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MOVING TOWARDS LANDSCAPE INITIATIVES: AN ANALYSIS OF ENVIRONMENTAL FRAMEWORKS, PROTECTED AREAS, AND COMMUNITY PERSPECTIVES IN THE VHEMBE DISTRICT, LIMPOPO PROVINCE, SOUTH AFRICA

By

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A thesis submitted to the Faculty of Science, University of the Witwatersrand, in fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY

March 2024

School of Geography, Archaeology and Environmental Studies

Supervisor: Professor Mary Evans

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the Doctor of Philosophy degree at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination at this or any other institution.



Alexandra Dalziel

Signed in Johannesburg on the 03/06/2024.

ABSTRACT

Conservation strategies have shifted towards a landscape-centric approach, emphasising conservation corridors and ecological networks. However, exploration of these strategies within the South African context is incomplete. This research aims to address this gap by applying various methods, including a systematic literature review, policy analysis, spatial analysis using GIS, and conducting interviews and surveys, resulting in four key contributions investigating the potential for conservation corridors and networks. The first is a comprehensive literature review underscoring the significance of corridors and networks while highlighting the discourse surrounding these emerging approaches in South Africa. The findings revealed a substantial global interest in landscape initiatives. However, South Africa's contribution is geographically limited, with 82% of studies focusing on the KwaZulu-Natal province. Understanding the efficacy of these studies in South Africa necessitates a comprehensive examination of the underlying regulatory frameworks governing protected areas and conservation efforts. Therefore, the second contribution evaluated protected areas and conservation legislation and policies to assess their alignment with landscape-focused initiatives. The study reveals a lack of explicit provisions supporting landscape-based conservation methods. The third study draws on these findings and uses the Vhembe District in the Limpopo Province as a case study to illustrate the overlooked potential of landscape initiatives. Initially, the protected areas in the district were evaluated. Subsequently, the analysis employed Key and Critical Biodiversity Areas to highlight the inadequacies within the existing protected area network. The findings revealed that although protected areas cover 38% of the Vhembe District, over 70% of Critical Biodiversity Areas and 60% of Key Biodiversity Areas lack protection. Over 2,000 km^2 of unprotected Critical and Key Biodiversity Areas were identified along the Soutpansberg Mountain Range and marked as ideal for a conservation corridor. The fourth contribution centres on community engagement, an essential consideration for sustainable long-term conservation. The results underscored strong community support for a corridor in the Vhembe District, primarily motivated by the anticipated socio-economic benefits. However, while landscape initiatives promise socio-economic improvement, such

outcomes are not guaranteed. Moreover, other potential challenges, including development, land rights, and financial constraints, were identified as possible impediments to corridors in the Vhembe District. The investigation into corridors and networks in South Africa, specifically the Vhembe District, revealed that the discourse on landscape initiatives is in its nascent phase. Nevertheless, when prioritising community engagement, these initiatives harbour tremendous potential. New legislation and policies that account for these factors will guide proponents of these initiatives and propel landscape initiatives into South Africa's conservation toolbox.

RESEARCH OUTPUTS

This study is organised into seven chapters, four of which are stand-alone research papers published or under peer-review. These are combined with a general introduction, discussion, and conclusion chapter to present a PhD thesis by publication. The four papers include:

1) Dalziel, A.B., & Evans, M. (2024). The Emergence of Landscape Initiatives as a Method for Biodiversity Conservation in South Africa. Submitted to the Journal for Nature Conservation (reviewed and under correction)

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   Dalziel A (80% contribution) collected and analysed the data and led the writing of the manuscript. Evans M (20% contribution) conceptualised the scope of the manuscript and edited the manuscript.

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   Dalziel A (80% contribution) conceptualised the scope of the manuscript, produced the maps, analysed the data, and led the writing of the manuscript. Evans M (20% contribution) provided guidance and edited the manuscript.

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   Dalziel A (90% contribution) conceptualised the scope of the manuscript, analysed the data, and led the writing of the manuscript. Evans M (10% contribution) provided guidance and edited the manuscript.

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I dedicate these words to my father, who passed away while I was working on this degree. Thank you for your insights into every paper I wrote. We all miss you beyond belief. I hope to honour your memory and carry on your legacy with pride.

"If I have seen further than others, it is by standing upon the shoulders of giants."
-Sir Isaac Newton

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ABBREVIATIONS

CBA:	Critical Biodiversity Area
CBD:	Convention on Biological Diversity
DFFE:	Department of Forestry, Fisheries, and the Environment
IUCN:	International Union for Conservation of Nature
IPBES:	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC:	Intergovernmental Panel on Climate Change
KBA:	Key Biodiversity Area
KMGBF:	Kunming-Montreal Global Biodiversity Framework
MMSEZ:	Musina Makhado Special Economic Zone
NBA:	National Biodiversity Assessment
NBF:	National Biodiversity Framework
NBSAP:	National Biodiversity Strategy and Action Plan
NEMA:	National Environmental Management Act
NEMBA:	National Environmental Management: Biodiversity Act
NPAES:	National Protected Area Expansion Strategy
OECMS:	Other Effective Area-based Conservation Measures
TFCA:	Transfrontier Conservation Area

CHAPTER ONE: INTRODUCTION

1.1 Background

Protected areas are prominent in the global conservation discourse and are promoted as conservation's cornerstone (Saura *et al*., 2019). The International Union for Conservation of Nature (IUCN) defines protected areas as "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008, p. 8). Protected areas are practical conservation tools for mitigating biodiversity loss, with over 100,000 protected areas worldwide (Feng *et al.*, 2021; Floigl *et al.*, 2022; Hayes, 2006; Hernandez-SaintMartin *et al*., 2015; Rahman & Islam, 2021; Sims, 2014; Timmers *et al*., 2022). However, only 5% of the Earth's landmass is untouched, with 30% of ecoregions minimally impacted (Kennedy *et al.,* 2019. pg 7).

Global targets have urged countries to expand their protected area coverage in response to rapid biodiversity loss. The Convention on Biological Diversity (CBD), launched in 1992 at the United Nations Conference on Environment and Development, is a multilateral treaty with 196 signatory parties. The CBD sets global targets for biological conservation (Hu *et al.*, 2022). For example, the Strategic Plan of 2011-2020 outlined 20 Aichi targets for conservation. Target 11 called for signatory parties to expand their protected area network so that by 2020, 17% of terrestrial ecoregions and 10% of marine regions would be designated as protected areas (Geldmann *et al*., 2021; Woodley *et al.,* 2012). However, despite these ambitious objectives, reports indicate minimal progress by participating countries in meeting these targets (Buchanan et al., 2020; Xu *et al.,* 2021; de Castro-Pardo *et al*., 2022). Consequently, in December 2022, the CBD signatories signed the Kunming-Montreal Global Biodiversity Framework (KMGBF). Although not legally binding, the KMGBF commits signatories to expand their protected area estate on land and sea to 30% by 2030, underlining the urgency of safeguarding the world's biodiversity (CBD, 2022; Obura, 2023; Schroter *et al.,* 2023).

However, several studies have highlighted shortcomings in traditional protected areas (Mora & Sale, 2011; Newmark, 1996; Venter *et al.,* 2014), indicating that they might not effectively conserve biodiversity. The literature cites financial restraints, implementation problems, location biases, and the potential for creating habitat islands. The isolation of protected areas could cause an 'extinction debt' wherein species could become extinct (Báldi & Vörös, 2006; Carroll *et al.,* 2004; Malanson, 2002). Recognising the shortcomings of protected areas, biodiversity conservation now encourages more contemporary methods focusing on large-scale landscape conservation extending beyond traditional protected area boundaries (Mirza *et al.,* 2023). Landscape initiatives in the form of conservation corridors and ecological networks have proliferated to protect critical ecosystems and restore connectivity while countering the silo mentality often adopted in conservation (Battisti, 2023; Bennett & Mulongay, 2006; Crooks & Sanjayan, 2006; Hilty *et al*., 2020; Mathur & Sinha, 2008; Sayer *et al.,* 2017; Sharma *et al.,* 2007).

Connecting protected areas through conservation corridors and ecological networks is widely regarded as an effective conservation strategy (see Battisti, 2023; Bennett & Mulongay, 2006; Haddad *et al.,* 2000; Joubert van der Merwe *et al.,* 2019; Kietzka *et al.,* 2015; Laborda *et al.,* 2018; Lindenmayer & Hobbs, 2007). Conservation corridors are areas of natural land that link protected areas and high-value conservation areas (Pryke *et al.,* 2015). Ecological networks are large strips of natural vegetation, including various protected areas and conservation corridors, that provide functional connectivity across fragmented landscapes (Pryke & Samways, 2012). Both landscape initiatives yield a plethora of environmental benefits. Some benefits include extending protected areas, supporting gene flow, genetic mixing and demographic interactions, alleviating threats from inbreeding depression and demographic stochasticity, expanding resource availability, protecting essential biodiversity areas, ensuring stable ecosystems, increasing landscape connectivity and dispersal, preventing species extinction, helping ecosystems and species cope with climate change, and promoting migration (Beier, 2018; Roever *et al.,* 2013; Rouget *et al.,* 2005; Simberloff & Cox, 1987). Moreover,

corridors offer socio-economic benefits through tourism, retail, and environmental employment opportunities. Corridors may increase regional development and infrastructure, drive economic activity, and enhance environmental education (Ryan & Hartter, 2012).

As a signatory of the KMGBF, South Africa is committed to the '30 x 30' target, which necessitates tripling its current protected area estate of 9% (King *et al.,* 2023). The National Protected Area Expansion Strategy (NPAES) of 2016 also mandates that an additional 146,814 km^2 of land must be protected to meet its proposed 20-year target (RSA, 2016). Landscape initiatives offer promising pathways to fulfil global and local targets in South Africa.

South African literature endorses conservation corridors and ecological networks (Joubert-van der Merwe et al., 2019; Kietzka *et al*., 2015; Pryke *et al.,* 2015; Pryke & Samways, 2012; Samways *et al.,* 2010; Theron *et al.,* 2022; van Schalkwyk *et al.,* 2019). These studies highlight the efficacy of corridors, particularly in mitigating the species-specific threats facing metapopulations. Recognising the paradigm shift in conservation, the thesis first comprehensively reviews global and South African literature on ecological initiatives between 2000 and 2022. The study aims to determine the geographical distribution of studies in South Africa and evaluate the efficacy of these ecological initiatives.

When establishing the context of landscape initiatives, examining the underlying regulatory frameworks supporting this shift is crucial. South Africa's principal environmental legislation is The National Environmental Management Act (NEMA) 1998 (Republic of South Africa, 1998). The National Protected Area Expansion Strategy (NPAES) also guides protected area expansion and provides national targets (RSA, 2016). Along with reviewing the literature, this thesis investigates the legislative and policy frameworks supporting landscape initiatives in South Africa. It highlights its lack of

specific focus on enhancing connectivity and facilitating the implementation of landscape-focused approaches.

While underlying, supportive regulatory frameworks are essential in landscape initiative establishment, the efficacy of these methods also hinges upon their strategic placement and thorough community involvement (Goldman, 2009; Kikoti *et al*., 2010; Townsend & Masters, 2015). Prioritising vulnerable regions is paramount, and Key Biodiversity Areas (KBAs) are indispensable tools for identifying critical at-risk zones (Eken *et al.,* 2004; Langhammer *et al.,* 2007). Defined as "sites of importance for the global persistence of biodiversity." (IUCN, 2016, p. 8), KBA sites are vulnerable and irreplaceable (see Eken *et al.,* 2004; Langhammer *et al.,* 2007). Despite their significance, less than half of KBAs globally experience formal protection (Kullberg *et al.,* 2019). South Africa utilises Critical Biodiversity Areas (CBAs) to identify significant local sites. These demarcations are natural areas that require management interventions to avert land-use changes that could result in the degradation of these critical zones (von Staden *et al.*, 2022). Key and Critical Biodiversity Areas help identify optimal corridor locations and show gaps in protected area networks. Using Geographical Information Systems (GIS) allowed the assessment of the protected area network in the Vhembe District (Limpopo Province) and estimated the reserves' coverage, size, and distribution. Additionally, CBA and KBA sites were employed to assess whether the protected areas effectively conserved species, threatened ecosystems, and irreplaceable ecosystems.

A corridor's potential to successfully connect and benefit surrounding communities is also contingent upon comprehensive community involvement (Kikoti *et al.,* 2010; Lombard *et al.,* 2010; Townsend & Masters, 2007). Community engagement emerges as a linchpin in the efficacy of conservation corridors and networks and can help mitigate conflict and enhance management and environmental conditions (Hemp & Hemp, 2018; Mbane *et al.,* 2019). By actively involving communities, a harmonious coexistence between anthropogenic activities and environmental conservation goals can be achieved (Lombard *et al.,* 2010). Utilising local surveys in the study allowed for

understanding the community's attitudes toward landscape initiatives and uncovered their anticipated benefits. Interviews with local stakeholders highlighted issues with corridor and network implementation and optimal establishment criteria for successful establishment.

This thesis explores the fundamental tenets of landscape initiatives by exploring the literature and legislative gaps, social and environmental potential, drawbacks, and essential parameters of corridors and networks. It focuses on the Vhembe District in Limpopo, South Africa. The Vhembe District is a predominantly rural area in the north of Limpopo. It is the northernmost South African district bordered by Botswana, Zimbabwe, and Mozambique. The Vhembe District has multiple protected areas and two major protected areas: Kruger National Park and Mapungubwe National Park, a UNESCO-declared World Heritage Site. This study aims to frame landscape initiatives as a new emerging conservation tool in South Africa, with potential in the Vhembe District and other regions. Additionally, this thesis focused on investigating challenges hindering corridor and network establishment.

1.2 Aims and Objectives of the Study

The study aims to explore the potential of landscape initiatives as a mechanism for conservation in the Vhembe District of Limpopo Province, South Africa.

The objectives are:

1. To review the literature on landscape initiatives in South Africa, assess their success, and examine their geographic distribution.
2. To assess the current institutional and policy frameworks and strategies that promote environmental conservation and landscape initiatives in South Africa.
3. To determine the extent of the current protected area network in the Vhembe District and assess its contribution towards South Africa's protected area estate.
4. To determine whether the current protected area network of Vhembe effectively conserves crucial areas by using Key and Critical Biodiversity Areas as indicators.

5. To explore community perceptions and establish whether landscape initiatives can and should be used in the Vhembe District to improve conservation and benefit the community.

1.3 Rationale

This study aims to explore the potential of landscape initiatives. KwaZulu-Natal emerges as a well-studied province due to the vast number of corridors in the region (Joubert *et al.,* 2016; Joubert & Samways, 2014; Kietzka et al., 2015; van Schalkwyk et al., 2017). The lack of supporting regulatory frameworks could explain the scarcity of corridors and networks elsewhere. South Africa's legislation is rooted in traditional conservation methods, ignoring contemporary approaches. This study explores this legislative gap in South Africa, highlighting the need to update environmental legislation.

As demonstrated in Kwa-Zulu Natal, landscape initiatives have significant ecological potential (Theron et al., 2022; Rouget et al., 2006; Pryke & Samways, 2012). However, further corridor and network implementation is stagnant and understudied in other provinces in South Africa. Addressing this imbalance requires exploring the potential of landscape initiatives in different regions.

Given its considerable cultural and ecological significance, the Vhembe District emerges as an ideal locus for such exploration. The District hosts numerous private and national protected areas, highlighting its ecological richness. Additionally, the Vhembe District faces significant developmental challenges, notably the proposed Musina Makhado Special Economic Zone (MMSEZ). Envisioned as a cluster of interconnected industries, the Chinese proposed MMSEZ spans 8,000 hectares and poses a significant threat to the District's ecological integrity (Delta, 2021; Neva, 2021). The exigency for conservation efforts is apparent, necessitating immediate action to mitigate potential environmental degradation.

Establishing corridors and networks can mitigate such degradation and increase ecological connectivity, which is regarded globally as essential for ecosystem processes

(Cadman *et al.,* 2010; Chetteri *et al.,* 2007). However, it is also imperative to identify vulnerable ecosystems that need immediate attention. This realisation has prompted the establishment of Key Biodiversity Areas and Critical Biodiversity Areas to pinpoint optimal corridor and network placements (CBD, 2022; Maxwell *et al.,* 2020), yet this method remains inadequately studied. Accordingly, this study presents a methodology employing Key and Critical Biodiversity Areas.

While the ecological benefits of landscape initiatives are well documented, their social facets are difficult to quantify (Ryan & Hartter, 2012). Engaging local communities in conservation methods is imperative to ensure cultural sensitivity, inclusivity, and long-term corridor success (Goldman, 2009; Kikoti *et al.,* 2010). Consequently, an in-depth exploration of community perspectives surrounding newer conservation methods is crucial.

Landscape initiatives are still nascent in many parts of the world, necessitating additional investigation into their supporting frameworks, geographical biases, identification of suitable sites, and consideration of socio-economic factors. This study aims to contribute to the global understanding of landscape connectivity, advocating for adopting updated and comprehensive conservation strategies.

1.4 Overview of Methodology

This section provides an overview of the methods used in this thesis to meet this study's objectives and describes the Vhembe District as the case study site. The specific analytical methods used to review literature and legislation, analyse the protected area estate, and explore community perceptions are detailed in each journal.

1.4.1 Description of the study site

The Vhembe District in Limpopo, South Africa (22° 46’ 10” S, 29° 58’ 26” E; *Fig*. 1) was selected as the case study area for this research. The population of Limpopo is 5,9 million people, and over half of the population lives in poverty (Limpopo Provincial

Government, 2023). Limpopo is divided into five districts: Capricorn, Waterberg, Mopani, Sekhukhune, and the Vhembe District. Botswana, Zimbabwe, and Mozambique border the Vhembe District north of Limpopo. The district comprises four local municipalities: Makhado, Musina, Thulamela, and Collins Chabane and covers an area of 25 596 km^2. The average temperatures in Vhembe range between 21°C and 37°C in January, with temperatures dropping to 5°C and 12°C in July. The Vhembe District is characterised by low rainfall and experiences 300-400 mm of rain yearly (Shikwambana *et al.,* 2021). The District's relief varies from flat plains to steep mountainsides and is dominated by the Savanna Grassland Biome.

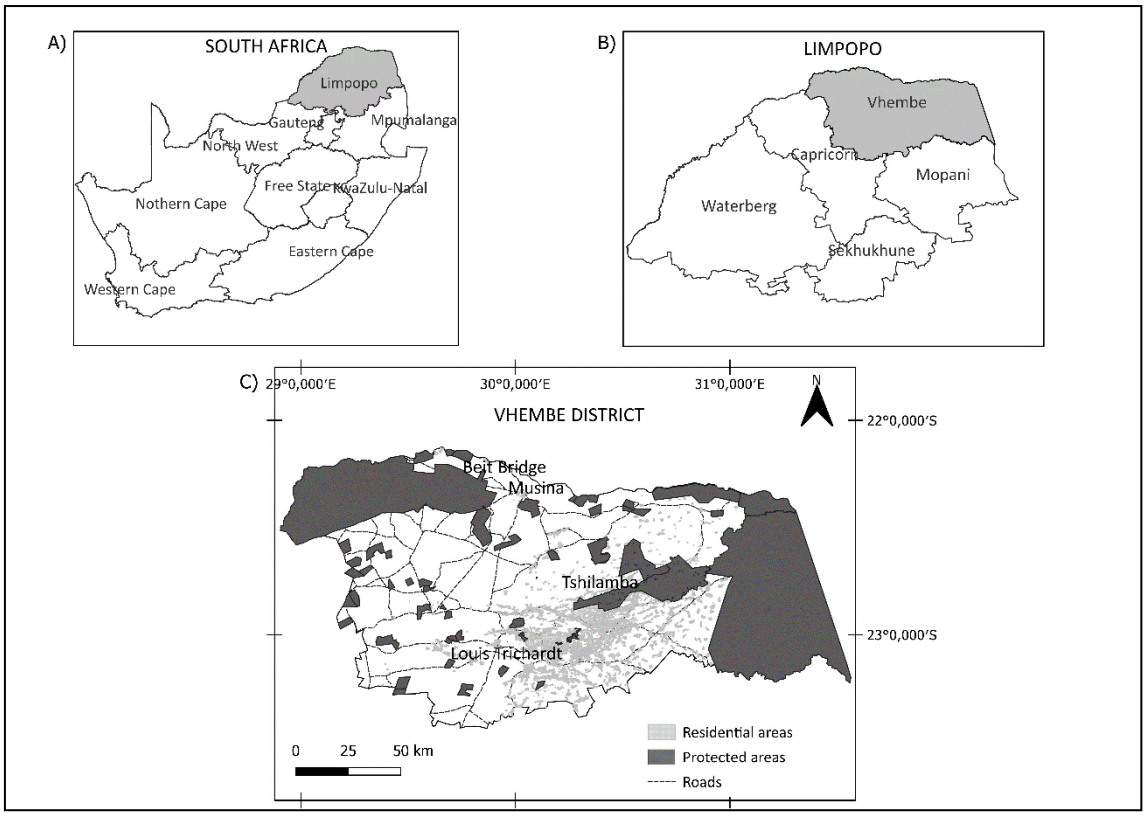


Figure 1: Map of the Study Site. A) South Africa's nine provinces and Limpopo, located in the country's northern region, are greyed. B) The five districts in Limpopo. The Vhembe District is shown in grey. C) A map of the Vhembe District illustrating the location of the residential areas, road networks, and the distribution of the protected areas. Map created using QGIS version 3.28.0.

The Vhembe District is the most densely populated among the districts in Limpopo, housing approximately 24.3% of the population (Limpopo Provincial Government, 2023). The population of Vhembe was estimated to be around 1.4 million people in 2021, with most of the population living in the south of the Vhembe District (Limpopo Provincial Government, 2023). Moreover, the district grapples with significant socio-economic challenges, as evidenced by a high unemployment rate of 43% (Limpopo Provincial Government, 2023). The functional literacy rate measures education levels and indicates the percentage of the population 20 years and above whose highest level of education is grade 7 and higher. Vhembe's functional literacy rate in 2021 was 68.9%, and of the 30.9% under the illiterate category, 66% are women (Limpopo Provincial Government, 2023).

