Environmental Impacts Integrated Assessment of the KwaZulu-Natal Electrification Programme: A case study of Ndumo Gezisa 132/22kV Multi-Circuit Power Line

KwaZulu- Natal

by

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Mini dissertation submitted in partial fulfilment of the requirements of the Degree

Masters (Environmental Management)

In the

Centre for Environmental Studies (CFES)

Department of Geography Geoinformatics and Meteorology

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University of Pretoria

South Africa

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December 2018

DECLARATION

I Xola Asanda Debe declare that this thesis is my original work written from investigations which I have undertaken myself. Where sources have been used or assistance received, the sources of such have been duly referenced. I further declare that this work has never been, prior to this instance, submitted partially or wholly for degree purposes at any other institution of higher learning.

Signature Date

..... 21.12.2018 .....

ACKNOWLEDGEMENTS

I would like to acknowledge my supervisor Dr Dan Darkey for without whom this project would not have been possible; Marinda Cilliers who rooted for me from the very beginning and my family and friends for their undying support and for having faith in me at all times. My work colleagues who willingly participated and offered me sound advice whenever needed and to my UP colleagues Thumo Neluvhani, Ayanda Khininda and Bigboy Zhou who through this process have become friends, my biggest motivators, and support system. Lastly and most importantly God who has enabled me to do things I never imagined possible by giving me the resources I needed and the right people in my corner.

DEDICATIONS

I dedicate this to all young girls; go as far as the eyes of your dreams can see.

ABSTRACT

Electrification forms a huge part of any developing nation's agenda. Access to electricity is a universal goal which many countries are still working towards. For this reason, there is growth in the introduction of electrical infrastructure and associated technology in areas which previously had no access to electricity. While electrification is notably important for socio-economic growth; the environmental impacts associated with the construction and operational infrastructure cannot be ignored. The introduction of distribution infrastructure which is mainly steel structured pylons, kilometres of conductor and substations is associated with impacts on vegetation, bird collisions and electrocutions and spillages from apparatus such as transformers. The study was prompted by the regulatory exemption of electrification from undergoing a Basic Assessment or an Environmental Impact Assessment due to the low voltage of reticulation lines. The study however shows that low voltage lines can have significant environmental impact particularly on indigenous vegetation and birds. Where birds are concerned the study shows that low voltage lines are more likely to be responsible for bird mortalities than sub-transmission lines are. The methods used for data collection were field observations, key informants, analysis of project and incident records which included licences and permits for cutting and trimming indigenous and protected trees and records of bird collisions and electrocutions. The study shows that 86% of licences and permits received over the 5 year period were for electrification projects while only 5% were for sub-transmission projects. From the bird mortality data reviewed 62% of the bird mortalities occurred on 11-22kV power lines and infrastructure; 10% on 88kV, and 22% on 132kV power lines and infrastructure. These findings are contrary to the notion that low voltage projects have lower impacts and thus should not be subjected to an authorization process. The study makes recommendations on how the negative impacts of electrification can be managed and minimized and also recommends introducing a tool similar in strategy and methodology to the EIA process but less intensive which can be used for smaller projects such as electrification.

Key Words: electrification, legislation, environment, voltage

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LIST OF ABBREVIATIONS

BA	Basic Assessment
CNC	Customer Network Centre
DESD	Distribution Environmental Screening Document process
DAFF	Department of Agriculture Forestry and Fisheries
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EMPr	Environmental Management Programme
EWT	Endangered Wildlife Trust
GIS	Geographic Information System
ISO	International Organization Standard
KZN OU	KwaZulu- Natal Operating Unit
NEMA	National Environmental Management Act 108 of 1998
SHEQS	Safety Health Environment Quality and Security

CHAPTER 1: INTRODUCTION

1.1. Background

Access to energy is a recognized as being essential for people across the world; this was demonstrated by the adoption of the goal to ensure reliable, sustainable and modern energy for all by 2030. This goal was adopted in 2015 by 193 countries, as part of the United Nations Sustainable Development Goals (SDGs) (International Energy Agency IEA, 2017). Energy access is recognized as being essential for countries to reach other SDG goals linked to economic growth, development and environmental sustainability (International Energy Agency IEA, 2017; National Planning Commission, 2018). In 2016, a global estimate of 1.1 billion people was recorded as having no access to electricity; this number had fallen from 1.7 billion in 2000 (Stojanovski et al., 2017). Nearly all those who gained access to electricity in this period (2000-2016) have done so through the connection to fossil fuel generated electricity (IEA, 2017). The people with no access to electricity are concentrated in developing countries with Sub Saharan Africa having the highest rate (43%) despite progress being made in the last few years (World Bank, 2010; Magnani and Vaona, 2016; IEA. 2017). South Africa has achieved approximately 85% of access to electricity. Most of the unelectrified areas occur in rural areas where electrification efforts are currently concentrated (National Planning Commission, 2018). In South Africa, KwaZulu- Natal (23%) and Eastern Cape (26.5%) have the highest number of households with no electricity (Carbon Trust, 2017). This is where the bulk of electrification activities are taking place in the country.

Electrification is the provision of electricity to previously unelectrified areas through the construction of substations, power lines and associated infrastructure. The Eskom definition for an electrification connection is, “the electrical connection to the Eskom grid or network funded through the National Electrification Fund” (Eskom, 2015 pp 5). Electrification in South Africa typically involves the connection to the grid of mainly rural communities, schools and clinics so that those with no access to electricity are able to gain access. This is done through linking the new customers to reticulation power lines with a voltage of 66kV and below.

In accordance with Environmental Impact Assessment (EIA) regulations; the construction of electricity distribution infrastructure with a voltage of 66kV or higher, requires an environmental authorization (EA). An EA is applied for with the Department of Environmental affairs prior to the commencement of the activity. The application is made through the submission of an Impact Assessment Report (BAR or S&EIA) and Environmental Management Programme (EMPr) which is compiled by independent environmental specialists. Activities involving the development of infrastructure and facilities in the range of 66kV- 88kV undergo a Basic Assessment, while activities above 88kV undergo a full Scoping and EIA process (National Environmental Management Act of

1998). This study investigates the environmental impacts of electrification projects which are not mandated to undergo any environmental impact assessment process, unless the process is recommended due to the sensitivity of the receiving environment. Eskom Distribution voluntarily undertakes an internal process of environmental screening for the construction and refurbishment of these medium and low voltage power lines and substations using a process known as the Distribution Environmental Screening Document (DESD) process.

The purpose of the study is to investigate the environmental impacts of the Eskom electrification programme in order to formulate ways in which the programme should be approached to achieve minimal damage to the environment. The power lines and infrastructure associated with electrification (11, 22 and 33kV) are not subject to a legislated environmental impact assessment and for this reason the study seeks to evaluate the impacts associated with electrification in order to determine if this stance is justified.

1.2. Eskom power generation

Eskom is a state-owned power producer, responsible for approximately 95% of the electricity used in South Africa, and a further 45% in Africa (Inglesi-Lotz, 2015). Eskom operates a fleet of 28 power stations with a capacity of approximately 42 810MW. The breakdown of the energy mix is as follows: coal fired 36441 MW, nuclear powered 1860 MW, gas fired 2409MW and wind farms 100MW as shown in figure 1.1 (Eskom, 2016). Eskom is largely criticized for its dependency on coal and for what some observe as reluctance to the transition to 'cleaner energy' options. Coal-fired power stations account for approximately 90% of the power produced, making Eskom the largest emitter in Africa (Makhado et al., 2012). Eskom was criticized for launching a New Build Programme in 2005 which was to add two new coal fired power stations namely; Kusile and Medupi; both said to have a capacity of 4800 MW each (Bohlmann et al., 2016). Coal-fired power stations produce greenhouse gases such as carbon dioxide, sulphur dioxide, nitrogen oxide, nitrous oxide, ash and dust particles all of which contribute to global climate change (Newbery and Eberhard, 2008). It would therefore, seem illogical for Eskom to announce the building of two power stations which would also be coal fired, thus exacerbating the climate change problem. With increasing environmental awareness amongst the public and the global commitments South Africa had made, building coal fired power stations was not received well.

Apart from the emissions problem; coal-fired power stations also consume large volumes of water during the cooling process which is also a major environmental concern since South Africa is a water scarce country. However, Medupi and Kusile Power Stations were designed to use dry cooling systems thus reducing their impact on the country's water resources. The plan was to reduce water usage from 1.35 L/kWh to 1.21L/kWh by 2015/16 (Bohlmann, 2016).

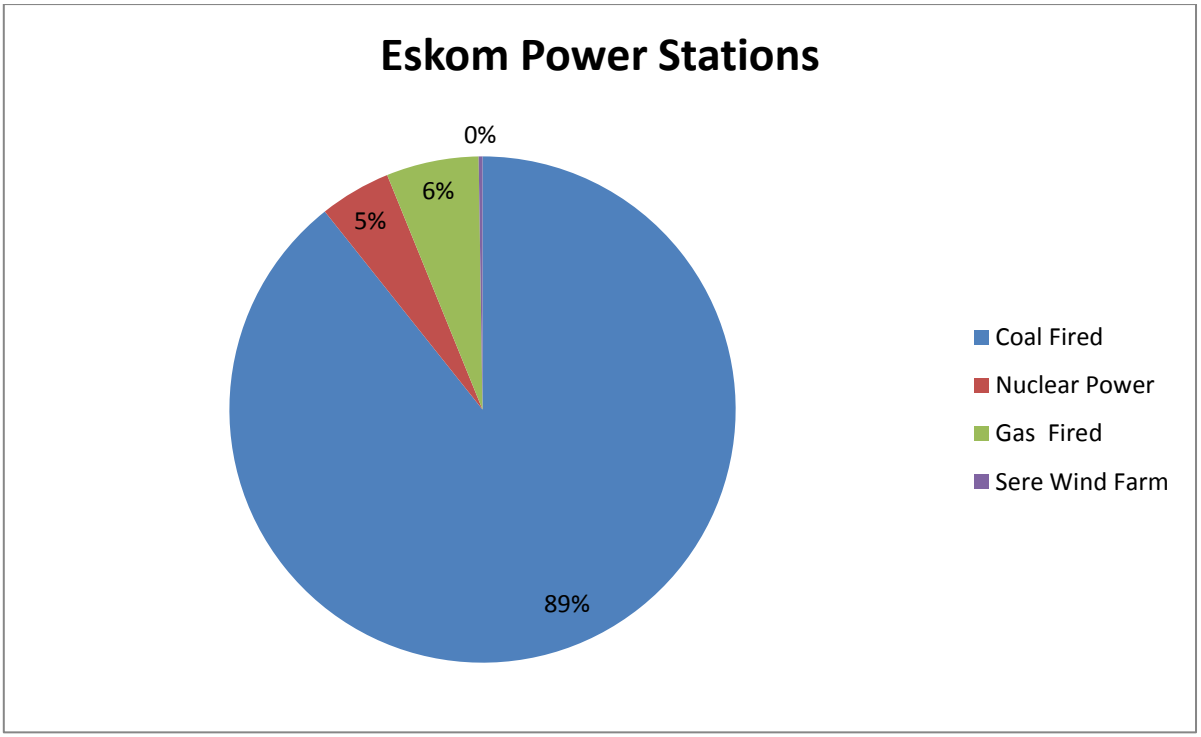


Figure 1.1 : Sources of electricity used in South Africa

Source: Eskom, 2016

1.3. Eskom power transmission

High voltage power lines are used to transport electricity from the power stations to where it is needed. The high voltage power lines are known as transmission power lines and are considered to be the most efficient and reliable way to send electricity from powerstations to load centers. Transmission power lines in South Africa collectively have a span of approximately 28000km, running from the power stations mainly in Northern Cape, Mpumalanga and Limpopo to the rest of the country (Vosloo, 2004). Transmission power lines carry voltages such as 132 000 volts (132 kV), 400 kV and 765 kV through conductors which are normally hoisted up using steel structures as per figure 2 below.

Figure 1.2: A typical transmission power line construction

Power lines have different clearance and width servitude requirements resulting in varying environmental impacts. The higher the voltage of the electricity, the higher the clearance distance is and the wider the servitude width under the line and so the resultant environmental impact (Eskom, 2007).

1.4. Eskom power distribution

The Distribution system is the final step in the electricity system which delivers the power to the end users. The voltage for the power lines and substation in a distribution system ranges from 11kV to 132kV (Vosloo, 2004). The networks which operate between 11kV and 33kV are known as medium voltage of (MV) and the electrical networks capable of operating below 1000 volts are known as low voltage (LV) networks. The Distribution (Dx) Division of the Eskom business is responsible for the building and the maintenance of the distribution assets namely the power lines, substations and associated infrastructure.

The mandate for the Eskom Distribution division is to provide reliable electricity supply through the creation and maintenance of electricity distribution infrastructure (Eskom, 2015). This mandate is in fulfilment of the government's obligation to make electricity accessible for economic activities and also to residential customers. This mandate is carried out by distribution operating units (OUs) which are divided according to the nine provinces in South Africa. The 9 Distribution OUs are: Limpopo OU, North West OU, Gauteng OU, KwaZulu- Natal OU, Western Cape OU, Northern Cape OU, Free State OU, Mpumalanga and Eastern Cape OU.

1.5. The Eskom Stance on the Environment

This research will focus on Eskom distribution and more specifically the direct impacts of the electrification programme. It is however important to first unpack a general overview of the impacts in the generation and transmission environment in order to give a holistic picture which can inform the resultant decisions taken at the electrification level. Also, in the way in which Generation and Transmission handle their operations specific environmental impacts; there may be methods which could be applied in the distribution environment as well.

Spalding-Fecher et al. (2002) briefly discussed the environmental impacts emanating from energy related activities. The major impacts of coal fired power stations are: air pollution from the emissions emanating from the combustion of fossil fuels, acid deposition, impacts on water quality and quantity. Transmission and distribution power lines on the other hand, interact directly with the physical environment and their impacts are widely spread through an array of ecosystems and biomes across the country. The construction and operation of power lines has an impact on fauna and flora, social environment, soil or agricultural land among other impacts (Jenkins et al., 2010; Powell and Lindquist, 2011)

1.6. Problem statement

Economic development is a major priority in South Africa and the availability of reliable electricity is important to support the aspirant economy of the country. Apart from the economic growth; South Africa also has a goal for achieving 100% access to electricity for all by 2030 which has placed a demand on the electrification programme (Department of Minerals and Energy DME, 2014). Electrification was endorsed through the Reconstruction Development Programme (RDP) in 1994.The RDP was initially funded by the electricity industry until 2001 when government later took part of the management and funding responsibility, under the Integrated National Electrification Programme (INEP) (Tinto and Banda, 2005). The programme has been running steadily with over 6.7 million households connected to the grid between 1994 and 2016 (DME 2016).

The goal for universal access to electricity has not been achieved yet and government is under pressure to deliver electricity for all (International Energy Agency, 2017). Yearly, electrification targets are set nationally with the goal of reaching as many people as possible. Since 1994 South Africa has achieved 88 percent access to electricity having made the progress over the years. In the 2015/2016 financial year alone, 231 012 (grid) and 25 076 (non-grid) connections were made (Department of Energy, 2016). The provinces with the highest targets for electrification are KwaZulu- Natal, Limpopo and Eastern Cape. Between 1994 and 2014 the bulk of connections occurred in these three provinces 44,266 (KwaZulu- Natal), 12,282 (Eastern Cape), and 9,381

(Limpopo). Although much progress has been made, these provinces still remain the focus areas for electrification (Department of Energy, 2015)

In South Africa electrification falls under a category of activities which legally do not require a basic assessment or an environmental impact assessment study to be conducted. Therefore, there is little known research on the environmental impacts of electrification programmes; their nature and extent. The assumption of the study is that the construction and operational impacts of reticulation and electrification power lines and infrastructure are similar in nature to those of power lines of higher voltage. The second assumption is that the cumulative environmental impact of electrification projects is significant due to the large volume of electrification projects and the type of environments they affect.

Electrification programmes are set to continue across developing countries for a long time until 100 percent electricity access for all is achieved. It is therefore, important that the environmental impacts of electrification are identified and measured in order for these programmes to follow a sustainable development path. If the impacts are known then they can be planned for and mitigated; this will minimise the environmental impacts of electrification and also ensure that the processes involved in electrification are not delayed by unforeseen environmental issues.

1.7. Study site

The study was based on the environmental impacts of Eskom Distribution in the KwaZulu- Natal Province except for areas not receiving direct supply from Eskom (EThekwini and Pietermaritzburg Metros). Although the overall study covered the entire KwaZulu- Natal Province, the field case study was conducted on a project in the Ndumo area, north of KZN. Approximately 86% of the Ndumo Gezisa project falls under the UMhlabuyalingana Local Municipality while the remainder of the project is in the Jozini Local Municipality as shown on figure 1.3 below. The final line route passes near a nature reserve and there was also a huge concern with the project its anticipated impact on protected sand forest (Golder Associates, 2014)

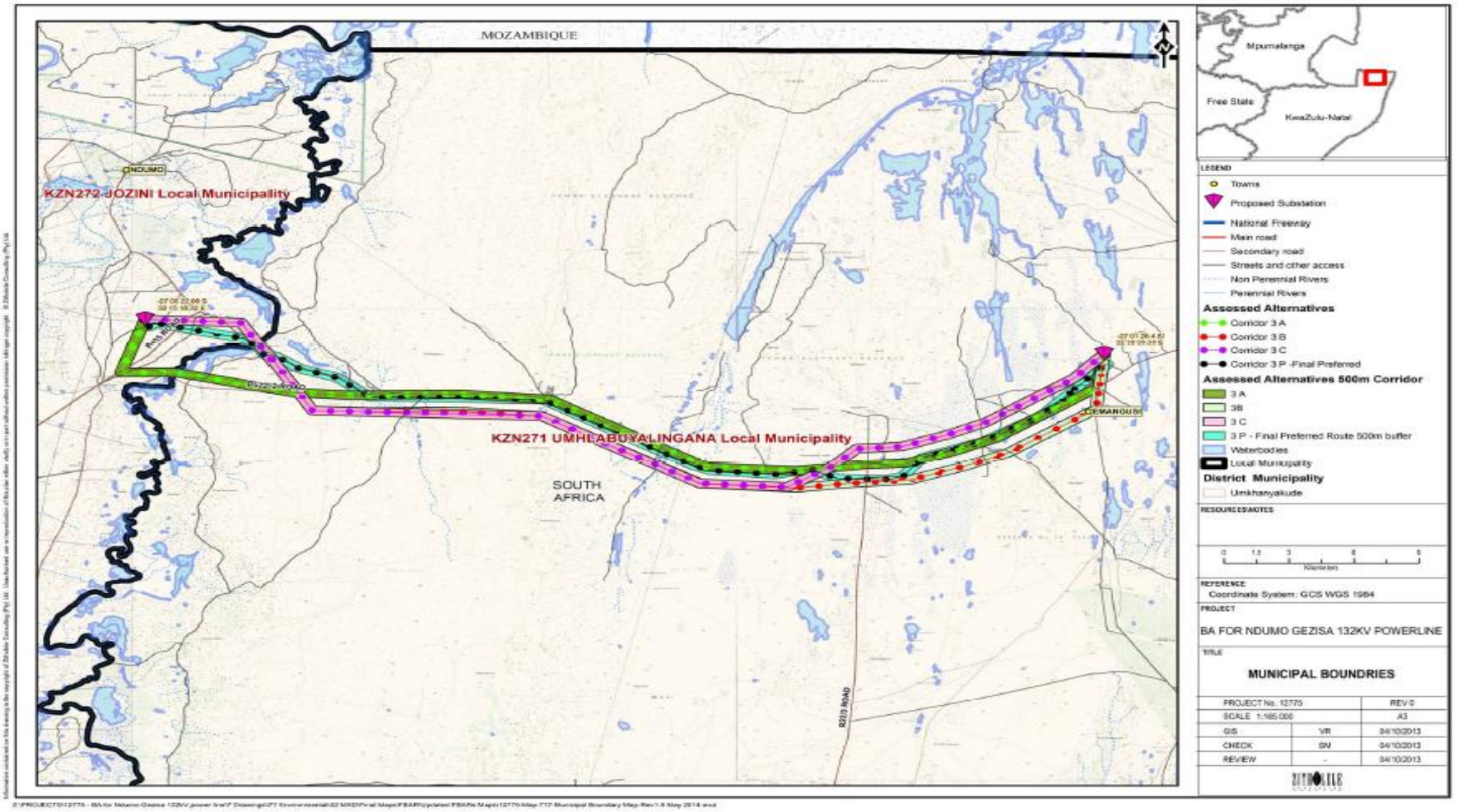


Figure 1.3: Ndumo Gezisa Municipal Boundaries

Source: Zitholele Consulting, 2014

1.8. Research questions:

- What is extent and nature of impacts posed by reticulation and electrification projects?
- Is there a difference between the impacts posed by a 66- 132kV line and those posed by a 11-33 kV line
- What proactive measures can Eskom take to reduce the environmental impacts of electrification?

