environmental Impact Report*.
- Skowno, A., Todd, S., Snaddon, K., & Ewart-Smith, J. (2014). *Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa; Appendix A4 terrestrial and aquatic biodiversity scoping assessment report*.
- Starmans, J. (2015). *Developing an Environmental Pre-Feasibility Assessment Tool for the evaluation of risks*

*and impacts of wind energy development in South Africa.* Universiteit Utrecht.

Todd, S. (2010). *Klawer wind farm: Ecological and biodiversity assessment.*

Todd, S. (2015). *DWARSRUG WIND ENERGY FACILITY: FAUNA & FLORA SPECIALIST IMPACT ASSESSMENT REPORT.*

Todd, S. (2016). *Komsberg West WEF Specialist Study Reports (Vol. II).*

Turner, A. (2012). *Western Cape Province state of biodiversity.* Stellenbosch. Retrieved from <http://www.capenature.co.za/wp-content/uploads/2013/09/State-of-Biodiversity-2012.pdf>

Underhill, L. (2016). Presentation at IAIA event "Biodiversity offsets and the launch of a biodiversity information tool" 26-05-2016. Cape Town.

Venzo, D. (2013). *Draft EIA report Loeriesfontein wind energy facility.*

Williams, A. J. (2012). *Avifaunal Specialist Report for the Environmental Impact Assessment Zen Wind Energy Facility, Western Cape Province.*

# 11 Appendices

## 11.1 Appendix A

The interview started with an introduction of the interviewer and the purpose of this interview: with this interview I wanted to determine the issues between Birdlife South Africa and wind energy development: greatest bottlenecks, opportunities and status quo. Below the interview with Samantha Ralston is summarized.

### **Interview report Samantha Ralston**

*What is your background, e.g. function description, experience on the subject?*

Samantha is Renewable Energy Manager at Birdlife South Africa. She tries to stimulate wind and solar power development in a way that has the least impacts on birds. Next to this the government regularly asks her opinion on certain EIA reports in the area of birds.

Birdlife acts as a middle-man between government, specialists, researchers and developers and tries not to engage fully in any field to keep their independence. Wind developers can approach Birdlife in an early stage of development to ask whether the particular area is a risk area concerning birds or not.

*What is your view on wind energy?*

Wind energy is a good thing and it should be developed although there are impacts on birds. The task of Birdlife is to minimize the impact of wind farms on birds, especially by location and placement of the turbines.

*What are the risks of wind energy for birds and what could be the impact on birds and the environment as a whole?*

Wind turbines could be placed in nesting, migration or roosting areas.

*What species are vulnerable for wind turbines?*

There is a list of priority species that are vulnerable for wind farms, this list is updated in 2015. More research is needed into these birds and the effects of wind energy on the species.

*What species are not on IUCN red list but are considered priority species? Some raptors?*

The earlier mentioned priority species are more useful to look at than the IUCN red list in the research. Species Birdlife is extra worried about are:

- Bearded vulture (contact Sonja Kruger)
- Cape Vulture (contact Morgan Pfeiffer or Daven Ellen) (20 km buffer?)
- Marshall Eagle (nests on power lines, possibly make a risk buffer around them)
- (Blue) Cranes (check African Crane Conservation Programme)
- Great white pelicans (they nest on Dassen Island and fly to shore for roosting. Coast should be avoided)
- Black Harriers (contact Rob Simmons)
- Black eagle, officially verreaux's eagle

*What makes a species vulnerable for wind turbines and what species are vulnerable?*

Flying at the height of the swept area of wind turbines.

*Are IBAs officially protected areas considering wind and solar energy?*

The areas are not considered official areas, but in a few cases they are taken into account by the government. The IBAs should not be considered as a no go area but as an area with risks. Large IBA South-East of Cape Town has a few smaller wind farms. At this moment no project is positively evaluated by Birdlife as the current wind farms should be monitored on bird impact. Blue crane is active in the area and might be vulnerable for wind turbines.

*You are co-author of Birds and Wind Energy Best-Practices Guidelines, third edition dated 2015. Is this considered a standard work for both developers and EAPs?*

This publication is not officially adopted by the government due to bureaucratic reasons, but the guidelines are accepted by specialists, developers and the government.

*Placement of wind turbines in migration routes can be a threat as well. Where are these migration routes located and is data available?*

South Africa is the end station of migration, so there are no large migration areas that would prevent a wind farm. There are however, some local migration routes of birds.

*Where can data of observation and distribution of bird species be obtained?*

SABAP2 data is publicly available, although not complete and performed by volunteers. No data is available of the amount, roosting or nesting or that the birds are trespassers. Other data such as raptor nests and roosting areas are more sensitive to collect. The persons who have this information will not share it easily as they fear for misuse of the data.

## 11.2 Appendix B

Weight ratio	Importance				High	High	High	Medium	Medium	Medium	Low	Low	Low
			Uncertainty		Low	Medium	High	Low	Medium	High	Low	Medium	High
1:1	Low	0,5	0,5	High	3	3	2	3	2	2	2	2	1
	Medium	1	1	Medium									
	High	1,5	1,5	Low									
1:2	Low	0,66	0,33	High	3	3	2	2	2	2	2	1	1
	Medium	1,33	0,66	Medium									
	High	2	1	Low									
1:3	Low	0,75	0,25	High	3	3	3	2	2	2	2	1	1
	Medium	1,5	0,5	Medium									
	High	2,25	0,75	Low									
1:4	Low	0,8	0,2	High	3	3	3	2	2	2	1	1	1
	Medium	1,6	0,4	Medium									
	High	2,4	0,6	Low									

Table 37  
Uncertainty analysis for different weight ratios between importance and uncertainty to calculate the weight of datasets. The corresponding numbers of importance and uncertainty degrees are summed and result in a weight of 1, 2 or 3.

Table 38 Uncertainty analysis for different weight ratios of abundance and repetition rate to calculate the impact score of CAR data. Abundance and repetition rate impact scores are varied in the upper two rows, the coloured rows represent the final impact score of CAR with the different weight ratios at the left of the table.

Weight ratio	Abundance impact score		1 1 1 1 2 2 2 2 3 3 3 3 4 4 4 4																
	Repetition impact score		1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4																
1:1	Final Impact Score CAR		1	2	2	3	2	2	3	3	2	3	3	4	3	3	4	4	
1:2			1	1	2	2	2	2	2	3	2	3	3	3	3	3	3	4	4
1:3			1	1	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4

## 11.3 Appendix C

The user manual of EPAT has been complemented with the impact categories Birds and Ecology. All other impact categories are written by Starmans (2015).

### User Manual EPAT

#### 1. Scouting

Before performing the EPAT assessment, project locations can quickly be scanned in the scouting part of EPAT QGIS. By selecting the group Scouting, all no-go areas (impact score 4) are indicated with their implemented buffers. The areas not covered by polygons will most likely provide possibilities for wind project development. There are a few remarks that should be noted.

- Drainage lines are incorporated without buffer due to the size of the file, normally a 32-meter buffer is applied
- Major rivers with a buffer of 200 meter is only incorporated for Birds category. In the Bats category the definition of a major river is wider and would lead to more rivers assigned as major river.

#### 2. Preparation

- 2.1. The first step is to create a new project map (under the name of the specific project) where all information, shape files and other data of the project can be stored. This map needs to be stored in the project folder<sup>1</sup>.
- 2.2. The next thing to do is to open the EPAT in QGIS and Excel and save both files in the new created project map. The two tools can now be used for the specific project assessment.

#### 3. Wind farm site layout

- 3.1. In order to test a certain site with this tool, it is necessary to have a site layout polygon shape file of the proposed wind farm. This site layout can either be self-made or collected from an external source. It is preferred that the turbine layout of the project is included to get the best results. Important to this regard is to store the shape file in the relevant project map on G7's web drive. In QGIS the site layout can be stored under the layer "Projects".

The actual environmental impact assessment exercise can now be carried out for each category.

#### 4. Assessment exercise bats

- 4.1. Unfold the layer Bats in QGIS and open the worksheet Bats in the EPAT Excel file.

The bat assessment exercise in Excel consists of 16 steps (potential risks and impacts) that have to be carried out to find an overall impact rating of the proposed project. Each step will be explained in more detail below.