Additionally, a considerable portion of its residents face economic hardship, with 51% of the population falling below the Upper-Bound Poverty Line (UBPL) (Limpopo Provincial Government, 2023). The UBPL delineates the threshold at which individuals can afford food and non-food essentials. Individuals living on around ZAR 1 335 per month, or just over $2 a day, fall within this poverty line (Limpopo Provincial Government, 2023).

In 2020, Limpopo had the most significant extent of protected areas across all provinces and contributed 21.5% of the country's protected area estate (StatsSA, 2021). The Vhembe District is one of the ten biosphere reserves in South Africa. Designated under UNESCO in 2009, the Vhembe Biosphere Reserve spans 30,700 km^2, featuring three biomes, four bioregions, and numerous archaeological sites. Central to the reserve's ecological significance are two protected areas: the Kruger National Park and Mapungubwe National Park, the latter being a UNESCO-declared World Heritage Site. Dominating the landscape is the Soutpansberg Mountain range. Recognised as a centre of endemism and diversification in South Africa, the Soutpansberg represents three-quarters of all vascular plant families in southern Africa and is home to over 20 endemic taxa (Hahn, 2019). Furthermore, it hosts 571 tree taxa, constituting 30% third of all

known trees in southern Africa, making this mountain range a vital ecological asset (Hahn, 2019).

1.4.2 Data collection

1.4.2.1 Rapid appraisal of literature, legislation, and policies

Arksey and O'Malley's (2005) framework was used to identify relevant literature to meet the study's objectives. This approach involves establishing keywords, screening sources, synthesising data, and reporting results. The study used the SCOPUS search engine (www.scopus.com) to find relevant literature, including peer-reviewed academic journal papers published between 2000 and 2022. Google Scholar was also used to supplement search outcomes and prevent apparent overlaps, thus enriching the scope of the literature review. Employing Boolean operators, as Topi and Lucas (2005) advocated, refined search queries, enhancing search precision and mitigating article overload. A rigorous screening process eliminated articles that did not align with conservation themes. After scrutinising their titles and abstracts, articles that contributed novel insights or addressed specific research areas of interest were retained.

The Department of Forests, Fisheries, and Environment (DFFE) website was searched to meet the second objective and identify environmental laws. Unfortunately, the website's repository does not predate 1992, so an additional investigation was undertaken utilising resources available at the University of the Witwatersrand's Online Library. This screening process focused on identifying acts and policies with a distinct focus on protected area management and broader legislative frameworks integral to environmental management (see Chapter 3).

1.4.2.2 Mapping of protected areas

The study used maps to provide a comprehensive regional assessment of protected area coverage within the Vhembe District (see Chapter 4). Six carefully selected datasets provided a multifaceted understanding of the region's ecological dynamics. These

datasets showcased the area's rich biodiversity, highlighted the essential ecoregions, depicted the distribution and coverage of protected areas, and illustrated the land use patterns and threats faced by Vhembe District.

1.4.2.3 Interviews and surveys

A multifaceted research approach was adopted to comprehensively explore the perspectives of local community members and stakeholders concerning landscape initiatives and conservation endeavours within the region. This approach entailed interviews with 15 participants comprising five academics and researchers, seven NGO representatives and three landowners (see Chapter 5). Interviews were conducted over the phone or in Microsoft Teams. Microsoft Teams meetings were recorded with the consent of the participant. Stakeholders and researchers provided expert perspectives on conservation practices in South Africa and the potential of corridors and networks in South Africa. Interviews were open-ended and semi-structured, focusing on critical thematic points relevant to conservation practices and relevant considerations preceding the implementation of landscape initiatives. The interview transcript and survey are in Appendix A.

In addition to interviews, surveys were distributed among community members residing in the Vhembe District to capture their sentiments. A representative sample size of 384 participants was determined, ensuring a margin of error of 5% and a confidence level of 95%. Community members were selected through a randomised approach, and residents assisted with translating the survey questions.

The University of the Witwatersrand's Human Research Ethics Committee (non-medical) granted ethics clearance. The clearance number for this study is H21/04/07. The study was ruled as low risk as interviews contained no sensitive questions, and no person in the vulnerable category was approached. Additionally, participants had to be over 18 to participate in the study. The ethics certificate for this study is in Appendix B.

1.4.3 Data analysis

Various methods were adopted in this study, leading to diverse forms of data analysis. Geographic Information System (GIS) mapping and analysis were conducted using QGIS version 3.28.0. All vector datasets were cleaned and converted to EPSG: 4148. Geoprocessing tools, including the field calculator, were used to analyse the dataset distribution, date of establishment, coverage, and size. This methodology is easily replicable for individuals with varying levels of GIS knowledge. For more detailed methodological information, see Chapter 4.

The interviews and surveys required different analyses. Once transcribed, the data were displayed graphically using Sigma Plot version 10. Results were arranged according to the respective questions to maintain a clear organisational structure. Subsequently, the data underwent statistical analysis to derive percentages and generate pie charts and bar graphs, enhancing the interpretation of the findings.

1.5 Structure of Thesis

This thesis comprises seven chapters: an introductory chapter (Chapter 1), a discussion chapter (Chapter 6), and a concluding chapter (Chapter 7), along with four investigative chapters (Chapters 2-5) forming the core body of the thesis. Each investigative chapter constitutes a publication that has been either published, accepted or is under review. The thematic focus of these chapters revolves around conservation corridors and ecological networks in South Africa, particularly within the Vhembe District.

Chapter 2 is a literature review manuscript exploring the existing literature on landscape initiatives in South Africa. Chapter 3 is a published manuscript examining legislation and policies on conservation in South Africa, aiming to ascertain how the current regulations accommodate and support newer conservation initiatives.

After exploring landscape initiatives in the South African context, Chapter 4 conducts a detailed examination of the Vhembe District. This manuscript evaluates the

effectiveness of the existing protected area network within the district, aiming to determine the feasibility of establishing a corridor and assessing the necessity of such an initiative.

Chapter 5 investigates community perceptions regarding conservation and corridors within the Vhembe District. This manuscript presents critical regional factors to consider before implementing landscape initiatives.

Chapter 6 encapsulates the main findings from each investigative chapter and expands on the connections between each chapter.

Chapter 7 synthesises the findings into a comprehensive conclusion. This concluding chapter provides overarching insights from the research, offering a cohesive summary of the thesis's key contributions.

Each investigative chapter adheres to specific formatting, spelling, and referencing styles as required by the respective journals to which it has been submitted or published.

CHAPTER 2: THE EMERGENCE OF LANDSCAPE INITIATIVES AS A METHOD FOR BIODIVERSITY CONSERVATION IN SOUTH AFRICA.

2.1 Brief Synopsis

A critical literature review on ecological networks and conservation corridors was conducted using Google Scholar and SCOPUS. The review elucidates the global importance and implementation of these methods while also examining their implications within South Africa. The results indicate that ecological networks and conservation corridors are widely studied and adopted globally. South Africa also contributes significantly to the literature on these initiatives. However, these publications have a limited geographical representation. The literature consistently advocates for the efficacy of landscape initiatives as a practical conservation tool in protecting biodiversity, sometimes surpassing the effectiveness of traditional protected areas. Given the scarcity of literature concerning landscape initiatives in South Africa, this chapter is an essential contribution highlighting a crucial gap for future research on landscape initiatives.

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The Emergence of Landscape Initiatives as a Method for Biodiversity Conservation in South Africa.

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Abstract

In biodiversity conservation and landscape planning, there has been a significant departure from the parochial reliance on traditional protected areas for biodiversity conservation. Instead, there is a growing emphasis on progressive methods that connect protected areas and ensure the preservation of entire landscapes. However, the implementation and effectiveness of these novel approaches in South Africa is unexplored. We present a critical literature review on two key landscape initiatives, ecological networks and conservation corridors, to underscore their global importance and evaluate the discourse surrounding these new avenues in South Africa. Our results reveal that these landscape initiatives are widely studied and adopted globally. South Africa also contributes significantly to the literature on these initiatives, producing 16.6% of the global literature on conservation corridors between 2000 and 2022. However, these publications have a constricted geographical representation, as 82% of studies are KwaZulu-Natal-based, one of the country's nine provinces. Additionally, findings indicated that only three provinces are studied, signifying a notable gap in regional representation.

Landscape initiatives have demonstrated efficacy in biodiversity conservation where implemented. However, the prevailing geographical bias in research distribution underscores a critical void in the literature on these innovative approaches.

Consequently, this study emphasises the imperative of broader geographic coverage in conservation studies. It highlights the underexplored potential of conservation corridors as a potent tool in South Africa, warranting further attention and implementation.

Keywords: conservation corridors; conservation planning; ecological networks; landscape initiatives; protected areas

1. Introduction

The escalation of human-induced economic activities, characteristic of modern society, poses an escalating threat to global biodiversity and ecosystem functionalities (Barnosky *et al.,* 2011; Galli *et al.,* 2014; Pievani, 2014; Ceballos *et al.,* 2015; IPBES, 2019; Kolipakam *et al.,* 2019). Ecosystems and their associated services are under immense pressure as a result of, among other things, habitat loss, rapid industrialisation, heightened pollution, and climate change, which could affect species distribution (Darkoh, 1997; Tie & Cao, 2009; IPCC, 2014; Qureshi *et al.,* 2015; Nazeer *et al.,* 2016; Wilson *et al.,* 2016; Karlsson *et al.,* 2018). Of these concerns, habitat fragmentation is considered the greatest threat to biodiversity (Wilson *et al.,* 2016; Karlsson *et al.,* 2018). Franklin *et al.* (2002) and Wilson *et al.* (2016) suggest that habitat fragmentation is the main factor and cause of biodiversity loss in the world, resulting in reduced connectivity, species extinction, and ecosystem degradation. Kennedy *et al.* (2019: 6) state that only 5% of the Earth's landmass is entirely untouched by human activity. Furthermore, only 30% of ecoregions have seen low degrees of human modification (Kennedy *et al.*, 2019). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reports that as of 2019, one million animal and plant species are currently threatened with extinction globally (IPBES, 2019), promoting the widespread adoption of protected areas as the primary strategy to combat habitat fragmentation.

Nevertheless, protected areas are not a panacea to the impacts caused by fragmentation. Therefore, newer progressive strategies are proposed to move away from isolated, solitary reserves and encourage landscape-level conservation planning. These include ecological networks and conservation corridors. These strategies aim to conserve entire landscapes, enhance connectivity between reserves, and facilitate the movement and migration of species. Conservation corridors and ecological networks are implemented in various regions including Australia (Pulsford *et al.*, 2004), the United States (Belote *et al.*, 2016), Brazil (de Oliveira Roque *et al.*, 2018), Europe (Jongman *et al.*, 2004), Central Asia (Ren & Gao, 2019), Italy (Pili *et al.*, 2019) and the United States of America (Perkin & Gido, 2012).

In South Africa, conservation focuses predominantly on traditional, isolated protected areas (Wynberg, 2002; Newmark, 2008; De Vos, 2019), with the extent of landscape initiatives remaining uncertain. More research is required on landscape conservation to expand the geographical range of studies across South Africa. It is vital to ascertain the effectiveness and potential of these methods in different landscapes with varying socio-economic factors. Therefore, it is necessary to ascertain these initiatives' geographical distribution and efficacy. Consequently, we have comprehensively reviewed the literature on the above initiatives globally and in South Africa between 2000 and 2022. We aim to discover the geographic distribution of the literature and determine how successful these ecological initiatives are by examining relevant literature. Finally, we consider the paradigm shift in conservation and posit these initiatives as potentially effective yet underexplored tools in South Africa.

2. Shifting from Traditional to Progressive Conservation Approaches

Protected areas are the primary conservation tools in South Africa and the world. Terrestrial protected areas can be private or national (*Fig*. 1), and currently, around 8% of South Africa's landscape is protected (King *et al.,* 2023). Regarding Figure 1, there are a plethora of private nature reserves in South Africa, mainly found in Limpopo and the Free State. In addition, national protected areas are widespread in Limpopo, Mpumalanga, and the Eastern and Western Cape. However, these protected areas are isolated and standalone reserves scattered throughout the country.

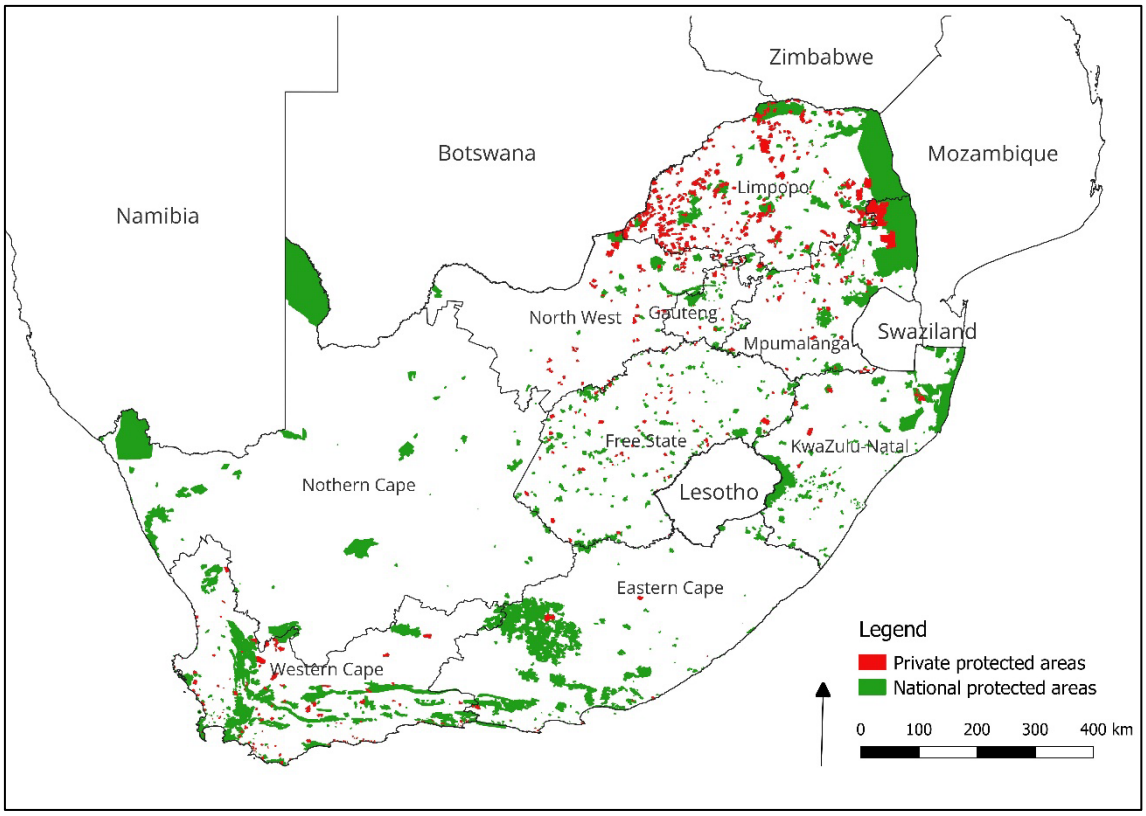


Figure 1: Map of South Africa showing private and national protected areas. QGIS 2022.

While protected areas, in their various forms, have generally garnered positive appraisal in the literature (Riemann & Ezcurra, 2005; Stolton & Dudley, 2010; Le Saout *et al.*, 2013), a notable shift is occurring with conflicting observations regarding their efficacy. As the landscape transforms and habitat loss increases, protected areas become more isolated from surrounding landscapes (DeFries *et al.,* 2005). Landscape ecologists posit that such isolation has dangerous ramifications as the restriction of movement creates population sinks- sites with unusually high species mortality rates (Newmark, 2008). In addition, protected areas are insular, provide insufficient coverage, and cannot facilitate large-scale migration and ecological processes vital for biodiversity sustainability (Mora & Sale, 2011; Belote *et al.*, 2016). Similar findings are seen in South Africa, where protected areas inadequately encompass threatened species, suffer from inadequate funding and staffing, exhibit weak compliance and enforcement measures and poor monitoring practices (Sowno *et al.*, 2019; Tolley *et al.*, 2019; Hoveka *et al.*, 2020).

Furthermore, Sharma *et al*. (2007) argue that if countries continue to rely on a protectionist paradigm for conservation, they will not fulfil their function. Landscape initiatives deal with the deficiencies of protected areas. They prioritise a comprehensive approach encompassing the maintenance, connectivity, management, and collaboration across landscapes, extending beyond the confines of designated protected areas (Chetteri *et al.,* 2007; Cadman *et al.,* 2010; Sandker *et al.,* 2010; Reyers *et al*., 2012; Sayer *et al*., 2013). While acknowledging the significance of protected areas, these initiatives integrate biodiversity conservation with developmental imperatives and cultural heritage preservation, thereby ensuring the achievement of both social and conservation objectives. Furthermore, landscape initiatives actively engage public participation to provide community benefits, such as employment opportunities, skill enhancement, and educational endeavours (Cadman *et al.,* 2010; King *et al.,* 2018).

This paper examines two landscape initiatives: ecological networks and conservation corridors. Conservation corridors are contiguous areas of relatively natural land identified for conservation and enable species mobility, dispersal, and in-situ protection (Rouget *et al.*, 2006; Beier, 2018) (*Fig.* 2). Ecological networks are large strips of natural vegetation that include various protected areas, stepping stones, low input production areas, and conservation corridors which aim to mitigate the adverse effects of fragmentation and conserve biodiversity (Pryke & Samways, 2012) (*Fig*. 2). Figure 2 illustrates the inclusion of buffer zones surrounding protected areas and are semi-natural habitats restricting human activities, while supporting wildlife, and facilitating linkages between protected areas (Lopes *et al.*, 2021). Aside from corridors, protected areas may also be connected using stepping stones (*Fig*. 2). Stepping stones are small areas that connect formerly isolated patches (Baum *et al.*, 2004). These stepping stones promote conservation and mitigate fragmentation, particularly when establishing a continuous habitat is impractical or when stepping stones are more suitable for the landscape (Baum *et al.*, 2004).

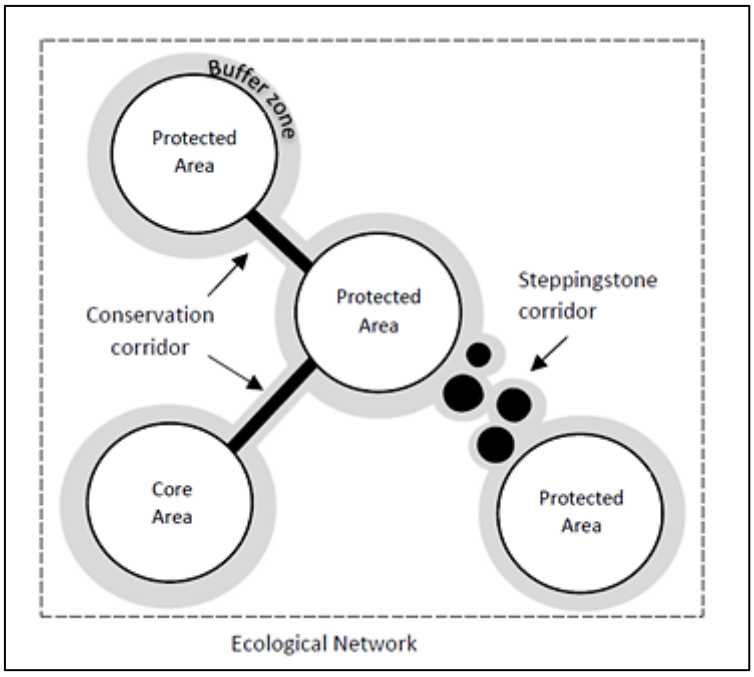


Figure 2: Representation of landscape initiatives. Ecological networks comprise protected areas, buffer zones, and corridors. (Adapted from Jongman, 2019).

Conservation corridors and ecological networks offer a multitude of environmental benefits, including supporting gene flow, alleviating threats from inbreeding depression and demographic stochasticity, expanding resource availability, protecting critical biodiversity areas, increasing connectivity and dispersal and promoting migration (Roever *et al*., 2013; Beier, 2018). Despite these notable benefits, this approach has drawbacks, including facilitating bushfires and accelerating the spread of diseases, exposing wildlife to predators, and heightening the risk of poaching. A significant challenge confronting the implementation of conservation corridors is the considerable cost involved, as fencing, management practices, and zoning of areas are expensive (Bienen, 2002). Nevertheless, these landscape initiatives remain favoured over traditional, preservationist methods. Therefore, it is vital to identify the literature on these conservation methods globally and within South Africa and assess their potential.

3. Methodology

We have adopted a scoping review methodology framework outlined by Arksey and O'Malley (2005) to identify the relevant literature systematically. This methodological approach involves mapping the main concepts within the research field and pinpointing the critical pieces of evidence involving multiple phases. The initial phase entails identifying relevant studies, which require the establishment of keywords. Subsequently, the studies undergo a screening process to refine results using predetermined inclusion and exclusion criteria. Finally, the data are synthesised, collated, and reported during the concluding phase.

To streamline our approach, we divided the process into two sections. Initially, we reviewed the global conservation landscape concerning landscape initiatives, followed by a focused examination of South Africa. This strategy enables a comprehensive analysis of broader trends and the regional discussion within landscape initiative literature.

3.1 Identification of Global Literature

We used the electronic search engine SCOPUS (www.scopus.com) to search the database for literature using the key terms "ecological networks" and "conservation corridors". We used SCOPUS as it provides a thorough database of peer-reviewed academic journal papers. In addition, a feature on SCOPUS allows the user to analyse and sort the results by different attributes, making it quick and easy to use. We searched for literature between the years 2000 to 2022. The two decades encapsulate a shift in landscape studies and allow for a thorough literature review. Using the 'analyse search results' feature, we could view the results by country and see which countries produced the most literature on each term. The search was conducted in February 2022.

