Evaluating the effectiveness of spatial information in EIA reports from a public participation perspective: Case study of selected projects in South Africa.

By

KHWEZI MNCWABE

(201470553)

A minor dissertation submitted in partial fulfilment of the requirements for the Coursework Masters (MSc Environmental Management) degree programme

in the

DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT, & ENERGY STUDIES,

in the

FACULTY OF SCIENCE

at the

UNIVERSITY OF JOHANNESBURG.

SUPERVISOR: Prof. Isaac T. Rampedi

November 2021

ACKNOWLEDGEMENTS

There are several people I would like to thank for their support and their contributions to the completion of this research:

- My Supervisor, Prof. Isaac T. Rampedi for his guidance on the direction of this research project and patience with the corrections that he suggested as I was writing this manuscript.
- To all the staff members and my fellow classmates at the Department of Geography, Environmental Management and Energy Studies who have encouraged me to complete this project and to have a meaningful and enjoyable experience at the University of Johannesburg.
- My parents, Ndumiso and Jessie Mncwabe for moral, emotional, financial support and guidance, discussions, love and advice as well as their interest and support throughout my research period and for affording me the opportunity to pursue my academic goals: Thank You!
- My siblings, Nondumiso Motlhala, Phila Radebe and aunt Phumla Radebe, my supporters for constantly believing in me and my capabilities, their friendship, love and always motivating me to push beyond all boundaries.
- And most importantly, to my Heavenly Father for his Grace and guiding me through the preparation of this research manuscript.

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LIST OF ABBREVIATIONS

EIA	Environmental impact assessment
PP	Public participation
EIAR/s	Environmental impact assessment report/s
PPP	Public participation process
I&APs	Interested and affected parties
PPS	Public participation stage
GIS	Geographic Information Systems
IAIA	International Association for Impact Assessment
DAPL	Dakota Access Pipeline
CGL	Coastal Gas Link
LNG	Liquified natural gas
MRC	Mineral Commodities
TEM	Transward Energy and Mineral Resources
DME	Department of Mineral and Energy
SWC	Sustaining the Wild Coast
ACC	Amadiba Crises Committee
PPGIS	Public participation geographic information systems

ABSTRACT

The aim of this study was to evaluate the effectiveness of spatial information used and presented during EIA processes, public participation process (PPP) and inside Environmental Impact Assessment Reports (EIARs) from a public participation perspective. To achieve this aim, the spatial information in 25 EIARs was evaluated on how it was utilised and presented for proposed renewable energy projects in the Northern Cape province. Such spatial representations help stakeholders to understand the geographical location of the proposed projects, their environmental feasibility, spatial extent, anticipated environmental and socio-economic impacts and how such information catered to the needs of stakeholders. Thus, the research identified the different uses of spatial representations and their varying degrees of visual realisms. The results revealed different types of spatial illustrations along with their degrees of visual realism. Furthermore, this study indicated different dimensions of PP and how the issues and concerns that were documented related to the use and depiction of spatial information. These dimensions (notification methods, participation method, venue, language used and type of participants) were evaluated alongside the issues and concerns that were raised by the EIA stakeholders. Lastly, a number of recommendations have been suggested for improved quality of spatial information provided during EIA processes.

Keywords: Environmental impact assessment, public participation process, spatial information, categories of spatial information, visual realism and dimensions of public participation.

CHAPTER 1

INTRODUCTION, JUSTIFICATION AND THE RESEARCH PROBLEM

1.1INTRODUCTION

One of the environmental management tools that is being used internationally to help provide a trade-off and a balance between environmental protection, industrial development of infrastructure, and meeting the socioeconomic needs of communities and stakeholders is the environmental impact assessment (EIA) process. The EIA process seeks to predict, identify, and evaluate the different environmental impacts that will arise out of proposed infrastructural projects and to provide guidelines on how the predicted impacts can be mitigated effectively (Wang & Chen, 2006; Betey & Essel, 2013; Machaka, 2017; Nicol & Chandes, 2017; Kantamaturapoj et al., 2018; Glasson & Therivel, 2019). Although there are some variations in the different stages that entail an EIA process, in many jurisdictions, stages such as the following ones are common: project screening, scoping, consideration of alternatives, environmental base line characterisation, public participation, impact monitoring and mitigation, EIA review as well as decision-making and authorization (Strydom et al., 2009). The value of an EIA is to ensure that both negative and positive impacts are systematically assessed while exploring the different alternatives to ensure that there is sustainable development.

Environmental impact assessment (EIA) also ensures that there is conflict resolution and the different stakeholders likely to be affected by the proposed development actions are taken into consideration when important decisions are undertaken (Machaka, 2017; Glasson & Therivel, 2019). Amongst all EIA stages, stakeholder involvement during the public participation stage (PPS) afford interested and affected parties (I&APs) the opportunity to be informed, involved, and consulted on the impacts (whether negative or positive) that may result from proposed projects (O' Faircheallaigh, 2010; Chompunth, 2017; Kantamaturapoj et al., 2018; Glasson & Therivel, 2019). The key elements to an effective public participation process (PPP) entail (1) early involvement, (2) meaningful stakeholder representativeness, (3) educating the participants and (4) transparency and information sharing during the EIA process (Rowe & Frewer, 2000; Videira et al., 2006; Chompunth, 2017). In many studies, public participation is being regarded as a fundamental part of an EIA to ensure sustainable development (Doell & Sinclair, 2006; Kantamaturapoj et al., 2018). However, the EIA process and the PPP does not always unfold as intended, hence there are many shortcomings, methodological inefficiencies, and poor communication of the findings that stem from EIA investigations and stakeholder engagements (O' Faircheallaigh, 2010; Machaka, 2017; Kantamaturapoj et al., 2018).

1.1.1 The Relationship between Public Participation and Spatial Information

Public participation (PP) is becoming an essential part of natural resource planning and management for proposed projects (De Freitas, 2010). One of the components of communicating with the different stakeholders during an EIA process and the associated impact predictions and mitigations is the effective utilisation of spatial information. The spatial information that is provided during the PPS help people to understand and appreciate the different ramifications of these projects but also the ecological and socioeconomic sensitivity of the locations and sites where such development actions would take place (Mwenda et al., 2015). Spatial information can show not only the project's location but also the spatial distribution of anticipated impacts and how they will change with different project alternatives (Mwenda et al., 2015). To this extent, impacts related to proposed projects can be highlighted by means of spatial representations. Spatial representations are many and may be in the form of three- dimensional (3DL) photographic visualisations as well as topographical maps, and orthophoto maps, among others (Harper, 2002; Prendergast & Rybaczuk, 2004; Lewis & Sheppard, 2006; Lai et al., 2010; Niyaz & Storey 2011).

According to Glasson & Therivel (2019), overlay maps can be used for the delineation and identification of optimum corridors for the development of linear facilities. Such facilities are varied and can include road networks, power lines, electric transmission lines, as well as railway lines. In this context, such spatial information aids the comparison between different alternatives and which ones are the most feasible ones from a sustainability point of view. Furthermore, other illustrations can be in the form of geographical location, impact distance, magnitude, direction, angle, colour, scale as well as visual realism (Liben, 2009; Gonzailez, 2012). Thus, different steps of the EIA process, including the prediction, assessment of impact magnitude and significance can benefit from Geographic Information Systems (GIS) by effectively communicating the impacts using spatial representations drawn to scale and legend, therefore depicting geographical features on the map with adequate clarity and degree of colour contrast (Mwenda et al., 2013). According to Satapapathy et al. (2008) and Mwenda et al. (2015), an enhanced consideration of environmental problems can be achieved using spatial data and representations during the EIA process. Spatial information can enrich the effectiveness of PPS in the EIA process when people understand the spatial dimensions and consequences of proposed developments (Satapapathy et al., 2008; Mwenda et al., 2015).

1.1.2 Statement of the Research Problem and Study Objectives

Despite the usefulness of spatial information during EIA processes, and public participation in particular, there are very few studies that provide a conceptual link between the use of spatial information and the prediction of impacts as well as their magnitude and significance (Vanderhaegen & Muro, 2005; Mwenda et al., 2015). This scarcity of information also applies to South Africa, where there are no detailed studies on the usefulness of the spatial information towards improved understanding of the location of proposed projects, their different impacts, ecological and socioeconomic sensitivities, and how their impacts can be reduced. In view of this literature gap, the present minor dissertation has evaluated the use of spatial information during PPP in EIA for effective environmental analyses. Thus, the study aimed to assess the effectiveness of the spatial data that were provided in the selected EIARs for public participation. The selected EIARs are mainly from the Northern Cape province, Energy sector. To achieve this broad aim, the following research objectives were formulated, and they are summarised as follows:

- To identify different kinds of spatial representations that were used in EIA reports to help stakeholders understand the location, environmental impacts, and their environmental feasibility.
- To establish how spatial information was used to provide details and spatial extent of proposed development projects.
- To establish if the spatial information given in the EIARs catered for the needs of the different stakeholders to conceptualize and comprehend the magnitude and the significance of anticipated environmental and socio-economic impacts.
- To identify the issues and concerns raised by the different stakeholders and how they relate towards the quality of the spatial data and representations provided.
- To make recommendations on how the quality of spatial information provided in EIARs can be enhanced.

1.1.3 Structure of the Minor Dissertation

This minor dissertation is presented in five different chapters. In Chapter 1, an introduction and study background as well as justification is given. The same chapter also provides the statement of the research problem as well as research objectives. Chapter 2 presents the research methodology that was utilized. Chapter 3 looks at the literature review and similar baseline studies. Chapter 4 presents the findings from the study, through the assessment of the different types and groups of spatial representations used in the different EIARs, the extent to which these spatial representations vary based on the level of visual realism, the various dimensions of PP as well as the issues and concerns raised by the I&APs. Furthermore, this chapter provides the discussion of the results. Lastly, chapter 5, provides the conclusion on the overall findings of the study and recommendations.

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CHAPTER 2

RESEARCH METHODOLOGY

2.1 INTRODUCTION

To evaluate the effectiveness of spatial information provided inside environmental impact assessment reports (EIARs) amongst selected proposed projects in South Africa, the current study followed the approach first adopted by Mwenda et al. (2012), Mwenda et al. (2013) and Mwenda et al. (2015). In subsection 2.1.1, the research methods are explained while data analyses and interpretation are given in section 2.1.2, primarily focusing on evaluating the types of spatial representations in subsection 2.1.2.1, secondly, evaluating the role of visual realism is in subsection 2.1.2.2, then, evaluating the role of visual realism and related aspect, in addition to assessing the dimensions of the public participation process (PPP) is found in subsection 2.1.2.4. In subsection 2.1.3, the research methodology flow chart is provided to provide a summary of this chapter.

2.1.1 Research Methods

This study adopted research methods developed firstly by Mwenda et al. (2012), Mwenda et al. (2013) and Mwenda et al. (2015) to conduct environmental impact assessment (EIA) studies in Kenya. Kenya, South Africa, Tanzania and Angola have all adopted similar EIA systems into public policies despite the limits that they might face. Moreover, they are moving over to a more flexible system with more public involvement (Rebelo & Guerreiro,2017). Mwenda et al. (2012) proposed 5 dimensions of public participation gathered from consultation with various stakeholders. These dimensions are briefly stipulated as follows:

- Methods of notifying stakeholders for public participation,
- Methods on how public participation is carried out,
- Venues selected for public participation,
- Types of languages used for public participation, and
- Types of stakeholders consulted

They further looked at these aspects from the background on EIA policy to validate them and justify their importance in having an effective public engagement on proposed projects. Furthermore, Mwenda et al. (2013) identified 7 aspects, which are related to spatial information relevant for public participation (PP). Such aspects included *accessibility*, *availability*, *language*, *content appropriateness*, *translation as well as technical support*. From these seven aspects, five of them (appropriateness, content, accessibility, translation in addition to technical support and language) could be assessed using surveys or questionnaires. However, two of such aspects, namely, 'availability' and 'content' can be utilized to evaluate the relationship between spatial information and PP from EIARs. According to Mwenda et al. (2013), '*Availability*' denotes the presence/absence of spatial representations and the different ways it is used (based on the level of how realistic they are visually). Also, the actual information presented is referred to as '*Content*', of which this entails the project location, project specifics, and areas that are of interest to the impact assessment process (Table 2.1) (Mwenda et al., 2013).

Table 2.1: Characteristic of spatial data that are considered

Types of spatial data	**Characteristics of spatial data**
Availability: representation forms	• Presence/absence of spatial representations • Forms detected (founded on level of visual realism
Content: representation of the problem	• Project site • Project activities/details • Special interest areas, e.g. organizational boundaries, hydrology, geography, protected areas, dispersal of endangered plant/animal species, etc.

Source: Mwenda et al. (2013).

Other additions to their research methodology, included seven specific aspects where spatial information is used for enhancing PP (Table 2.2) (Mwenda et al., 2015). Thus, their methodological framework depicted specific and relevant aspects whereby spatial information was required for furthering the goals of PP. All these aspects were intended to enhance effective communication amongst the interested and affected parties (I&APs) during the EIA process. The aspects in Table 2.1 combined with the classification in Table 2.2, produced the final categorisation of visual realism (Table 2.3) that was used by Mwenda et al. (2015) to assess the relationship between spatial information and PP from to generate the final data.

Table 2.2: Categories representative of the 7 aspects that can be found in spatial representations.

Category	**Details**
1.	Project location/site
2.	Project activities/details
3.	Special interest areas
4.	Project location+ project activities/details
5.	Project location+ special interest areas
6.	Project activities/ details+ special interest areas
7.	Project location+ project activities/details + special interest areas

Source: Mwenda et al. (2015)

Table 2.3: Different levels of visual realism.

Category 1 **Low visual realism**	**Category 2** **High visual realism**	**Category 3** **Mix visual realism**
Topographic maps Cadastral maps CAD drawing/maps Site layouts/plans Survey maps	Photographs Google maps 2D/2D visualization Land-cover maps	Comprising displays with mutually low and high visual realism

Source: Mwenda et al. (2015)

The use of this Mwenda et al., approach is also evident to a certain extent in comparative overview of EIA systems and practice studies conducted in in Kenya, South Africa, Mozambique, Tanzania, Mozambique, Angola and the EU in order to assess their effectiveness by Rebelo and Guerreiro (2017). This study addressed issues such as: Which EIA procedures are followed? What are the details of EIA requirements? Are the implemented EIA systems effective? What are the main constraints and gaps for genuine effectiveness of EIA systems? (Rebelo & Guerreiro, 2017, pg. 605). What are the next steps to improve the effectiveness of EIA systems and practice in these countries? As stated before, in the current study, the methodology used by Mwenda et al. (2013 & 2015) were adopted.

Copies of approved EIARs were accessed from the websites of different EIA consulting companies in South Africa. In total, 25 such reports were obtained for detailed analysis from company websites which were accessed and a total of 17 approved EIARs were acquired for this study, this is due to companies now restricting public access to EIARs. The other 8 were all from the department's archives. Most (i.e. 80%) of these were written for the environmental authorization of various renewable projects in the Northern Cape province of South Africa. Therefore, the study used a non-probability sampling technique, which is purposive sampling. Purposive sampling is regarded as a non-probability sampling technique, which can be useful in the unfortunate circumstance of limited resources, time, and workforce (Etikan et al., 2016). Purposive sampling also provides a better matching of the sample data to the aims and objectives of the study (Sharma, 2017; Campbell et al., 2020). However, it also has its limitations due to its subjective nature and may not be a 100 percent representation of the overall sampled data (Etikan et al., 2016).

2.1.2 Data Analysis and Interpretation

Data analysis was conducted to address the aim of the study, which is to evaluate the effectiveness of spatial information in EIARs from a public participation perspective in South Africa. The evaluation was conducted through a content analysis of the EIAR. This was meant to determine how efficient was the presentation and use of spatial information in depicting the different project aspects as well as their social and environmental impacts. This exercise was guided by the current research objectives, which were: (1) to identify different kinds of spatial representations that were used in EIARs for engaging stakeholders; (2) to establish how spatial information provided details and spatial extent of proposed development projects; (3) to establish if the spatial information given in the catered for the information needs of stakeholders to conceptualize and comprehend the magnitude and the significance of anticipated environmental and socio-economic impacts; (4) to identify the issues and concerns raised by the different stakeholders and how they relate to the spatial representations; and (5) to make recommendations on how the quality of spatial information provided in EIARs can be enhanced in future studies. What follows below is an explanation on how the different objectives were addressed in terms of data analysis.

2.1.2.1 Evaluating the Types of Spatial Representations

To evaluate the use of spatial information, the EIARs were reviewed individually to first document if the spatial information was present or absent in such reports. The spatial information were recorded as a group and those that showed no spatial information were also recorded as another group. A further analysis was conducted on those reports that depicted spatial representations. This analysis evaluated the type of spatial representations that were used in each of the EIAR documents. Essentially, the goal was also to highlight if the spatial representation were orthophoto maps, topographic maps, land-cover maps, google maps, site layouts/plans, cadastral maps, CAD drawing/maps, photographs, survey maps or 2D/2D visualization. Alongside the types of spatial representations that were used, the use of appropriate map elements was also evaluated. Such an evaluation was based on the use and appropriateness of scales, legends, degree of clarity and colour contrasts on the maps. Moreover, the spatial representations were then grouped together according to their different map types. Finally, the total numbers of the different spatial representations were collated and displayed in the form of graphs and pie charts as well as descriptive statistics.

2.1.2.2 Evaluating the Role of Visual Realism

In examining how spatial information provided the details and spatial extent of the proposed development projects during the PPP, the level of visual realism was evaluated. Such realism plays a major role in fostering public understanding and their ability to participate meaningfully in the PPP (Fan et al., 2014). Visual realism contributes to the transparency of stakeholder engagement and therefore the ability of stakeholders to comprehend the different project aspects, environmental impacts as well as impact magnitude and significance and reach a decision on the proposed project. Thus, the different levels of visual realism were categorised as follows:

- High visual realism (being the most preferred),
- Low visual realism (least preferred), and
- Mixed visual realism (also mostly preferred) (Table 2.3).

These realisms were used to interpret the different types of spatial representations that were found on the selected EIARs. The spatial representations were subsequently counted and then classified into the categories of **high** (i.e. photographs google maps 2D/2D visualization and land-cover maps), ***low*** (i.e. topographic maps, cadastral maps CAD drawing/maps, site layouts/plans, survey maps) and ***mixed visual realism*** (i.e. combined use of both low and high visual realism).

2.1.2.3 Evaluating the Role of Visual Realism and Related Aspects.

In terms of establishing if the spatial information given catered for the different stakeholder needs and assisted them in conceptualizing the magnitude and the significance of anticipated environmental and socioeconomic impacts, the data depicted in spatial representations were in addition evaluated according to the 7 aspects designed for presentation and analysis purposes by Mwenda et al. (2015) alongside visual realism. This was done through an observation of how different types of spatial representations used in the EIARs were depicted: firstly, the geographical location of proposed projects, preferred sites and different site alternatives, secondly, project surrounding activities and baseline conditions, thirdly, impacts on the physical environment, impacts on human environment, and lastly, the overall environmental sensitivity of the preferred sites. Every aspect that was depicted in each EIAR document was then recorded and categorised according to the 7 aspects by Mwenda et al. (2015). The data were then presented using tables, pie charts, bar graphs as well as percentages and proportions.

2.1.2.4 Assessing the Dimensions of PPP

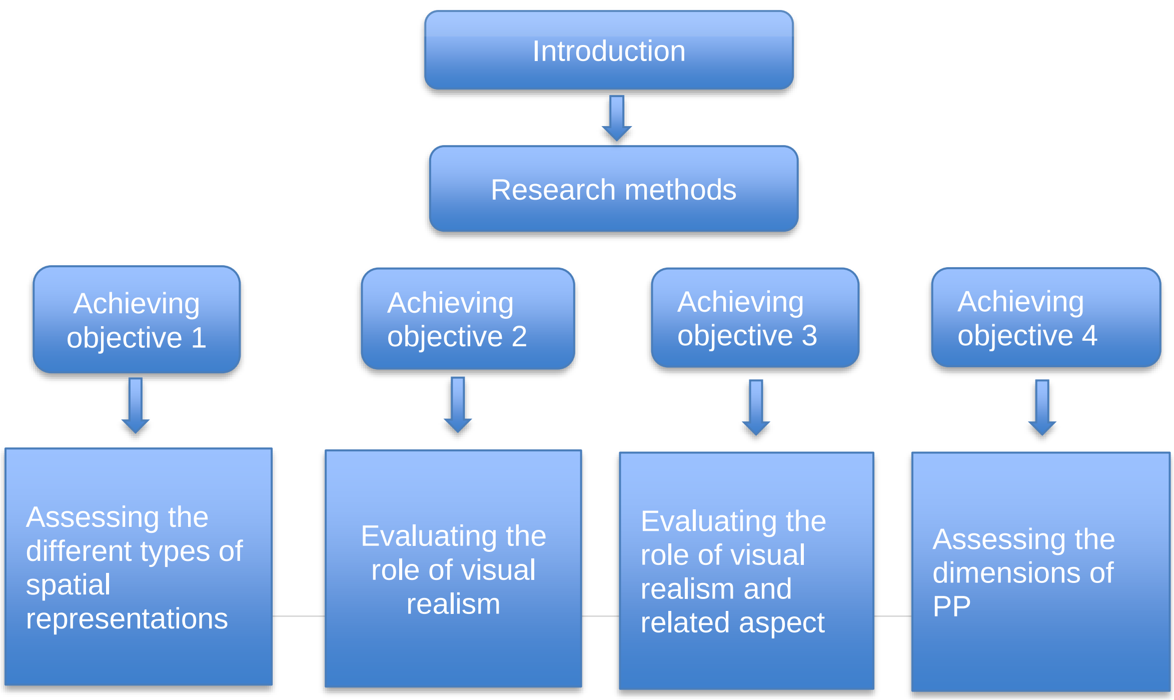
To evaluate the understanding and transparency levels in the PPP among the different stakeholders and I&APs, the dimensions of participation were also evaluated. The method adopted from Mwenda et al. (2012) was implemented by individually evaluating each EIAR. This was done to record how each dimension (notification method, participation method, venue, language used and types of participants) of PP was implemented and addressed. The implementation methods were then graded using a Likert scale (Table 2.4) and the results were displayed in a table form as well as in a descriptive analytical format on how satisfactory the dimensions of PP were highlighted during the PPP. Moreover, the comments that were recorded during the PPP and the EIA process were also taken into consideration in this research study. Some of these comments related to mitigation measures, indigenous knowledge, land claims and overall project impacts. This exercise was meant to identify the issues and concerns raised by the different stakeholders and how they relate to spatial representations. Furthermore, the data were then graded to determine the degree to which the dimensions subsequently advanced the effectiveness of the PPP.

