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Development of a Desktop Tool for the Assessment of the Potential Environmental Risks And Impacts of Wind Energy Power Plants in South Africa

Bachelorarbeit

im Studiengang

Umwelttechnik /Environmental Engineering

Vorgelegt von

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am 09. Januar 2012

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Die Abschlussarbeit wurde betreut und erstellt in Zusammenarbeit mit der Firma G7 Renewable Energies (Pty) Ltd in Cape Town, South Africa

Executive Summary

The aim of this study was to create a desktop based tool which allows any user, regardless of the level of experience or expertise in the field of potential environmental impact of wind energy power plants in South Africa, to run a simple and quick environmental risk assessment along specific impact categories for any planned wind farm project or anticipated future wind farm site at any development stage it finds itself, countrywide. The main challenge was to collect available expert knowledge and common practice methodology for each impact category and simplify the complex processes into a clear and efficient model which applies this expertise through a clear and simple interface. The outcome of this work is the release of a commercially usable Environmental Pre-feasibility Assessment Tool (EPAT).

During the course of this work the scope to assess 8 impact categories such as birds, bats, fauna etc. as initially set could not be fulfilled and had to be limited to 2, general and flora; reasons being the underestimated work volume per impact category and the limited available local expertise. Out of all categories general and flora were chosen which define a very important part of direct and measurable impact and cover a major part of the environmental challenges faced during the wind farm development process.

These challenges were faced with three separate tools which were created to fulfil three different purposes, each covering specific development stages from pre- to post-scouting of a project. This leads to a determination of potential environmental project threatening risks by the developer at an early stage when using the EPAT appropriately; potentially avoiding enormous cost and bearing powerful strategy implications.

The detailed tests of the EPAT undertaken for a chosen wind farm project did not only meet the challenging requirements set as standard for this tool, but also resulted in matching the outcome of several state of the art specialist assessments of the South African environmental practitioners industry.

The EPAT is a powerful instrument ready to be implemented into the project development framework of any wind farm developer in South Africa; G7 is prepared to use the tool for its vision of a pro-active ecological and economic development future.

Table of Contents

Annexures:

Abbreviations and Definitions

Constraint Map	Environmental maps collected for the EPAT which could potentially turn out to be a constraint to the project
DSET	Detailed Site Evaluation Tool
EIA	Environmental Impact Assessment
EPAT	Environmental Prefeasibility Assessment Tool
GIS	Geographic Information System
GIST	Geographic Information System Tool
Google Earth	Google Earth software as publically available by Google
G7	G7 Renewable Energies (Pty) Ltd
Impact Category	Environmental categories defined in the EPAT such as General, Flora, Birds etc. which impact risk will ultimately be assessed
KML	Keyhole Markup Language, standard Google Earth file format
Site	The project/site currently assessed
The tool	Synonym for EPAT
VSE	Visual Site Evaluation, one of two tool categories next to the Detailed Site Evaluation
WTG (1 to 12)	Wind Turbine Generator (together with the turbine number 1 to 12)
1 General	Impact Category “General” and its number in the order defined for the EPAT
2 Flora	Impact Category “Flora” and its number in the order defined for the EPAT

1 Introduction

1.1 Short overview of the history of wind energy in the world and in South Africa

The operation of the first wind turbines producing electricity take us back in history to the year 1887, where the Scotsman James Blyth was able to light up his holiday home with a single turbine and a battery charging system (1). Around 1900, already 2500 wind turbines with an estimated peak power of 30 MW were installed in Denmark, 100'000s were followed on farms in the US mainly for water pumping purposes up to 1930. The first turbine installed using today's common set up with a horizontal axis was invented in 1931 in the USSR with a capacity of 100 kW and the first grid connected one was installed in the UK in 1951 (2).

Ever since the world's markets and governing arms have adopted this form of electricity generation rapidly (particularly in the last 2 decades); and for countries new to this technology the growth in installed capacity has increased in a near exponential way over the last few years (3). The Technology itself went through major development as well, where turbines with capacities of up to 7.5 MW (4) are now available and operating; and where the offshore sector contributes substantially to this growth bringing it to new levels. In 2010 the installed wind power capacity worldwide reached 196.6 GW; countries like Denmark, Portugal, Spain and Germany reached a wind energy share of their overall energy mix in the region of 21, 18, 16 and 9% respectively (3).

South Africa is currently in the process of adopting renewable energies including large scale grid connected wind power generation under the IRP 2010 (Integrated Resource Plan) allocating some 1850 MW for wind alone to be built until 2016. A government driven Request for Proposal (RfP) was issued earlier this year on 4th of August with the aim to have projects competing on price and electing the best performing projects according to various other criteria. According to the time frame as set in the RfP, the construction of the first commercial wind farms in South Africa could start as early as June 2012. Such regulatory framework as created a favourable environment for the development of renewable energies in the country and a very strong interest from project developers to have as many projects as possible developed.

The Department of Environmental Affairs received a flood of (approximately 90) applications for Environmental Impact Assessments of wind farm developments in the past two years. The legal framework regulating environmental matters in South Africa is already quite sophisticated and competes equally in complexity and limitations with the European legislation (5) and (6).

However, for conservationists the history of the rapid adoption of this technology has proven in many other countries to be extremely alarming. Therefore wind farm developers are facing serious resistance from all sides of conservation, due to South Africa's unique environment, habitat and species and the local inexperience as well as lack of knowledge of the technology in general and its local impacts. Hence, this matter is of high sensitivity and a potential serious threat to both, the environment and the successful development and integration of wind power projects in the local natural environment.

1.2 Potential environmental impact of wind farm development

Before a wind farm can operate, the construction of various infrastructure such as roads, electrical installations, foundations and the turbine themselves is required. These infrastructure impacts on an existing landscape and environment either in transforming the land itself or its airspace above. Such change is impacting several areas in a local environment in various ways.

These impacts can be categorized in different impact categories as follow:

- General
- Flora
- Fauna
- Birds
- Bats
- Heritage
- Visual
- Noise

The potential of priority birds or bats colliding with the turbines, important ecological habitats being limited due to the construction of infrastructure or a landscape of high visual and heritage value can be challenged by the development. The impact might not only be local but can also affect the environment in a national or global manner, in the case of endemic species.

Therefore the National Environmental Management Act (7) (NEMA) (Act No. 107 of 1998) and the Environmental Impact Assessment (EIA hereafter) Regulations of 2006 promulgated under NEMA require an environmental authorisation where all activities are investigated which may have a potential impact on the environment, socio-economic conditions and cultural heritage.

The EIA process itself is undertaken by an independent environmental consultant and includes extensive and costly specialist studies for each impact category for which all potential impacts are assessed and collected in a report (the specialist report hereafter). The results and outcome of the specialist reports forms the base for the Environmental Impact Report (EIR hereafter) proposed by the environmental consultant to the Department of Environmental Affairs in order to apply for an environmental authorisation.

1.3 Regulatory Framework

The assessment of the potential environmental impact of a project is based on the following legislation, applicable on the date of commencement of this report. :

- National Environmental Management: Protected Areas Act (Act 57 of 2003)
- National Water Act (Act No. 36 of 1998)
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
- National Heritage Resources Act (Act No. 25 of 1999)
- Electricity Regulation Act (Act No. 4 of 2006)
- Aviation Act (Act No. 74 of 1962)
- Occupational Health and Safety Act (Act No. 85 of 1993)
- Subdivision of Agricultural Land Act (Act No. 70 of 1970)
- Noise Control Regulations, Environment Conservation Act (Act No. 73 of 1989)
- National Environmental Management Act (NEMA) (Act No. 107 of 1998) as amended

- Environmental Impact Assessment (EIA) Regulations of 2006 promulgated under NEMA

2 Purpose of the Prefeasibility Assessment Tool

2.1 General

Like any other sizeable development a wind farm project is implemented in numerous different steps and milestones, each requiring additional investment. Many factors are influencing these steps whether they are of economical, technical or ecological nature. Every factor feeds into a risk assessment, which results into a decision to take a project further and gives effect to the required investments to ensure a successful development.

The developer general aim is to manage carefully its business risk against its expenses and up to the point where a project has received all authorization required for it to be built without unmanageable risk. Consequently it is the aim of every developer to minimise risk where possible and in particular regarding environmental risks. By categorising potential environmental impacts and weighing the risk factors for each impact category, the developer can partly but simply achieve its aim through a quick and cost-effective desktop study for each of its projects. To ensure a reliable process easy to operate for any user, a tool was to be created which fulfils the requirements and offers the advantages of a living document where a frequently updating process can take place in case of changes of regulations, guidelines, reports, environmental database or papers. The latter form the base of the tool, a library containing national as well as international assessment methods. This library feeds three different methods to accomplish a prefeasibility assessment for projects in different stages and detail.

To keep these stages as simple as possible the development is divided into 2 Phases, Pre- Scouting and Post Scouting as indicated in Figure 1 below.

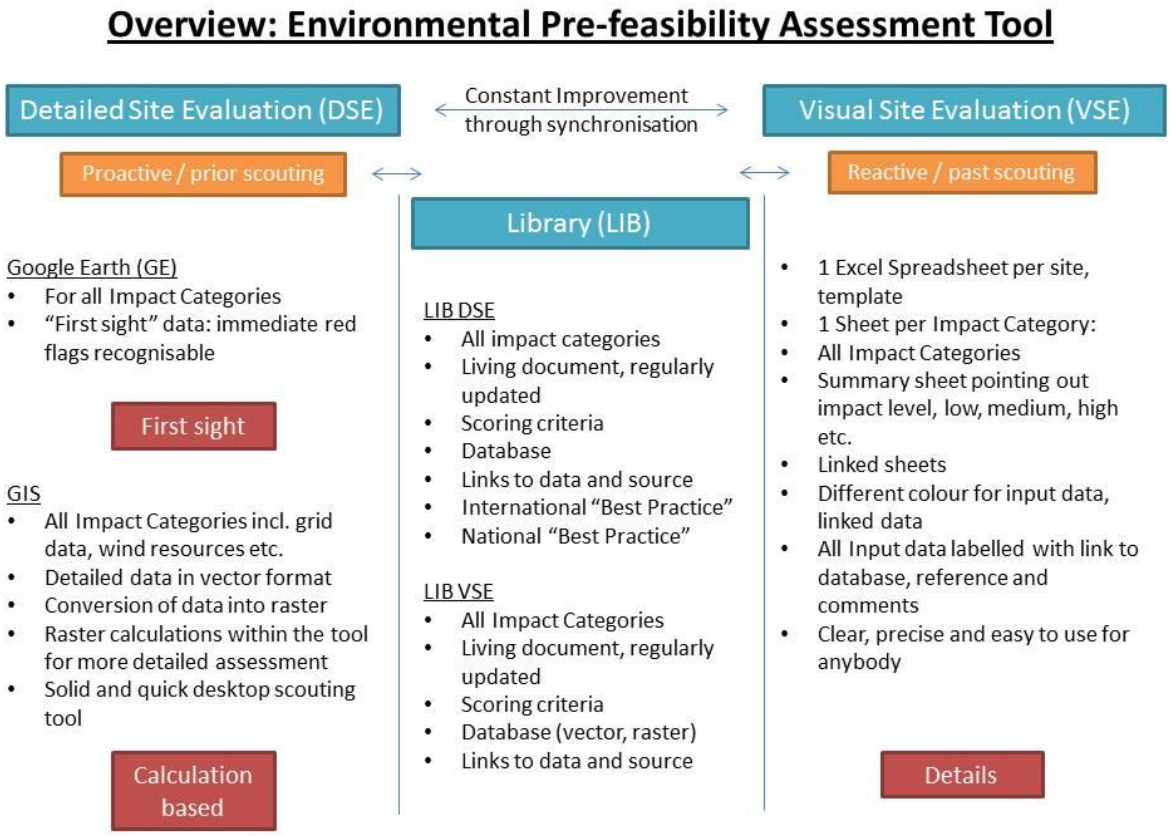

Figure 1 Overview of the EPAT

Pre-Scouting, where no physical scouting took place yet (a mere desktop study), does not offer much information or details on the identified site; nonetheless, potential impacts can be already assessed indicating whether a site is worth being elected as a potential project or not. It also provides the opportunity to scout for sites according to environmental parameters defined by the user, hence certain risks can be avoided already from the beginning without even the developer mobilizing for a site visit.

A site considered to be in the phase of post scouting is already in a development stage as a project, where several development steps already took place, including a site visit. Where more details on a particular site are available, a more detailed approach of an environmental prefeasibility assessment can be initiated.

2.2 Pre-Scouting Phase

The pre-scouting phase is the starting point of every development. Based on different parameters such as wind resources, topography or connectivity and access (electrical grid and roads), a site is evaluated to become a project. Experience showed that most of the current G7 projects were discovered first via desktop study, considering the different parameters available. Occasionally

phone calls or recommendations of landowners attracted the attention to a site; however a desktop assessment followed thereafter. Therefore, the desktop study is a very powerful tool, which, if applied correctly and as detailed as possible, can limit most potential risks and unnecessary costs from the beginning.

Experience proved as well that environmental authorisation is one of the main pillars a project is founded on and its impact can be severe, if not addressed in early development stage. Therefore the assessment of potential environmental impacts need to be undertaken as early as possible and implemented into the pre-scouting Phase.

The Environmental Prefeasibility Assessment Tool (EPAT) covers two different approaches, which are both part of the group Visual Site Evaluation (VSE) of the tool.

Firstly, a purely visual process using Google Earth with the possibility to identify and red flag risks immediately. It is based on publicly available maps, from sources such as SANBI (8), collected in the Tool's Library and converted to, geo-referenced or overlays in the software Google Earth, in its common file formats KMZ and KML. Where a site is identified and processed in the Google Earth data base, the maps of the environmental data can be overlaid and the site can be evaluated as a "first sight" risk assessment. This tool will also be helpful in internal (i.e. between the assessor and the project manager) and external (i.e. potential investors) demonstration processes, will be used for quick analysis in case a site is recommended by third parties and inform the Detailed Site Evaluation tool described in Section 2.3 of this report.

For a more accurate and detailed method the second tool of the group of VSE is employed, with the use of Geographic Information Systems (GIS). The database contains all environmental constraint maps such as conservation areas and their common buffer areas as well as technical aspects such as wind resource, grid or airfield maps. This collection of Vector and Raster files offers detailed Raster calculations in any GIS Software such as Quantum GIS (QGIS, Open Source software). A calculation can integrate any applicable map and parameter of all Impact Categories from the database to identify all areas where the chosen buffers relating to the parameters do not apply, resulting into a new map where the risk for development is identified and minimised where possible. The data is available per region, province and even nationally which allows to "scout from your desktop" for a site anywhere in South Africa in a quick, precise and cost-effective manner. The level of risk a developer is willing to take in approaching the site is fully dependent on the choice of parameters, and therefore can be pre-configured.

2.3 Post-Scouting Phase

Given that a desktop scouting as described in section 2.2 can provide reasonable results for a potential environmental risk assessment, it will not however replace a more detailed approach, which is achievable with the use of the third tool of the EPAT, the Detailed Site Evaluation Tool (DSET).

The DSET is based on the methodology of the Environmental Impact Assessment, taking all Impact Categories into account and incorporating impact scoring criteria defined or applied by national and international scientific knowledge or best practice. This tool is in the form of a spreadsheet (Excel),

where all steps are clearly defined and refer to the data collected in the EPAT's Library. It still requires operating with both of the Visual Site Evaluation tools, Google Earth and GIS.

The actual site visit includes several scouting processes which are required from a developer to assess a site on its viability in terms of road and grid access, wind resources in connection with a preliminary layout, ground feasibility etc. These site visits had so far incorrectly disregarded all environmental aspects; this will now be amended and integrated into the future company development methodology and process.

The desktop study conducted with both tool categories, the VSE and the DSE, refined with the findings of a following site visit, will minimise to a very large extend any possible surprise regarding environmental impacts identification from specialists during the actual environmental impact assessment; his work allows to highlight upfront the serious potential risks a development could face. The EPAT will be one of the main developer decision tools within G7 for the election of a project to be taken to the next steps of development with its initial large investments such as a full independent environmental impact assessment or the start of a wind measuring campaign.

3 Methodology

3.1 Research

The motivation for the creation of the EPAT as described in Section 2 are originated from the "Pre-feasibility Assessment for 14 proposed wind energy facility sites in South Africa" (9) undertaken by the consultant Coastal & Environmental Services. In order to evaluate potential risks prior to the commencement of the EIA phase, G7 subcontracted the company Coastal & Environmental Services, specialised in EIA processes, to run such a desktop study for all projects under development at that time. The study itself plays a key structural role in the creation of the EPAT and is referred back to for the confirmation of assessment results of the EPAT in Annex C at a later stage.

However, the main input to the EPAT is provided by extensive research on national and international studies, papers, best practice guidelines and specialist reports for EIAs. The aim of that research is to feed the library of the EPAT, to which every single step of this tool refers back.

3.1.1 Pre-feasibility Assessment for 14 proposed wind energy facility sites in South Africa

This prefeasibility assessment was meant to be a quick and inexpensive desktop method to assess the potential environmental risk for every site, to collect its findings and to point out issues to be expected in an impact significance rating process which finally fed into a project prioritisation process.

The study provides a broad methodology and structure that was partly used in the creation of the EPAT. This includes regulatory framework, the important impact categories, data references, evaluation criteria and map material for comparison. However, the report neither undertakes a detailed assessment nor does it cater for detailed information on how to evaluate the impacts for each category. Comparison of the results between the prefeasibility assessment and the actual specialist reports submitted for the undertaken EIA thereafter highlighted major disparity for a same site, which influenced the development progress enormously as some part of the risk was clearly underestimated or not even identified in the initial study.

Therefore the need for more detailed research occurred in order to fulfil the ultimate purpose of the EPAT.

3.1.2 Specialist Reports

More detail on the assessment methodologies can be found in the reports prepared by specialists for each impact category in the EIA process. A specialist determines the potential impact and the possible mitigation methods of the impact induced by the development in his Specialist Report based on his experience, scientific knowledge, literature and the specialist findings made on a site visit.

Having seen the site and equipped with the resources and experience to undertake such a detailed assessment, the reports deliver plenty of information to refine the methodology of the EPAT, to build evaluation criteria and to fill the library with reference data. At the time this report was written, an estimated amount of 90 EIA processes for wind farm projects were in the process nationally, only some of them were granted an environmental authorisation. All EIAs and related reports are public information and available on the websites of each representative environmental consultants. The main environmental practitioners dealing with wind farm development in the country are listed in Table 1 below.

Table 1: List of main Environmental Consultants involved in the EIA process for Wind Farm projects

Name of Consultant	Website
Coastal & Environmental Services	http://www.cesnet.co.za/
CSIR	http://www.csir.co.za/
ERM Group, Inc.	http://www.erm.com
GIBB	http://www.gibb.co.za/
Savannah Environmental (PTY) LTD	http://www.savannahsa.com/

Different consultants appoint different specialist; this results into a large pool of reports addressed from various angles and/or with various methodologies, scoring evaluation and references. Such diversity of specialist knowledge made up the main grounds for the scoring definition and evaluation of each impact category of the EPAT.