3.2. Identifying South African Literature

Next, we identified South African literature using Google Scholar and SCOPUS electronic databases. We used Google Scholar to strengthen the results and provide an additional dataset. Google Scholar allowed for the addition of extra articles not identified through SCOPUS. The search concentrated primarily on conservation studies in South Africa, focusing on ecological networks and conservation corridors. The first search generated a large amount of literature that needed to be sorted and reduced. We used Boolean operators, which improved the online search performance and reduced the number of articles (Topi & Lucas, 2005). These include using parenthesis, quotation marks, and AND or OR operators for queries, resulting in more specific and exact matches since it considers terms as phrases and not two separate words. We applied this method for the first screening process. The keywords and South Africa were placed in inverted commas, and the word “and” was added between them. This first screening phase drastically reduced the results.

We performed a second screening process to reduce the results. Finding articles that aligned with this paper's research aims was imperative. We reviewed paper titles and abstracts to determine their relevance and only included articles that have studied existing corridors, networks, proposed future areas, or articles that have clarified terminology or provided general information that is not repetitious. In addition, studies focusing on a landscape approach had to be related to the environment or conservation matters and not a landscape approach commonly studied in urban studies.

4. Results

4.1 Global Literature

The results indicate that research on ecological networks is geographically distributed across four continents: Asia, North and South America, and Europe (Table 1). Specifically, China produced 23.57% of the literature on ecological networks, followed by the United States (22.01%) and the United Kingdom (10.50%) (Table 1). Over two decades, ten

countries produced 3 657 articles on ecological networks, with South Africa contributing 96 articles.

A search for the term “conservation corridor” on SCOPUS produced 126 articles. Of these, 38% were papers on conservation corridors in the United States (Table 1). South Africa ranked second with 21 articles, followed by Canada with 12 papers (Table 1). Like ecological network research, conservation corridor studies span the world's various regions, with four of the top ten contributors originating from Central and South America and two countries from Europe. Interestingly, South Africa is the only African country in the top ten, with Kenya producing only two papers. These results indicate that ecological networks receive more research attention than conservation corridors.

Table 1: Results of the global landscape initiative search. The top ten locations are indicated below. SCOPUS 21/02/2022.

* South Africa does not feature in the top ten countries producing research on ecological networks; however, they are added here for context

Initiative	**Top ten countries or regions**	**SCOPUS search results**	**Percentage**
Ecological networks	China	862	23,57%
	USA	805	22.01%
	United Kingdom	384	10.50%
	France	287	7.84%
	Spain	267	7.30%
	Germany	261	7.13%
	Italy	232	6.34%
	Canada	223	6.09%
	Brazil	176	4.81%
	Netherlands	160	4.37%
	*South Africa	96	
	Top 10 total (South Africa excluded)	3 657	
	USA	48	38.09%
	South Africa	21	16.66%
	Canada	12	9.52%
	China	8	6.34%
	Brazil	7	5.55%

Conservation corridors	Germany	7	5.55%
	Mexico	7	5.55%
	United Kingdom	6	4.76%
	Colombia	5	3.96%
	Peru	5	3.96%
	Top 10 total	126	

4.2 South African Literature

The preliminary search on ecological networks yielded substantial results, totalling 825,000 (Table 2). Two rounds of screening identified 17 relevant papers. Table 3 provides an overview of the geographic distribution of these study sites. Among the 17 papers, 14 referred to ecological networks in KwaZulu-Natal's midlands, grasslands, or estuaries (Table 3). Two publications focused on the Eastern Cape (Scharler & Baird, 2005; Pryke & Samways, 2012), while the remaining contributions were theory-oriented (Samways *et al.*, 2010; Samways, 2007).

Regarding conservation corridors in South Africa, the initial search yielded 75,100 publications (Table 2), subsequently refined to 20 relevant studies. Among these, 11 were KwaZulu-Natal-based. Seven focused on the Eastern and Western Cape provinces, while two studies addressed the Northwest and Mpumalanga conservation corridors (Table 3).

Table 2: Results of the South African literature search queries. Data were collected on 11 February 2022.

Stage:	**Keywords:**	**Google Scholar Results:**	**SCOPUS results:**
Initial search	Ecological Networks South Africa	825 000	252
	Conservation Corridors South Africa	75 100	92
First screening	"Ecological networks" AND "South Africa"	2 840	96
	"Conservation corridors" AND "South Africa"	753	21
Second screening	"Ecological networks" AND "South Africa"	17	
	"Conservation corridors" AND "South Africa"	20	

Table 3: Identified South African literature on ecological networks and conservation corridors.

	Study site/description	**References**
Ecological networks	KwaZulu-Natal	Lipsey & Hockey 2010, Bazelet & Samways 2011, Chrystal & Scharler 2014, Joubert & Samways 2014, Kietzka *et al.* 2015, Pryke *et al.* 2015, Pryke & Samways 2015, Joubert *et al.* 2016, Ortega-Cisneros *et al.* 2016, van Schalkwyk *et al.* 2017, Hansen *et al.* 2018.
	KwaZulu-Natal and Eastern Cape	Pryke & Samways 2012
	Maputuland-Pondoland-Albany conservation corridor (KwaZulu-Natal)	Smith *et al.* 2006, Samways & Pryke 2016
	Eastern Cape Estuary	Scharler & Baird 2005
	Effectiveness of ecological networks	Samways *et al*. 2010
	Implementation of ecological networks	Samways 2007
Conservation corridors	Cape Floristic Region (Western Cape)	Rouget *et al.* 2003, Lombard *et al.* 2010, West *et al.* 2016.
	Subtropical Thicket Biome (Western and Eastern Cape)	Pierce *et al.* 2005 Rouget *et al.* 2006, Knight & Cowling 2012.
	Albany-Subtropical Thicket Biome (Eastern Cape)	Potts *et al.* 2013
	Maputuland-Pondoland-Albany conservation corridor (KwaZulu-Natal)	Di Minin *et al.* 2013, Deacon *et al*. 2018
	KwaZulu-Natal	Bullock & Samways 2005, Terblanche 2018, Gaigher *et al.* 2019, Joubert-van der Merwe *et al.* 2019, van Schalkwyk *et al.* 2019, Van Schalkwyk *et al*. 2020, van der Merwe *et al.* 2020, Kietzka *et al.* 2021, Theron *et al.* 2022.

	North West province	Bologna & Spierenburg 2015
	Mpumalanga	Blignaut & Moolman 2006

5. Discussion

5.1 Landscape Initiative Literature Distribution

Regarding ecological networks, out of the 17 papers examined, a substantial majority, comprising 14 papers (82%), focused specifically on the KwaZulu-Natal (KZN) region (Table 3). Similarly, 11 out of 20 papers addressing conservation corridors also concentrated on KZN. The research pertaining to corridors and networks predominantly focused on plantations and expansive grasslands. These timber plantations encompass 22 ecological networks and corridor sites established to enhance hydrology and preserve biodiversity.

A thorough analysis of the literature sheds light on the predominant focus on this particular region. Notably, the Mondi Group, a global entity engaged in paper and packaging production, manages 256,000 hectares of land in KZN and southern Mpumalanga. A significant portion, approximately 20%, of this land has been allocated for conservation purposes (Mondi, 2023). Collaboration with specialists from Stellenbosch University in South Africa enables the Mondi Group to assess the effectiveness of their implemented corridors and networks. The Mondi Group has provided funding for several articles identified in this study, including works by van Schalkwyk *et al.* (2017), Pryke and Samways (2015), Kietzka *et al.* (2015), Deacon *et al.* (2018), van Schalkwyk *et al.* (2020), among others. This collaborative partnership explains the considerable volume of literature dedicated to this region. This plethora of literature is vital to understanding landscape conservation in South Africa, as these papers form the foundation of the discourse.

While entities like Mondi are committed to sustainable practices and actively fund research within their operational sites, other regions remain relatively underexplored.

Notably, only five out of the nine provinces in South Africa have been subject to study, with only three provinces undergoing extensive research (refer to Table 3). Research on landscape conservation requires a more extensive geographic distribution due to the variability of landscapes. Given that South Africa encompasses diverse biomes and bioregions, conducting research across different biomes is crucial, considering varying land uses and social factors. The success of conservation corridors and ecological networks in KwaZulu-Natal is a compelling case study, underscoring the need for similar research in other regions with distinct conditions.

5.2 Landscape Initiative Efficacy

Research on ecological networks and corridors began in 2005, with the majority of studies conducted in 2015 and 2016. Similarly, studies on conservation corridors commenced in 2003, with a significant increase in publications occurring from 2013 onwards. The studies underscore the efficacy of corridors and networks as conservation tools. Ecological networks enhance biodiversity value significantly, emerging as a highly successful and practical approach for conserving dragonflies and other fauna and flora (Joubert & Samways, 2014; Kietzka *et al.,* 2015; Pryke *et al*., 2015; Pryke & Samways, 2015; Joubert *et al.,* 2016). This effectiveness is contingent upon the width of the corridor, emphasising the necessity of adequate width for optimal functionality (Pryke & Samways, 2012; van Schalkwyk *et al.,* 2017). Moreover, studies elucidate the potential of ecological networks and stress the importance of landscape planning to accommodate species-specific variables (van Schalkwyk et al., 2017).

Noteworthy examples from South Africa highlight the effectiveness of conservation corridors. For instance, research conducted by Bullock and Samways (2005), Rouget *et al.* (2006), Joubert-van der Merwe *et al.* (2019), Joubert-van der Merwe *et al.* (2020), and Kietzka *et al.* (2021) praise the effectiveness of corridors, while Di Minin *et al.,* (2013), showcases the mitigation of species-specific threats facing metapopulations within the Maputuland-Pondoland-Albany biodiversity hotspot. Similarly, conservation corridors have proven instrumental in maintaining and supporting grasshopper diversity

in the grasslands of KwaZulu-Natal (Theron *et al.,* 2022). These studies collectively underscore the critical role of ecological networks and corridors in biodiversity conservation efforts, particularly within South Africa's diverse ecosystems.

However, one study proved that networks in a pine plantation in KwaZulu-Natal created a "much unsuitable habitat for grassland specialist birds, and thus seems inappropriate as a grassland conservation strategy for afforested areas in the region" (Lipsey & Hockey 2010: 141). Nevertheless, an overwhelming majority of studies on connected landscape practices underscore their efficacy. However, importance is placed on detailed management plans of corridors and networks, with the width of corridors remaining a frequently contested theme in the discourse (van Schalkwyk *et al*., 2020). Moreover, a consensus on the vision of a corridor and a detailed social assessment is needed prior to the landscape initiative establishment (Lombard *et al.,* 2010).

6. Conclusion

South Africa adopted a parochial approach to biodiversity conservation, relying on protected areas as the cornerstone of its conservation efforts. However, the limitations of these solitary reserves are exposed, and more connected landscapes are endorsed. We conducted a comprehensive literature review on conservation corridors and ecological networks using Google Scholar and SCOPUS. Our review encompassed numerous publications on ecological networks and conservation corridors globally and within South Africa.

Compared to global figures, South African research substantially contributes to the body of knowledge on these ecological strategies. Although abundant research is published on networks and conservation corridors in South Africa, these studies' geographical range is limited to a few provinces and biomes due to the available funding. Regrettably, other regions, biomes, and vegetation types in South Africa receive insufficient attention. Notably, to our knowledge, there has been inadequate research in the North West and Mpumalanga. Further, no studies have explored the Northern Cape, Free State, and

Limpopo despite their high levels of biodiversity, highlighting a crucial gap in conservation studies in South Africa.

A literature review of these ecological strategies confirmed that they are generally successful in attaining conservation goals. The literature praises ecological networks and corridors for conserving landscapes and biodiversity. However, proponents of these methods stress the importance of detailed landscape planning to implement the correct corridor width.

Given South Africa's numerous biomes, high levels of endemism, rich biodiversity, and multiple biodiversity hotspots coupled with high levels of development and encroachment, the imperative lies in stepping away from traditional fortress-style conservation efforts and towards landscape initiatives. Despite the extensive yet limited research on these methods, the potential of landscape initiatives elsewhere is unknown. The studies reviewed assess preexisting corridors and networks. Therefore, it is crucial to investigate the establishment process of these strategies, including underlying legislation, policies, and their impact on local community development. Thus, landscape initiatives require further research. Despite their functionality, ecological networks and conservation corridors remain relatively under-researched in South Africa, underscoring the need for continued efforts to advance our understanding and application of these vital conservation tools.

This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CHAPTER 3: CONSERVATION CORRIDORS AND ECOLOGICAL NETWORKS IN SOUTH AFRICA: SHORTCOMINGS OF ENVIRONMENTAL LEGISLATION AND POLICIES

3.1 Brief Synopsis

This critical review examines the regulatory frameworks governing protected areas and conservation practices in South Africa. Chapter 2 highlighted the lack of literature on landscape initiatives in some regions in South Africa. This paper takes this further by analysing the regulatory frameworks concerning conservation practices in South Africa from 1976 to 2021. The review aims to identify deficiencies hindering the transition towards landscape initiatives. The findings reveal that the legislation fails to explicitly address, safeguard, or implement landscape-focused conservation methods. Instead, South Africa's environmental legislation focuses primarily on forming and managing conventional protected areas. The policies echo this sentiment and lack a cohesive and corresponding stance on conservation. South Africa's conservation strategies are entrenched in traditional methods, failing to adapt or evolve. This review underscores a significant gap in legislation and highlights the potential challenges proponents may encounter when advocating for and implementing landscape initiatives. This review contributes to the discourse surrounding landscape initiatives by shedding light on these deficiencies within the regulatory framework. It underscores the need for legislative reform and a shift towards landscape-based strategies.

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Conservation corridors and ecological networks in South Africa: shortcomings of environmental legislation and policies

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ABSTRACT

Protected areas have long been the leading strategy to combat habitat fragmentation. However, studies have shown that this traditional approach can create habitat islands where populations are isolated, leading to their eventual extinction. As a result, conservation strategies have shifted to include more landscape-focused methods, including conservation corridors and ecological networks. However, what is not yet known is the extent to which South Africa's legislative and policy frameworks support this move. We identified and reviewed legislation and policies on conservation and protected areas in South Africa between 1976 to 2021 and outlined their shortcomings regarding a shift towards landscape-focused initiatives. None of the seven acts reviewed describe, protect, or enforce progressive landscape-based conservation methods. South Africa's environmental legislation is embedded in establishing and creating traditional protected areas while disregarding other methods. Moreover, the non-statutory policies reviewed were monotonous and had a limited scope that failed to provide an integrated and coordinated approach to conservation. Despite the plethora of protected area legislation and policies, South Africa's conservation approaches remain uninspiring and steadfast in traditional methods and have failed to evolve in 45 years.

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KEYWORDS
Environmental legislation; environmental policies; conservation corridors; ecological networks; landscape conservation; protected areas

1. Introduction

Modern-day development and industrialization are a hallmark of our society; however, these advancements pose a growing threat to the world's biodiversity and ecosystem functionalities (Barnosky et al., 2011; Ceballos et al., 2015; IPBES, 2019; Kolipakam et al., 2019). An increase in habitat loss, habitat fragmentation, rapid industrialization, changes in climate and variability, and increased levels of environmental pollution have put ecosystems and landscapes under immense pressure (Darkoh, 1997; Karlsson et al., 2018; Nazeer et al., 2016; Pachauri and Meyer, 2014; Qureshi et al., 2015; Tie & Cao, 2009; Wilson et al., 2016). To navigate this, countries depend heavily on environmental legislation for policies, regulations, guidelines, parameters, principles, and implementation procedures that regulate, manage and monitor activities that encroach on or

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threaten natural land and biodiversity (King et al., 2018). New policies that accommodate the ever-changing nature of biodiversity conservation and landscape ecology have emerged, and initiatives that protect biodiversities, such as protected areas, ecological networks, and conservation corridors, are encouraged.

Globally and in South Africa, protected areas have long been the popular and preferred choice in biodiversity conservation to protect against habitat fragmentation. Between 6–13% of South Africa's landscape is formally protected, with private protected areas significantly contributing to this number (Nel et al., 2017; Petersen et al., 2017). South Africa established the first conservancies in the mid-19th century after passing the Forest and Herbage Preservation Act 18 of 1859, which led to a plethora of environmental legislation focusing on protected natural environments, special nature reserves, and protected areas- both public and private (Steyn & Wessels, 2000). However, a shift has occurred in ecology studies where protected areas are no longer the panacea to habitat fragmentation (Mora & Sale, 2011; Venter et al., 2014). Protected areas may not effectively conserve biodiversity from a wide range of threats, often have financial constraints, implementation issues, and location biases, and may result in habitat islands (Mora & Sale, 2011; Newmark, 1996; Venter et al., 2014). Some studies have also shown that protected areas may create 'extinction debt' where the eventual extirpation of species in isolated areas is inevitable (Báldi & Vörös, 2006; Carroll et al., 2004; Malanson, 2002). Biodiversity conservation has stepped away from solitary fortress-style conservation in the form of protected areas and now encourages more progressive methodological innovations (Mathur & Sinha, 2008; Sharma et al., 2007). One such innovation is conservation corridors- a term often used interchangeably with ecological networks. Conservation corridors are areas of natural land that link protected national and private areas and are generally considered a successful conservation method (see Haddad et al., 2000; Joubert van der Merwe et al., 2019; Kietzka et al., 2015; Laborda et al., 2018; Lindenmayer & Hobbs, 2007). Corridors encourage the movement and migration of fauna and flora, enhance the variability of species populations, prevent species extinction, and protect threatened landscapes (Beier, 2018; Simberloff & Cox, 1987). There have been numerous studies on conservation corridors in South Africa, and their potential as a conservation tool is stressed (Dalziel & Evans, 2023). However, what is not yet known is to what extent South Africa's legislative and policy frameworks support and promote corridors and networks. We seek to determine whether these laws and policies advise and advocate for corridor implementation and management. Clear jurisdictional guidelines are especially prevalent as national and private protected areas comprise South Africa's conservation estate.

In addition, due to its past, conservation in South Africa goes hand in hand with political and social issues that shape how protected areas are managed and perceived today. This paper briefly traces the history and complexities of conservation in South Africa before identifying and reviewing fundamental legislative and policy frameworks supporting South African biodiversity conservation. We explore legislation and policies from 1976 to 2021 and outline the focus and shortfalls of these acts and policies regarding landscape ecology initiatives. As traditional protected areas are no longer the preferential choice for conservation, legislation and policies encompassing different landscape ecology methods are vital to ensure they are well established, conserve landscapes effectively, and meet their aims and objectives.

2. Context of protected areas and conservation in South Africa

2.1 South Africa's environmental and protected area history

Colonialism and Apartheid are important strands in South Africa's protected area and broader conservation history. These two forces shaped protected areas in South Africa and how the government and people view these areas today. Colonialism fostered the notion that nature could only be conserved and protected through dispossessing and excluding people (Martínez-Alier, 2001). During colonial conquests, fences ensured control and occupation as conservation through preservation became prevalent. By the 1920s and 1930s, two opposing views on wildlife management existed. The first was a holistic, *laissez-faire* approach where nature would not be manipulated or altered (Carruthers, 2008). This fortress-style conservation saw a hands-off and people-out approach to protected areas. During this time, South Africa's environmental legislation allowed for the declaration and protection of protected areas. However, the management of the parks was ineffective as non-professionals, often with military backgrounds, were left to run the parks without management plans (Goosen & Blackmore, 2019). Colonialism set a precedent for conservation during Apartheid which included the dispossession and segregation of citizens to create protected areas (Brooks, 2005; Carruthers, 2008; Gewald et al., 2018). The Natives Land Acts 27 of 1913 and Act 18 of 1936 (Union of South Africa, 1913, 1936) restricted the majority of the population to only 13% of the land in South Africa and was a way to control land, land use, and resources and assert power over people (Cock & Fig, 2000; Ramutsindela, 2004). The Union of South Africa disregarded environmental issues to increase economic activity and grow its military (Steyn, 2001). Early conservation in South Africa reflected complex power and social relations.

As political tension increased in the country, a second approach to wildlife management emerged. From the 1940s until the 1990s, 'management by intervention' was adopted, which saw what Cock and Fig (2000) termed 'double exclusion', where most of the population could not visit parks and were excluded from decision-making processes. National parks remained a symbol of exclusion, and protected areas reflected the government's domestic policies. The government's approach to wildlife management aligned with their authoritarian regime as a manipulative command and control approach strengthened through the decades.

2.2 Complexities and the politics of conservation post-Apartheid

Post-Apartheid conservation efforts, including co-management, community-based conservation, and improved public participation, sought to relinquish previous conservation approaches rife with political agendas while also catching up to global conservation targets (Kepe, 2008; Ngubane & Brooks, 2013; Olivier, 2013). Co-management aims to reconcile land claims while conserving biodiversity (Gewald et al., 2018). Post-1994 saw dispossessed people claim rights to land that now fell under protected areas and conservancies (Olivier, 2013). However, in the early 2000s, the government clarified that conservation was an issue of land management, not ownership (Kepe, 2008; Ngubane & Brooks, 2013). Co-management and land reform programmes aiming to undo past injustices have been heavily criticized in the literature and branded as unsuccessful

initiatives (Carlos Bezerra & Paphitis, 2021; Kepe et al., 2005; Kepe, 2008; Ngubane & Brooks, 2013). Another method used to include communities post-democracy is public participation. Public participation seeks to include affected communities in pre-development decisions and discussions (Kidd, 1999). Previous acts, specifically the Environmental Conservation Acts, Act 100 (Republic of South Africa, 1982 Act 73 Republic of South Africa, 1989), had weak public participation processes. However, the National Environmental Management Act of 1998 (Republic of South Africa, 1998) saw the introduction of provisions which allowed more thorough public participation (Kidd, 1999).