Table 2.4: Likert scale showing degrees of satisfaction on the clarity of spatial information from satisfactory to unsatisfactory (1-5) levels of detail.

Suitability	**Score**
Very unsatisfactory	1
Unsatisfactory	2
Neutral	3
Satisfactory	4
Very satisfactory	5

2.1.3 Research Methodology Flow Chart

To summarise the whole research methodological approach, a flow chart is provided below, to show the relationship between the introduction, research objectives, research methods, data analysis and the presentation of the results (Figure 2.1).



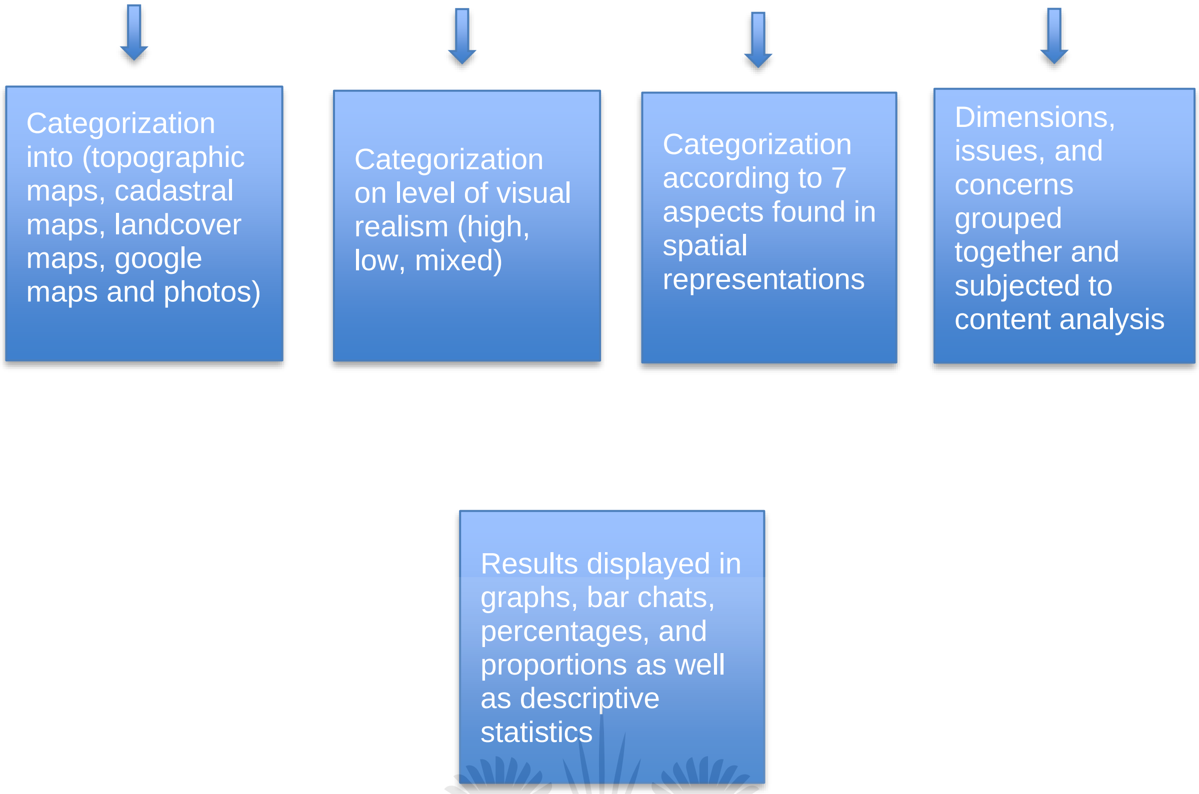


Figure 2.1: Research methodology flow chart.

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CHAPTER 3

LITERATURE REVIEW

3.1 INTRODUCTION

This chapter is based on the review of literature relevant to the research problem. Section 3.2 is based on a brief overview of the environmental impact assessment (EIA) process as an instrument for assessing the environmental feasibility of proposed development projects. While an EIA process has different stages, section 3.3 examines only EIA and stakeholder engagement. It looks at the value of spatial information that is relevant for effective public participation (PP) and the different types of such representations. Furthermore, this section highlights cases in development projects, whereby planning problems could have been avoided through effective stakeholder engagement. In section 3.4, different ways, methods and approaches for assessing the importance of spatial information during PP are reviewed as well as the developments of visual realism. Furthermore, this section looks at how South Africa's legislations and regulations address the importance of spatial information for environmental decision-making process.

3.2 Brief Overview of EIA

The EIA process originated from the USA around 1969 and is comprised of several stages such as screening, scoping, impact prediction and analysis, stakeholder engagement or PP, mitigation and impact management, review, decision-making as well as implementation and follow up (Figure 3.1) ((Nakamura, 2008; Machaka, 2017; Glasson & Therivel, 2019). According to Sadler et al. (2012), EIA is a "forward looking instrument that proactively advices decision-makers on the consequences of the proposed actions that are to be implemented" (Morrison-Saunders, 2018). The International Association for Impact Assessment (IAIA), simply defines EIA as "a process of identifying the future consequences of current or proposed actions" (Morrison-Saunders, 2018). EIA ensures that anticipated environmental impacts are systematically considered when new projects are proposed for development. According to Hayes (2017), impact assessment during an EIA process entail anticipating as well as assessing the difference between present and future environmental conditions and determining the magnitude and significance of predicted impacts (Hayes, 2017). Where undesirable impacts of a development projects are foreseen, the main opportunity for their prevention and mitigation arises during the EIA process, the goal being to reduce environmental degradation and promote sustainable development (Nicol & Chades, 2017).

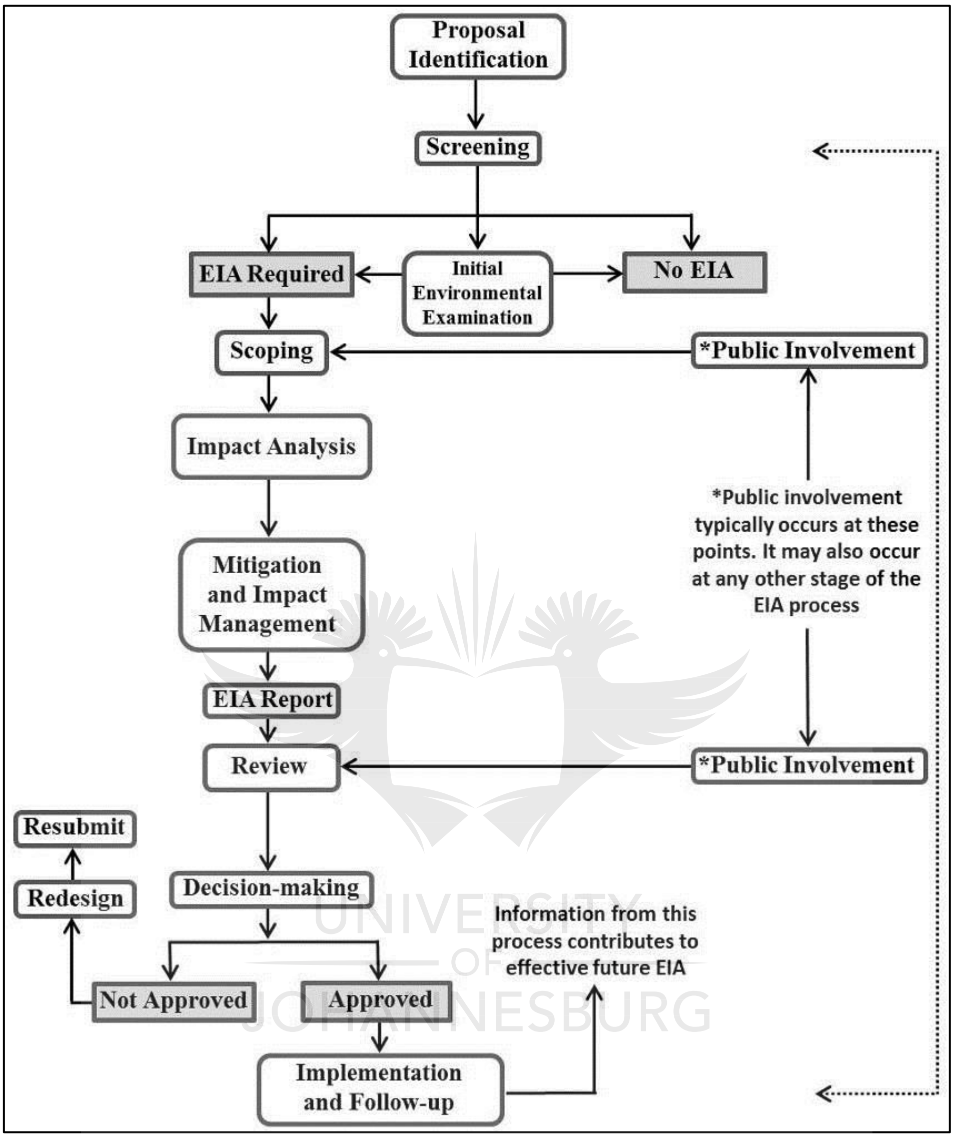

Figure 3.1: Generic EIA process.

Source: Glasson & Therivel (2019)

During the EIA process, evidence on environmental impacts of a proposed project is gathered and evaluated by the planning authority, together with all proponents, regulators and communities for decision-making on whether the development should be approved or not (Hayes, 2017; Nicol & Chades, 2017; Morrison-Saunders, 2018; Glasson & Therivel, 2019). EIA's administrative processes and main objectives can be easily grasped from standard policies and regulations (Fonseca, 2019). Impact assessments of the environmental effects (both positive and negative) of planned development projects are conducted within the framework of relevant laws, regulations and management tools that are based on the “think before you act “ principle, that engages stakeholders in the planning, designing and implementation phase of a development activity (Machaka, 2017; Nicol & Chades, 2017; Morrison-Saunders, 2018). Such projects may have a wide range of impacts on the natural and human environments. Thus, EIA can contribute towards sustainable development by identifying and preventing potentially undesirable impacts on the land surface, biodiversity, water resources, and ambient air quality because people depend on such environmental goods and services for their livelihoods and sustenance (Mwenda et al., 2015; Machaka, 2017; Kantamaturapoj et al., 2018).

3.3 EIA and Stakeholder Engagements

Sustainable development and the planning process have been proven to be more effective when the stakeholders are involved and included in the decision-making process. This process also assists in comparing the interests and preferences of all the different stakeholders (Bryan et al., 2010; Cox et al., 2019). A growing body of research has established that, by collaborating with different stakeholders in the planning process of development projects, tensions between developers and stakeholders may decrease, while public support, trust, awareness, empowerment and implementation efficiency are likely to increase (Donovan et al., 2009; Cox et al., 2019). In this context, EIA becomes a very valuable instrument for engaging communities and stakeholders, and helping those that are likely to be affected negatively by the developments to be informed and consulted about the magnitude and significance of impacts and possible mitigation (Reed, 2008; Riddlesden et al., 2012; Wu et al., 2014). Thus, the public participation process (PPP) is a crucial stage within the EIA process.

In many countries, failure to conduct effective PP during an EIA process has led many proposed projects into public disarray and distresses, resulting in costly delays and eventually project termination (Energy & Prasad–India–Law, 2020). For example, in February 2020, Canada witnessed a ground swell of public opposition and resistance across many localities due to the unlawful proposal for a Coastal Gas Link (CGL) pipeline, which is part of the Liquified Natural Gas (LNG) Canada pipeline project, that was expected to traverse tribal lands inhabited by indigenous communities. The LNG Canada project is a joint venture company mainly comprised of the Royal Dutch Shell (40%), Mitsubishi Corporation (15%), PetroChina Company Ltd. (15%) and Korea Gas

Corporation (5%) (Shell, 2018).The project entails the extraction of natural gas and its transportation via a 670 km long pipeline in Dawson Creek and British Columbia as well as its ultimate liquification in Kitimat as the gas is prepared for export (Kaiser & Lakhani, 2020). According to Energy & Prasad–India–Law (2020), anti-pipeline protests are spreading in many parts of Canada in solidarity with the Wet'suwet'en Nation's disagreement against the planned pipeline. One of the main causes of the conflict is the insufficient and superficial environmental assessment process that has created negative perceptions in the eyes of the native Wet'suwet'en people. The people also stated that the project will bring destruction of Wet'suwet'en archaeological sites and their cultural heritage (Dhillon & Parrish, 2019; Energy & Prasad–India–Law; 2020).

These misunderstandings in projects can be avoided if proper stakeholder engagement during the EIA process is conducted and adequate spatial information is provided to everyone involved so that different alternatives can be explored. In August 2016, the United States had a widespread media attention, which later turned into a growing encampment of the Lakota and Dakota people and their allies, referring to themselves as Water Protectors, with a similar goal as the Wet'suwet'en people, to stop the proposed Dakota access pipeline (DAPL) (Deem, 2019; Estes, 2019). Thus, plans to construct the Dakota Access Pipeline were announced in 2014 by Energy Transfer Partners (ETP) in South Dakota, North Dakota, Illinois and Iowa (Estes, 2019). As a business endeavour, DAPL investors sought to profit by providing a cheaper transportation alternative to rail (Whyte, 2017). This business venture was proposed to produce energy independence in the US, more employment opportunities, and charitable donations. However, it was unclear how this proposed pipeline would increase oil production, oil consumption, state tax, and employment (Whyte, 2017).

In September 2014, a meeting took place between the U.S. Army Corps of engineers and the various tribes, where the tribes made their opposition to the DAPL clear. This conflict is commonly known as 'No DAPL', which captured international attention (Grossman, 2017; Estes, 2019). The '#NoDAPL' movement believed that the pipeline posed a risk to the water quality and cultural heritage of the Lakota and Dakota people of the Standing Rock Sioux tribe. In July 2020, the DAPL operations were ordered to be ceased, until a thorough environmental impact statement was prepared (Mengden, 2017; Deem, 2019; Estes, 2019). The struggle over DAPL is certainly not over. Environmental injustices may happen when one or more groups of people seek to attain their own perceived economic, cultural, and political ambitions by systematically imposing harm and risks on other people (Deem, 2019). Yet, the United States government refused to participate meaningfully in a treaty-making process that would allow native leaders to reach an agreement based on their native governance procedures (Whyte, 2017). Therefore, meaningful engagement with interested and affected communities would have helped in avoiding conflicts and unnecessary legal clashes (Johnson, 2019).

Due to proposed titanium mining in Kenya around 2001, more than 3000 residents were relocated from their ancestral land in Kwale in 2007. Also, the local community was in conflict with the government and the mining company regarding resource control on this mining project (Uchendu, 2007). The major source of conflict was over who owns the resources, and thus control the land on which the mining project was taking place. While the indigenous people held the opinion that they are the rightful owners of the disputed land by virtue of living on it, government considered itself as the statutory owners (Akpan, 2005; Uchendu, 2007). This view then resulted in conflicts over how much compensation they were to receive. Since mining can lead to social displacement, the affected community was expecting to be compensated in order to reduce the intensity of the impacts of displacement, thus minimising conflict (Abuya, 2017). According to Abuya (2017), to minimise this conflict an ethno-ecological consideration of resources that are being fought over can also be a solution.

Ethno-ecological knowledge may provide the necessary insights to governments on the importance that communities hold on the assets lost and/or targeted for compensation, which will enable policy makers to enact better laws that take consideration of this reality (Uchendu, 2007; Abuya, 2017). It was therefore crucial for Kenya to carry out much-needed reforms in their mining sector. For instance, Mnwana (2014) suggested that it could borrow some insights from South Africa, which has passed laws that allow for community ownership and management of mining resources Mnwana (2014). South Africa also presents an interesting case as their legislation allows for community ownership and control of minerals, with adequate engagement between all the interested and affected parties (I&APs) in a public participation process (PPP). However, there are still many project conflicts that still arise despite the legislations in South Africa.

For instance, in Mgungundlovu, on the Wild Coast of South Africa, in the province of the Eastern Cape, there has been much controversy and undesirable social dynamics associated with the Xolobeni Heavy Minerals Sands Project. The proposal of this mining project has created a highly contested development that has bred division within the affected communities. The majority of affected communities are opposing the development proposal from going ahead (Pillay 2010; Huizenga, 2019). The proposal was presented by an Australian mining company, Mineral Commodities (MRC), and its South African subsidiary, Transworld Energy and Minerals Resources (TEM) (Bennie, 2011). To a certain extent, this development proposal was supported by trade unions who were more concerned about employment creation opportunities more than environmental issues (Bennie, 2011). Therefore, there was a need to include environmental issues, and particularly the protection of natural resources which form the basis of local livelihoods (Bennie, 2011). Nevertheless, the Xolobeni proposed mining project has been characterised by unequal power relations, and a lack of participation by the affected communities ((Bennie, 2011; Huizenga, 2019). Those who are in favour of the mine argue that it will bring development to the region, while, those opposed to it, argue that it will destroy local natural ecosystems and the livelihoods of the affected population, and therefore it is the 'wrong kind' of development (Bennie ,2011; Bedford et al., 2020).

There was clearly a lack of participation by the affected communities and this was shown by the awarding of the right for TEM to begin mining the Kwanyana Block. This environmental authorization was granted from the then Department of Minerals and Energy (DME) on the 14th of July 2008. But the public and the communities only became aware of the decision on the 4th of August 2008 (Bedford et al., 2020). Nevertheless, after realising the level of opposition to the mining and lack of consultation, the Minister of Mineral Resources revoked the mining licence on environmental grounds in June 2011 with a period of 90 days to reapply (Pillay 2010; Bennie ,2011; Bedford et al., 2020). Resistance to the mining continued to arise out of the community itself in the form of the Amadiba Crisis Committee (ACC) and from the South African environmental movement organised under Sustaining the Wild Coast (SWC). There is growing advocacy for encouraging more sustainable opportunities that are grounded in sustainable livelihoods and environmental justice (Bennie, 2011; Bedford et al., 2020). In view of these environmental planning problems, there is an increase in the research on the efficiency, quality, successes, and failures of PPP (Riddlesden et al., 2012; Mwenda et al., 2013; Vanclay et al., 2013; Mwenda et al., 2015). Public participation in EIA can become an effective vehicle to address conflicts and how they can be resolved (Wu et al., 2014; Machaka, 2017).

The intensity of most of the afore-mentioned conflicts can be significantly reduced if proper stakeholder engagement during the EIA process can be conducted and adequate spatial information is provided to everyone involved so that different alternatives can be explored openly and in a transparent manner in the design phase of such projects. Furthermore, the utilization of spatial data and representations generated from Geographic Information Systems (GIS) is one of the ways in which EIA practitioners can increase the extent to which the public and other stakeholders are assisted to understand the different aspects of the proposed projects, the different environmental impacts they would produce during their life cycle as well as the magnitude and significance of these impacts (Satapathy et al., 2008; Mwenda et al., 2015). Using spatial representations during the project's lifecycle to enhance stakeholder knowledge and awareness often ensures that project implementation proceeds without many difficulties (Planek, 2016). However, this does not mean that the mere use of spatial information during an EIA process will create complete agreements and harmony between the different stakeholders during the EIA process. Thus, spatial information is just one of the aspects that can contribute to mutual understanding of proposed projects, their technical layout and even route alignment where linear infrastructure such as roads, pipelines, and power transmission lines are to be constructed. According to Brown (2015), the quality of information that is collected during the involvement of stakeholders in the participation process is also as important as the level of fairness, collaboration, and citizen empowerment. The PPP needs to exploit the benefits of 'crowd wisdom', while aiming to achieve independence and diversity. It is also important to ensure that the type of information gathered during the PPP is accurate and represents the views of the different stakeholders (Brown, 2015).

3.4 Geographic Information Systems and Spatial Information

A GIS is a computer system for managing spatial data (Unger-Holtz, 2007; Bonham-Carter, 2014). The word geographic indicates that locations of the data objects are known, or can be calculated, in terms of geographic coordinates such as latitude and longitude. Most GIS are limited to data in 2-dimensions, although some systems, for example particular to Geologist have 3-dimentional capabilities. Information suggests that the data in a GIS are arranged to produce useful knowledge, frequently as coloured images and maps, but also as statistical tables, graphics as well as several on-screen responses to interactive queries. The word 'systems' imply that a GIS is made up of several linked and interrelated components, that have different functions

(Bonham-Carter, 2014). Therefore, GIS have efficient abilities for data capture, input, manipulation, combination, analysis, query, transformation, modelling and output, applied in several fields of study (Table 3.1). A GIS is comprised of a computer program packages with user interface that offers access to precise functions (Bonham-Carter, 2014). Manipulating maps, digital images and tables of geographically located data items can be completed through GIS computer tools (Unger-Holtz, 2007; Suresh & Usha, 2008; Panek, 2016. GIS organises spatial data from diverse sources into integrated databases, using a variety of digital data structures, representative of spatially changing phenomena as a series of data layers, all of which overlap correctly at all locations in a spatial register (Bonham-Carter, 2014).

Table 3.1: Application areas for GIS.

Activity	Application	Activity	Application
Socio-economic/government	Health Local government Transport planning Service planning Urban management International aid and development	Utilities	Network management Service provision Telecommunication Emergency repairs
Defence agencies	Target site identification Tactical support planning Mobile command modelling Intelligence data integration Homeland security and anti-terrorism	Environmental management	Landfill site selection and mineral mapping potential Pollution monitoring Natural hazard assessment Disaster management and relief Resource management Environmental impact assessment
Commerce and business	Market share analysis Insurance Fleet management Direct marketing		

	Target marketing Retail site location		

Source: Unger-Holtz (2007).