1.9. Purpose of the study

The purpose of the study is to evaluate the impacts of electrification and determine whether there is a significant difference between the environmental impacts of an 88/132kV and those of an 11/22kV line. The aim is also to make recommendations on measures which Eskom can take to reduce the environmental impacts of electrification. Figures 1.4 and 1.5 below show the physical differences between a sub-transmission line and a reticulation line respectively.

Figure 1.4: Example of a sub-transmission line

Figure 1.5 Typical reticulation line

Source: https://www.zitholele.co.za/ba-for-pongola-13kv-power-line/

1.10. Objectives of the study

- To evaluate the impacts of electrification projects and determine whether they differ from the impacts of projects with a higher voltage (sub-transmission).
- To make recommendations on measures that can be taken to improve the screening and assessment process for electrification and reticulation projects.

1.11. Sampling

The KwaZulu- Natal Operating Unit (KZN OU) is divided into three zones (see figure 1.5), namely; the Empangeni Zone which extends from the North Coast of KZN up to the Swaziland border; the Newcastle Zone which is North West of KZN inland; and the Pietermaritzburg Zone which spans from Pietermaritzburg to the South Coast of KZN until the Eastern Cape border. The study was approached by collecting data using three different methods namely document and record reviews, key informant surveys and interviews and field observation data from a construction project. The data collected represented projects and incidents from the entire province and the specialists interviewed also have experience with Eskom projects across the entire province. The data analysed focused on impacts on indigenous vegetation and collision and electrocution of birds on distribution electrical infrastructure.

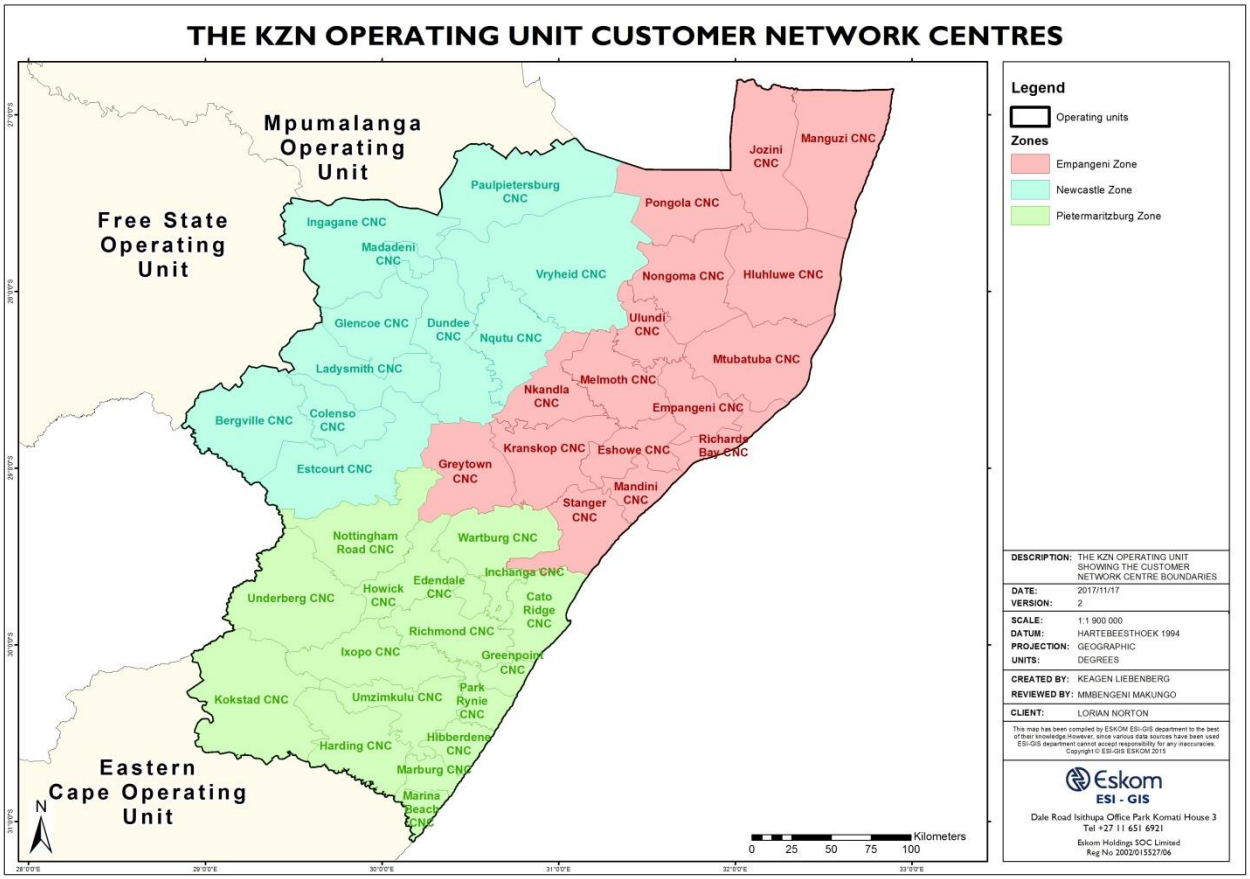


Figure 1.6 Map depicting three zones

Source: Eskom Land Development, 2017

1.12. Document and record review

A total of 200 licences and permits were analysed out of a total of 255 collected. The licences and permits consisted of both sub-transmission and electrification projects. The licenses were requested from the license holders by means of email. Licenses and permits were from both the Department of Agriculture Forestry and Fisheries (DAFF) and the Ezemvelo Wildlife authorities. The period for the licenses collected was from 2013-2017. Bird collision and electrocution data was also collected from the same period and all the records collected were analysed for the purpose of the study.

1.13. Key Informant Surveys and Interviews

The sampling method used to determine the key informants who participated in the study is known as convenience or purposive sampling. This type of sampling is done when the target of respondents is known based on the research design and desired outputs (Acharya et al., 2015). The people invited to participate in the research are those who had extensive knowledge and experience with Eskom distribution projects and could provide sound input. These respondents are known as key informants. Key informants were sent questionnaires by email and interviews were also conducted with some of the respondents. A representative from each relative sector was selected at random, 22 people were invited to participate in the study, and out of those 13 people agreed to the participation. All the major stakeholders (Endangered Wildlife Trust (EWT), Department of Environmental Affairs (DEA), DAFF and Eskom Environmental Management staff) were represented in the study as they directly interact with Eskom projects and operations and the resultant impacts on the environment.

The disadvantage of key informant interviews is that they are usually limited to a small sample; therefore the results provide a limited basis for quantitative analysis (Lee and Wakabayashi, 2013). This limitation can be overcome by employing other research methods. The main advantage of key informant interviews is that the data provided is reliable and often cannot be collected by any other means. Key informants give in-depth accounts on the subject of inquiry and also provide good input where recommendations are needed.

1.14. Field case study

A case study was also chosen to supplement the data collected. The Ndumo Gezisa 22/132kV, a line under construction at the time of the study, was used as a case study to identify the impacts of the construction of power lines of different voltages in the same locality. The case also revealed the effectiveness of an EIA and how EIAs are a useful tool in minimising and managing negative environmental impacts. The purpose of selecting a case study is so that the subject can be studied in order to ensure that all the elements of the study are adequately covered. A case study approach allows the researcher an in depth analysis of the subject matter at hand (Mills et al., 2010).

The subject of the case study was a sub-transmission (88-132 kV) project and a reticulation / electrification (11-22 kV) project in the same environment. The project chosen for the study is the Ndumo Gezisa 132kV Multi-Circuit Power Line Project which will be compared with the 11-22 kV line in the same environment.

The project Ndumo Gezisa was selected for various reasons; namely that it is a high priority project, covers a large area, has political importance and falls in a sensitive environment. The sampling method used was convenience purposive sampling which is a type of non-probability sampling. This is where the probability of the selection of a subject is unknown (Acharya et al., 2013). The sampling strategies presented above were first explained in-detail in a study by Patton (2002). The subject was chosen based on predetermined criteria which narrowed down the projects which met the requirements at the time of the study. The following criteria were designed in order to ensure that the chosen site for the study could provide the desired field data. Thematic maps of KwaZulu Natal and Umkhanyakude Municipality were created to depict various environmental conditions and also to demonstrate how GIS can be used as a tool when impacts are being evaluated and planes for.

Table 1:1 Site Selection Criteria

CRITERIA	**REASON**
Project must have undergone a Basic Assessment or an Environmental Impact Assessment	Basic Assessment Reports provide an existing record of the environmental impacts which were anticipated prior to the construction work and a record of mitigation measures taken. Furthermore, projects that undergo the basic assessment process are assigned an Environmental Control Officer (ECO) whose audit reports have records of public complaints; pollution incidents and other records of non-compliances. These reports give an indication of the issues encountered during construction and the compliance level to Environmental Authorisations and the project EMPr.
The 132kV line must be in close proximity to the reticulation line	It was an essential requirement that the sub-transmission line chosen for the study was in close proximity with the reticulation line which was the subject of comparison. This was to increase the credibility of the observations made because the 2 power lines and associated infrastructure affected a similar environment.
	The case study focused on a line that was under

Line must be in construction phase or newly built	construction in order to evaluate construction impacts. This also allowed the researcher to audit the compliance against EMPr and Environmental Authorization issued where required.

1.15. Data collection methods

1.15.1. Record and Document Review

Table 1.2 below lists the types of records and documents which were collected for review for the study. For impacts on indigenous and protected vegetation, tree cutting licenses were collected. For bird incidents, the Endangered Wildlife Trust database for the past five years was reviewed as well as the legal contraventions in the OU for the last 5 years. These documents and records gave an account of all the recorded environmental impacts and incidents which have occurred on each project from the construction phase to the operational phase.

Table 1:2: Documents and Records for review

LIST OF DOCUMENTS AND RECORDS REVIEWED	PURPOSE OR TYPE OF INFORMATION TO BE DERIVED
Tree cutting licences or permits	Tree cutting licences and permits are issued under the National Forest Act 84 of 1998 and the Nature Conservation Ordinance 15 of 1974 respectively. The presence of these for any of the projects will show that that particular project had an impact on indigenous and protected plants. Licences and permits further indicated environmental sensitivities which may be highlighted in the license conditions.
Endangered Wildlife Trust (EWT) reports	Eskom has a partnership with the EWT. The purpose of the partnership is for the EWT to advise on, and investigate wildlife interaction incidents which involve any Red Data Species. EWT also plays a proactive role in advising Eskom on wildlife risks during the planning phase. Incident records for the last 5 years were studied to determine if there is a difference in the wildlife incidents when reticulation power lines are compared to sub-transmission power lines. The aim of this exercise was to determine whether sub-transmission power lines had more occurrences of wildlife interactions than electrification power lines.
Environmental legal contraventions (ELC)	The Eskom Environmental, Occupational Health and Safety Incident Management Procedure (2015), defines an ELC as an incident where a provision of environmental legislation or condition of an approval (e.g. environmental authorisation, waste license, water use licence) or any other legal document issued in terms of environmental legislation is contravened.

1.15.2. Key Informant Surveys and Interviews

Key informant surveys were conducted with various stakeholders to obtain their expert opinion on the differences (if any) in the environmental impacts of electrification projects versus sub-transmission projects. Their responses and inputs were informed by professional experiences having interacted with both sub-transmission and electrification projects for a long time at Eskom. Obtaining information from the stakeholders was useful for the development of possible process recommendations on how electrification projects should be approached because their recommendations stemmed from experience. The interviews also provided the researcher with an opportunity to collaborate inputs from the different stakeholders to formulate an all-encompassing management plan for electrification in the OU. Data was collected by means of survey questionnaires sent via email and where necessary follow up telephonic calls and face-to-face interviews were arranged with some of the respondents. The interviews were open-ended while the survey was designed to be uniform in order to facilitate a process which could be easily measured and compared. The questions were slightly altered in some cases to accommodate the specific discipline of the respondent.

1.15.3. Field data collection

The following factors were evaluated through site visits and document reviews in order to measure the impacts of each line. The criteria used for the evaluation was adopted from the methods used by Marc, et al., (1998) to measure the environmental impacts of World Bank funded projects namely:

1. Compliance to legislation and other legal requirements: this was evaluated through auditing the project against its environmental authorization, vegetation management licenses and its environmental management programme. Past monitoring and audit reports also gave a history of non-compliances which would have been documented by the independent Environmental Control Officer (ECO).
2. Pollution
    - Evaluation of waste management practices on projects
    - Evaluation of spillages of substances such as oil
3. Evaluation of the affected natural environment
    - Impact on indigenous vegetation (tree cutting, trimming and relocation)
    - Impact on wildlife (impact of direct contact with power lines for instance bird and animal collision with distribution power lines)
4. Measures to conserve the environment
    - Evaluation of mitigation measures enlisted in the project EMP

1.16. Summary of chapters

Chapter 1 covers the general information needed to provide an overview of the key elements of the study. This includes the background of the study, the problem statement, the research objectives, research questions, sampling methods, data collection methods and a description of the hypotheses to be tested by the study. This chapter gives an overview of access to electricity, globally, regionally and also in South Africa. This chapter shows that electrification is set to continue, not just in South Africa but across many developing nations. The chapter shows the need for measures to be developed to ensure that the environmental impacts are investigated and effectively managed.

Chapter 2 covers the literature which was consulted in relation to the study at hand. The literature describes current data available in terms of environmental impacts associated with power lines where the prevalence of certain environmental impacts is also supported through the literature from different parts of the world. From the literature reviewed, the main environmental impacts of powerlines are habitat destruction and fragmentation, loss of birds through collisions and electrocutions, impacts on wetlands and pollution from oil and diesel spillages. The studies which are prevalent in literature are however focused on transmission lines of high voltages. There is therefore a gap in literature on the impacts of lower voltage lines and how these can be managed considering the amount of electrification which is still to happen.

Chapter 3 covers the research methodology and the research design employed by the study. The chapter describes in detail the type of tools that were used to attain data and also support the reason for choosing the described tools. A mix of methodologies were used to collect data. These include key informant surveys and interviews, review of documents and records related to environmental impacts recorded by the power utility Eskom. Geographic Information Systems were also used to develop thematic map to show the receiving environment where electrification is most concentrated. The data collected allowed for the distinction to be made between impacts emanating from low voltage electrification lines and those emanating from sub-transmission infrastructure.

Chapter 4 is the presentation of findings and analysis chapter which deals with the organisation and interpretation of the data collected. The data was collected through key informant interviews, questionnaires, site visits, review of records and documents which include vegetation permits and licenses, environmental monitoring reports, environmental authorisations, environmental screening documents and bird incident reports. The data is presented in the form of charts and graphs to depict the impacts of electrification and the perspectives of key informants around its environmental impacts. Thematic maps were also produced to give a representation of KwaZulu-Natal and Umkhanyakude Municipality which is where most of the electrification activities are concerntrated.

The maps are a tool which is available to Eskom which can be used for better planning and impact minimization and mitigation.

Chapter 5 is the chapter that gives the recommendations and conclusions having analysed the findings. This chapter includes recommended approaches which can be used by Eskom to produce better quality screening results and therefore better management plans for electrification projects. Such tools can also enable environmental specialists, Eskom and the Department of Energy to collaborate in advancing the electrification programme while also ensuring due diligence in terms of Environmental Management.

1.17. Conclusion

Universal access to electricity remains a target for South Africa to attain. There is no doubt that access to electricity is essential to the socioeconomic growth of the country and also the improvement of livelihoods. Eskom is tasked with electricity delivery and the distribution division is the final leg to get electricity into homes and other small power users. Electrification is the vehicle that facilitates this through the use of substations and low to medium voltage power lines. There are various environmental impacts associated with the construction and operation of distribution infrastructure. Legislated processes such as Environmental Impact Assessments (EIA) or Basic Assessments (BA) provide a tool that facilitates the documentation and management of impacts. EIAs and BAs are however only required for high voltage lines (66kV and above), which leaves environmental impacts of electrification sparsely investigated and documented. The study aim is to investigate the impacts of electrification by looking at records of impacts on indigenous and protected vegetation, records of bird collisions and electrocutions and also conducting key informant interviews and surveys. From this introduction it can be seen that there is a need to evaluate the impacts of electrification in order for appropriate recommendations to be made in the management of the environmental impacts resulting from electrification activities

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Africa, being one of the less economically developed continents, still has a large proportion of its population having no access to electricity. In 2014, the Africa Energy Outlook Report stated that Sub-Saharan Africa has more than 620 million people living without access to electricity. Furthermore, the number of people living without electricity is said to be increasing in most African countries due to rapid population growth which diminishes the reach of some positive efforts (in terms of service delivery) (International Energy Agency; 2014). At the same time, it is important to note that the provision of electricity to Africans has been successful, having electrified over 145 million people since 2000 (International Energy Agency; 2014).

Figure 2.1 below indicates the state of access to electricity in the African continent. As observed in millions of people in the continent still remain without access to electricity, with 13 countries mostly in central Africa having a percentage of more than 75% of the population not connected to the electricity grid (www.south-energy.com) This implies that in the future Africa will undergo vigorous electrification programmes which will have environmental impacts.

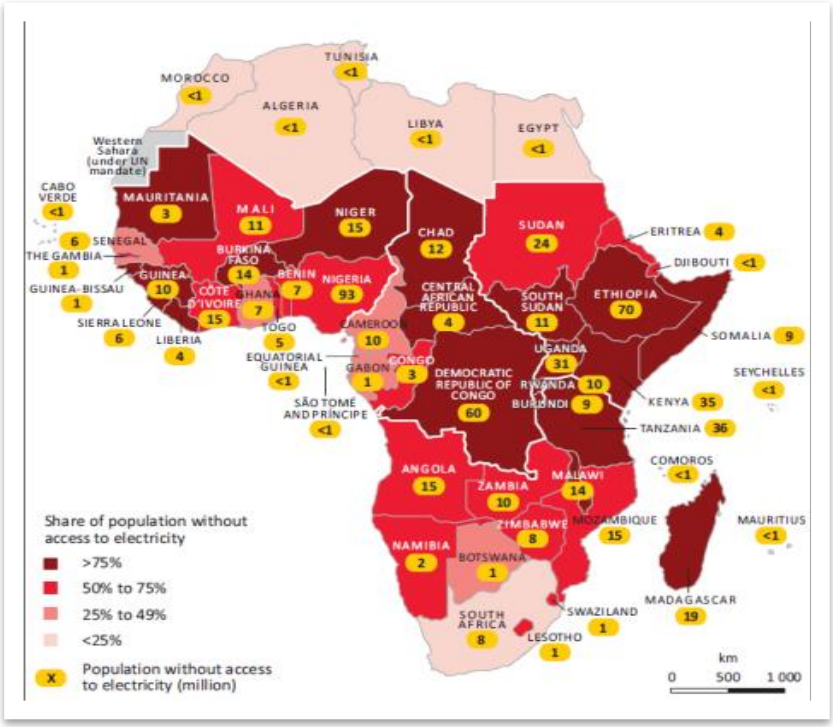


Figure 2.1: Number of people without access to electricity by country in Africa
Source: http://www.south-energy.com/, 2014

In the case of South Africa, the percentage of households connected to the electricity grid has increased steadily from 77% in 2002 to 85.5% in 2015. Similarly, the percentage of houses using electricity for cooking also increased from 58% in 2002 to 78% in 2015 (Statistics South Africa, 2015). Although progress is evident, there is a steady growth in the number of households that have access to electricity and as of 2012 1.45 million households were still not connected to the electricity grid.