Today, policies attempt to balance development and social factors with the pressing need to conserve biodiversity. National parks initially reflected power structures, appropriated land, and asserted identities. South Africa's past was inimical to society, power relations, identity, and conservation perceptions and practices, which are still seen today. Protected areas still protect land rights and hide behind the conservation façade. The conversion of land for apparent ecological reasons further drives exclusion and reasserts power dynamics, creating politically and economically contested spaces (Brandt & Spierenburg, 2014; Kamuti, 2014). National parks still have social consequences (see Ramutsindela, 2004). However, a significant shift is rapidly transpiring where protected areas are utilized far less in biodiversity conservation.

2.3 Conservation territorialization

The late 1990s and early 2000s saw the popularization of peace parks and cross-boundary conservation to balance economic and social development mandates with conservation goals (Büscher, 2013). While boasting various benefits, including increasing international cooperation, increased tourism and species migration, underlying issues of power, politics, and social relations are often unmentioned (Büscher, 2013). Peace parks or Transfrontier conservation areas are a form of neo-liberal conservation where markets and profit-generated finance conservation goals (Büscher, 2013). Their neoliberal nature means they are isolated from the realities of conservation today and disregard the historical factors and power relations mentioned above (Büscher, 2013). Even corridors and networks within national borders may mirror past injustices through territorialization by and for conservation. Governments and organizations establish corridors and networks where communities depend on the land for resources, leading to dispossessing of land for conservation needs (Bluwstein & Lund, 2018). Before establishing corridors and networks, power relations and land use must be considered, as these newer initiatives may still reflect old systems. Due to South Africa's complex history with conservation, conservation methods must be cautious so as not to emulate past practices.

3. Methodology

We identified environmental legislation and policy documents supporting biodiversity conservation and establishing, managing, and implementing protected areas in South Africa from 1976 to 2021. We chose 1976 as this was when the National Parks Act 57 was established. For this study, we only reviewed acts and policies as bills, green papers, and white papers are often discussion papers that form. We searched the Department of

Forests, Fisheries and Environment (DFFE) website (https://www.dffe.gov.za/) for legislation; however, the website does not provide acts and regulations older than 1992, guidelines and policies before 1996, and green and white papers before 1996 and 1997. We, therefore, examined the University of the Witwatersrand's Online Library (https://libguides.wits.ac.za/environmental_affairs). This portal includes the 'Union of South Africa Statutes' encompassing laws between 1910 and 1989. This portal also provides a database of environmental acts, bills, white papers, green papers, and gazettes.

Under the screening process, we identified acts and policies solely focused on protected area management. We also included broader overarching legislation that is a tenet of environmental management. We excluded amendments from our search as the National Parks Act alone has been amended multiple times.

4. Results

The initial search on the DFFE website (DFFE, 2022) produced 354 pieces of legislation, of which 192 were acts and regulations and 162 were guidelines (Table 1). The University of the Witwatersrand's Online Library search identified 186 articles that comprised 135 acts and regulations, six policy documents and 45 statutes under the Union of South Africa (Table 1) (University of the Witwatersrand, 2022).

The screening process saw the identification of three crucial statutes under the Union of South Africa; the National Parks Act 57 of 1976 (Republic of South Africa, 1976), Environment Conservation Act 100 of 1982 (Republic of South Africa, 1982), and Environment Conservation Act 73 of 1989 (Republic of South Africa, 1989) (Table 2), and a further four critical pieces of legislation; the Constitution of the (Republic of South Africa, 1996, 1996), the National Environmental Management Act 107 of 1998 (Republic of South Africa, 1998), the National Environmental Management Act: Protected Areas Act 57 of 2003 (Republic of South Africa, 2003), National Environmental Management Act: Biodiversity Areas Act 10 of 2004 (Republic of South Africa, 2004) (Table 2). This screening process resulted in a total of seven acts.

Additionally, we identified 11 important policy documents on the DFFE website. These policies and guidelines are as follows; Guiding Principles for Projects on Biosphere Reserves 2002; National Biodiversity Strategy and Action Plan 2005 and 2015–2025; National Protected Areas Expansion Strategy (NPAES) 2008, 2016 and 2018; National Biodiversity Framework 2009 and 2021; National Biodiversity Assessment 2004, 2011 and 2018 (Table 2).

Table 1. Legislation search and screening results from the Department of Forests, Fisheries and Environment website and the University of the Witwatersrand's Online Library. Search conducted on 1/03/2022.

Legislation type:	DFFE website	Wits University Online Library
Acts and regulations	192	135
Policy documents	162	6
Union of South Africa Statutes	/	45
After screening		
Acts and regulations	4	4
Policy documents	11	0
Union of South Africa Statutes	/	3

Table 2. Identified and screened conservation and protected area legislation and policies between 1976 and 2021.

Date	Legislation	Comments
1976	National Parks Act 57	Advocates for and protects National Parks in South Africa today. It fails to accommodate other conservation initiatives and is outdated.
1982	Environmental Conservation Act 100	First, all-inclusive conservation legislation with a weak public participation process.
1989	Environmental Conservation Act 73	It replaced Act 100. It was more comprehensive and worked on the relationship between human activities and the environment. It remained focused on protected areas as a conservation method.
1996	Constitution of the Republic of South Africa	The highest law of South Africa. Section 24 addresses environmental rights and responsibilities.
1998	National Environmental Management Act 107	It replaced Act 73. Focused on integrated environmental management and considers the environment at all levels. However, it fails to mention other conservation methods to combat habitat fragmentation and conserve biodiversity.
2002	Guiding Principles for Projects on Biosphere Reserves	However, no implementation plan was provided for the first mention of ecological networks.
2003	National Environmental Management Act: Protected Areas Act 57	Auspice under Act 107 of 1998. Protects and outlines protected area management. Establishes protected areas as the core of conservation in South Africa.
2004	National Environmental Management Act: Biodiversity Act 10	Used concurrently with Protected Areas Act 57. Identifies priority areas through bioregional plans. However, it does not accommodate other landscape initiatives.
	National Biodiversity Assessment	Monitors the state of biodiversity, mentions corridors as part of South Africa's 'ecological infrastructure' and encourages corridor identification. However, the assessment is solely a guide that informs other policies and has a narrow scope.
2005	National Biodiversity Strategy and Action Plan	First policy under the Biodiversity Act. Informed by the National Biodiversity Assessment, this plan sought to create a conservation network but did not provide steps and processes.
2008	National Protected Areas Expansion Strategy	Outlines and promotes protected area expansion by possibly using corridors. It does not identify exact locations for this or provide a detailed strategy for this expansion.
2009	National Biodiversity Framework	This framework requires provinces to draft bioregional plans identifying CBAs, corridors, and networks.
2011	National Biodiversity Assessment	Mentions that corridors can be used to mitigate the effects of climate change. However, it does not elaborate on this.
2015	National Biodiversity Strategy and Action Plan 2015–2025	Similar to the 2005 plan. Proves no action plan or strategy regarding corridor expansion.
2016	National Protected Areas Expansion Strategy	It provides provincial expansion strategies and is more detailed than the 2008 version. However, like the 2008 version, it lacks implementation strategies.
2018	National Protected Areas Expansion Strategy	Same as the 2016 version with data from the Northern Cape added.
	National Biodiversity Assessment	Same as the 2011 assessment, even though it should include new findings from other policies.
2021	National Biodiversity Framework 2019–2024	Final policy reviewed. Mentions a landscape approach but fails to provide evidence for this approach- conservation corridors are mentioned as a method to increase stakeholder participation.

5. Discussion

5.1 Early protected area legislation in South Africa

We reviewed 18 pieces of legislation and policies focusing on protected areas in South Africa from 1976 until 2021 (Table 2). The first Act reviewed was the National Parks Act 57 of 1976 (Republic of South Africa, 1976), which replaced Act 56 of 1926. Act 57 governs all national parks in South Africa. Under Section 4, national parks have numerous objectives, including preserving and promoting the scientific study of animals, plant

life and objects of significance (Republic of South Africa, 1976). Here, traditional conservation methods are encouraged in the form of national parks. In the 1970s, protected areas, national parks, and reserves were popular conservation strategies. However, 46 years later, Act 57 remains the same and has not adapted to a newer conservation discourse. Act 57 is vital in the proclamation of national parks today, even though there is no mention of connecting reserves or conserving landscapes. A paradigm shift has occurred where newer conservation methods are favoured; however, South Africa's current ruling National Park Act ignores this shift.

Six years after the National Parks Act was ratified, the first all-encompassing conservation statute was passed. The Environmental Conservation Act, Act 100 of 1982 (Republic of South Africa, 1982), was initially praised as South Africa's first general environmental policy (Rabie, 1989). However, Act 100 became inadequate and had an abundance of deficiencies, particularly its weak public participation process. The Act was converted into the Environmental Conservation Act 73 in 1989 (Republic of South Africa, 1989). The enactment of the Environmental Conservation Act 73 was a crucial milestone for environmental management in South Africa (Steyn & Wessels, 2000). The Act sought to control and manage human activities that would negatively affect the environment, including land-use changes, developments, mining and mineral extraction, resource removal, and pollution (Republic of South Africa, 1989; Sowman et al., 1995). While still imperfect, the Act considered public opinion, making it more inclusive by integrating public and social matters into environmental conversations. The degree of inclusion is debatable as the vast majority of the population was still marginalized and excluded from National Parks (Cock & Fig, 2000). Act 73 heavily focused on creating protected natural environments and special nature reserves, which fall under a traditional, silo approach to conservation. Early environmental legislation in the late 1980s did not allow for the protection of landscapes, which would soon become widespread. These early acts and environmental legislation in South Africa, as a whole, were criticized for being fragmented, as various pieces of legislation emerged that were disjointed and uncoordinated (Hamann et al., 2000; Quinlan, 1993; Sowman et al., 1995). For example, Act 73 did not consider the Integrated Environmental Management (IEM) principles published in 1989 by the Council for the Environment; therefore, a set of regulations was subsequently published in 1997, making impact assessments mandatory (Hamann et al., 2000). This haphazard approach to environmental legislation shifted with the proclamation of the National Environmental Management Act, Act 107 of 1998 (King et al., 2018).

5.2 The National Environmental Management Act: continuing the unchanging conversation

The National Environmental Management Act (NEMA) of 1998 (Republic of South Africa, 1998) replaced the Environmental Conservation Act 73 as the need to encompass IEM strategies grew after Apartheid ended. The NEMA is a significant resource for environmental management in South Africa (Strydom & King, 2009). In 1996, the Constitution of the Republic of South Africa was ratified, to which NEMA gives effect to Section 24 (Republic of South Africa, 1996). The NEMA offers a set of principles that include the environment at all levels of planning and guides the decision-making

processes (Republic of South Africa, 1998). Compared to its predecessors, the Act encompasses social and economic factors in environmental discussions and has a well-founded public participation process, a first for post-democracy South Africa (King et al., 2018, 1147).

Under the NEMA, five specific environmental management acts emerged to make provisions for more detailed environmental laws for different aspects and elements of the environment (Strydom & King, 2009). First, and importantly for this paper, the National Environmental Management: Protected Areas Act, Act 57 of 2003; second, the National Environmental Management: Biodiversity Act, Act 10 of 2004; third, the National Environmental Management: Integrated Coastal Management Act, Act 24 of 2008 (Goble et al., 2014; Sowman & Malan, 2018); fourth, the National Environmental Management: Air Quality Act, Act 39 of 2004 (Tshehla & Wright, 2019); lastly, the National Environmental Management: Waste Act, Act 59 of 2008 (Zhakata et al., 2016).

Since 1982 with the Environmental Conservation Act 100, protected areas have been the cornerstone of conservation in South Africa; this remained unchanged with the National Environmental Management: Protected Areas Act 57 of 2003 (NEMPA) (Republic of South Africa, 2003). Today, protected areas are currently regulated and guided by Act 57 (Goosen & Blackmore, 2019; Strydom & King, 2009). Under Act 57, management plans became mandatory; decision-making processes included the public, and precise guidelines were set (Freitag et al., 2014; Goosen & Blackmore, 2019; Wylie et al., 2018). The Act clarifies protected area issues and regulates procedures, policies, and plans (King et al., 2018). However, the conversation regarding connected areas, corridors and networks remains unchanged compared to legislation from the 1980s. Objective 2 (d) of the Act aims to create a protected area network that includes state and privately-owned land (Republic of South Africa, 2003)- the first and only mention of a 'network' in the Act. However, the Act fails to recognize the importance of corridors or ecological networks. At the same time, protected areas remain favoured and divided into different categories: special nature reserves, national parks, nature reserves and protected environments, World Heritage Sites, marine protected areas, specially protected forest areas, forest nature reserves and forest wilderness areas, and mountain catchment areas. Not only does Act 57 not mention the importance of conserving landscapes, but it is also fragmented to the point that practitioners must rely on additional legislation, including the National Environmental Management Biodiversity Act 100 of 2004, when establishing management plans for protected areas (Goosen & Blackmore, 2019). While Act 57 deals with the declaration, implementation, and management of protected areas, these sections are disjointed, and its tenets correspond to those used in early environmental management legislation (Goosen & Blackmore, 2019).

The final legislation reviewed was the National Environmental Management: Biodiversity Act, Act 100 of 2004 (NEMBA) (Republic of South Africa, 2004). When establishing management plans for protected areas, practitioners must consult the NAMPA and NEMBA. Objective 2 (a)(i) of the Biodiversity Act states that the Act provides for the management and conservation of biological diversity (Republic of South Africa, 2004). According to section 39 (c), this is accomplished by identifying priority areas for conservation and establishing protected areas (Republic of South Africa, 2004). Bioregions, bioregional plans, and biodiversity management plans are also encouraged through the Act. Similar to the above legislation, the Biodiversity Act does not mention

corridors or networks or the protection of landscapes and remains steadfast in using protected areas to protect biodiversity. Bioregional and biodiversity management plans merely provide management and monitoring plans for a region to ensure the survival of a species or ecosystem and do not mention the inclusion of threatened landscapes, corridors, or networks. In addition, Chapter 4 sees the protection of critically endangered, endangered, and vulnerable ecosystems, again, with no emphasis on protecting landscapes.

NEMA and its auspices are the primary environmental legislation in South Africa. However, the legislation assumes a parochial approach to how landscapes, ecosystems, fauna, and flora should be protected and conserved. Consequently, the seven acts examined fail to describe, promote, and enforce other methods of biodiversity conservation. However, Section 38 requires the preparation of multiple policies and plans under the Biodiversity Act (Republic of South Africa, 2004). While non-statutory, these plans are regularly updated to incorporate new issues and discussions in and around conservation and may support newer conservation methods, including corridors.

5.3 Protected area policies: shifting the conservation discourse

South Africa's environmental legislation from 1976 to 2004 remained consistent in its exclusion of corridors and networks. Nevertheless, these conservation tools have been circulating in South African environmental policies since 2002. Of the 11 policy documents reviewed, the first mention of conservation corridors was in the Guiding Principles for Projects on Biosphere Reserves document in 2002 (Department of Forestry, Fisheries, and the Environment, 2002). This policy encourages regional networks to assemble large-scale ecological corridors, the first mention of this approach in South Africa. Unfortunately, no implementation or management plan is attached to this policy- it remains a suggestion. The following ten policies fall under the NEMBA. Under Section 38 of the NEMBA, the minister must prepare and adopt a National Biodiversity Framework three years after ratifying the Biodiversity Act (Republic of South Africa, 2004. However, the first National Biodiversity Framework was only published in 2009 (Table 2), five years after the Act was ratified.

Section 38 of the Biodiversity Act also states that the framework must be reviewed every five years. However, the second National Biodiversity Framework was only published in 2021, 12 years after the first version. Under Section 38, the framework must provide an integrated approach to biodiversity conservation and management, identify priority areas, and be consistent with NEMA principles (Republic of South Africa, 2004.

5.3.1. National Biodiversity Framework: worth the wait?

The National Biodiversity Strategy and Action Plan, National Biodiversity Assessment, and the National Protected Area Expansion Strategy inform the National Biodiversity Framework (*Figure* 1). The first National Biodiversity Framework (NBF) was published in 2009, and the latest version, the National Biodiversity Framework 2019–2024, was released in 2021. The framework aligns the strategic objectives identified in the National Biodiversity Strategy and Action plan, first published in 2005, with other national policies, strategies, and frameworks. Under this framework, regional plans, which identify critical biodiversity areas

(CBAs), networks and conservation corridors, are required. However, this is a nonbinding requirement (Republic of South Africa, 2009). Revised 12 years later, the NBF of 2019–2024 boldly claims South Africa has adopted a landscape approach (Republic of South Africa, 2021, p. 12). Still, the policy provides no evidence, as no examples of corridors, networks, or protected landscapes are provided. One of the principles outlined in Section 2.5 of the NBF 2019–2024 focuses on a landscape approach to biodiversity conservation and working beyond the boundaries of protected areas (Republic of South Africa, 2021). However, when discussing this approach, the NBF focuses heavily on stakeholder participation and social inclusivity, with no focus on the environmental benefits and why shifting away from protected areas is imperative.

The National Biodiversity Framework's purpose is not to provide the steps required to meet conservation goals. However, the framework is informed by other policies and must consider the findings and proposals from these plans and provide a congruent, coordinated, and integrated approach that advises South Africa's biodiversity management (Republic of South Africa, 2021, p. 1). This objective is not achieved regarding landscape initiatives as the framework barely mentions networks and corridors. The only mention of corridors is under the aims of the National Botanical Gardens Expansion Strategy, where the creation of corridors is encouraged. This solo mention of corridors is brief and limited to a specific location. Additionally, a clear step away from protected areas and towards corridors and networks is absent in this framework; despite Section 2.5 stressing the importance of a landscape approach, it remains an unconvincing suggestion as the framework ignores ecological networks and corridors. Both versions of the NBF were published past their deadlines and show little for this delay. The Biodiversity Act only requires the framework to be reviewed every five years. Therefore, the frameworks must have foresight encompassing various issues and solutions that will come about over the five or, in this case, 12 years between reviews. The National Biodiversity Frameworks fail to do this as the 2019 NBF only partly extends the ambit of its predecessor. According to the frameworks, biodiversity conservation in 2024 will be similar to that practised in 2009 as the framework provides no contemporary strategies.

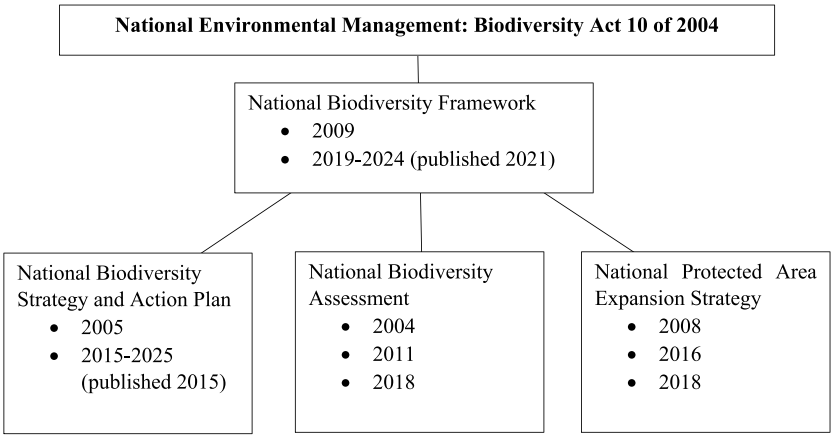


Figure 1. Policies under the National Environmental Management: Biodiversity Act 10 of 2004.

5.3.2. The National Biodiversity Strategy and Action Plan

The first policy produced under the Biodiversity Act was South Africa's National Biodiversity Strategy and Action Plan (NBSAP) of 2005, which informs the National Biodiversity Framework (*Figure* 1). The plan posited a strategy for biodiversity management in South Africa. It was created due to the Convention on Biological Diversity, where parties must outline how they intend to fulfil the convention's objectives (Republic of South Africa, 2005). Describing itself as a mainstreaming tool, it attempts to comprehensively outline its strategic objectives and develop a detailed implementation plan to achieve its conservation goals (Republic of South Africa, 2005 .

Strategic Objective 5 of the NBSAP sought to create a conservation network that conserves biodiversity across the landscape (Republic of South Africa, 2005; Moreover, objective 5.1 mentions protected area network expansion to conserve threatened species-prioritized as urgent. However, similarly to the previous policy, actual implementation and management steps are absent, which is ironic considering the name of the policy. The policy seeks to create a network of connected areas yet fails to mention how, why, or where this will happen, making it far from the comprehensive mainstream report promised.

Revised ten years later, the National Biodiversity Strategy and Action Plan from 2015 to 2025 again encourages the expansion of the conservation area (Republic of South Africa, 2015). The 2015 policy admits that there have not been 'fundamental changes in biodiversity policy in South Africa since 2009' (Republic of South Africa, 2015), p. 5). We agree because, in the six years, only one policy- the National Biodiversity Assessment- was published (Table 2). When reflecting on the 2005 plan, the 2015 plan notes strategic objective five as 'substantially achieved', even though there is no evidence. The strategic objectives changed in the 2015 plan as Strategic Objective 5 deals with developing a skilled workforce. Corridors and networks seem to have fallen under Strategic Objective 1 – an elusive move. Strategic Objective 1 states that protected areas must be comprehensive, represent a wide range of species and ecosystems, and be correctly and efficiently managed. The plan recommends expanding the conservation network 'through mechanisms under the Biodiversity Act, contract law and other informal agreements between the landowner and conservation authority' (Republic of South Africa, 2015), p. 20). Here, the policy fails to refer to these precise mechanisms and promotes conservation network expansion through informal agreements, typically not associated with coherent and effective management. The plan sought to provide detailed, comprehensive action strategies that address its objectives, but instead, it has provided a brief, narrow and incomplete plan.

The original 2005 NBSAP was far more progressive and realized the potential of corridors and networks early on. The plan prioritized protected area expansion and the creation of networks, even though its action plan was weak, with no implementation and management steps provided. The focus shifted ten years later as landscape initiatives, corridors, and networks were further side-lined, and actionable measures were absent. The policy admitted that no specific legislation protects or supports the implementation and management of landscape approaches but does not go on to endorse this.