Geographic Information Systems (GIS) assimilates important information quickly, efficiently, and visually, which then aids in facilitating collaboration, communication, and decision-making. GIS is a facilitator of organisational evolution. Moreover, organisations as well as public policy makers have identified GIS as an important component to their operations (Tomlinson, 2007; Unger-Holtz, 2007). The discernment of the geographical space using GIS creates an image in the consciousness of your surroundings, while spatial knowledge is often related to spatial control (Panek, 2016). Therefore, GIS plays a major role when it comes to projects and developments in terms of location, patterns of the concentration of people or services, trends of how the patterns change in relation to the development, the conditions of the resulting development as well as the implications of the changes (Unger-Holtz, 2007). The ultimate purpose of GIS is to combine spatial information from diverse sources, to describe and analyse interactions, to make prediction with models and to provide support for decision-makers (Suresh & Usha, 2008). The general questions that GIS can answer can be summarised as: "Where can particular features be found? Where have changes occurred over a prescribed period? What geological patterns exist? Where do certain conditions apply? What are the certain spatial implications for certain actions of organisations?" (Unger-Holtz, 2007, pg. 41).

Spatial information generated using GIS can be utilized for describing the geographical features of proposed projects while putting them in a proper geographical context (Riddlesen et al., 2012; Mwenda et al., 2015). A well designed GIS is able to provide: (1) a quick and easy access to large volumes of data, (2) the ability to select detail by area or theme; link or merge one data set with another; search for particular characteristics or feature in an area; analyze spatial characteristics of data; model data and assess alternatives and update data quickly and cheaply, (3) output capabilities (maps, graphs, address lists and summary statistics) tailored to meet particular needs (Unger-Holtz, 2007).GIS has the ability to complete spatial modelling and investigation like, spatial analysis of resources, spatial queries, overlay operations, constraint analysis and others, in the generation of spatial information and this has been considered as one of the important advantages that GIS can offer EIA practitioners (Wu et al., 2014). With GIS, it is possible to establish environmental baseline conditions such as climate, vegetation cover, habitats, land use types, archaeological and historical resources, hydrology, soil types, topography, roads, land possession, services and others (Satapathy et al., 2008; Slotterback, 2011; Sheate et al., 2012; Gonzailez, 2012; Mwenda et al., 2015). Determining baseline conditions is useful in the identification of impacts, informing different stakeholders on these impacts, and making geographically sound decisions (Hammond et al., 2011; Sheate et al., 2012; Lei & Hilton, 2013). Spatial information can be analysed and integrated into EIA processes, thus enabling people to understand the various aspects of social, economic, and environmental issues (Satapapathy et al., 2008; Riddlesen et al., 2012; Mwenda et al., 2015).

Furthermore, GIS provides a clearer presentation of spatial relationships, as well as advanced and complex visualization of objects (Sheate et al., 2012; Lei & Hilton, 2013). With GIS it is possible to update spatial data, which is important for developing alternative states that are crucial in EIA studies (Sheate et al., 2012; Lei & Hilton, 2013). Other advantages of GIS involve its flexibility and speed, precision, accuracy, and reliability (Hammond et al., 2010).The introduction of GIS in PP has also contributed to the development of what is known as public participation geographic information systems (PPGIS), known as a social valuation method (Brown & Fagerholm, 2015; Rall et al., 2019). PPGIS has been recognised as research method and visualization tool by geographers. PPGIS also promotes the empowerment and inclusion of underrepresented and marginalized populations in the use and development of spatial information (Brown & Kytta, 2014; Cox et al., 2019; Rall et al., 2019). Introduction of GIS in the PPP allows stakeholders and the I&APs to shift from only being the objects of geographical research for proposed development projects to being the creators of the agenda and decision-makers (Vlok & Pánek, 2012; Planek, 2016). Even so, GIS makes analysis easier to perform and paves the way for spatial modelling (Wu et al., 2014).

3.5 Visual Realism and Effectiveness of Spatial Information

The introduction of GIS technologies and spatial information was a major step in the development of visualization, literary cartography, and literary maps (Beconytė et al., 2019). According to Fan et al. (2014), visual realism is fundamentally the extent an image gives the impression of being an actual photograph comparatively than a computer-generated image to people, thus contributing to spatial knowledge (Fan et al., 2014). Spatial information has been utilized in support of PP by enhancing the visualization of spatial phenomena and spatial relationships within maps designed for

EIA purposes (Hammond et al., 2010; Riddlesen et al., 2012; Mwenda et al., 2015). Literature shows that the presentation of spatial information has evolved from the use of traditional maps to include presentations such as satellite images, cartographic maps, photo-realistic 3D city models, terrain models, oblique 3D views, street-level photography, geovisualisations, orthophotos, sketches as well as the handling of spatial notions comparable to location, distance, magnitude, direction, angle, scale, visual realism and colour (Liben, 2009; Niyaz & Storey, 2011; Kettunen et al., 2012; Gonzailez, 2012 ; Çöltekin et al., 2015; Çöltekin et al., 2018).

During an EIA the use of spatial data can improve the impact assessment process by means of communicating information effectively (Mwenda et al., 2015). Therefore, the quality and clarity of the detail that shows spatial relationships on certain aspects pertaining to proposed projects and the receiving environment are very important in the EIA process. Developments in technology have contributed to the creation as well as the use of increasingly clear displays in spatial representations, along with the seemingly shared belief that geospatial information of more visual realism are better (Çöltekin et al., 2018). The success and the relevance of the use of realistic spatial representation has been measured through its success rate in various tasks and proposed project developments (Lokka & Çöltekin, 2020). Mwenda et al. (2015) also proposed seven characteristics that may well be used in determining the relevance of spatial data and representations during PP, that is; (1) accessibility, (2) availability, (3) content (4) language, (5) appropriateness, (6) translation and (7) technical support. The aspects of 'content' and 'availability' were additionally broken down into smaller categories shown in Table 3.2.

Table 3.2: Characteristics of spatial information.

Characteristic of spatial information	**Indicators**
Availability: Presentation forms	• Presence/absence of spatial representation • Forms observed (founded on level of visual realism)
Content: Presentation of the problem	• Project location • Project activities or details • Special interest areas, e.g. organizational boundaries, hydrology, geography, protected

	areas, dispersal of endangered plant/animal species, etc.

Source: Mwenda et al. (2015).

To determine these aspects (Table 3.2) on the landscape, one of the parameters used is the level or degree of visual realism, which is the degree of visual similarity of a geo-spatial image on a real land surface (Kettunen et al., 2012). Participant characteristics (i.e. individual and group differences, such as spatial abilities, expertise, and age) have also been said to contribute and play a significant role in visual realism and spatial knowledge acquisition (Lokka & Çöltekin, 2020). To asses spatial presentation types, levels of visual realism can be categorized into “low-level” visual realism (whereby the image appears to be more of a technical sketch) (Figure 3.2) and “high-level” visual realism (whereby the image appears to be visually similar to the real land-surface it represents) (Figure 3.3), and thereafter put into different categories within EIA study reports (Figure 3.4) (Kettunen et al., 2012). The level of visual realism also plays a key role in how the spatial representations inform participant on details of the proposed development project such as location, project activities/details, and special interest areas (Table 3.3), as well as support decision making. With these analytical frameworks, it is possible to evaluate the effectiveness of how spatial information was presented in an EIA report and how readable and understandable it was, thus aiding the different stakeholders to understand the relevant spatial phenomena and spatial relationships involved.

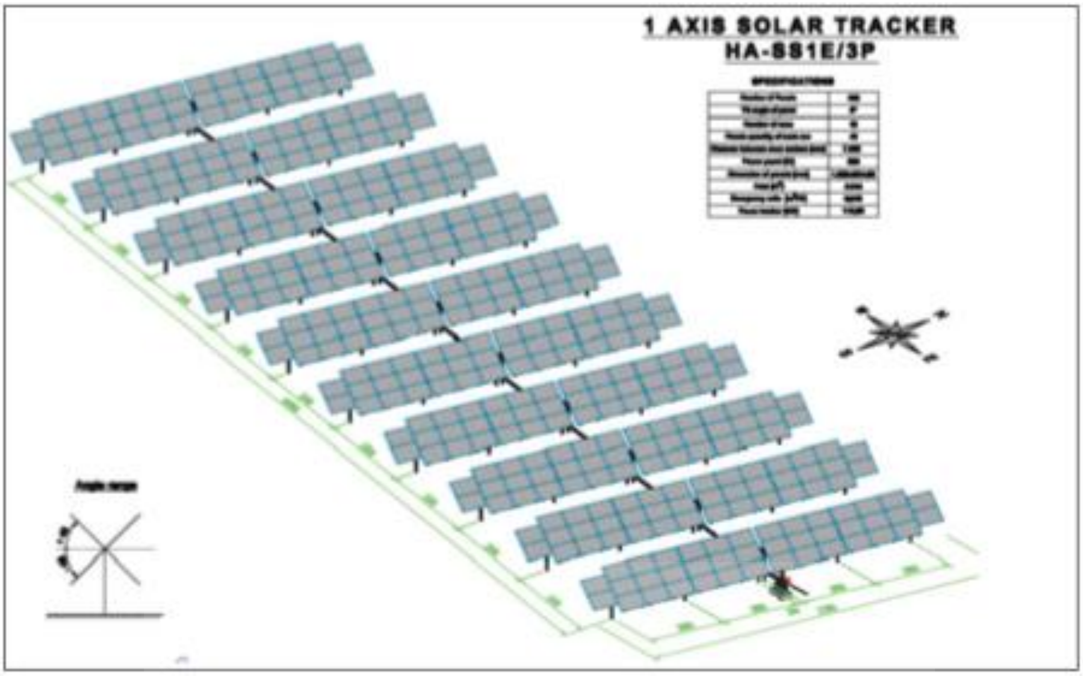

Figure 3.2: Example of low-level visual realism.

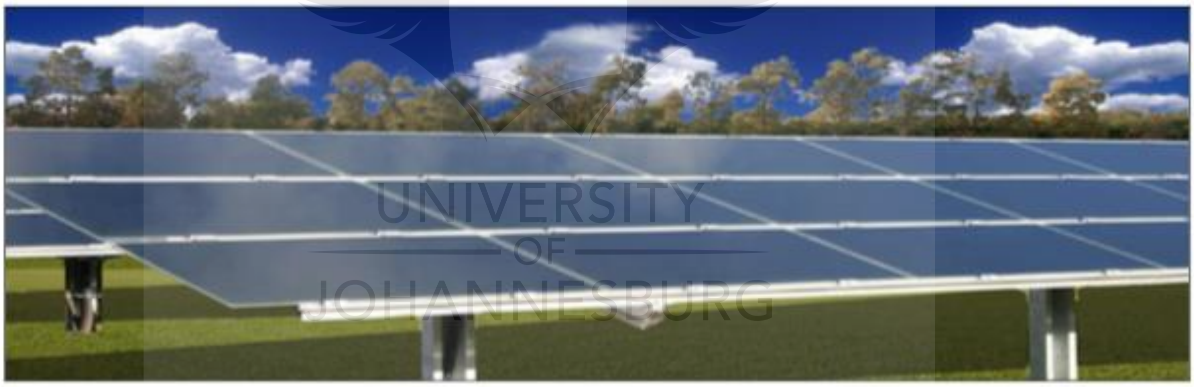

Figure 3.3: Example of high-level visual realism.

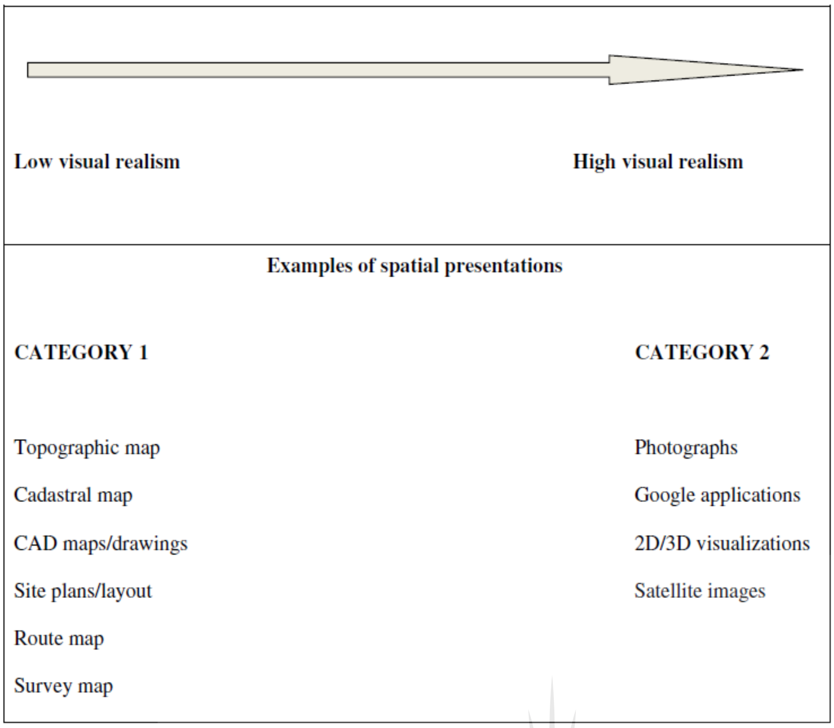

Figure 3.4: Categories of visual realism.

Source: Mwenda et al. (2015).

Table 3.3: Categories representative of the 7 aspects that can be found in spatial representations.

Category	Details
1.	Project location/site
2.	Project activities/details
3.	Special interest areas
4.	Project location+ project activities/details
5.	Project location+ special interest areas
6.	Project activities/ details+ special interest areas
7.	Project location+ project activities/details + special interest areas

Source: Mwenda et al. (2015).

In the studies conducted by Mwenda et al. (2012), Mwenda et al. (2013) and Mwenda et al. (2015) on EIA implementation during development projects and the use of spatial information throughout PP in Kenya, findings initially depicted that the execution of EIA and PPP was relatively low. This was established through the analysis of EIA study reports submitted to Kenya's Environment authority between 2002 and 2010. This changed relatively during the study period, especially in 2010. Evaluation of PP dimensions also demonstrated improvement over time, with participation methods, types of participants depicting the highest level of improvement, attributed to increasing emphasis by Kenya's Environment Authority on public participation activities and their reporting in EIA Study Reports. Venues used, notification methods and language continued to lag behind. Further analysis was done on the EIA Study Reports from 2002 to 2013, where the presence/absence of spatial presentation, levels of visual realism exhibited, and content presented was evaluated and findings demonstrated a high popularity of spatial information, and preference for the combined use of spatial presentations with mixed visual realism, with combination of project location and activities/ details being the most popular content in the spatial presentations. The spatial presentations surveyed also met all the requirements for 'content' as set out in the legal and regulatory framework. However, the issue of 'availability' of spatial information still needs further considerations, to avoid presenting inappropriate and poor-quality spatial information to the public.

3.6 South African Requirements for Spatial Information in EIA

In South Africa, there are several pieces of legislation and regulation that specifically address the importance of spatial information for environmental decision-making processes. These were catered for through the introduction of the National Environmental Management Act (NEMA), Specific Environmental Management Acts (SEMA's), and various regulations, norms, and standards, which have been published to give effect to these Acts. NEMA also contain important environmental provisions such as the principles of duty of care, emergency incident provisions and the requirements for EIA and environmental authorizations (Kotze, 2006; du Plessis & du Plessis, 2011). According to NEMA, development must place people and their needs at the forefront of its concern, and should serve their physical, psychological, developmental, cultural and social interests equitably. Therefore, development is expected to be socially, environmentally, and economically sustainable (du Plessis &

du Plessis, 2011) through the application of appropriate policies, programs, products and services or activities throughout the projects lifecycle.

Moreover, the decisions taken during the project's lifecycle must take into account the interests, needs and values of all I&APs, the promotion of community wellbeing through environmental education, participation in environmental governance, and the promotion of decisions reached in an open and transparent manner (Glasson & Therivel, 2019). In the current NEMA, EIA legislation and related regulations, there are several provisions on the importance of spatial information in EIA during PPPs. These provisions are mainly listed in the Environmental Impact Assessment Regulations (2014) as amended in April 2017 and July 2018 as well as in Chapter 6 that covers Public Participation. A summary of what these provisions entail is provided in Table 3.4, with a brief description of their spatial relevance. These policies and legislations are also an effective vehicle to addressing conflicts in addition to environmental protection.

Table 3.4: South African EIA.

Section	Provisions	Spatial relevance
Section 39	**Activity on land owned by person other than proponent** (1) If the proponent is not the owner or person in control of the land on which the activity is to be undertaken, the proponent must, before applying for an environmental authorization in respect of such activity, obtain the written consent of the landowner or person in control of the land to undertake such activity on that land.	The land has spatial relevance in terms of its location and surrounding spatial extent
Section 41	**Public participation process**	Spatial relevance is based on the location and accessibility of these sites

	a) fixing a notice board at a place conspicuous to and accessible by the public at the boundary, on the fence or along the corridor of— (b) giving written notice, in any of the manners provided for in section 47D of the Act, to— (i) the occupiers of the site and, if the proponent or applicant is not the owner or person in control of the site on which the activity is to be undertaken, the owner or person in control of the site where the activity is or is to be undertaken and to any alternative site where the activity is to be undertaken; (ii) owners, persons in control of, and occupiers of land adjacent to the site where the activity is or is to be undertaken and to any alternative site where the activity is to be undertaken. (iii) the municipal councilor of the ward in which the site and alternative site is situated and any organisation of ratepayers that represent the community in the area; (iv) the municipality which has jurisdiction in the area. (v) any organ of state having jurisdiction in respect of any aspect of the activity; and	and their alternatives as well as identifying the project boundaries

	(c) placing an advertisement in— (i) one local newspaper; or (d) placing an advertisement in at least one provincial newspaper or national newspaper, if the activity has or may have an impact that extends beyond the boundaries of the metropolitan or district municipality in which it is or will be undertaken	
Section 42	**Register of interested and affected parties** A proponent or applicant must ensure the opening and maintenance of a register of interested and affected parties and submit such a register to the competent authority, which register must contain the names, contact details and addresses of stakeholders	The register has spatial relevance in terms of providing an overview of where the stakeholders are located relative to the proposed project
Section 43	**Registered interested and affected parties entitled to comment on reports and plans** (1) A registered interested and affected party is entitled to comment, in writing, on all reports or plans submitted to such party during the public participation process contemplated in these Regulations and to bring to	Views of stakeholders must be recorded to note what they comment on and to show the spatial connotations related to the comments

	the attention of the proponent or applicant any issues which that party believes may be of significance to the consideration of the application, provided that the interested and affected party discloses any direct business, financial, personal or other interest which that party may have in the approval or refusal of the application	
Section 44	**Comments of interested and affected parties to be recorded in reports and plans** (1) The applicant must ensure that the comments of interested and affected parties are recorded in reports and plans and that such written comments, including responses to such comments and records of meetings, are attached to the reports and plans that are submitted to the competent authority in terms of these Regulations.	The recorded comments contribute to the decision making and site selection based on suitability and spatial extent

In conclusion. The United Nations Conference on the Human Environment (Stockholm, 1972), the United Nations Conference on Environment and Development (Rio de Janeiro, 1992), and the World Summit on Sustainable Development (Johannesburg, 2002) laid a compact foundation and high-level obligation for assimilating economic development and environment protection to attain sustainable development worldwide. The instrument for integrating sustainable economic development and environment protection have been added to public polies and focus a lot on integrated planning, social analysis and participatory economics. They also promote capacity building in evaluation of the environmental impacts related to developments (Rebelo & Guerreiro,2017). Today, more than 100 countries, most international agencies and all development banks require EIAs for major activities and projects (Muigua, 2012; Rebelo & Guerreiro, 2017). Studies looking at how effective the instruments in place for EIA are, and how they can be further improved are very immense. These studies also look at including other instruments in the EIA process for improved results (Kotzé, 2006; Nakamura, 2008; Hammond et al., 2010; Gonzailez, 2012; Mwenda et al., 2012; Mwenda et al., 2013; Lei & Hilton 2013; Vanclay et al.,2013; Brown & Kyttä, 2014; Mwenda et al., 2015; Machaka, 2017; Cöltekin et al., 2018; Kantamaturapoj et al., 2018; Cox et al.,2019; Fonseca, 2019; Lokka & Çöltekin 2020 etc.).

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter is based on the presentation and discussion of results. In total, the spatial information in 25 different environmental impact assessment reports (EIARs) was examined. In section 4.2, the different types and groups of spatial representations are presented. The spatial representations evaluated were biophysical features of the locations reserved for the different projects of renewable energy, their activities, project details, and areas of special interest. The extent to which these spatial representations varied based on the level of visual realism, which is the 'the degree of visual likeness of a geospatial image with the physical world' (Kettunen et al., 2012) is covered under section 4.3. Section 4.4 gives the various dimensions of relevance to the public participation process (PPP) in an environmental impact assessment (EIA) and also looks at the issues and concerns raised by the interested and affected parties (I&APs), meanwhile section 4.5 is based on the discussion of overall results.

4.2 Types and Groups of Spatial Representations

The initial evaluation of the 25 EIARs examined the presence or absence of spatial information. This was done by analysing the different types of spatial information that relates to the proposed projects as well as the proposed sites or areas earmarked for such projects and the areas of special interest in the project boundaries. Out of the 25 EIARs evaluated for the quality or effectiveness of spatial representations, a total of 24 EIARs communicated the details of the proposed projects using various types of spatial information. On the other hand, one environmental impact report (EIAR) used only tables and non-spatial sketches (Figure 4.1). However, the spatial information found in the other EIARs depicted different aspects of interest related to these projects. Most of the spatial information that was depicted on EIARs was used to show the locations, environmental sensitivities of the project areas, as well as project activities. They were displayed through representations that ranged from topographical maps (60%; n=15 EIARs), land-cover maps (64%; n=16 EIARs), google maps (72%; n=18 EIARs), site layouts (16%; n=4 EIARs , cadastral maps (16%; n= 4 EIARs) and photos (96%; n=24 EIARs) (Figure 4.2) . These representations varied broadly in terms of their level of visual realism, colour contrast. appropriateness of map scales, legend and degree of clarity. Evaluation of the EIARs shows that most of the spatial representation were presented in a PowerPoint presentation format (80%), while the rest we presented with hard copy maps (20%).