3.1.3 Other Media

As wind energy is a fairly new technology, in fact does not yet exist in South Africa, apart from 3 pilot projects (Darling Wind Power, Eskom's Klipheuvel and Coega with totalling some 8 turbines), some impacts are very difficult to assess in a local context even for specialists. Therefore, most of the specialist had to undergo a process of gathering international experiences, papers, books and guidelines and in turn project or correlate similar approaches onto or with the local environment.

This information gathering process will be on-going and eventually reviewed until baseline data are sufficient enough to finally enable local specialists to grasp the actual local impact.

For some impact categories such as birds and bats this process resulted in the draft of "Best Practice Guidelines" (10) , led by the European and American guidelines for pre and post-construction monitoring. These follow the precautionary principle and are to ensure that the currently limited knowledge about the impact of Wind Farm Projects will not result into a non-repairable damage of

potentially sensitive species and will allow the collection of local baseline data to make informed recommendations.

Experience shows that specialist reports have a tendency to argue based on international experiences while taking into account worst case scenarios which might actually not apply anymore due to the progress of technology. In other cases a complete disregard of other studies concerning the same field led to different results and evaluation of the actual impact. To obtain an overview and fund an appropriate judgement for the scoring criteria to be used in this tool, research on any international literature such as published papers, reports or books is necessary where references cannot be linked to local experience.

3.2 Library

The EPAT is based on scientific valuable data and information obtained through research as per Section 3.1 on national and/or international experience and expertise that build the foundation of the Library and mainly fulfils three purposes as described below. A user manual for the Library is provided in the library and is dealt with in Section 4 of this report.

3.2.1 Reference

Every scoring evaluation, rule defining buffer area or particularly chosen sensitivity map applied in the various tools is linked to the library either in the “Link to Library” and/or the Reference column in the tool itself (in case of the DSET) and in the “Overview list of data, source and reference links” spreadsheet provided within the library.

This is to ensure the validity of chosen assessment parameters as well as to follow the chronological change such assessments might undergo over time.

3.2.2 Database

All digital maps used in the Visual Site Evaluation constitute a database in the library, from which the tools sources its input. This database only applies to the Visual Site Evaluation which again is divided into two separate tools, the GIS Tool, GIST hereafter and the Google Earth Tool, GET hereafter.

The GET consists of one main KML file (Keyhole Markup Language, standard Google Earth file format) including all used parameters for each impact category. The parameter KMLs for each constraint map from which the GET sources its data are also saved within the Library. The GIST is working with two different file formats, Vector and Raster, and therefore two different folders in the Library.

3.2.3 Update

Science is always developing with new researches and new findings which could potentially change sensitivities or scoring criteria and could therefore potentially change the risk of a project. Hence, updating the entire tool appropriately and regularly is absolutely necessary and crucial in order to implement the latest findings and again, minimise risks where possible. During the research process notes were taken on update frequencies of maps and papers and included to the “Overview list of data, source and reference links” spreadsheet when available and assumptions were met when necessary due to the lack of information. The maintenance process of the tool would include a regular updating procedure based on the time frame provided in this spreadsheet.

3.3 Construction of the Tools

Based on the research undertaken earlier and the applicable information and data available in the Library, the construction of the various tools could be started. All tools forming the main components of the EPAT, are indirectly or directly linked to each other and fulfil different purposes in a site assessment. Changes made to one tool such as including a new sensitivity factor will have a direct effect on each tool; therefore each tool needs to be reviewed which results into a permanent development between the tools through latest findings or experiences made.

3.3.1 Google Earth Tool (GET)

The GET is the first part of the Visual Site Evaluation Tools and it is based on the project KML (GET_EPAT.kml) file which contains all collected and important constraint maps for each impact category as shown in Figure 2 below.

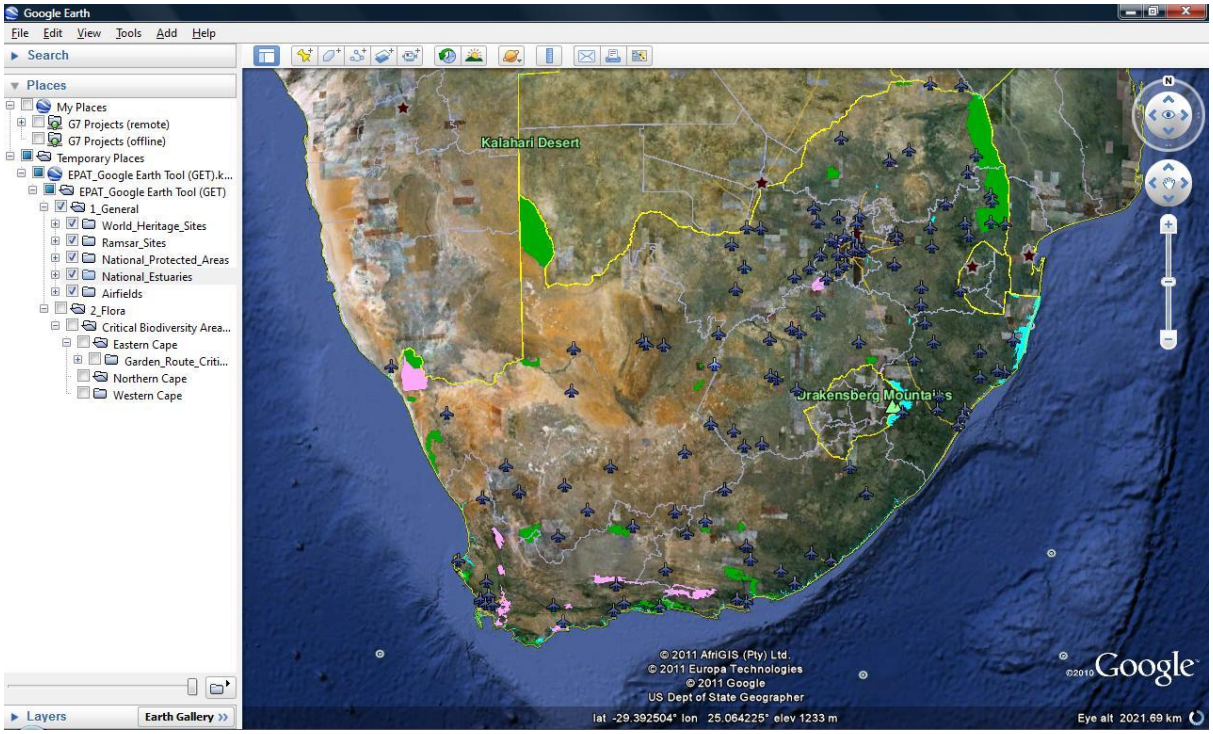

Figure 2 Overview of the GET in the Google Earth structure in early development stage including most of constraint maps for 1_General (World Heritage Sites enabled and marked in pink, National Protected Areas in green etc.) and some of 2_Flora (no constraint maps enabled)

For each impact category a main KML file (i.e General.kml) which includes all applicable constraint maps was created with the software Quatum GIS from the publicly available shape files collected in the research process. All impact categories and map KML files are stored at their associated place within the library. Network links between the Google Earth Tool KML and the impact category KMLs are created to ensure the GET is only launching the latest updated maps. The tool allows for the enabling of each impact category and constraint map according to the purpose of the site evaluation separately which simplifies the focus area and disregards unnecessary information.

3.3.2 GIS Tool (GIST)

This Analysis Tool is carried out using the QGIS open source GIS software v1.7 (11) , coupled with various raster processing tools (v1.8) provided by the GDAL project (12).

Similar to the GET, the GIST takes the publically available GIS vector data to produce the constraint maps for each impact category covering entire South Africa where possible. The constraint map can be used as a stand-alone visual site assessment, where project details with higher accuracy and less uncertainty compared to Google Earth can be added.
However the actual power of the tool and its implementation requires the user to take a step further. All vector inputs collected in the research process are rasterised into a Boolean raster in a 1x1 km grid first and into distance raster files thereafter as shown in Figure 3; the vector and raster projection applied and transformed to is UTM South Zone 34, which implies the use of metric measurements which is not possible with the original available data in Latitude/Longitude coordinate System.

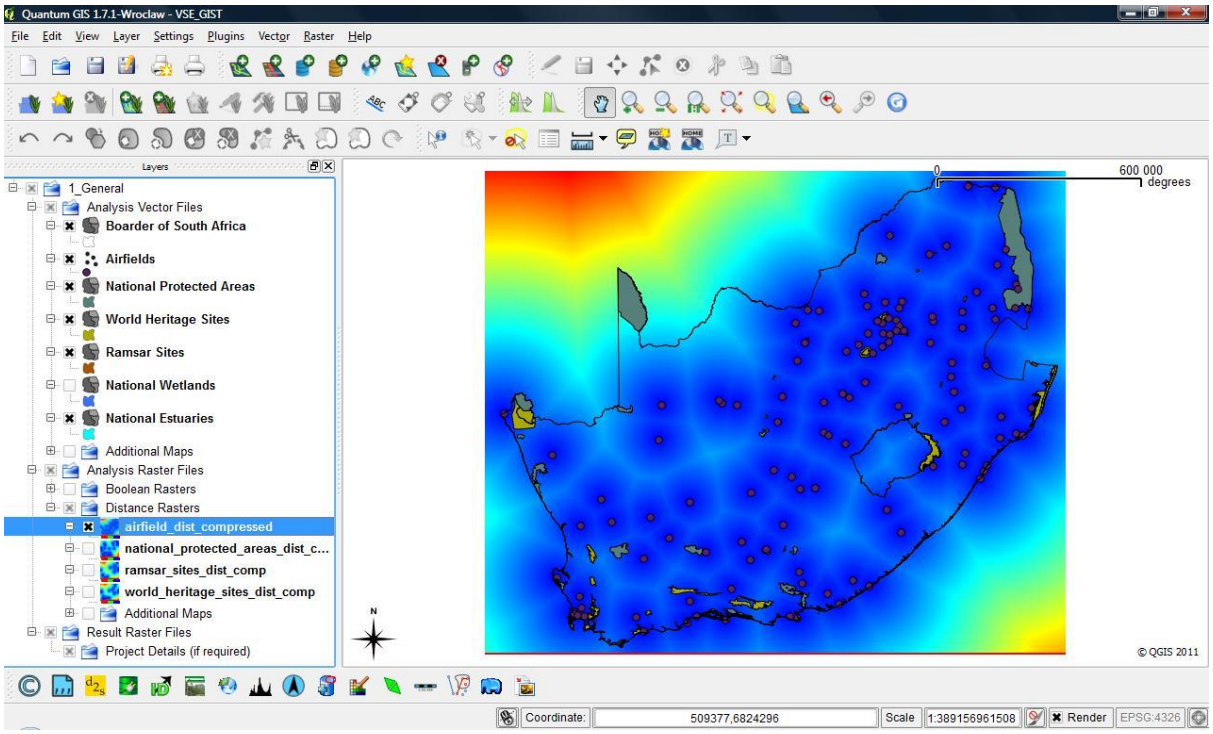

Figure 3 Overview of the impact category 1 General of the GIST in the software Quantum GIS; The Analysis Vector Files such as Airfields (purple dots), National Protected Areas (green-grey) etc. are enabled as well as the Distance Raster Grid for airfields (the colour ranges from red for far distance to dark blue for close proximities).

The Quantum GIS built in raster calculation tool can now use the distance raster files, applies required buffer per individual constraint map such as Airfields or National Protected Areas and creates a new raster grid that shows all 1x1 km grid cells that are not affected by the potential environmental constraints. This results into the determination of low risk development areas in the entire country via simple precise desktop calculations.

3.3.3 Detailed Site Evaluation Tool (DSET)

The DSET is an Excel based document which contains one or more spreadsheets per impact category. To use the Tool appropriately a preparation for each impact category needs to be undertaken first. Therefore each spreadsheet is divided into two parts, the site preparation and the impact assessment. The extent of the site preparation is dependent on the impact category, it involves both tools of the VSE and is directly linked to the Impact Assessment.

The impact assessment itself takes into account all constraint maps, the Scoring and the Guidelines as per Figure 4 below.

1	General	Project Name				Assessment Details	Date	Name of Assessor
	Site Description					Guidelines		
Ref #	Map Description			Status / Scoring		References	Link to Library	Comments, Considerations
1.1	Site Preparation							
1.1.1	Set up of the Project			Status	Comment	User Manual # 1.1.1		
1.1.1.1	Set up of the Project folder						LIB_Detailed Site Evaluation	
1.1.1.2	Changing the Project Details					Cell C1, I1 and J1 of 1 General	n/a	
1.1.1.3	Adding of the project to the Library						LIB_Detailed Site Evaluation/Projects	
1.1.2	Construction of a Preliminary Site Layout			Status	Comment	User Manual # 1.1.2	LIB_Detailed Site Evaluation/Projects/Project KML	
1.1.2.1	Property boundaries					Supplementary Data/Farm Portions		
1.1.2.2	Turbine layout							
1.1.2.3	Road layout							

1.2.	Impact assessment	Scoring					Guidelines	
Ref. No.	Constraint Map	Weighing factor	Score	Scoring / Site description	Score evaluation	Scoring criteria	References	Link to database	Comments, Considerations
1.2.1	Airfields	1			4	Distance < 10km	20091218_G7 Prefeasibility	LIB_Detailed Site	Values according to reference are
					3	Distance < 20km	Assessment FINAL.doc &	Evaluation/1_General	different, a more conservative
					2	Distance > 20km	201003_1.2.1_Airfileds_NATS	&	approach is taken here
					1	None in close proximity	Safety Analysis PE Airport.pdf	1_General/201110	

Figure 4 Exemplary excerpt of DSET - Impact category: 1_General

3.3.4 Testing of the Tools

3.3.4.1 GET

The GET is a simple visualisation and measurement tool to indicate potential risks. Tests were followed up in Annex C to this report for G7's Klawer Project.

3.3.4.2 GIST

The tool is designed to be used for desktop scouting as part of the development process of G7's future sites and a test was undertaken in Annex C of this report for G7's Klawer Wind Power project. The test is quite simple and uses buffers as suggested in the DSET.

3.3.4.3 DSET

To ensure the working order and the precision of the DSET, the tool needs to undergo detailed testing against existing site assessments, namely the specialist reports undertaken in the EIA process for G7's Klawer Project and the "Prefeasibility Assessment for 14 Proposed Wind Energy Facility Sites in South Africa" (9). The tests can be found in Annex C to this report.

The purpose of such testing is first of all to see whether the DSET is functioning well together with the library and all references made for simple use. In case there are any issues, the relevant items need to be reviewed and changed accordingly. The most important part of the testing is to get similar, preferably the same results, as indicated in the specialist report. If there are any differences, these need to be evaluated within the tool; scoring criteria or weighing factors potentially have to be reviewed and changed and research might need to be extended to inform the review of the tool. Afterwards, the testing phase needs to be rerun and yet again, results have to be compared with the existing literature until they are sufficient enough for the DSET to be classified as in working order hence, ready to be used for future scouting processes.

3.4 Construction of the User Manual

The next step it is to create detailed user manuals for each tool, the library and updating cycles. The user manuals themselves will be stored within the guideline section of the EPAT and shall be used as guidelines to assess each impact category to the best possible standards as set in the EPAT. Their purpose is to be simple, precise, easy and quick to use by anybody, even by employees that are inexperienced in the field of Environmental Impact Assessments.

4 User Manual

This chapter contains detailed user guidance for each tool, the library as well as updating cycles and form the guidelines to run the EPAT appropriately, efficiently and with the expected accuracy.

4.1 Library

A well working and living library requires a structure, maintenance and correct labelling. The purpose of this section is to ensure this in an efficient way, which covers the above while limiting the efforts of maintenance.

4.1.1 Structure

The library is one of the three main pillars of the Tool and sits below the EPAT next to site evaluation tools and guidelines as indicated in Figure 5 below. The library is separated into the two different tool categories, LIB_Detailed Site Evaluation and LIB_Visual Site Evaluation and their impact categories such as 1_General and 2_Flora thereafter. Each impact category contains the directory named “201110” (YYYYMM) which indicates the date of the update cycle of the data and includes all constraint maps and literature used in each tool. It has to be mentioned that the data from GIST and GET are mostly identical as most files were converted into the required file type format only.

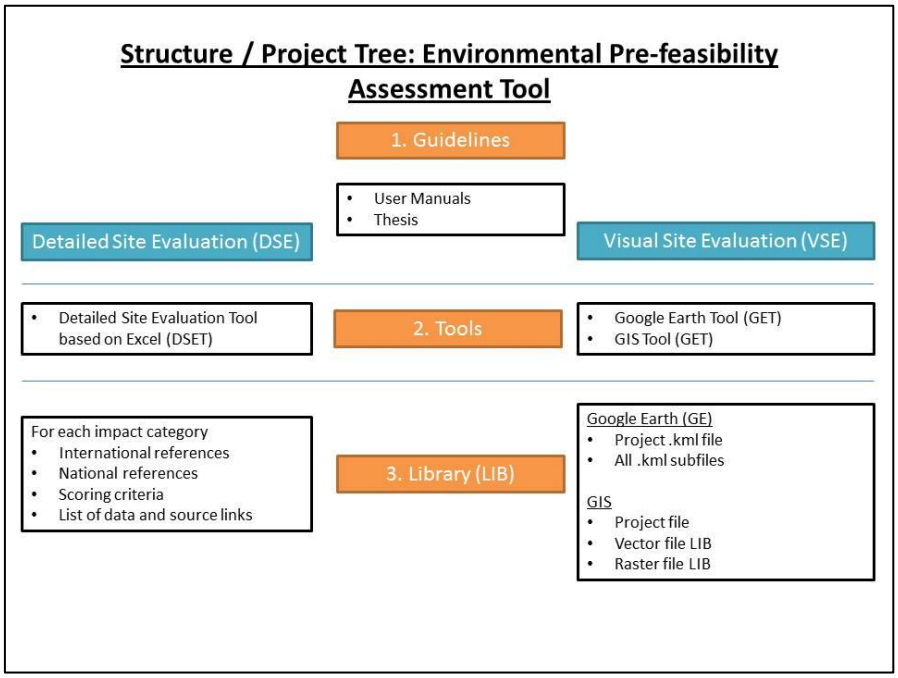

Figure 5 Simplified Structure / Project tree of the EPAT

4.1.2 Database

Details of the database content of each tool are provided in Table 2 below.

Table 2 File description of the Library's various databases

Tool / Data	File Description
DSET	PDF, DOC
GET	KML
GIST	
Vector	SHP (Shape File mostly accompany 3 or more files such as DBF, PRJ, SBX and SHX which are necessary to be kept in the same place)
Raster	TIFF (Geo Tiff files)

It is important to keep the same file types in order to avoid potential complications thereafter.