5.3.3. The National Protected Area Expansion Strategy

The National Protected Area Expansion Strategy (NPAES) is another mandatory policy under NEMBA (*Figure* 1). The 2008 NPAES sought to achieve cost-effective, protected area expansion to ensure the protection of priority areas identified through the plan (Republic of South Africa, 2008). While it seems promising at first, when outlining the strategy in chapter 1, the plan clarifies that it does not identify exact locations for protected area expansion or provide detailed implementation planning to expand the network (Republic of South Africa, 2008, p. 8). Instead, the plan encourages protected area agencies to use NPAES as a guide to coordinate protected area expansion.

The NPAES describes corridors as part of South Africa's 'ecological infrastructure', a promising phrase advocating for corridors at face value. The original version of NPAES in 2008 briefly defined ecological infrastructure as 'nodes and corridors of natural habitat that provide a range of ecosystem services and resilience to the impacts of climate change and natural disasters' (Republic of South Africa, 2008, p. 9). The plan prioritized protected areas to mitigate the effects of climate change- specifically, the protection of natural connected landscapes and corridors. NPAES 2008 identifies 42 'focus areas' for protected area expansion. However, per its objectives in chapter 1, the plan does not provide exact, detailed sites but rather large sections of land, often spanning two provinces, with weak, broad, and minimal justification for protecting these areas. NPAES was updated in 2016 and 2018. However, these versions are the same as data from the Northern Cape was included in the latest publication (Republic of South Africa, 2018). The NPAES of 2016 extends the ambit of its predecessor by providing expansion strategies for each province, with corridors used as an essential principle to guide protected area expansion (Republic of South Africa, 2016). All the policies produced under the Biodiversity Act should advise each other. There should be a level of synergy between the policies. An objective from NPAES should be assigned a detailed action plan under the NBSAP. However, we know from section 4.3.2 that this is not the case.

5.3.4. The National Biodiversity Assessment

The National Biodiversity Assessment is the last policy that informs the National Biodiversity Framework. National Biodiversity Assessments (NBA) provide a spatial assessment of ecosystems and monitor the state of biodiversity in South Africa. Similar to the NPAES report, in the first Biodiversity Assessment in 2004, corridors were mentioned as part of South Africa's 'ecological infrastructure' (South African National Biodiversity Institute, 2005). Like NPAES, this report encourages the identification of corridors, but this remains a subtle suggestion. The 2011 and 2018 National Biodiversity Assessments state that corridors are vital for climate change resilience (South African National Biodiversity Institute, 2012, 2019). The 2011 report outlines that ecological networks can be planned and managed successfully (South African National Biodiversity Institute, 2012). However, the report does not elaborate on this, perhaps because it is out of scope as the NBA informs other policies and does not provide actionable plans.

5.4 Reflecting on South Africa's legislative and policy frameworks

The Biodiversity Act sees the publication of numerous policy documents (*Figure* 1). These documents have varying scopes, aims and objectives. Of the 11 we reviewed,

they all mention corridors in some form. While it is not within the ambit of the NBA, NPAES, or NBF to provide an action or implementation plan on protected area expansion or ideal locations for corridors, these policies are influential. The guidelines can promote new conservation methods and encourage a change from traditional forms towards more contemporary, effective initiatives. However, these policies waste this opportunity. The NBA states it is possible to manage ecological infrastructure sustainably but fails to mention what this would entail. The scope of NPAES is far too narrow as it omits the potential of corridors and networks to fast-track its expansion goals. The NBF claims South Africa has adopted a landscape approach but provides little to no proof. Although these policies are flawed, they have remained within their narrow scope. However, the National Biodiversity Strategy and Action Plan, which aims to develop a detailed implementation plan to achieve its conservation goals, does not outline the potential use of conservation corridors and networks except that informal agreements are encouraged. The policies reviewed in the sections above read as isolated plans and rarely refer to their predecessors and other strategies. The guidelines are out of touch with the current conservation discussions and recent findings. As a result, the planning and managing of corridors remains elusive in South Africa, even though discussions have occurred for 16 years in policy documents.

Legislation has also failed to acknowledge, implement, and protect corridors and networks. Compared to South Africa's early environmental legislation, the legislation is unchanged, ignoring newer initiatives. Moreover, the legislation currently governing national parks in South Africa is 46 years old. Currently, South Africa's *ad hoc* approach to environmental legislation does not support the establishment of newer measures. However, not everyone supports this view.

According to Keeley et al. (2019, p. 10), South Africa has 'strong national-level requirements to consider connectivity in spatial planning'. The evidence provided to support this claim was the National Biodiversity Act, which, as discussed in Section 4.2, that requires the development of bioregional plans, and the Spatial Planning and Land Use Act of 2013, which involves the zoning of each hectare in South Africa into spatial planning categories which include conservation. However, we argue that establishing bioregional plans and the zoning of conservation areas does not make for sound connected spatial planning in South Africa, especially compared to other countries where corridors and networks are established and protected through legislation.

Conservation corridors have been regulated through land-use planning legislation in Ontario, Canada, leading to a significant decline in development on private land in the area (Whitelaw & Eagles, 2007). Moreover, some Eastern European countries have mandated corridors and networks into national legislation. For example, Lithuania, Slovakia, and the Czech Republic have explicitly added ecological networks into national legislation (Jongman et al., 2004). In Poland, the Act on the Protection of Nature defines ecological networks and provides for their functions. It formally protects ecological networks as protected landscapes and provides for the ability to create protected landscape areas (Izakovičová & Świąder, 2017). While South Africa has many policies that encourage landscape initiatives to some degree- our legislation is far behind.

5.5 A way forward

Studies have shown that connectivity is critical regarding protected areas, and this may be achieved in South Africa by linking national protected areas with private land. However, as discussed in section two, converting and protecting land under the pretence of conservation recreates past themes of inequality and exclusion. Since the 1940s, legislation has permitted landowners to protect their land legally (De Vos et al., 2019). The NEMPA Act 57 of 2003 further protects private protected areas in South Africa (De Vos et al., 2019). Objective 2d states that the Act aims to create a network of protected areas, including state and privately-owned land. However, this diversification of protected area tenure types requires clear jurisdictional and legislative guidelines, currently unavailable in South Africa. Private game reserves cover 16.7% of South Africa, while national reserves only cover 6.2% (Holmes, 2013). Private protected areas ensure that the private sector is engaged in conservation matters, the conservation estate is expanded, and may play a significant role in conservation by reintroducing flagship species and starting breeding schemes (Holmes, 2013). Synergy is required between national and private protected areas- but this is absent in legislation and policies and is difficult in a country like South Africa with a problematic conservation past. In this case, the informal agreements encouraged in the NBSAP 2015 (Republic of South Africa, 2015) will not be sufficient. Merging national and private protected areas will unlock huge conservation potential and may be a cost-effective way to expand South Africa's conservation network and undo past injustices.

Approaches including biodiversity stewardship- which seeks to facilitate collaboration between private and communal landowners to protect and manage biodiversity-rich areas- have been adopted and used to create some corridors in South Africa (Barendse et al., 2016; Cockburn et al., 2019). Stewardship is voluntary and requires stewards to balance conservation requirements with social and economic needs. While it holds the potential to enable a high degree of collaboration among stakeholders (Brownlie et al., 2017; Cockburn et al., 2019; Stoll-Kleemann & O'riordan, 2002, issues of accountability and inadequate implementation have been documented (Barendse et al., 2016; Boon et al., 2016), further demonstrating the need for effective legislative and policy frameworks that act in congruence.

6. Conclusion

Biodiversity conservation has moved away from fortress-style protected areas to more progressive approaches encouraging corridors, networks, and connected landscapes. We sought to determine if South Africa's legislative and policy frameworks accommodate this shift. The above sections have explored and evaluated the past and current legislation and policies surrounding biodiversity conservation and protected area management in South Africa. Through this, we considered South Africa's conservation and protected area history, early conservation policies and practices and established a timeline where we traced the establishment of the NEMA. Additionally, we explored the auspices of NEMA, and the NEMPA, while not without its flaws, was identified as a crucial piece of legislation for the establishment, declaration, and management of protected areas-the cornerstone of biodiversity conservation in South Africa. While South Africa has

impressive environmental and protected area legislation, these acts do not support the new wave of landscape-focused initiatives, especially compared to other countries. South Africa's legislation does not protect or mandate the creation of corridors or networks. However, policies seem more encompassing, yet they provide no tangible action or implementation plans and are not regularly updated. No legislation provides a legal framework for establishing corridors and networks. While they are encouraged through policies, they cannot be established, regulated, managed, protected, and standardized across South Africa without supporting legislation. A shift must occur with a greater focus on connected landscape initiatives to effectively conserve threatened landscapes and South Africa's biodiversity. These initiatives must be rooted in legislation to implement clear guidelines and ensure they are formally protected while not repeating the past. South Africa should learn from other countries and include landscape initiatives in its legislation and policies to ensure that our conservation strategies move on from those practised in 1976.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Báldi, A., & Vörös, J. (2006). Extinction debt of Hungarian reserves: A historical perspective. *Basic and Applied Ecology*, *7*(4), 289–295. https://doi.org/10.1016/j.baae.2005.09.005

Barendse, J., Roux, D., Currie, B., Wilson, N., & Fabricius, C. (2016). A broader view of stewardship to achieve conservation and sustainability goals in South Africa. *South African Journal of Science*, *112*(5–6), 1–15. https://doi.org/10.17159/sajs.2016/20150359

Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O., Swartz, B., Quental, T. B., Marshall, C., McGuire, J. L., Lindsey, E. L., Maguire, K. C., & Mersey, B. (2011). Has the Earth's sixth mass extinction already arrived? *Nature*, *471*(7336), 51–57. https://doi.org/10.1038/nature09678

Beier, P. (2018). A rule of thumb for widths of conservation corridors. *Conservation Biology*, *33*(4), 1–3. https://doi.org/10.1111/cobi.13256

Bezerra, J., & Paphitis, S. (2021). Epistemic injustice and land restitution in the case of protected areas: From policy to practice in South Africa. *Society & Natural Resources*, *34*(7), 906–924. https://doi.org/10.1080/08941920.2021.1900962

Bluwstein, J., & Lund, J. F. (2018). Territoriality by conservation in the Selous–Niassa Corridor in Tanzania. *World Development*, *101*, 453 465. https://doi.org/10.1016/j.worlddev.2016.09.010

Boon, R., Cockburn, J., Govender, N., Ground, L., Slotow, R., Mclean, C., Douwes, E., Rouget, M., & Roberts, D. (2016). Managing a threatened savanna ecosystem (KwaZulu-Natal sandstone sourveld) in an urban biodiversity hotspot: Durban, South Africa. *Bothalia-African Biodiversity & Conservation*, *46*(2), 1–12. https://doi.org/10.4102/abc.v46i2.2112

Brandt, F., & Spierenburg, M. (2014). Game fences in the Karoo: Reconfiguring spatial and social relations. *Journal of Contemporary African Studies*, *32*(2), 220–237. https://doi.org/10.1080/02589001.2014.925300

CHAPTER 4: USING KEY AND CRITICAL BIODIVERSITY AREAS TO IDENTIFY GAPS IN THE PROTECTED AREA NETWORK

4.1 Brief Synopsis

Chapter 4 delves deeper into the examination of conservation corridors and ecological networks by examining the coverage and gaps in Key and Critical Biodiversity Areas and Protected Areas. As revealed in Chapter 2, landscape initiatives receive less attention in other provinces. Thus, the potential of establishing a corridor or network within the Vhembe District, situated in Limpopo, is investigated. Utilising Geographic Information Systems (GIS), the paper scrutinises the existing protected area network's coverage, distribution, and size. Subsequently, Key Biodiversity Areas and Critical Biodiversity Areas are employed as evaluative metrics to gauge the effectiveness of these protected areas in safeguarding essential ecoregions and species. In doing so, gaps and location biases within the current protected area network are identified, thereby underscoring the potential for implementing landscape initiatives in the region.

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Using Key and Critical Biodiversity Areas to Identify Gaps in the Protected Area Network

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Using Key and Critical Biodiversity Areas to Identify Gaps in the Protected Area Network.

Abstract

The Kunming-Montreal Global Biodiversity Framework (KMGBF) commits signatories to expand the global protection of land and sea by 30% in 2030. Additionally, in South Africa, a local target set in 2016 aims to conserve 16% of terrestrial areas using protected areas within a two-decade time frame. Concurrently, it is crucial to recognize and prioritize sites where biodiversity must be protected immediately. This recognition has given rise to global Key Biodiversity Areas (KBAs) and South Africa's Critical Biodiversity Areas (CBAs). KBAs are sites of significance for the global persistence of biodiversity. In South Africa, CBAs delineate primarily or partially natural areas needing management. Despite their significance, an assessment of KBAs and CBAs in South Africa's Limpopo province, specifically the Vhembe District, is lacking. Employing GIS techniques, our evaluation focused on the coverage, size, and distribution of protected areas in the Vhembe District. Our analysis revealed that protected areas cover an impressive 38% of the Vhembe District. Critical Biodiversity Areas cover 9,465 km^2 (36%) of the region. Alarmingly, 70% (6,809 km^2) of these CBA sites lack protection. Additionally, KBAs cover 30% of the region, with 39% of sites covering approximately 3,273 km^2 and laying outside the protected area network, rendering them entirely unprotected. Sluggish protected areas establishment rates and a deficiency in the strategic targeting of significant sites have resulted in over

10,000 km^2 of land warranting protection, particularly along the Soutpansberg Mountain Range. Moreover, South Africa's national target, established in 2016, which aims to protect a mere 16% of terrestrial areas by 2036, falls short of the global KMGBF target, reinforcing the urgency for an update in national policy and embracing other conservation methods. These findings suggest that, despite the commendable 38% protection of the district, setting a precedent for the rest of the country, there is a crucial need for municipalities, districts, and provinces to draw insights from the shortfalls of the Vhembe District.

Introduction

Protected Areas are considered the cornerstone of conservation methods, and global and local targets have been set to encourage expansion. At the 15th meeting of the Conference of Parties to the United Nations Convention on Biological Diversity, representatives from 196 countries signed the Kunming- Montreal Global Biodiversity Framework. The KMGBF delineates 23 targets to maintain and restore biodiversity in an increasingly human-dominated matrix. These targets include restoring 30% of degraded ecosystems, ceasing species extinction, protecting species genetic variability, and reducing human-wildlife conflicts. Notably, Target 3 aims to ensure that 30% of the global land and sea area is conserved by 2030 (CBD, 2022; Obura, 2023; Schroter *et al.,* 2023).

On a local level, South Africa, as a signatory of the Convention on Biological Diversity (CBD), has instituted a National Biodiversity Strategy and Action Plan. These are the primary instruments that implement the principles of the CBD nationally. However, the National Protected Area Expansion Strategy (NPAES) guides protected area expansion and provides national targets (RSA, 2016). Last updated in 2016, the plan states that an additional 146,814 km^2 of land must be designated as a protected area in South Africa to meet its 20-year target (RSA, 2016, p. 22). This would mean that protected areas would cover approximately 16% of South Africa. However, current figures show that protected areas cover only 9% of South Africa's terrestrial landmass (King *et al.,* 2023). It is imperative to update the current NBSAP to align with the objectives of the KMGBF.

Two core principles are emphasized to meet global and local targets. Firstly, the frameworks and policies demand prioritizing areas of particular importance of biodiversity (CBD, 2022; RSA, 2016). Secondly, they underscore the importance of establishing well-connected protected areas (CBD, 2022; Kettunen *et al.,* 2021; RSA, 2016).

To prioritize essential biodiversity areas and ensure protected areas are ecologically representative, identification of Key Biodiversity Areas (KBAs) is encouraged (CBD, 2022; Maxwell *et al.,* 2020; Plumptre *et al.,* 2024). KBAs are "sites of significance for the global persistence of biodiversity" (IUCN, 2016). KBAs cover around 8% of the earth's land (Farooq *et al*., 2023; Kullberg *et al.*, 2019). Regrettably, only around half of KBAs are protected (Kullberg *et al.,* 2019). The Global Standards for the Identification of Key Biodiversity Areas establish criteria identifying sites of biodiversity significance. A site qualifies if it meets one of the eleven criteria. The criteria include globally threatened and geographically restricted species and ecosystems, ecological integrity, biological processes, and irreplaceability (IUCN, 2016). KBAs identify globally valuable sites nationally using international organizations, including BirdLife and the World Wildlife Fund, to endorse, fundraise for, and back KBAs. KBAs have the potential to enable countries to protect crucial regions. The synergy between KBAs and other national sites should be harmonious as they collectively contribute to overarching conservation goals.

At the local level, in South Africa, Critical Biodiversity Areas (CBAs) identified by the South African National Biodiversity Institute (SANBI) represent areas in a natural or near-natural condition necessary to meet biodiversity targets (von Staden *et al.,* 2022). CBAs are typically divided into two categories. Category 1 areas are designated to remain natural, with stringent prohibitions on further habitat loss. Additionally, efforts are directed towards rehabilitating degraded areas within this category. The overarching goal in CBA Category 1 is to prevent additional natural habitat loss. Conversely, CBA Category 2 focuses on minimizing habitat loss while acknowledging that some level of impact may be inevitable. CBAs are identified using Systematic Conservation Planning (SCP) processes (von Staden *et al.,* 2022). CBAs are a requirement under the National Biodiversity Framework, a prerequisite under the National Environmental Management: Biodiversity Act 10 of 2004 (Dalziel & Evans, 2023). In summary, KBAs are sites of biodiversity importance identified through

threshold-based methods, whereas CBAs are local sites pinpointed through a spatial prioritization exercise.

Global and local principles stress the importance of protecting specific regions and expanding protected areas. Exploring these fundamental tenets, our research identifies gaps in the protected area network of the Vhembe District in Limpopo, South Africa. Using GIS, we analyze the current protected area network in the 25,596 km^2 area of the Vhembe District, assessing its coverage, size, and distribution. We aimed to determine if this local network contributes to South Africa's national and global goals. Additionally, we utilize KBA and CBA sites to assess whether the existing protected areas effectively conserve species with a restricted geographical range, protecting species and ecosystems at risk of collapse or extinction and ensuring threatened species and ecosystems that are irreplaceable are protected. We use the Vhembe District as a local analog for a larger global perspective.

Methods

Context

According to the International Union for Conservation of Nature (IUCN) (2008), protected areas are a "clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." They hold a prominent position in the global conservation discourse, often touted as the cornerstone of conservation. Research praising these methods is not scant; see Feng *et al.* (2021); Floigl *et al.* (2022); Timmers *et al.* (2022); Rahman & Islam (2021); Sims (2014); Hernandez-SaintMartin *et al.* (2015). However, a body of literature also exists that scrutinizes the effectiveness of protected areas, featuring critiques from Nagendra (2008), Beresford (2011), Oberosler (2019), Watson *et al.* (2014), Venter *et al.* (2018).

Globally there are over 280,000 protected terrestrial and marine areas worldwide, and the number is steadily rising (Saura *et al*., 2019; UNEP-WCMC, 2022). According to the

latest Protected Planet Report of 2020, only 16.64% of the world's landmass is protected (UNEP WCMC *et al*., 2020). Despite these earnest efforts, global protection still falls short of CBD's 2030 target of 30%.

In addition, the private land sector has emerged as a significant participant in achieving global biodiversity benchmarks (Palfrey *et al*., 2022). Private protected areas represent 5.7% of global protected areas and significantly contribute to protecting Key Biodiversity Areas (Palfrey *et al*., 2022). For example, over 100,000 km^2 of private land in southern Africa is currently used for conservation purposes (Kamal *et al.,* 2015). Private and national protected areas are hegemonic in the conservation discourse.

South Africa joined the Convention on Biological Diversity in 1995. The National Protected Area Expansion Strategy (NPAES) directs protected area expansion and was last updated in 2016. The plan delineates a 20-year strategy for encompassing 16% of South Africa in protected areas and states that an additional 146,814 km^2 of landmass must be designated (RSA, 2016). However, currently, protected areas cover 112,806 km^2 of South Africa, equating to only 9% of South Africa's terrestrial landmass (King *et al.,* 2023).

Protected area coverage exhibits variation across South Africa's nine provinces, with Limpopo having the most extensive extent of protected areas. Despite comprising only 10.3% of South Africa's total area, the province contributes 21.5% of the country's protected area estate (StatsSA, 2021). Regardless of the numerous protected areas in Limpopo, regional assessments of their effectiveness are lacking. The 2013 Limpopo Conservation Plan V.2 produced a map of Critical Biodiversity Areas in Limpopo and analyzed threats to the province and ecosystem status, vegetation types, and coverage. Additionally, the plan unearthed deficiencies in the current protected area coverage, indicating the need for an additional area of around 11,000 km^2 to achieve biodiversity targets in Limpopo (Desmet *et al.,* 2013).

Study area

The Vhembe District, in the north of Limpopo, is bordered by Botswana, Zimbabwe, and Mozambique (*Fig.* 1). The region is semi-arid and experiences 300 to 1,000 mm of yearly rainfall. Encompassing a substantial area of 25,596 km^2, the district comprises four local municipalities: Makhado, Musina, Thulamela, and Collins Chabane. As of 2021, the estimated population of the Vhembe District is around 1.43 million people 2021 (Limpopo Provincial Government, 2023). The southern part of the district is primarily occupied by populated residential areas and cultivated land, with some towns situated in and around Musina (*Fig*. 2). Mining, agriculture, and community services are the district's main economic activities.