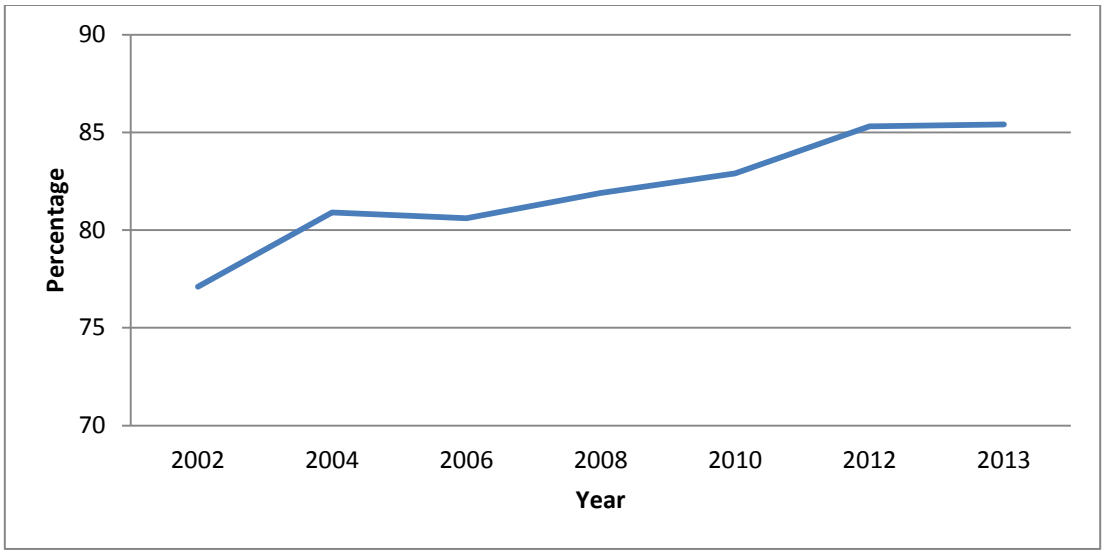
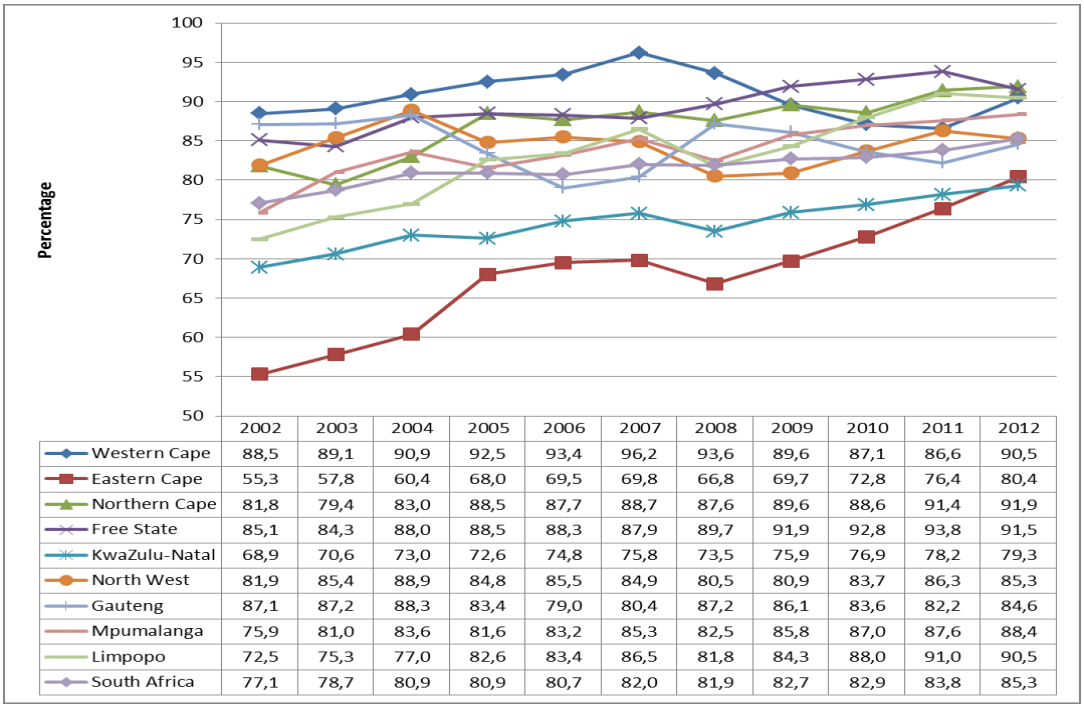


Figure 2.2: Access to electricity

Source: StatsSA, 2013

Access to electricity varies in the nine provinces, as it also varies between urban and rural areas. KwaZulu- Natal has the highest percentage (16.6%) of households with no access to electricity Most of the population without access to electricity comprises of previously disadvantaged groups who had no access to services (Statistics SA, 2012).



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Western Cape	88,5	89,1	90,9	92,5	93,4	96,2	93,6	89,6	87,1	86,6	90,5
Eastern Cape	55,3	57,8	60,4	68,0	69,5	69,8	66,8	69,7	72,8	76,4	80,4
Northern Cape	81,8	79,4	83,0	88,5	87,7	88,7	87,6	89,6	88,6	91,4	91,9
Free State	85,1	84,3	88,0	88,5	88,3	87,9	89,7	91,9	92,8	93,8	91,5
KwaZulu-Natal	68,9	70,6	73,0	72,6	74,8	75,8	73,5	75,9	76,9	78,2	79,3
North West	81,9	85,4	88,9	84,8	85,5	84,9	80,5	80,9	83,7	86,3	85,3
Gauteng	87,1	87,2	88,3	83,4	79,0	80,4	87,2	86,1	83,6	82,2	84,6
Mpumalanga	75,9	81,0	83,6	81,6	83,2	85,3	82,5	85,8	87,0	87,6	88,4
Limpopo	72,5	75,3	77,0	82,6	83,4	86,5	81,8	84,3	88,0	91,0	90,5
South Africa	77,1	78,7	80,9	80,9	80,7	82,0	81,9	82,7	82,9	83,8	85,3

Figure 2.3: Electricity access by province

Source: StatsSA, 2013

2.2. Electricity Distribution

The nature of electricity distribution activities is like that of linear construction developments, which require amongst other things, the clearing of vegetation and the use of natural resources such as energy and water. The impacts which may result from the construction of power lines include: pollution of land and water, habitat fragmentation and destruction, loss of biodiversity and the production of waste. Impacts that may be unique to the operational phase of a power line include: oil spillages from damaged transformers, collisions of birds and other wildlife with power lines, electrocution of wildlife and wildfires caused by electrical flashovers (Vosloo, 2004).

South Africa, like many developing countries faces a dual commitment of development and environmental integrity. Adverse environmental impacts often cannot be avoided when economic development is pursued (Naser et al., 2008). The role of electricity in the development of a country's economy cannot be denied. Electricity essentially powers a country's economic growth. It is not enough that electricity generation power plants be built and maintained. Transmission and distribution power lines are also equally important in getting the electricity to industry and residences. The KwaZulu- Natal Operating Unit (KZN OU) Impacts and Aspects Register in accordance to ISO 14001:2004 lists the following to be the potential impacts of the construction and the operation and maintenance of power lines. The impacts and aspects are divided according to departments in relation to the activities they perform, which have an impact on the environment.

Table 2:1 KZN OU impacts and aspect register (Eskom, 2015)

ACTIVITY	ASPECTS	IMPACTS
Asset creation (AC) and Operations and Maintenance (O&M)	Design, survey, construction, operations and maintenance of power lines and substations	Loss of biodiversity (injury or death of birds and animals from collision or electrocution hazards)
AC/O&M	Design, survey, construction, operations and maintenance of power lines and substations	Community/landowner concerns
AC/O&M	Design, survey, construction, operations and maintenance of power lines and substations	Loss of biodiversity (trimming or cutting indigenous and protected trees and plants)
AC (LD)	Environmental Assessments	Land, air, water contamination or biodiversity (tree and animals) loss
AC (PE)	Construction of power lines and substations	Land, air, water contamination or biodiversity (tree and animals) loss
AC/O&M	Design, survey, construction, operations and maintenance of power lines and substations	Land Degradation / Erosion
AC/O&M	Waste disposal from construction, operations and maintenance of power lines and substations	Pollution of land, air and water

AC/O&M	Design, survey, construction, operations and maintenance of power lines and substations	Damage/disturbance of heritage resources (graves, fossils, etc.)
SHEQ	EMS/ISO14001 Management System	Land, air, water contamination or biodiversity (tree and animals) loss
CONTRACTORS	Design, survey, construction, operations and maintenance of power lines and substations	Land, air, water contamination or biodiversity (tree and animals) loss

Key

AC -Asset Creation: Overarching department responsible for the construction and acquisition of assets. This department includes other major departments such as Land Development, Survey, Geographic Information Systems and Programme Management. Electrification and reticulation fall under Programme Management.

O&M –Operations and Maintenance is also an overarching department responsible for the maintenance of existing infrastructure and the maintenance of the quality of supply. O&M consists of mainly Power Plant Maintenance, responsible for monitoring line and substation performance and Field Services which conduct line patrols, respond to faults on the power lines and monitor the power lines for incidents.

LD –Land Development falls under AC and carries much of the preconstruction responsibility for projects. This department is responsible for the impact assessment of proposed projects, land or servitude acquisition, survey of proposed areas of development. The departments under LD are Land and Rights, Geographic Information Systems (GIS) and Environmental Management.

PE –Project execution is responsible for managing the actual work on the ground. This is done through construction contractors or internal construction teams. Project Execution falls under Programme Management and is divided into sub-transmission projects (88kV – 132kV), Reticulation projects (11kV – 66kV) and Electrification which comprise of house connections to the electricity grid.

SHEQ (Safety Health Environment and Quality) - this department is the governance department which is mainly based on the international standards for each section. The Environmental Management section in this department is responsible for the implementation and the maintenance of the ISO 14001 requirements and other legal requirements (Distribution Operating Model Transition Programme, 2012).

As it can be seen from the impacts and aspects register many adverse impacts can be anticipated from the construction and the operation and maintenance of power lines and this requires regulation, impact assessment studies and management plans to be in place in order to mitigate and minimize environmental impacts.

The National Environmental Management Act (NEMA) 107 of 1998 is the overarching statute which governs environmental management in South Africa. As described in the NEMA, 'the purpose of the Act is to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment'. Section 24 of the Constitution of the Republic of South Africa states that: "Everyone has the right—

(a) to an environment that is not harmful to their health or wellbeing; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

NEMA is the national Act which gives effect to this right. NEMA also addresses national commitments such as Sustainable Development and also recognizes inequality and poverty along with the state of the environment resulting from environmentally harmful practices (NEMA; 1998).

Section 153 of the Constitution states that

"A municipality must—

(a) structure and manage its administration and budgeting and planning processes to give priority to the basic needs of the community, and to promote the social and economic development of the community; and

(b) participate in national and provincial development programmes".

The constitution overall demonstrates commitment to development but at the same time commits to an environment that is not harmful to health or wellbeing; and one that is protected from harm and degradation. This implies that South Africa must pursue development but also ensure environmental sustainability. In this context, electrification forms part of the development programme mandated to municipalities, but it must be done sustainably in line with national legal obligations. In 2010, the first regulations for NEMA were published as per section 44 of the Act. The purpose of regulations was to regulate or give direction and clarity on the criteria to be used for managing different activities under the Act (GN R544, 2010).

In the case of electricity distribution, the following activities are regulated; either requiring a basic assessment (BA) or a full scoping and environmental impact assessment (S&EIA) study to be conducted:

GN R544 Activity

10. The construction of facilities or infrastructure for the transmission and distribution of electricity

(i) outside urban areas or industrial complexes with a capacity of more 33 but less than 275kV;

(ii) inside urban areas or industrial complexes with a capacity of 275kV or more.

11. The construction of

(ix) a power line structure which covers an area of 50m² or more where such a structure will be placed within a watercourse or within 32 metres measured from the edge of a watercourse.

27 (ii) The decommissioning of existing facilities or infrastructure for electricity transmission and distribution with a threshold of more than 132kV

38 The expansion of facilities for the transmission and distribution of electricity where the expanded capacity will exceed 275kV and the development footprint will increase.

GN R 546 (2010) Activity 12

The clearance of an area of 300 square meters or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation;

(a) Within any critically endangered or endangered ecosystem listed in terms of section 52 of NEMBA or prior to the publication of such a list, within an area that has been identified as a critically endangered in the National Spatial Biodiversity Assessment 2004

(b) Within critical biodiversity areas identified in bioregional plans

(c) Within the littoral active zone or 100 meters inland from high water mark of the sea or an estuary, whichever distance is greater, excluding where such removal will occur behind the development setback line on erven in urban areas.

2.3. Environmental impact assessments

Environmental Impact Assessments (EIA's) were first seen in the USA. The practice grew more significantly under the National Environmental Policy Act of 1970 where Environmental Impact Statements were required for major projects (Turner, 2008). Glasson et al., (2013:22) defined environmental assessments *as "a technique and a process by which information about the environmental effects of a project is collected, both by the developer and from other sources, and taken into account by the planning authority in forming their judgements on whether the development should go ahead".* In South Africa; Environmental Impact Assessment (EIA) regulations were first promulgated in 1997 to give effect to the Environment Conservation Act 73 of 1989; before the regulations were effective, environmental impact assessments were voluntary practices and were not regulated by law (Duthie, 2001).

EIA's exist for the main purpose of protecting the environment and ensuring that as developments occur, there is a consideration for maintaining the integrity and productivity of natural systems (Naser et al., 2008). The purpose of an EIA report is to explicitly describe the nature and extent of the proposed development and associated potential impacts to the relevant decision-makers and stakeholders. When an EIA study is conducted its purpose is to identify the effects of a proposed project. Effects may be categorized as immediate or long term, positive or adverse, cumulative or non-cumulative, direct or indirect. The EIA report also presents alternatives to the developer and decision maker where alternate sites or technologies are presented with their associated potential impacts. Another component of an EIA study is public consultation, where stakeholders are involved so that their views are considered in the decision making (Li, 2008).

2.4. The electrification drive

From the year 2015, the KwaZulu- Natal Operating Unit (KZN OU) was on an electrification drive with a target of 81 000 connections to be made in the province (Eskom, 2016). The main targets for electrification are rural communities, schools and clinics; customers may however request connections for business or household purposes as individual entities for which they cover the costs. By February 2017, a total of 40 000 connections had been made of which 13000 were in the uMkhanyakude District of KwaZulu- Natal (KZN OU GM Communique, 2017). Electrifying; especially, rural areas is one of the priorities for South Africa, in a quest to improve the quality of life for rural dwellers. There is no doubt that electricity is a much-needed resource which also leads to the relief of pressure on environmental resources such as forests upon which rural communities depend, in the absence of other energy sources. The impacts of electrification however, need to be measured, evaluated and mitigated to minimize negative impacts, where possible.

2.5. Environmental Impacts of the distribution business

KwaZulu- Natal Operating Unit Distribution is an ISO 14001: (2015) certified organization. This implies that the business unit is aware of their environmental impacts and has a management plan in place to manage the impacts identified. Based on the organization's impacts and aspects register; the following environmental impacts are identified and significant impacts:

- Loss of biodiversity (injury or death of birds and animals from collision or electrocution hazards
- Community/landowner concerns and complaints
- Loss of biodiversity as a result of trimming and cutting of indigenous and protected trees and plants
- Land, air, water contamination
- Land Degradation and soil erosion
- Pollution of land, air and water
- Damage/disturbance of heritage resources (graves, fossils, etc.).

For the purpose of this research, focus is on the electrification impacts on birds (wildlife interactions) and on indigenous and protected trees.

2.6. Distribution power lines and wildlife interactions

Wildlife interactions are common with distribution power lines. Animals and birds interact with power lines in various ways and the risks they are exposed to also vary. Eskom infrastructure impacts on wildlife through electrocutions, collisions and habitat disruption. Wildlife can also have negative

impacts on Eskom infrastructure by causing electrical faults and damage to infrastructure through activities such as nesting on powerlines and streaming. Some birds and insects also damage wooden poles (Bevanger, 1993; Martin, 2011). It is therefore in the interest of power utilities to prevent and reduce bird mortalities for power line performance improvement and in the interest of biodiversity conservation (Sundararajan and Gorur, 2005; Jenkins et al., 2010).

Bird collisions and electrocutions have financial implications for power utilities. For instance, they affect the quality of supply and network performance by increasing the frequency of network outages and faults (Institute of Electrical and Electronics Engineers, 2010). They also expose the utility to reputational damage, legal liability and financial costs, which result from costs associated with restoration of supply, equipment failure, equipment replacement, financial claims for resultant fires and loss of sales during supply loss (Bevanger, 1993; Shunmugam, 2017). Bird and power line interactions are regarded as a significant impact of the distribution division operations (Kruger and Koos, 2017).

Bird electrocutions are particularly limited to power lines of voltages below 275kV and transformers in substations (McCann, 2005). Birds are affected by power lines either through collisions or electrocutions. Collision and electrocution of birds on power lines are the most common unnatural causes of bird mortality within small populations and limited distributions (Shaw et al., 2010). Collisions are usually characterized by carcasses under the span of the power line while electrocutions are usually below the structures (Costantini et al., 2016). Bird collisions occur when birds accidentally fly into power lines due to various factors such as poor visibility, technical aspects, weather conditions, topography, flight behaviour and other biological characteristics of the bird itself (Bevanger, 1994; Shaw et al., 2010). Collisions result in injury to the bird or death. Bird collisions are common among large birds and smaller fast flying birds. Examples include cranes, bustards, flamingos, waterfowl, shorebirds, gamebirds and falcons (Jenkins, 2010).

Bird electrocutions are also regarded as a major threat to birdlife in South Africa and the world at large. By definition bird electrocutions occur when a bird comes into contact with live electricity apparatus and is fatally wounded or "when birds die due to them bridging the phase-phase or phase-earth clearances" (Shunmugam, 2017). Electrocuted birds are mainly found under the pole structures because that is where they perch mostly. Bevanger (1994), states that the main factors which should be investigated in order to understand bird electrocutions are body size of the affected birds, the characteristics of the electrical installation itself, and the relationship between the two.

Bird species that are most prone to electrocution in South Africa include species of vultures and eagles (Boshoff, 2011). Bird electrocutions occur when a bird bridges the gap between two phase conductors or a single conductor and earth wire. This therefore limits bird electrocution incidents to

distribution power lines below 88kV, which have smaller insulation clearances (Vosloo, 2004; Bevanger, 2005). In this case the theory of lower voltage power lines having less environmental impacts is not true as bird electrocutions occur mainly on distribution reticulation and electrification power lines.

2.7. Loss of biodiversity through vegetation cutting

For power lines to operate safely and without interruption of supply, the clearance under the power line must be maintained at acceptable thresholds. The thresholds are prescribed by the Electrical Machinery Regulations (2011), based on section 44 of the Occupational Health and Safety Act of 1993. Section 19 of the regulations specifically deals with power lines and states that; *"The supplier or user of power lines shall control vegetation in order to prevent it from encroaching on the minimum safety clearance of the power lines and the owner of the vegetation shall permit such control".* Apart from maintenance purposes vegetation is also cleared during the construction phase to allow for vehicle and machinery access. This means that access roads are created so that Eskom has access to towers lines and substations for construction purposes and thereafter for the maintenance of the infrastructure (Eskom Environmental Liaison Committee, 2007).

There are two authorities who govern the vegetation in KwaZulu- Natal, these are the Department of Forestry and Fisheries and the provincial Authority Ezemvelo Wildlife. Eskom employs the services of vegetation management contractors who are responsible for vegetation license and permit applications and the cutting and trimming of vegetation under the power lines or for access. Eskom also has a panel of Botanists who are responsible for tree identification, license and application applications, license induction and compliance monitoring. While vegetation management contractors are responsible for license applications for maintenance of vegetation under existing power lines; Eskom internal staff is responsible for license acquisition for new projects. The following table shows the servitude requirements in terms of width in relation to power line voltage.

Table 2:2: Servitude requirements (Eskom, 2007)

Maximum voltage	Servitude building restriction widths (measures from the centre line of the power line)
11kV	9m to 11m
22kV	11m
88kV	11m
132 kV	15,5 m
275 kV	22m to 23,5 m
400 kV	23,5m to 27,5m
765 kV (d.c.)	40m
533 kV	15m

When looking at the distribution power lines, the 11kV and 22kV (low voltage), have the same servitude width requirements as the 88kV which is a sub-transmission line with a requirement for a basic assessment (Eskom, 2007). The servitude width requirement for a 132kV power line is 15.5m; this is slightly higher than that of the lower voltage lines (Eskom, 2007). This table shows that while there is more clearance required for the higher voltage line there difference is not major where distribution lines (11kV – 132 kV) are concerned.

Vegetation maintenance contributes to habitat loss and habitat fragmentation through the construction of new power lines which require the clearing of vegetation for vehicle access for construction and maintenance purposes (Boshoff, 2011; Powell and Lindquist, 2011). Apart from the access requirement, vegetation is also trimmed or cut to maintain safe operation of the electrical infrastructure (Eldegard et al., 2015). Vegetation clearing by power utilities contributes to biodiversity loss and habitat fragmentation, which is the creation of an artificial edge between two habitats (Lindenmayer and Fischer, 2006). This is not a widely researched area and although impacts of forest fragmentation are known the local impacts of abiotic factors on the forest edge have not been fully investigated (Powell and Lindquist, 2011). South Africa has a total of 47 protected trees protected under the National Forestry Act 84 of 1998. KwaZulu- Natal hosts at least 27 of these species in varying distribution and abundance. Some of these trees occur in northern KwaZulu-Natal where the bulk of electrification projects are taking place. Figure 2.4 below shows the distribution of KZN forests.