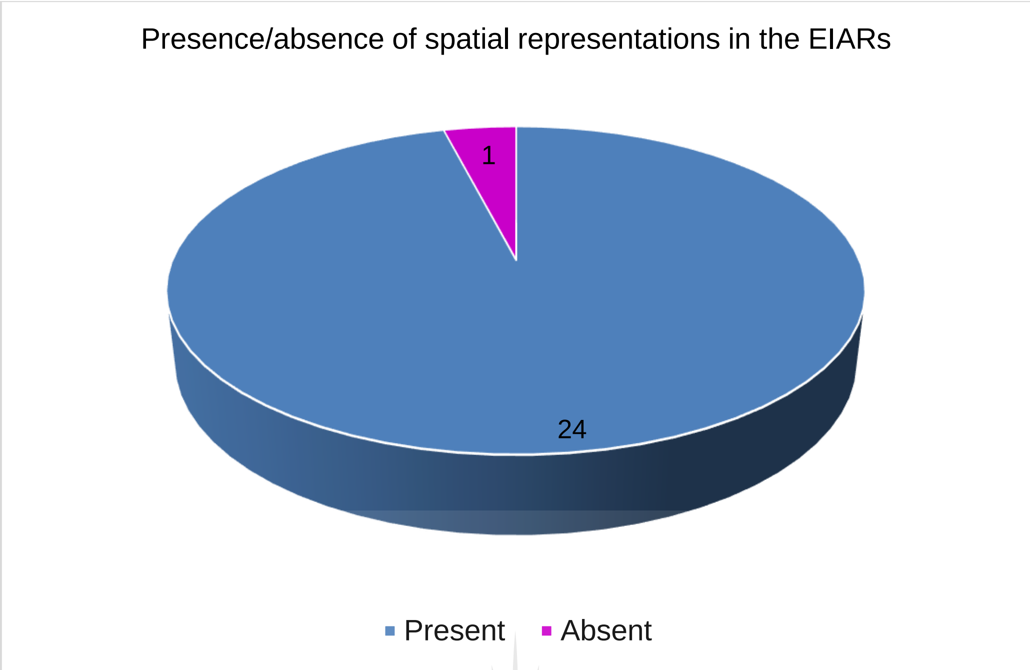

Figure 4.1: Number of EIARs based on the presence/ absence of spatial representations.

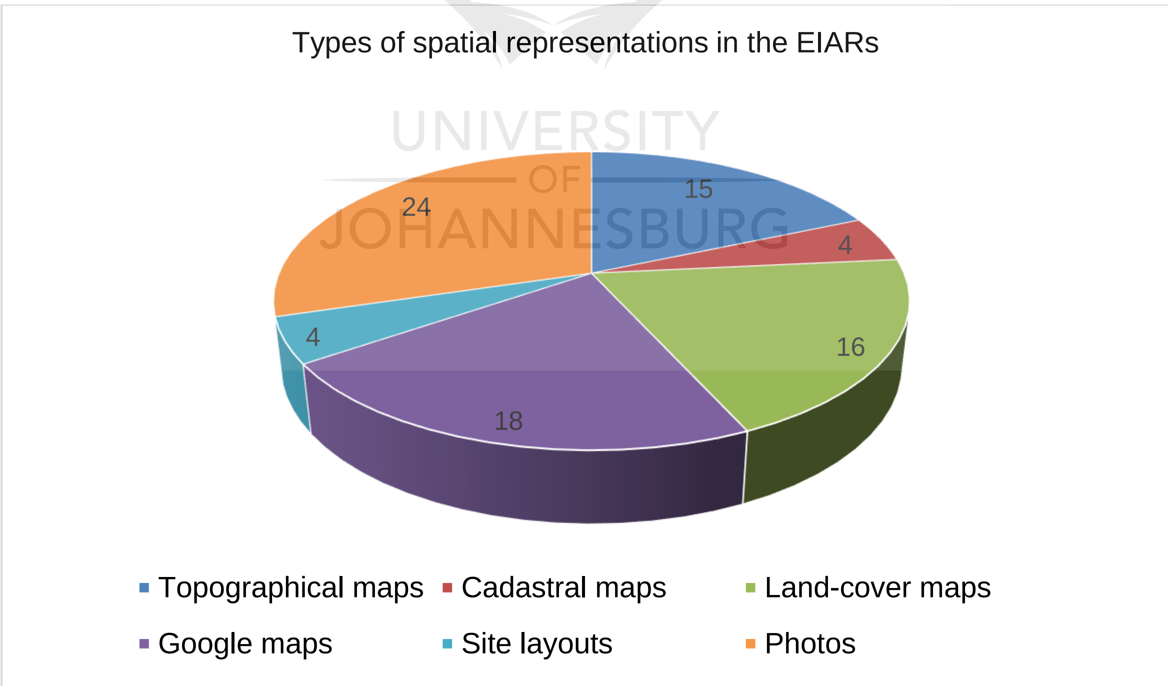

Figure 4.2: Types of spatial representations in the selected EIARs.

Colour contrasts on a map show important variations in spatial phenomena (Griffin & Pupedis, 2020). Thus, such contrasts on a map renders them more readable and user-friendly (Chesneau, 2011). The use of colour variation depicts some of the relationships or associations between spatial data. For example, contrast of hues can be used to differentiate patterns as well as contrasts of lightness or saturation (Griffin & Pupedis, 2020). Also, colour is used in thematic and reference maps for representing information and highlighting important features. Using colour effectively in maps requires an understanding on how people would see and understand the meaning of such colour, the medium in which the map is published (electronic vs. paper), and characteristics of the data that is being represented in the map (Griffin & Pupedis, 2020). Effective colour schemes match data characteristics to colour dimensions in logical ways and choose colours with knowledge of their potential meanings to map readers (Griffin & Pupedis, 2020).

Map scales indicate the amount of real-world ground units that are represented by a single unit in a map They dictate the extent of the mapped area, that appears in any given view. Scale has two key meanings in EIA: firstly, scale as the extent of the area of assessment (size of area studied, distance from activity causing the impact) and secondly, scale in terms of the amount of detail or coarseness (map scales, rate of sampling) used. Extent determines the size of the 'window' to view the world, while the amount of detail is related to the level of resolution and determines the smallest units that can be seen in the study (João,1998). The resolution of the scale contributes to the clarity of the map and the precision of an image. Large scale maps show fine detail, while small scale maps show coarse detail for example, using cartographic terminology, 1:250 000 is a smaller scale map than 1:10000 (João, 2007). The appropriateness of the scale plays a significant role in enabling understanding of spatial representations together with legends (Bělka 2014; Peng, 2021). In a study conducted by Joao (1998) he found that changes in scale on spatial representations, in terms of spatial extent and details also play a key role in the outcome of the PPP during an EIA. The choice of an appropriate scale is very circumstantial and affects the potential effect that scale issues might have on the outcomes of EIA (e.g. by influencing the type of impacts found, their magnitude and significance, the type of mitigation measures recommended, and ultimately the end decision regarding the proposal) (João,1998; João, 2002; João, 2007).

Legends are a classification that is implemented over space (Milovidova, 2013). A legend with an effective design enables an accurate and efficient visual search for features. Legends are vital for most maps, the whole display of the titles, sizes, contrasts, the design and arrangement of symbols and descriptions impact the effectiveness and efficiency of a legend (Li & Qin, 2014). The overall use of map elements aid in the degree of clarity of spatial representations. However, while some spatial representations clearly displayed adequate map elements in the proposed projects considered in the present study, the rest of the spatial presentations had no map elements on them (i.e. legend, scale, and map orientation) at all. Without such elements it is increasingly difficult for different stakeholders, including interested and affected parties to understand the magnitude and the significance of the anticipated environmental impacts, impacts on adjacent land-uses, impacts on biophysical features as well as the impacts on the human environment where such projects would be build.

4.2.1 Topographical Maps

Topographical maps depict the physical and artificial structures on the landscapes. The 'invention' of topographic maps led to the direct use of maps for terrain navigation and the traditional way to represent topography on maps has been through contour lines, which are lines of constant elevation (Zentai, 2018). Without the contour lines on a topographical map it is difficult to understand the spatial configuration of the features that are being shown (Caselles & Monasse, 2009). The topographical maps that were found in the analysed EIARs were used to portray a number of features using colour coding to show contour lines (brown) (Figure 4.3.1), project locations (Figure 4.3.2), degrees of site (habitat) sensitivity (Figure 4.3.3), existing road networks, access roads, and alternative power transmission lines (red) (Figure 4.3.4), as well as power lines, stations, perennial and non-perennial rivers (blue) (Figure 4.3.5). However, for people to see and understand the meaning of these colour variations, the map legend must have a clear focus, thus easy to read and interpret.

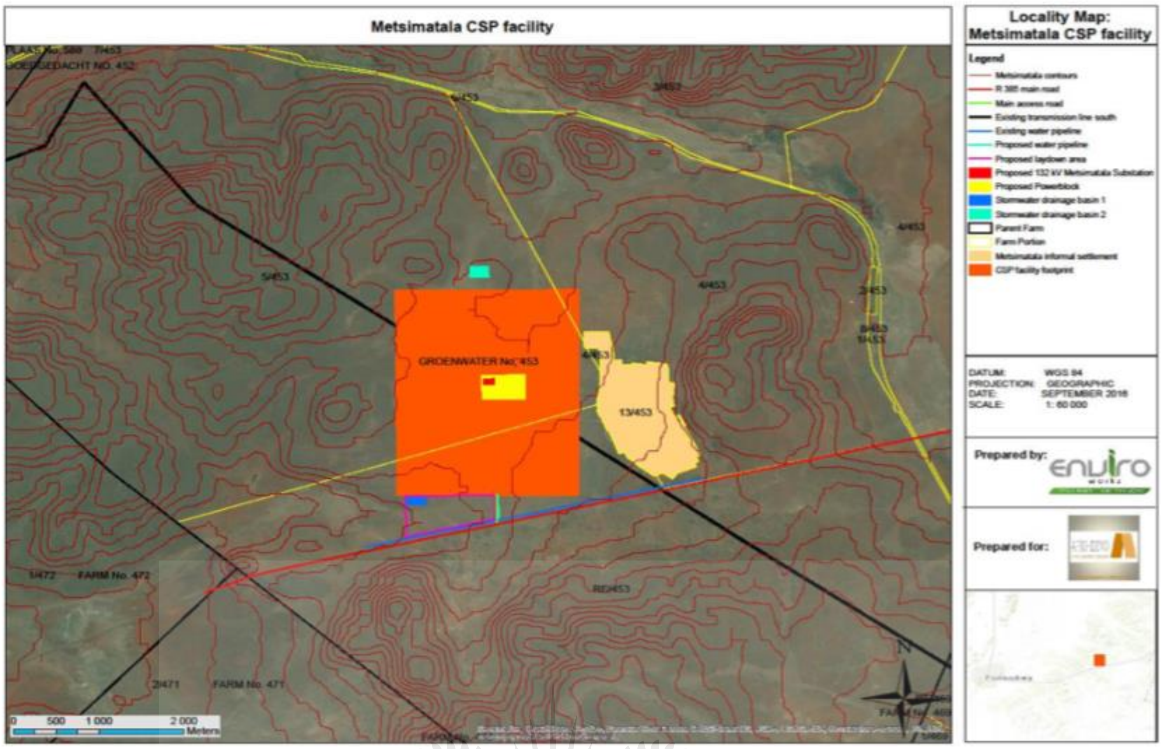

Figure 4.3.1: Contour lines depicted as brown thin lines that are closer or further apart from one another on the map depicted.

Furthermore, out of the total number of 48 different topographical maps that were appearing in the 24 EIARS that had these illustrations, most (80%, n=38) maps used appropriate map elements and colour variations. The highest number of topographical maps per EIR was found to be 10 while the lowest number was 1. On average, three topographical maps were presented for each EIR selected for this study

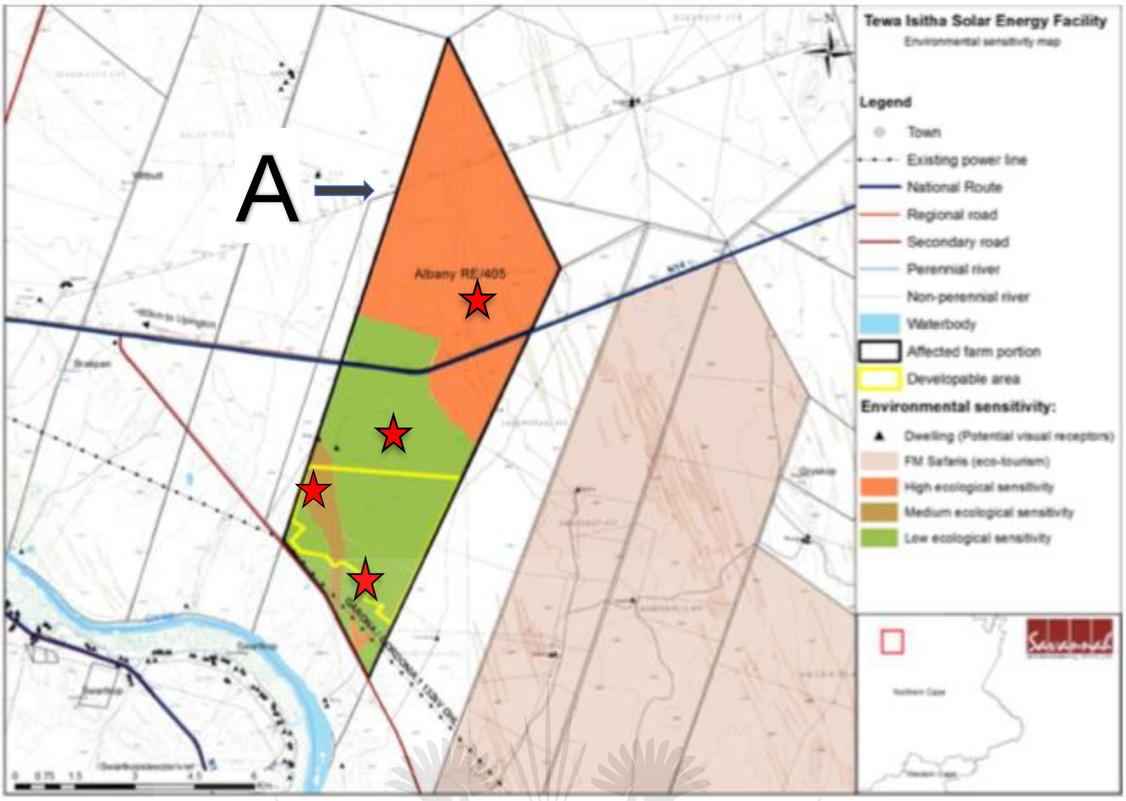

Figure 4.3.2: Topographical map showing a proposed site location (marked A) and environmental sensitivities (shown by different colours in the map legend) for a solar energy project.

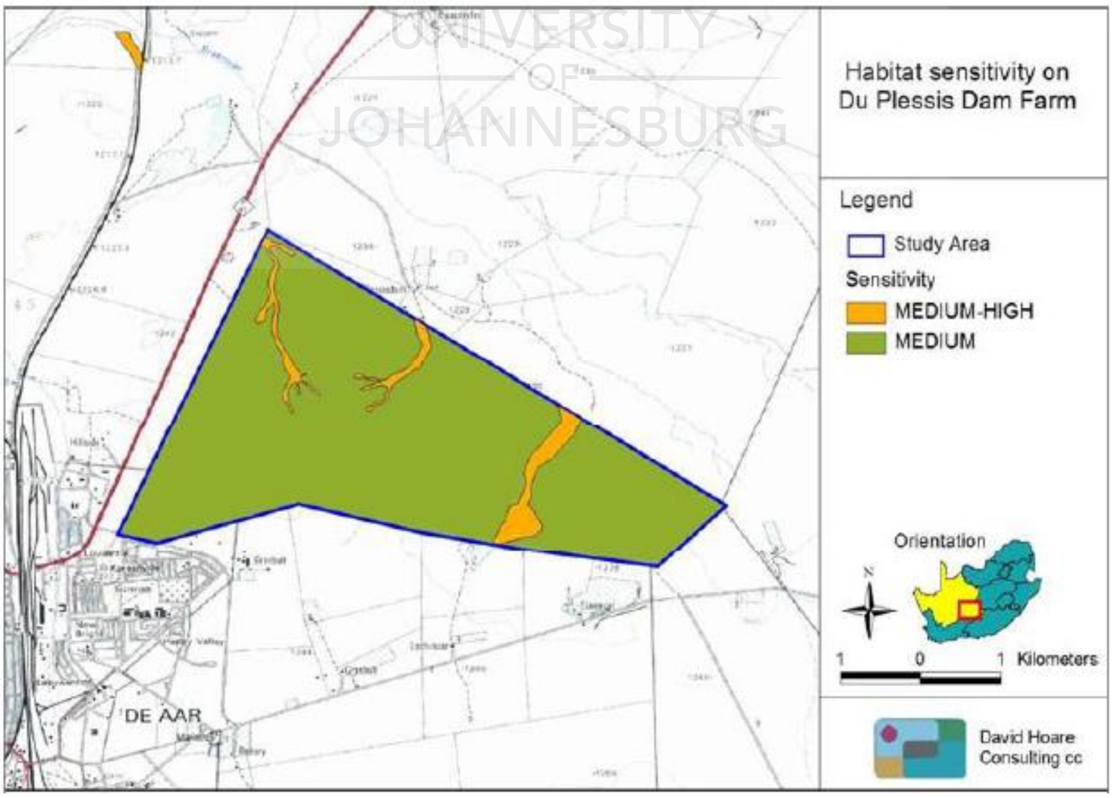

Figure 4.3.3: Degrees of site and habitat sensitivity classed as medium-high and medium risk depending on the natural vegetation types. Colour contrasts appear on the map legend.

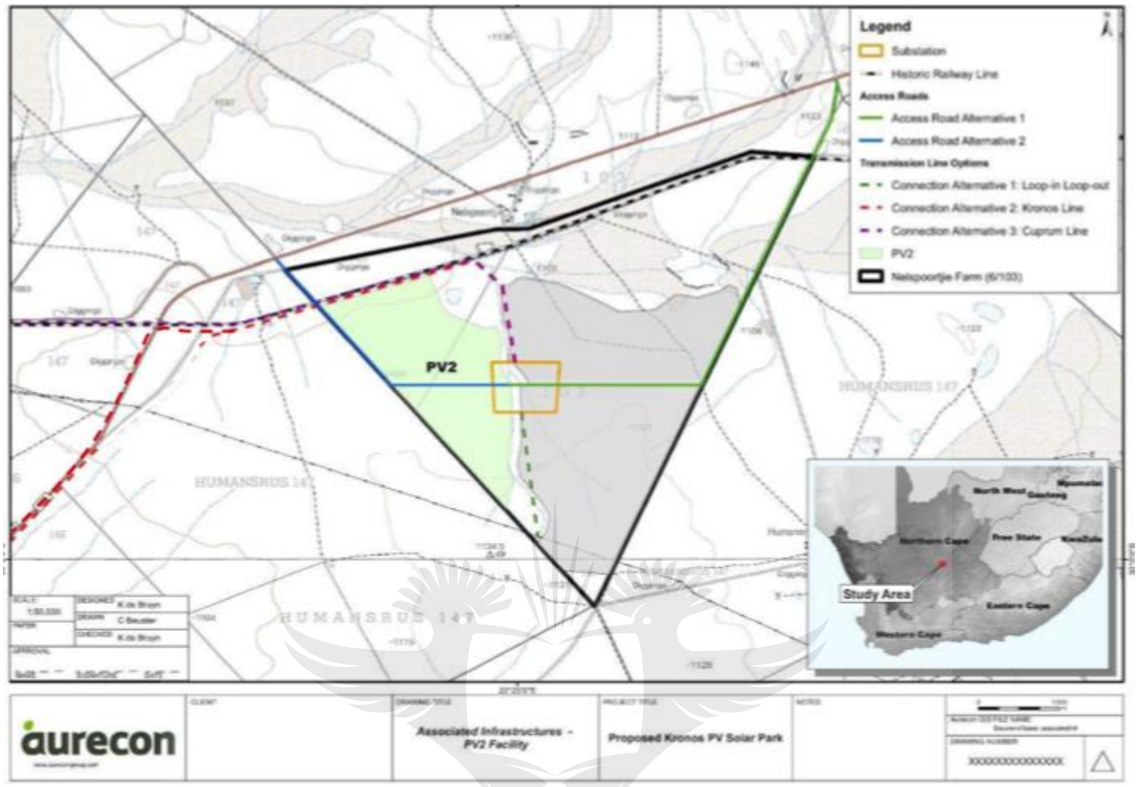

Figure 4.3.4: Topographical map showing existing road networks, access roads (alternatives shown in green and red), and alternative power transmission lines (dotted line in green, red, and purple colours. The colour contrasts appear on the map legend.