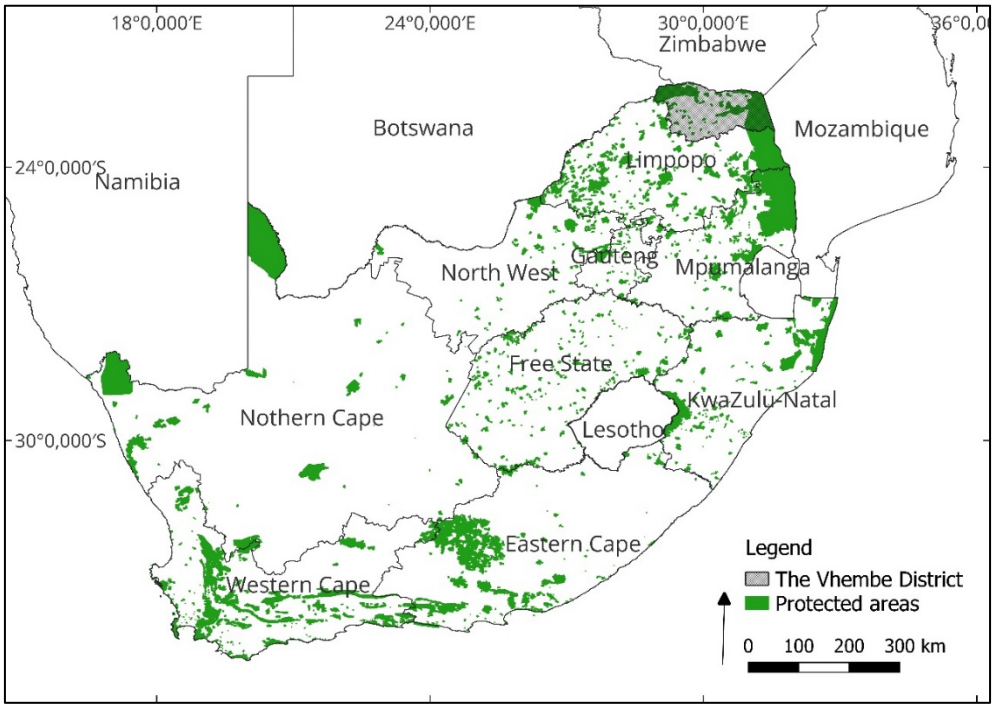


Figure 1: Fragmented protected area network of South Africa. The Vhembe District is outlined in grey. (The map was created using QGIS version 3.28.0).

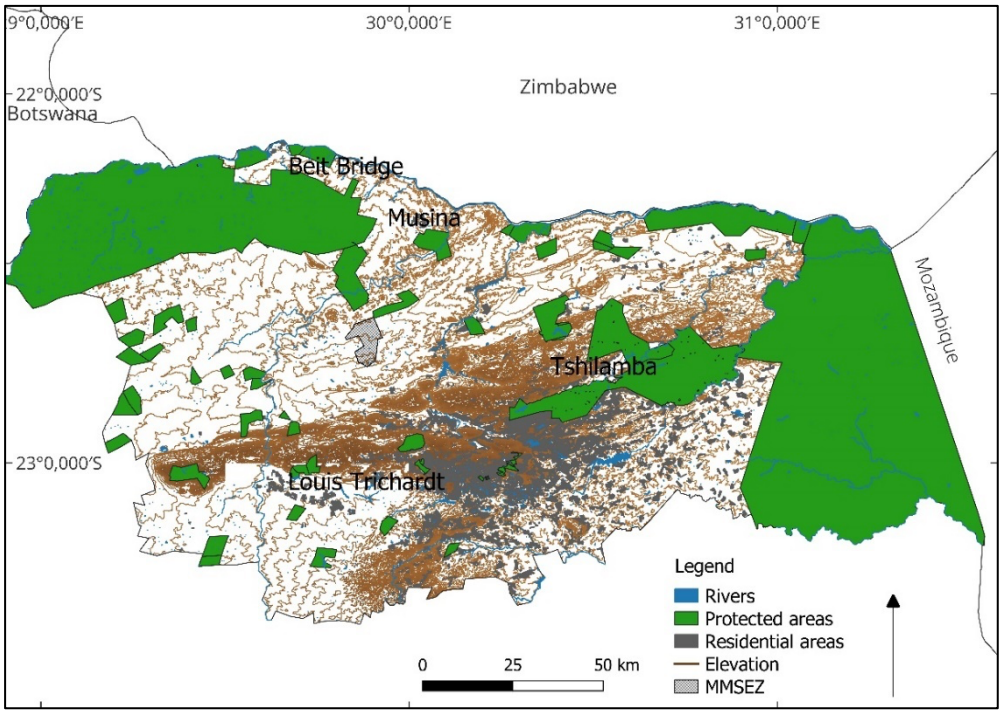


Figure 2: Land-use zones of the Vhembe District. Map created using QGIS version 3.28.0.

The Vhembe District is one of the ten biosphere reserves in South Africa. Designated under UNESCO in 2009, the Vhembe Biosphere Reserve spans 30,700 km^2, featuring three biomes, four bioregions, and numerous archaeological sites. The Vhembe District has two major protected areas, the Kruger National Park and Mapungubwe National Park, a UNESCO-declared World Heritage Site. The Soutpansberg Mountain range runs through the district, with the town of Louis Trichardt at the foot of the mountain (*Fig*. 2). Recognized as a center of endemism and diversification in South Africa, the Soutpansberg represents 74% of vascular plant families in southern Africa and is home to 22 endemic taxa (Hahn, 2019). Furthermore, the Soutpansberg is home to 571 tree taxa, constituting one-third of all known trees in southern Africa (Hahn, 2019).

The Vhembe District faces various developmental challenges, notably the proposed Musina Makhado Special Economic Zone (MMSEZ) situated in the heart of the District (*Fig*. 2). Envisioned as a cluster of interconnected industries, including a power station, steel plant, coking coal plant, and lime plant, the MMSEZ spans 8,000 hectares (Neva,

2021). This project, with a projected lifetime emission of 1 billion tons of carbon dioxide, equivalent to 10% of South Africa's carbon budget, is deemed to have a "Very High" potential impact (Delta, 2021, p. 456), posing significant threats to the district's ecological integrity.

The Vhembe District offers a rich tapestry of pertinent socio-economic factors, developmental challenges, significant biodiversity, and variously sized and owned protected areas. This confluence provides a multi-faceted, intricate environment for investigation and analysis.

Data Collection

The methodology has been adapted from the regional assessment of protected areas in the Hindu Kush region by Chaudhary *et al.* (2022). We utilized six datasets to conduct a regional assessment of the protected area coverage in the Vhembe District. These datasets are in Table 1 and include the boundaries of South Africa, the South African Protected Areas Database, a land use layer, a polygon showing the proposed Musina Makhado Special Economic Zone, and a layer showing the Key and Critical Biodiversity Areas. These datasets showcase the area's rich biodiversity, highlight the essential ecoregions, depict the distribution and coverage of protected areas, and illustrate the land use patterns and threats faced by Vhembe District, thereby contextualizing the study site. However, one data set was excluded from the site. The KMGBF aims to conserve 30% of land and marine areas through protected areas and Other effective area-based conservation measures (OECMs). OECMs were intentionally omitted from this study as OECM identification in South Africa is only beginning. Nonetheless, this chosen methodology allowed us to show trends in the area and identify where essential sites are unprotected.

Table 1: Datasets used in creating the maps.

Feature	Comments	Source
Boundaries	Administrative boundaries of the Republic of South Africa. Shapefile includes national, provincial, district, municipal, and wards.	ROSEA, 2023
Protected Areas	The South African Protected Areas database is available through the Department of Forest, Fisheries, and the Environment website. The data is released quarterly, and we used quarter 1 for 2023. This data was added to show protected areas in the region and was analyzed to show area, date declared, and coverage.	DFFE, 2023
Land use and land cover -rivers -elevation -residential	They were taken from the Department of Rural Development and Land Reform's SASDI portal (South African Spatial Data Infrastructure). We used residential areas, rivers, and elevation in 40 m increments. This data was added to provide context to the study site.	SASDI, 2022
Musina Makhado Special Economic Zone	Co-ordinates of the proposed site were taken from the Environmental Impact Assessment prepared by Delta Consultancies and show where one of the threats facing the Vhembe District is located.	Delta, 2021 p. 116
Key Biodiversity Areas Dataset for South Africa	Key Biodiversity Areas are sites of significance for the global persistence of biodiversity (IUCN, 2016) There is a global standard for identifying KBAs; an area must meet one of the 11 criteria to be listed (see reference for criteria). We used these sites to assess their coverage and whether they are protected.	BirdLife International, 2022
Critical Biodiversity Areas	These areas are identified in the SANBI biodiversity plan and inform decision-making processes on national and local levels regarding which areas are a priority for conservation (SANBI, 2018). These sites were overlayed with protected areas and Key Biodiversity areas to indicate their protection level.	SANBI, 2018

Data Analysis

The mapping process utilized QGIS version 3.28.0 to create the maps. Prior to analysis, all the vector datasets were collected and cleaned before being converted to EPSG: 4148- Hartebeesthoek94 reference coordinate system. While screening, datasets were selected by overlaying the Vhembe District boundary file with the datasets and utilizing the Geoprocessing Tool 'clip.' This method ensured that only the polygons and features within the boundary of the study site were analyzed. These layers were saved as

individual shapefiles with their respective attribute tables. Subsequently, the clipped protected area file was analyzed based on criteria such as date of establishment, coverage, size, and ownership type. The saved KBA and CBA polygons were then overlaid with the protected area layer to identify gaps in the protected area network. The 'clip' tool was used again to generate new polygons depicting KBAs and CBAs that did not overlap with protected areas, facilitating the creation of clear maps illustrating areas needing protection. Furthermore, the 'field calculator' was employed to determine the area of the original and overlayed layers. This allowed for accurate quantification of the size of protected areas, KBAs, and CBAs.

This methodology is intended for policymakers, landowners, and individuals with limited GIS expertise. The data is easily accessible, and the software utilized is freely available. This methodology streamlines the identification of vital unprotected regions, eliminating the need for multiple stages and applying sophisticated tools requiring additional software programs, such as Marxan.

This methodology allowed for the creation of three distinct maps : (1) a map illustrating the Critical Biodiversity Areas within protected areas (*Fig.* 4), (2) a map showcasing where Key Biodiversity Areas are protected (*Fig*. 5), and (3) A map to show where Critical and Key Biodiversity Areas are bereft of protection (*Fig.* 7).

Results

Distribution and Coverage of Protected Areas in South Africa

According to the South African Protected Areas Database 2023, quarter 1, there are 1,643 features, including nature reserves, private nature reserves, sanctuaries, national parks, game reserves, game farms, marine protected areas, and protected environments in South Africa. Of these, there are 1,598 terrestrial protected areas across South Africa's 1.22 million km^2 landscape. The largest protected area, the Kruger National Park, spans an impressive 19,169 km^2. Consequently, the aggregate area designated as protected in South Africa amounts to 144,567 square kilometers,

surpassing the combined territorial extents of Belgium, the Netherlands, and Sri Lanka combined. Therefore, only 11.6% of South Africa's terrestrial landscape is formally protected. While protected areas are expanding, this expansion is entrenched in traditional paradigms characterized by fragmented reserves across the country (*Fig.* 1).

Regional Assessment of the Vhembe District

The Vhembe District spans an area of 25,596 km^2. There are 68 protected areas in the region, of which only 22 hold national designation, while the remaining 46 are under private ownership. These protected areas cover an impressive 9,811 km^2, equivalent to 38% of the landscape (Table 2). The two most extensive protected areas- Mapungubwe National Park and the Kruger National Park- account for 69.7% of the protected area network, with areas of 2,630 km^2 and 4,210 km^2, respectively.

Table 2: Tabulated outcomes of GIS overlays showing protected and unprotected CBAs and KBAs.

Layer	Area formally protected (km^2)	Percentage formally protected	No. of PAs covering sites	Area unprotected (km^2)	Percentage unprotected	**Total area (km^2)**
CBAs:						
CBA 1	1875	35%	49	3428	65%	**5303**
CBA 2	781	19%	44	3381	81%	**4162**
Combined CBA	2656	28%		6,809	72%	**9465**
KBAs:						
Kruger National Park KBA	4210	100%	1	0	0,00%	**4210**
Mapungubwe National Park	302	100%	1	0	0,00%	**302**
Soutpansberg KBA	620	16%	16	3,273	84%	**3893**
KBA total	5132	61%		3,273	39%	**8405**

An interesting historical trend emerges from the data as 38 of the protected areas were initially designated during the 1960s, albeit collectively occupying a relatively modest total area of slightly over 800 km^2 (*Fig*. 3). The largest cumulative area was in the 1920s, primarily attributed to the establishment of the Kruger National Park, the sole protected area declared during that period measuring at 4,210 km^2. Additionally, there has been minimal growth in the following decades, with only one protected area declared in the last three years (*Fig.* 3).

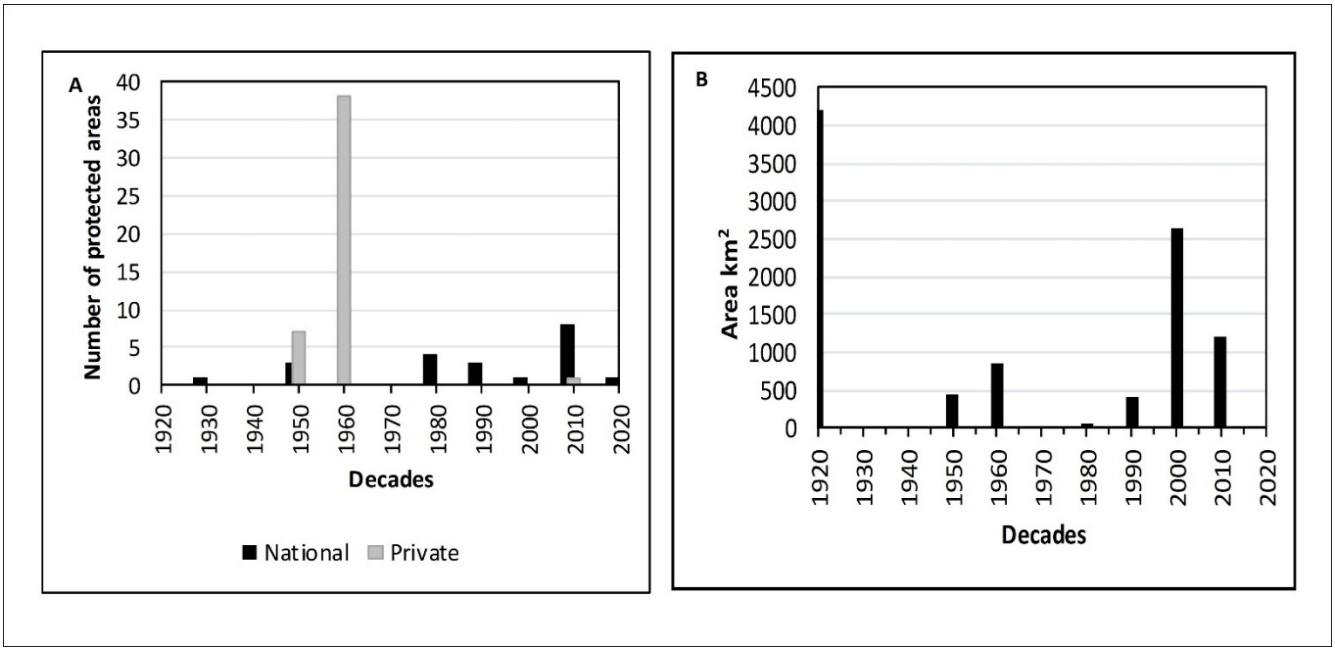


Figure 3: A. Vhembe District protected area declaration dates per decade by ownership type. B. Area in km^2 of declared protected areas per decade. Data from the South African Protected Area database Quarter 1 of 2022.

Focusing on the sites in the region, Critical Biodiversity Area Category 1 covers 20.7% of the Vhembe landscape, equivalent to 5,303 km^2 (Table 2). Additionally, CBA Category 2 covers 16% of the landscape, amounting to 4,162 km^2. The combined extent of Critical Biodiversity Areas from both categories totals 9 465 km^2, representing nearly 40% of the Vhembe District, thus constituting a substantial area for biodiversity conservation. Additionally, Key Biodiversity Areas cover 32% of the district, equivalent to 8,405 km^2

(Table 2). The amalgamation of both KBAs and CBAs results in comprehensive coverage of 17,866 km^2 identified as essential for conservation.

Ecological Representation in the Protected Area Estate

Three maps were generated (refer to Fig. 4, Fig. 5, Fig. 7) to determine the ecological representation and coverage of the protected areas in Vhembe. These maps were developed by overlaying the protected area layer with the Critical Biodiversity Areas (CBAs) and Key Biodiversity Areas (KBAs) layers. This approach facilitated a visual and numerical examination of the current protected area network coverage and the extent of coverage.

Protected Areas and Critical Biodiversity Areas.

Critical Biodiversity Areas run throughout the Vhembe District. The elevation of CBA 1 and 2 ranges between 200 and 1740 meters above sea level (masl). The average elevation of CBAs in the Vhembe District is 762 masl. An analysis of the intersection between protected areas and Critical Biodiversity Areas 1 and 2 was generated, and the results were visually represented in Figure 4. Results show that 1,875 km^2 of CBA Category 1 is protected by 49 protected areas (Table 2). This means that only 35% of this site is protected, resulting in only partial protection (Table 2). Forty-four protected areas protect CBA 2, yet only 781 km^2, or 19% of the landscape, is protected, meaning CBA 2 is poorly protected (*Fig.* 4).

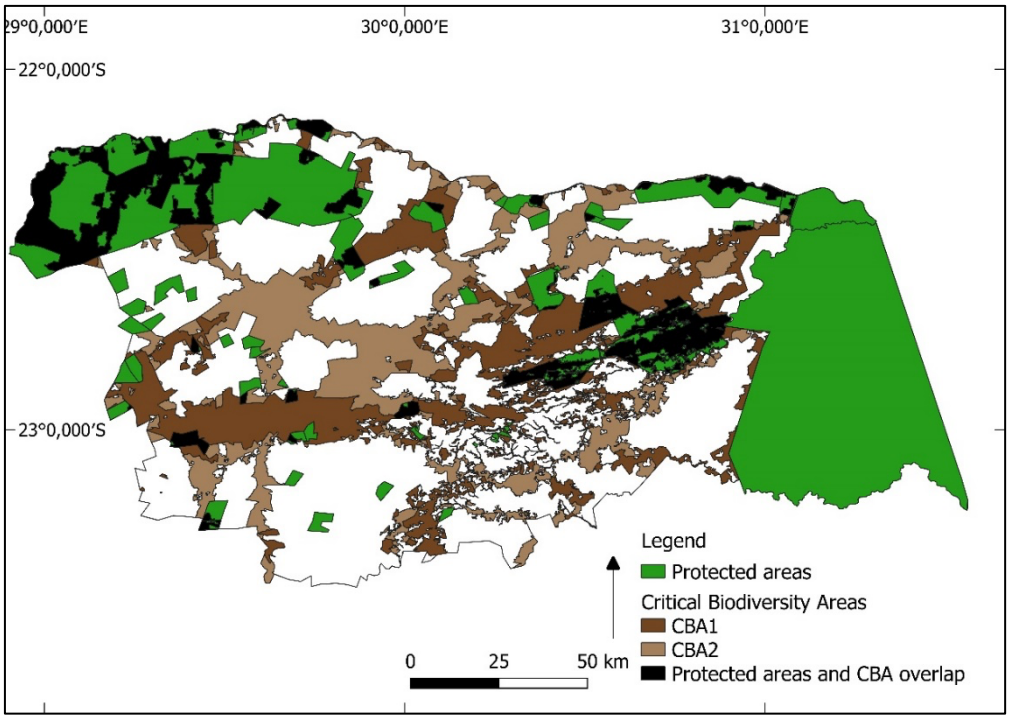


Figure 4: Intersection between protected areas and Critical Biodiversity Areas. CBA Category 1 is only partially protected by 49 protected areas, and only 44 cover CBA 2. Map generated using QGIS version 3.28.0.

Protected Areas and Key Biodiversity Areas

A second map illustrates where the Key Biodiversity Areas are protected by the existing protected area network (*Fig*. 5). There are three identified KBA sites in the regions: The Kruger Nation Park KBA, the Mapungubwe National Park KBA, and the Soutpansberg KBA. The KBAs in the Vhembe District have varying topographies. The relief of the Kruger National Park KBA varies from flat plains to hills, with elevation ranging between 200 to 500 masl. The Mapungubwe National Park KBA elevation ranges from 500 to 600 masl, and the highest point of the Soutpansberg KBA is 1740 masl. Impressively, 61% of the combined area of these three KBAs is protected (Table 2). In fact, the Kruger and Mapungubwe KBA are entirely protected by their respective parks (*Fig*. 5). However, the Soutpansberg KBA, encompassing an area of 3,893 km^2, experiences sub-optimal protection, with only 16% of its extent covered by 16 protected areas (*Fig*. 5). Substantial portions of the Soutpansberg KBA remain unprotected.

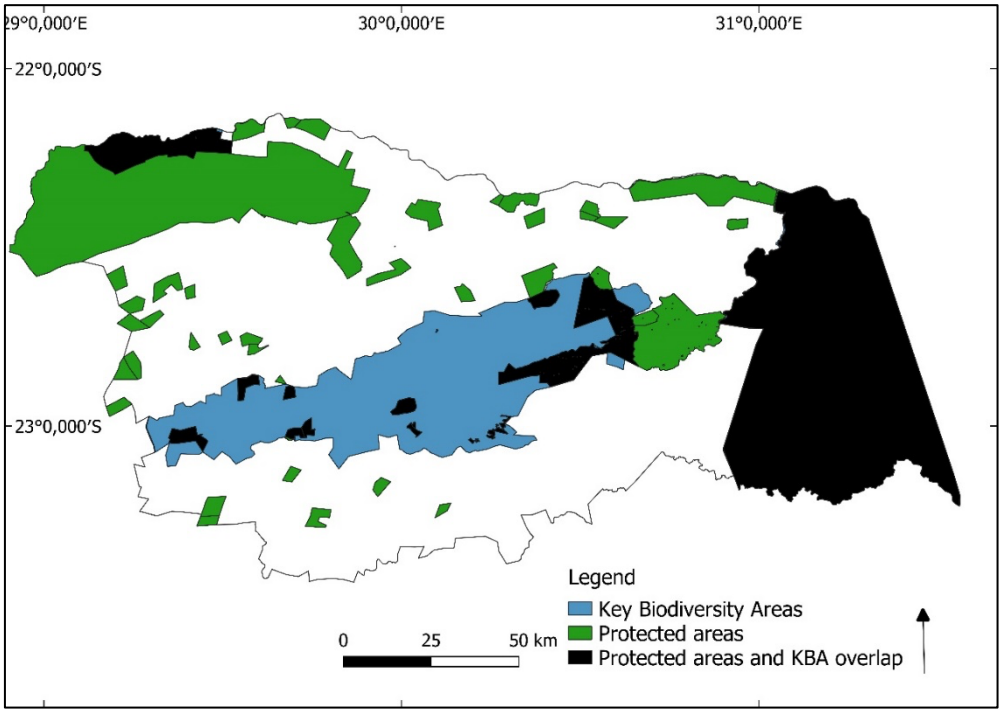


Figure 5: Intersection between the protected areas and Key Biodiversity Areas. Their respective protected areas completely protect the Kruger National Park and Mapungubwe National Park KBAs. Soutpansberg KBA is partially protected by 16 protected areas. Map created using QGIS version 3.28.0.