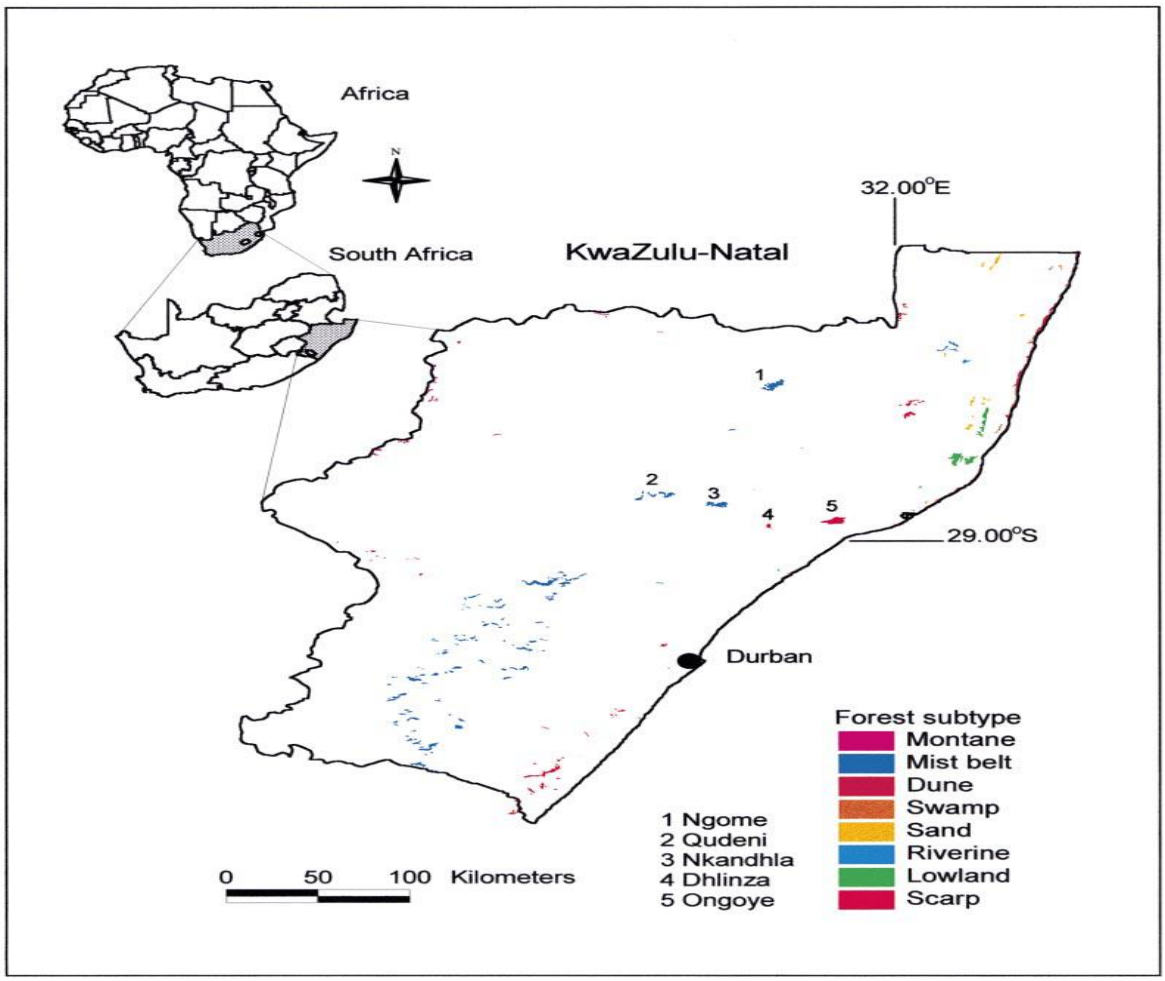


Figure 2.4: The distribution of indigenous forest (50 ha or more) in the KwaZulu- Natal province

Source: Eeley et al., 1999

The KwaZulu- Natal Province is a biodiversity rich region comprising of three biomes the coastal Indian Ocean Belt; the Savanna Biome and the Grassland Biome (Huntley, 1984). KwaZulu- Natal also hosts the Maputoland-Pondoland-Albany hotspot which is listed as one of the world's biodiversity hotspots (Department of Agriculture, Environmental Affairs and Rural Development DAEARD, 2010). Part of the Ndumo Gezisa project falls within the Maputoland region and affects the sand forest which is of biodiversity importance. Figure 2.5 below shows the bioregions of KZN. The project area which is in the north of KZN is dominated by the Indian Ocean Coastal Belt and the sub E Escarpment Savanna vegetation. The Savanna bioregion is unique to the northern parts of KZN. There are many pressures on indigenous vegetation resulting from different types of environmental and anthropogenic factors, these include; unplanned urban development, habitat fragmentation, expansion of farming land and practices, unplanned development of rural settlements, large infrastructure development, infestation by alien invasive plants, improperly managed fires and the construction of new major roads (Russell and Ward 2015; SANBI, 2013).

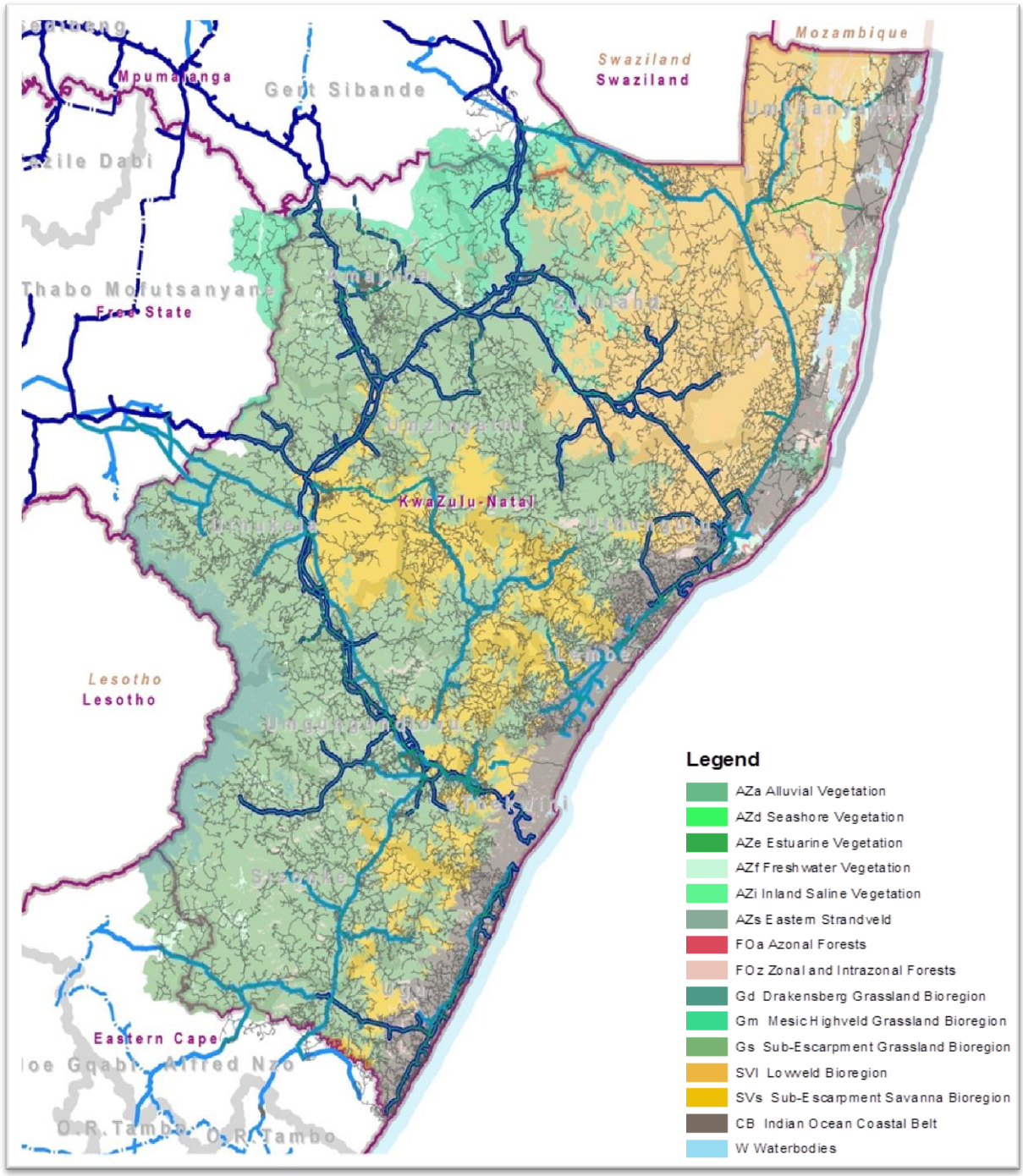


Figure 2.5: KZN Bioregions

2.8. Conclusion

The literature reviewed in this chapter shows that environmental impacts of distribution powerlines are known and there are some studies (Vosloo, 2004) which have been conducted to determine the impacts of electricity distribution infrastructure. The literature also included a significant amount of procedures and policies drawn up by the power utility Eskom. Eskom, in its aspects and impacts register, ranks bird mortality on powerlines and the trimming and cutting of indigenous vegetation as significant impacts (Eskom, 2015). These impacts are a result of construction and operation of electricity distribution powerlines and associated infrastructure. Literature shows that bird collisions and electrocutions are most common on lower voltage lines; these lines are however not subjected to a BA or EIA process under SA legislation (Bevanger, 1993; Boshoff et al., 2011; Kruger and Koos, 2017). The studies which have been conducted have largely been on transmission powerlines and more literature exists for this category of lines since scientific studies are conducted during the BA and EIA phases. There exists a gap in the quantification and evaluation of the impacts of low and medium voltage lines which this study seeks to address to some degree. The next chapter (chapter 3) describes the methodology used to collect and interpret data in order to reach the findings presented in chapter 4.

CHAPTER 3: METHODOLOGY

3.1. Introduction

Research methodology describes the manner in which data is collected in order to meet the specified research objectives. The types of methods chosen have to be compatible with the desired research outcomes; in complexity and application (Leedy, 1997). Methods that a researcher can use can either be quantitative or qualitative or otherwise a combination of both may be used. As Borrego et al., (2009) state; there is no method of research superior than the other but rather a researcher should choose suitable methods as guided by the research question. Other factors which a researcher has to consider when selecting the research methods include; ability to test hypothesis, feasibility in terms of resource availability, ethical risk, and whether the methods are readily applicable by the researcher (Brewerton and Millward, 2011).

For the purpose of this research both quantitative and qualitative research methods were used. Qualitative research included the key informant interviews and the field observation at the Ndumo Gezisa site. Quantitative methods were survey and the coding of the data collected, and the quantification of the data from the documents which were reviewed. The aim for using different methods was to strengthen the validity of the outcomes. When different methods are applied and they yield a similar outcome it gives more confidence of the research findings. Clissett, (2008) describes qualitative research as an approach used where the intention is to explain certain behaviour or gain the perception of people on the subject being investigated. The data collected can be used to explain the reasons behind prevalent actions or phenomena (Rosenthal, 2016). In the case of this study the understanding and perception of the key informants was investigated through the use of a survey.. In some instances the key informants were also interviewed where the researcher needed further clarification on the responses provided. The aim of this exercise was to gain an understanding of what experts in the subject matter thought about the legal obligations which exist for high voltage projects as opposed to the lack thereof for electrification projects. The structured questionnaires were designed in such a way that some sections were quantifiable while others were left open ended to facilitate a more in-depth discussion. The disadvantage of using qualitative methods is that it is difficult to summarize the data and also that some things may be lost in translation if care is not taken to engage the respondents further where the responses are vague.

Quantitative research methods provide a more prescribed and unbiased way of collecting data which is easily traceable and can be used to describe cause and effect relationships (Clissett, 2008). Quantitative data can be presented as charts and also depicted in thematic maps for easy interpretation.

3.2. Research methods

The overall research approach is a descriptive approach which provides a picture of the conditions on the ground. The purpose of the research is to collect data which describes the impacts of electrification by giving an in-depth account of expert views; a history of incidents and a general overview of the documented environmental impacts of electrification projects. Descriptive approaches are the most suitable to use when the research aim is to bring to light current conditions in the field in order to inform future practices and policy direction. Descriptive approaches also help to answer normative and correlative questions and are used mainly when the aim of the research is to quantify phenomenon by numbers, frequencies, time, cost, or other characteristics (Moustakas, 2011). The use of surveys in the study is a form of a quantitative method where inferences which represent the population may be drawn from the findings of the data collected from the sample (Creswell et al., 2014).

3.2.1. Record and document review

Document analysis is a process whereby existing documents are analysed in order to determine trends and patterns that could emerge from the data. Document analysis begins as the documents are selected for their usefulness or relevance for a particular research (Mills et al., 2010). The records analysed for the study were, past bird incident reports, tree licenses, vegetation permits, environmental authorisations and site audit reports.

Tree cutting licenses and permits were used to measure the extent to which construction and maintenance of distribution electrical infrastructure affect indigenous vegetation. Licenses and permits varied in the level of detail available for analysis, therefore general common themes which existed across the sample data were used to inform the overall findings. The data from each licence and permit analysed was organised in a Microsoft Excel spreadsheet to facilitate the interpretation process. The reference number of the license as issued by the relevant authority was used as the identifying detail on the spreadsheet; this ensured that there was no duplication in the data analysed as repetitions were picked up by the software. Where the duplicate licenses or permits were found to be renewal licences or permits; the latest licence or permit issued was used as the valid record. Other identifying details such as the area, name of the project, voltage of the line applied for and the issuing authority were recorded. The variance in the issuing authority gave an indication of the type of species which were affected. The number of trees or species was recorded together with the details of the type of species affected, where the information was available. Lastly, the conditions of the licenses were looked at to identify if any special conditions were listed on the licenses or permits. Special conditions could be a requirement to plant trees elsewhere to offset the environmental impacts or special requirements for stringing in densely vegetated areas.

The records for bird mortalities were collected for the period (2013-2017). The records were provided by the Endangered Wildlife Trust in the form of an excel spreadsheet which provided the following incident details: incident report number, date reported, locality, locality detail, tower or pole number, line name, type of line, species common name, number individuals and the cause of the mortality. The data was cleaned up to remove all the records which did not fall into the specified period of study; furthermore, where birds were recorded as unknown or unidentified these records were also removed from the sample. The data that were analyzed met the following criteria: incident was within the specified period of research and the line voltage of the line could be established. The line voltage was not specified for some of the records which made these records unusable since the research was focused on the voltage of the affected power lines. To determine the voltage for some of the recorded incidents, an internal GIS software (SpaceMan) was used to identify the voltage of the power lines. After all the data cleaning the following results for bird mortalities emerged:

3.2.2. **Thematic mapping**

The use of Geographic Information Systems (GIS) in environmental impact assessments is an existing practice. Gharehbaghi and Scott-Young (2018) describe GIS as a tool which can provide statistical analysis and information technology thus aiding for more accurate and useful data to be available for use in EIA decision making. The advantage of using GIS is that the data can be easily assimilated and cover a large study area without exhausting time and financial resources. GIS in environmental management can be used as a tool for presenting data and also for integrating data in a way that produces rich data that can aid the environmental impact assessment process (Bussink, 2003).

Thematic mapping is based on a 3-stage process: theme identification, theme interpretation and theme intervention (Ridley et al., 2017). Theme identification is where the researcher organizes data to discover and describe patterns; theme interpretation is where the process of deductive reasoning begins and the dominant themes and patterns in the data emerge. The third stage is the analysis stage where the focus shifts to comprehensiveness; simplification, observation and inference, and an idiographic approach (Cohen, 2011). The use of thematic maps assists in developing a data rich database which has information readily available for the planning of new projects (Denil, 2006).

A strategic assessment tool can be devised from this information, where areas of concern or sensitivity hotspots are easily identifiable from the maps. This will assist planners in pre-empting the need for alternatives, for licenses and give sufficient time for mitigation measures to be applied. This information may be useful for further studies and also inform offset projects in the future.

For the purpose of this study, different types of maps for the KZN province and UMkhanyakude District were produced in order to depict the status of distribution infrastructure and the types of environment in which the infrastructure occurs. The maps covered environmental features such water, protected areas, high risk areas for Red Data Species and the overview of biomes and bioregions in KwaZulu- Natal. The maps were used to compare the footprint of high voltage power lines against the footprint of medium and low voltage power lines in relation to the environmental features above. The maps also depict electrification polygons and households where those electrified can be seen and future electrification trends can be forecasted. The different overlay functions utilised give an indication of the current status and possible impacts but more importantly the maps can be used to inform future decision making where environmental issues are concerned. These maps are an example of a tool that can be used to inform future project planning and also integrated in future strategic environmental management assessments. The maps were created using the ArcGIS software together with the internal Eskom GIS software, SpaceMan.

3.2.3. **Key informant surveys**

Key informant surveys and interviews are widely used in research where experts and professionals are respondents on various issues; in order to inform research on current conditions and also provide professional opinions which can influence further research or solution guidelines. Key informant surveys and interviews are particularly useful when the research aim is to describe an occurrence, reasons why the phenomenon occurs and the effects of different events or occurrences (Borrego et. al, 2009).

A questionnare was designed and disseminated to a target group of key informants. The questionnaire consisted of a mixture of questions either structured to solicit a yes or no answers, rate severity or open-ended questions which required more detailed accounts from the key informants. This questionnaire design facilitated data coding and easy quantification of data (Brewerton and Millward, 2011). The research participants were contacted telephonically and briefed about the research and then the consent form was emailed to the participants together with the survey questionnaire for them to fill in. The questions focused on the impacts of electrification; how it affects the environment; why electrification projects do not undergo an intensive environmental impact assessment and what the environmental effects of this stance are. Initially the planned number of key informants was 22 and this included more than one person from each organisation or discipline listed below. Where more than one person consented then all participants were interviewed but in cases where no party was available to participate, they were excluded from the research. The sample adequately represented environmental personnel who have vast experience in order to knowledgably weigh in on the subject concerned. The parties who participated in the survey consisted of the following:

EWT – Eskom partnership representatives: a representative from the EWT partnership with Eskom, provided input based on experience with wildlife interaction incidents and Eskom power lines. This was done though the written survey and a telephonic interview.

Botanist on Eskom panel: Two botanists responsible for permit and licence acquisition and monitoring in the KZN OU participated in the survey questionnaire.

Eskom Environmental Manager (Environmental Management Systems): The manager in the OU's Environmental Management Systems section participated in the survey and was also available for further clarity on the responses provided.

Eskom Environmental Management Officers: 2 environmental management officers who work with both electrification and sub-transmission projects participated in the survey.

Department of Environmental Affairs Official: A representative of the Department of Environmental Affairs participated in the survey and was further interviewed telephonically. The interview with the DEA official focused on the legislation itself where the questions asked probed issued of thresholds for Environmental Authorizations and the process behind determining legislation. The purpose of the interview was to determine the factors which led to the exclusion of electrification projects from the BA and EIA process.

Department of Agriculture Forests and Fisheries Official: A DAFF Official in the KZN area participated in the survey and was further interviewed by means of a face to face open ended interview. The process ensured that ample information was collected and that the department was given opportunity to adequately cover all issues regarding the impact of distribution activities on indigenous and protected vegetation.

Some of the data collected could be summarized quantitatively as the survey questionnaires distributed were similar in nature and some responses easily quantifiable. The survey conducted, although performed on a small sample population; provided rich descriptive data which supported the research objectives. The key informants represented all the experts directly related to the environmental impacts being investigated. The only stakeholders not represented in the sample were the vegetation management contractors who were unwilling to participate in the study. When the questionnaire was returned some of the respondents were contacted via telephone for further questions or clarity.

3.2.4. **Key informant interviews**

In addition to the survey, the officials from DEA and EWT were both interviewed telephonically while the official from DAFF was interviewed face to face. The interviews each lasted about 30 minutes and constituted going through the responses submitted by the respondent and soliciting additional information where necessary. Key informant interviews are a form of descriptive qualitative data collection method. The interviews mainly consisted of open ended questions where respondents could provide details and elaborate on certain responses. Interviews are a useful method to use where the research involves other methods of data collection. This is because interviews are instrumental for probing other results and also gaining the in depth understanding of the subject being investigated. The advantage of interviews it gives the researcher an opportunity to prompt narrative data from the respondents and gain a greater depth of understanding (Alshenqeeti, 2014). The interviews conducted contributed to building a holistic picture of the perception of different industry stakeholders on the issue of electrification and the associated environmental impacts.

3.2.5. **Field data collection**

A third means of investigation was the case study of the Ndumo Gezisa Multi Circuit Power Line project which was in construction at the time of the study. Case studies can either be based on a single case or a collection of several cases (Yin, 2003; Scholz and Tietje, 2011). In this case, two cases were studied; one representing electrification/reticulation (11-22kV) and the other, a sub-transmission line. The aim of conducting a case study is so that the case can be studied thoroughly in order to ensure that all the elements of the study are adequately covered (Farquhar, 2012). The case study approach allowed the researcher to have an in depth analysis of the subject matter at hand (Mills et. al, 2010).