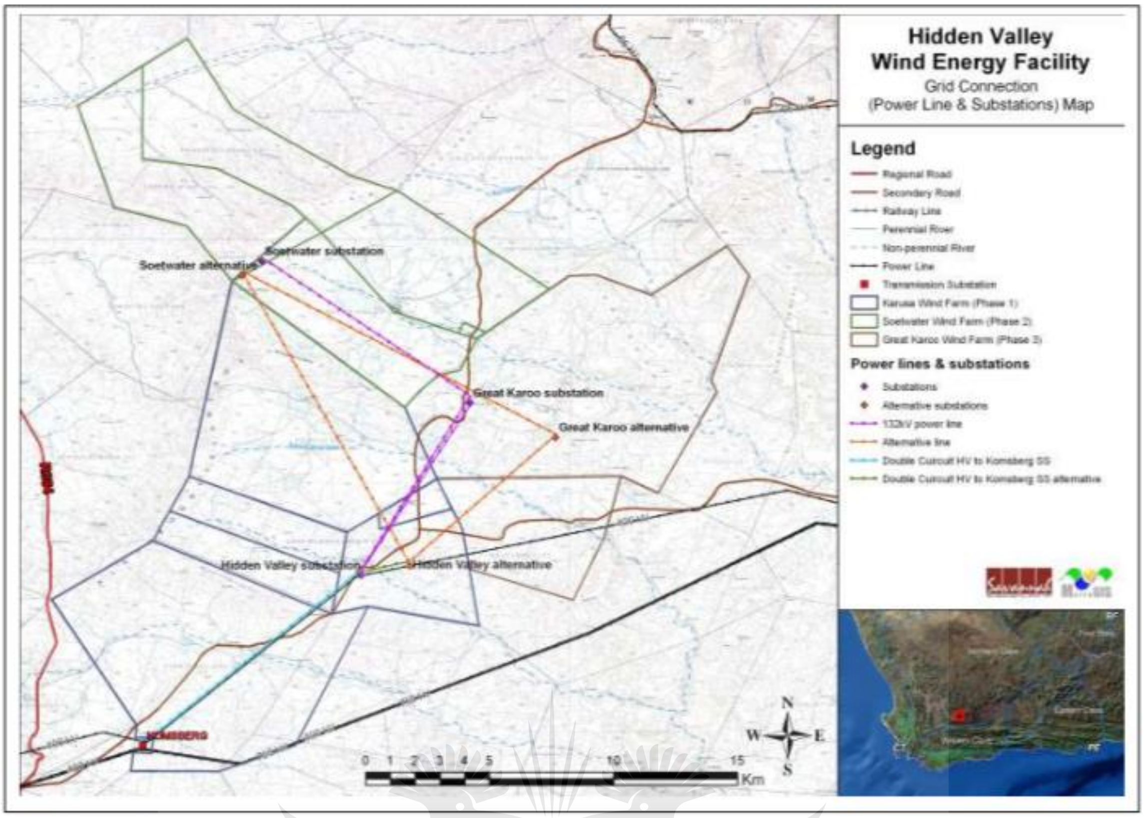

Figure 4.3.5: Topographical map showing powerlines, substations and alternatives (purple and pink), existing road networks as well as perennial and non-perennial rivers (blue). The colour contrasts appear on the map legend.

4.2.2 Cadastral Maps

Cadastral maps display the boundaries of units of land, their directions, length, and the zones of specific territory with a large-scale map (Williamson & Enemark, 1996). In most countries, Cadastral maps are regarded as the most essential part of land-management infrastructure (Williamson & Enemark, 1996). In the past, cadastral maps have also been used as a key to understanding local history (Mou, 2012). These are gathered for the determination, reporting, and recording of possession. They also demonstrate the society or customs and features concerning the use of land (Femenia-Ribera et al., 2014). Territorial demarcation provides a method of defining the zone where a state, municipal area or privately owned landlord can administer ownership rights (Femenia-Ribera et al., 2014). The cadastral maps in this study were generally used to show the project location (Figure 4.4.1), areal boundaries and sensitive areas (Figure 4.4.2a & Figure 4.4.2b) and to a lesser extent the waterbodies in the area (Figure 4.4.3). Thus, sometimes, locations were depicted along with special interest areas. Furthermore, these features were clearly presented in some of the cadastral maps with visible scales, legends, and colour contrasts for the different boundaries, while others had no details at all. Furthermore, out of the total number of 14 different cadastral maps that were appearing in the 24 EIARS that had these illustrations, only about 60% (n=8 maps) used appropriate map elements and colour variations. The highest number of cadastral maps per EIR was found to be 6 while the lowest number was 2. The lack of sufficient detail and map elements in some spatial representations indicate a lost opportunity to provide adequate information to the different stakeholders who were participating in the PPP.

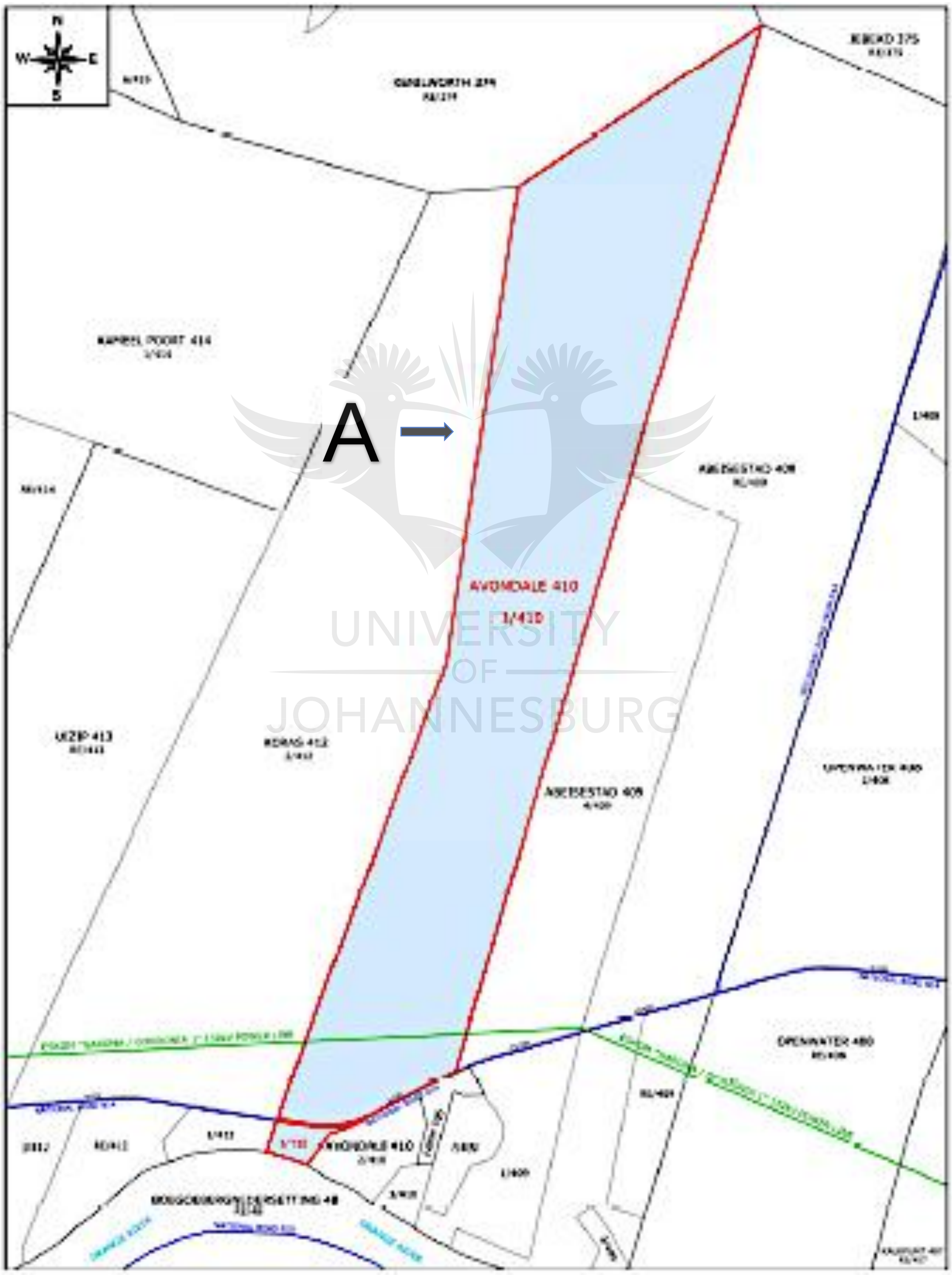

Figure 4.4.1: Cadastral map showing the proposed project location (marked A).

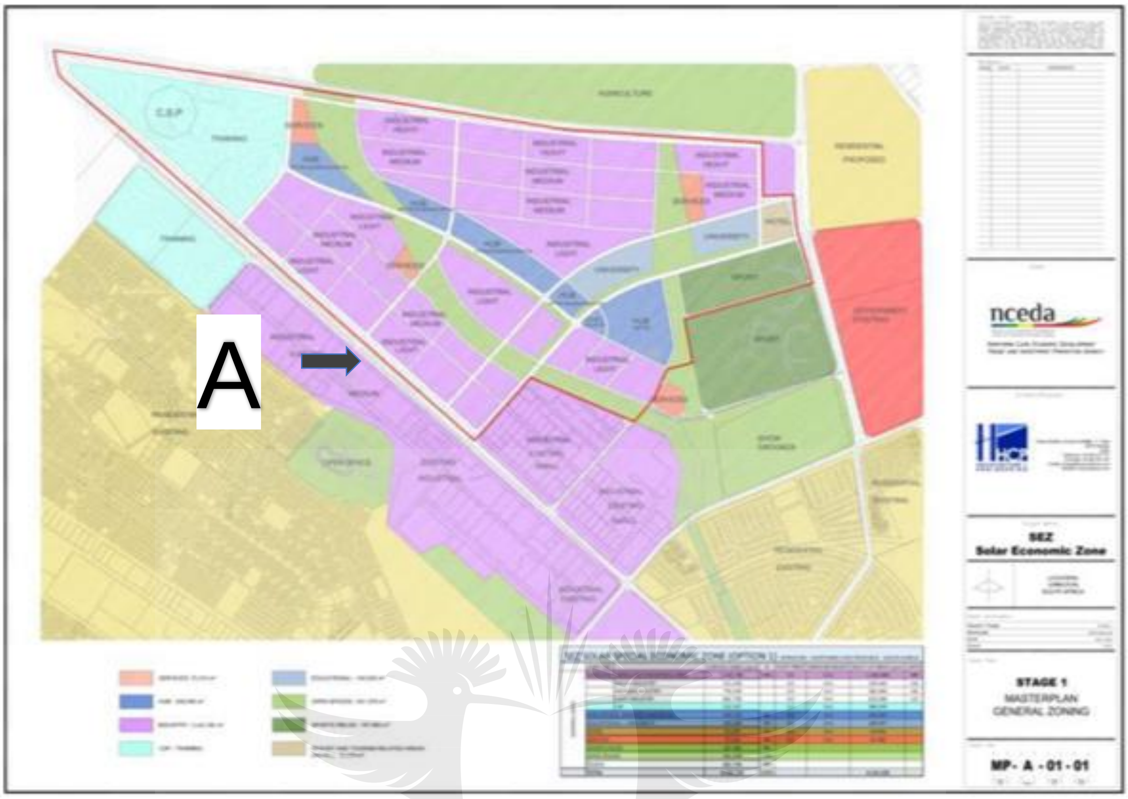

Figure 4.4.2a: Cadastral map showing the proposed location (marked A) and sensitive areas for the solar economic zone (SEZ) project.

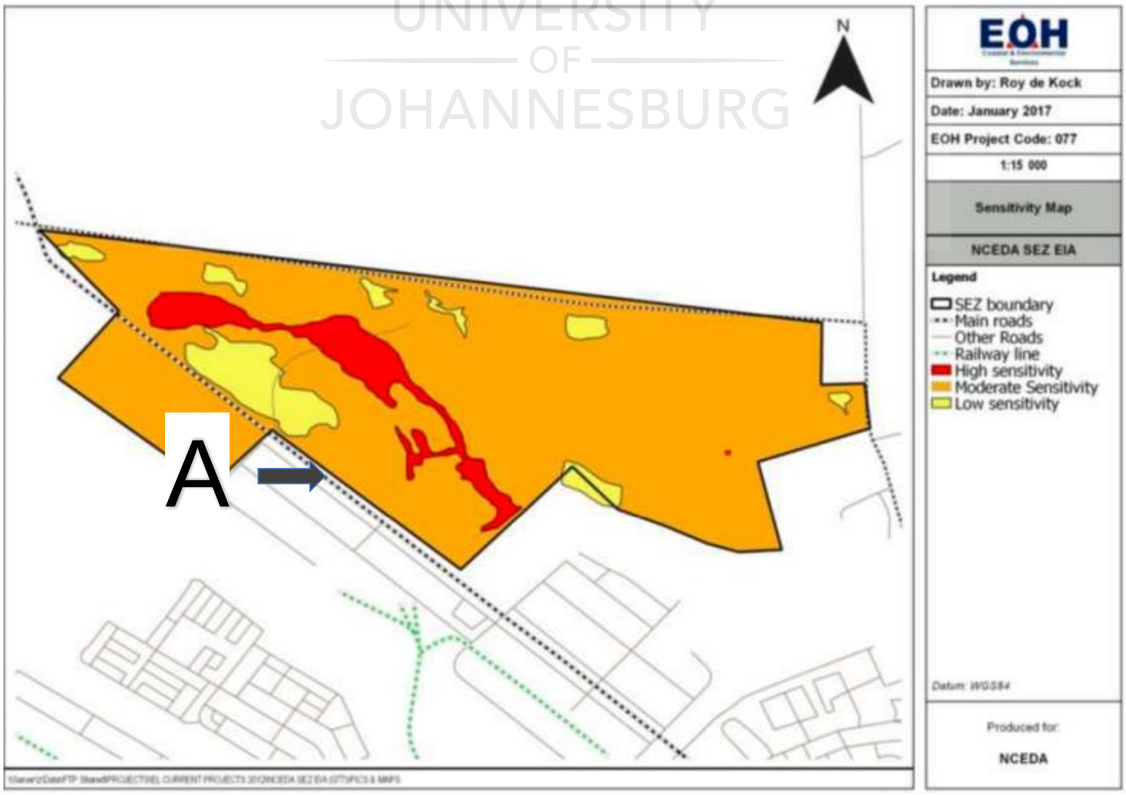

Figure 4.4.2b: Cadastral map showing the proposed location boundary (marked A) and sensitive areas classified as high, moderate and low sensitivity for the solar economic zone (SEZ) project.

Figure 4.4.3: Cadastral map showing project location and water bodies in the study area.

4.2.3 Land-Cover Maps

Land-cover maps depict the observed biophysical cover on the earth surface in the form of vegetation types (grasslands, forests; mangroves), croplands, and water bodies (lakes and wetlands) (Yang, 2017). Such maps provide valuable information for monitoring land-cover types as well as land use transformation and are derivatives of satellite imagery (Jewitt, 2015). The maps also provide elements that offer feedback on the human influence on the structure of ecosystems and their functions at global, regional and catchment scales (Poff, 2018; Alam et al., 2021). This information is key in monitoring temporal changes in land-use as well as monitoring spatial patterns (Ingle et al., 2021). The land-cover maps in this study were predominantly used to present (1) vegetation cover classes (Figure 4.5.1, Figure 4.5.2 and Figure 4.5.3) in the areas to be occupied by the proposed projects, (2) biodiversity, and (3) overall environmental sensitivities.

Colour variations and contrasts were also used to display the different types of vegetations layouts as well as their variations over time. Other land cover maps used colour contrasts to depict the different boundaries that apply to geological features and soil bodies that were likely to be impacted by the proposed projects. Furthermore, most of the spatial representations had clear map elements depicted on them to visibly communicate the project aspects and associated impacts. However, out of the total number of 23 different land-cover maps that were appearing in 24 EIARS, most (90%, n=21) maps used appropriate map elements and colour variations. The highest number of land-cover maps per EIR was found to be 4 while the lowest number was 1.

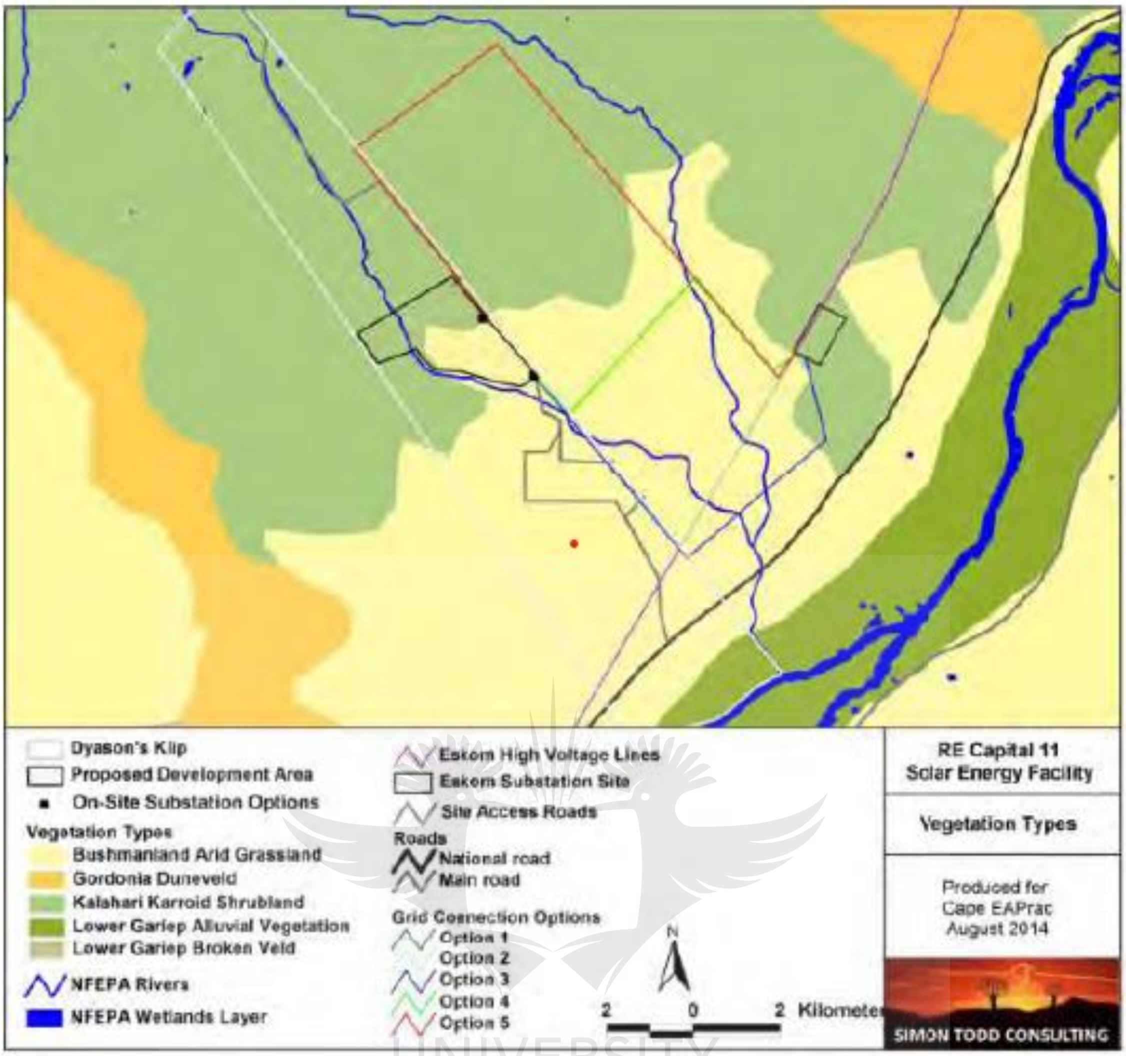

Figure 4.5.1: Natural vegetation classes inside and around the proposed development area.

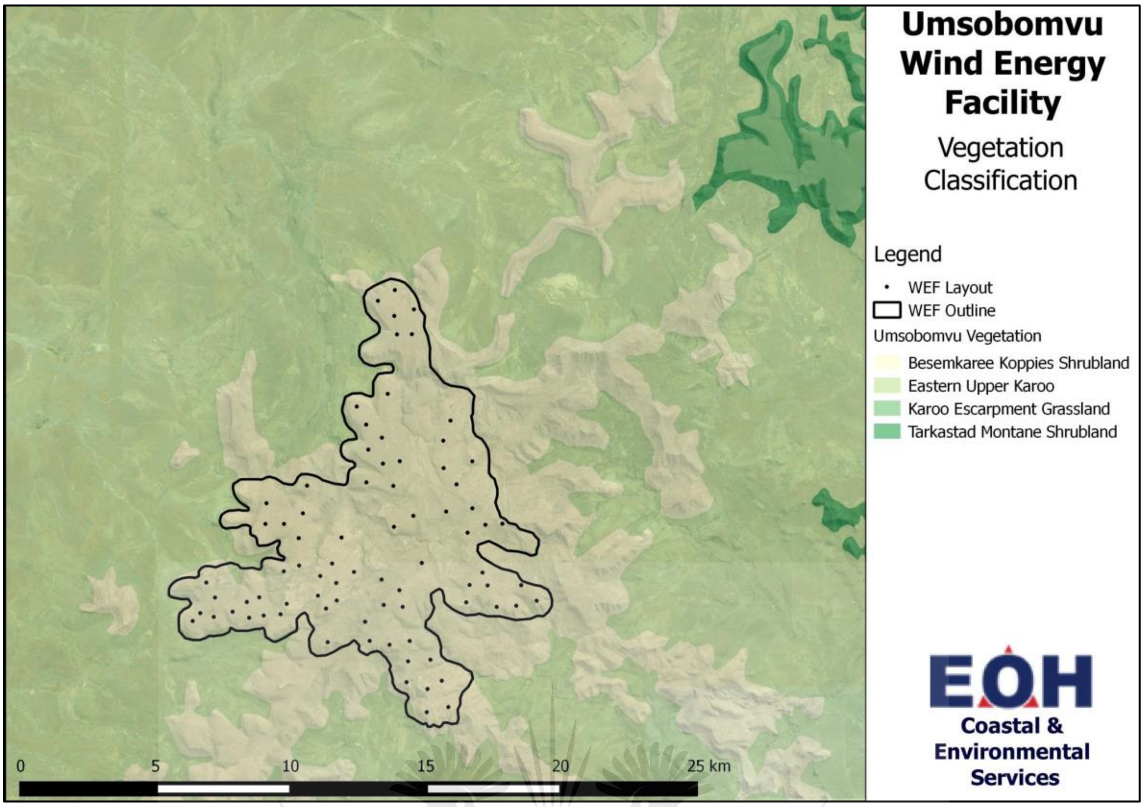

Figure 4.5.2: Natural vegetation classes in and around the project area as shown in different colours.