##### 4.2. Step 1 – *Potential bat species occurring on site*

Create a 200 km buffer around the wind farm polygon shape file. In QGIS this is done by opening the tool *buffer*<sup>2</sup>. The display of Figure 17 shows up. Select the relevant wind farm shape file in the input vector layer dropdown list. Change the segments to approximate 30 (in order to create well shaped buffers) and fill in the buffer distance in meters. Click the box "dissolve buffer results" to get one new

---

<sup>1</sup> Z:\Scouting\EPAT\EPAT new\Projects\ "Name project"

<sup>2</sup> In QGIS: menu > vector > geoprocessing tools > buffer

polygon that includes the original site and the 200 km buffer. Save this new shape file in the appropriate project map on G7's web drive and click ok.

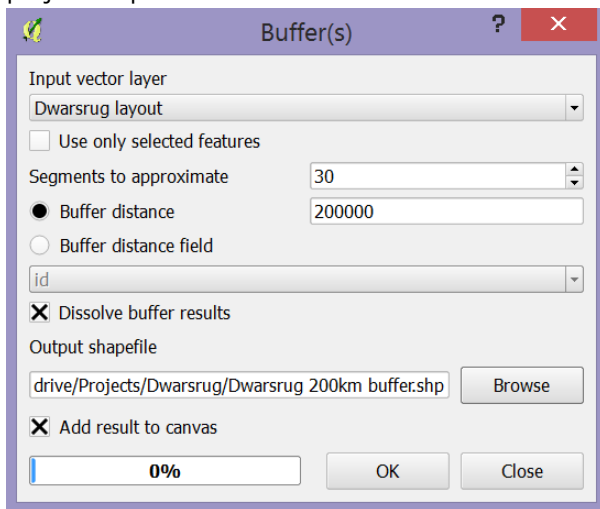


Figure 17 QGIS tool to create buffer(s).

The next thing to do is to find out which bats species (represented by point features) are located within the 200 km buffer. In QGIS this is done by opening the tool *select by location*<sup>3</sup>. The window of Figure 18 will show up. Under the dropdown list select features in, the shape file "All Bat species in SA + 500 km buffer" has to be selected. Subsequently, select the 200 km buffer wind farm shape file under the second dropdown list. Select the first box "Include input features that intersects the selection features" and click ok.

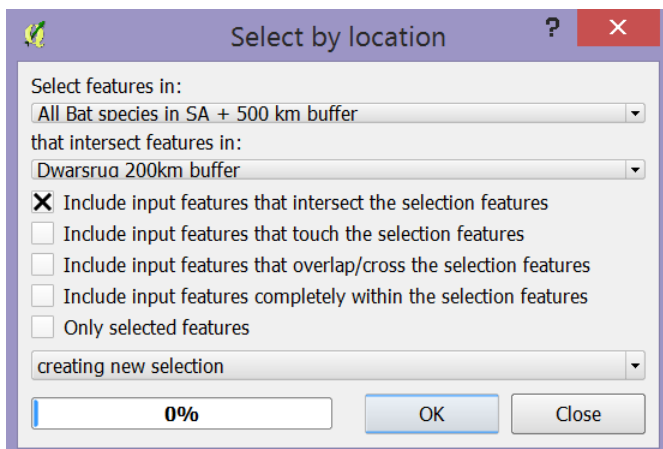


Figure 18 QGIS tool to selection features by location.

All point features (bat species) within the 200 km buffer are now selected and highlighted by the colour yellow. The next task is to identify the names of these bat species and to list each different species in the table under step 1 of the assessment exercise in Excel. When there are only a few point features selected, these can simply be identified by opening the attribute table

of the All Bat species in SA + 500 km buffer shape file<sup>4</sup>. However, when there are many point features selected, it can be more useful to create a new shape file that only includes the bat species within the 200 km buffer<sup>5</sup>. When creating this new shape file, the window of Figure 19 will show up. Select the ESRI shape file format to create a vector shape file. This new shape file also needs to be stored within the appropriate project map within G7's web drive. An important task is to select the box "save only selected

<sup>3</sup> In QGIS: menu > vector > research tools > select by location

<sup>4</sup> In QGIS: right mouse click on the relevant shape file and go to "open attribute table".

<sup>5</sup> In QGIS: right mouse click on the relevant shape file and go to "save as".



features” to get a shape file with the bat species within the 200 km buffer only. Click ok since the other variables do not have to be adjusted.

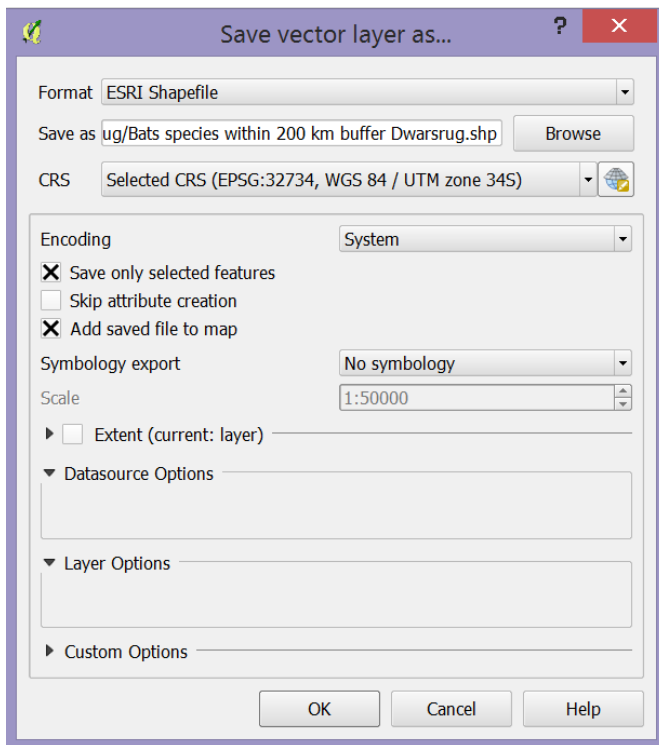


Figure 19 Creating new shape files in QGIS.

Open the attribute table of this new shape file and identify the different bat species potentially occurring on site. These bat species can now be listed in the table under step one of the assessment exercise in Excel.

This table also demands addition species information such as collision risk, South African conservation status and potential migration. This information can be found in the BSID Excel file which is stored in the library in the folder bats<sup>6</sup>.

The remaining steps are similar to each other and more straightforward. For most of these steps, the main task is to measure the distance between the site boundary/turbine/all infrastructure and the specific sensitive feature in QGIS. Measuring distances in QGIS can be done with the *measure line* tool. After obtaining results, for each step an associated impact score has to be given. Guidelines for the allocation of scores are provided in each step in the assessment exercise in Excel.

#### 4.3. Step 2 - Total number of bat species on site

Count the total number of bat species listed in step 1. Fill in the result and the associated impact score.

#### 4.4. Step 3 - Collision risk

Count the total number of bat species with a collision risk of medium-high or high in step 1. Fill in the result and the associated impact score.

#### 4.5. Step 4 - Conservation status

Identify the most endangered conservation status of bat species in step 1. Information about the order of conservation status can be found in **Error! Reference source not found.**. Fill in the result and the associated impact score.

<sup>6</sup> Z:\Scouting\EPAT\EPAT new\Library\Environmental impact categories\bats\BSID.

4.6. Step 5 – *Migratory species*

Identify migratory species in step 1. The result has to be filled in with either yes or no. Furthermore, provide the associated impact score.