The study site falls in the KwaZulu- Natal province in the UMkhanyakude District Municipality; figure 1.3 shows the locality of the site. Ndumo Gezisa was chosen for various reasons; namely that is a high priority project, covers a large area, has political importance and falls within a sensitive environment (Zitholele Consulting, 2014). The reasons stated above are some of the sampling strategies identified by Patton (2002). Using the case study approach allows the researcher to investigate a problem within a real-life context and allows for solutions to be formulated for the existing project and projects of the same nature (Scholz and Tietje, 2011). Case study research can either be holistic or embedded, where holistic represents a qualitative descriptive method and the embedded allows for quantitative methods to be used (Scholz and Tietje, 2011). The study site presented a unique prototypical study whose conditions provide a diverse baseline from which an all encompassing guideline can be drawn. Data from the site was collected by means of a site visit, field observations and a review of the project BAR, environmental authorization, permits, licences, specialist reports and construction monitoring reports.

The project was in the construction phase during the time of the site visit. The approach used by the researcher for data collection is an auditing approach where the compliance of the project was checked against legal requirements. Data was also available from the site reports which gave evidence of the mitigation measures undertaken during construction; this included the trees cut per line; fitting of bird mitigation apparatus, public complaints received and number of environmental incidents reported on the project.

3.3. Study site

Figure 3.1: Map showing study site
Source: https://hluhluwegamereserve.com/hluhluwe-imfolozi-park/

3.4. Ethical Considerations

Ethical considerations were taken into account during the course of the research. Permission had to be requested from Eskom Holdings SOC. Ltd., KZN OU, prior to the commencement of any research activity. Permission to conduct the research was granted by Eskom and the ethical clearance was also granted by the University of Pretoria, in line with the university's guidelines. Ethical clearance was granted for the research under the reference number EC170625-134.

Ethical clearances are important in order to safeguard the data and information of the parties participating and affected by the research being conducted. Furthermore, researchers should be

upfront and transparent about issues such as confidentiality, purpose of the study and should also express that participation in the study is not compulsory (White, 2000). Ethical clearance also provides confidence to the participants that data provided will not be used maliciously or for any other purpose not related to the research (Gitlin and Czaja, 2016). All of these considerations were taken into account by the researcher and the respondents were made aware of all the expectations from them and the point of voluntary participation and confidentiality was emphasized. The request for participation form and the consent form were drawn up to meet the University's guidelines.

3.5. Conclusion

The methods used in the research proved to be successful in collecting meaningful data from the various subjects. The data collected was suitable for analysis and also suited for meeting the research objectives. The mix method approach used was good for conducting cross reference checks on the data provided. Ethics were also maintained in accordance to the clearances given to the researcher. The methods used capitalized on using existing data sources and using that information to describe the current field conditions and also prompt for recommendations going forward. This shows that there is potential for Eskom to used field data for everyday impact analysis and decision making. Chapter four below discusses the findings made from the research.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter covers the results and discussion based on the data collected. The discussion will cover; the impacts of power lines on birds and indigenous vegetation, results from key informant interviews and surveys, GIS mapping, and the findings from the Ndumo Gezisa field study. The results are presented in the form of charts and maps to facilitate easy interpretation of the results.

4.1. Impacts on indigenous vegetation

A licence is required for the cutting, pruning or disturbing indigenous trees in a natural forest; or protected trees according to the National Forest Act No. 84 of 1998. Additionally, a permit is required for cutting, pruning or disturbing specially protected species in KwaZulu- Natal under the Nature Conservation Ordinance No. 15 of 1974. Permits and licences for the past 5 years were collected from the Environmental Management Department; KZN OU contracted botanists and vegetation management contractors. The licences and permits included both sub-transmission and electrification projects in the KZN OU. A total of 200 out of 255 licences and permits collected were selected at random for analysis. The licences and permits issued for Ndumo Gezisa were also studied and the impact on vegetation was verified through a site visit and monitoring reports compiled by the Environmental Control Officer (ECO) for the site.

Vegetation is either affected by trimming, cutting or translocation. Ezemvelo Wildlife permits formed 14% of the permits and licenses analysed while the majority (84%) were licenses issued by DAFF. From the figure 4.1 below it is evident that indigenous and protected trees are more affected by power line activities than specially protected species under NCO 15 of 1974.

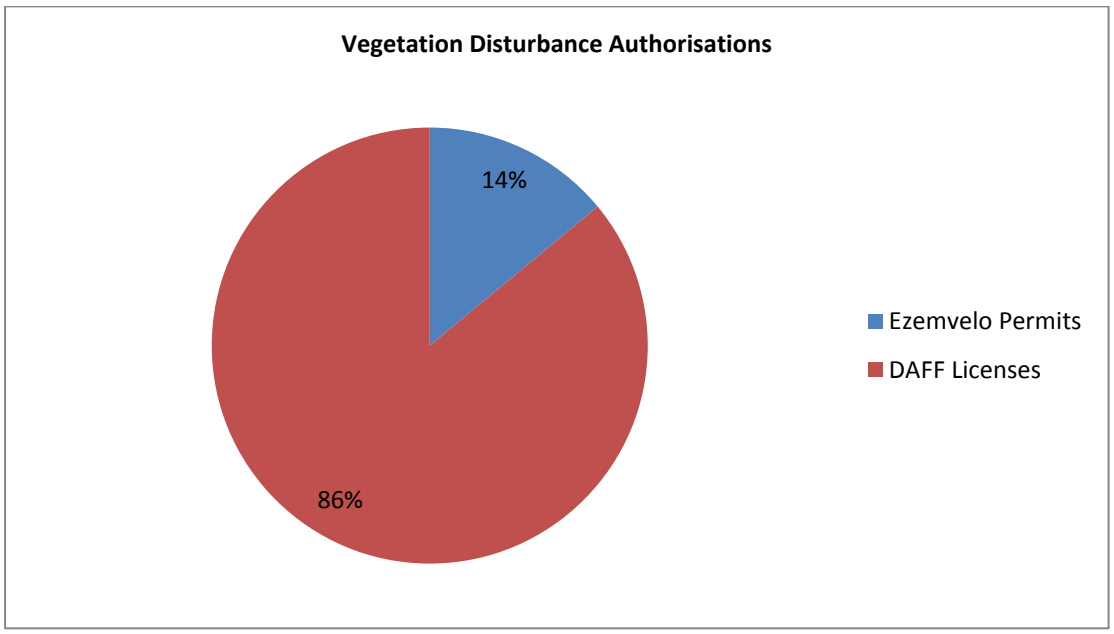


Figure 4.1: Vegetation disturbance authorisations

Figure 4.2 below depicts the type of work or project for which a license was issued. This information was available on the licenses and permits and where details were unclear the relevant stakeholders were contacted to verify the project type for which the license or permit was issued. Looking at figure 4.2, it is evident that electrification projects account for the majority (86%) of disturbance to indigenous vegetation in KZN OU projects. From the licenses analyzed only 5% were related to transmission or sub-transmission projects and these are the projects which would undergo a Basic Assessment or a full Scoping and EIA process. Maintenance, refurbishments and upgrading of existing power lines contributed 7% to the total volume, while the connection of street lights and the diversion of existing power lines constituted 1% each.

From this observation it can be concluded that majority of the impacts on vegetation come from the electrification activities. These projects are low voltage projects but collectively they have a large footprint in the province. It is however important to note that even though the sub-transmission projects are usually much lower in terms of frequency; in the 2013-2017 period, this was also compounded by budget constraints experienced in Eskom Distribution. Sub-transmission projects had to be put on hold in favor of electrification projects which are viewed as high priority.

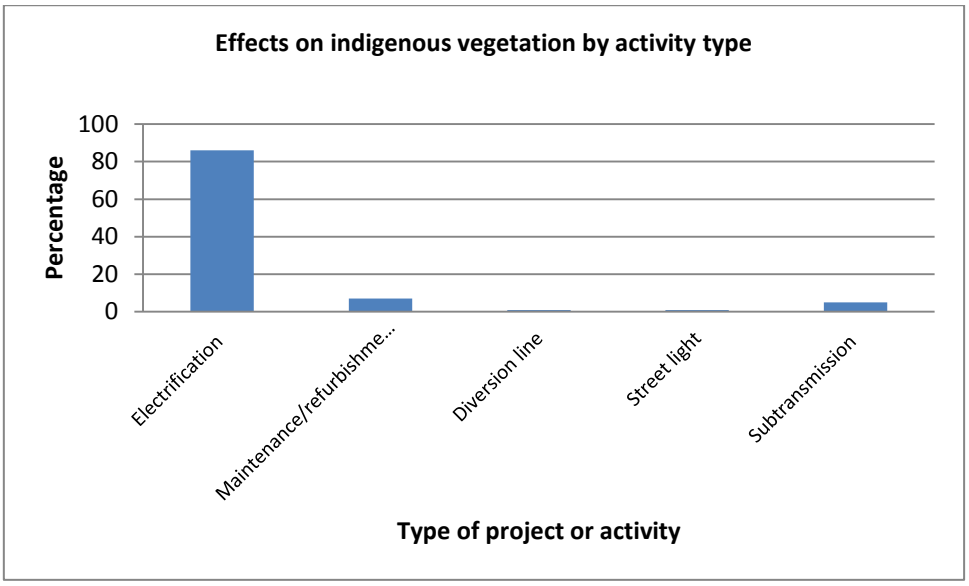


Figure 4.2: Effects on indigenous vegetation by project type

Figure 4.3 below shows the distribution of licenses across the different district municipalities in the province. UMkhanyakude District Municipality accounts for about 42% of all the licenses collected. This is where electrification is happening most vigorously and also where there is a higher concentration of indigenous vegetation.

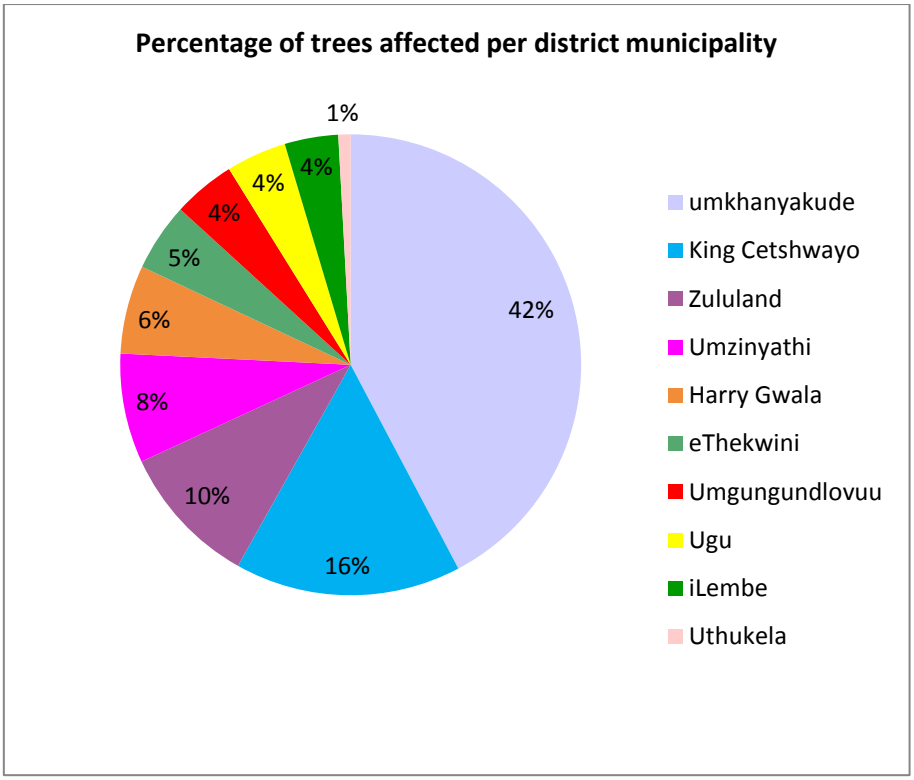


Figure 4.3: Percentage of trees affected per district municipality.

UMkhanyakude is also the municipality with the highest rate of non-electrified households; this means that vegetation disturbance is set to continue in this area. There should therefore, be measures put in place to proactively protect the environment in this area.

4.2. Impacts on birds

The bird incident records for the period 2013-2017 were obtained from the Endangered Wildlife Trust (EWT) which manages all Red Data Species related incidents in partnership with Eskom. The data obtained from the EWT was in the form of an excel spreadsheet and included information about location of the incident, the name of the species involved, number of individuals involved and identifying information of the Eskom infrastructure such as the name of the line or pole and transformer numbers. Not all the data collected could be used as some of the bird species were unknown or where the voltage of the line could not be determined. The focus of the research was on Red Data Species bird mortality and determining which voltage of line is most likely to cause bird mortality where low voltage and high voltage power lines are compared. The results were then presented in the form charts. Additionally, sensitivity maps were developed to depict bird vulnerability data for the entire KwaZulu- Natal OU.

Table 4:1: Bird mortalities

Conservation Status	Species common name	Scientific name	No. of mortalities

Critically Endangered	White-backed Vulture	*Gyps africanus*	4
Endangered	Cape Griffon	*Gyps coprotheres*	11
Endangered	Grey Crowned Crane	*Balearica regulorum*	15
Least Concern	Black-headed Heron	*Ardea melanocephala*	1
Least Concern	Cape Eagle Owl	*Bubo capensis*	1
Least Concern	Cape Shoveler	*Spatula smithii*	3
Least Concern	Cattle Egret	*Bubulcus ibis*	4
Least Concern	Egyptian Goose	*Alopochen aegyptiaca*	1
Least Concern	Giant Eagle Owl	*Bubo lacteus*	1
Least Concern	Greater Flamingo	*Phoenicopterus roseus*	15
Least Concern	Gymnogene	*Polyboroides typus*	1
Least Concern	Jackal Buzzard	*Buteo rufofuscus*	1
Least Concern	Long-crested Eagle	*Lophaetus occipitalis*	1
Least Concern	Peregrine Falcon	*Falco peregrinus*	1
Least Concern	Pied Crow	*Corvus albus*	5
Least Concern	Spotted Eagle Owl	*Bubo africanus*	7
Least Concern	Yellow-billed Duck	*Anas undulata*	1
Near Threatened	Crowned Eagle	*Stephanoaetus coronatus*	3
Near Threatened	Southern Banded Snake Eagle	*Circaetus fasciolatus*	4
Vulnerable	Blue Crane	*Anthropoides paradiseus*	5
Vulnerable	Southern Ground Hornbill	*Bucorvus leadbeateri*	1
Vulnerable	Wattled Crane	*Bugeranus carunculatus*	4

The conservation status of each bird was determined using the information available on the IUCN red list website http://www.iucnredlist.org as accessed on the 24th of April 2018. Figure 4.4 below gives an overview of the conservation status hierarchy as determined by the IUCN.

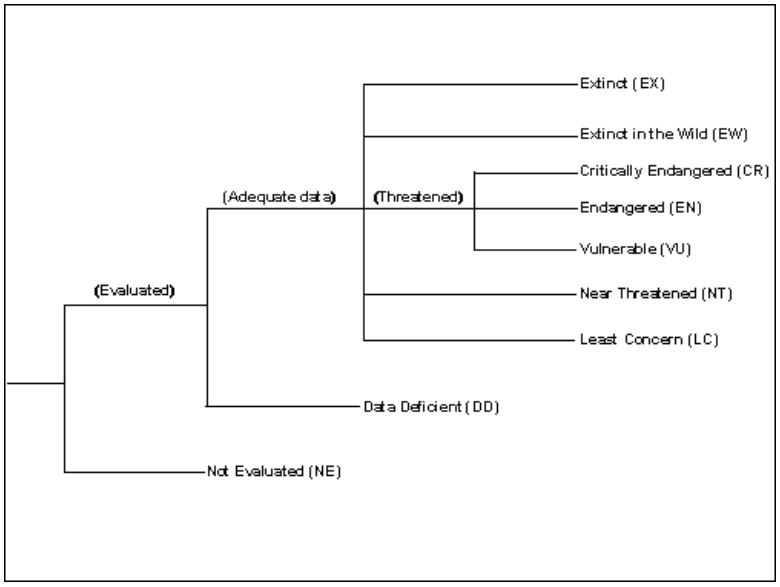


Figure 4.4: Red Data Species Categories

Source: IUCN, 2018

From the data collected, figure 4.5 was drawn to depict bird fatalities by conservation status. This is an important analysis as the impacts of power lines are listed among the causes for bird mortalities across the world (Rubolini, 2005; Jenkins et al., 2010; Taylor and Peacock, 2018).

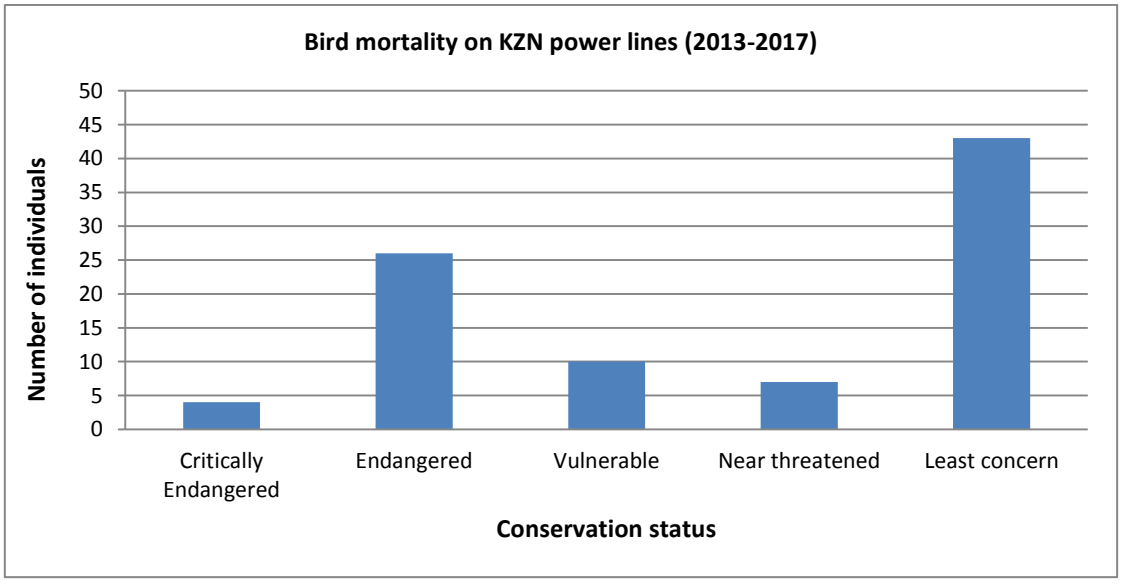


Figure 4.5: Bird mortality on KZN distribution power lines

In terms of the number of individuals killed on KZN OU distribution power lines; 48% were of least concern (widespread and do not qualify to be in the categories which indicate a threat to the species); and 7% were near threatened (birds that do not qualify as threatened now but are at risk of qualifying as threatened in the near future). Vulnerable constituted 11%, while endangered and critically endangered constituted 29% and 4% respectively. The critically endangered birds were all White-

backed Vultures (*Gyps africanus)* while the endangered species killed were either Cape Griffon (*Gyps coprotheres*) or Grey Crowned Crane (*Balearica regulorum).*

An analysis was also done on the types of power lines responsible for the bird mortalities. Figure 4.6 below shows the results.

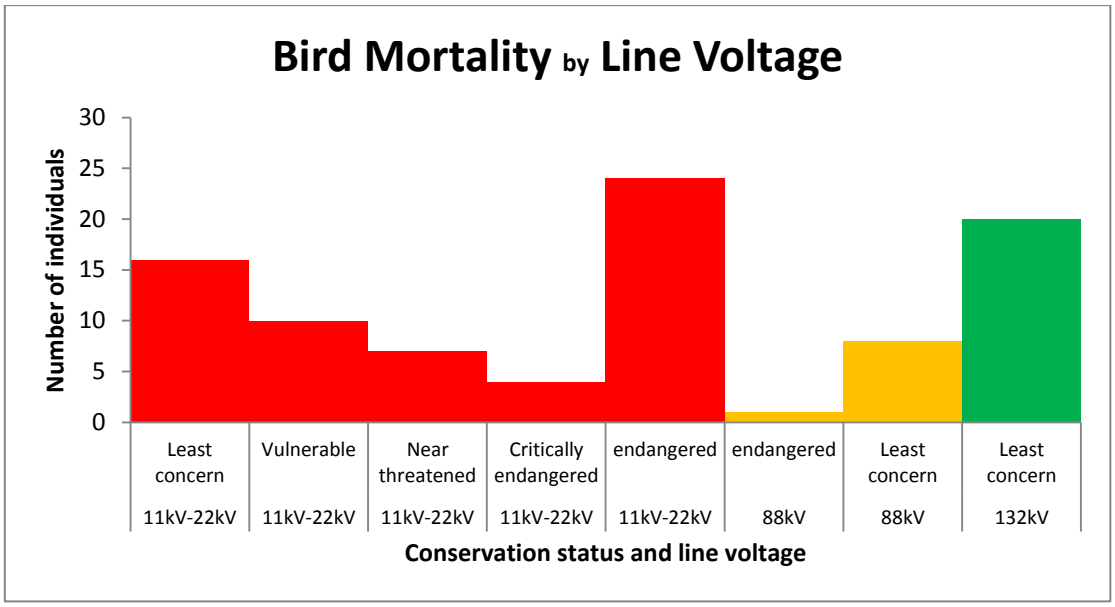


Figure 4.6: Bird mortality by line voltage.