4.1.3 Update

This first version of the EPAT is based on 201110 data and referenced as such in the various tools. Revision of the data is required in certain frequencies as indicated in the spreadsheet "Overview list of data, source and reference links". Every revision of data or literature of each impact category needs to be saved in a new folder indicating the name of the new revision cycle, e.g. a year later: "201210" (YYYYMM). References to the data used by this new revision cycle shall be made accordingly in the various tools.

4.2 Tools

Each one of the tools GET, GIST and DSET is used for different purposes and the methodology on how to assess the potential risk of a site varies therefore as well. This section describes the steps to follow in order to obtain such results accordingly and in a comprehensive way. For some steps a basic knowledge of standard processes in the various software (Google Earth, GIS, GRASS) being used is required, however this exceeded the scope of this study hence not covered here. For more information the user is advised to contact a supervisor, refer to the literature online or on G7 servers.

4.2.1 Visual Site Evaluation (VSE)

This section contains the user manuals for the GET and for the GIST.

4.2.1.1 Google Earth Tool (GET)

Google Earth offers the possibility to simply illustrate satellite imagery information together with any overlay required by the user anywhere in the world. Hence, Google Earth is not only a very powerful tool for presentation of developments such as wind farms, but sharing its content with any party involved in such a development process is not restricted to software licences, hardware limitations or location. Its use for the scouting process is therefore of great practical value and common standard in the industry.

This user manual does not include the general use of Google Earth, which can be found online under http://earth.google.com/support/bin/static.py?page=guide_toc.cs . Knowledge how to drive Google Earth is expected upfront and a qualification criteria to use the GET.

4.2.1.1.1 Location and Structure

The Google Earth file format is either KML or KMZ, whereas the latter of the two is a compressed format of the KML. The main KML (GET_EPAT.kml) used by the tool sits in the repository under main/scouting/EPAT/Site Evaluation Tools/Visual Site Evaluation (VSE)/ Google Earth Tool(GET). The KML includes all potentially affected impact categories and each constraint map respectively.

Each impact category such as General, Flora etc. has its own KML file, i.e. General.kml. Same applies for all constraint maps within the impact category, which are stored together in a dated folder in the repository under main/scouting/EPAT/ Library (LIB)/ LIB_Visual Site Evaluation/Google Earth/ for example as General/201110. The folder 201110 is indicating the date of the revision cycle of the data (YYYYMM). When ensuring the storage of constraint map file according to the correct revision cycles of the tool within the library, a history of changes to the maps is built up; which, when compared, might add additional value for the assessment on how the conservation of the particular map tends to progress.

4.2.1.1.1 Use of the GET

The use of the tool is simply based on the visual inspection of satellite imagery and the possibility to measure distances between project-related infrastructure and overlaid constraint maps.

The GET works in the following steps:

1. Identification of the potential site - This user manual does not cover the scouting procedures, which G7 is undertaking in a complex development process in order to identify potential sites.
2. Mapping of the site - Once a site is identified, a place mark with the coordinates can be set in Google Earth under temporary files in the GE project tree.
3. Use of the GET - All impact categories and constraint maps can be enabled individually as required by the user.
4. Risk assessment:
   - 4.1. Location of the Site – The location of the site can indicate potential risks already due to common knowledge about scenic routes or places of special value to locals or tourists, for example Table Mountain in Cape Town, the Swellendam area or Cape Point.
   - 4.2. Constraint maps – The constraint maps indicate more details to the surrounding of the location of the Site. Depending on the impact category affected, a site could be directly or of close proximity to a national park, close to an airfield or within a Critical Biodiversity Area of high sensitive ecology, an example is indicated in Figure 6. By clicking on the constraint map within the map area, a window will pop up displaying more information on the area of interest.
   - 4.3. Distances – Google earth contains a measurement tool to measure distances in its maps, which increases the accuracy of assessing a potential risks. Most environmental specialists work according to buffer zones around conservation areas; these are identified in the DSET and accompanied with references to the applicable section in the library.
   - 4.4. Conclusion – Based on the steps before, a conclusion can be drawn, which is followed by a decision whether to undertake a more detailed approach (DSET) or avoid the site due to the risk being determined as being too high. A decision for or against a development is only based on the environmental perspective and the available constraint maps here; other

factors such as wind resources and accessibility will play a major role as well, before sites are possibly fully discarded.

4.2.1.1.2 Simplified example of the use of the GET:

Simplified example of the use of the GET:

1. Location - The example in Figure 6 shows such an identified Site (Potential Site A), north of Plettenberg Bay near Knysna. The area is commonly known as a scenic place with a great biodiversity area stretching along the Garden Route; hence, it will face several environmental risks including General, Visual, Heritage, Birds and Ecology. Therefore the risk might already be determined as too high for a developer to progress with further investigations and investments.
2. Constraint Maps and Distances – The affected Constraint Maps are as follows:
   2.1. National Parks (in green)
   The Site is surrounded by national parks situated at distances as close as 2.5km. The risk here is very high, as a general distance to National parks is recommended by local guidelines to be 10km
   2.2. World Heritage Sites (in pink)
   The distance to the risk area is approx. 20km, which will have a high impact on the evaluation of heritage authorities and major issues are to be expected (as this could possibly affect the 'sense of place' of the concerned world heritage)
   2.3. National Estuaries (light blue)
   The distance to this constraint map is approx. 15km which shall be a sufficient distance in order to minimise the risk here (mainly bird impact is of concern here).
   2.4. Airfield of Plettenberg Bay
   The Civil Aviation Authority (CAA) will decide whether 25km distance to Plettenberg Bay Aerodrome will be sufficient or not. This is dependent on the flight frequency, the size of the airfield (e.g. large scale airport) and minimum required distances thereof. Experience at G7's Richtersveld proofed that a distance of approximately 23km allowed for a CAA approval being granted, but a potential risk that the CAA decides differently still remains.
4. Conclusion
   Overall, this site is not considered to be favourable for wind farm development. The Location itself, National parks together with the World heritage site being too close to the planned development which is a major risk and can potentially result in major difficulties to receive Environmental Authorisation for this site. Alternatives should be considered.

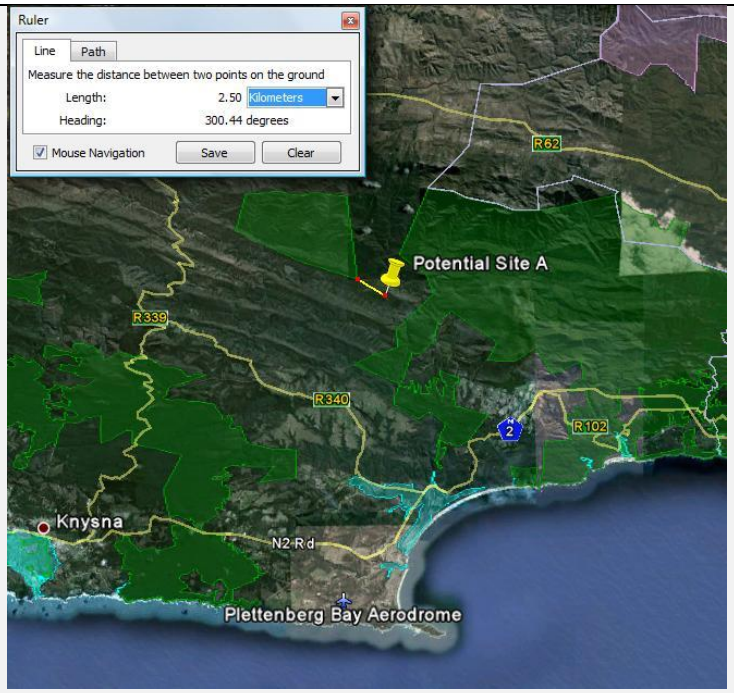

Figure 6 Simplified example of the use of the GET

4.2.1.1.3 Additional possibilities of the GET

The GET offers additional possibilities to get more details for such a first sight overview assessment. This takes its importance if a conclusion does not lead to a clear decision. Obtaining more details here involves the addition of several different maps within the project development database.

1. Adding of land parcels (Farm Portions)
   Adding the map of the land parcels of interest can give a better overview and might change distances substantially depending on the size of such a farm portion. The areas within the property boundary where turbines could potentially be constructed can be identified and might take the distances to a level where risk is acceptable.
   If the original parcel is not suitable or ideal for wind farm development, the neighbouring farms can be investigated further on the same principles as above.
2. Adding road and grid infrastructure
   The accessibility is another critical point for any further investigation and can be defined through adding the road and grid maps. As the construction of new infrastructure requires a large portion of the development costs, a decision in the conclusion might be altered when considering the distances to roads, the local grid and their particularities, e.g. tarred wide roads and a large capacity grid line (132 kV) on site being ideal in such a case, as opposed to a narrow farm road surrounded by ancient trees and a farm-feeding power line (11 or 22kV) crossing the site.
3. Use of satellite imagery
   An important factor of environmental impacts is the transformation of the existing natural habitat, the sense of place and how pristine a site in its environment is. The use of detailed satellite imagery investigation in Google Earth helps identifying the proportion of converted land (i.e. agricultural use) or other developments such as other industry, a railway, power lines, radio

communication masts etc., which have already impacted the site to an extent that potentially minimises the additional risk that a development such as a wind farm could introduce.

4. Future local development
   Research on other future development in close proximity to the site already authorised or in progressed planning stage can be added with simple polygons or place marks, which might again decrease the originally evaluated risk.
5. Creating buffers
   In addition to the actual mapping of the sensitivity areas buffers commonly used by specialists can be applied, in order to simplify the possibility of potential layout alternatives. Simple buffers can be created with the online tool of Geo-News.Net under http://www.geo-news.net/index_buffer.php.
   5.1. The Tool offers 3 options: Buffer Line, Buffer Point and Buffer Polygon
   5.2. Once the preferred option is selected the KML file to which Buffers shall be applied is to be identified, chosen and uploaded.
   5.3. The tool creates a download link on top of the screen which directs to the newly created buffer and should be saved as a separate KML file (Note: Make sure the file is renamed to .kml otherwise Google Earth software will not be able to read it).

4.2.1.2 GIS Tool (GIST)

This section describes the processes involved in the use of the GIST, but excludes the actual process how to use the different software which enabled us to create new parts or functions of this tool. Basic knowledge for the general use of Quantum GIS and Raster Calculation is required, which can be obtained online under http://www.qgis.org/en/documentation/manuals.html , various other online tutorials and/or from your supervisor.

G7's scouting procedure was solely based on wind resources and infrastructural connectivity (roads and grid) so far with some rudimentary environmental consideration. The GIST's purpose is to add another pillar to a simplified future scouting procedure based on a pre-selection of areas according to the two initial main aspects above and more detailed environmental constraints.

4.2.1.2.1 Location and Structure

The GIST project file is the Quantum GIS (QGIS) project file "VSE_GIST.qgs" and sits in the repository under main/Scouting/EPAT/Environmental Pre-feasibility Assessment Tool/Site Evaluation Tools/Visual Site Evaluation (VSE)/GIS Tool(GIST). The projects file is not constituted by the layers used within the file, but refer to them and their path via a link. If a layer (constraint map) is shifted into another directory or the tool is used from another computer, QGIS will not find the file due to a path error. Quantum GIS does not yet offer (or not to the authors knowledge) the possibility to link the files to relative paths rather than absolute ones. The main tool will be set up for G7's "Boreas" desktop computer; all other users who want to use the tool externally have to manually redefine the location of all maps used in the project file to their relative path in the repository. This is indeed a rather frustrating task but unavoidable for now and only takes approximately 5min of the user time after all.

The Project file is divided into 3 main groups which are found in the Library of the EPAT under LIB_Visual Site Evaluation\GIS in the same structure:

1. Analysis Vector Files – re-projected files from the original files (mostly in Latitude/Longitude, to be found under the same name in the Library) to UTM South Zone 34 coordinate system.
2. Analysis Raster Files
   2.1. Boolean Rasters – created from the Analysis Vector Files using the "gdal_rasterize" tool of the Gdal platform
   2.2. Distance Rasters – created from the Boolean Rasters using the "gdal_proximity" tool of the Gdal plugin to Quantum GIS
3. Result Raster Files – Project related, results from "raster calculation" plugin to Quantum GIS shall be moved and saved here under a project specific name.

4.2.1.2.2 Use of the GIST

The use of the tool is described as a generic step by step tutorial, which applies to any of the Impact Categories:

1. Open the VSE_GIST.qgs file
2. Scroll to Result Raster Files at the bottom
   2.1. An empty template folder named "Project Details" is a sub-group to Result Raster Files and will be called Project Name hereafter
   2.2. Copy an identical Group below the existing one
   2.3. Change the Project Name (2.2) from "Project Details" to the date (YYYYMMDD) where the assessment takes place and the initials of your name; e.g. 20111031_SH
3. Raster Calculation
   The "Raster Calculation" tool is a plugin from QGIS, is to be found in the main menu under Raster and looks, dependent on your version of QGIS, similar to Figure 7 below. A description of the input and output parameters of the tool will be provided hereafter.

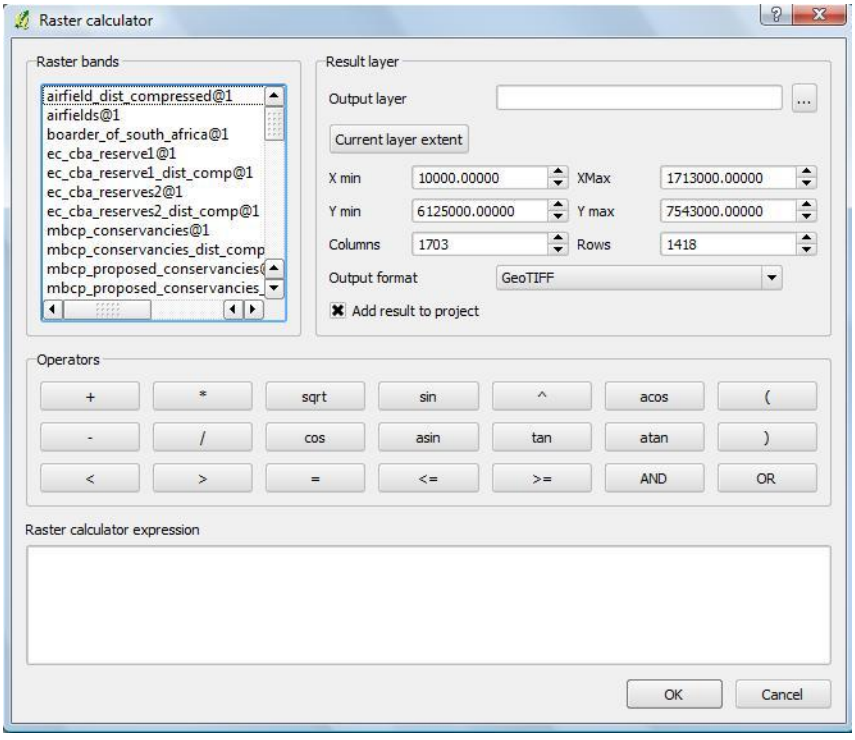

Figure 7 QGIS Raster calculator tool

3.1. Raster bands

3.1.1. Lists all available raster files that can be used for calculations

3.1.2. If a file is to be used for the calculation, one simply double clicks on the file name and it will appear in the “Raster calculator expression” field on the bottom

3.2. Operators

3.2.1. The operator field offers a selection of the most important or frequent operators the raster calculator is able to apply

3.2.2. If an operator is clicked, it will also appear in the “Raster calculator expression” field on the bottom where the cursor is placed, separated by a space before and after the operator

3.3. Raster calculator expression

3.3.1. All raster bands and operators can be added here either by using the pre-selection as described 3.2 above or can be entered manually (NOTE: Spaces between raster bands and operators must be kept otherwise a calculation is not possible; an additionally appearing field below the raster calculator expression field will provide indication whether a calculation is valid or not)

3.3.2. The calculation can take as many raster bands and operators to create the planned output file as required by the user

3.3.3. For the purpose of the GIST one should calculate with the Distance Raster Files only. Including the South African Boarder Boolean Raster into the calculation limits the output file within the extent of South African territory and disregards everything that is not required of the layer extent as described in 3.4.2 below

3.3.4. A simplified example for such a calculation can be the following:
airfield_dist_compressed@1 > 10000 AND world_heritage_sites_dist_comp@1 > 15000 AND boarder_of_south_africa@1
The calculation regards all 1x1km grid cells that have a minimum distance of 10 km to Airfields, 15km to World Heritage Sites and are within the boarder of South Africa.

3.4. Result Layer

3.4.1. Output layer

3.4.1.1. The output file shall be saved in the Library of the EPAT under LIB_Visual Site Evaluation/GIS/Result Raster Files in a new created directory named according to the Project Name as described in Step 2 above; e.g. 20111031_SH

3.4.1.2. The name of the output layer shall be according to the project details planned for the raster calculations

3.4.1.3. Any buffers (in km) applied to any map of the new project shall be added to the output layer name and separated via underscore; e.g. Airfields 10_National Protected Areas 15_WC FSP Bergrivier Municipality CBA 2_etc.

3.4.2. Layer extent – can be set to the current layer extent per click or selected manually in the fields below (Note: The coordinate system works in meters. The grid maps are based on a 1000 x 1000 m grid. Therefore, every change to the output layer shall be a multiple of 1000 m); all raster files in this tool are based on the greater extent of whole South Africa

3.4.3. The default output format is specified according to the input files and should be kept by GeoTIFF

3.4.4. The tick-box “add result to project” adds the calculated output layer to the top of the GIS project after the calculation proceeded. A manual drag and drop step should move the file into the “Project Name” group in the “Result Raster Files” group

For a detailed example of the GIST and the raster calculation, please refer to Annex C.

4.2.1.2.3 Possibility and Constraints of the GIST

1. Other Possibilities

   The tutorial above describes only simple calculations processes necessary to fulfil the GIST’s purpose here. The raster calculation tool offers far more options for complex calculation and analysis of such data. Potential useful statistics can be created if the scope of the projects allows and requests such.

   The more likely case for the extended use of the tool is the combination with other factors important for the scouting phase for future sites and potential projects. Grid and road connectivity plays a fundamental role concerning cost implications for a project. Shape files for both, roads and grid infrastructure, are available and can be used thereof; e.g. the grid connection shall not be further away than 5 km, roads not more than 8 km. Future planned infrastructure by the national grid provider Eskom can play a certain role as well; once it is confirmed that a particular grid line will be built within a certain time schedule. The project development can be managed as such to match these time lines accordingly, e.g. the last construction steps of a project are finalised just in the same time where the new power line goes online. However this approach is rather risky and requires a separate risk evaluation.

   Even more important, the GIST can add high resolution meso-scale wind data such as the Mesoscale Wind Atlas of Such Africa (13) and calculate all sites into the Result Raster File, where wind speeds exceed a certain average defined by the user. Areas for low winds could be disregarded completely for any further scouting and a focus can be placed on sites with high wind resources.