4.7. Step 6 - *Foraging/ drinking habitat - Major rivers or open water bodies*

Select the shape files "major rivers" and "open water bodies" in QGIS and find the shortest distance of these features to any of the proposed turbines. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.8. Step 7 - *Foraging habitat - Non-perennial rivers*

Select the shape file "non-perennial rivers" in QGIS and find the shortest distance of a non-perennial river to any of the proposed turbines. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.9. Step 8 - *Foraging habitat - Agricultural fields*

Select the shape file "agricultural fields" in QGIS and find the shortest distance of an agricultural field to any of the proposed turbines. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.10. Step 9 - *Foraging habitat/ Roosts – Forests*

Select the shape file "All forests" in QGIS and find the shortest distance of a forest to any of the proposed turbines. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.11. Step 10 - *Roosts - Building structures*

Select the shape file "Building structures" in QGIS and find the shortest distance of a building structure to any of the proposed turbines. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.12. Step 11 - *Roosts - Unconfirmed Bat Caves*

Select the shape file "Unconfirmed Bat Caves" in QGIS and find the shortest distance of an unconfirmed bat cave to the wind farm's site boundary. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.13. Step 12 - *Roosts - Confirmed Small Bat Caves*

Select the shape file "Confirmed Small Bat Caves" in QGIS and find the shortest distance of an confirmed small bat cave to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.14. Step 13 - *Roosts - Confirmed Medium Bat Caves*

Select the shape file "Confirmed Medium Bat Caves" in QGIS and find the shortest distance of an confirmed medium bat cave to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.15. Step 14 - *Roosts - Confirmed Large Bat Caves*

Select the shape file "Confirmed Large Bat Caves" in QGIS and find the shortest distance of an confirmed large bat cave to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.16. Step 15 - *Cave sensitivity – Coastal areas*

Select the shape file "Coastline" in QGIS and find the shortest distance of the coast to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

4.17. Step 16 - *Cave sensitivity - Limestone & dolomite layers*

Select the shape file "Limestone & dolomite layers" in QGIS and find the shortest distance of these formations to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

When all these different steps have been carried out, the EPAT will automatically calculate the total impact score of the proposed development on bats. This score in combination with potential fatal flaws will determine the final impact rate. Furthermore, depending on the user's decision on possible mitigation options, the EPAT will provide information about further actions needed.

## **5. Assessment exercise Heritage**

5.1. Unfold the layer Heritage within QGIS and open the worksheet Heritage within Excel.

The Heritage assessment exercise in excel consists of 11 steps (potential impacts) that have to be carried out in order to find an overall impact rating of the proposed project. Each step will be explained in more detail below.

5.2. Step 1 - *UNESCO World Heritage sites*

Select the shape file "UNESCO World Heritage sites" in QGIS and find the shortest distance of an UNESCO World Heritage site to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.3. Step 2 - *Grade 1 National heritage sites*

Select the shape file "Grade 1 National heritage sites" in QGIS and find the shortest distance of a Grade 1 National heritage site to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.4. Step 3 - *Grade 2 Provincial heritage sites*

Select the shape file "Grade 2 Provincial heritage sites" in QGIS and find the shortest distance of a Grade 2 Provincial heritage site to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.5. Step 4 - *Grade 3A Local heritage sites*

Select the shape file "Grade 3A Local heritage sites" in QGIS and find the shortest distance of a Grade 3A Local heritage site to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.6. Step 5 - *Grade 3B Local heritage sites*

Select the shape file "Grade 3B Local heritage sites" in QGIS and find the shortest distance of a Grade 3B Local heritage sites to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.7. Step 6 - *Grade 3C Local heritage sites*

Select the shape file "Grade 3C Local heritage sites" in QGIS and find the shortest distance of a Grade 3C Local heritage site to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.8. Step 7 - *Ungraded monuments*

Select the shape file "Ungraded monuments" in QGIS and find the shortest distance of an ungraded monument to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.9. Step 8 - *Ungraded cultural landscapes*

Select the shape file "Ungraded cultural landscape" in QGIS and find the shortest distance of an ungraded cultural landscape to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.10. Step 9 - *Ungraded other heritage sites*

Select the shape file "Ungraded other heritage sites" in QGIS and find the shortest distance of an ungraded other heritage sites to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.11. Step 10 – *Cemeteries*

Select the shape file "Cemeteries" in QGIS and find the shortest distance of a cemetery to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

5.12. Step 11 - *Fossil sensitivity*

Go to <http://www.sahra.org.za/sahris/map/palaeo> and determine the fossil sensitivities of the geological formations on site. The most fossil sensitive formation present on site determines the impact score. Fill in the result and the associated impact score.

When all these different steps have been carried out, the EPAT will automatically calculate the total impact score of the proposed development on heritage. This score in combination with potential fatal flaws will determine the final impact rate. Furthermore, depending on the user's decision on possible mitigation options, the EPAT will provide information about further actions needed.

## **6. Assessment exercise General**

6.1. Unfold the layer General within QGIS and open the worksheet General within Excel.

The General assessment exercise in excel consists of 19 steps (potential impacts) that have to be carried out in order to find an overall impact rating of the proposed project. Each step will be explained in more detail below.

6.2. Step 1 - *Aviation - Licensed airports category 3*

Select the shape file "Licensed airports category 3" in QGIS and find the shortest distance of a licensed airport category 3 to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.3. Step 2 - *Aviation - Licensed airports category 1 & 2*

Select the shape file "Licensed airports category 1 & 2" in QGIS and find the shortest distance of a licensed airport category 1 or 2 site to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.4. Step 3 - *Aviation - Unlicensed airports*

Select the shape file "Unlicensed airports" in QGIS and find the shortest distance of an unlicensed airport to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (yes or no) for mitigation options.

6.5. Step 4 - *Aviation - Helistops*

Select the shape file "Helistops" in QGIS and find the shortest distance of a helistop to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.6. Step 5 - *Protected areas - National parks*

Select the shape file "National parks" in QGIS and find the shortest distance of a national park to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.7. Step 6 - *Protected areas - Other formally protected*

Select the layer "Other formal protected areas" in QGIS (contains several shape files) and find the shortest distance of another formal protected area to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.8. Step 7 - *Protected areas - Informally protected*

Select the layer "Informal protected areas" in QGIS (contains several shape files) and find the shortest distance of an informal protected area to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.9. Step 8 - *Ramsar sites*

Select the shape file "Ramsar sites" in QGIS and find the shortest distance of a Ramsar site to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.10. Step 9 - *Coastal areas - Estuaries*

Select the shape file "Estuaries" in QGIS and find the shortest distance of an estuary to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.11. Step 10 - *Coastal areas - coastline*

Select the shape file "Coastline" in QGIS and find the shortest distance of the coast to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.12. Step 11 - *Hydrology - Major rivers*

Select the shape file "Major rivers" in QGIS and find the shortest distance of a major river to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.13. Step 12 - *Hydrology - Open water bodies*

Select the shape file "Open water bodies" in QGIS and find the shortest distance of an open water body to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.14. Step 13 - *Hydrology - Non-perennial rivers*

Select the shape file "Non-perennial rivers" in QGIS and find the shortest distance of a non-perennial river to any of the wind farm's infrastructure. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.15. Step 14 - *Astronomical observatories - legally protected*

Select the shape file "Astronomical observatories legally protected" in QGIS and find the shortest distance of a legally protected astronomy observatory to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.16. Step 15 - *Astronomical observatories - not legally protected*

Select the shape file "Astronomical observatories not legally protected" in QGIS and find the shortest distance of an astronomical observatory that is not legally protected to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.17. Step 16 - *Astronomical observatories - SKA components*

Select the shape file "SKA layout phase 1" in QGIS and find the shortest distance of a SKA component to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.18. Step 17 - *Astronomical observatories - KCAA*

Select the shape file "Karoo Central Astronomy Advantage Area" in QGIS and find the shortest distance of the KCAAAA to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.19. Step 18 – *Renewable energy projects – onshore wind energy*

Select the shape file "Onshore wind energy projects" in QGIS and find the shortest distance of a wind energy project to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

6.20. Step 19 - *Renewable energy projects - other*

Select the shape file "Other renewable energy projects" in QGIS and find the shortest distance of another renewable energy project to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

When all these different steps have been carried out, the EPAT automatically calculates the total impact score of the proposed development on General. This score in combination with potential fatal flaws will determine the final impact rate. Furthermore, depending on the user's decision on possible mitigation options, the EPAT will provide information about further actions needed.

## 7. Assessment exercise Visual

7.1. Unfold the layer Visual within QGIS and open the worksheet Visual within Excel.

The visual assessment exercise in Excel consists of 13 steps (7 potential impacts and 6 potential VAC features) that have to be carried out in order to find an overall impact rating of the proposed project. Each step will be explained in more detail below.