Gaps in Protected Area Coverage

In total, 7,788 km^2 of KBAs and CBAs benefit from formal protection (Table 2 and *Fig.* 6 and *Fig*. 7). Yet over 10,000 km^2 of combined CBAs and KBAs remain unprotected (Table 2 and *Fig*. 6), rendering these areas susceptible to development pressure and potential impacts from the MMSEZ.

The substantial contribution of the Mapungubwe National Park and the Kruger National Park to protecting KBAs in the region is unmistakable. Omitting these parks would result in a drop in KBA protection, and the overall protected area coverage in the Vhembe District would diminish from 38% to only 11%.

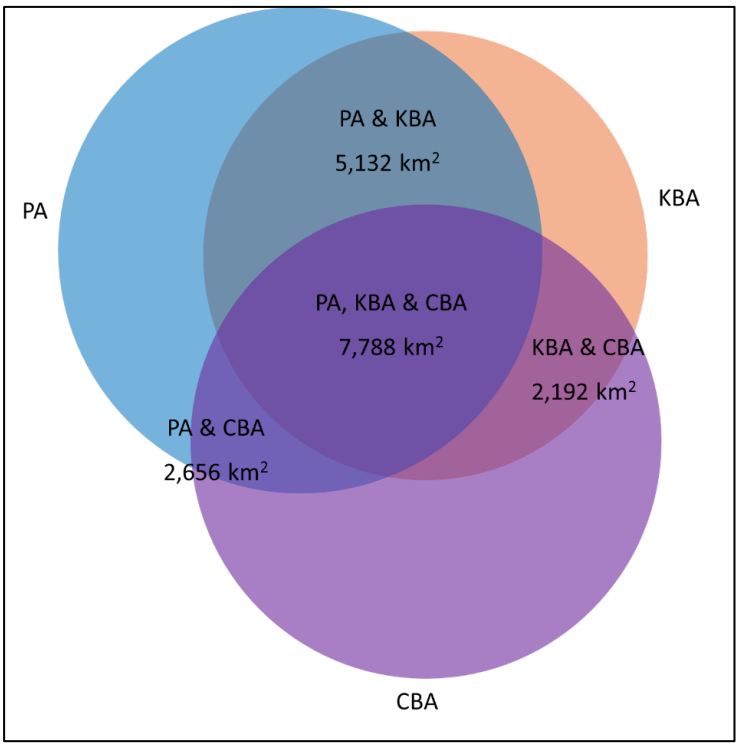


Figure 6: Proportional Venn diagram illustrating the spatial distribution of protected areas (PA), KBAs, and CBAs. The protected areas in the Vhembe District encompass a total area of 9,811 km², whereas KBAs and CBAs cover 8,405 km² and 9,465 km², respectively, as depicted by circle sizes. The extent of the overlap reflects relative area coverage.

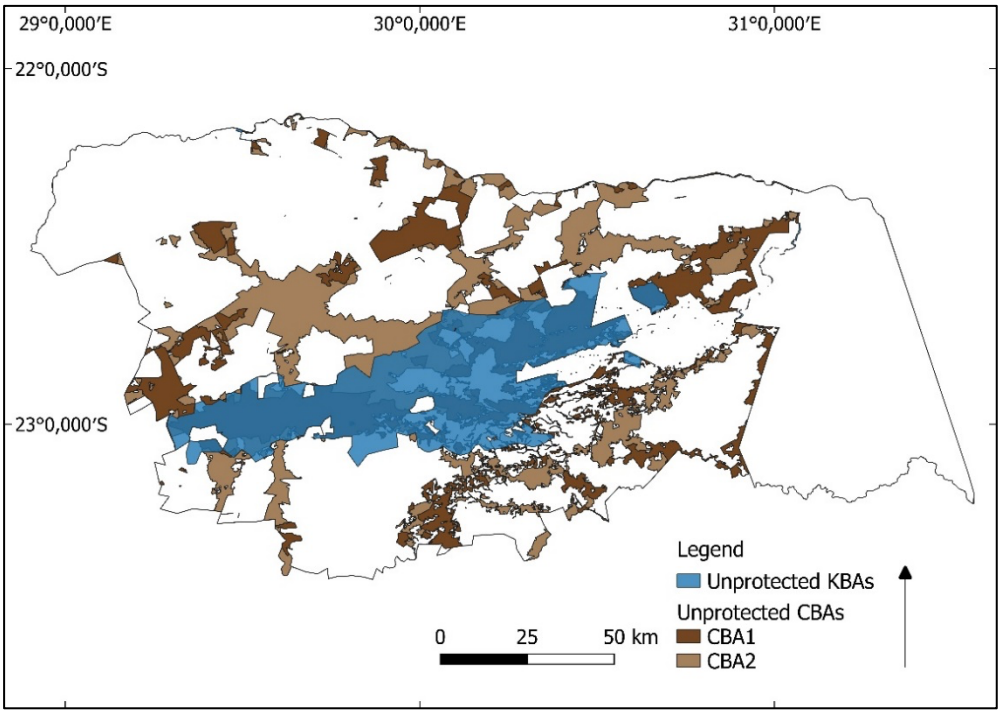


Figure 7: Critical and Key Biodiversity Areas that do not fall under the coverage of protected areas. Map created using QGIS version 3.28.0.

Discussion

South Africa's National Protected Area Expansion Strategy (NPAES) of 2016 reiterates the ambit of the CBD's global targets. NPAES aimed for an estate covering 202,604 km^2, constituting approximately 16% of South Africa. However, recent global targets suggest this figure should be higher. Our results show that the total area of the protected areas in South Africa is presently 141,616 km^2. Therefore, only 11.6% of South Africa's terrestrial landscape is formally protected, which is two percent higher than the figure presented by King et al. (2023). Our results align with the StatsSA (2021) figures, stating that the protected area coverage 2021 was 11%, a 2% increase from the findings reported in 2020 (StatsSA, 2021). To meet global targets, the growth and expansion of protected areas must persist. To facilitate this, the NPAES from 2016 must be updated by increasing its overall national targets, delineating province-specific protected areas' targets, and encouraging more relevant solutions.

Protected Areas in the Vhembe District

The slow growth of protected areas is noteworthy, as only ten protected areas have been declared in the last 12 years since 2011 (*Fig.* 3). Establishing protected areas in South Africa has always varied, often influenced by changing political landscapes. An Age of Environmentalism was ushered in in the 1960s, during which protected areas gained popularity globally (Carruthers, 2017). In South Africa, protected areas have successfully saved species from extinction. In the late 1950s and early 1960s, the National Parks Board (NPB) recognized the significance of protected areas, leading to a substantial budget increase from R300 000 in 1952 to R3 million in 1966 (Carruthers, 2008; Carruthers, 2017). With the acknowledgment of the scientific value of protected areas and financial backing, the establishment of protected areas in South Africa drastically increased in the 1960s (Carruthers, 2008). This trend is illustrated in Figure 3, where 55% of the protected areas in the Vhembe District were declared in the 1960s, all privately owned. While Mapungubwe and the Kruger National Park significantly contribute towards conservation in the Vhembe District, the role of the 46 private protected areas cannot be overlooked.

The Vhembe District is rich in biodiversity. However, the protected areas in the region only protect 9,811 km^2 or 38% of the landscape. Excluding the Kruger National Park and Mapungubwe National Park would reduce the protected areas' coverage to a mere 11% of the landscape, highlighting the pressing need for protected area expansion. Already in 2013, the Limpopo Conservation Plan found that most vegetation types were poorly protected. The protected area estate covered 13,670 km^2 of Limpopo, and the report stated that an additional area of 11,556 km^2 is needed to meet biodiversity targets in Limpopo (Desmet *et al.*, 2013). Contrastingly, our research shows that 10,121 km^2 of unprotected landscapes require conservation interventions in the Vhembe District alone.

The 2017 Vhembe Bioregional Plan, operating within an advisory capacity, sought to facilitate the safeguarding of biodiversity within biodiversity-priority areas, as identified in the 2013 Limpopo Conservation Plan (Desmet *et al.,* 2013). However, its recommendations lack enforceability. Evaluating land cover change in the Vhembe Biosphere Reserve, Evans (2017) focused on proposed core areas to determine which vegetation types are protected. While these studies provide insight into the previous policies, current network, and land cover changes, they fail to evaluate the complete protected area network in Vhembe. Such an assessment should encompass Key and Critical Biodiversity Areas, including their distribution, status, and coverage.

While only 38% of the Vhembe District is formally protected, nearly 7% of national protected area coverage originates from Vhembe, which occupies 2% of South Africa's landmass. Incorporating the additional 10,121 km^2 identified in this study would elevate Vhembe's total protected area estate to around 20,000 km^2, doubling the district's national contribution from 7% to 14%.

Key and Critical Biodiversity Areas

Key Biodiversity Areas (KBAs) have served as valuable tools in previous studies to identify gaps in protected area coverage (Ambal *et al*., 2012; Eken *et al.,* 2004; Kullberg *et al.,* 2019; Roberto *et al*., 2017). The UN Sustainable Development Goals use KBAs as indicators for goals 14 and 15. Donald *et al.* (2019) found that protected areas cover 63% of KBAs in South Africa. Our findings at a smaller scale align closely, indicating that 61% of KBAs are formally protected in Vhembe (Table 2). While KBAs have relatively high coverage provided by protected areas, only 28% of Critical Biodiversity Areas (CBAs) are protected. This disparity could be attributed to two reasons. Firstly, the combined area of CBAs surpasses that of KBAs by over 1,000 km^2. Therefore, the protected area network may protect fewer CBAs due to the larger expanse. Secondly, the Kruger National Park (KNP) is classified as a KBA but lacks a CBA designation. If the KNP, measuring 4,210 km^2 in Vhembe, were listed as a CBA, the percentage of protected CBAs would increase substantially from 28% to 72%.

Over 10,000 km^2 of unique biodiversity remains vulnerable to modification (Table 2). The establishment of protected areas in Vhembe is characterized as sluggish, which is evident because, since 2000, only 11 new protected areas have been designated. Establishing protected areas focusing on KBAs and CBAs has been entirely inadequate. Over 24 years, merely six protected areas encompassed the Soutpansberg KBA, ten covered CBA 1, and nine covered CBA 2. While it cannot be conclusively stated that these reserves were explicitly designated for these sites, it is evident that a fundamental change is necessary to rectify this deficiency.

The KBAs within the Vhembe District were initially identified using earlier versions of KBA criteria. Currently, there is an ongoing process to comprehensively apply the Global Standard, which will significantly revise the network of KBAs in South Africa. The updated KBA database and its coverage of protected areas need to be incorporated into South Africa's revised National Biodiversity Strategy and Action Plan.

Potential for Landscape Initiatives

South Africa’s protected area policies, including the National Protected Area Expansion Strategy (NPAES), align partially with the Global Biodiversity Framework by loosely advocating for establishing corridors and networks to expand the conservation estate. Conservation corridors and ecological networks play a crucial role in maintaining species spatial-temporal connectivity, promoting gene flow, and reducing demographic stochasticity and inbreeding (Beier, 2018; Hudgens & Haddad, 2003; Roever *et al*., 2013). While corridors are contiguous areas of relatively natural land that connect protected areas, ecological networks are large strips of natural habitat that include various protected areas and conservation corridors (Pryke & Samways, 2012).

These show potential, especially in Africa (Battisti, 2023; Hilty *et al.,* 2020) and South Africa (Pryke & Samways, 2012; Theron *et al.,* 2022; van Schalkwyk *et al.,* 2023). Landscape initiatives present an opportunity in regions where numerous protected areas are established, but critical sites remain unprotected. Connecting existing protected areas through corridors and networks may be more feasible than

establishing entirely new protected areas, particularly in light of the recent stagnation in protected areas (*Fig*. 3). There are currently no corridors or ecological networks in Vhembe, with over 50% of KBAs and CBAs remaining vulnerable. Therefore, Vhembe District presents an opportune setting for establishing conservation corridors and networks to connect protected areas. Notably, there is a convergence between unprotected CBAs and KBAs along the Soutpansberg, where 2,192 km^2 of unprotected CBAs fall within the unprotected KBA belt (*Fig*. 7). Prioritizing conservation efforts within this area would significantly increase the protection of essential ecoregions. However, it is crucial to consider that the area is primarily rural and is highly populated with developments, including towns and roads (*Fig*. 2). Any landscape initiatives must be carefully considered to not only protect important sites of biodiversity but also consider the socio-economic activities and factors in the area.

Conclusion

Several global, national, and provincial goals and targets exist to expand the network of protected area estates. The Global Biodiversity Framework delineated ambitious targets intending to achieve 30% terrestrial protection worldwide by 2030. Equally, South Africa has articulated its national commitment through the National Protected Areas Expansion Strategy, aiming to safeguard 16% of the country within a 20-year timeframe. Within Limpopo, provincial targets prescribe an additional 11,619 km^2 of protection measures.

Assessing the Vhembe District was a case study to evaluate the existing protected area network. Regarded as a critical component, the study sought to discern the district's contribution to South African conservation targets and identify areas where key and critical biodiversity areas lack protection. The investigation posits that channeling conservation efforts toward the Soutpansberg region holds significant potential for enhancing the protection of Critical Biodiversity Areas (CBAs) and Key Biodiversity Areas (KBAs).

Delineating an urgent need, the results underscore an immediate imperative for intensified protection of the region's KBAs and CBAs, given that a substantial expanse exceeding 10,000 km^2 of indispensable landscapes remains unprotected and necessitates conservation intervention. Against the backdrop of global and local targets influencing South Africa’s conservation planning, policies must move beyond merely paying lip service to ideas and instead enact tangible measures. Leveraging a proactive approach, the study advocates aligning policies with practical implementations to address the pressing conservation concerns.

CHAPTER 5: COMMUNITY PERCEPTIONS AND SOCIO-ECONOMIC IMPLICATIONS OF CONSERVATION CORRIDORS AND NETWORKS IN THE VHEMBE DISTRICT, LIMPOPO, SOUTH AFRICA

5.1 Brief Synopsis

Chapter 4 identified the Vhembe District as an ideal site for landscape initiatives. This chapter explores community perceptions of conservation efforts and the socio-economic potential of corridors and networks in the Vhembe District. The results revealed strong community support for corridor implementation, driven by the anticipated socio-economic benefits. In assessing community perceptions, the study identified several challenges to corridor establishment. These included infrastructure and financial constraints, concerns over protected areas' accessibility, and a lack of supporting policies and legislation, previously identified in Chapter 3. This cross-disciplinary chapter explores conservation measures and interconnected social factors, providing invaluable insights into the global discourse on corridors and the importance of community engagement. The field data obtained for this paper is in Appendix C.

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Community Perceptions and Socio-Economic Implications of Conservation Corridors and Networks in the Vhembe District, Limpopo, South Africa

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Abstract

Social facets linked to conservation corridors and ecological networks have received relatively limited attention. This study explores community perceptions of conservation efforts and corridor potential in the Vhembe District, Limpopo, South Africa. Surveys and interviews were conducted with communities, regional stakeholders, and landowners. The findings revealed strong community support for corridor implementation, driven by the anticipated socio-economic benefits. However, the employment opportunities might not align with the residents' expectations. The study identifies several challenges to corridor establishment, including infrastructure and financial constraints. Moreover, the findings revealed a lack of supportive legislation and highlighted concerns over protected areas' accessibility. This cross-disciplinary inquiry explores conservation measures and interconnected social factors. The study provides invaluable insights into the global discourse on corridors and the importance of community engagement. The significance of this study transcends its regional context while offering actionable insights applicable worldwide.

Keywords: community engagement; conservation corridors; ecological networks; protected areas

1. Introduction

Conservation corridors and ecological networks are among the most popular strategies for biodiversity conservation as habitat fragmentation and biodiversity loss continue to increase. Research consistently underscores the beneficial impact of increased habitat connectivity facilitated by corridors on species conservation and ecological functions (Battisti, 2023; Bennett & Mulongay, 2006; Crooks & Sanjayan, 2006; Haddad *et al.,* 2014; Hanski & Ovaskainen, 2000; Hilty *et al.,* 2019; Hilty *et al.,* 2020; Joubert van der Merwe *et al.,* 2019). Additionally, realizing a corridor's potential to connect and benefit surrounding communities is contingent upon thorough community involvement (Goldman, 2009; Kikoti *et al*., 2010; Townsend & Masters, 2015). Active participation in public hearings, community projects, development planning, NGO engagement (Bennett, 2004), and community consensus is imperative to ensure the corridors or networks' feasibility and guarantee the fulfillment of environmental and local needs (Rosenthal *et al.,* 2012).

Global examples underscore the importance of community engagement in conservation initiatives (Adhikari *et al.,* 2007; Hemp & Hemp, 2018; Kikoti *et al.,* 2010; Mbane *et al.,* 2019; Townsend & Masters, 2007). For instance, in the Terai Arc landscape of Nepal, the utilization of community forests as an implementation instrument allowed the community to use the land, control some of the forested areas, and foster a sense of ownership. At the same time, environmental goals were achieved (Adhikari *et al.,* 2007). Community engagement mitigated conflict and enhanced forest management and environmental conditions (Birch *et al*., 2014). However, the sustained success of such initiatives hinges upon ongoing community involvement, as exemplified by the cautionary example of the Kitenden corridor in the Kilimanjaro region of Kenya (see Hemp & Hemp, 2018; Kikoti *et al.,* 2010). Despite initial local support, the corridor's integrity was jeopardized over time due to land use tenure changes and encroachment,

leading to heightened human-wildlife conflicts (Hemp & Hemp, 2018; Mbane *et al.,* 2019).

Community engagement emerges as a linchpin in the efficacy of conservation corridors and networks, fostering a sense of collective responsibility and stewardship among locals (Kikoti *et al.,* 2010; Townsend & Masters, 2007). By actively involving communities, a harmonious coexistence between anthropogenic activities and environmental conservation goals can be achieved (Lombard *et al.,* 2010).

Dalziel and Evans (2024) noted a deficiency in the protected area estate of the Vhembe District in Limpopo Province, South Africa. Over 10,000 km^2 of essential Key Biodiversity Areas remain unprotected. The authors recommend establishing corridors and networks in the region to increase the coverage of essential ecosystems. However, comprehensive assessments of communities' land use, expected benefits, and conservation perceptions are imperative before introducing landscape initiatives.

Taking the Vhembe District in Limpopo, South Africa, as an illustrative case study, we conducted a preliminary screening phase. We used local surveys to understand the community's attitudes toward landscape initiatives and uncover their anticipated benefits. Interviews with local stakeholders highlighted corridor and network implementation issues and optimal establishment criteria for successful implementation. This comprehensive approach identified landscape initiatives' potential social benefits, drawbacks, and applicability. These findings exceed the regional context, as community engagement is framed as a critical factor when establishing corridors.

2. Methods

2.1 Study Area

The study was conducted in the Vhembe District located in the Limpopo province in South Africa (22° 46’ 10” S, 29° 58’ 26” E *Fig.* 1). Encompassing an area of 25, 596 km^2, the Vhembe District stands as the most densely populated among the districts in Limpopo, housing approximately 24.3% of the provincial population (Limpopo Provincial Government, 2023). The latest estimates put the population of the Vhembe District at around 1.4 million people (Limpopo Provincial Government, 2023). Predominant economic activities include mining, retail, finance, and community services. The district has a high unemployment rate of 43%. A sizable portion of its inhabitants live in poverty, as 51% of the population falls in the Upper-Bound Poverty Line (UBPL) (Limpopo Provincial Government, 2023). The UBPL refers to the food poverty line, and individuals living on around ZAR 1 335 per month, or just over $2 a day, fall within this poverty line and can purchase adequate food and non-food items.