   A map can then determine all grid cells that have a minimum average wind speed of 7 m/s, are close to the grid (2km) and access roads (5km) and avoid any major environmental impact. The development risk is therefore already limited without having even left the office.

2. Constraints

   Beside all the possibilities the tool offers as described above, the GIST also has its limitations. The shape files provided by national conservation bodies such as SANBI are mostly based on desktop studies themselves. The proof whether these are correct or not was not scope of this study. However it can be assumed that the error is of rather positive nature from a conservation point of view, as conservative measures and the precautionary principle is the general approach here.

   Any possible error is dragged into each tool as the constraint maps of each impact category are all based on the original files publically available by SANBI. Other than this aspect an additional uncertainty adds due to the re-projecting process from Latitude/Longitude coordinate system to UTM. UTM is divided in its different zones (UTM South Zone 34 in the EPAT) which promise a maximum error of 1 part of 1000 (14) (e.g. 1m by 1000 m) within the zone but will result into increasing offsets beyond, depending on the distance from the zone. These offsets might have

distances of several 10 m. This issue is known by the Author, but in order to apply countrywide metric calculations this had to be accepted. However Zone 34 and Zone 35 are the two centred UTM Zones in South Africa and tends to minimise the offsets as much as possible. The choice between 34 and 35 was purely based on the current project setup of G7, where a standardisation to UTM South Zone 34 already took place.
The offsets regarding the project projection is however minimal to the one occurring in the vector to raster transformation. A Vector file is either based on points or lines or a polygon existing of a certain amount of vertices, depending on the accuracy a vector file is created of. When rasterizing a vector file within the Gdal platform, the tool is converting every point (vertex) where data or information is available into information in the new grid (e.g. 0 or 1), based on the resolution requested by the user. The Tool is using a 1x1 km resolution grid, whereof the Gdal platform is giving the user 2 options to create the information from the vector file to the grid.
The first one is: wherever the centre point of a grid cell is matching with the vector file it creates information for the raster output file. This resulted into disregarding many small but important areas of the vector file and therefore had to be discarded. The second one writes information to a grid cell of the raster file where the vector data matches anywhere with the grid cell. The result is that a 1x1 km grid cell will contain the information of a constraint map present anywhere in this cell, even though the actual data of the vector files is only touching the cell on the outer perimeter. The tool therefore creates another buffer which could be up to the maximum of diagonal of 1x1 km which is the square root of 2 and results into approximately 1.4 km. When applying a buffer of 10 km to any of the constraint map's distance rasters later in the "Raster calculator", the result might therefore have a distance of up to 11,4 km and not 10 km as requested in the tool. However the overall distance will never be lower than the requested distance and yet again, the error is of rather positive nature from a conservation point of view and can be added to the category precautionary principle.

Hence, it is important to note that caution needs to be applied in order to not create buffers ruthlessly and to disregard constraint maps where nonsensical buffering would result into no identification of actual potentially excellent wind farm development sites.
The impact category Flora for example is not part of the GIST as buffers are to be regarded as zero for CBAs or any other critical vegetation (due to the uncertainty described above a Buffer of up to 1.4 km could be created even though a Buffer of 0 is requested); furthermore only project specific detailed site assessment (DSET) can determine the correct risk on site as the given maps do not provide any information on the transformation status of a site.
The impact category General disregards Wetlands and National Estuaries in the GIST as well. As per Ecology Specialist Reports such as "Ecology and Biodiversity Specialist Report" (15), the common sense is to stay out of water bodies with a buffer of 50 m, which again is not possible to realise in a grid with 1x1 km grid cells and potential and unnecessary buffers of 1.4 km being created. In any case, a distance of 50 m will fall into the later phase of micro-siting within the stages of wind farm development hence will be handled in a more detailed approach such as the DSET.

4.2.2 Detailed Site Evaluation Tool (DSET)

The scouting process for new projects is based on several different parameters and methods such as the Environmental Pre-feasibility Assessment, which this user manual is limited to.

The DSET is used once the conclusion leads to the decision to take a site into a more detailed assessment, a site trip has been conducted and a preliminary layout is drafted.

For more details and explicit examples please refer to Annex C of this report.

4.2.2.1 Location and Structure

The DSET is operated in Microsoft Excel and sits in the repository under main/scouting/EPAT/Site Evaluation Tools/Detailed Site Evaluation Tool (DSET). Each impact category such as General or Flora has its own spreadsheet which is divided into two main parts, the site preparation and the impact assessment. A third part is formed by additional maps thereafter, which fulfil the purpose of information only.

In order to prepare a detailed impact assessment, the site preparation which includes the drafting of a layout, the preparation of overlay maps and measurements undertaken in the GET, needs to be conducted first as they consequently build the basis for the section “Impact Assessment” per impact category. The worksheet itself is again vertically divided into the site description on the left and the guidelines on the right as per Figure 4 of section 3.3.3.

The site description contains all information on the maps used, its preparation statuses, reference number, pre-calculations and scoring criteria of the assessment which are based on the reference literature in the database of the EPAT’s library. These are described in the references, links to the library and comments occurred during the preparation of this tool in the guidelines part of the worksheet.

The score evaluation is divided into four different categories whereas 4 is the category with the major or maximum risk and 1 stands for minor or negligible risk of impact as per Table 3. The categories are leaning on the general impact rating used in Environmental Impact Assessments e.g. undertaken for G7 (16) and can be seen and understood as equal.

Table 3 Overview of scoring criteria in the DSET

Score Evaluation	Description
4	Major
3	Moderate to Major
2	Moderate
1	Minor

The overview list (TABLE 4) below indicates a general guideline how to operate the tool correctly. It is to be noted that changes during following updating cycles might apply hence this table shall implement these changes accordingly.

Table 4 General guidelines to the use of the DSET

Field Colour / Field Name	Description
Yellow	To be filled in by the user, partly applies to the two sections within the Site Description, Map Description and Status/Scoring
Green	Fixed, either depending on another section in the tool or are developed criteria in the preparation of the latest update cycle of the tool
Red	Project Name, Date and Name of Assessor as per 1.1.1.2 General
Grey and Blue	Fixed structural headers
Status	"Done" once a task has been applied, saved in its correct folder and project specific comments have been made
Comment	Project and task specific, no comments should be indicated as "None"
Score	According to the applicable scoring criteria
Scoring / Site description	Reasons for the applied Score need to be indicated here

4.2.2.2 Use of the DSET

The use of the tool is described for each Impact Category hereafter and references in this user manual are made to the Reference Number (Ref #) in the first column of the DSET itself.

4.2.2.2.1 General

1. General

   This impact category not only describes all general and commonly known and obvious environmental impacts, where some of them are hard to define for only one of all other impact categories, i.e. National Parks for Birds, Fauna, Ecology etc., but is also dealing with the simple organisation and administration of a new project.

   The following Constraint maps are assessed in General:

   - Airfields
   - National Protected Areas
   - National Wetlands
   - Ramsar Sites
   - World Heritage
   - National Estuaries

   1.1. Site Preparation

   1.1.1. Set up of the Project

   A template of the tool is available in the EPAT under Site Evaluation Tool/DSET. In order to start a new project one has to create a new project folder in the library under LIB_Detailed Site Evaluation/Projects/ with the name of the Project to start with (1.1.1.1).

   Once the template of the tool is launched the "Project Name" in cell C1 and the "Assessment Details" (Date and Name Assessor) in I1 and J1 shall be changed accordingly (1.1.1.2). This cell is linked to all other impact category worksheets hence, the change of project name is only required in 1 General.

   Thereafter the project shall be saved in the library under the new created Project Folder (1.1.1.3).

1.1.2. Construction of the Preliminary Site Layout

Before the impact of all constraint maps can be assessed, a preliminary layout for the site has to be drafted. This might be available from earlier development stages, which, if this is the case, would lead in skipping this part of the site preparation.
If there is no such available, it is the user of this tool's responsibility to ensure that a layout according to the G7 standards is prepared. This requires the gaining of knowledge on how to prepare such a layout together with more experienced staff or referring to previous reports on that matter in the G7 development database.
The layout includes:

- All property boundaries (1.1.2.1) of interest;
- All potential turbine positions (1.1.2.2);
- Existing and new planned access roads (1.1.2.3).

The layout shall be created in Google Earth and temporarily saved as a KML file in the library under its new project folder.

1.2. Impact Assessment

Once the site preparation is finalised each constraint map can be assessed through the use of the GET and its measurement tool. Important is to determine the infrastructure potentially impacting the constraint map and to take into account this approach when evaluating the score of a risk. For example a new constructed road will affect the National Protected Areas (1.2.2) outside its boundary less as a wind turbine does due to its visual presence.
Development within any of the constraint map areas described below is to be seen as absolute no-go zones.

1.2.1. Airfields

Impact Infrastructure: Wind Turbines
Data source for digital maps: Unknown
Date of data: Unknown
Update Frequency: 5 years suggested
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

The scoring criteria and its buffers are based on experience of granted approvals as the Civil Aviation Authority (CAA) doesn't have experience with the wind industry yet and guidelines are sparsely available. Two impacts are regarded here, the physical obstacle a wind turbine forms for an aircraft in the process of taking off or landing and the potential electromagnetic interference (EMI) of radar and telecommunication crucial for the air traffic.
The score evaluation criteria are shown in Table 5 which regards smaller airfields but excludes commercial large scale airports. The latter requires the undertaking of more detailed analysis in any case as radar of up to 90 miles (17) might be affected.

Table 5 Scoring for 1.2.1 Airfields

Score evaluation	Scoring criteria
4	Distance < 10km
3	Distance < 20km
2	Distance > 20km
1	None in close proximity

Experience from the CAA authorisation applications showed that distances to any airfield greater than 20 km are highly likely to receive an approval, the risk is therefore moderate. Closer proximities increase the potential impact and might require further investigation such as electromagnetic interference studies and/or safety analysis such as NATS - Wind Farm Safety Analysis for Port Elisabeth Airport in Relation to Potential Wind Farm Development in the Region (17) as they potentially increase the risk to high or very high. However the distance of 10 km to an active airfield is not recommended for the development of wind farms.

1.2.2. National Protected Areas

Impact Infrastructure: Wind Turbines, visible other infrastructure
Data source for digital maps: SANBI, NPAES
Date of data: June 2010
Update Frequency: 5 – 7 years
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

This Constraint Map includes all formal national protected areas such as National Parks, Provincial Nature Reserves, Forest Act Protected Area etc. and was prepared under the National Protected Area Expansion Strategy 2008 (NPAES) (18). These areas are protected regarding their high conservation value, exceptional natural habitat and environment and attraction to tourism.

Table 6 Scoring for 1.2.2 Protected Areas

Score evaluation	Scoring criteria
4	Distance < 5km
3	Distance < 10km
2	Distance > 10km
1	None in close proximity

Therefore the development of a Wind Farm would have a very high impact in proximity closer than 5 km and would bear high risks within 10 km.
Only with a minimum buffer of 10 km, where visual impact decreases to marginal due to its fading visibility in the distance, the impact risk would reach a moderate status.
An overview is provided in Table 6.

1.2.3. National Wetlands

Impact Infrastructure: Turbines, other infrastructure as good as possible
Data source for digital maps: SANBI
Date of data: 2010
Update Frequency: 5 – 7 years
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

This map does not only cover a huge extent of water bodies such as rivers, lakes and wetlands, but also regards temporary ones like drainage lines. This is very powerful in order to define buildable areas for a wind farm in a more detailed Layout phase, but also to create areas to avoid construction of any infrastructure from the beginning. Reasons being firstly the high sensitivity for flora, fauna and avifauna close to water bodies and secondly the construction constraints in watered area.
The impact of this constraint map on avifauna and fauna will be discussed in each impact category chapter separately and will play no role for the section 1 General. Weighing up the scoring criteria, it was experienced that flora specialist apply buffers of 50 m away from water areas, which should be adhered to for turbine construction. Roads and electrical infrastructure cannot always avoid these areas, but are advised to be kept as minimal as possible. Overall there are only 2 score evaluations to choose from, very high for development that cannot avoid 50 m buffers to water bodies and moderate for sites that can. Moderate supersedes the choice for low impact for a rather conservative approach and the precautionary principle. Table 7 indicates the scoring of National Wetlands.

Table 7 Scoring for 1.2.3 National Wetland

Score evaluation	Scoring criteria
4	Distance < 50 m
2	Distance > 50 m

1.2.4. Ramsar Sites

Impact Infrastructure: Turbines
Data source for digital maps: The Ramsar Convention on Wetlands (19)
Date of data: 2010
Update Frequency: occasionally, latest 2010 (Ntsikeni Nature Reserve)
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

Ramsar is a more commonly used name for the original one “Convention on Wetlands”, which was founded 1975 in Ramsar (Iran) and focuses on wetlands of international importance. The list of Ramsar Sites carries more than 1600 wetlands around the world, whereas 20 are currently classified as such in South Africa.
These sites have a high conservation value, habitat unique ecology, botany, zoology, limnology or hydrology, are designated for international long term research projects and monitoring, draw a high media attention and the support of big conservation companies such as World Wildlife Fund (WWF) or BirdLife South Africa.

The scoring in respect to the importance of such sites and the potential public awareness and resistance is set very conservatively and shown in Table 8 as there is no valid information available to the author by the time this report was written to evaluate the buffers to a higher certainty.

Table 8 Scoring for 1.2.4 Ramsar Sites

Scoring Evaluation	Scoring Criteria
4	Distance < 10 km
3	Distance < 15 km
2	Distance > 15 km
1	None in close proximity

1.2.5. World Heritage

Impact Infrastructure: Turbines
Data source for digital maps: UNESCO, (20)
Date of data: 2011
Update Frequency: occasionally, latest 2007 (Richtersveld Botanical and Cultural Landscape)
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

Properties of the World Heritage List and the List of World Heritage in Danger are granted international assistance under the World Heritage Fund and are backed up by national and international support in favour for their protection and conservation. Methodologies, targets, and rules are collected in the World Heritage Convention and can be read up on in the Operational Guidelines by UNESCO (21).
Due to the lack of information of the potential impact of wind farms on such sites, again a very conservative approach similar to the Ramsar sites has been taken for the scoring process. Experience at G7's Witberg site showed that a distance of 9 km to the significant provincial heritage site Matjiesfontein caused major resistance from the relevant organisations like Heritage Western Cape, South African Heritage Resources Agency (SAHRA) and the support of Cape Nature. Hence, the status of a World Heritage Site might draw the public, media and resistance therefore even more significantly, which directly affects and increases the potential risk.
A minimum distance of 15 km should minimise the risk to be acceptable, as the visibility of such new technology will be eliminated. The risk score in relation to the distance is shown in Table 9. National Heritage Sites will be assessed in the separate impact category chapter for heritage.

Table 9 Scoring for 1.2.5 World Heritage Sites

Scoring Evaluation	Scoring Criteria
4	Distance < 10 km
3	Distance < 15 km
2	Distance > 15 km
1	None in close proximity

1.2.6. National Estuaries

Impact Infrastructure: Turbines, other infrastructure as good as possible
Data source for digital maps: SANBI
Date of data: September 2009
Update Frequency: 5 – 7 years
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

An estuary is defined as “a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area or when there is little or no fluvial input an estuary can be isolated from the sea by a sandbar and become a lagoon which may become fresh or hypersaline” (22).
Due to the special environment given by the mixed water conditions in the estuarine areas, these areas offer a unique habitat and reserve a separate conservation status similar to wetlands. This constraint map includes the potential extent of these areas respecting flood levels and tidal influence in a conservative approach, meaning the upper boundaries of 5 m contours supersedes the salinity penetrated boundary where no clear scientific proof is available.
Therefore a scoring can be undertaken confidently with the adherence of a 50 m buffer to estuarine areas as per Table 10.

Table 10 Scoring for 1.2.3 National Estuaries

Score evaluation	Scoring criteria
4	Distance < 50 m
2	Distance > 50 m

1.3. Additional Maps

Whereas the Impact Assessment is dealing with actual and clear risks to be counted into an overall Risk Assessment, the Additional Maps section highlights potential risk maps which are not assessed here, but are determined important enough not to be disregarded hence, fulfil the purpose of information and future consideration only.

1.3.1. Focus Areas

Impact Infrastructure: Turbines, visible other infrastructure
Data source for digital maps: SANBI, NPAES
Date of data: June 2010

Update Frequency: 5 – 7 years
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

This additional map is not part of the formal protected areas as per 1.2.2, but as large, intact and unfragmented areas of high importance for biodiversity representation and ecological persistence they play a certain role in the future expansion of these (22).
The map also includes local and private nature reserves, private game farms, extensions to mountain catchment areas etc.
It is not clear to the author at this stage whether the Focus Areas of NPAES are part of the specialists focus during the EIA phase due to their status not being formally gazetted yet.
Therefore this additional map should be seen as an additional red flag criterion; if required, further steps such as taking the map into account for the risk assessment rather than using it for the purpose of additional information only should be investigated.
Experience showed that particularly private nature reserves and game farms form durable resistance to a development, which can result into delays of the development and extensive legal costs.
The scoring is indicated in Table 11 and is based on the Formal Protected Areas.

Table 11 Scoring for 1.3.1 Focus Areas

Score evaluation	Scoring criteria
4	Distance < 2 km
3	Distance < 5 km
2	Distance > 5 km
1	None in close proximity

1.3.2. Local Protected Areas

Impact Infrastructure: Turbines, visible other infrastructure
Data source for digital maps: SANBI, FSP and other
Date of data: 2009
Update Frequency: 5 – 7 years
Link to Library: LIB_Detailed Site Evaluation/1_General/201110

These areas need some more detailed research. According to the descriptive information provided with maps, these protected areas are of national protection status. In this case the NPAES (2010) should cover these areas but neither Protected Areas (1.2.2) nor the Focus Area (1.3.1) map is matching with the data. It was first assumed that these areas are local protected areas or local extensions of national protected areas and should be flagged therefore. This has been confirmed with a phone call to Fahiena Daniels (Project Management, SANBI). Experience while working with these maps will have to proof whether this data shall be taken into the assessment or not.
The Scoring is outlined in Table 12.

Table 12 Scoring of Local Protected Areas

Score evaluation	Scoring criteria
4	Distance < 2 km
3	Distance < 5 km
2	Distance > 5 km
1	None in close proximity

4.2.2.2.2 Flora

2. Flora

This Chapter assesses the potential impact risk on sensitive vegetation for all infrastructural development that is involved in order to get the first wind turbine spinning.

2.1. Site Preparation

2.1.1. Determination of local major vegetation types on site

"The Vegetation Map of South Africa, Lesotho and Swaziland" (23) shall be used here. This map covers not only the major vegetation types of the entire country more or less accurately, but also offers a table of detailed information to a vegetation type similar to the one in Figure 8, when mouse-clicked and enabled in the GET.