7.2. Step 1 - *Observers – Population*

Select the layer "Population" in QGIS (contains several shape files) and find the highest number of people living in the area where the proposed wind farm is located. In QGIS this can be determined by clicking on the different polygons of the population shape files (that are overlapping the wind farm's site) with the identify feature cursor. Fill in the result and the associated impact score.

7.3. Step 2 - *Observers - Urban resident areas*

Select the shape file "Land cover 2013-2014" in QGIS and find the shortest distance of any urban resident area to the wind farm's site boundary. **Error! Reference source not found.** can be used to identify relevant urban resident areas on the land cover shape file. However, if the actual land cover/use is hard to determine (many different land covers in a small area), select the shape file "places" instead and find the shortest distance of any place to the wind farm's site boundary. Fill in the result and the associated impact score.

7.4. Step 3 - *Observers - National roads*

Select the shape file "National roads" in QGIS and find the shortest distance of a national road to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

7.5. Step 4 - *Observers - secondary roads*

Select the shape file "Secondary roads" in QGIS and find the shortest distance of a secondary road to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (yes or no) for mitigation options.

7.6. Step 5 - *Observers - scenic routes*

For projects in the Western Cape, select the shape file "Scenic routes" in QGIS and find the shortest distance of a scenic route to the wind farm's site boundary. For projects in all other South African provinces, give a medium sensitivity until more information about localities of scenic routes becomes available. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

7.7. Step 6 - *Observers – railways*

Select the shape file "Railways" in QGIS and find the shortest distance of a railway to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

7.8. Step 7 - *Shadow flicker*

Select the shape file "Building structures" in QGIS and find the shortest distance of a building structure to any of the proposed turbines. Fill in the result and the associated impact score. If there is a high impact, provide the possibility (either yes or no) for mitigation options.

7.9. Step 8 - *VAC – Forests*

Select the shape file "Forests" in QGIS and find the shortest distance of a forest to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high negative impact, provide the possibility (either yes or no) for mitigation options.

7.10. Step 9 - *VAC - Industrial areas*

Select the shape file "Land cover 2013-2014" in QGIS and find the shortest distance of an industrial area to the wind farm's site boundary. **Error! Reference source not found.** can be used to identify industrial areas on the land cover shape file. Fill in the result and the associated impact score.

7.11. Step 10 - *VAC - Telecommunication masts*

Select the shape file "Telecommunication masts" in QGIS and find the shortest distance of any telecommunication mast to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high negative impact, provide the possibility (either yes or no) for mitigation options.

7.12. Step 11 - *VAC - Transmission lines & substations*

Select the layer "Transmission lines & substations" in QGIS (contains the two relevant shape files) and find the shortest distance of any transmission line or substation to the wind farm's site boundary. Fill in the result and the associated impact score. If there is a high negative impact, provide the possibility (either yes or no) for mitigation options.

7.13. Step 12 - *VAC - Other obstacles*

Select the shape file "other obstacles" in QGIS and find the shortest distance of any other obstacle to the wind farm's site boundary. Check the type of obstacle and determine if it has VAC obstacle. If not, find the next obstacle. Fill in the result and the associated impact score. If there is a high negative impact, provide the possibility (either yes or no) for mitigation options.

7.14. Step 13 - *VAC – Agricultural fields*

Select the shape file "Agricultural fields" in QGIS and find the shortest distance of any agricultural field to the wind farm's site boundary. Fill in the result and the associated impact score.

When all these different steps have been carried out, the EPAT automatically calculates the total impact score of the proposed development on visual. This score in combination with potential fatal flaws will determine the final impact rate. Next to this, it will provide an indication of the VAC of the proposed area. Furthermore, depending on the user's decision on possible mitigation options, the EPAT will provide information about further actions needed.

## 8. Assessment exercise Birds

8.1. Unfold the layer Birds within QGIS and open the worksheet Birds in Excel

The Birds assessment exercise in Excel consists of fifteen steps of which four are executed outside of the QGIS environment. Completing this exercise will give an impact rating on avifauna of the proposed project. However, this is an indication and does not replace a field survey by a bird specialist.

8.2. Step 1 - *Important Bird Areas*

Select the shapefile "IBA 34S" under the folder Important Bird Areas. Find the shortest distance of an Important Bird Area to the project site boundary by using the measure line tool in the toolbar. Fill out the distance in km in step 1 in Excel and assign the corresponding score. If there is a high impact score indicate the possibility for mitigation options (yes or no). Deselect shapefile "IBA 34S"

### 8.3. Step 2 – South African Bird Atlas 2 – Raptors

This step is an online assessment of bird observations. Select the shapefile "QDGC 34S" under South Africa and click with the Identify Features tool on the square below the project shape file. Note from the window that appears the latitude, longitude and the last two letters of the qdgc line like this: 2831DB (Figure 20). This is the Quarter Degree Grid Cell (QDGC) of the project site.

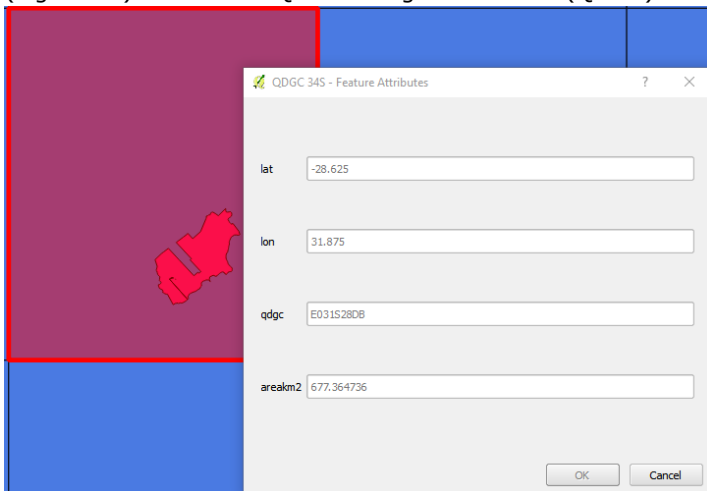


Figure 20 Identify features tool. Note the latitude, longitude and last two letters of qdgc line to get the QDGC of the project site.

Next open the following website: <http://sabap2.adu.org.za/index.php>. Go to "Coverage maps" in the left menu and zoom in towards the project site's area (Figure 21). By clicking on a coloured section a pop-up shows the location in two sections: latitude and longitude. Make sure the two first numbers of each section match the numbers of the QDGC.

Now deselect the shapefile "QDGC 34S", select "Google Satellite" in QGIS and select satellite in the map of the online SABAP2 tool. Now you can select the area that matches best with the project location and click on the numbers to go to the database. If there are however, no observations at the project location or surrounding area that could be an alternative, the steps 2 to 5 cannot be completed. Proceed to step 6. Otherwise scroll down in the database and click on the green tab "SABAP2 Species list Alphabetical order". An alphabetical list of bird species observations will appear.