From the bird mortality data reviewed 62% of the bird mortalities occurred on 11-22kV power lines and infrastructure; 10% on 88kV, and 22% on 132kV power lines and infrastructure. Furthermore the vulnerable birds were mostly killed on 11-22kV power lines while 132kV power lines only resulted in the mortality of birds of least concern. From a technical point of view this is because power lines of a larger voltage are more visible thus reducing the risk of bird collisions. Also, the distance between two phases is much larger making it difficult for a bird to bridge the gap, resulting in an electrical short circuit. Another reason may be that when sub-transmission projects undergo EIAs or BAs the risk for bird mortality is likely picked up before construction and therefore successfully mitigated through the fitting of bird flight diverters and insulation pipes. Research on power lines and bird mortality is not very wide (Jenkins et al., 2010), however, for most of the endangered and critically endangered birds, power lines have been listed as a significant contributing factor (IUCN, 2018). There is also poor reporting of bird incidents by landowners who see reporting incidents as burdensome or a futile exercise this further contributes to the limitation of data available on bird and power line interactions. Bird incidents which do not result in interruption of supply go unrecorded thus compromising available data. Some incidents which occur in the wild are also unrecorded because wild animals feed on the dead birds before they can be discovered and reported. All of these indicate that the number of birds killed on distribution power lines may be higher than what is recorded.

Conclusions which can be drawn from this data are that 11-22kV power lines pose a higher risk to birds than 88-132kV power lines. A limitation to the study was that the cause of the mortality could not be determined. While there is enough research to support that lower voltage lines pose a higher risk for electrocution (Kruger and Koos, 2017; Boshoff et al., 2011; Bevanger, 1993); research is unclear on whether power line voltage is a factor for bird collisions. Power lines are contributing to the decline of birds and mitigation measures should be put in place to proactively reduce the impacts. The screening process conducted at Eskom should be done in consultation with the EWT in order for high risk areas to be identified and proactively mitigated. At present, most mitigation measures are retrofitted after there has been an incident; although this is good practice, there is no telling how many birds have been killed prior to the mitigation measure being implemented. Landowners and the general public should be encouraged to report incidents to Eskom or the EWT; this will ensure accuracy in available data so that the correct decisions to protect birds can be made. Another way to involve landowners would be to consult them so that their experience and knowledge is also incorporated into the environmental management plan of the project. The screening process for 11-22kV power lines should mimic the basic assessment process as far as possible. This is by principle and exercising duty of care and not necessarily duplicating the extent and scale of a basic assessment or EIA process. It is important to note that Eskom Distribution has a Bird Mitigation Project in place to minimize Eskom's impacts on birds. The aim of the project is to proactively reduce bird mortalities on distribution power lines. The approach to the project was using historical data and GIS to determine high risk areas which have been prioritized for the retrofitting of bird mitigation infrastructure or the changing of Eskom infrastructure to make it more bird friendly.

4.3. Thematic Mapping

Maps were developed to depict the footprint of high voltage (HV) power lines compared to medium and low voltage power lines. The power lines were also shown against environmental features such as water, the biomes and critical bird areas in the KwaZulu- Natal Province and UMkhanyakude Municipality. UMkhanyakude District Municipality is the area where most of the electrification activities are taking place at present and also where the Ndumo Gezisa project lies. GIS was used to produce the maps with the aid of Spacemen which is used for internal Eskom GIS software. The maps show that LV and reticulation power lines have a larger footprint on the ground and this supports the conclusion that reticulation power lines have a larger cumulative impact that high voltage power lines, even though they are considered low impact. Another analysis which could be performed is using all the data to create environmental sensitivity hotspots where those areas with important biodiversity features could be identified. This data can then be used as part of a strategic environmental assessment and can be used to inform impact assessment studies and environmental screening.

Figure 4.7 shows the high risk areas for birds prone to collisions and electrocutions with Eskom power lines. The map also depicts the HV network in comparison with the MV/LV and electrification polygons. The map depicts the critical raptor breeding areas, the foraging areas and the high risk areas for bird mortalities on distribution infrastructure. The high risk areas were determined in an Eskom Research Study through the overlaying and combination of different datasets related to red-listed species with a special focus on cranes and vultures. The information used to determine sensitivity was previous incidents, modelled suitable habitat, global and regional threatened status of the species, species distribution, nesting sites and Important Bird and Biodiversity Areas (Pretorius and Hoogstad, 2016). The map clearly depicts the footprint of HV power lines as being much lower that the MV networks and electrification polygons. From past incidents analysed in this study; MV and LV power lines pose a greater threat to birds than HV power lines. This type of information is currently being used by Eskom to mitigate existing structures in order to prevent or reduce bird mortalities on power lines. There is also an opportunity for this type of data to be used during planning where if a proposed construction falls within an identified high risk area the power line can be proactively mitigated. GIS should be actively utilized and updated in order for meaningful studies to be conducted within the OU.

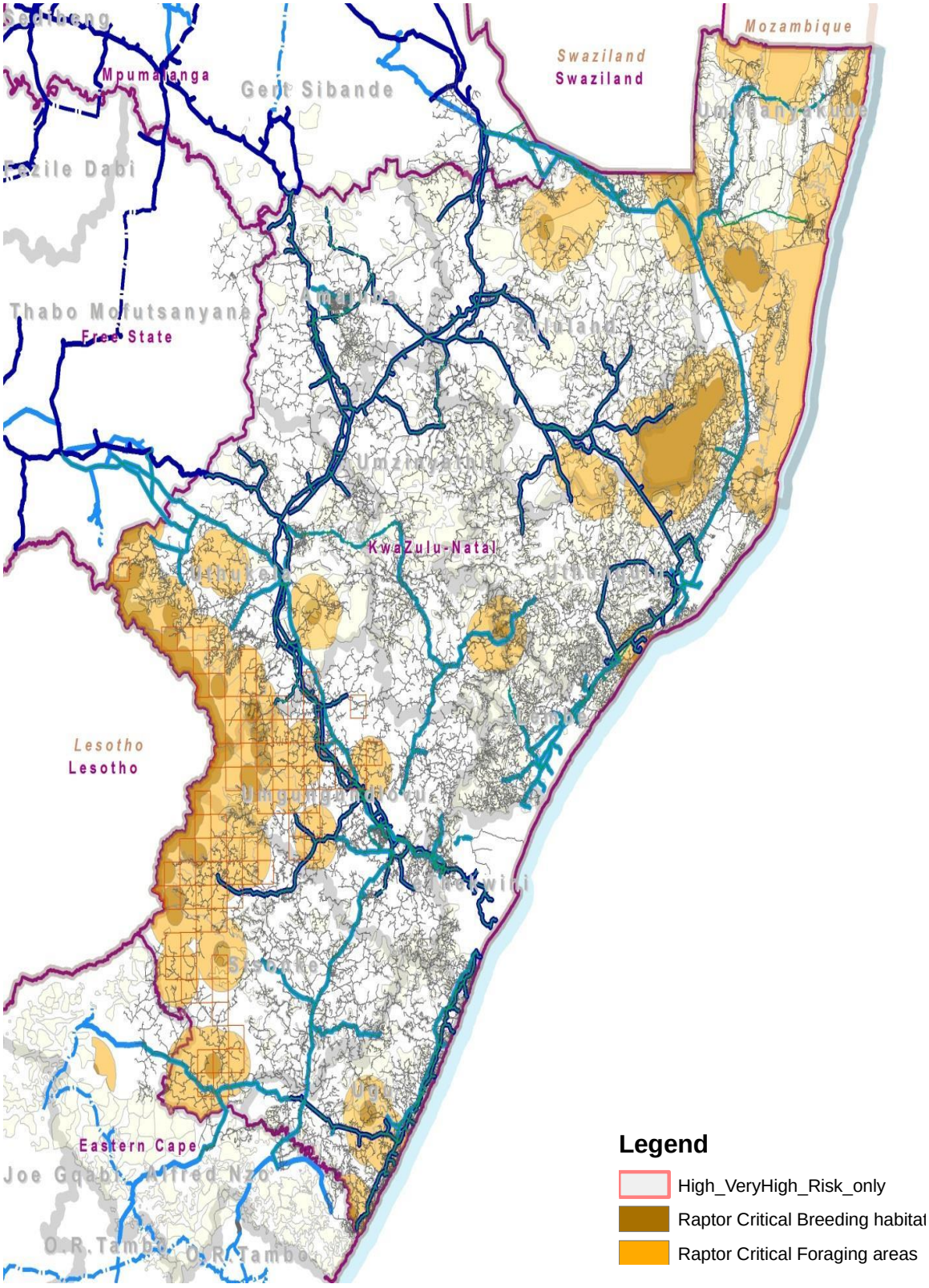


Figure 4.7 Map of KwaZulu Natal showing high risk area for birds

Figure 4.8 depicts the distribution of households and along with the distribution network infrastructure of various voltages. Unelectrified households are concentrated in Northern KwaZulu-Natal in the Umkhanyakude District Municipality. This municipality is characterized by the Indian Ocean Belt, Savanna and Forest biome as shown on figure 4.9. This means that electrification is still likely to affect these biomes and therefore strategic planning should be done to minimize potential environmental impacts.

Mapping can be used to forecast future electrification needs and strategically assess possible environmental impacts. This would allow for adequate time for mitigation and impact avoidance to be planned and implemented. The nature of electricity provision unfortunately means that environmental impacts sometimes cannot be completely avoided; this is because the location of the power lines is determined by where the need for electricity exists. In other words if the demand for electricity supply is in a sensitive environment the only option available is minimization of negative impacts as complete avoidance cannot be achieved in most cases. Some flexibility exists the in determination of the direction of the power line route however, there isn't much flexibility in the nature of the environment which a line would transverse.

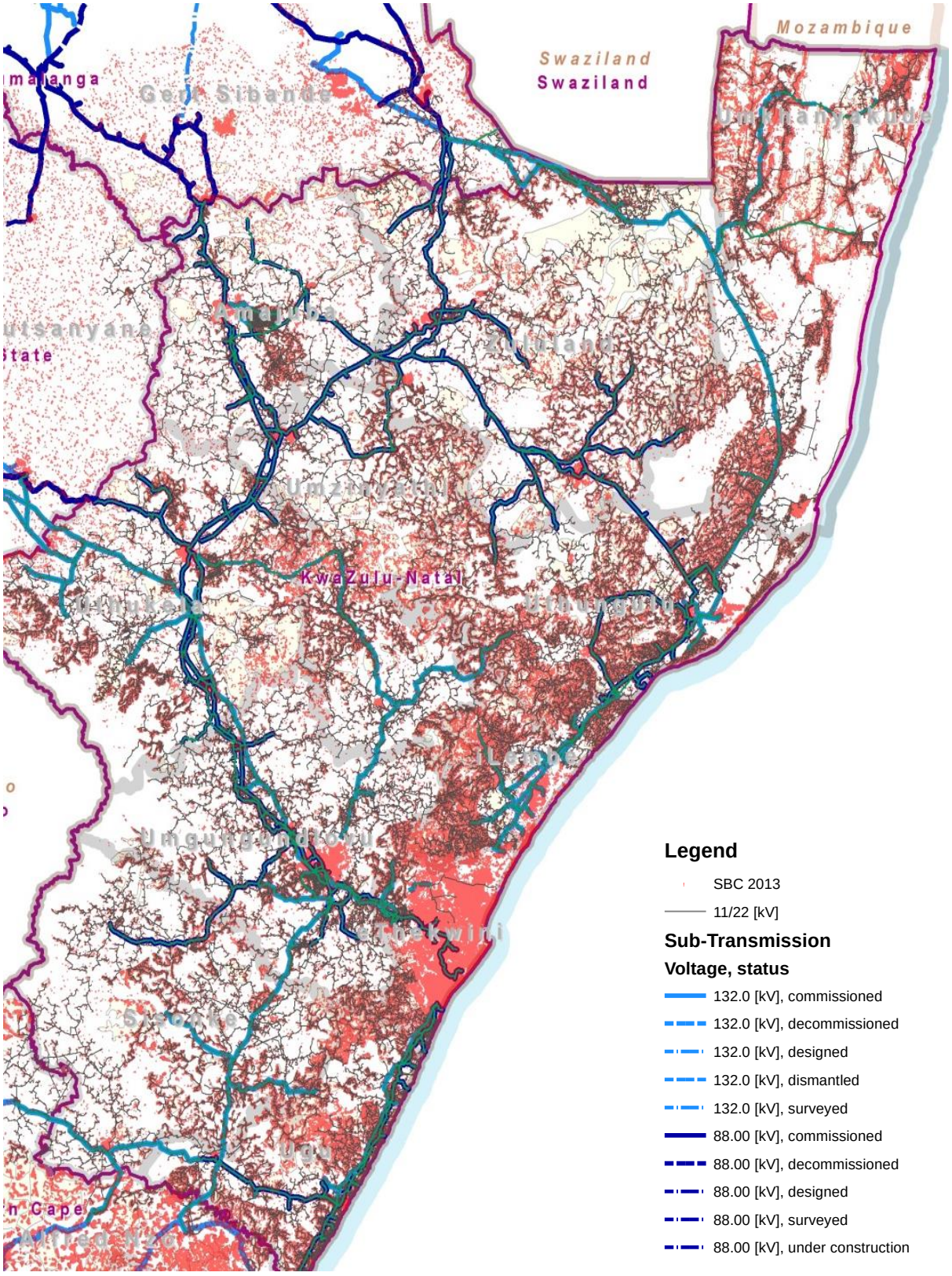


Figure 4.8 household and network distribution in KZN

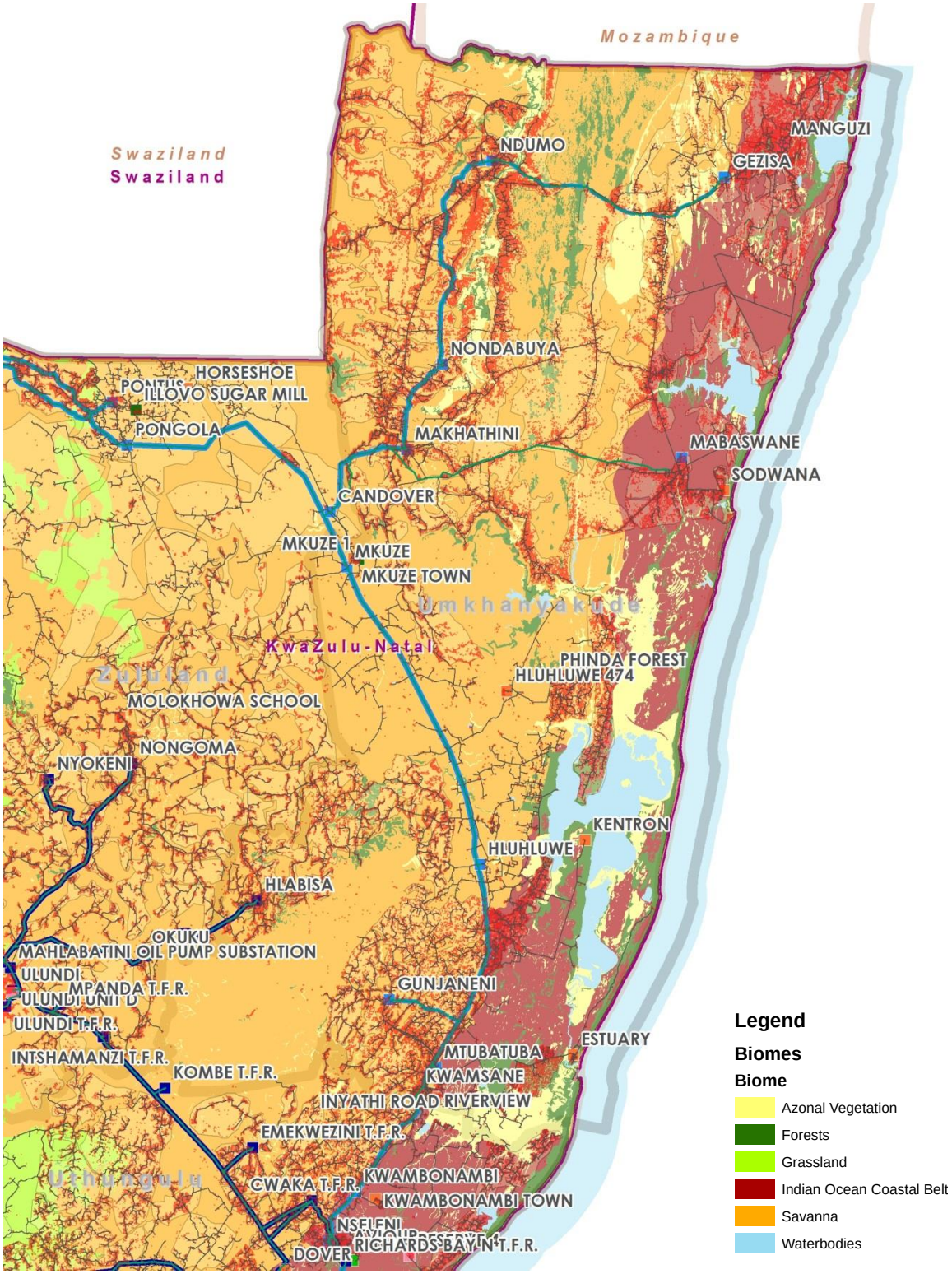


Figure 4.9 UMkhanyakude biomes

4.4. Key Informants and Field Observations

From the survey, all the respondents agreed that Eskom distribution activities affect the environment negatively. In terms of the types of impacts caused by such activities, all the impacts listed on the questionnaire (appendix A4) were chosen at least once. The impacts listed were animal electrocution, soil erosion, bird collisions, vegetation clearing, bird electrocution, chemical spillages, oil spills, and building in wetlands. The respondents additionally listed the following as impacts of distribution projects; habitat transformation, promotion of exotic weed invasion, latent effects on prey and predator relations resulting from changes in perching points caused by power lines, habitat segmentation, compaction of soil by heavy machinery and vehicles, disturbance of nesting sites, impacts on heritage resources, pollution from waste, the use of renewable and non-renewable resources and the contribution to climate change impacts caused by the consumption patterns of a large workforce. In terms of the ranking of the significance of the impacts identified; disturbance of vegetation was ranked as the highest impact while bird electrocutions and oil spills were ranked second and third respectively. The only other items each appearing once in the ranking were habitat fragmentation and climate change. The second part of the survey focused on the environmental impacts identified and how these compare where different voltages are concerned. From the figure 4.10 below, the respondents were equally divided on which voltage had the most impact in terms of bird collisions and electrocutions; low voltage power lines had more impact on vegetation than high voltage power lines and low voltage power lines are perceived to have more impacts resulting from oil spills.