BIOME	Savanna Biome
BIOMECODE	SV
BIOMEID	7
BIOREGION	Eastern Kalahari Bushveld Bioregion
BOOKCODE	SVk 1
BOOKSEQU	06 05 001
BRGNCODE	SVk
BRGNID	8
CNSRVTNSTT	Vulnerable
CONSTRGT	16%
GROUP	Eastern Kalahari Bushveld Bioregion
GROUPCODE	SVk
GROUPID	8
LEGEND	SVk 1 Mafikeng Bushveld
MAPCODE	SVk1
NAME	Mafikeng Bushveld
PDFNAME	pdf\SVk_1_Mafikeng_Bushveld.pdf
POLYGONID	17795
POLYSQKM	14389.0744
PROTCTD	
PRTCTNSTTS	Not protected
REMAINING	75.1%
TOCLEGEND	06 05 001 SVk 1 Mafikeng Bushveld
VEGTYPEID	731
VTYPESQKM	14389.0744

Figure 8 Major Vegetation Type information table, Example: Mafikeng Bushveld, Eastern Kalahari, Northern Cape

For the purpose of this tool only the name of the vegetation type (NAME), the conservation status (CNSRVTNSTT in the table) and the conservation target (CONSTRGT in the table) are important.

The conservation status is indicating the status of the vegetation type which is divided into four main categories within the map: Critical Endangered (CR), Endangered (EN), Vulnerable (VU) and Least Threatened (LT). Some other vegetation types are not yet defined and can show a conservation status of "see text" or "none".

The conservation target is a figure given in percentage which is indicating the share amount from originally available figure of the vegetation type to the amount that shall be achieved in a conservation process of the targeted species.
The example above is looking at the Mafikeng Bushveld with a conservation status of vulnerable and a conservation target of 16%, which means the status to achieve the conservation target, is vulnerable.
Once the properties for a potential development are mapped as per 1_General, all Vegetation types that occur on the property shall be listed in 2.1.1 of the DSET, together with their conservation status and target. This overview list will help to assess the impact on vegetation type at a later stage. Where a conservation status of "see text" or "none" occurs, a status is not required and a short comment in the column next to it shall be made.

The vegetation types and their conservation status listed should be crosschecked with the "Draft National List of Threatened Ecosystems" (24) which supersedes the conservation status of the Mucina and Rutherford Map and is available in the library of this tool. The list is currently under draft status hence officially not valid yet, but will be gazetted as is in due course and should be seen as the status quo.

2.1.2. Mapping of Sensitivity

The mapping of onside and accurate sensitivity maps is the most important part of the flora risk assessment in order to get a precise map to base the impact assessment on. Many of the constraint maps publicly available as described in section 2.1.1 offer overviews and therefore only low resolution maps. These are often not useful for an assessment of potential impacts of wind farm development, which strongly depends on micro siting due to its relatively small and clustered footprint.
The use of aerial imagery and the GET, preferably supported by a site visit will offer a sufficient basis to create the sensitivity maps. What needs to be born in mind is that the Google Earth imagery does have offsets which can be identified through GPS by tagging significant waypoints during the site visit. The comparison between some points on the satellite image and the waypoint taken on site indicates the actual shift or offset to be expected for the sensitivity map. Note that the GPS itself will have uncertainties of several meters (+- 3m), which are negligible compared to the offset of the satellite image. Experience showed that satellite image can be off by more than 20 m which can be significant on borders of low and high sensitivity areas.
The process of such mapping is based on the simple use of Google Earth tools, which allow new paths and polygons to be overlaid according to the imagery. The site specific sensitivity map shall be saved as 2 Flora_Sensitivity Map_Project Name.kml in the project folder in the library under LIB_Detailed Site Evaluation/Projects/Project Name/ . Where possible and available the offset described above should be applied to the map, which is a manual exercise. Angles and distances can be measured with Google Earth tools therefore the shift can be classified and applied to every new path or polygon.

The mapping of the following features on site shall be undertaken.

2.1.2.1. Mapping of Local Major Vegetation Types

Buffer applied by specialists: None

The site preparation undertaken in 2.1.1 indicates to what extent this step is necessary to be adhered to. In the case of any vegetation type with a conservation status of critical endangered, endangered or vulnerable occurring on the property of development, a detailed mapping of the areas has to be followed thereafter.

If the site bears vegetation types with a conservation status of least threatened only, this step can be skipped, the amount of turbines within the different endangered statuses in 2.1.3.2 can be set to 0 and a score of 1 can be applied in the impact assessment for the Impact Map Major Vegetation Types in 2.2.1.

2.1.2.2. Transformed Areas

Buffer applied by specialists: None

Mapping the transformed areas such as agricultural land and existing roads is determining the definite low sensitivity areas of a site, where no new transformation from natural vegetation takes place in the planned development. A project layout that allows construction solely on transformed areas will highly likely cause no issues in the flora specialist assessment during the EIA and should be a development target, where possible.

However some sites do not offer the luxury of space to avoid natural vegetation, do not include any transformed areas or the natural vegetation is of low conservation status, which again needs to be looked at in more detail using this tool.

All transformed areas shall be mapped with polygons and existing roads as path with one centre line as low sensitivity areas.

2.1.2.3. Site Specific Water Bodies and Drainage Lines

Buffer applied by specialist: 50 m

1 General includes the constraint map of national wetlands, which is providing a good overview, but might lack on site specific details and accurate or additional determination of water bodies and drainage lines. Due to the proximity of permanent or temporary water bodies, sensitive vegetation is assumed to be present by the specialist during their study. Further investigation through detailed site visits might disproof this first assumption, but prior to such an approach implies no-go zones of high sensitivity for these areas including the suggested buffer of 50 m.

The satellite imagery and 1:50000 map overlays where available can deliver this detailed assessment. Dams and erosion areas shall be mapped with polygons, drainage lines and rivers with a centre line as very high sensitivity areas and 50 m buffers applied.

2.1.2.4. Special Features

Buffer applied by specialist: 0 to 20 m

Special features such as single rocky outcrops on site are given special attention and need to be mapped here. These can be potentially identified on a site visit and/or with a specialist only. Therefore this step can be skipped if the lack of expertise does proof to misinterpret this point in the assessment. Southern slopes are commonly known to offer good habitat conditions for high sensitive vegetation and are mapped as such by several specialists (22).

Steep slopes are also playing an important role due to potential wind and water erosion. Although civil construction planning tries to avoid these, it still mentioned here to as another flag, but the need for mapping does not apply here.

Both, southern slopes and special features, if applicable, shall be mapped with polygons as high sensitivity areas. No buffers are applied on southern slopes; special features shall be given a 20 m buffer.

2.1.2.5. Local Conservation Plans

Buffer applied by specialist: None

The mapping of sensitive vegetation is of national priority, but the actual work in order to achieve a national conservation map is done in local conservation plans within defined areas or municipalities of their provinces. A national conservation map like "The Vegetation of South Africa, Lesotho and Swaziland" (23) provides an excellent overview, but local conservation plans take additional maps such as Critical Biodiversity Areas (CBA) into account, which are not yet gazetted and therefore not officially to be used by conservationists. However, experienced during several EIA phases showed that these play an important role for specialists and are referred to by Cape Nature[1] when commenting on behalf of the Department of Environmental Affairs in the public participation process of an EIA, regardless of their validity and potentially inaccuracy due to their low resolution. It is important therefore to map these areas specifically for each Site.

The Western Cape only identifies 17 different local conservation plans such as the Subtropical Thicket Ecosystem Project (STEP), Succulent Karoo Ecosystem Program (SKEP), Fine Scale Plans (FSP) etc. which offer all different approaches in assessing the current status of vegetation. All these could be assessed here and with the use of the GIST and the GET added to the sensitivity map.

The lack of expertise and restriction in time of the user in the process of the tool will most probably not allow implementing these very specific maps and therefore, most of them can be seen as optional. However, all available data specifically on CBAs where

[1] *CapeNature* is a public institution with the statutory responsibility for biodiversity conservation in the Western Cape. It is governed by the Western Cape Nature Conservation Board Act 15 of 1998 and mandated to: promote and ensure nature conservation; render services and provide facilities for research and training; and generate income. (40)

incorporated into the GET under 2 Ecology/CBA's, as these seem to play a crucial role in the flora assessment and the impact status in final environmental assessment reports and should be mapped thereof.

2.1.3. Evaluation of Infrastructure and Sensitivity

This section defines the actual location of infrastructure to the area of sensitivity where the environmental impact assessment is based on at a later stage. The preliminary site layout (1.1.2 General) and the Sensitivity Map (2.1.2 Flora) are pre-requirements in order to undertake this evaluation.

2.1.3.1.1. Total amount of turbines planned on site

The total amount of turbines needs to be provided here.

2.1.3.1.2. Major Vegetation Types

From the Sensitivity Map (2.1.2.1) the amount of turbines for the following areas needs to be provided where applicable:

- Protected and/or Critical Endangered (CR)
- Endangered (EN)
- Vulnerable (VU)

The Tool will automatically calculate the applicable share of turbines for each sensitivity area relative to the total amount of turbines.

2.1.3.1.3. Local Conservation Plans / Critical Biodiversity Areas

From the Sensitivity Map (2.1.2.5) the amount of turbines in such areas needs to be filled in here.

The tool will automatically calculate the applicable share of turbines for each sensitivity area relative to the total amount of turbines.

2.1.3.1.4. Sensitivity Map

Based on the Sensitivity Map (2.1.2.2 to 2.1.2.4) the amount of turbines for the following areas needs to be provided where applicable:

- Very High (VH)
- High (HI)
- Medium and Low (ML)

The tool will automatically calculate the applicable share of turbines for each sensitivity area relative to the total amount of turbines.

2.2. Impact Assessment

Scoring criteria are generally applied in a conservative pro-conservation manner and therefore imply the precautionary principle.

2.2.1. Major Vegetation Types

This impact map is referring to 2.1.3.2 of the evaluation infrastructure / sensitivity where the amount of turbines within a critical endangered (CR), endangered (EN) and vulnerable (VU) is determined. The scoring criteria to the score evaluation as per Table

13 indicate different criteria values for each of the three vegetation statuses whereof the matching of only one criterion is sufficient to fulfil the linked score evaluation.

Table 13 Scoring criteria for Major Vegetation Types

Score evaluation	Scoring criteria
4	CR >5%; EN >10%; VU >20%
3	CR >2%; EN >5%; VU >10%
2	CR <2%; EN <5%; VU <10%
1	None of the above affected

A score evaluation of 4 needs to be applied if either the amount of turbines in CR exceeds 5%, for EN exceeds 10% or for VU exceeds 20%. All other score evaluation works respectively. A score of one can only be achieved if no turbine is placed in each vegetation status, meaning all turbines are within the vegetation status least threatened (LT).
As this map is on a very broad scale and does not regard the actual site specific vegetation such as the transformed areas, but is still considered in each and every specialist assessment for EIAs, this impact map will be applied with a weighing factor of 1.

2.2.2. Local Conservation Plan / CBA

This impact map is referring to 2.1.3.3 of the evaluation infrastructure / sensitivity where the amount of turbines within a CBA is determined. The scoring criteria to the score evaluation as per Table 14 indicate the criteria to the linked score evaluation.

Table 14 Scoring criteria for Local Conservation Plan / CBA

Score evaluation	Scoring criteria
4	In >10%
3	In >5%
2	In <5%
1	Out = 100%

A Score Evaluation of 4 needs to be applied if the amount of turbines in a CBA exceeds 10%. All other score evaluation works respectively. A score of one can only be achieved if no turbine is placed in CBA areas.
As this map is on a very broad scale and does not regard the actual site specific vegetation such as the transformed areas, but is still considered in each and every specialist assessment for EIAs, this impact map will be applied with a weighing factor of 1.

2.2.3.Sensitivity Map

This impact map is referring to 2.1.3.4 of the evaluation infrastructure / sensitivity where the amount of turbines within a very high (VH), high (HI) and medium and low (ML) is determined. The scoring criteria to the score evaluation as per Table 15 indicate different criteria values for each of the three vegetation statuses whereof the matching of only one criterion is sufficient to fulfil the linked score evaluation.

Table 15 Scoring criteria for Sensitivity Map

Score evaluation	Scoring criteria
4	VH >5%; HI >10%
3	VH >2%; HI >5%
2	VH <2%; HI <5%
1	ML = 100%

A score evaluation of 4 needs to be applied if either the amount of turbines in VH exceeds 5% or HI does by 10%. All other score evaluation works respectively. A score of one can only be achieved if no turbine is placed in each vegetation status, meaning all turbines are within the vegetation status medium to low (ML). This map undergoes very detailed and site specific criteria and can be seen as accurate as possible within the limited expertise of the user of this tool and not having conducted a site visit with a specialist yet. The sensitivity map takes special features, transformed areas, slope predictions and water bodies into account and therefore represents the actual flora environment on site. Due to the amount of detail within the assessment a weighing factor of 4 is applied.

2.2.4.Impact Risk

The overall impact risk of the impact category 2 Flora is placed in this section. It first calculates the risk factor according to the score applied for each impact map, multiplies it with the according weighing factor and divides it by the sum of the single weighing factors again. The result is given in 2 decimals after the comma.
In a next step the tools rounds either up or down to the applicable final impact risk scoring.

2.3. Additional Maps

2.3.1.Species of Special Concern / Red List

This section allows the user to collect all species of special concern and red listed data as optional indicators whether a site might need some special attention and care for those species. The assessment of red listed data is rather to be seen as optional and might need the attention of a specialist site visit to point out the actual data of concern on site. The latest version of the Red list (25) is available in the library.

2.3.2. Mitigation Possibility

Almost as important as the impact risk assessment itself is the indication of whether or not mitigation of the potential risk is possible and to what extend mitigation is achievable.

The scoring for the possibility of mitigation is listed in Table 16.

Table 16 Scoring of the Mitigation Potantial

Score evaluation	Scoring criteria	Detailed Description
1	Easy	Sufficient space to review turbine layout
2	Possible	Potential for a Layout review is given; Potential downsizing of several turbines
3	Not Impossible	Revision of turbine layout very difficult; Downsizing of the project necessary up to a feasibility boarder
4	Impossible	No changes in layout possible; Project infeasible if any changes apply

Unlike any other part of the DSET the section mitigation possibility requires the user of the tool to define not only the scoring and the description and reasons for the particular score, but also rectify the score with references to the guidelines used. The reference can simply be a site visit undertaken by the specialist and the according report to it, which indicates the reasons why the original evaluated score in 2.2.4 can be mitigated or why a new site layout is suggested implementing modifications taking into account highly sensitive areas.

This process of creating a new data in the Library and references thereto shall be commented in the third column of the guidelines section of the tool.

2.4. Constraints to the Section 2_Flora

The impact assessment of the Flora section is limited to the impact of wind turbines and does not consider access road and electrical infrastructure directly. The author is aware of this issue; several attempts were undertaken to implement other infrastructure separately, but discarded after all.

The reasons thereof are based on the experiences made in five EIA processes undertaken for G7 over the past years (for more information, please refer to Annex B of this report). It has to be noted that the points made below are based on the current experience; its validity has to be reviewed according to future approaches of specialist studies where other infrastructure might raise similar concerns as turbines are currently looked at.

<u>Electric Infrastructure</u>

In all five EIAs the electrical components such as substations and additional overhead power lines never played an important role for almost all impact categories (Birds stand out as the only exception).
A substation is a single storey "building" including all transformers and works as the connection point between the wind farm and the distribution or transmission infrastructure which appears in different sizes (e.g. 100 x 100 m) depending on the capacity of the wind farm. Any layout changes and the moving of the substation thereof did only raise the awareness of specialists regarding the new turbine positions.
Similar experience was made with planned new overhead power lines, which indicated to take up to several 10 km in length. The footprint of the power line is not only limited to the carrying pole structures but are accompanied by a small service road for the case of emergencies on the line.
According to the specialist's reactions, the impact risk of electrical infrastructure is currently seen as negligible, but shall remain flagged here for further revision. However, a substation should be placed in low sensitive areas where possible in order to avoid any additional risk of increased impact significance in the EIA at a later stage.

Road Infrastructure

For roads one has to distinguish between access roads and turbine roads. Access roads are leading from the property boundary where a wind farm is planned on to the turbine roads which interlink each turbine with one another.
Access roads have only been in the focus of specialist, where new ones are planned which implements the destruction of natural vegetation. However a development is strongly dependent on costs hence, one tends to minimise those and use existing road infrastructure for the development phase and upgrade those where necessary in the construction phase instead. Development and conservation targets go hand in hand here if an existing road infrastructure is available. Where new roads have to be constructed in the development phase, the site shall be flagged in any case, which is common sense in the project development of G7 and not past of the scope of this study.
Upgrading existing road infrastructure will require some micro-siting of a specialist in any case. The experience with such site visits was mainly positive hence, an impact assessment for access roads was not regarded here.
Turbine roads are directly linked to each turbine and can be assumed to solely fulfil that purpose as such. If a turbine is placed in a high sensitive area the turbine road will likely or partly go through the same sensitive area. The impact of a turbine position informs the impact of a turbine road thereof. Due to their strong dependency, a turbine and its access road cannot be separated in a different category and is assessed within the turbine impact risk assessment. However, the micro-siting of turbine roads shall regard or avoid the sensitive areas where possible and technically feasible.

4.2.2.2.3 Overall Results

The results of the impact risks of each impact category are put together in an overview sheet named "0 – Overall Results", which is describing the impact category, the constraint maps, outlining the impact risk score individually and showing the impact risk (not rounded) and mitigation possibilities where applicable as shown in Figure 9. All figures are interlinked to the overall risks and scores and

will be filled in automatically while processing each impact category. An extra column for comments is added and can be used in a final assessment of the results where necessary.

0	Overall Results	Project Name	Assessment Details	Date	Name of Assessor
Ref. No.	Constraint Map	Impact Risk	IR (not rounded)	Mitigation Possibility	Comments
1	General				
1.2.1	Airfields	0	n/a	n/a	
1.2.2	National Protected Areas	0	n/a	n/a	
1.2.3	National Wetlands	0	n/a	n/a	
1.2.4	Ramsar Sites	0	n/a	n/a	
1.2.5	World Heritage	0	n/a	n/a	
1.2.6	National Estuaries	0	n/a	n/a	
1.3.1	NPAES Focus Areas	0	n/a	n/a	
1.3.2	Local Protected Areas	0	n/a	n/a	
2	Flora				
2.24	Overall Impact Risk	0	0.00	0	

Figure 9 Overview of the template of all Impact Risks collected in 0_Overall Results

5 Conclusion

The aim of this study was to create a desktop-based tool which allows any user, regardless of his experience or expertise in the field of environmental impacts, to run simple and quick environmental risk assessments for any planned wind farm project or anticipated future wind farm sites in any development stage. The challenge was to collect available expert knowledge and common practice methodology for each impact category and simplify the complex processes to a clear and efficient form containing the expertise “behind the scenes” controlled by a clear and simple interface. The outcome of this challenge is the Environmental Pre-feasibility Assessment Tool (EPAT).

The Author himself was involved in several environmental impact assessment processes undertaken by G7 Renewable Energies as described in more detail in Annex B; the creation of the EPAT did directly profit from the gained experience and expertise thereof.