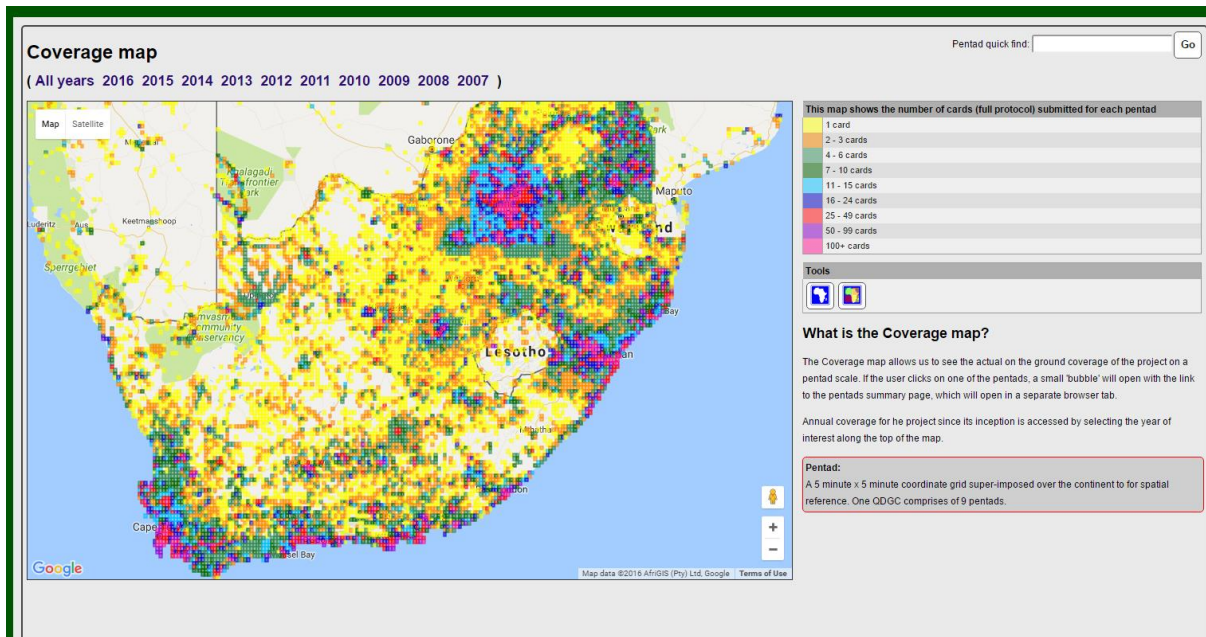


Figure 21 Outline of the Coverage map, zoom in to find the correct location.

Now open the Excel file "SABAP2 Priority Species Evaluation List"<sup>7</sup> and go to the tab Raptor. Put the lists next to each other and note all observed raptors from the Raptor list in the EPAT Excel file on the right. Now report the number of species and assign the corresponding score. It is not possible to determine mitigation possibilities for this step.

#### 8.4. Step 3 – South African Bird Atlas 2 – Very high priority species

This step evaluates the top of the priority species list by Birdlife excluding raptors. It is a continuation of the previous step. Now open the Very High Priority tab in "SABAP2 Priority Species Evaluation List" and put this list next to the online observation list. Note in Step 3 all observed Very High Priority Species and put in the number of species and the corresponding impact score. It is not possible to determine mitigation possibilities for this step.

#### 8.5. Step 4 – South African Bird Atlas 2 – High priority species

This step again continues with the previous two. Now switch to the High Priority list in the "SABAP2 Priority Species Evaluation List" file and repeat the exercise.

#### 8.6. Step 5 – South African Bird Atlas 2 – Medium priority species

This is the last step that continues with the online assessment of SABAP2. Now switch to the Medium Priority list in the "SABAP2 Priority Species Evaluation List" file and repeat the exercise. Deselect "Google Satellite" in QGIS and close the online tool.

#### 8.7. Step 6 – Rivers and Wetlands – Rivers

Select shapefile "NFEPA rivers 34S" under Rivers in QGIS. Right-click on the shapefile and click on "Filter...". Select only major rivers with an order three or higher by Double clicking in the appearing window on the field "ORDER\_" and finish the expression as follows: "ORDER\_" >= '3' and click OK (Figure 22).

<sup>7</sup> Z:\Scouting\EPAT\EPAT new

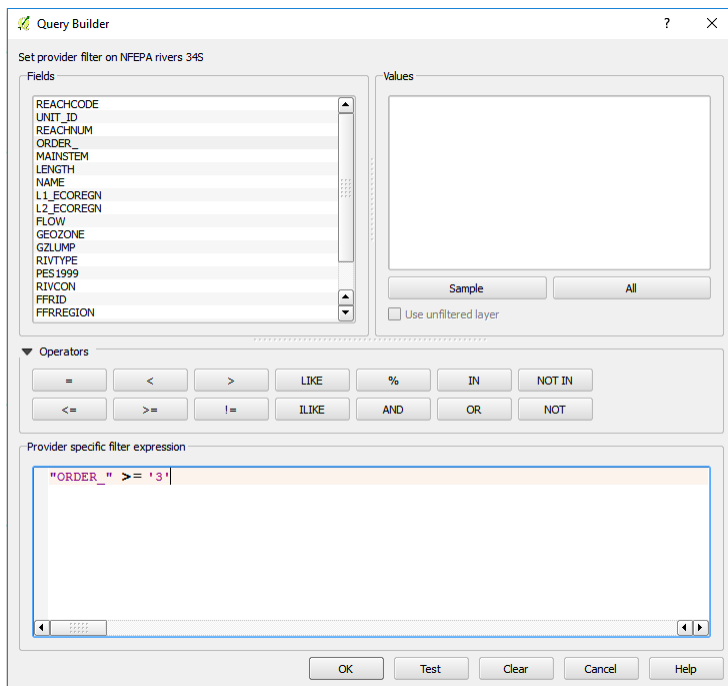


Figure 22 Double Click on ORDER\_ and use the operators to finish the expression as shown in the figure

Now Determine the distance of the river closest to a planned wind turbine or the project site boundary with the measure line tool in the toolbar. Note the distance and assign the corresponding impact score in Excel. If the impact is high indicate (yes or no) possibilities for mitigation. When no turbine layout is available and the feature on site gives a very high impact while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect the "NFEPA rivers 34S" shapefile.

#### 8.8. Step 7 – Rivers and Wetlands – Crane Wetlands

Select shapefile "Crane Wetlands 34S" in the Wetlands group and determine the distance to the closest turbine or project site boundaries. Fill in the distance and assign the impact score.

When a wetland is present near or on a project site it might be useful to create a buffer of 200 meter around the wetland to indicate no-go areas within the site. Click on the "Crane Wetlands 34S" and the "Select features" tool in the toolbar and select wetlands by clicking (use Control-click for multiple wetlands). Next open the buffer<sup>8</sup> tool (Figure 23): Make sure "Use only selected features" box is selected, 30 segments and buffer distance is 200 (meter). Save the Output shapefile as "Wetlands 200m buffer" in the project map and click "OK". The new shapefile indicates no-go areas regarding crane wetlands. If there is a high impact provide the possibility (yes or no) for mitigation. When no turbine layout is available and the feature on site gives a very high impact while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect shapefile "Crane Wetlands 34S" in QGIS.

<sup>8</sup> In QGIS: menu > vector > geoprocessing tools > buffer

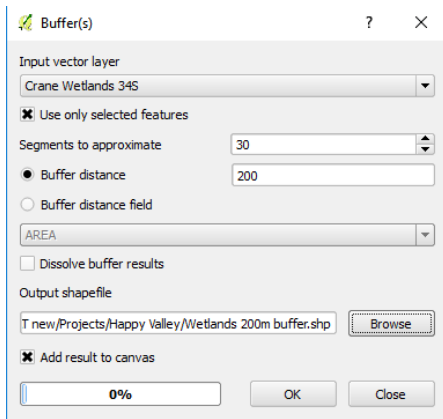


Figure 23 Creating a buffer with the buffer tool in QGIS

### 8.9. Step 8 – Rivers and Wetlands – Wetland Clusters

Select the shapefile “Wetland Clusters 34S” and determine the distance of the closest wetland cluster to a turbine or project boundary. Fill in the distance and the associated impact score. If there is a high impact provide the possibility (yes or no) for mitigation. When no turbine layout is available and the feature on site gives a very high impact while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect shapefile “Wetland Clusters 34S” in QGIS.

### 8.10. Step 9 – Dams

Select the shapefile “Dams 34S” under Dams and activate “Google Satellite”. Locate the dam reservoir that corresponds with the data point and create a new polygon of the dam by clicking “New Shapefile Layer” in the left toolbar. Select “Polygon” type and make sure the coordinated reference system is set on “WGS 84 / UTM 34S” and click “OK” (Figure 24). Save the file (“Dam ‘Project’”) in the project map and right-click on the new shapefile and select “Toggle editing”. Select the “Add Feature” tool in the upper toolbar and start circumcising the dam reservoir along its edges by clicking. To stop right-click and “OK”. Click again on “Toggle editing” with a right-click and save.

Use the new shapefile to determine the distance of the dam reservoir to the closest turbine or project boundary. Fill in the distance and the corresponding impact score. If there is a high impact provide the possibility (yes or no) for mitigation. When no turbine layout is available and the feature on site gives a very high impact while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect shapefile “Dams 34S” in QGIS.