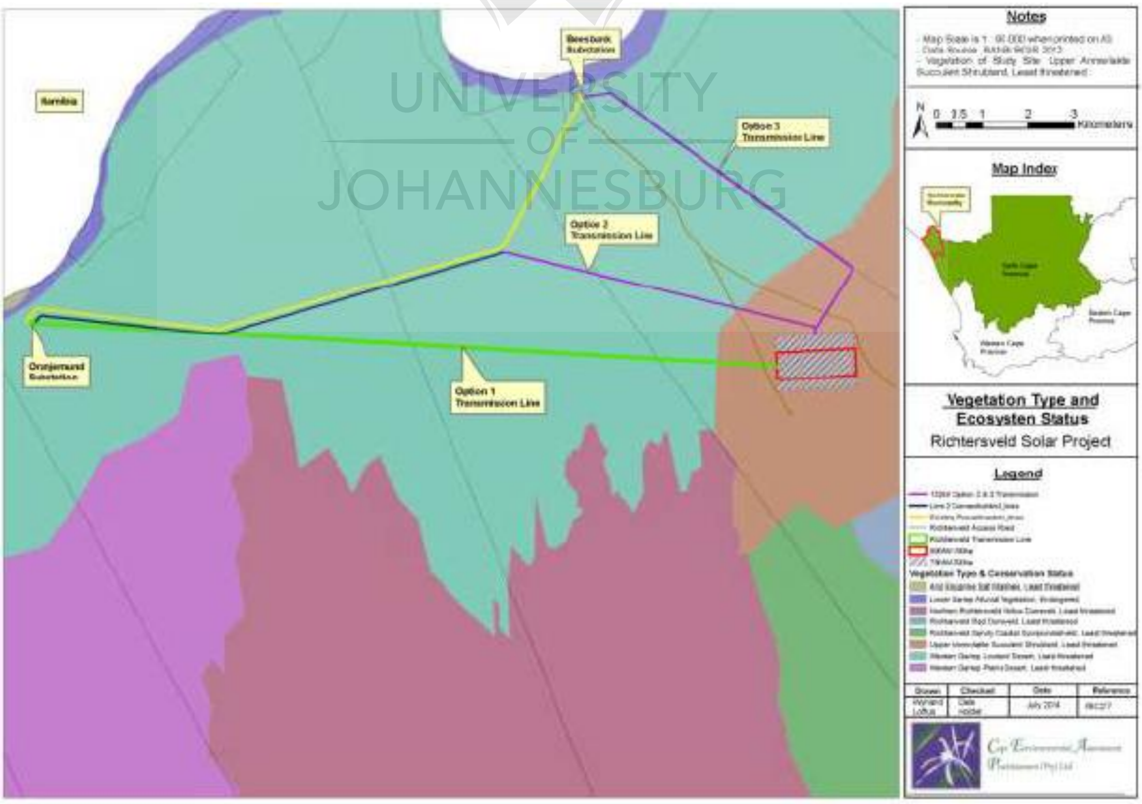

Figure 4.5.3: Natural vegetation in the proposed project site for the solar farm.

4.2.4 Google Maps

Google maps provide detailed spatial information about locations and sites worldwide. Their focus area is presenting satellite and aerial views of several places alongside conventional road maps (Planek, 2016). Google maps are a structuring force for geographic knowledge in society and the rise of the web has promoted an alternative configuration for mapping. In this configuration, maps can be much more easily modified, reused, and remixed by users (Plantin, 2018). These maps can change the spatial database on its own interests and the interests of countries where the maps are visible (Planek, 2016). They even offer street views in some cities together with photographs taken from automobiles. Google maps have created new possibilities for measuring social landscape values and preferences (De Vries et al., 2013). They also allow people to mark standards and distinct places directly on GIS-based maps instead of paper versions of maps, which later need to be digitized (Miller, 2006).

In the present research, Google maps were immensely used in the selected EIARs, although they were quite diverse in terms of how map features were displayed. The highest number of google maps per EIR was found to be 7 while the lowest number was 1. On average, three google maps were presented for each EIR selected for this study. However, out of the total number of 49 different google maps that were appearing in the 24 EIARS that had these illustrations, most (80%, n=39) maps used appropriate map elements and colour variations. The maps displayed a variety of spatial properties such as project locations, project activities and details, surrounding land uses, roads, geological features, special interest areas, relief, waterbodies as well as slopes and terrain of the area. For example, in Figure 4.6.1 and Figure 4.6.2, some of these features are shown on a google map, namely, the (1) different locations of adjacent land uses including several pre-existing solar parks in the project area; (2) linear infrastructure such as power transmission lines, national roads, and secondary roads, as well as (3) perennial and non-perennial rivers. Even so, as shown in Figure 4.6.3, some of the google maps were used to display not only the spatial location of the project areas but also the different degrees of ecological sensitivities that are triggered by the proposed location of specific renewable energy projects

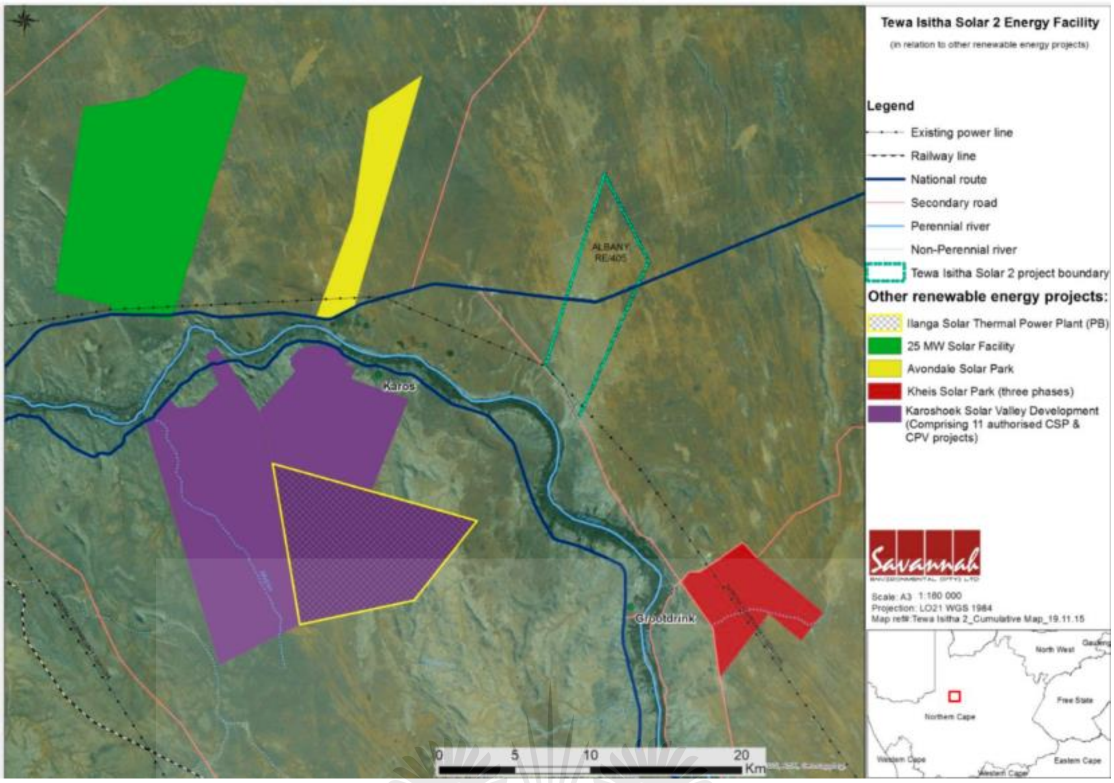

Figure 4.6.1: A google map showing the location of pre-existing solar parks; linear infrastructure; as well rivers in the project area.

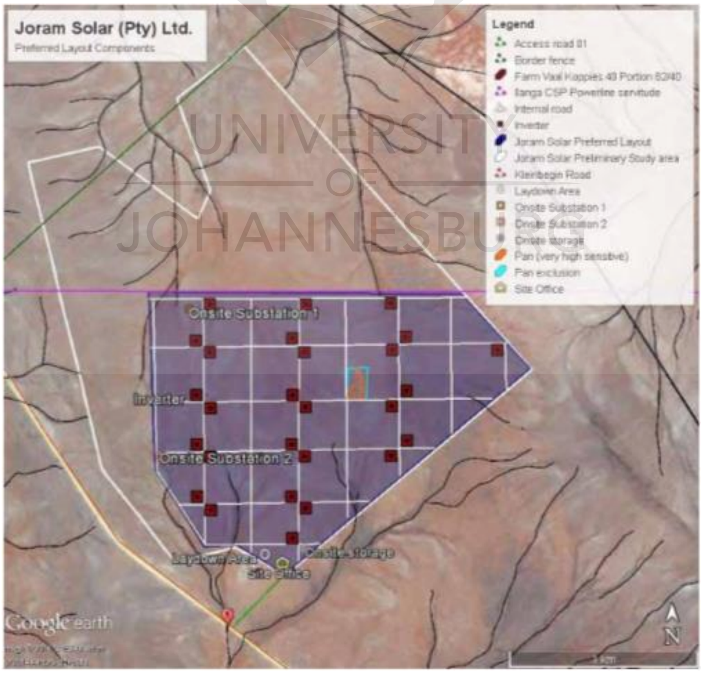

Figure 4.6.2: Google map showing project location.

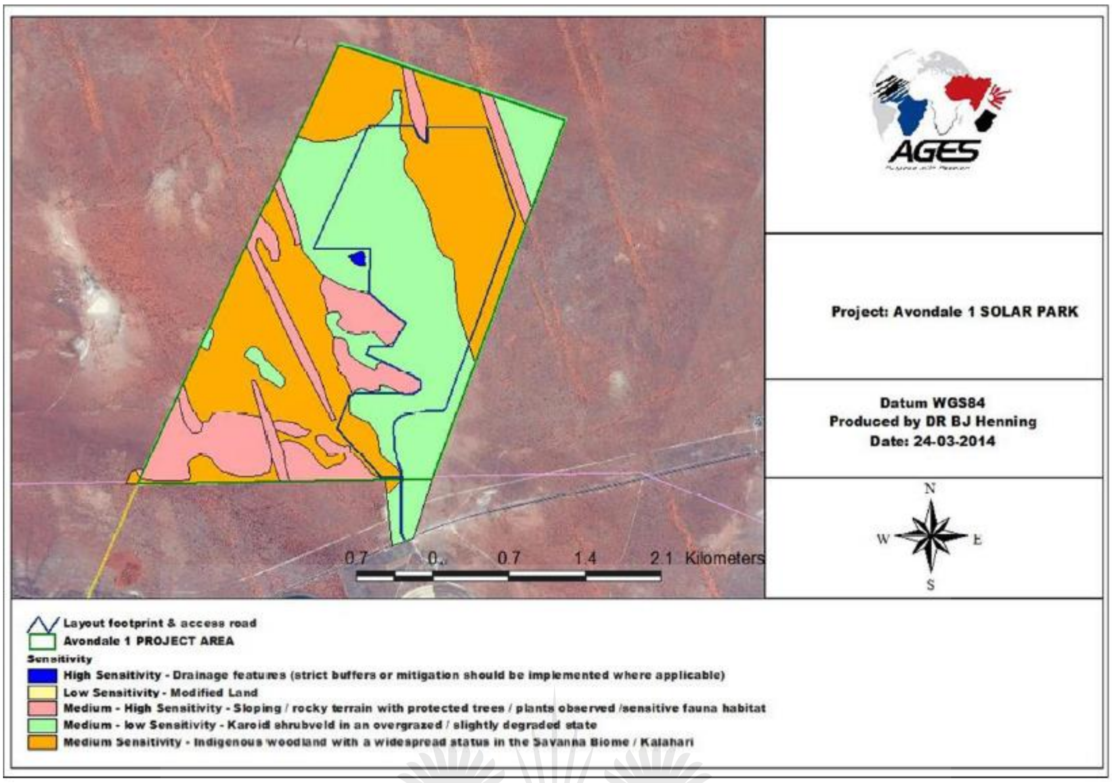

Figure 4.6.3: Google map showing project area relative to classes of ecological sensitivities.

4.2.5 Site Layouts

For understanding the different technical configurations of proposed projects, site layouts and related sketches are vital factors. A proper site layout will show what entities are located where within the allocated site, and this is especially important to maximise safety during the construction processes (Akanmu et al., 2016). Most site layouts show the proposed project location in a block plan in addition to their surrounding settings (Torrent & Caldas, 2009). Such a block plan is also recognised as a site plan that illustrates the proposed development in added detail. Site modelling techniques and their derivatives for site layout preparations, address varying project needs such as construction progress monitoring, and may trigger spatial awareness of the context of the construction site to those who are reading them (Song et al.,2006; Torrent & Caldas, 2009; Akanmu et al., 2014; Akanmu et al., 2016). The maps are usually depicted in an average metric scale generally as 1:1250 or 1:2500 for bigger sites. These illustrations show the roads, constructions on land connecting the applicable site, the north arrow, applicable site boundaries of the proposed project and all land aspects that necessary for the development (Russ, 2009).

The site layouts used in the present research showed the proposed project locations and layouts for the installation of PV facilities, wind turbines and their control stations (Figure 4.7.1 and Figure 4.7.2). In terms of the extent or frequency of their use in the analysed for the present study, site layouts were found to be the least used spatial representations compared to the other types of spatial illustrations such as topographical maps, google maps, landcover maps, cadastral maps, and photos. The highest number of site-layout maps per EIR was found to be 4 while the lowest number was 1. Furthermore, most of the site layout maps did not have adequate map elements and details. Out of the total number of 7 site-layout maps that were appearing in 24 EIARs, only 55% (n=4) of them used appropriate map elements and colour variations. Thus, they were less effective in communicating the proposed project aspects and their associated impacts.

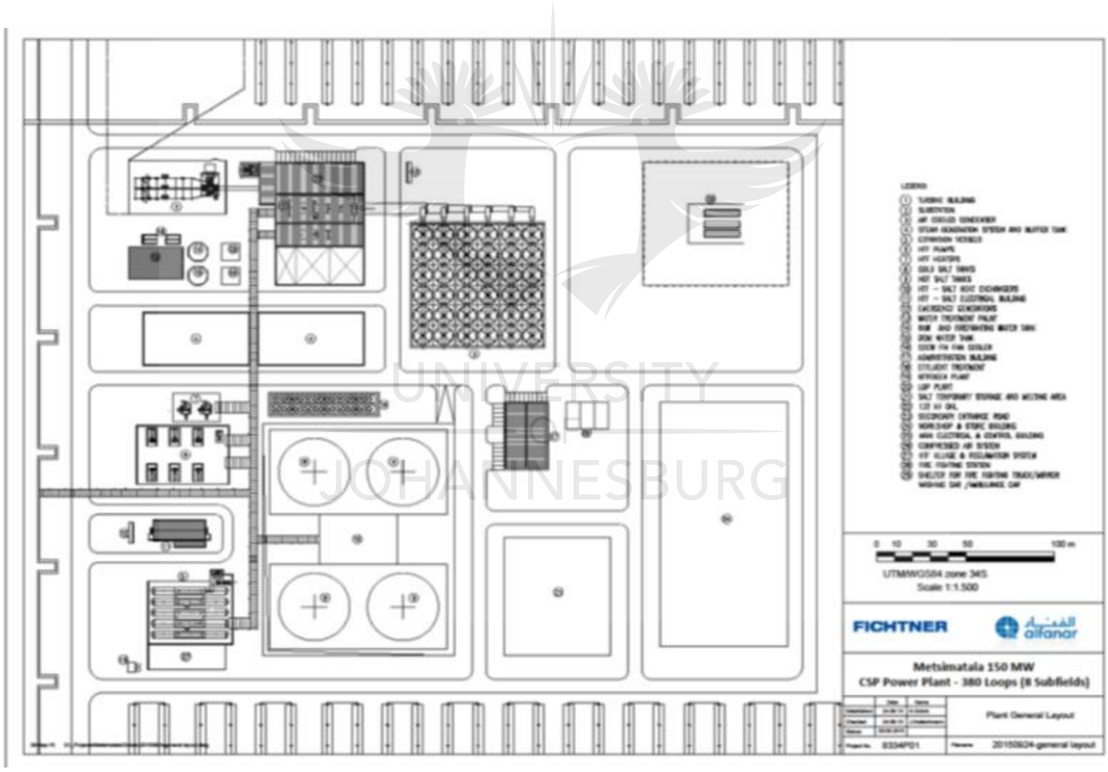

Figure 4.7.1: Site layout of the proposed project location for the solar plant.

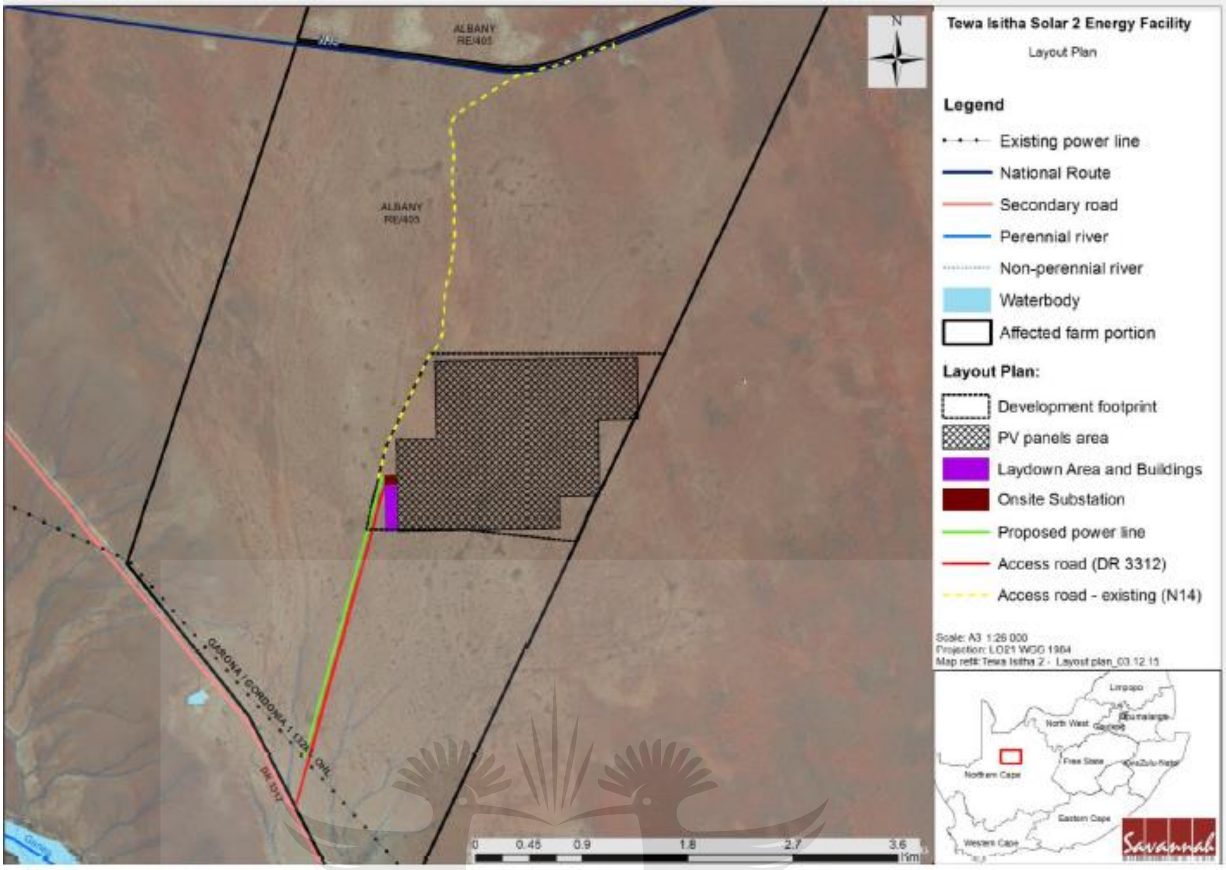

Figure 4.7.2: Site layout (marked A) of the proposed location for the solar energy project.

4.2.6 Photos

Photos are used as visual representations of a real land surface and they are not computer-generated but instead they have the capability to capture the visual dimensions of the phenomena under investigation (Fan et al., 2014). Photos were the most common and extensively used spatial presentations in the assessed EIARs. The photos clearly depicted the project aspects, impacts as well as sensitive biophysical and socioeconomic receptors and efficiently communicated all the details on the proposed projects as well as the receiving environments. Some of the photos that were used in these EIARs were adopted from other similar projects that had been conducted before. These clearly aided in bringing the proposed project to a much clearer perspective for an effective engagement with the affected communities and interested and affected parties. In total, about 382 were appearing in the 24 EIARs that were evaluated in this study. The highest number of photos per EIAR was found to be 52 while the lowest number was 3. On average, eleven photos were presented for each EIAR selected for this study. The photos depicted the proposed project locations, project activities details, impacts of the project on the physical and human environments. What follows below is the different photos presented per project locations, project activities and impacts on the receiving environments,

4.2.6.1 Project Locations

The EIARs that depicted photos of the proposed locations presented different views of the actual area (Figure 4.8.1, Figure 4.8.2 & Figure 4.8.3) selected for these projects, the layout of the facilities and equipment as well as the access routes to the areas using illustrations adopted from previous comparable projects. The areas of interest around the proposed locations were also highlighted in these photos. The photos also showed the existing electricity grid connections present in the area as well as transport routes, and access points. What follows next is an explanation of what spatial information was depicted by the different photos that were used in the various EIARs.

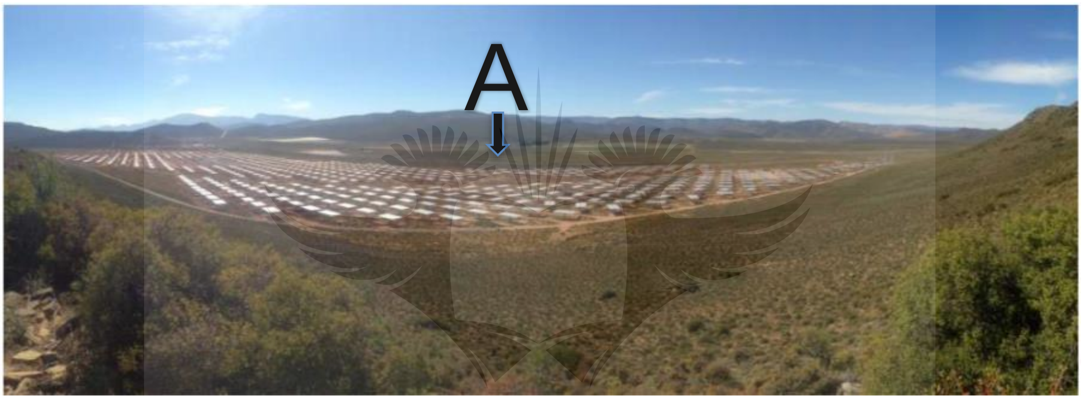

Figure 4.8.1: Photo showing the proposed project location (marked A) in EIAR No. 22.