Three different tools within the EPAT were created which fulfil three different purposes for different development stages. These are linked to one another as they feed from the same database; therefore constant improvement is expected among the various tools through a permanent synchronisation process while using the EPAT to new sites or projects.

The detailed tests of the EPAT undertaken for G7’s Klawer Site in Annex C meet not only the challenge requirements set as standard to this tool, but results also in a match with industry state of the art specialist assessments. The test however was conducted on only one site and the tool might not give similar results for an entirely different project. The constant development process will allow for the implementation of changes to the tool making it a truly living document.

Furthermore the tool creates a self-sustainable library, collecting available data in defined updating cycles and undergoes a permanent development process thereof.

Limitations to the scope, further detailed in Annex A of this report, allowed this process to cover only 2 of 8 impact categories, General and Flora. Both impact categories are crucial for the development of wind farm projects and are handled as such, now ready to be implemented into future development processes. The clear defined methodology in this report, together with the user

manuals and the detailed examples will assist the preparation process for all other impact categories following and finalising the tool thereafter.

6 References and Literature

1. **Price, Trevor J.** Oxford Dictionary of National Biography, Oxford University Press . [Online] 09 2004. http://www.oxforddnb.com/public/dnb/100957.html.

2. **Wikipedia.** Wikipedia. [Online] 14 2011. http://en.wikipedia.org/wiki/Wind_turbine.

3. **WWEA.** *World Wind Energy Report 2010.* Bonn, Germany : c World Wind Energy Association WWEA 2011, 2011.

4. **Enercon.** Enercon - Energie fuer die Welt. [Online] 11 2011. http://www.enercon.de/de-de/66.htm.

5. *National Environmental Management Act (NEMA Act No. 107 of 1998).* 1998.

6. *Environmental Impact Assessment (EIA) Regulations promulgated under NEMA.* 2006.

7. National Water Act (Act No. 36 of 1998). 1998.

8. **SANBI.** *SANBI- Biodiversity for Life.* [Online] 09 2011. http://www.sanbi.org/.

9. **CES, Coastel Environmental Services.** *Pre-feasibility Assessment for 14 proposed wind energy facility sites in South Africa.* Cape Tow, South Africa : CES, 2009.

10. **Jenkins, A.R., et al., et al.** *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa.* s.l. : Endangered Wildlife Trust &, 2011.

11. **QGIS, Quatum GIS.** *Quantum GIS.* [Online] 09 2011. http://www.qgis.org/.

12. **GDAL, Geospatial Data Abstraction Library.** *GDAL.* [Online] 09 2011. http://www.gdal.org/.

13. **Hagemann, Kilian.** G7 Renewable Energies. *Mesoscal Wind Atlas of South Africa, PhD Kilian Hagemann.* [Online] 11 2008. http://www.g7energies.com/Mesoscale_Wind_Atlas_of_South_Africa_-_KH_PhD.pdf.

14. **The Pennsilvania State University.** Penn State - College of Earth and Mineral science. *The UTM Grid and Transverse Mercator Projection.* [Online] 2011. https://www.e-education.psu.edu/natureofgeoinfo/c2_p22.html.

15. **Todd, Simon.** *Klawer Wind Farm, Ecological and Biodiversity Assessment:Terrestrial Vertebrate Fauna & Botanical Specialist Study.* Cape Town, South Africa : Simon Todd Consulting , 2011.

16. **ERM.** ERM. *Environmental Impact Assessment, G7 Renewable Energies (Pty) Ltd.* [Online] 2011. http://www.erm.com/G7_Renewable_Energies..

17. **Kirkland, Kel.** *NATS - Wind Farm Safety Analysis for Port Elisabeth Airport in Relation to Potential Wind FArm Development in the Region .* UK : NATS, 2011.

18. **SANBI.** *BGIS, Biodiversity GIS.* [Online] 09 2011. http://bgis.sanbi.org/index.asp?screenwidth=1280.

19. **Ramsar Secretariat.** The Ramsar Convention on Wetlands. [Online] 11 2011. http://www.ramsar.org/cda/en/ramsar-home/main/ramsar/1_4000_0__.

20. **UNESCO.** United Nations Education, Scientific and Cultural Organization . [Online] 11 2011. http://whc.unesco.org/.

21. —. *Operational Guidelines for the Implementation of the World Heritage Convention.* Paris, France : UNESCO World Heritage Centre, 2008.

22. **Hirschmann, Sebastian.** Lirary of the EPAT. 11 2011.

23. **Mucina, L. and Rutherford, M.C.** *The Vegetation Map of South Africa, Lesotho and Swaziland.* Pretoria, South Africa : CD Set, Strelitza 19, SANBI, 2010.

24. **DEA.** *Draft National List of Threatenned Ecosystems.* Pretoria, South Africa : Department od Environmental Affairs, 2009.

25. **IUCN.** The IUCN Red List of Threatened Ecosystems. [Online] 11 2011. http://www.iucnredlist.org/.

26. **Press", "Oxford University.** "James Blyth", Oxford Dictionary of National Biography. *www.oxforddnb.com/public/dnb/100957.html.* [Online] 09 2004.

27. *National Environmental Management: Protected Areas Act (Act 57 of 2003).* 2003.

28. *National Environmental Management: Biodiversity Act (Act No. 10 of 2004).* 2004.

29. *National Heritage Resources Act (Act No. 25 of 1999).* 1999.

30. *Electricity Regulation Act (Act No. 4 of 2006).* 2006.

31. *Aviation Act (Act No. 74 of 1962).* 1962.

32. *Occupational Health and Safety Act (Act No. 85 of 1993).* 1993.

33. *Subdivision of Agricultural Land Act (Act No. 70 of 1970).* 1970.

34. *Noise Control Regulations, Environment Conservation Act (Act No. 73 of 1989).* 1989.

35. **Ltd, Darling Wind Power (Pty).** *Darling Wind Power.* [Online] http://www.darlingwindfarm.co.za/.

36. **DoE, Department of Energy.** Renewable Energy. [Online] 09 2011. http://www.energy.gov.za/files/esources/renewables/r_wind.html.

37. **Coega, Coega Development Cooperation.** Coega. *Electrawinds launches first wind turbine at Coega IDZ .* [Online] 05 2010. http://www.coega.co.za/NewsArticle.aspx?ID=16.

38. **GE - User Guide.** User Guide - Google Earth. [Online] 11 2011. http://earth.google.com/support/bin/static.py?page=guide_toc.cs.

39. **Geo-News.Net.** Buffering for Google Earth. [Online] 11 2011. http://www.geo-news.net/index_buffer.php.

40. **CapeNature.** CapeNature. [Online] 11 2011. http://www.capenature.co.za.

Annex A

Constraints of Scope

Constraints of Scope

The EPAT was originally meant to cover all environmental Impact Categories such as Birds, Bats, Heritage etc. as it was undertaken for General and Flora. However, the work involved in such a process and the development of individual tools within the Tools of the EPAT for each Impact Category was underestimated in the initial project scope proposal as the time requirement to complete such study would have extended beyond the scope of this thesis by far.

If the methodology described in Chapter 3 of the EPAT's Guidelines covers the study purpose, the work itself started already with the extensive Research section. In the beginning of this Thesis the focus of the Author was to work on the research for each Impact Category, gather all the data and information required and start constructing the tools of the EPAT only thereafter. Therefore several impact categories, namely Birds Bats, Visual and Flora, had to undergo a general research process resulting in the collection of first results in a Draft Excel Tool which was meant to become the DSET at a later stage. This work was basically undertaken during the course of 2011, during which several attempts were initiated to commence the work involved in this Thesis on a solid basis.

Therefore due to the lack of structure, the lack of knowledge in respect of the greater picture the EPAT covers today and being completely overwhelmed by the extent and amount of data required for the full study in the very beginning of this study, a lot of the work was not finalised and did not conform to the standards set for the final version of this Tool. However, it has to be mentioned that a lot of time was spent into this work and the result thereof can assist as a basis for further assessment of the mentioned Impact categories. This Work is filed within the EPAT under Additional work and can be used and/or provided as required.

In order to comply with the objectives set and to address the broad spectrum of possibilities the Tool offers, it was decided to limit the study to the two categories, General and Flora. These play already a significant role not only for the detailed risk assessment, but also for their most relevant use in G7's scouting phase for all future potential projects.

It also has to be mentioned, that the EPAT requires certain basic knowledge in order to use the individual tools adequately. This includes the simple processes in Excel, the general applications within Google Earth and the specialised processes of GIS and its components. Excel and Google Earth are Standard tools within the project development processes of G7 and assisted the Author in the advancement of the study. GIS work was barely known to the Author at the start of the study and most of the processes had to be learned from scratch which resulted into an extensive time effort in order to acquire the necessary skills to work with this tool correctly, understand the complexity of the software Quatum GIS and the Gdal platform used and be able to filter out the parts adding value to the GIST.

The Guideline of the EPAT was written with the aim to be clear and efficient in order to achieve three purposes. Firstly the user shall understand how to use the Tool and follow a step by step process to achieve the expected reliable results. The second purpose is a learning process where a non-experienced user automatically understands the complexity of expert methodology and processes behind the interface. Thirdly, the clear and detailed description of the Methodology and

User Manuals shall be used as basis and standard to develop later the guideline and tools for all other Impact Categories.

Annex B

Undertaking of Commitment

To whom it may concern

Within the past 1.5 years, G7 has been undertaken five different Environmental Impact Assessment (EIA)for five individual projects together with the Environmental Practitioner and Consultant ERM, based in Tokai Cape Town South Africa. Full information to the EIA processes is publically available on the webpage of G7's Environmental Practitioner ERM under
http://www.erm.com/G7_Renewable_Energies

A full EIA process in South Africa takes approximately 12 to 16 months, including

- Scoping,
- Specialist reviews and discussions for the Impact Categories Ecology, Visual, Noise, Birds, Bats, Heritage and Socio-Economic,
- Public participation of Interested & Affected Parties, Public meetings and several open commenting periods
- Client Draft and Final Report reviews

Two EIA processes have been finalised from scoping to submission and Environmental Authorisation has been granted. Other two projects are currently in the phase of finalisation and one project has been dropped after scoping and specialist reviews due to a shift of the development strategy.

All five projects have dealt with their individual issues regarding their potential impacts and many efforts have been undertaken by G7 to understand, address alternatives and mitigate such issues individually.

These efforts started from a specialist workshop together with the G7 team and all Specialists involved in the EIAs around the table for all five projects, went along with the participation in several additional external workgroups and is still dealing with individual issues such as Site trips not only together with Visual, Ecology and Heritage Specialists, but entities such as Heritage Western Cape, the Department of Agriculture and the Department of Environmental Affairs itself. Furthermore is to mention, the outcome of the BAWESG (Bird And Wind Energy Specialist Group) meetings resulted into the setup of 12 months monitoring programs for bats and birds prior to construction, which again where addressed individually and site specifically. Two sites are currently running such a pre-construction monitoring, which involved a development process itself and several trips together with the practicing specialist as assessor.

I, Sebastian Hirschmann, have been strongly involved in this process for all projects from the beginning hence I would announce to have obtained certain experience in the field of EIAs, which influenced the work in and assisted the development the EPAT.

Wherever the Guidelines of the EPAT mentions experience, it refers to the collected expertise within the processes described above.

Yours Truly,

Sebastian Hirschmann | Project Management / Engineering

Annex C

Detailed Tool Test on G7's Klawer Site

Table of Contents

1. Introduction

All developed methods and criteria of the EPAT are issued from simplified scientific specialist expertise and the experience gathered in several Environmental Impact Assessment processes in order to give any user the chance to operate this tool regardless of its basis-knowledge or experience in EIAs.

This section, "Testing of the Tool", is mainly dealing with the quality assurance of the tool and is an important part of the constant development and improvement of the EPAT.

It will however only focus on the test of the GIS Tool and Detailed Site Evaluation Tool which partly covers the Google Earth Tool in any case. The testing process will include detailed maps and explanations and can be used as a template reporting format on any other site.

Furthermore it will compare its results to the ones available from the "Pre-feasibility Assessment for 14 proposed wind energy facility sites in South Africa" (CES, 2009) and the "Klawer Wind Farm: Ecological and Biodiversity Assessment" (Simon Todd, 2010) as one of the Specialist Reports undertaken in the EIA process for G7's Klawer Site.

In order to compare the results of this assessment to the studies above, the layout version assessed here matches the one submitted for the EIA phase.

Due to the constraints and Limitations of the EPAT as developed so far and as described in Annex A of this Report, the testing only includes the Impact Categories 1 General and 2 Flora.

2. Site Description

Klawer Site, today known as Klawer Wind Power, is one of the first and most developed projects of G7, which is located in the Matzikama Municipality Western Cape approximately 230 km North of Cape Town along the West Coast. Further details to the Site can be found in Table 1, the Site Layout plan in Figure 1.

Table 1 Site Details

Information	Description
Number of Turbines	12
Project size classification	Small
Average Wind Speed	Medium
Accessibility	Simple (existing electrical and road infrastructure on site)

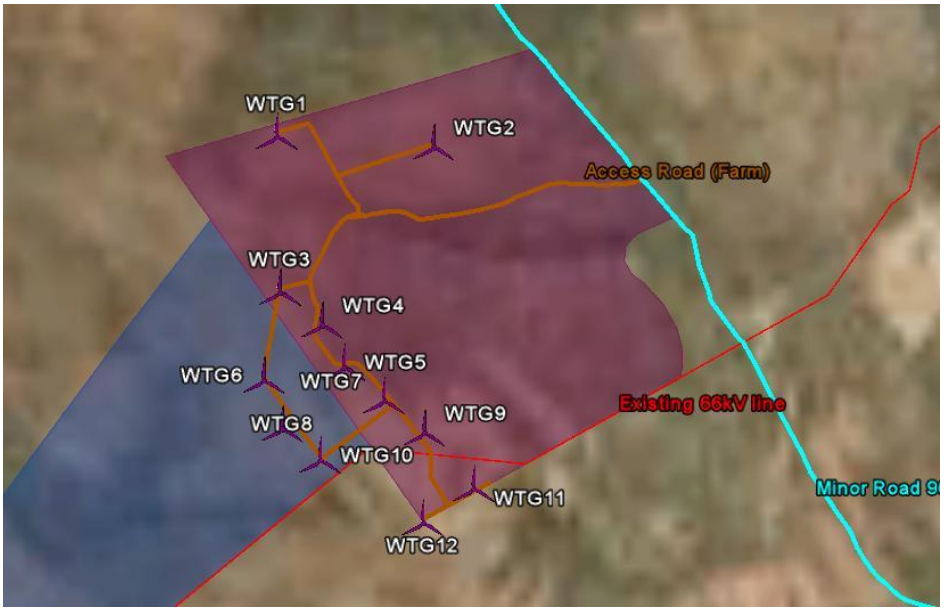

Figure 1 Simplified Site Layout including Property Boundaries, Turbine Positions and planned Access and Turbine Roads

3. GIS Tool (GIST)

The GIST has been created and designed for desktop scouting only. For the purpose of testing, the tool was used for the particular region of the Site and Project data was overlaid in order to check whether a similar given outcome of the Final EIA will be achieved with the GIST.

In a first step the GIST was launched in the Quantum GIS software and the Klawer site boundaries as well as the turbine positions were added to the map. Thereafter the applicable maps were chosen for the site, which are the following of 1 General:

- Airfields
- National Protected Areas
- Ramsar Sites
- National Heritage Sites
- Boarder of South Africa
- National Protected Area Expansion Strategy (NPAES) Focus Areas
- Fine Scale Planning (FSP) Matzikama Municipality Protected Areas

Figure 2 shows Klawer Site (light blue represent the Property boundaries and the green dots the Turbine Positions) and the enabled Vector maps. The purple layer represents the NPAES Focus Areas, the lighter purple close to the site a State Forest Nature Reserve (FSP Matzikama Municipality) and the purple dot North-East of the site on the image boundary the Van Rhynsdorp Airfield.

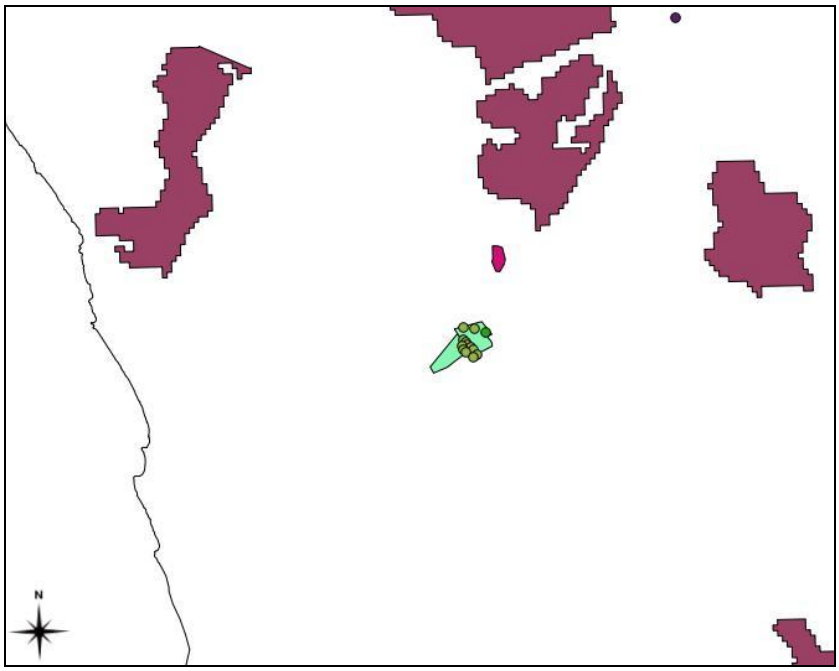

Figure 2 Klawer Site with adjacent Constraint Vector Maps

The next step is the actual implementation of the GIST: the application of buffers with the use of the distance raster files according to the applicable maps as chosen above. The buffers applied are according to the DSET suggested ones in order to achieve a maximum impact risk of moderate (2). An overview is provided in Table 2.