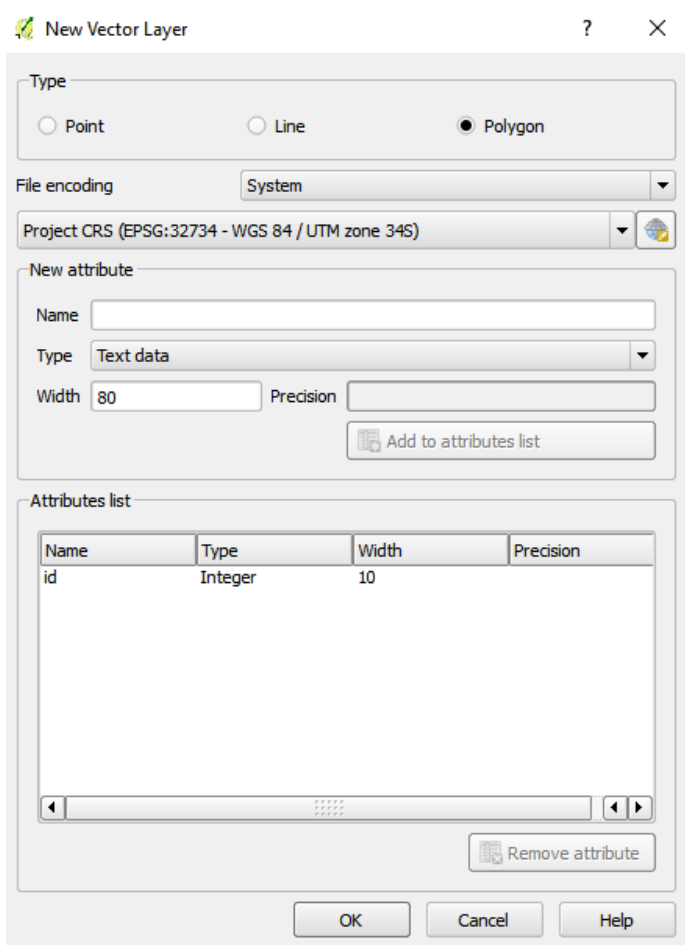


Figure 24 Create new polygon for dams in QGIS

8.11. Step 10 – Coordinated Avifaunal Roadcount – Raptor

Select the shapefile “CAR routes 20 km buffer 34S” and determine whether the project site boundaries intersect with the buffer. If this is not the case this assessment cannot be performed; proceed to step 13. If the buffer intersects you can deselect “CAR routes 20 km buffer 34S”.

The next step is to create different buffers from the project site, click on the project shapefile and open the buffer tool to create the buffers that are stated in Table 39 Buffers to create for CAR exercise and save them as “Project’ distance’ km buffer”. Put the shapefile layers in the group Projects under the right project name.

Table 39 Buffers to create for CAR exercise

Buffer	Distance (m)
‘Project’ 3.5 km buffer	3500
‘Project’ 5 km buffer	5000
‘Project’ 7 km buffer	7000
‘Project’ 10 km buffer	10000
‘Project’ 15 km buffer	15000
‘Project’ 20 km buffer	20000

Once the buffers are created select “CAR raptor priority 34S” and the newly created 5 km buffer of the project site. Select all raptor points that are within the 5 km buffer with the Select features tool in the toolbar and open the attribute table with a right-click on “CAR raptor priority 34S” and select “Show selected features” bottom left. Now only the points are visible that are within the 5 km buffer, count the number of unique years (between 2009-2013) and the total number of birds observed in the column “TotalCount”. For ease and precision, especially with larger numbers, the selected rows can be copied to

an Excel spreadsheet and the total number of birds can be calculated using Excel. In Table 40 the repetition impact score for a specific distance can be derived and in Table 41 the same for the abundance. The two impact scores are merged according to the following formula:

$$I = 0.66 * a + 0.33 * r$$

With I impact score, a abundance and r repetition rate. For convenience all possible outcomes are already pre-calculated in Table 42.

Now the impact score for Raptors within 5 km distance is calculated, repeat this exercise for all distances (10 km, 15 km and 20 km) and pick the highest impact score retrieved and insert the abundance impact score, repetition impact score and total impact score in Excel. If there is a high impact provide the possibility (yes or no) for mitigation.

The species observed in the CAR Raptor observations received a code name in GIS, Table 43 provides the full names as extra information. Deselect the shapefile "CAR raptor priority 34S" and any buffer shapefiles.

Table 40 Repetition impact scores for Raptors

Repetition impact score Raptors		Number of unique years present in the last five years				
		0-1	2	3	4	5
Distance (km)	0<d≤5	1	2	3	3	3
	5<d≤10	1	2	2	3	3
	10<d≤15	1	1	2	2	3
	15<d≤20	1	1	1	2	2

Table 41 Abundance impact scores for Raptors

Abundance impact score Raptors		Number of birds in all observations last five years					
		0	1-4	5-8	9-12	12-15	>15
Distance (km)	0<d≤5	1	2	3	4	4	4
	5<d≤10	1	2	2	3	4	4
	10<d≤15	1	1	2	2	3	4
	15<d≤20	1	1	1	2	2	3

Table 42 Final Score Matrix for CAR

CAR Final Score Matrix		Impact score abundance			
		1	2	3	4
Impact score repetition rate	1	1	2	2	3
	2	1	2	3	3
	3	2	2	3	4
	4	2	3	3	4

Table 43 Code names used in QGIS for raptor species

Code name QGIS	Full common name
HAR	Black Harrier
SEC	Secretarybird

#### 8.12. Step 11 – Coordinated Avifaunal Roadcount – Very High Priority

Select shapefile "CAR very high priority 34S" and the created 3.5 km buffer and repeat the procedure of the previous step, now using the scoring of Table 44 and Table 45 and buffers 3.5 km, 7 km, 10 km and 15 km. Table 42 can again give the final impact score of this step. The code names used for species in the very high priority group can be seen in Table 46. Deselect the shapefile "CAR very high priority 34S" and any buffer shapefiles.

Table 44 Repetition impact score for very high priority

Repetition impact score very high priority groups		Number of unique years present the last five years				
		0-1	2	3	4	5
Distance (km)	0<d≤3.5	1	2	3	3	3
	3.5<d≤7	1	1	2	3	3
	7<d≤10	1	1	1	2	3
	10<d≤15	1	1	1	2	2

Table 45 Abundance impact score for very high priority

Abundance impact score very high priority groups		Number of birds in all observations last five years					
		0-10	11-30	31-100	101-150	151-200	>200
Distance (km)	0<d≤3.5	1	2	3	4	4	4
	3.5<d≤7	1	2	3	3	4	4
	7<d≤10	1	1	2	3	3	4
	10<d≤15	1	1	1	2	3	3

Table 46 Code names used in QGIS for bird species in the very high priority group

Code name QGIS	Full common name
BC	Blue Crane
BI	Southern Bald Ibis
BS	Black Stork
CC	Grey Crowned Crane
DB	Denham's Bustard
GH	Southern Ground-Hornbill
LB	Ludwig's Bustard
WC	Wattled Crane
YS	Yellow-billed Stork

8.13. Step 12 – Coordinated Avifaunal Roadcount – High Priority

Select shapefile "CAR high priority 34S" and the created 3.5 km buffer, repeat the procedure of the previous step now using Table 47 and Table 48 with the same buffers and determine the total score via Table 42. Deselect the shapefile "CAR high priority 34S" and any buffer shapefiles.

Table 47 Repetition impact score for high priority

Repetition impact score high priority groups		Number of unique years present the last five years				
		0-1	2	3	4	5
Distance (km)	0<d≤3.5	1	2	3	3	3
	3.5<d≤7	1	1	2	3	3
	7<d≤10	1	1	1	2	3
	10<d≤15	1	1	1	2	2

Table 48 Abundance impact score for high priority

Abundance impact score high priority groups		Number of birds in all observations last five years					
		0-5	6-10	11-20	21-30	31-50	>50
Distance (km)	0<d≤3.5	1	2	3	4	4	4
	3.5<d≤7	1	1	2	3	4	4
	7<d≤10	1	1	1	2	3	4
	10<d≤15	1	1	1	1	2	3

Table 49 Code names used in QGIS for bird species in the high priority group

Code name QGIS	Full common name
JKBZ	Jackal Buzzard
KB	Kori Bustard
UK	Blue Korhaan
WBK	White-bellied Korhaan

Although the medium priority group is not taken into account in the EPAT assessment, it is included in the QGIS file and can be checked for more in-depth information when necessary. The birds present in the medium priority group including the QGIS codes can be found in Table 50.