Figure 4.8.2: Photo of the proposed location for the wind energy project near an unpaved road in EIAR No. 20.

Figure 4.8.3. Photo of the proposed PV facility to be sited in the project location (marked A) in EIAR 16.

4.2.6.2 Project Activities/Details

Photos that depicted the project activities or details in the sampled EIARs also highlighted the technical layout of the proposed solar PV facilities, wind turbines and hydropower plants (Figure 4.9.1, Figure 4.9.2 & Figure 4.9.3). They also showed details of the construction phase, the actual installation processes as well as the substations and the trench dimentions in the area and the contructions base complex. Moreover, these illustrations and sketches were used to depict the different phases of the projects, project area and scope. Futhermore, the proposed measures to mitigate negative impacts during the contruction phase that would be put into place were also indicated alongside the monitoring aspects.With the ilustrations of this kind provided in the EIARs, I&APs, including the competent authorities that have to give or decline the environmental authorization for these projects, can visualise better most of the technical features involved.

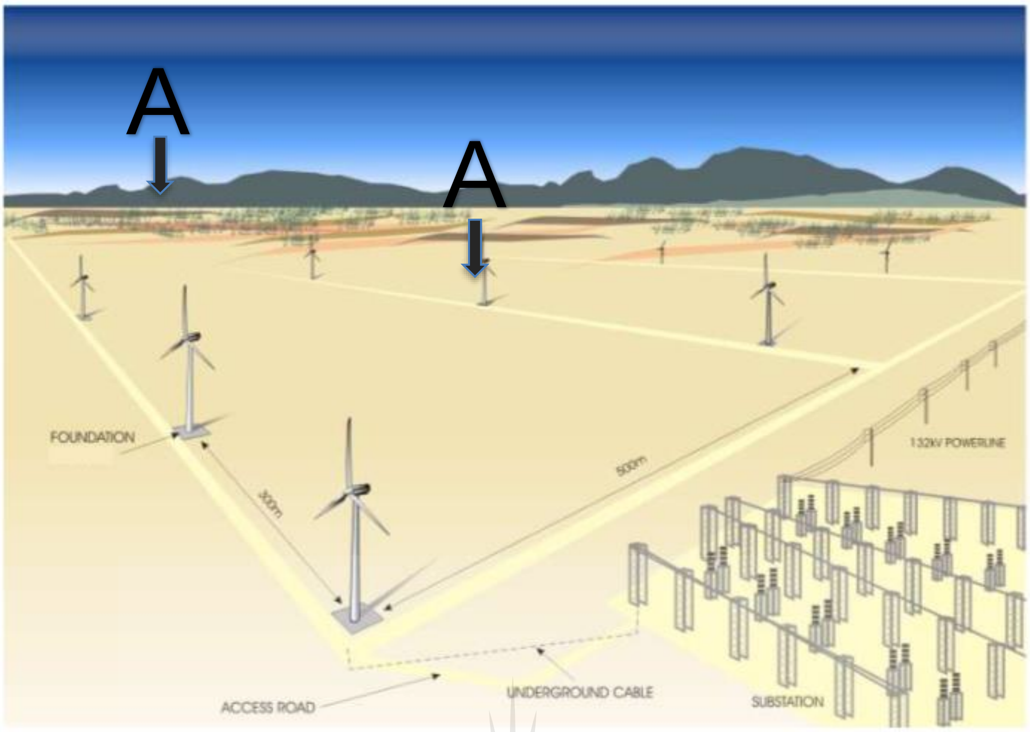

Figure 4.9.1: Photo of proposed assembling (marked A) of the wind turbines in EIAR 7.

Figure 4.9.2: Photo of proposed mounting of the PV modules in the solar park in EIAR 6.

Figure 4.9.3: Photos of the mounting of frames for the PV panels in EIAR 23.

4.2.6.3 Impacts on Physical Environment

Photographic displays of the impacts of the proposed projects on the receiving physical environment were the most popular illustrations in the analysed EIARs. Photos were used to show the perennial and non-perennial streams, rivers, lakes, and watercourses in selected project areas (Figure 4.10.1 & Figure 4.10.2). They also depicted vulnerable vegetation bodies, biodiversity hotspots, areas dominated by shrub vegetation, soil cover (i.e. areas sensitive to erosion) (Figure 4.10.3) and geological features (Figure 4.10.4). Moreover, other reports focused mainly on the potential impacts on red-listed fauna and flora. Furthermore, some photos displayed the recommended mitigation measures to be included in the revised layouts, while others portrayed the receiving environments, the bare areas that are susceptible to erosion, and even the location of boreholes, fountains and reservoirs and the adjacent land-uses that are likely to be affected both negatively and positively.

Figure 4.10.1: Photo of a stream in the proposed project location representing hydrological sensitivities and potential impacts on this physical environment in EIAR No. 25.

Figure 4.10.2: Photo showing the location of waterways within and nearby proposed project location, thus site sensitivities and potential impacts on physical environment in EIAR 9.

Figure 4.10.3: Photo showing natural vegetation in the proposed project location representing site sensitivities and potential impacts on physical environment in EIAR 2.

Figure 4.10.4: Photo of geological features and landscapes in the proposed project location representing site sensitivities and potential impacts on physical environment in EIAR 11.

4.2.6.4 Impacts on Human Environment

The different impacts on the human environment were also depicted by means of photos. These illustrations ranged from livestock populations that graze near the selected project sites (Figure 4.11.1); community borehole and livestock drinking water points and associated infrastructure (Figure 4.11.2); as well as the heritage and archaeological remains in the form of abandoned buildings, stone walls, and metal crafts (Figure 4.11.3).

Figure 4.11.1: Photo of cattle camps in the proposed project location representing site sensitivities and potential impacts on human environment in EIAR No. 7.

Figure 4.11.2: Photo of a community borehole in the proposed solar project location representing site sensitivities and potential impacts on human environment in EIAR 15.

Figure 4.11.3: Photos of archaeological remains in the proposed hydropower project location representing site sensitivities and potential impacts on human environment in EIAR 17.

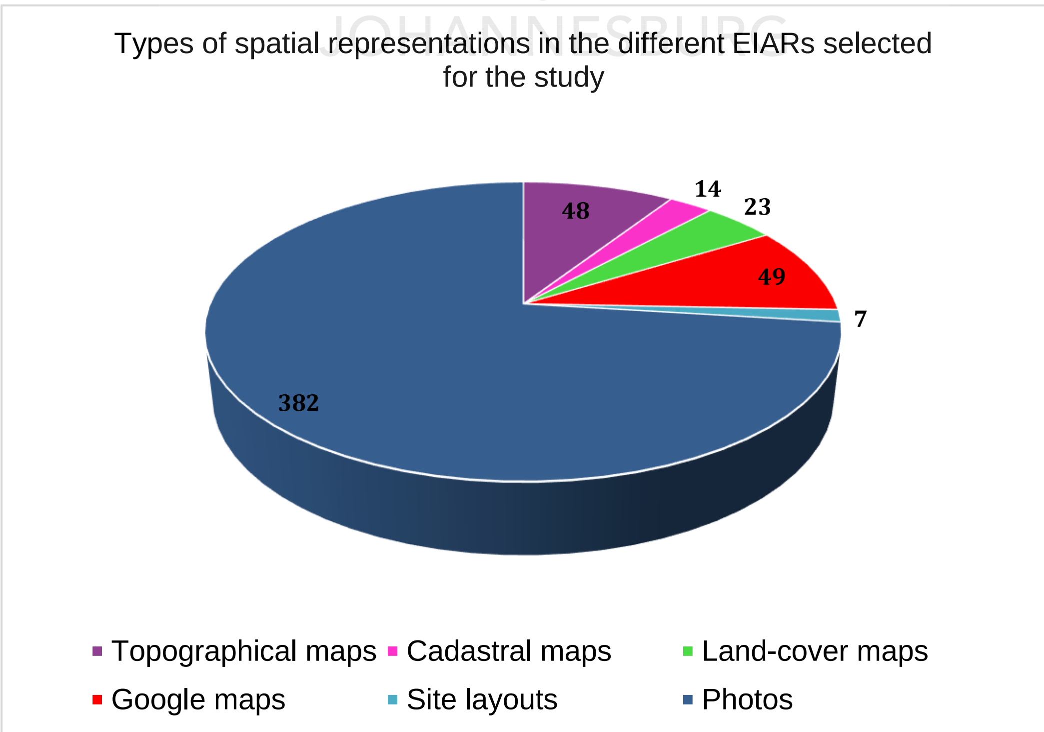

Figure 4.11.4: Types of spatial representation that were used to depict spatial information in the analysed EIARs

In summary, Figure 4.11.4 is showing the actual number of all spatial representations that were shown in the 24 EIARs that were assessed in this research. The most common spatial representation were photos (numbering 382 in total), followed by google maps (49), topographical maps (48), landcover maps (23), cadastral maps (14), and, finally the least being site maps (7). Overall, the use of spatial representations was very broad and varied. Furthermore, most of the spatial representations were clearly presented from different phases of the proposed projects and from different points of view of the proposed project sites with all the suitable map elements. However, there were some spatial representations in these EIARs that showed little to no detail at all.

.4.3 Degree of Visual Realism amongst Spatial Representations

The degree of visual realism is one of the important indicators used in spatial analyses. The more realistic visualization is found in any image, the easier it can be captured, analysed, and understood by individuals (Stachoň et al., 2018). Visualization models need to be effective when it comes to communicating spatial data and allowing human vision to capture all the features in them without any difficulties (Semmo, 2016). Thus, spatial information used in public participation (PP) for decision-making needs to be easily understood by showing the detail that pertains to the proposed developments, the activities and the receiving environment in any visual model using a suitable level of visual realism (De Freitas, 2010; Semmo, 2016). According to Fan et al. (2014), the level and degree of visual realism is the extent an image gives the impression of a photo to people instead of it being computer generated. Based on this, Mwenda et al. (2015) classified visual realism into 3 main categories: low, high, and mixed visual realism.

None of the EIARs in this research depicted a low level of visual realism (Figure 4.12.1) such as using only (1) topographical maps, (2) cadastral maps, (3) CAD maps/drawings, (4) site plans and (5) survey maps. Instead, the research uncovered a combination of various forms of spatial representations in the various EIARs that were sampled for this study. Out of 24 EIARs, about 33% (8) (Figure 4.12.1) depicted high levels of visual realism. High level of visual realism includes spatial illustrations such as photos, google maps, 2D/3D visualizations and landcover maps. Computer graphics with high level visual realism produce images with a visual reality that is close to the one embedded in pictures (Westerbeek, 2016). Moreover 67% (16) of the spatial representations (Figure 4.12.1) depicted mixed level of visual of realism, where more than one spatial representation was observed. This means there was a combination of low and high visual realism in the spatial representations in these EIARs (Figure 4.12.1). Overall, the mixed use of spatial representations in any single EIR was the most frequent pattern.

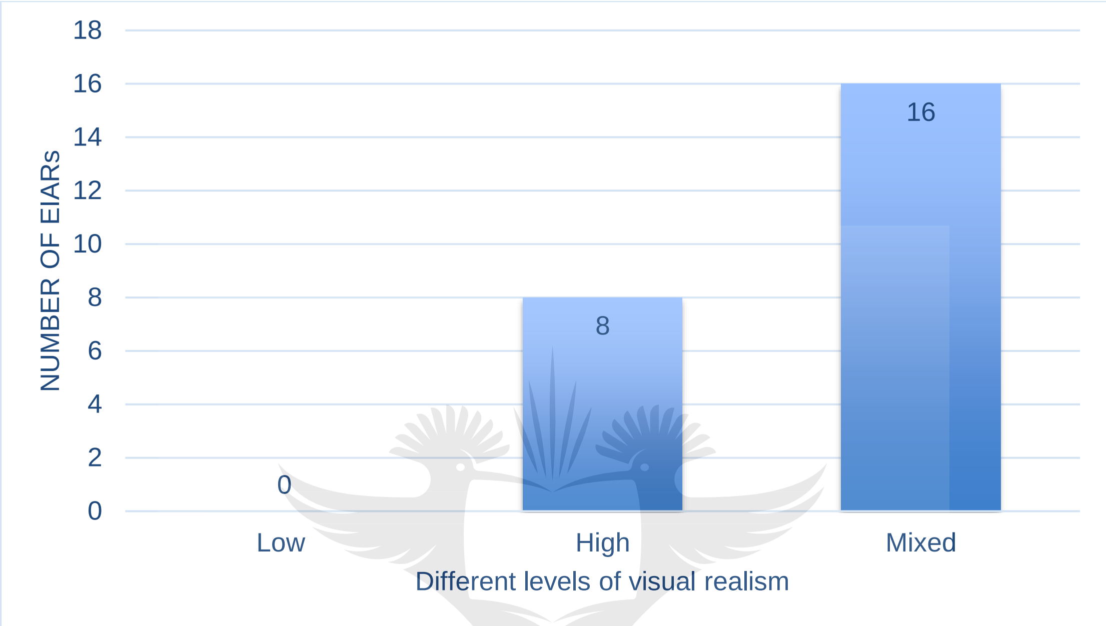

Figure 4.12.1: Different levels of visual realism as summarised from the spatial representations that were found.

In conjunction with evaluating the level of visual realism, the study also looked at the information that was found in these spatial representations. According to Mwenda et al. (2015), for spatial representations to support decision-making and inform all the stakeholders during an EIA in an effective manner, they are expected to display adequate spatial detail specific about the proposed projects. These details consist of the location of the relevant projects, project activities/details and areas of special interest in the impacted physical as well as human environments (Mwenda et al., 2015). The results on this phenomenon are depicted in Table 4.1. The current spatial information on the EIARs shows that project locations (**Category 1**) were the most common degree of visual realism , followed by special interest areas (**Category 3**), then the locations of projects and special interest areas (**Category 5**), and, lastly project locations and activities/details (**Category 4**).

Table 4.1: Table of matrix for level of visual realism and the aspects found in spatial representations.

	Low visual realism	**High visual realism**	**Mixed visual realism**
(P)	0	8	16
(PA/D)	0	2	4
(SIA)	0	8	16
(P + PA/D)	0	3	10
(P + SIA)	0	5	16
(PA/D + SIA)	0	0	0
(P + PA/D + SIA)	0	0	0

Legend: (P); (PA/D); (SIAs); (P + PA/D); (P + SIAs); (PA/D + SIAs); (P+ PA/D + SIAs)

- (P) = Project location
- (PA/D) = Project activities/details
- (SIAs) = Special interest areas
- (P + PA/D) = Project location + activities/details
- (P + SIAs) = Project location + special interest areas
- (PA/D + SIAs) = Project activities/details + special interest areas
- (P+ PA/D + SIAs) = Project location + activities/details + special interest areas

In terms of the different project locations of the proposed renewable energy projects in the Northern Cape province of South Africa, no spatial representations were found to display low visual realism. This means they were in the form of illustrations such as photographs which have a relatively higher degree of visualisation as opposed to topographical maps and site layout illustrations. However, the spatial representations that exhibited project locations with mixed visual realism were comparatively more (i.e. 16) while those with a high visual realism were only eight (8). Mixed visual realism was indicated by both spatial representations with low and higher realism. For example, on the one hand, the spatial features were in the form of topographical maps and site layouts which displayed low levels of visual realism. On the other hand, there were more photos (i.e. highest), landcover maps, google maps and cadastral maps (. i.e. relatively lower) that were used to depict project locations with a relatively higher degree of visual realism. Regarding the spatial information that was provided to depict project activities and details, there was no low visual realism and those with higher (2) or mixed (4) visual realisms were relatively fewer. In this instance, the different EIARs that were examined had very few illustrations that would give much detail on project activities and related details.

Special interest areas that were depicted on the various EIARs included water features, natural vegetation, ecological habitats, geology and topography, historical and archaeological features, as well as different components of the human environment such as settlements and surrounding land uses. Similarly, with spatial information that was used to depict project locations, the most preferred representations displayed mixed visual realism (i.e. 16) while those with high visual realism were only eight (8) in number. As illustrated in Table 4.1, the following patterns were observed for the types of spatial representations that were used to show a combination of project locations, project activities and associated details (P + PA/D). No spatial illustrations could be characterized as having low visual realism when it came to these three aspects (P + PA/D). However, of the spatial representations that were used, 10 of them were found to have mixed visual realism. Such a mixture is derived from having illustrations such as topographical maps and site layouts which have low visual realism as well as photos, land cover maps, and google maps which have higher visual realism. By contrast, only 3 EIARs had a high degree of visual realism because they were provided in the form of photos especially for the various features that could be regarded as project activities.

In terms of spatial representations that displayed a combination of both the project location and special interest areas (P + SIA), the most preferred method of presenting these spatial representations was mixed visual realism (16). This is the combination of both low visual realism and high visual realism, specifically using photos and google maps, topographical maps as well as landcover maps which was very dominant way of displaying this type of spatial representations. The use of high level of visual realism only was another preferred method but shown to be less common than the use of mixed visual realism representations. None of the EIARs showed a complete use of low visual realism (just topographical, site layouts or cadastral maps) to display the project locations and their special interest areas. As shown in Table 4.1, none of the EIARs depicted spatial representations that showed a combination of project activities/details and special interest areas as well as the combination of project location, activities/details and special interest areas. However, these were entirely depicted just as project locations, project activities, special interest areas or combinations such as project location and activities/details as well as project location and special interest areas. All these spatial representations used high level of visual realism entirely or the combination of both high and low visual realism in the form of photos with the highest degree of visual realism, landcover maps, google maps cadastral maps and site layouts which have a relatively lower degree of visual realism.

4.4 Dimensions of Public Participation

As indicated earlier, Mwenda et al. (2012) designed a schema for the development of certain dimensions that can be considered relevant for public PP when environmental impact assessments are being undertaken. According to their theoretical schema, these dimensions are as follows: (1) notification methods (site notices (Figure 4.13.1), flyers, emails, newspaper, radio announcement and letters), (2) participation method (public meetings, focus groups, workshops, surveys, fact sheets, websites, open houses etc.), (3) venue (accessible and convenient or not accessible and convenient) , (4) language used (the extent to which language is widely accommodating catering for the communication needs of all stakeholders) and (5) the type of participants (whether civil society, local community, NGOs, government agencies, industries, or business communities) play a major role in the effectiveness of the PPP. The effectiveness in the deployment of these dimensions contribute largely to the overall decision-making process as well as the overall outcome of the proposed project. In the EIARs evaluated for this study, the results on the dimensions that were evaluated are presented in Table 4.2. In the methodology chapter, it was stated that these dimensions would be evaluated by means of scores acquired from the use of a Likert scale.

Figure 4.12.1 Site notices on the boundary of proposed project location.

Only the dimension that was represented by 'notification methods' (Table 4.2) was rated to be very satisfactory in conveying the relevant spatial information and notifications to the interested and affected stakeholders about the proposed development projects. For most EIARs, the site notices were displayed on the boundaries of the proposed project locations as well as the neighbouring community buildings such as municipal buildings, libraries, and entry points in certain settlements (Figure 4.13.2). These notifications were varied and entailed information collected from newspaper advertisements published in the local/regional newspapers, electronic mail, and letters with relevant information. As indicated earlier, their scoring was very satisfactory (i.e. 5) because there was a variety of channels that provided the required information.

The dimension that was rated to be 'just satisfactory' (4) included the category that was based on the various participation methods to inform the different stakeholders on project locations, project impacts and ecological sensitivities as well as other relevant aspects. These methods ranged from public meetings, focus group meetings, online correspondences, email communications, project information from relevant websites, as well as the utilisation of facsimiles and telephonic consultations. However, some EIARs did not specify the participation methods that were used, which made it hard to determine if the PPP was efficient and effective and therefore resulting in an overall score of 4 (Table 4.2). In terms of the dimension that pertained to the suitability of venues, for an effective PPP, the legal requirements in South Africa state that the venue selected for public participation should be accessible and convenient for all stakeholders to reach. This is required for encouraging maximum public participation for any given project that is subjected to an EIA process. Judging from the extent to which relevant information on selected venues were provided, this dimension was rated to be 'just satisfactory'. The venues used in the EIARs selected in this study were relatively accessible although some EIARs did not specify anything about them. Hence, this dimension was assigned an overall score of (4), which denotes 'just satisfactory'.

The dimension that was rated "unsatisfactory" (2) is relating to language usage. This is because South Africa is a very diverse country with 11 official languages. The use of various languages in the PPP is highly recommended for accommodating as many people as possible so that stakeholders can understand the proposed projects as well as their aspects and impacts. In the studied EIARs, the use of English and Afrikaans as the main languages of communication was prevalent while other languages appeared to have been excluded. While it is not suggested that EIARs must be written in the local ethnic languages such as Setswana or Sesotho or isiXhosa*,* where opportunities arise, certain key information may be presented in those languages to aid and enhance the understanding of the relevant spatial information that is associated with them.

Finally, the dimension that pertained to types of participants that were involved in these EIAs, shows that the participants included all relevant I&AP, stakeholders, members of the public, local communities, government departments, government bodies, relevant districts and businesses, landowners, conservation authorities, NGOs and planning specialists. The feedback and comments from these participants were documented in the applicable EIARs. However, most of this feedback seemed to be from major stakeholders and specialists while nothing was received from the local community members.

Table 4.2: Dimensions of Public Participation.