Table 2 Minimum distances of applicable Constraint Maps

Constraint Map	Distance in km
Airfields	>20
National Protected Areas	>10
Ramsar Sites	>15
World Heritage Sites	>15
Boarder of South Africa	0
NPAES Focus Areas	>5
FSP Matzikama Municipality Protected Areas	>5

These minimum distances were now included in the raster calculator tool of the GIST. The complete calculation formula was as follows, the result raster map for South Africa is shown in Figure 3:

boarder_of_south_africa@1 ***AND*** *airfield_dist_compressed@1 > 20000* ***AND*** *national_protected_areas_dist_compressed@1 > 10000* ***AND*** *ramsar_sites_dist_comp@1 > 15000* ***AND*** *world_heritage_sites_dist_comp@1 > 15000* ***AND*** *npaes_focus_areas_dist_comp@1 > 5000* ***AND*** *wc_fsp_matzikama_municipality_protected_areas_d_c@1 > 5000*

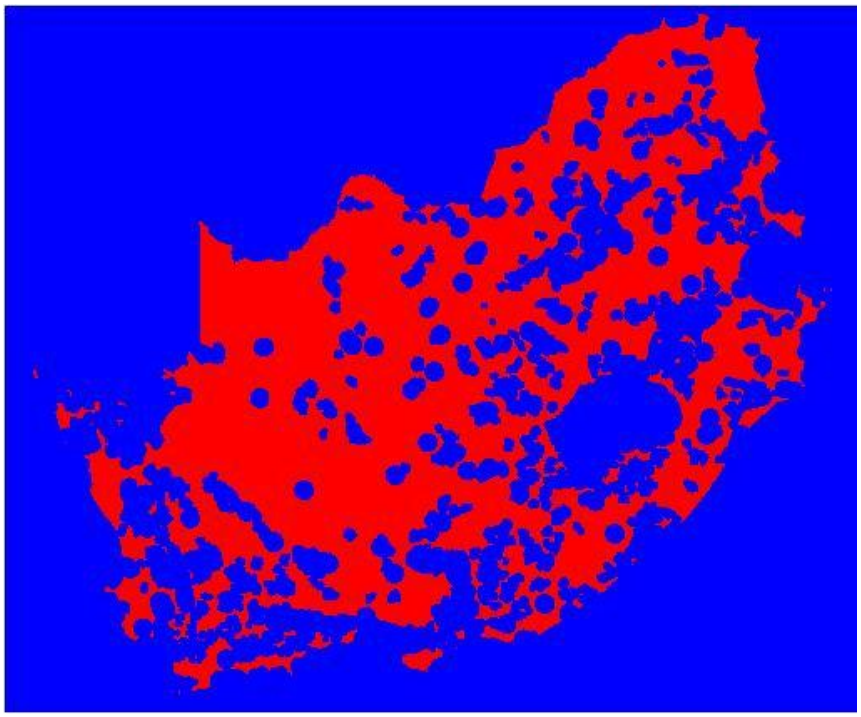

Figure 3 Result Raster Map after the use of Raster calculator

The red area is the remaining part of South Africa respecting all buffers applied as above in order to achieve a moderate impact risk for all constraint maps. An excerpt of the Klawer area is demonstrated in Figure 4. Note that the site maps for the project boundaries and the turbine positions have been overlaid with a transparency of 60%.

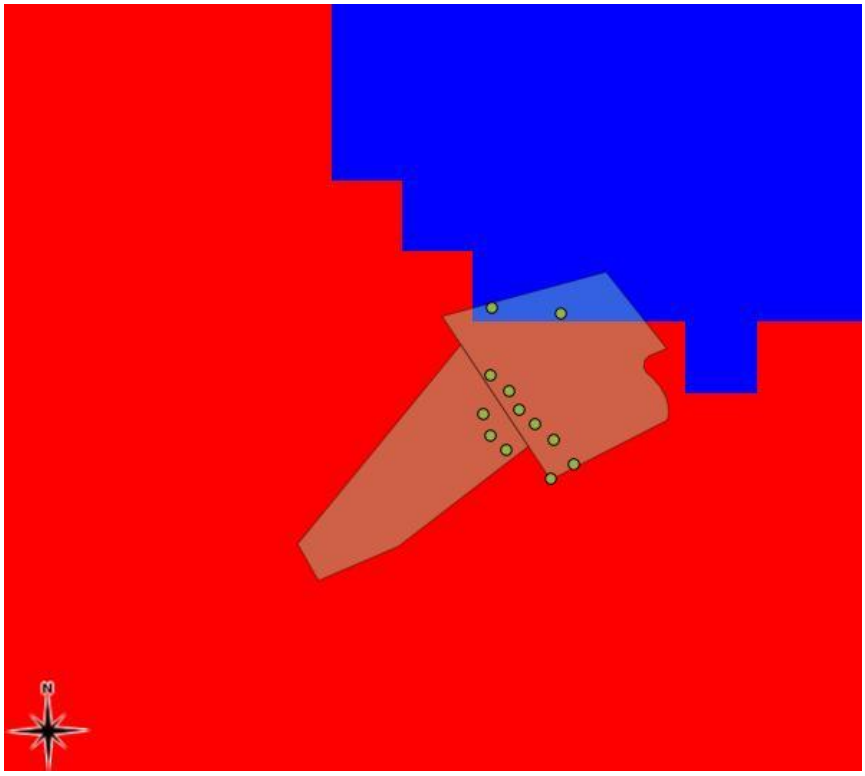

Figure 4 Klawer Site including the Calculated No-Go Zones (in blue)

Conclusion

Klawer Wind Power falls mainly into buildable areas, but tangents the no-go area as defined in the raster calculation closely. 2 of 12 turbines are placed in the “Non-buildable” area, when such conservative buffers are applied. If one reviews Figure 2 again the map clearly determines the origin of the buffer. The light purple area North-East of the site is the private reserve “Kapel Conservation Area” of the type State Forest Nature Reserve which is included in the map FSP Matzikama Munipality Protected Areas. As described in the limitations section of the GIST, the applied buffer of 5km is bearing uncertainties of a pro-conservation nature, meaning the buffer is at least 5 km, but potentially up to 6.4 km. Therefore the risk for all constraint maps used in this assessment will remain by moderate for Klawer Site and would have been categorized as a potential site determined by the GIST.

Interesting enough is that the owner of the “Kapel Conservation Area” is very well known to G7 and still remains one of the most difficult Interested & Affected Parties in the public participation process of the EIA to this project.

4. Detailed Site Evaluation Tool (DSET)

This test was undertaken for all steps from the beginning to the end of the DSET. The Reference numbers used here are used in the same order as per guidelines of the tool.

4.1 General

1. General

1.1. Site Preparation

This first step of the Tool is already done, a site layout is available (see 3 GIST of this report) and the project will be saved temporarily in the project Folder. The filled in part of the Tool is outlined in Figure 5 below.

1	General	Klawer temp			Assessment Details	20111112	Sebastian Hirschman
	Site Description				Guidelines		
Ref #	Map Description		Status / Scoring		References	Link to Library	Comments, Considerations
1.1	Site Preparation						
1.1.1	Set up of the Project		Status	Comment	User Manual # 1.1.1		
1.1.1.1	Set up of the Project folder		Done	only temporary		LIB_Detailed Site Evaluation/Klawer	
1.1.1.2	Changing the Project Details		Done	n/a	Cell C1, I1 and J1 of 1 General	n/a	
1.1.1.3	Adding of the project to the Library		Done	n/a		LIB_Detailed Site Evaluation/Projects	
1.1.2	Construction of a Preliminary Site Layout		Status	Comment	User Manual # 1.1.2	LIB_Detailed Site Evaluation/Projects/P	
1.1.2.1	Property boundaries		Done	available in Main/Projects	Supplementary Data/Farm Portions		
1.1.2.2	Turbine layout		Done	available in Main/Projects			
1.1.2.3	Road layout		Done	available in Main/Projects			

Figure 5 Part 1.1 of the DSET

1.2. Impact Assessment

In order to evaluate the risks in the DSET, the Google Earth Tool needs to be opened and used simultaneously and the process becomes a measurement exercise with Google Earth. Figure 2 in 3 GIS Tool already indicated that no major constraints of 1 General are close to the Site hence, the scores for the potential impact risk for this category are expected to be low.

Table 3 shows the measured distances from the closest turbine to every constraint map and the score resulting thereof according.

Table 3 Result Overview of the Impact Asessment

Constraint Map	Measured Distance in km	Description	Resulting Score
Airfields	31.5	VanRhynsdorp Airfield	2

National Protected Areas	112	Tankwa Karoo National Park	1
National Wetlands	0.5	Small river on site	2
Ramsar Sites	55	Verlorenvlei	1
World Heritage Site	47	The Cape Floral Region	1
National Estuaries	>50	None on site	2

1.3 Additional Maps

Similar to the impact assessment the distances to the additional maps were measured using the GET. The results are collected in Table 4.

Table 4 Result Overview of Additional Maps

Constraint Map	Measured Distance in km	Description	Resulting Score
NPAES Focus Areas	9.8	Knersvlagte Hantam	2
Local Protected Areas	5.2	Kapel Conservation Area	2

Conclusion for General

Each Constraint map implements a moderate or low risk to the site, which it was expected to be. During the EIA phase of the project, none of the constraint factors threatened the project seriously apart from the private nature reserve “Kapel Conservation Area”, which is a pure personal matter which is difficult to capture with figure, guidelines or methods.

An excerpt of the filled in DSET for 1.2 Impact Assessment and 1.3 Additional Maps is provided in Figure 6.

1	General	Klawer temp					Assessment Details	20111112	Sebastian Hirschman
		Site Description						Guidelines	
Ref #		Map Description				Status / Scoring	References	Link to Library	Comments, Considerations
1.1	Site Preparation								
1.2.	Impact assessment	Scoring						Guidelines	
Ref. No.	Constraint Map	Weighing factor	Score	Scoring / Site description	Score evaluation	Scoring criteria	References	Link to database	Comments, Considerations
1.2.1	Airfields	1	2	VanRhynsdorp airfield is approx. 32 km North-East	4	Distance < 10km	20091218_G7 Prefeasibility Assessment FINAL.doc & 201003_1.2.1_Airfileds_NATS Safety Analysis PE Airport.pdf	LIB_Detailed Site Evaluation/1_General & 1_General/201110	Values according to reference are different, a more conservative approach is taken here
					3	Distance < 20km			
					2	Distance > 20km			
					1	None in close proximity			
1.2.2	National Protected Areas	1	1	Tankwa Karoo National Park approx. 112km South-East	4	Distance < 5km	201006_protectedareasNPAES_metadata_NationalParks.pdf	LIB_Detailed Site Evaluation/1_General /201110	Assumption, no data for general buffers available, NPAES data 2010, NSBA will be updated 2011, Including all Formal Protected Areas
					3	Distance < 10km			
					2	Distance > 10km			
					1	None in close proximity			
1.2.3	National Wetlands	1	2	Next waterbody approx. 500m from closest WTG	4	Distance < 50m	SW_Todd_Klawer Ecological Assessment_Draft _2.docx & 2010_RSA wetland types Metadata.pdf	LIB_Detailed Site Evaluation/2_Ecology/ 201110 & 1_General/201110	Buffers only include construction restrictions from ecology perspective.
					2	Distance > 50m			
1.2.4	Ramsar Sites	1	1	Verlorenvlei approx. 55km South	4	Distance < 10km	2006_Ramsar_manual2006e.pdf 201001_The Annotated Ramsar List_South Africa.pdf	LIB_Detailed Site Evaluation/2_Ecology/ 201110 & 1_General/201110	Assumption, no data for general buffers available, based on visual impact (sense of place)
					3	Distance < 15km			
					2	Distance > 15km			
					1	None in close proximity			
1.2.5	World Heritage	1	1	47 km to The Cape Floral Region	4	Distance < 10km	200801_World Heritage Sites_opguide08-en.pdf 2011_UNESCO World HeritageSites_South Africa.pdf	LIB_Detailed Site Evaluation/2_Ecology/ 201110 & 1_General/201110	Assumption, no data for general buffers available, based on heritage & visual impact (sense of place)
					3	Distance < 15km			
					2	Distance > 15km			
					1	None in close proximity			
1.2.6	National Estuaries	1	2	None in close proximity	4	Distance < 50m	200910_national_estuaries_metadata.pdf	LIB_Detailed Site Evaluation/2_Ecology/ 201110 & 1_General/201110	No data on buffers available, based on 1.2.3 National Wetlands
					2	Distance > 50m			
1.3	Additional Maps	For information only						Guidelines	
1.3.1	NPAES Focus Areas	1	2	Knersvlagte Hantam approx. 9.8 km North-East	4	Distance < 2km	201006_protectedareasNPAES_metadata_FocusAreas.pdf	LIB_Detailed Site Evaluation/1_General /201110	Assumption, no data for general buffers available, NPAES data 2010, NSBA will be updated 2011, Focus areas for protected areas expansion
					3	Distance < 5km			
					2	Distance > 5km			
					1	None in close proximity			
1.3.2	Local Protected Areas	1	2	Kapel Conservation Area approx. 5.2 km North-East	4	Distance < 2km	Eastern Cape, Mpumalanga, Northern Cape and Western Cape	LIB_Detailed Site Evaluation/1_General /201110/Local Protected Areas	Assumption, no data for general buffers available, FSP data and other, not part of NPAES project, needs to be confirmed
					3	Distance < 5km			
					2	Distance > 5km			
					1	None in close proximity			

Figure 6 Part 1.2 Impact Assessment and 1.3 Additional Maps of the DSET

4.2 Flora

2. Flora

2.1. Site Preparation

First Step of the Site Preparation is the determination of the major vegetation types on site according to 2.1.1 of the tool. The in the GET enabled Mucina and Rutherford map distinguishes between two major vegetation types on Klawer Site as per Table 5.

Table 5 Major Vegetation Types on Site as per Mucina and Rutherford

Vegetation name and description	Conservation Status	Conservation Target in %	Status	Comments

Doringrivier Quartzite Karoo	LT	19	Done	All turbines placed here
Leidpoldtville Sand Fynbos	EN	29	Done	No turbines in this Area

When mapping the 2 Vegetation Types as per 2.1.2.1, the Leidpoldtville Sand Fynbos Vegetation is situated in the North East of the actual turbine positions. The only turbine affecting this vegetation type is the most northern turbine (WTG 1) which sits exactly on the boarder of the two areas as indicated in Figure 7, whereas the left part of the picture is representing the endangered Fynbos species, the right part is the Dorinngrivier Quartzite Karoo and the black line the border between the 2 species.

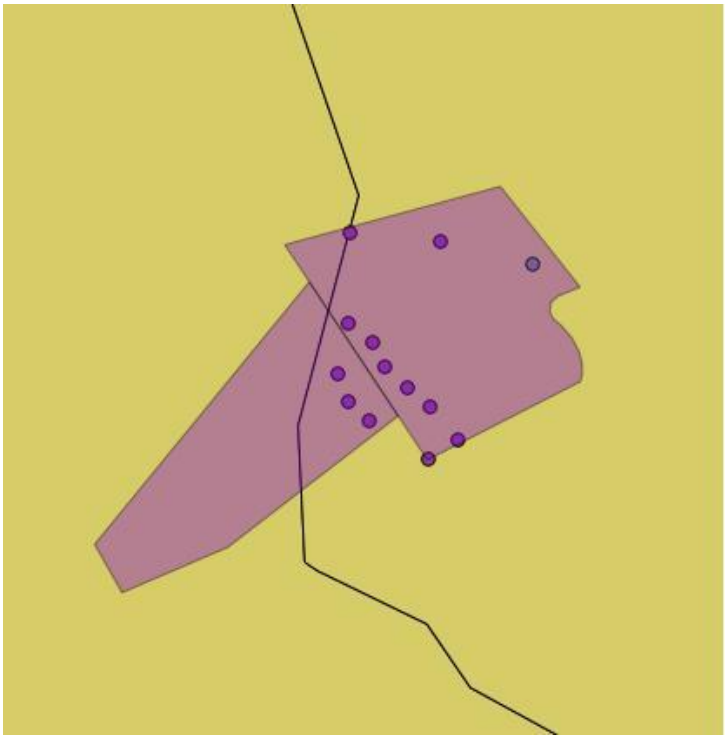

Figure 7 Mapping of the 2 Major Vegetation Types

In a next step (2.1.2.2) the transformed areas are mapped, again using the GET. For simplification of this exercise in the testing section only turbine adjacent areas where marked (in white) as demonstrated in Figure 8. Most of the turbines are in already transformed areas which results into a limited impact on natural vegetation. Turbine position WTG 5 is placed in a mixed zone of transformation and vegetation which appears to be different due to several roads built around it hence, was assessed with a medium sensitivity. The turbines WTG 4 and WTG 9 are not located in transformed areas; their impact is directly on natural vegetation. The sensitivity of the area will be assessed in a next step (2.1.2.4).

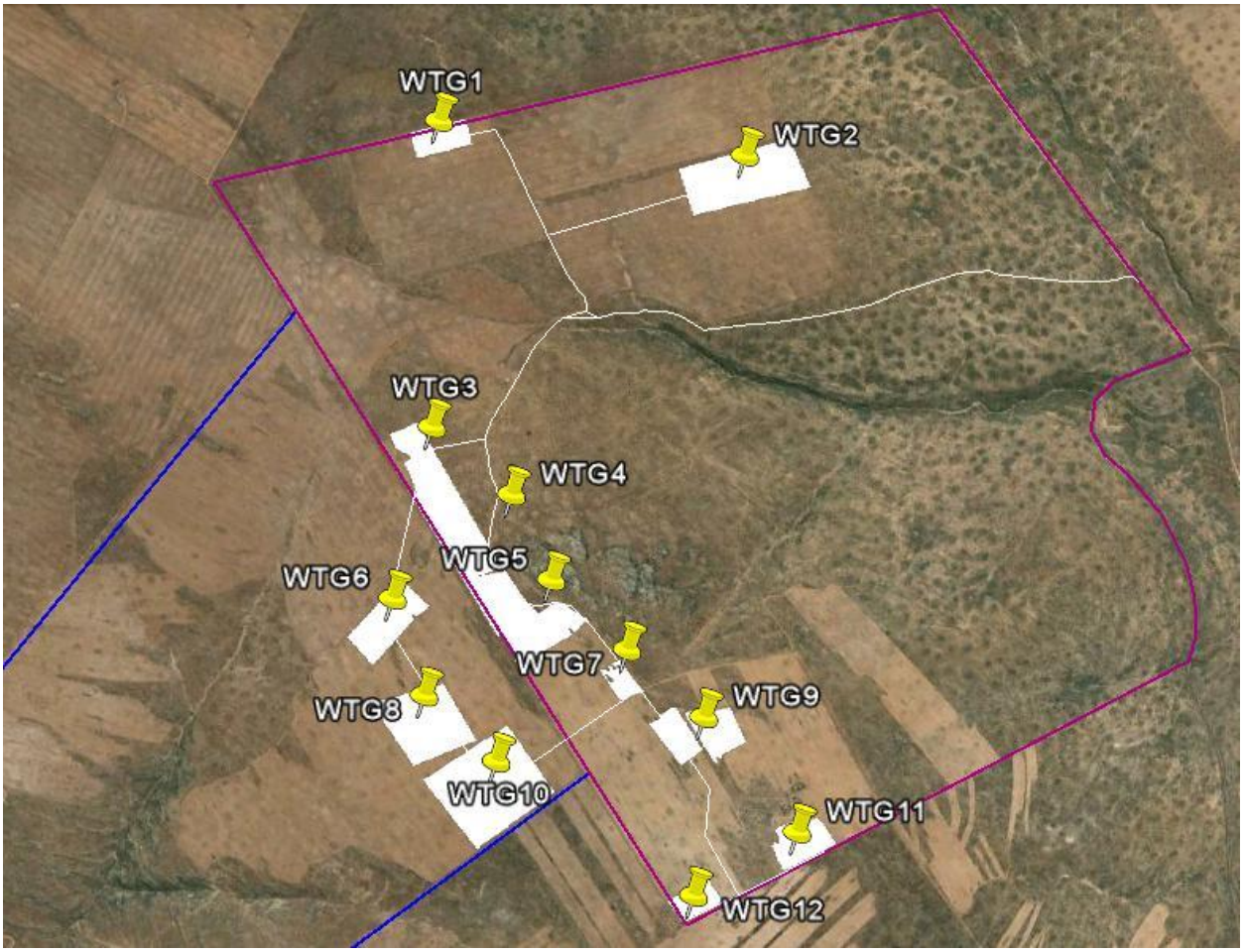

Figure 8 Simplified Transformed areas of the site

But before moving to the mapping of the remaining natural vegetation, local water bodies and drainage lines are supposed to be mapped (2.1.2.3). This step is skipped here as the only water body on site is the drainage line running south of the access road (white) from West to East below Wind Turbine Generator 2 and is not affected by any planned wind turbine.