Table 50 Code names used in QGIS for bird species in the medium priority group

Code name QGIS	Full common name
BBK	Black-bellied Korhaan
BSKT	Black-shouldered Kite
KK	Karoo Korhaan
NBK	Northern Black Korhaan
SPBZ	Steppe Buzzard
WS	White Stork

#### 8.14. Step 13 – Endangered Wildlife Trust Crane Data

Select the shapefile “EWT crane data 15 km buffer” and determine whether the project site boundaries intersect with the buffer. If this is not the case this assessment cannot be performed; proceed to step 14. If the buffer intersects you can deselect “EWT crane data 15 km buffer 34S”.

This step, just as the previous two, works with project buffers of 3.5 km, 7 km, 10 km and 15 km. Select shapefile “EWT crane data 34S” and the 3.5 km project buffer and proceed with the instructions given in Step 10 but use Table 51 for impact scores, for the final impact score of EWT crane data Table 42 is usable as well. If there is a high impact provide the possibility (yes or no) for mitigation. Deselect the shapefile “EWT crane data 34S” and any buffer shapefiles.

Table 51 Repetition and abundance impact score for EWT crane data

Repetition impact score EWT crane data		Number of unique years present the last five years				
		0-1	2	3	4	5
Distance (km)	0<d≤3.5	1	2	3	4	4
	3.5<d≤7	1	1	2	3	4
	7<d≤10	1	1	1	2	3
	10<d≤15	1	1	1	2	2
Abundance impact score EWT crane data		Number of birds in all observations last five years				
		0-5	6-10	11-15	16-20	>20
Distance (km)	0<d≤3.5	2	3	4	4	4
	3.5<d≤7	1	2	3	4	4
	7<d≤10	1	1	2	3	4
	10<d≤15	1	1	1	2	3

#### 8.15. Step 14 – Cliff tool

The cliff tool is a separate QGIS assignment not incorporated in EPAT QGIS. If the manual does not lead to the envisioned result, do not hesitate to ask the G7 team for help on this. Check in EPAT Excel in Step 2 if among the list of observed species, a Verreaux’s Eagle or Booted Eagle is located within the project area and use the terrain function of Google Maps to assess cliffs in the area. If one or both conditions are true, check the availability of a Digital Terrain Map with a 5 to 25 meter resolution. It might be needed to buy this elevation data, discuss this with the G7 team. If both conditions are not true, no Digital Terrain Map is available or there is little time to do the assessment, proceed with Step 15.

Otherwise, open the Digital Terrain Map in a new QGIS project and open the Slope<sup>9</sup> tool (Figure 25). Select the correct elevation layer and save the file in the Output layer as "Project' slopes" in the project map.

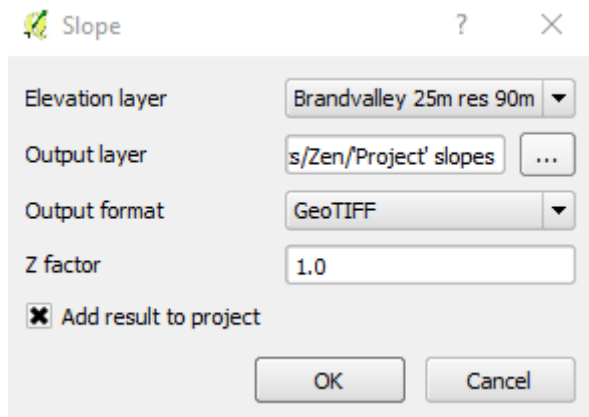


Figure 25 Settings for the Slope tool to create a slope map

Now the slope map has been created, only visualize slopes of 35 degrees and save the file as 'Potential raptor nest site' in the project map. Click on the 'Potential raptor nest site' file and create a buffer with the buffer tool<sup>10</sup> and save it as 'Potential raptor nest site 1.5 km buffer' in CRS projection 'WGS 84 / UTM zone 34S'. Implement the buffer file into the QGIS project map and activate the layer.

Select by hand all turbine layers that are not situated within the 1.5 km buffer and count the number and fill in the associated score in Excel. If there is a high impact provide the possibility (yes or no) for mitigation. This exercise requires a turbine layout of the project. Deselect the shapefile "Potential raptor nest site 1.5 km buffer".

#### 8.16. Step 15 – Bearded vulture density map

Select the shapefile "Mask Layer Bearded Vulture" and determine whether the project site is located within the mask layer or outside of it and fill in the associated impact score in Excel. When the project site partly overlaps with the mask layer the maximum score should be given. If there is a high impact a specialist should be contacted about the Bearded Vulture risk in the specific area. Deselect shapefile "Mask Layer Bearded Vulture" in QGIS.

Now check if any of the steps could not be performed. If this is the case, change cell D316 in the correct score distribution seen in the cells above. Also change cell F316-F319 and add the 'Per four category' of the corresponding score distribution to the formula. Example: if there is no CAR data available and the Cliff tool was not necessary, select cell D316 and type '=G305' (lowest score of 'Without CAR and Cliff tool') and change cell F316-F319 formulas to '=D316+G308', '=D317+G308' etc.

When all these different steps have been carried out, EPAT automatically calculates the total impact score of the proposed development on Birds. This score in combination with potential fatal flaws will determine the final impact rate. Furthermore, depending on the user's decision on possible mitigation options, the EPAT will provide information about further actions needed.

### 9. Assessment exercise Ecology

#### 9.1. Unfold the layer Ecology within QGIS and open the worksheet Ecology in Excel

The Ecology assessment exercise in Excel consists of fifteen steps of which five are executed outside of the QGIS environment. Completing this exercise will give an impact rating on ecology of the proposed project. However, this is an indication and does not replace a field survey by an ecology specialist. It is always advised to send an ecology specialist to the project site and perform an assessment as this assessment contains major uncertainties.

<sup>9</sup> In QGIS: Menu > Raster > Terrain Analysis > Slope

<sup>10</sup> In QGIS: menu > vector > geoprocessing tools > buffer



#### 9.2. Step 1 – Vegetation Type

Select the shapefile "Vegetation Map 34S" and start the Select by Location tool<sup>11</sup>. Select for Select features in "Vegetation Map 34S" and for intersect features in the project location shapefile and click OK. Close the tool and open attribute table of the vegetation map and select in the lower left Show Selected Features. Write down the names of the different vegetation types into Excel. Deselect the shapefile "Vegetation Map 34S".

#### 9.3. Step 2 – Vegetation Map with Threatened Ecosystems

Select the shapefile "Vegetation map threatened ecosystems 34S" and start the Select by Location tool again. Select for Select features in "Vegetation map threatened ecosystems 34S" and for intersect features in the project location shapefile and click OK. Close the tool and open attribute table of the vegetation map and select in the lower left Show Selected Features. Note the conservation status of the selected polygons in the column "CNSRVTNSTT" in Excel and the impact score associated with the most threatened ecosystem. Mention in the comments section the threatened ecosystems if applicable. Deselect the shapefile "Vegetation map threatened ecosystems 34S".

#### 9.4. Step 3 – National Protected Areas Expansion Strategy

Select the shapefile "NPAES focus areas 34S" and determine the closest distance between the project site and an NPAES area. Fill in the distance in km in step 3 in Excel and assign the corresponding impact score. If there is a high impact score indicate the possibility for mitigation options (yes or no). Deselect shapefile "NPAES focus areas 34S".

#### 9.5. Step 4 – KZN Macro-Ecological Corridors

Select the shapefile "KZN macro-ecological corridor 34S" and determine the closest distance between the project site and the corridor area. Fill in the distance in km in step 4 in Excel and assign the corresponding impact score. If there is a high impact score indicate the possibility for mitigation options (yes or no). Deselect shapefile "KZN macro-ecological corridor 34S".