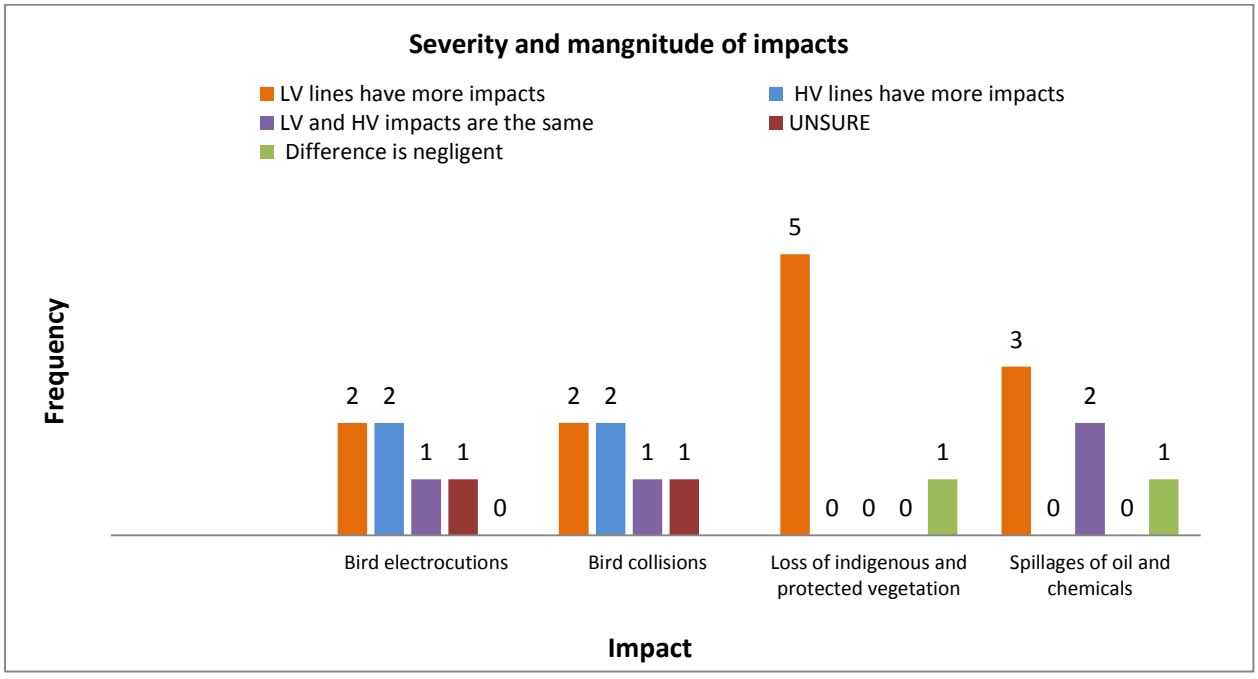


Figure 4.10: Severity and magnitude of impacts

Figure 4.11 shows the collective responses and compares the overall perceptions on the impacts of the different voltage power lines. The results are based on the responses submitted by key informants. The total number of participants was 13. From the survey, LV power lines are seen to have more impacts than voltage HV power lines 63% of the time, while high voltage power lines are seen to have greater environmental impacts 13% of the time. From the key informant surveys it can be concluded that LV power lines are perceived to have more environmental impacts than HV power lines.

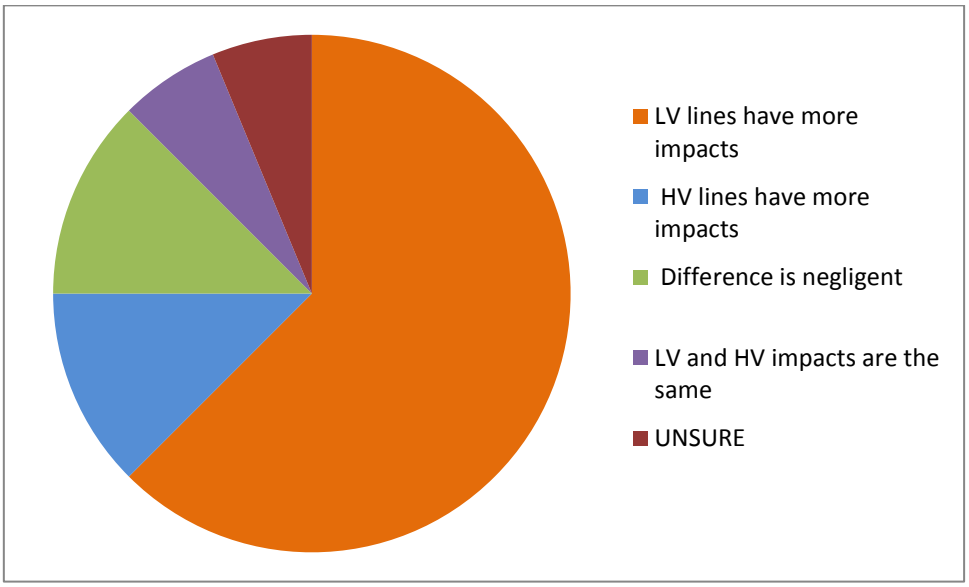


Figure 4.11: Environmental impacts by line voltage

All the respondents agreed that conducting Basic Assessments helps mitigate negative environmental impacts. Some of the reasons stated for this stance are that BAs:

- assist in the identification of potential disturbance factors,
- allow for adequate and suitable planning for actions to be put in place to prevent or minimize environmental impacts,
- provide for specialist studies to be conducted assisting in the rolling out of the necessary mitigation measures specific to identified sensitivities,
- assist in the sound understanding of the different impacts,
- call for the mandatory involvement of interested and affected parties which allows for indigenous knowledge to be incorporated into the planning,
- are a holistic approach which does not only look at the immediate impacts but also identifies and plans for the cumulative impacts of an activity which may pose a greater threat to the environment.
- guide the development of an EMP to mitigate or manage potential impacts

When asked the same question about the Distribution Environmental Screening Document all the respondents agreed that DESDs also help avoid negative environmental impacts. The following reasons, concerns or issues were raised by the respondents regarding the effectiveness of DESDs:

- although DESDs are an effective tool for environmental management there is still a concern that they are not conducted by environmental specialists and therefore may not always be able to provide an accurate screening assessment.
- DESDs lack the level of detail contained in in BARs even though they assist in the avoidance of negative impacts.
- There is a concern in that they are not conducted by environmental specialists but rather surveyors who have no formal environmental management training in most cases.
- DESDs are only effective when they are done by a knowledgeable resource that practices good science.
- DESDs are only effective to certain extent; they are not sufficient to identify and mitigate all environmental impacts completely, especially given the volume of projects, the diverse range of impacts, and the resources allocated for their completion.
- DESDs do not provide guidance on how to mitigate impacts and ensure legal environmental compliance

When the DESDs and BAs were compared, all the respondents indicated that BAs were a better environmental tool. However, the concern with this tool was the time and cost of applying it across the board; considering the volume of electrification projects. BAs were deemed to be time consuming, tedious and costly. Similar reasons were stated when respondents were asked what they thought is the reason for the exclusion of low voltage power lines from the basic assessment process. Some respondents also believed that electrification projects have a lower impact and mostly occur in areas that are already disturbed. However, as the evidence shows, the cumulative impact of electrification outweighs the impacts caused by sub-transmission power lines. The basis of the exclusion of electrification from the BA application is heavily influenced by administrative concerns rather than the physical environmental impacts.

From the results above, Basic Assessments are the preferred tool for the prevention or minimization of negative environmental impacts. DESDs, although useful, are not as effective as basic assessments and lack the depth of investigation into potential impacts which is what is necessary to avoid negative environmental impacts. From the study with the key informant respondents and the in depth interviews conducted with the various stakeholders, what is evident is that the primary reason for excluding low voltage projects from the basic assessment process is the cost and time which is invested into a basic assessment process and the decision is not heavily based on environmental

science and the consideration of impacts on a case by case basis. While low voltage power lines can pose a lesser threat to the environment in some cases; their cumulative impacts may be much greater as their footprint far exceeds the footprint of high voltage power lines. Additionally when future developments are considered; it is likely that there will be more electrification projects than there will be higher voltage developments. For this reason there is a need for the impacts to be fully investigated and addressed. If volume alone is to be considered, the argument that listing low voltage power lines would essentially halt development is a valid argument for development. This is due to the urgency of service delivery in the country and also the large number of areas which still need to be electrified in the country. A fair compromise would be to develop an environmental impact assessment tool which is more effective than the current DESD process and then employ the principles used in a basic assessment study. For example, consideration of alternatives, consultation of affected parties, rating of environmental risks and the development of an Environmental Management Plan (EMP).

4.5. Ndumo Gezisa case study

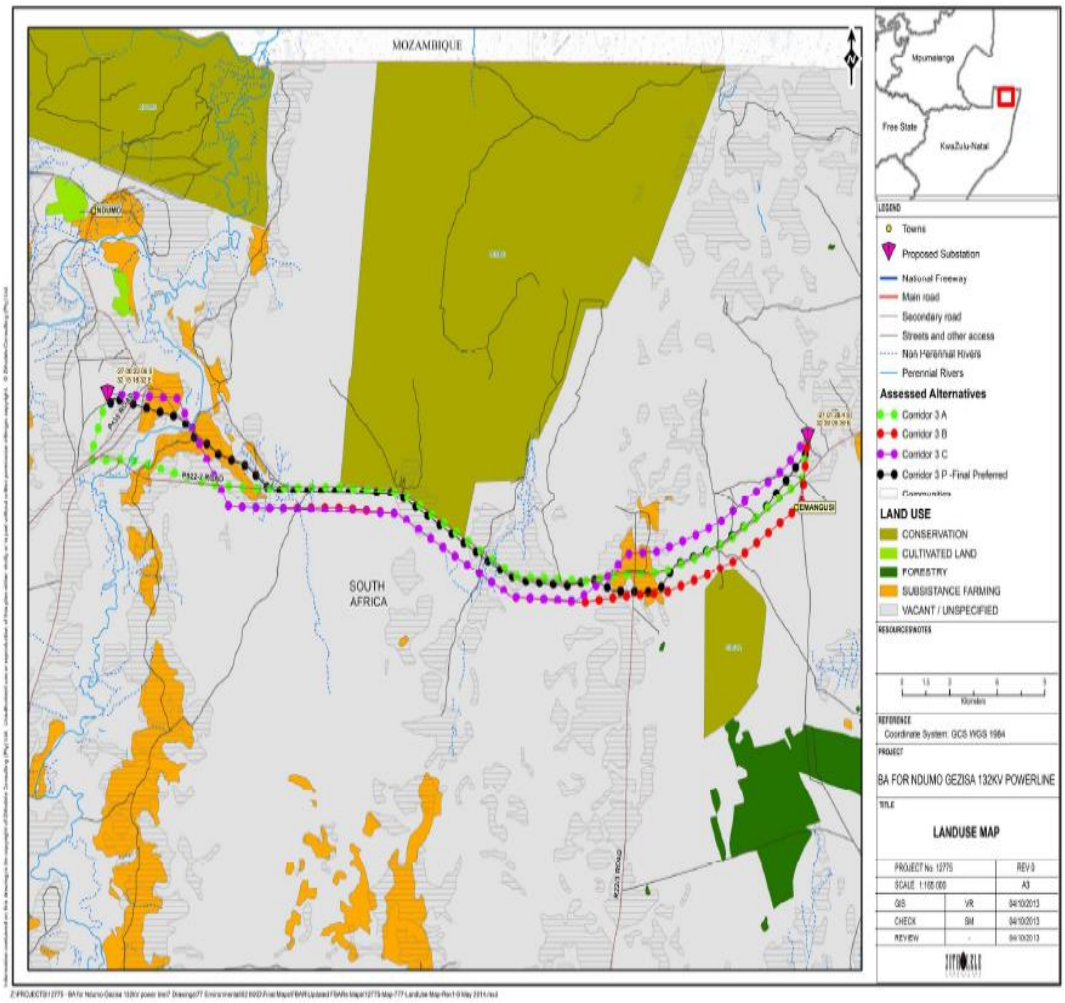


Figure 4.12 Ndumo Gezisa project

Source: Zitholele Consulting, 2014

Figure 4.10 above shows the considered routes for the Ndumo Gezisa Project with corridor 3P being the final approved route. The project as of May 2018 was at its final stages where the line construction had been completed and the remaining work on the project was the substation yard. The site was visited in March 2018 to observe the impacts of the line construction on the environment. Additionally the ECO monitoring reports for the project were obtained for better insight into the project history. The line which is approximately 44km runs between the Ndumo and Gezisa substations, and traverses conservation areas particularly the sand forest. Measures therefore had to be taken to minimize damage to indigenous vegetation. As per the stipulation of the Occupational Health and Safety Regulations, the vegetation under the line had to be kept to a minimum clearance of 18m under the 22kV and 24m for the 132kV line. The width of the servitude for the 132kV line was 18m on either side of the centre line (36m).

The project required a number of different permits and licenses in line with the work being conducted and the environment affected. The environmental authorization for the project was received on the 24 of November 2014 from the Department of Environmental Affairs. In addition; an authorization was obtained from the Department of Water and Sanitation for the crossing of the Pongola River; a tree cutting license from DAFF for the cutting and pruning of indigenous trees; and a schedule 12 permit from Ezemvelo KZN for the disturbance of schedule 12 plant species, which were relocated to give way for the tower bases and access roads. A number of specialists were also appointed during the EIA process and some were involved throughout the construction phase of the project as indicated in the subsequent EMP. The specialist reports produced for this project included an ecological assessment, surface water, visual report, avifaunal report and a heritage assessment. The level of specialist studies required for the report shows the sensitivity of the receiving environment. The project was subject to a number of different audits due to the environmental sensitivities around the project, however, there were no legal contraventions related to the project found by DAFF and DEA.

Negative impacts on indigenous vegetation were minimized though the avoidance of the cutting of trees as far as practicably possible. This was done through making use of existing access roads and avoiding the creation of new routes which would not be utilized in the operational phase of the line. In some areas however; it was evident that access roads were widened in order to accommodate larger vehicles and trucks. A portion of the line transversed through the highly protected and sensitive sand forest, however only one or two indigenous trees were cut in this area and the tree cutting activities largely focused on the alien vegetation. The EMPr for the project specified the need for the involvement of a Botanist, who would guide and monitor the vegetation clearing in this area in order to minimize the impact on the indigenous vegetation. Helicopters (figure 4.11) were used in the stinging in this portion of the line to minimize negative impacts on the sand forest. Selective pruning

was done on trees which could not be avoided. Additionally during tree felling; care was taken to prevent trees from falling on the forest and damaging the trees.

Figure 4.13 Helicopter stringing.

*Source: Sineke Developments, 2017***.**

The management of vegetation, especially in the sand forest area on the project shows the benefit of the BA process and also the effectiveness of environmental authorization conditions in preventing harm to the environment. The collaboration of stakeholders is what influences the best possible methods employed in order to protect the environment. Stakeholder input also played a big role on the methods used on the project and these are the beneficial elements of a basic assessment study which do not come to play on lower voltage projects. Different types of towers were used on the line as shown in figure 4:11 and 4:12 below. The tower type depends on the engineering design and the receiving environment in that particular tower position. Where vegetation was cleared for the 132kV servitude the requirement was 40 x 40m at the tower base for a stay tower, and 20x20m at self supporting towers. The servitude width cleared for the 132kV power line was 32m wide while the servitude for the 22kV power line was 24m.

Figure 4.14 Waist-type self supporting tower source:

Source: Sineke Developments, 2017.

Figure 4.15 Stay supported structure

Source: Sineke Developments, 2017.

Mitigation measures were implemented to prevent collisions and electrocutions on the line. These were in the form of pigtail bird diverters to mitigate collisions and insulators to prevent electrocutions. Bird flight diverters were identified as vital in areas such as Phongolo and Mseleni Rivers. This is because birds have a higher likelihood of collisions near rivers and wetlands therefore it was important for mitigation measures to be focused in such areas. To prevent collision the clearances

between the live and earth conductors were 1.8m for lattice towers and 1.5 m for the low voltage structures. This is so to prevent electrocutions of birds with a large wing span.

The findings from the Ndumo Gezisa case study show the value of the Environmental Impact Assessment process. The project was in a highly sensitive area, however with the thorough basic assessment, the collaboration of the various specialists and the interested and affected parties; damage to the environment was minimized as far as practically possible. The study also shows that the impact of a 132kV line can be minimized even though this type of line is considered to have a large environmental footprint. The difference in the impacts for the 22 and 132 kV line are only seen when the width for vegetation is considered where a clearance of 36m is required for a 132 kV power line as opposed to 24m for a 22kV line. This is not however a benchmark that can be used to determine the impacts by voltage because the impact on the environment will be determined by the nature of the receiving environment. For instance a 22kV line falls within a densely vegetated area even though the width to be cleared may be narrower; it would have more ecological impact than a 132 kV line in a fragmented disturbed area.

4.6. Conclusion

The findings from the data collected show that project environmental impacts differ on a case by case regardless of the line voltage. The assessment methods used therefore should largely be determined by the receiving environment rather than the line voltage. The way in which the current listed activities have been structured for distribution activities limits the scope for more meaningful environmental assessments to be carried out. The study also found that the decision to list some activities under the EIA regulations is for the most part influenced by cost, time and procedural considerations and less by the environmental conditions. The study however acknowledges the thought process behind such and therefore recommends for an improvement on the existing screening process already employed by Eskom. It is also evident that there are many different mediums of information available which can be used to improve the existing environmental screening process currently being used by Eskom. Furthermore the impacts between electrification and high voltage projects are similar in nature with the footprint of electrification projects being cumulatively higher than the impacts of high voltage power lines which occur in smaller volumes.

The current screening (DESD) process could be improved by using principles used in the BA and EIA process and also coupling them with the use of GIS. The collaboration of tools will improve the quality of the assessment data produced by the DESD process and will also minimize the impacts caused by electrification and other low voltage power lines. Eskom should approach electrification as a bulk project in instances where many electrification activities occur in one area. For example,

UMkhanyakude District Municipality could be subjected to a strategic impact assessment where submissions are made to the relevant authorities listing the intended activities and likely impacts. This would give authorities confidence that Eskom is practicing due diligence when it comes to environmental issues and also provide for an opportunity for more meaningful mitigation measures to be applied, thus reducing the impacts of electrification. Recommendations to this effect are made in the subsequent chapter.

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CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

This chapter covers the concluding remarks based on the findings presented and also makes recommendations on how electrification environmental impacts can be proactively identified to aid effective impact prevention and mitigation.

Part of the objective of the research was to determine whether the exclusion of low voltage projects from the Basic Assessment process is justifiable, especially where environmental integrity is concerned. What the research has shown is that the impacts of low voltage power lines are essentially the same in nature as those of high voltage power lines but mainly vary in the magnitude of the impact. For instance; the servitude width for high voltage power lines is 32m while the width for low voltage power lines is 24m; all things equal then an individual high voltage line would have more impact on vegetation than a low voltage line where clearance of servitude is concerned. Even though some low voltage power lines are likely to have less environmental impacts during construction, the cumulative impacts of electrification projects outweigh the impacts of larger voltage power lines. Where bird collisions and electrocutions are concerned the study found that low voltage power lines have greater impacts than high voltage power lines and this is mainly because of the technical and structural differences in the infrastructure. The decision to exclude low voltage power lines from the basic assessment process is unjustified if the decision is to be evaluated against environmental impacts only. This conclusion however cannot be drawn without looking at the matter holistically.

The study found that the decision not to undergo a basic assessment is largely influenced by the need to save time and costs and not necessarily informed by the nature of the environmental impacts of electrification. Basic Assessments are a costly and tedious exercise often requiring the appointment of specialists who also pose a cost implication. Subjecting electrification projects to BAs would give the country a backlog of applications caused by limited resources to attend to applications both at the Department of Environmental Affairs and also on the side of applicants. Therefore, although there seems to be no significant difference in the impacts Basic Assessments for electrification are not a viable option.

There is a need for a more meaningful approach to assessing the potential impacts of activities which do not require Basic Assessments or full Environmental Impact Assessments. There is also an opportunity for improvement where the impacts, of both the construction and the operational phases can be better measured and documented in order for this information to be available for future decision making. There is a gap that exists where the environmental data available in the organization is not being integrated and used in a way which enhances environmental impact management.

Strategic integration of data could assist in developing a better management programme for projects of similar nature. These findings may not be unique to the electricity distribution environment but there may also be opportunity for other activities excluded from the BA and EIA thresholds to be evaluated so that recommendations can be made to safeguard the environment while upholding the principles of sustainable development.

It is evident that in the pursuit of economic and social development there is a crisis for environmental management and biodiversity. Even though there are legislated processes in place and organisations also undertake voluntary environmental policy systems, impacts have not discontinued suddenly and there is still a need for more effective environmental management tools to emerge (de Wit, 2016). The following recommendations are made to either improve the existing screening process or develop a new assessment tool which would be effective in impact mitigation but also not as extensive or as costly as a BA or EIA process.

Criteria for listed activities

The process of a BA has proven to be an effective process in mitigating negative environmental impacts. The legislated requirements provide a fail proof method so that all possible impacts are identified and planned for beforehand. However, as the study has shown this Bas and EIAs cannot and should not be applied across the board as per reasons stated above. In view of this; there are two options which can be explored; one streamline the basic assessment process to make it less costly and tedious while maintaining its integrity so that it can be applied on electrification projects or develop a separate tool for assessing projects which are deemed as smaller.

Blanket licenses

The study recommends that there be a threshold where Eskom must apply for ‘blanket’ authorization wherever there is a large concentration of electrification projects occurring in a biodiversity rich area. For instance the data collected in this research shows that many of the projects are concentrated in the uMkhanyakude Municipality. This municipality is also characterized by various environmental sensitivities including wetlands, indigenous forests, natural grasslands, water bodies and vulnerable bird species. Eskom can still maintain the screening process per project but a strategic assessment would be beneficial and allow for adequate planning and mitigation. Strategic Impact Assessments would also ensure that the impact assessment stage of electrification projects is conducted in advance without the undue pressure from the applicants for electricity and other time pressures.