Special features were now added which are limited to rocky outcrops only and marked in red in Figure 9. The sensitivity of such a special landscape feature which is surrounded by mostly sandy areas was marked as Very High (VH). All other natural vegetation was treated with a sensitivity of high(HI) only which is supposed to be avoided were possible. Mixed landscape features with partly transformed and partly natural vegetation are treated with a sensitivity level of medium to low (ML).

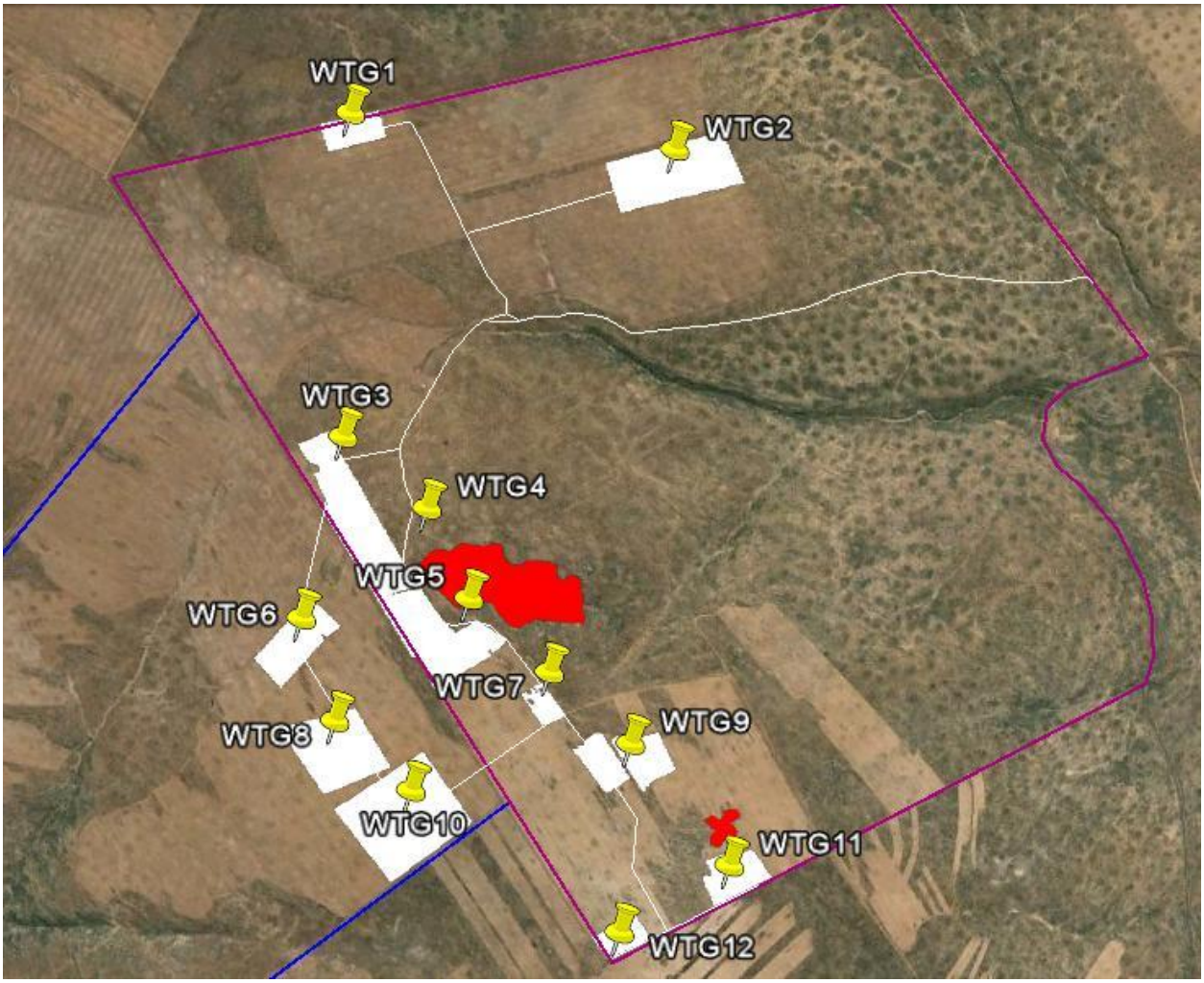

Figure 9 Sensitivity Map including Special Features

In a last step to the sensitivity map, local Critical Biodiversity Areas (CBA, as per 2.1.2.5) were added to the site specific map. None of the CBAs (in green) of the FSP Matzikama Municipality constraint map falls within the site boundaries as illustrated in Figure 10 hence, was assessed as such later in the impact assessment.

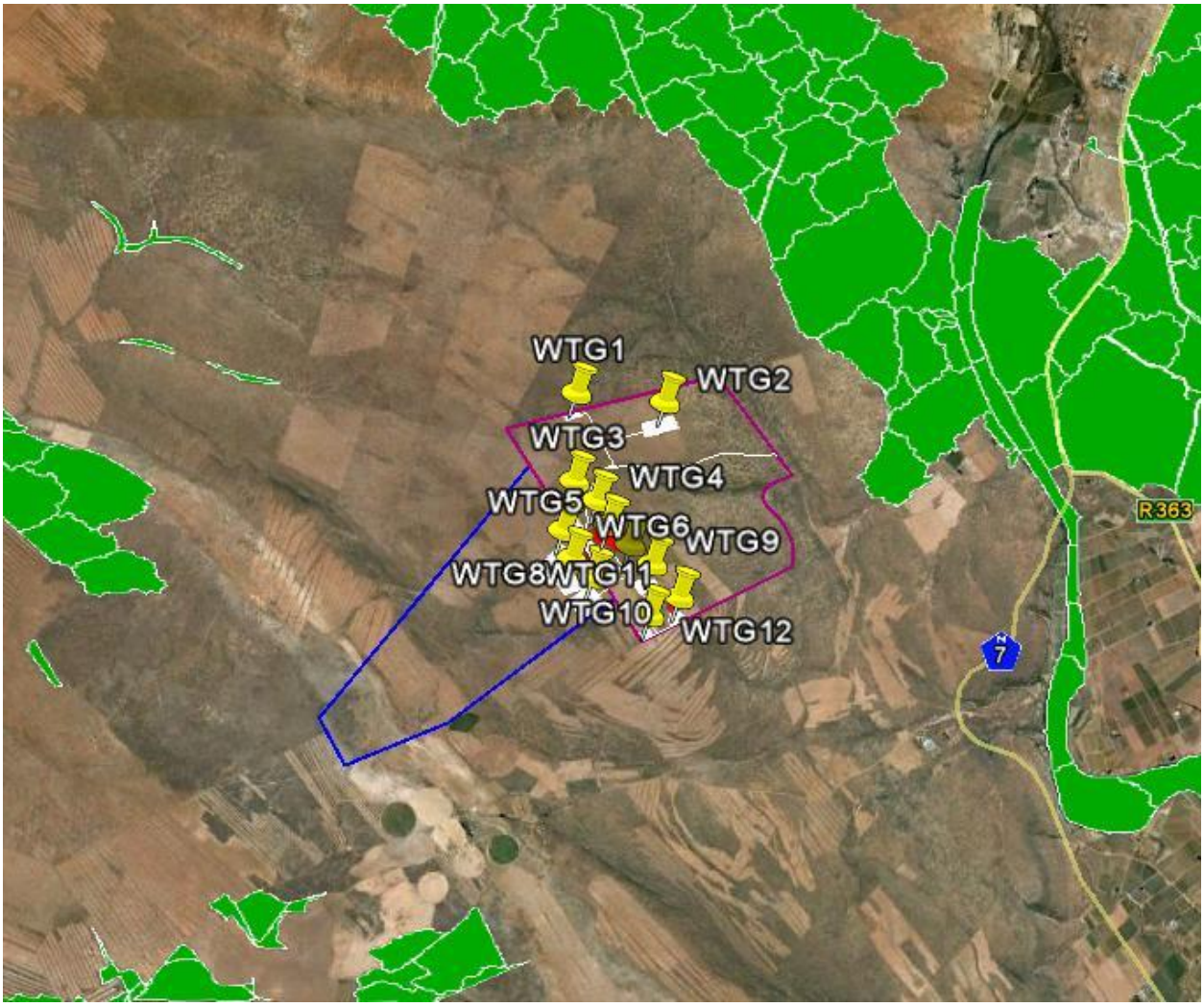

Figure 10 Sensitivity Map regarding CBAs

Based on all these preparation steps the Evaluation of Infrastructure / Sensitivity assessment as per 2.1.3 was undertaken which implements the correct interpretation of the data produced in 2.1.1 Determination of Major Vegetation Types and 2.1.2 Sensitivity Map.

The first part (2.1.3.2) deals with the actual turbine disturbance within the major vegetation types. As per Figure 7, one turbine, WTG 1, is affecting the species rated with a sensitivity of endangered (EN). All other turbines are placed in least threatened (LT) vegetation.

2.1.3.3 refers to the CBA assessment undertaken before where no turbines were detected to impact those sensitive areas.

As a third part of the Evaluation of the infrastructure and the Sensitivity, the mapped sensitivity areas will be applied in 2.1.3.4. The result is that 2 turbines as indicated above are within high sensitivity areas and the rest is placed in medium or low sensitivity.

The results can be inspected in Figure 11.

2.1.3	Evaluation Infrastructure / Sensitivity	Turbine [#]	Share [%]	Status	Comments
2.1.3.1	Total amount of turbines planned on Site	12	100.00	Done	n/a
2.1.3.2	Major vegetation Types (2.1.2.1)				
	Protected and/or Critical Endangered (CR)	0	0.00	Done	n/a
	Endangered (EN)	1	8.33	Done	Turbine 1
	Vulnerable (VU)	0	0.00	Done	n/a
2.1.3.3	Local Conservation Plans / Critical Biodiversity Area (2.1.2.5)				
	In	0	0.00	Done	n/a
	Out	12	100.00	Done	no turbines within CBAs
2.1.3.4	Sensitivity Map (2.1.2.2 to 2.1.2.4)				
	Very High (VH)	0	0.00	Done	n/a
	High (HI)	2	16.67	Done	WTG 4 and WTG 9
	Medium and low (ML)	10	83.33	Done	All other turbines

Figure 11 Evaluation of Infrastructure and Sensitivity

2.2. Impact Assessment

Once the site preparation was finalised the impact risk assessment was approached. Again the 3 categories Major Vegetation Types (2.2.1), CBAs (2.2.2) and Sensitivity Map (2.2.3) were taken a step further and scoring criterion according to the individual results of the evaluation of infrastructure and sensitivity preparation step in 2.1.3 were applied.

Major Vegetation Types were scored with moderate to major because of one turbine impacting the vegetation with a conservation status of endangered. CBA areas are not affected by the proposed development hence this category was implied with a score of low. The sensitivity map was scored to an impact risk of major due to the amount of 2 turbines being placed in high sensitive areas.

After weighing factors being applied, the impact risk of the Klawer Site for 2 Flora reached a status of moderate to major, but on the upper boundary (the value is rounded from 3.33 to a solid 3). Figure 12 shows an overview of the Impact Assessment.

2.2.	Impact assessment			Scoring		
Ref. No	Constraint Map	Weighin	Score	Scoring / Site description	Score evalua	Scoring criteria
2.2.1	Major Vegetation Types (as per 2.1.3.2)	1	3	EN is exceeding 5%	4	CR >5%; EN >10%; VU >20%
					3	CR >2%; EN >5%; VU >10%
					2	CR <2%; EN <5%; VU <10%
					1	None of the above affected
2.2.2	Local Conservation Plans / CBA (as per 2.1.3.3)	1	1	No CBAs affected	4	In >10%
					3	In >5%
					2	In <5%
					1	Out = 100%
2.2.3	Sensitivity Map (as per 2.1.3.4)	4	4	HI is exceeding 10 %	4	VH >5%; HI >10%
					3	VH >2%; HI >5%
					2	VH <2%; HI <5%
					1	ML = 100%
2.2.4	**Imapact Risk** (including weighing factor):		3.33			
	Rounded		3			

Figure 12 Flora Impact Assessment

2.3. Additional Maps

Species of special concern and the red listed data can be assessed optionally, but has not been included into this testing phase. The purpose is for pure information and lists all endangered species that might occur on site. A site visit might proof or disproof the list in any case. For completion sake this Map 2.3.1 can be done in a later stage of the development.

The Mitigation Possibility in 2.3.2 however was undertaken here. The impact risk evaluated in 2.2 Impact Assessment was determined as too high and mitigation appears not to take major challenges at this site. By shifting WTG 1 by 30 m out of the vegetation with a conservation status endangered to the one with a conservation status of least threatened, the Impact Risk remains unchanged but the actual calculated value decreases to 3.0. Even though the Site is very limited in space this and one additional slight shift of turbine 9 for another 30 m in East or West direction will not affect the wind settings of the site negatively but will have an enormous positive change to the Risk Impact. By applying these 2 minor changes a final impact risk of moderate (value unrounded = 2.33) can be achieved. Part 2.3.2 in the tool is indicated in Figure 13.

2.3.2	Mitigation Possibility	Score	Score description						
		1	Shifting of Turbine 1 and 9 by approx. 30m	1	Easy	New Layout, Wind assessment, 3D Compliance	main/Projects/Klawer.kml	changes have been applied and checked against all constraints, Impact Risk of Mderate Possible
				2	Possible			
				3	Not Impossible			
				4	Impossible			

Figure 13 Mitigation Possibility

Conclusion to Flora

The DSET for Flora works as expected, the time investment in order to assess a site properly is quite demanding, but still within fair limits to be implemented into the project development phases by G7.

The impact result seems to be very high for the site and the environment assessed before. However, as the scoring is highly dependent on the total amount of turbines and the share thereof in sensitive areas, mitigation on one turbine will have a huge effect on the impact rating for a small site like Klawer. Therefore the context of the entire tool seems to work fine.

4.3 Overall Results

0 – Overall Results

On the zero sheet of the DSET all results of each Impact Category are automatically linked in an overview as displayed in Figure 14.

2	Flora	Klawer temp	Assessment Details	20111112	Sebastian Hirschman
Ref. No.	Constraint Map	Impact Risk	IR (not rounded)	Mitigation Possibility	Comments
1	General				
1.2.1	Airfields	2	n/a	n/a	
1.2.2	National Protected Areas	1	n/a	n/a	
1.2.3	National Wetlands	2	n/a	n/a	
1.2.4	Ramsar Sites	1	n/a	n/a	
1.2.5	World Heritage	1	n/a	n/a	
1.2.6	National Estuaries	2	n/a	n/a	
1.3.1	NPAES Focus Areas	2	n/a	n/a	
1.3.2	Local Protected Areas	2	n/a	n/a	
2	Flora				
	Overall Impact Risk	3	3.33	1	Impact risk of Moderate (2.33) possible after Mitigation

Figure 14 Overall Results for the Klawer Test Run

4.4 Result Comparison

In order to evaluate the DSET against assessments undertaken by specialist in the field, the impact category Flora will be compared to the results in the “Pre-feasibility Assessment for 14 proposed wind energy facility sites in South Africa” (2009, CES) first and afterwards to the detailed Ecology assessment “Klawer Wind Farm: Ecological and Biodiversity Assessment” (2010, Simon Todd).

Table 3-4 Klawer Impact Significance Rating on Page 48 of “Pre-feasibility Assessment for 14 proposed wind energy facility sites in South Africa” (2009, CES) rates the impact on flora in a similar approach used in the DSET to moderate. The appearance of Leipoldtville Sand Fynbos (Conservation Status: Endangered) was determined as well thus the impact is rated to moderate due to the large share of transformed area. Furthermore the mitigation potential was rated to easily achievable.

The study does not provide any more detail to the grounds this result was determined on.

The detailed specialist report on the Klawer Project undertaken by Simon Todd during the EIA phase, rates the impact significance for two separate phases, construction and operation. The operation impact rating is moderate and mainly concerns potential erosion due to the newly created not vegetated areas. Mitigation limits the impact to minor. Figure 15 is an excerpt of the impact rating on page 25 of the specialist report.

Table 1. Assessment of the impact of the development of the G7 Klawer Windfarm site on vegetation. Mitigation refers to the development proceeding under the alternative layout which avoids areas of Very High Sensitivity as wind turbine sites, as well as applying the other recommendations listed in *Section 4*.

CRITERIA	IMPACT			
	CONSTRUCTION		OPERATION	
Magnitude:	Without mitigation	With mitigation	Without mitigation	With mitigation
Extent	Local	Local	Local	Local
Duration	Long-Term	Long-Term	Long-term	Long-term
Intensity	High	Medium	Medium	Low
Likelihood:				
Probability	High	Medium	Medium	Low
Significance Rating:				
Significance	Major	Moderate	Moderate	Minor
Status & Certainty:				
Status	Negative	Negative	Negative	Negative
Confidence	High	Moderate	High	Moderate

Figure 15 Impact Significance Rating of the Klawer Porject, EIA Ecology Spcialist Report (2010, Simon Todd)

The construction phase with the focus of the flora section in the DSET determines a pre-mitigation impact significance of major, which drops to moderate once mitigation measures are applied. The Author Simon Todd used only 3 impact ratings from minor to major and is therefore in line with the results evaluate in the testing process of the DSET. The suggested mitigation method is to shift the turbines out of the high sensitivity areas for a moderate (lower) impact rating to be achieved, which again covers the same results assessed here.

5. Conclusion

Both tests, for the GIST as well as for the DSET, fulfil the expectations for at least Klawer site and are comparable to the results of the specialist assessments. The simplification of the complex processes the specialists is undergoing when assessing the study field tends to have been efficient for the EPAT as well.

However a single test on one site cannot proof the model alone and all future assessments will have to be looked into with care and caution in order to fully validate the tool's functionality. Wherever issues might occur, the Tool shall be reviewed and changes made shall be kept in small Maintenance Reports in the Library.