#### 9.6. Step 5 – Critical Biodiversity Areas

Select the shapefiles of the group "CBA 1" and "CBA unknown" and determine the closest distance between the project site and CBA areas. Fill in the distance in km in step 5 in Excel and assign the corresponding impact score. If there is a high impact score indicate the possibility for mitigation options (yes or no). Deselect the groups "CBA 1" and "CBA unknown". For extra information the groups CBA 2 and CBA 3 are incorporated into EPAT QGIS as well, but they are considered not important and are not assessed.

#### 9.7. Step 6 – Drainage Lines

Select the shapefile "Drainage lines 34S" and determine the closest distance between turbine locations and a drainage line. Fill in the distance in m in step 6 in Excel and assign the corresponding impact score. If there is a high impact score indicate the possibility for mitigation options (yes or no). If multiple turbine locations are located within the no-go areas mention the number of turbines in the comments section. When no turbine layout is available and the feature on site gives a very high impact while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect shapefile "Drainage lines 34S".

#### 9.8. Step 7 – Frog data NFEPA wetlands

Select the shapefile "NFEPA frog wetlands 34S" and determine the closest distance between the turbine locations or project site and the frog wetlands. Fill in the distance in meter in step 7 in Excel and assign the corresponding impact score. If there is a high impact score indicate the possibility for mitigation options (yes or no). When no turbine layout is available and the feature on site gives a very high impact

---

<sup>11</sup> In QGIS: Menu > Vector > Research Tools > Select by Location...

while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect shapefile "NFEPA frog wetlands 34S".

#### 9.9. Step 8 – Virtual Museum – FrogMAP

Go to the website of the Virtual Museum <http://vmus.adu.org.za/> and click on the icon with FrogMAP, select Maps in the left menu and go to the Coverage tab in the screen. Select the 1° map grid and choose the RSA (old map) and request summary. Figure 26 shows the coverage map that should be visible, click on the right QDGC (see Birds Step 2) and a list of observed frog species is loaded. Check the red-list category: a species is threatened with the red list categories vulnerable, endangered and critically endangered, other categories are considered non-threatened. Note in Excel threatened, non-threatened or no species and the corresponding impact score. In the case of threatened frog species observations, note the common species name. Return to the home page of the Virtual Museum.

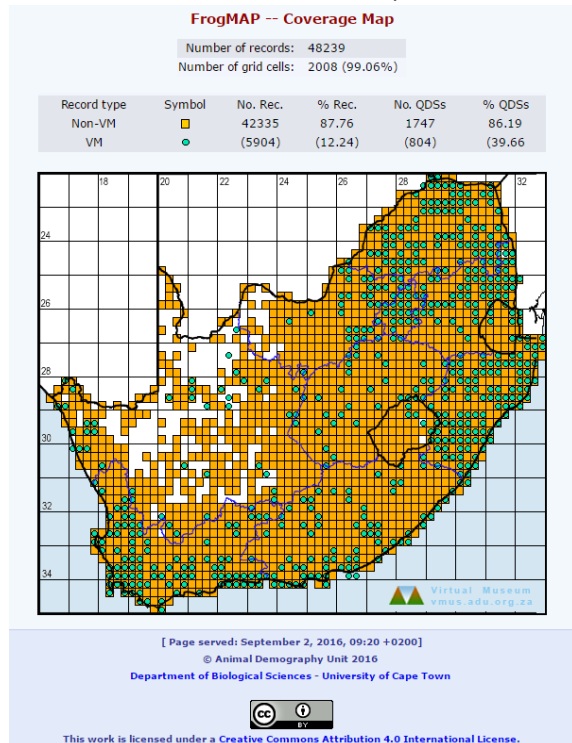


Figure 26 FrogMAP online coverage map part of the Virtual Museum of ADU

#### 9.10. Step 9 – Virtual Museum – ReptileMAP

Click on the ReptileMAP icon on the home page of the Virtual Museum and go again to Maps in the left menu and the Coverage tab. Follow the same procedure as the FrogMAP assessment in Step 8 and write down the results in Excel. Return to the homepage of the Virtual Museum.

#### 9.11. Step 10 – Virtual Museum – MammalMAP

Click on the MammalMAP icon on the home page of the Virtual Museum and go again to Maps in the left menu and the Coverage tab. Follow the same procedure as the FrogMAP assessment in Step 8 and write down the results in Excel. Close the website of the Virtual Museum.

#### 9.12. Step 11 – Landscape – Rocky outcrops

Activate the Google Satellite layer and zoom in to the project site. For convenience, delete the fill of the project's polygon by right-click on the layer and go to properties. Select in the tab Style the Simple fill, now adjust the colour fill and click OK. Assess the project area on the presence of rocky outcrops. If there are rocky outcrops present create a new polygon shapefile by clicking on New Shapefile Layer in the left toolbar, select Polygon under Type, select Project CRS and click OK. Save the shapefile as "Rocky

outcrops 'project name'" in the project map. Click the Toggle Editing in the upper toolbar and Add feature. Create a polygon around the outcrop with your mouse and right-click to end. Give each outcrop a different id number. When all outcrops have been processed click again on Toggle editing and save the changes. If there are no rocky outcrops present give an impact score of 1. Next step is to create a buffer<sup>12</sup> of 50 meter around the rocky outcrops that serve as no-go areas. Determine the closest distance of a turbine to a rocky outcrop and fill in the distance in meter and the associated impact score in Step 11 of Excel. If there is a high impact score indicate the possibility for mitigation options (yes or no). In the case of multiple turbines placed within the no-go zone, note this in the comments section. When no turbine layout is available and the feature on site gives a very high impact while this can be easily mitigated by micro-siting of turbines, assign a high impact score instead. Deselect the created shapefiles.

#### 9.13. Step 12 – Landscape – Land cover

Continue to use the Google Satellite layer and the project site with no fill. Inspect the area on the presence of cultivated and natural land and make an estimation of the ratio between them. With a majority of cultivated land, the project development will likely be preferred on cultivated land and the other way around. Check if turbines are located on the majority of the land cover or on the minority of the land cover. Fill in the result and the associated impact score in Excel. If turbines are located within different sections (cultivated/natural) note the number of turbines located in the minority land cover in the comments section. Change the fill of the polygon shape in a visible colour.

When all these different steps have been carried out, the EPAT automatically calculates the total impact score of the proposed development on Ecology. This score in combination with potential fatal flaws will determine the final impact rate. Furthermore, depending on the user's decision on possible mitigation options, the EPAT will provide information about further actions needed.

When finished with all EPAT categories there will be an overview of all categories assessed in the worksheet Total Result. Also the overall impact on all categories is automatically calculated here (average).

---

<sup>12</sup> In QGIS: menu > vector > geoprocessing tools > buffer

## 11.4 Appendix D

The EPAT DSET Excel file is digital available on request, Figure 27 is a screenshot of the file.

EPAT - Birds							
<p><b>Step 1</b></p> <p>Feature: Important Bird Areas (IBA)            Task: Determine the distance to the nearest IBA            Data used: Important Bird Areas            Scoring criteria based on: <a href="#">Avifaunal Exclusion Zones</a></p>							
Weighting factor	Scoring criteria		Distance (in km) to nearest IBA	Score	Fatal flaw	Possibility for mitigation (yes or no)	Comments
	Distance (in km) to nearest IBA	Score					
2	$d \geq 5$	1			no		
	$2.5 \leq d < 5$	2					
	$d < 2.5$	3					
<p><b>Step 2</b></p> <p>Feature: Raptors South African Bird Atlas 2 (SABAP)            Task: Determine the amount of species in the area counted by SABAP2            Data used: SABAP2            Scoring criteria based on: Self-developed methodology</p>							
Weighting factor	Scoring criteria		Number of species	Score	Fatal flaw	Possibility for mitigation (yes or no)	Comments
	Number of raptor species present in the area	Score					
3	$s=0$	1			no		
	$1 \leq s < 4$	2					
	$s \geq 5$	3					
<p><b>Step 3</b></p> <p>Feature: Very high priority species South African Bird Atlas 2 (SABAP)            Task: Determine the amount of species in the area counted by SABAP2            Data used: SABAP2            Scoring criteria based on: Self-developed methodology</p>							

Figure 27 Screenshot of EPAT Birds category