Training of DESD compilers

The competency of the personnel which conduct the environmental screening process for low voltage projects was a concern raised in the key informant surveys and interviews. Currently these are

conducted by surveyors who concurrently identify the line route for the proposed line. To have these tasks done simultaneously is good practice as it saves cost and time for the project. There is existing DESD training for the surveyors which covers the environmental issues related to such developments; however, the quality of some the DESDs being produced in the OU is still poor. There is therefore a need for the training to be revised to focus on the impacts of electrification and thus sensitizing surveyors to the need to avoid causing harm to the environment. Surveyors need to increase their awareness of indigenous trees and also need to be equipped so that they can identify areas which would be high risk for bird electrocutions and collisions. An example would be migratory paths of birds or power lines near lakes and rivers.

Data Integration for assessments

There are many mechanisms that already exist within Eskom which record and track environmental issues. There is an opportunity for collaboration of these datasets to create a tool that provides a representation of the natural environment in the field. This tool could be used to conduct effective screening for electrification and this will allow for assessments to be more effective and accurate. Eskom has a SAP system where environmental incidents are captured and therefore the history of many areas is known, additionally there are licences and permits which have been attained over the years and these could be used in the GIS software to alert users of the presence of protected and indigenous vegetation which should be avoided. There is also technical software which monitors electrical faults in the field some of which are caused by birds and animals interacting with electrical infrastructure through collisions, electrocutions, streaming and nesting. There is also data from the EWT as used in this research which could assist in the screening process so that high risk areas are either avoided or mitigation measures are applied from the onset and not as reactive measures after an incident has occurred. All of this information can be updated in the GIS database to maximize the potential of desktop studies which are performed prior to on site assessments.

The figure below (figure 5.1) shows a model of data integration for effective impact assessments using the environmental management system approach. Eskom KZN OU is an ISO 14001:2015 certified utility; creating a systematic approach to the screening process could be beneficial to the organisation and provide a seamless systematic approach which promotes the continual improvement of the process. The system has heavy reliance on GIS and regards GIS as one of the main tools for effective environmental management (Gharehbaghi and Scott-Young (2009). There is definitely an opportunity for Eskom to consider centralizing all available information to create a more effective impact assessment or screening process. This would aid the surveyors conducting the assessments and thus allow for more sound environmental management. Additionally making this information available to planning departments would also have positive environmental benefits.

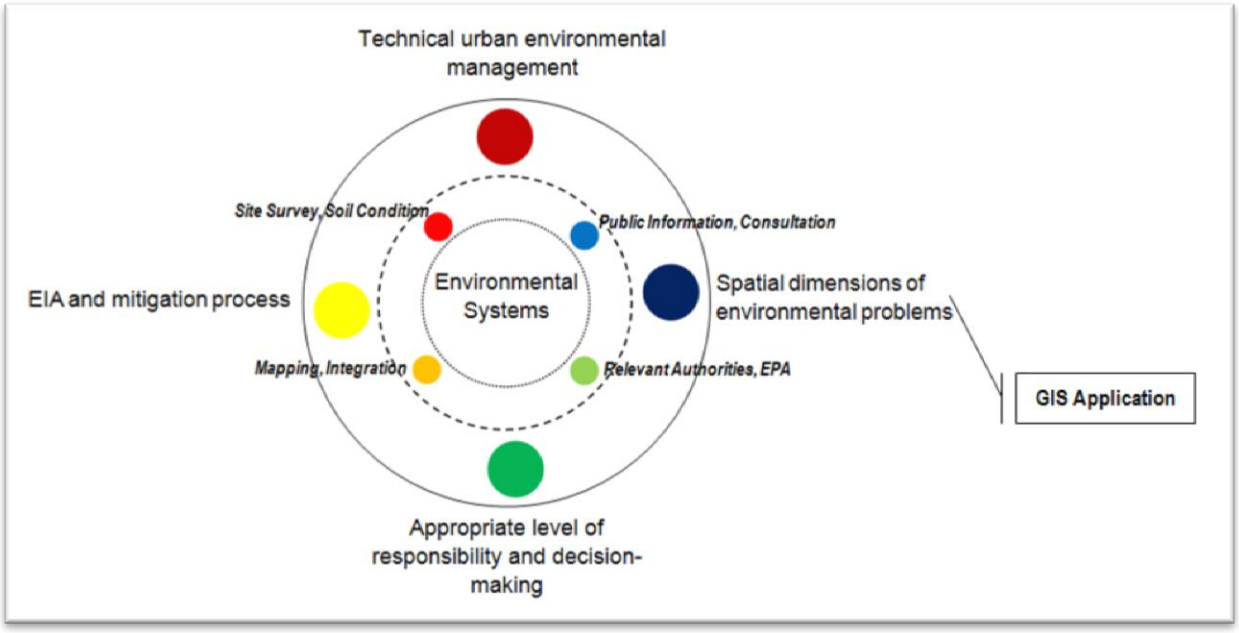

Figure 5.1 GIS and Environmental Data integration
Source: Gharehbaghi and Scott-Young (2018)

Gharehbaghi and Scott-Young (2018) describe GIS as a tool which provides a premeditated roadmap which guides or informs future developments, additionally it also serves as data storage and integration tool which allow for easy analysis functions to be performed.

Where UMkhanyakude is concerned, it is evident that there are a number of households which are still not connected to the electricity grid. Such data can be used by the power utility to plan ahead for future electrification and allow for sound screening to occur in order to minimize environmental impacts. The household data can further be overlaid with other datasets to provide a full picture of potential environmental impacts beforehand. Similarly figure 4.9 shows the infrastructure against the biomes in UMkhanyakude District Municipality. This type of information can be used for proactive planning and effective mitigation of environmental impacts. By determining the likely impacts on the vegetation and the type of vegetation in an area the organization can plan for contingencies well in advance. There are many other environmental features which can be checked on the GIS software which could aid the screening process for electrification projects, if the data is used correctly and optimally. The respondents raised the issue of poor DESD reports which result in project delays and poor preparation for environmental sensitivities on site. Promoting the use of GIS and increasing data input into the available software would greatly improve DESD quality and further promote sound environmental management.

Environmental Offsets

Environmental offsets are activities that are done in order to compensate for the environmental damage or impact caused by an activity. Offsets were discussed with DAFF and their position was that the idea of offsets is easier to implement with private developers who own land and essentially can dedicate a portion of that land to offset projects. This model would not be practical to the Eskom Dx case as land is not owned but rather there is permission for servitudes. KZN OU had however undertaken some indigenous tree planting project in a bid to make a positive contribution to the environment. Such projects need to be promoted and need to be made a national target. For instance if KZN OU had pledged to plant 2000 trees and there is no space available; such trees may be planted in another OU where space is available. Another way offsets can be done is through monetary donations to bird rehabilitation centers and funding of studies which deal with bird electrocutions and collisions.

5.1. Conclusion

Electrification is a mandate that stems from universal development goals and is something which many developing countries are embarking on. It is essential for economic development and the improvement of the quality of life for recipients. South Africa is one of the developing countries which are ahead in terms of reaching universal access of electricity. It is therefore important that the utilities responsible take the responsibility to manage environmental impacts adequately in order for other countries to learn and adopt the similar strategies. Environmental legal requirements should be reviewed in a meaningful manner which informs process improvement based on information being channeled into the system through various feedback mechanisms. If the assessment process for electrification projects can be improved it will reduce the impacts of electrification as it is evident that thorough assessments are useful in successful impact mitigation.

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APPENDIX A: Key Informant Interviews

APPENDICE A1: **Impacts on indigenous vegetation (DAFF)**

A face-to-face interview was conducted with a DAFF official on the 21st of December 2017. DAFF has the national mandate to regulate activities affecting indigenous and protected trees at a national level. When a proponent identifies indigenous and or protected trees that need to be cut or trimmed then an application is submitted to DAFF indicating the need; species to be affected; number of trees amongst other requirements. When the application is received a DAFF official is assigned and they then go to site to verify the application. DAFF officials on site then have the opportunity to see if the application is justified and suggest modifications which can be done to avoid and minimize impacts on vegetation. In some cases this includes stringing power lines by helicopter, diverting the line to avoid sensitive environment or increasing line clearance so that trees do not interfere with the conductors.

The DAFF official interviewed is based in KwaZulu- Natal and has been involved with Eskom related projects for the last 10 years. The interview followed his completion of the questionnaire and was an open ended interview mainly focused on the department's position and future plans to minimize development impacts on indigenous vegetation. The interviewee also engages with Eskom on a regular basis as a strategic partner, in order to streamline the vegetation management process. This is done through providing advice and guidance on how Eskom can minimize impacts and prevent legal contraventions arising from license conditions.

From the face to face interview DAFF expressed concern on the volume of electrification projects and their impact on vegetation, seeing that KZN is one of the most biodiverse provinces in terms of indigenous vegetation. He expressed that the department is more at ease when projects have undergone a BA or EIA as these processes ensure that there has been adequate specialist input in route selection and impact mitigation and that there will be monitoring during construction. He also expressed that as an authority their mandate is to regulate activities and not prevent them and therefore the department cannot refuse tree cutting or trimming if it is justifiable and supports the country's development agenda. In recent years DAFF has been implementing an offset requirement when they issue licenses but this method has mostly been successful with the private sector and not so much government and SOE developments. At present there are no offset projects being implemented across the board as standard practice. Offset projects are successful with organizations which own land and can set aside land for offset projects and conservation. Eskom does not particularly own land where electrification happens but rather has servitude rights; even if offset projects were implemented they would not occur in the same environment where the degradation takes place. The respondent also

noted that electrification projects have a positive impact on the environment as they provide electricity to rural areas that otherwise depend on trees for fuel.

APPENDICE A2: **Environmental Impact Assessment Process (DEA)**

A telephonic interview was conducted with an employee from the Department of Environmental Affairs (DEA) who works under the Framework and Policy Support section. The survey questionnaire was also sent to the respondents but the main aim of the telephonic interview was to answer the following questions:

1. What criteria are used to determine which projects require a BA, a full scoping and EIA or none of the above?
2. What is taken into consideration when the different listing notices are drawn up?
3. What is the purpose of the legislated environmental impact assessments?
4. Who are the stakeholders consulted when these determinations are made?
5. What are the common concerns or issues raised by industry or the public when it comes to environmental impact assessment legislation?
6. What is the risk when there are no Bas or EIAs undertaken?
7. How often is the law reviewed?

Based on the officials response Environmental Laws are drafted through a participatory process where proposals are made and the public is given an opportunity for comment as per the gazzetting period. The comments received from the public are considered before the final legislation is passed. In cases such as the listing of certain activities under the National Environmental Management Act 107 of 1998 major stakeholders such as state owned utilities are afforded meetings with the regulators depending on the need. In such cases the stakeholders have ample opportunity to voice concerns related to proposed changes. This consultative process allows for good negotiation and for the best decisions to be made to safeguard the environment and also the development of the country.

Listed activities are legally determined by the Minister as provided for under section 24 of NEMA. Listed activities constitute activities which are known to or likely to cause environmental damage or degradation. This is informed by international best practice, input from stakeholders, past incidents and reports and the nature of the activity. Therefore activities which are seen as high risk to the environment are listed so that comprehensive studies are undertaken, mainly to explore alternatives and mitigation measures. The official also expressed that listed activity criteria are not only limited to this but the also consider he geographical area and also the sensitivity of the receiving environment. The purpose of the EIA and BA process is therefore to ensure that activities are adequately managed to prevent environmental degradation by conducting a risk assessment, planning for impacts and incorporating best practice. Another value added by the EIA process is the mandatory public participation which is a tool to inform the public of the intended development and allow for comments from the public.

The main reason why some activities are not listed is that they are not seen as activities which cause significant harm to the environment. This is the same for reticulation power lines (11-22kV) which are not listed under the current regulations. The official also expressed that due to the high volume of electrification and reticulation infrastructure being built across the country; it would halt development if each and every single line went through an EIA or BA process. This is due to the resources needed to process a BA or EIA application. On the Eskom side this would also have serious implications for resources; human and financial. Therefore the cost, time and volume played a major role in determining whether low voltage power lines are included in the listed activities or not. The official however expressed that the Department of Environmental Affairs is investigating introducing new regulations which will allow for other forms of environmental assessment tools to be utilized for environmental impact assessments which can lead to the acquisition of an environmental authorization without having to undergo a BA or EIA. Another option being explored is the use of new tools for impact assessments which negate the need for an environmental authorization.

Conclusion

From this interview it can be concluded that there are other factors apart from anticipated environmental impact assessments which influence the legal framework. In this case it would be impractical for the Department of Environmental Affairs to rule that all power lines regardless of voltage should undergo a BA or EIA process. This is considering the number of reticulation projects across South Africa. KwaZulu- Natal on its own has a target of 88000 connections in a three year period and going through the Environmental Authorization acquisition process would significantly hinder service delivery for people. The Department is not oblivious to the environmental impacts of electrification power lines and the current drafting of new regulations is evidence that there is a need for a tool for environmental assessments even for developments which are otherwise seen as low impact. Another factor to consider is the cumulative impacts of such projects; although when a single low voltage line is compared to a high voltage line, the environmental footprint of the high voltage may be greater but because there are so many low voltage power lines being built everyday the cumulative impacts of these power lines may far outweigh the impacts of large voltage power lines which a fewer in number.

APPENDICE A3: **Impacts on birds (EWT)**

A Senior Field Officer for the EWT Threatened Grassland Species Programme was interviewed telephonically on the 17th of November 2017. The interview followed his submission of the completed survey and its aim was to further investigate issues raised on the submitted questionnaire. The official strongly supported the hypothesis that low voltage power lines have more impact on birds than higher voltage power lines. This is based on his 15 years of experience with power lines and bird conservation. He further expressed that bird collisions and electrocutions are avoided when BAs or EIAs are undertaken because the risks are identified and mitigated. There is no need for birds to be killed on power lines because there is evidence to support a high success rate for mitigation measures such as the installation of bird flight diverters, bird flappers and insulation pipes. The officer also made mention of incidents that go unreported or unseen which distorts the picture of Eskom's impacts on power lines; some birds are also unidentifiable which poses a data integrity issue.

APPENDIX B: Sample Questionnaire for Key Informants

PART 1: PERSONAL DETAILS

Reference number	(office use only)
Position	
Company	
Years of experience in current position	
Years of experience with Eskom Distribution	

PART 2: ENVIRONMENTAL IMPACTS

1. Do Eskom distribution activities and operations affect the environment negatively?

YES		NO	

Mark with X

…….

1. When you compare the overall impacts of low and medium voltage power lines to high voltage power lines, is there a difference in the **types** of impacts

YES		NO	

Mark with X

2. When you compare the overall impacts of low and medium voltage power lines to high voltage power lines, is there a difference in the **severity/magnitude** of impacts

Impact	**Yes, LV power**	**Yes, HV power**	**Yes but the Difference is**	**No the impacts**

	lines have more impacts	**lines have more impacts**	**negligent**	**are the same**
Bird electrocutions				
Bird collisions				
Loss of indigenous and protected vegetation				
Spillages of oil and chemicals				

3. In your opinion does conducting Basic Assessments help avoid negative impacts on indigenous and protected vegetation? If yes how so?

4. In your opinion do Eskom internal screening processes help avoid negative impacts on indigenous and protected vegetation? If yes how so?

5. Of the two tools (screening and BA/EIA) which is more effective in preventing environmental damage?

6. Why do you think Basic Assessments and Environmental Impact Assessment are not conducted for Electrification (smaller voltage power lines)?

7. What measures can Eskom put in place to minimize the impact of electrification on vegetation?

APPENDIX C: Informed Consent Form for participant

Name and Surname
Work Position
Physical Address

Date:
23 October 2017

Enquiries:
Tel +27 31 710 5291

Dear Participant

Informed Consent Form for participant

Reference Number

This letter serves as an invitation and request for you to take part as a respondent in a series of interviews I will be conducting as part of my Masters Research project. The research is on the Environmental Impacts of Electrification and is being undertaken through the University of Pretoria under the supervision of Dr. D. Darkey, in the Geography Department.

The aim of the study is to evaluate the environmental impacts of reticulation power lines associated with electrification, and compare them to those of sub-transmission projects. Electrification (low voltage) projects are not legally mandated to undergo basic assessments therefore another aim for the study is to develop a guideline that helps regulate and reduce environmental impacts of electrification.

As part of the research I would like to interview you and use your experience and opinion to inform the study and also formulate recommendations. The interview will require approximately an hour of your time and will be set up in advance according to your availability. The information from this interview will form part of the research records.

The interview will solely focus on your professional opinion and will not require any personal details. Information from the interview will be analyzed and included in the thesis without the inclusion of your name and personal details. The interview, with your permission will be recorded and records will be kept for verification process. You have the right of access to your data and an opportunity to review your remarks upon request. The participant consent sheet on page 2 below will be used to assign you with a reference number. This sheet will be locked away by the researcher and the personal details contained therein will be kept confidential and not publicly published or shared.

Your participation in this research is voluntary and you have the right to withdraw your participation without stating reasons should there be a need to do so. Withdrawal from the study will not result in any penalty or loss. You have the right to ask questions and request further information related to the study. You may do so by contacting myself (Tel: 031 710 5291 email: xola.asandad@gmail.com) or the principal investigator Dr. Daniel Darkey (email:daniel.darkey@up.ac.za; Tel: +27 (0) 12 420 3710).

Kindly read and sign the consent sheet below should you agree to participate in the study.

Yours sincerely
ASANDA DEBE

PARTICIPATION CONSENT SHEET (for record purposes, personal details to be kept confidential)

I ……..... employed at …..……

Name and surname **Name of company**

declare that I have read the above information regarding my participation in the study and I consent to participate in the study.
By signing below I declare that

I have read, and I understand the Participant Information Sheet.	Yes ☐	No ☐
I have had the opportunity ask questions and understand the study.	Yes ☐	No ☐
I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without any negative consequences.	Yes ☐	No ☐
I know who to contact if I have any questions about the study in general.	Yes ☐	No ☐
I wish to receive a summary of the results from the study.	Yes ☐	No ☐

DECLARATION BY PARTICIPANT

I hereby consent to take part in this study.

Participant's name:

Signature: Date:

Contact number: email address:

APPENDIX D: ETHICS CLEARANCE CONFIRMATION

Eskom

Date:
28 September 2017

Enquiries:
Tel +27 31 710 5291

Dear Monde Bala

RE: Request for permission to conduct research in KwaZulu Natal Operating Unit.

My name is Asanda Debe I am a student at the University of Pretoria currently, completing a Masters Degree in Environmental Management. As part of the requirements; I am conducting research that is focused on the evaluation of the environmental impacts associated with electrification; and comparing them to those of sub-transmission projects. This project will be conducted under the supervision of Dr. Daniel Darkey of the University of Pretoria, South Africa.

As part of the research I will be visiting Ndumo- Gezisa as the main case study for the research, reviewing OU historical records of environmental incidents, environmental authorizations and licenses. I will also conduct key informant interviews with 10-15 personnel and managers who are directly involved with the electrification process, operations and maintenance and environmental compliance.

I hereby seek your consent to conduct the study and approach various people in the OU in order to attain the data I need for the study. Upon completion of the study the full research report will be shared with the OU. Should you agree please may you sign the consent on page two below. If you require any further information kindly contact me.

Yours sincerely

ASANDA DEBE: SHEQS ENVIRONMENTAL MANAGEMENT

Signed

28/09/2017
Date

Supported:
Troy Govender, Manager,

Environmental Management, KZNOU

SIGNATURE DATE: 28/09/2017

Supported:
Lenny Babulal ,Manager,

SHEQS Manager, KZNOU

SIGNATURE DATE: 10 October 2017

KwaZulu Natal Operating Unit,
SHEQS Distribution
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Tel +27 31 710 5291 www.eskom.co.za
Eskom Holdings SOC Ltd Reg No 2002/015527/30

Eskom

Date:
Enquiries
Telephone

To: The Registrar
University of Pretoria

ETHICS CLEARANCE: CONFIRMATION OF CONSENT AND CLEARANCE FOR MSC DISSERTATION "INTEGRATED ASSESSMENT OF THE ENVIRONMENTAL IMPACTS OF THE KWAZULU NATAL ELECTRIFICATION PROGRAMME: A CASE STUDY OF NDUMO GEZISA 132/22KV MULTI-CIRCUIT POWER LINE". BY MISS XOLA ASANDA DEBE.

This memorandum serves as an Ethical Clearance and confirmation that Eskom is aware and supports the study being undertaken by Miss Xola Asanda Debe.

This is a general clearance for the duration of the study and in no way does it waiver Eskom's Intellectual Property Rights.

Signed (General Manager, Eskom Distribution, KZN OU)

MONDE ZALA
.....

Printed name 31/10/2017
.....

Date

.....