Dimensions	Legal requirements	Indicators	Score
Notification methods	Requirements of the NEMA EIA regulations. sections 54, 55, 56 and 57 of the EIA 2010. Section 41 of EIA regulations 2014 and 2018	Site notices, newspaper adverts, letters, and emails	5
Participation methods	Requirements of the NEMA EIA regulations. Section 42 of EIA regulations 2014 and 2018	Public meetings, focus groups, online correspondence, emails, websites, fax, telephonic consultation	4
Venues	Requirements of the NEMA EIA regulations. sections 54, 55, 56 and 57 of the EIA 2010. Section 41 of EIA regulations 2014 and	Accessible venues (public libraries and community halls), most not specified	4
Language used	Requirements of the NEMA EIA regulations. sections 54, 55, 56 and 57 of the EIA 2010. Section 41 of EIA regulations 2014 and 2018	2 mentioned in most (English and Afrikaans) most common is English	2
Types of participants	Requirements of the NEMA EIA regulations. Section 40-44 of EIA regulations 2014	All I&APs are mentioned in most EIR documents	2

In addition to the dimensions shown in Table 4.2 that were evaluated, the concerns that were raised by the stakeholders and I&APs were also taken into account in order to evaluate the effectiveness of the spatial representations in providing the details and spatial extent of the proposed projects. Common issues that were raised are summarised in Table 4.3 The issues and concerns were spatially related as well as livelihood related. Most of the issues of concern were brought forward by the following key stakeholders (for example, Square Kilometre Array (SKA), Department of Agriculture, Land Reform and Rural Development, Department of Agriculture Forestry and Fisheries, SANRAL and Eskom). Issues from local community members were not frequented raised nor documented in the EIA reports. This could be due to less involvement or lack of access, or not a lot of I&APs registering, which might appear as a lack of information sharing during the PPP. Other documents provided no details at all on the comments from the PPP.

Table 4.3: Some of the issues of concern brought forward during PPP(They are highlighnted in colour).

Issues of concern as raised by different stakeholders
• Some projects are bordering other different provinces and therefore require additional permits and license. • The names/boundaries of the local municipalities should be indicated on the maps. • Eskom requirements for works at or near Eskom infrastructure should be considered and implemented. • Employment opportunities need to be shared evenly between the local neighbouring communities. • The impacts on listed protected trees should be assessed and avoided as far as possible. • Appropriate buffers to protect sensitive biodiversity features must be clearly shown. • Wind turbines also cause large turbulence downwind and may affect existing infrastructure, this needs to be considered and mitigation plans mapped. • A minimum distance needs to be introduced between a wind turbine/solar panels and other infrastructure to ensure that debris and/or turbulence would not negatively impact on the infrastructure. • Removal of pockets of vegetation will eventually damage ecosystem functioning and must be mitigated. • Removal and relocation of protected tree species needs to be highlighted on maps. • If amount of water for the construction phase exceed the limits covered in general authorization, they should be additional licensing. • Watercourses, wetlands and thicket vegetation should be No-Go areas. • SANRAL must be consulted before movement of loads on national roads • Locals complained on the traffic that will possibly result in the deterioration of the road. • Farmers rely on the roads for the transportation of livestock and deterioration will result in impact on the livelihoods.

- A clear demonstration of how all recommendations and mitigation proposed by all specialists that have been taken into consideration must be made.
- Where impacts are unavoidable, this should be clearly stated and motivated.
- Noise impacts on animals should be avoided by all means.
- Dust generation through the cleaning of panels and mirrors should be mitigated.
- The possibility of the solar plants generating a 'heat island" must also be investigated.
- Visual impacts and the direct/indirect effect on tourism needs to be further investigated and mitigated were possible.
- Impact on value of farms in the study area need to be further investigated.
- Negative social impacts (crime, alcohol and substance abuse, woman abuse HIV/AIDs etc.) need to be mitigated were possible.
- Impact on service delivery needs to be considered.
- Should the project be abandoned due to financial shortfalls, what measures are available to ensure no further environmental degradation takes place? Who would be responsible?
- Duty of Care and good housekeeping by the contractor will be required to mitigate impacts.
- Drip trays also to be placed under the engine of all heavy vehicles on sites.
- Although it is good practice to advertise in English and Afrikaans in Local and Regional newspapers, it would have been appropriate to also advertise in isiXhosa/ other languages.

4.5 Discussion of Results

The extent and effectiveness of the use of spatial information during the EIA process for PP was evaluated from 25 EIARs. These EIARs were predominantly from the renewable energy sector, based largely on projects in the Northern Cape province in South Africa. The objectives were firstly, to identify the different kinds of spatial representations that were used in the EIARs. Secondly, establish how spatial information was used to provide the details of the proposed projects. Thirdly to establish if the spatial information catered to the needs of the different stakeholders and the I&APs. Fourthly, to identify the issues and concerns that were raised and how they relate to the quality of the spatial representations provided. Lastly to make recommendations on improving the quality of spatial information provided in EIARs. To achieve these objectives, the methods and techniques that were used by Mwenda et al. (2012), Mwenda et al. (2013) and Mwenda et al. (2015) were adopted for this study. Their techniques were applied to the different types of spatial representations used, the extent to which they vary in visual realism considering seven aspects by Mwenda (2015) (Table 4.1) and the dimensions of PP (Table 4.3).

The EIARs sampled for this research showed a high level of using various spatial representations. Spatial representations were used in almost all aspects of the EIA process in 24 out of the 25 EIARs. They ranged from topographic maps (15%), land-cover maps (16%), google maps (18%), site layouts (4%), cadastral maps (4%) and photos (24%) (Figure 5). Most of the spatial representations had clear details and adequate map elements, while others were lacking such spatial information. Failing to provide spatial annotations that will show project features and site characteristics with sufficient detail means a lost opportunity for environmental data analyses because there is no basis for understanding inherent spatial relationships within each project. Spatial representations that were provided in the EIARs also depicted all the possible site alternatives for the proposed projects. An analyses of various project alternatives is one way of bringing sustainability in the selection of feasible sites (Glasson & Therivel, 2019). However, in the schemata that Mwenda et al. (2015) proposed, there was no consideration of project alternatives, therefore raising the need for including them in future studies.

In terms of the visual realism presented in all the spatial displays, the most popular one was the use of mixed visual realism (Figure 4.12.1). Mixed visual realism is the combinational use of both low visual realism (were spatial features are topographical maps, cadastral maps, CAD maps/drawings, site plans and survey maps) and high visual realism (were spatial features are photos, landcover maps, google maps, 2D/3D visualizations and landcover maps). Similar with previous research it has been shown that mixed level of visual realism featured more prominent than other categories of visual realism. For example, mixed level of visual realism has been reported by several researchers (Slocum et al., 2001; Al-Kodmany, 2002; Lai et al., 2010), thus implying its usefulness in portraying the environmental data that needs to be understood by all role players and stakeholders alike. These types of spatial representations have the capacity to show not only where the proposed facilities are to be located but also other spatial relationships in terms of the proximity and the location of buffers. Even better is the case of high visual realism, which is most ideal form of spatial representativeness. Unlike EIARs mentioned in other studies, in the present study it was established that mixed visual realism was frequently used in such reports to depict spatial phenomena of various kinds studies.

As mentioned by Kettunen et al. (2013) and Fan et al. (2014), with high visual realism, the spatial representations (i.e. google maps; photos; land cover maps etc) being used closely resemble the project and site characteristics that are under investigation the EIA process. Thus, using spatial features with high level of resolution enable different stakeholders to clearly understand the implications of relevant objects of enquiry. In the light of low visual realism, none of the EIARs presented spatial phenomena with low visual realism entirely on one document. This finding reflects better on the quality of the spatial information that was provided in these EIARs, since low visual realism is undesirable from an impact assessment perspective. In other words, representations of low visual realism are very limited in helping different stakeholders to comprehend the full spatial dimension of relevant aspects. Thus, the degree of abstraction is relatively too low in such representations, and people are not likely to understand the spatial interactions involved and the location of features (Kettunen et al.,2012; Fan et al., 2014; Mwenda et al., 2015).

Furthermore, in these results, visual realism was used to frequently display aspects such as Project location=(P), Project activities/details = (PA/D), Special interest areas= (SIAs), Project location + activities/details =(P + PA/D) as well as Project location + special interest areas = (P + SIAs) (Table 4.1). These aspects were shown by means of the spatial representations mentioned above, such as photos with the highest degree of visual realism, landcover maps, google maps cadastral maps and site layouts, which have a relatively lower degree of visual realism. In terms of the Project locations= (P), no spatial representations depicted low visual realism. However, the spatial representations were dominantly depicted using mixed visual realism (16), while those with a high visual realism were (n=8 EIARs). Regarding the spatial information that was provided to depict Project activities and details= (PA/D), there was no low visual realism. Those with higher visual realism were (2) and mixed visual realism were (4). In relation to displaying the Special interest areas= (SIAs), the most preferred form of spatial representation for showing this aspect was mixed visual realism (16) and high visual realism, which were (8) in number. Low visual realism was not used at all.

The aspect Project location + activities/details = (P + PA/D) was depicted predominantly using mixed visual realism (n=10 EIARs) also to a lesser extent high level of visual realism (n=3 EIARs) and no use of low visual realism was observed. Furthermore, the spatial representations that displayed both the Project location and special interest areas= (P + SIA), were also predominantly depicted in mixed visual realism (n=16 EIARs) and to a lesser extent depicted using high visual realism (n=5 EIARs) and none were displayed using low visual realism. The remaining aspects i.e. Project activities/details + special interest areas= (PA/D + SIAs) and Project location + activities/details + special interest = (P+ PA/D + SIAs) of the 7 aspects by Mwenda et al. (2015) were less prominent in the present investigation. None of the EIARs depicted spatial representations that showed a combination of project activities/details and special interest areas as well as the combination of project location, activities/details, and special interest areas entirely using low, high, or mixed visual realism (Table 4.2).

Moreover, to identify if the spatial representations catered to the different needs of the different stakeholders, including local people, the PP dimensions that were adopted from the research carried out by Mwenda et al. (2012) were evaluated. The results showed that the dimensions such as the following ones were frequently used: for example, (1) the notification method, which was assigned a very high rating as it varied quite a lot and was spread across all the neighbouring community buildings and community central areas; (2) the participation method, which accommodated all levels of I&APs and stakeholders through the use of (i.e. public meetings, focus groups, online correspondence, emails, websites, fax, and telephonic consultation) as well as the information on (3) venues for public participation was assigned a medium rating. These findings show that the different EIA studies in the present research were carried out relatively adequately in terms of these criteria. However, (4) language used, and (5) types of participants was unsatisfactory and scored a low rating. As indicated already, most EIARs presented the use of only 2 languages, which is English and Afrikaans. Traditional indigenous knowledge is very important in EIA studies and needs to be effectively incorporated in the PPP (Nakumura, 2008). To the extent possible, developers need to also communicate the benefits of the project effectively to the indigenous communities in languages such as Setswana and Sesotho, and even Afrikaans as they are spoken widely in some of the selected regions.

Lastly, the study also looked at the issues and concerns that were raised by the stakeholders and I&APs in the comments sections. Spatially related comments were more dominant in all the evaluated EIARs, while the rest of the comments were related to the expected livelihood changes. Unfortunately, there was an element of bias if one looks at the source of these comments. Most comments highlighted issues and concerns that were raised mostly by key stakeholders. This suggests that the key stakeholders were able to participate in the PPPs fully, whereas the participation of ordinary rural community members was much lower. This could be due to local community members not registering for the PPP process, or not having access to resources for participation or struggling to comprehend and follow the issues that were being raised during the PPP.

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CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter, the conclusions and recommendations from the study are provided. In Section 5.2 the various conclusions are given based on the research objectives and results obtained from the data analysis, while section 5.3 is based on the recommendations. These recommendations are for the use of improved spatial information during the environmental impact assessment (EIA) processes as well as for future research.

5.2 CONCLUSIONS

The aim of this study was to evaluate the effectiveness of using spatial data in EIARs conducted in South Africa during public participation, which were mainly from the Northern Cape Province. This aim was addressed by the formulation of five different research objectives:

- To identify different kinds of spatial representations that were used in EIARs to help stakeholders understand the location, environmental impacts, and their environmental feasibility.
- To establish how spatial information was used to provide details and spatial extent of proposed development projects.
- To establish if the spatial information given in the EIARs catered for the needs of the different stakeholders to conceptualize and comprehend the magnitude and the significance of anticipated environmental and socio-economic impacts.
- To identify the issues and concerns raised by the different stakeholders and how they relate towards the quality of the spatial data and representations provided.
- To make recommendations on how the quality of spatial information provided in EIARs can be enhanced.

The evaluation conducted has determined how effective was the representation of spatial information in depicting the different features of proposed projects as well as their environmental impacts. This provided the basis to also evaluate the extent of using such spatial information as well as the efficiency of communicating proposed project's characteristics through visual realism. According to the results generated by this study, there was widespread use of spatial representations in the sampled EIARs. As a result, about 90% of the assessed EIARs contained spatial information of one kind or another. This varied largely from topographic maps, land-cover maps, google maps, site layouts, cadastral maps and photos (Figure 4.2). This reveals the high popularity of such spatial representations in the practice of EIA in this study area. Furthermore, these spatial representations were used to inform the different stakeholders on aspects such as project locations, project activities/details and special interest areas. In this way, stakeholders were afforded an opportunity to understand the spatial relationships between the proposed projects and their receiving environments.

As mentioned earlier in the methodology chapter, the spatial information in the present study was categorised into 7 different classes which are briefly summarised in the following table (Table 6.1) and according to the approach followed by Mwenda et al. (2015):

Table 6.1 Categories representative of the 7 aspects that can be found in spatial representations.

	Details
1.	Project location/site
2.	Project activities/details
3.	Special interest areas
4.	Project location+ project activities/details
5.	Project location+ special interest areas
6.	Project activities/ details+ special interest areas
7.	Project location+ project activities/details + special interest areas

Source: Mwenda et al. (2015)

For all categories (i.e. category 1-7) of spatial information that was presented in the selected EIARs, none of them was exhibited with illustrations that carried only low visual realism, thus reflecting an area of strength or an advantage because reduced realism does not show much to the eye in terms of 'spatiality' or 'spatial thinking' except for the technical and engineering considerations of these projects. This finding applied to the individual project aspects such as those ranging from category 1-3 (i.e. Project location (P); Project activities/details (PAs); and lastly; Special interest areas (SIAs). The same realism was found for combined projects aspects (i.e. category 4-7); for instance, Project location + Project activities/details + Special interest areas ((P+ PA/D + SIAs).

The research also found a relatively greater number of spatial information that was exhibited with high visual realism. Such realism was gleaned from the google maps, land cover maps as well as photos that were provided in the EIARs. These types of spatial information aided the different stakeholders to better visualise and interpret the different features they observed on the diagrams provided and the extent to which the same features represent reality on the ground. According to Kettunen et al. (2012) and Fan et al. (2014), visual realism means the degree of similarity between what is seen on an image or diagram relative to how such an image appears on the actual land surface.

Furthermore, other project aspects were displayed frequently with mixed visual realism. Such realism applied to the spatial information ranging from category 1 (P) right up to category 5 (P + SIA) while category 6-7 information was not included. In the present research, the widespread use of spatial information with mixed realism mirrors the findings reported by Mwenda et al. (2015) who found it to be the most popular and frequently used in their study area in Kenya. The overall implication here is that combining different levels of visual realism is an advantage in the sampled EIARs because of an element of data complementarity. For example, spatial information such as architectural designs or engineering layouts have low visual realism, but they are strong in terms of showing the technical detail that applies to the different components of the proposed renewable energy infrastructure planned for the Northern Cape province. Likewise, google maps and photos are rich in the spatial envisioning (i.e. where projects would be located, situated and their neighbourliness) elements but they are all deficient in terms of exhibiting technical and engineering information.

Some EIARs also fail to mention in explicit terms the scale used. The use of scale in most of the EIARs (60%) was poor. It therefore seems unlikely that EIA would be immune from the effects of the scale, which is likely related to strict budgetary and time constraints. Geographical scales are an issue that receives inadequate attention in the majority of EIA studies, and in many cases can represent a fundamental limitation to the production of an effective PPP during an EIA and clarity on potentially significant environmental impacts (João, 2002). The scale at which studies are undertaken contributes to the conclusions made by the stakeholders because processes and parameters important at one scale may not be depicted and acknowledged as important or predictive at another scale.

Lastly, another separate category of spatial information was identified as various dimensions of public participation. Such dimensions included, the (1) public notification methods, (2) public participation methods (i.e., just involving stakeholders; or just consulting them; or long term collaboration between the relevant parties); (3) venue selection and the (4) communication language used as well as the (5) type of participants (Table 4.2). The notification methods were scored higher compared to the other dimensions and this is attributed to their increasing emphasis in the South African EIA regulations as well as National Environmental Management Act (NEMA). However, not all of them were met satisfactorily and not all I&APs were fully accommodated in the PPP. All public participation processes (PPPs) should aim to have meaningful engagement with all stakeholders, be able to identify not only the issues and concerns raised by key stakeholders but also include other stakeholders and I&APs, promote transparency and the understanding of the proposed project.

5.3 RECOMMENDATIONS

The recommendations are grouped into two groups: the first group being for improved utilisation of spatial information in EIA processes including PPP, and the second being recommendations for future research.

5.3.1 Recommendation for Improved EIA Spatial Information

The following interventions are being recommended for improved EIA spatial information in South Africa mirrored by the evaluation of the EIARs from the Northern Cape province, and they are stipulated as follows:

- To overcome the bad quality of some of the spatial information that was provided, there is a need to use better spatial representations, particularly with respect to the appropriateness of map elements. Map elements entail map scale; legend; colour contrasts; and spatial coordinates.
- Although the level of visual realism was relatively high in this study, it is important to ensure that the spatial information presented has mixed visual realism, thereby promoting spatial data complementarity as mentioned earlier.
- Since the research methodology of the present study was modelled according to the approach used by Mwenda et al. (2015) and included only 7 categories of spatial information, it is important to also consider project alternatives and how they are depicted by making use of appropriate spatial information.

5.3.2 Recommendations for Future Studies

- Future studies can consider the further application of the aspects proposed by Mwenda et al. (2015), with the inclusion of more aspects such as project alternatives. The more project alternatives such as (1) alternative sites, (2) alternative routes, (3) alternative technologies, and (4) alternative raw materials are considered during an EIA process (Aucamp, 2009), the greater will be the probability of achieving sustainable development.
- Future studies can also look at further evaluation of the Dimensions of PP that were scored relatively low in the current study.
- Future research can further evaluate the function that spatial information performs within the EIA process in South Africa as they have been identified and investigated in other studies, for example, the presentation of baseline environmental information (Satapathy et al., 2008; Slotterback, 2011), the identification and prediction of impacts (Gonzalez et al., 2008; Atkinson & Canter, 2011), or the extent to which they support public participation and environmental management decision making (Riddlesden et al.,2012; Lei & Hilton, 2013).
- Another area of new research could examine the appropriateness of spatial information for members of the public who do not have any spatial literacy, either because of limited geographical knowledge or any forms of physical disability.
- In most instances, the provision and display of spatial information on the EIARs does not tell us anything about the financial and technical costs involved. There

is therefore a need to understand how these constraints limit the provision of adequate spatial information and accurate spatial elements (scales, colour contrast, legend and map orientation) in the EIARs.

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Appendix

Environmental Impact Assessment Documents

	Topographical maps	Cadastral maps	Landcover maps	Google maps	Site layout	Photos
EIAR 1 Project: San Kraal wind power Consultants: Arcus	0	0	0	0	0	25
EIAR 2 Project: Tewa Isitha Solar Consultants: Savannah Environmental Pty ltd	3	0	0	4	1	7
EIAR 3 Project: DU Plessis dam solar energy Consultants: Aurecon South Africa	6	0	1	1	0	8
EIAR 4 Project: Avondale solar park Consultants: AGES	0	3	1	2	1	6
EIAR 5 Project: Carodex solar park Consultants: AGES	1	2	1	1	0	5
EIAR 6 Project: Dyasonsklip solar facility Consultants: Cape Environmental Assessment practitioners	0	2	2	3	0	52
EIAR 7 Project: Hidden Valley wind energy facility Consultants: Savannah Environmental Pty ltd	10	0	1	1	0	11
EIAR 8 Project: Ilanga solar power Consultants: AGES	0	0	0	0	0	0
EIAR 9 Project: Joram solar park Consultants: Cape Environmental Assessment practitioners	0	0	1	3	0	19
EIAR 10 Project: Kloofsig solar power plant Consultants: srk consulting	2	0	2	6	0	14
EIAR 11 Project: Kokeboom wind facility Consultants: Aurecon	0	0	0	3	0	16
EIAR 12 Project: Krono solar park Consultants: Aurecon	4	0	1	3	1	32
EIAR 13	0	0	1	5	0	11

Project: Maralla wind facility Consultants: BioTherm Energy Pty ltd						
EIAR 14 Project: Metsimatala solar park Consultants: Enviro works	1	0	1	0	0	4
EIAR 15 Project: Postmasburg solar park Consultants: Cape Environmental practitioners	0	0	2	1	0	39
EIAR 16 Project: Richtersveld solar park Consultants: Cape Environmental practitioners	0	0	4	2	0	21
EIAR 17 Project: Rooikat hydropower plant Consultants: Enviro works	1	0	1	7	0	26
EIAR 18 Project: Sand Draai solar park Consultants: Royal HaskoningDHV	3	0	1	4	0	13
EIAR 19 Project: SEZ solar park Consultants: EOH Coastal and Environmental services	1	6	2	0	0	8
EIAR 20 Project: Umsobomvu solar park Consultants: EOH Coastal and Environmental services	1	0	1	1	4	13
EIAR 21 Project: Kutulo Tsatsi solar plant Consultants: Savannah Environmental Pty ltd	6	0	0	0	0	12
EIAR 22 Project: Vlakpan solar park Consultants: AGES	2	3	0	0	0	5
EIAR 23 Project: Bloemhoek solar park Consultants: Eco Compliance Pty ltd	0	0	0	1	0	3
EIAR 24 Project: De Aar solar park Consultants: CCA Environmental Pty ltd	2	0	0	1	0	19
EIAR 25 Project: Prieska solar park Consultants: Savannah Environmental Pty ltd	5	0	0	0	0	3
Total	**48**	**14**	**23**	**49**	**7**	**382**