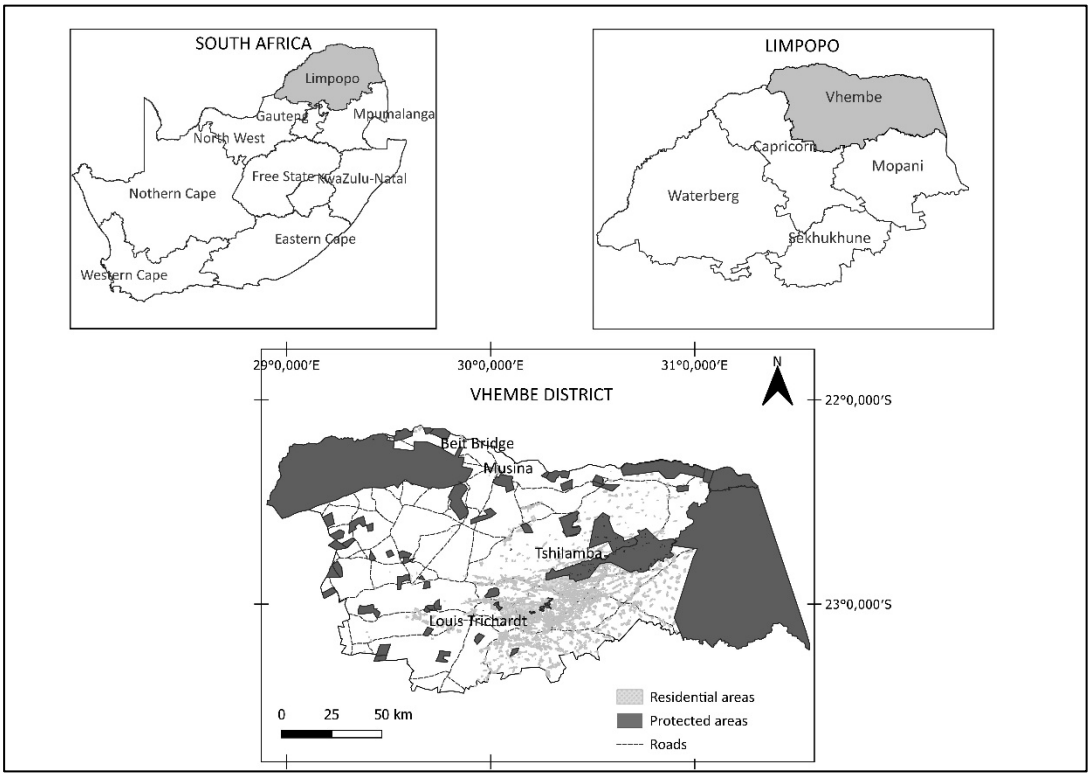


Figure 1: Map of the Vhembe District in the northern part of Limpopo, South Africa. It illustrates the location of the major urban centers, road networks, and the dispersion of the protected areas.

The Vhembe District contains 68 protected areas, including two major protected areas, the Kruger National Park and Mapungubwe National Park, a UNESCO-declared World Heritage Site (*Fig*. 1). Encompassing an impressive 38% of the district's landmass, these protected areas collectively contribute to 7% of South Africa's national protected area estate (Dalziel & Evans, 2024). The Soutpansberg Mountain range runs through the district and is a center of endemism in South Africa. This region is the habitat for 22 endemic taxa (Hahn, 2019). Nevertheless, large sections of Key Biodiversity Areas (KBAs) are unprotected in the region (Dalziel & Evans, 2024). KBAs are "sites of significance for the global persistence of biodiversity" (IUCN, 2016, pg. 8). Only half of the world's KBA sites are protected (Kullberg *et al.,* 2019).

2.2 Research Method

To understand the perceptions of the local community and stakeholders regarding landscape initiatives and conservation efforts in the region, we employed methodological triangulation, which uses multiple methods to maximize the validity of fieldwork (Denzin, 1970). Our study adopted a mixed-method approach, which entailed interviews with researchers contributing to new landscape methods and critical stakeholders. Additionally, representatives from conservation organizations such as SANParks, PeaceParks, African Parks, Boundless South Africa, and landowners were interviewed. Furthermore, to capture the sentiments and viewpoints of the community, we administered and collected surveys.

The University's Ethics Committee (non-medical) granted ethics clearance, and the ethics clearance number for the study is H21/04/07. The committee ruled the study low-risk as we did not approach anyone in the vulnerable category or under 18 years old.

2.2.1 Interviews

We conducted interviews with various stakeholders, totaling 15 participants, including academics and researchers (*n*=5), NGO representatives (*n*=7), and landowners (*n*=3), leveraging pre-established connections within the target population. We used open-

ended, semi-structured interviews with critical thematic points pertaining to conservation practices and essential considerations preceding implementing landscape initiatives. Questions specifically focused on the potential and applicability of landscape initiatives in South Africa and the Vhembe District. Interviews were conducted telephonically or over Microsoft Teams sessions between March and August 2022. We then transcribed the interviews using a thematic analysis approach.

2.2.2 Surveys

We also distributed surveys to community members in the Vhembe District. The district's population is 1,402,779 individuals, with 748 128 falling within the age bracket of 18 to 60. A representative sample of 384 participants was calculated from this population, ensuring a 5% margin of error and a 95% confidence level. Data were collected between June and August 2023. Community members were approached using simple random sampling, where individuals are selected to ensure each person has an equal chance of selection (Noor *et al.,* 2022). Residents assisted in translating and explaining the survey questions as we distributed them throughout developed towns and rural areas, including Louis Trichardt, Khubvi, and Thohoyandou, to ensure an accurate and diverse sample. Depending on their understanding of the questions, participants filled in the forms themselves or were assisted by the research team.

Data collection stopped after reaching the predetermined sample size. The survey encompassed inquiries about land use, comprehension of conservation concepts, visitation frequency to the area's nature reserves, perceptions regarding the potential benefits of linking such reserves, and anticipated advantages thereof.

3. Results

3.1 Benefits of Landscape Initiatives and Their Potential in the Vhembe District

Among the 15 participants, including landowners, researchers, and NGO representatives, 73% felt that traditional protected areas were no longer effective in mitigating habitat fragmentation and biodiversity loss at present rates. Their

dissatisfaction stems from various shortcomings of these conventional methods. Landowners felt protected areas had limited coverage and decreased species migration (Table 1). Researchers and NGO representatives added to this and felt that protected areas isolated populations and contributed to landscape fragmentation (Table 1). Moreover, 80% of participants advocated for an alternative approach of connecting protected areas as a more viable solution to mitigate fragmentation and biodiversity loss. Stakeholders notably endorsed this strategy's potential applicability in South Africa. This sentiment was attributed to the plethora of benefits associated with corridors and networks, including increasing migration and protected area coverage, providing resilience to existing protected areas, and effectively protecting vulnerable species and ecosystems (Table 1).

Table 1: Participant perspectives on reasons for protected area ineffectiveness and landscape initiative effectiveness. Participants were allowed to select multiple answers.

Participant type	**Number of responses (*n*= 11)**	**Reasons for protected area ineffectiveness.**	**Number of responses (*n*= 12)**	**Reasons for Landscape Initiative Effectiveness**
Landowners	2	Inadequate coverage (2), limited species migration (1)	2	Increase in protected area coverage (1), increased migration (2)
Researchers	4	Inadequate coverage (3), limited species migration (3), isolating genetic populations (4)	4	Increase in protected area coverage (3), increased migration (4), genetic mixing (4), provide resilience to ecosystems and species (1)
NGO representatives	5	Inadequate coverage (2), limited species migration (5), isolating genetic	6	Increase in protected area coverage (5), increased migration

		populations (3), furthering the fragmentation of landscapes (1)		(4), genetic mixing (3)

Most participants (80%) were ‘very familiar’ with the Vhembe District, and 83% believed a corridor or network would benefit the area. This sentiment was motivated by the area’s geography, characterized by large strips of undeveloped land deemed ideal for a corridor. Furthermore, three participants noted the potential socio-economic advantages, such as job creation, that could benefit the local community through conservation corridors or networks.

3.2 Factors Hindering Corridor and Network Implementation.

Interviews suggested a preference for landscape initiatives and their potential benefits for South Africa and the Vhembe District. Considering specific factors is essential before implementing corridors and networks. Foremost is land ownership. When asked if private and national protected areas should be linked, 60% of participants said no and cited jurisdiction issues as a hindrance, as land rights would be questioned.

Results underscore additional potential obstacles associated with landscape initiatives and the expansion of protected areas (*Fig.* 2). Infrastructure, in the form of roads or ongoing developments and human settlements, land rights, funding, and political will emerged as recurring themes (*Fig.* 2).

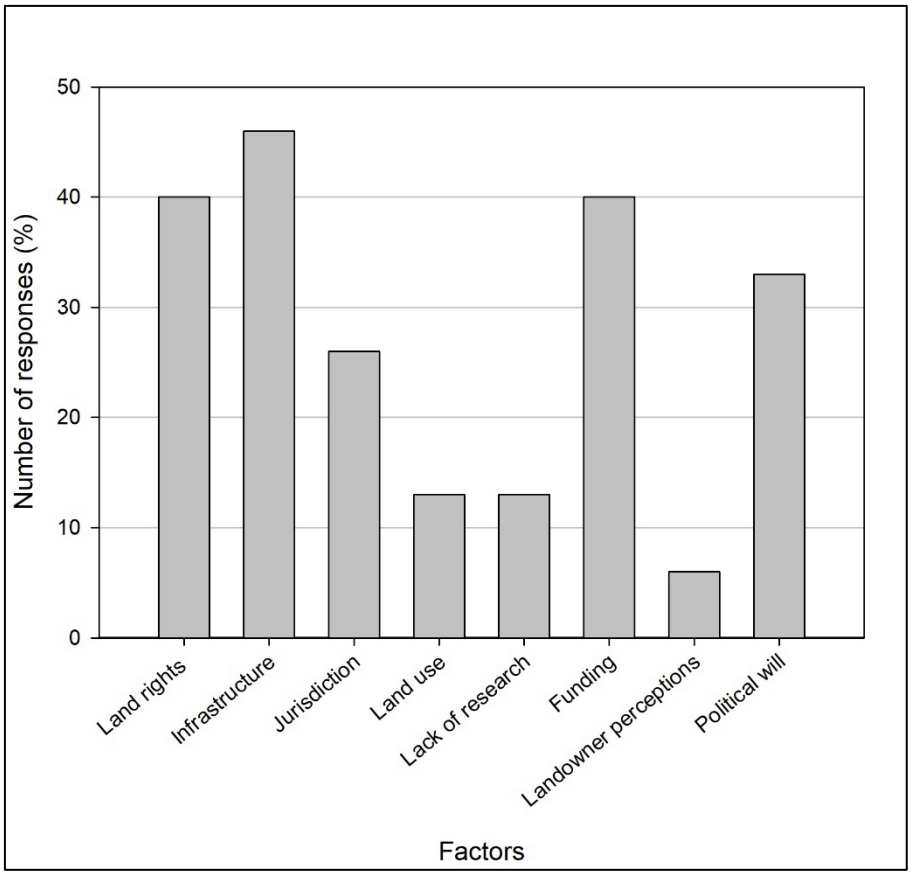


Figure 2: Factors hindering protected area expansion and corridor and network implementation. Findings were derived from interviews (*n* = 15).

Moreover, corridors and networks must meet specific physical parameters to conserve and capture vulnerable ecosystems effectively. The first parameter involves the optimal width of the corridor, a topic often debated in conservation corridor literature (Andreassen *et al.,* 1996; Beier, 2018; Ford *et al.,* 2020; van Schalkwyk *et al.,* 2020). Over 30% of participants advocated for corridors wider than two kilometers (Table 2). In contrast, only 13% deemed corridors with widths between 50 and 300 meters ideal—a sentiment shared between a landowner and a researcher (Table 2).

The second important parameter concerns the optimal number of protected areas included within a network. Results show that 46% of participants assert that for ideal, comprehensive conservation, networks should incorporate more than four protected areas, a belief unanimously shared across all stakeholders (Table 2).

Table 2: Interview responses regarding the optimal corridor width and the preferred number of protected areas in ecological networks (*n* = 15).

Parameters	**Interval**	**Stakeholder type**	**Percentage (%)**
Width	50 m- 100 m	Researcher	6.6%
	100 m-300 m	Landowner	6.6%
	300 m-500 m	NGO	20%
	500 m to 1 km	Researcher, landowner	13.3%
	1 km to 2 km	Landowner, Researcher, NGO	20%
	Over 2 km	NGO, Researcher	33.3%
Number of protected areas	1-2	Landowner, Researcher	20%
	2-3	Researcher	13.3%
	3-4	NGO	20%
	More than 4	Landowner, NGO, researcher	46.6%

These findings show a preference for wider corridors and networks with multiple protected areas. However, as one participant stated:

> *"It is very difficult to say exactly what the optimal corridor and network layout should be as landscapes vary. Of course, you want wide corridors and your networks to include as many protected areas as possible, but this is not always possible. What works in one area may not work in another".* (Pers. Comm, 2023a, researcher).

3.3 Community Demographics and Land Use

In addition to conducting stakeholder interviews, 384 surveys were distributed to local community members living in the Vhembe District to gauge their perceptions of conservation and corridors. Most participants, 46%, were between 18 and 30 years old, with the second highest percentage (26%) falling between the 31- and 40-year-old age bracket (*Fig* 3). Most participants (56%) had finished high school as their

highest level of education, with 25% holding a diploma. The occupation distribution revealed that 27% of participants were students, and 25% were unemployed (*Fig* 3).

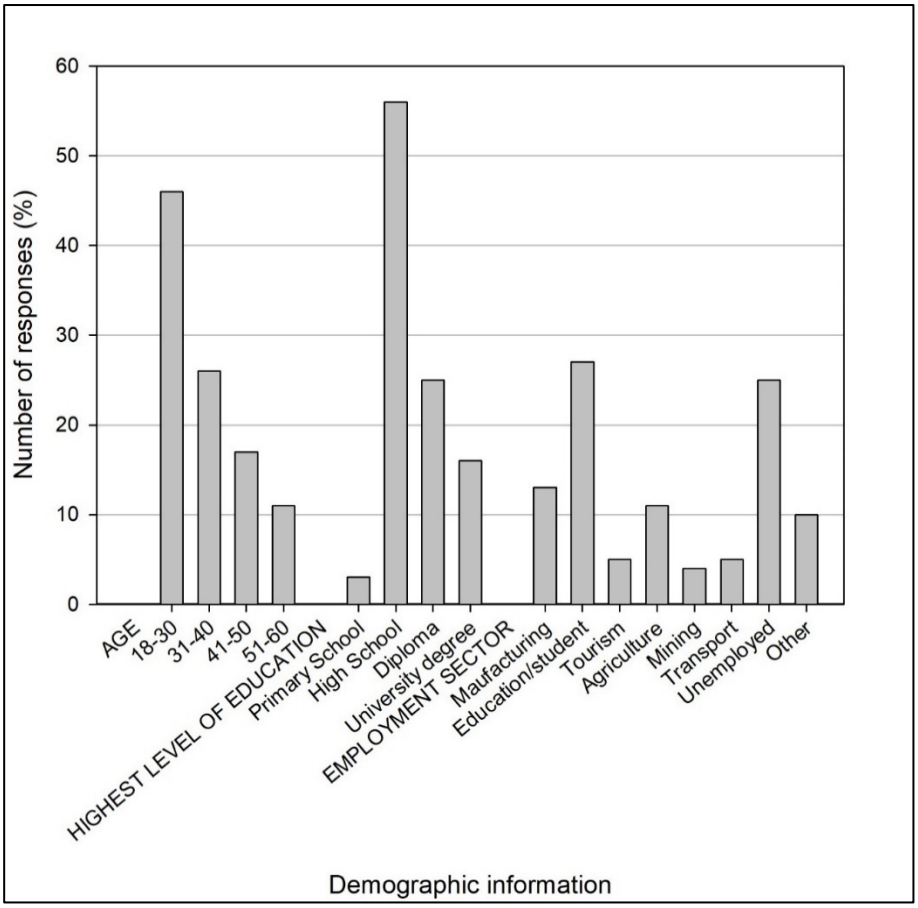


Figure 3: Demographic information including age, highest education level, and employment sector obtained from surveys (*n* = 384).

Inquiries into land use activities were made among locals to ascertain the range of activities conducted in the area. Most participants (87%) selected one or more activities listed (*Fig.* 4). The top four responses included (1) visiting nature reserves (51%), (2) collecting wood from the bush/veld (37%), (3) farming (28%), and (4) collecting water from rivers (23%) (*Fig*. 4). Merely 13% of participants stated they did not engage in any of the listed activities (*Fig*. 4). However, we contend that living in an area constitutes a form of land use, as it involves occupying space.

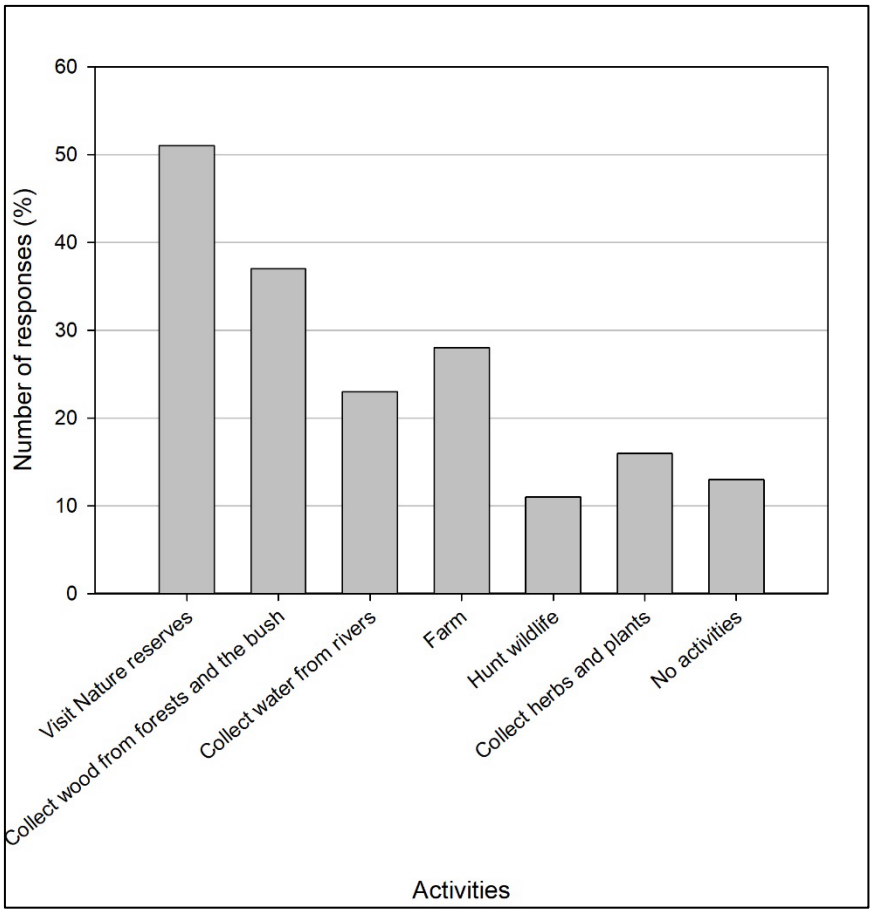


Figure 4: Land use activities in the Vhembe District according to 384 participants.

3.4 Community Perceptions of Conservation and Protected Areas

Determining the community's understanding of conservation is paramount as this may impact their perceptions of conservation methods. When provided with four different meanings of conservation, 40% of the participants selected conservation as "protecting plants and animals." In contrast, only 16% of participants believed that conservation means "isolating land for the exclusive use of plants and animals" (*Fig*. 5). The Vhembe community views conservation as a form of protection, not a tool to isolate land. Ideas of isolation and accessibility of protected areas are significant to the community, as 85% of participants believe that nature reserves must be accessible to the local community. Additionally, 89% of participants believe that nature reserves

can develop communities, improve infrastructure, attract tourists, generate employment opportunities, and alleviate poverty.

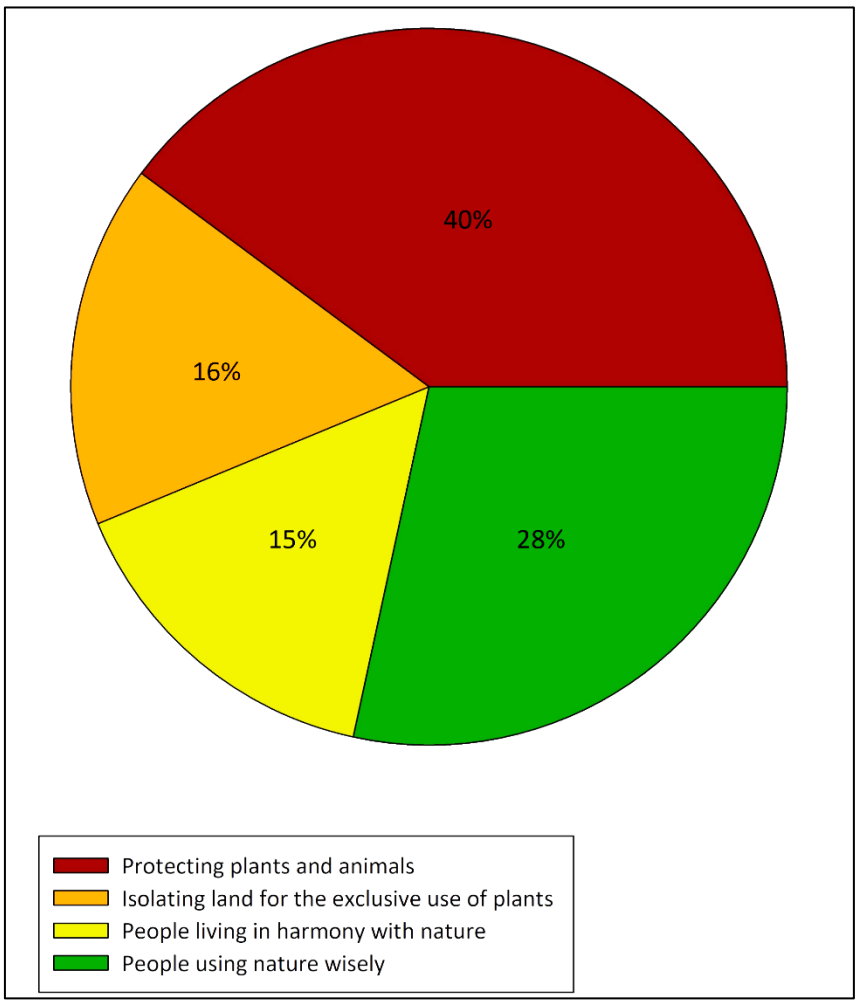


Figure 5: Community members' understanding of conservation (*n* = 384).

However, a disparity arises when considering the low local visitation numbers in the area. Only 51% of participants visit nature reserves (Table 3). More specifically, 45% of the population visited the Soutpansberg Mountain Range, 44% visited Mapungubwe National Park, and 31% visited the Kruger National Park (Table 3).

Table 3: Proportion of the population that visited nature reserves in the Vhembe District (*n* = 384).

The proportion of the population that visited:	**Number**	**Percentage**
Local nature reserves in the area	196	51%
The area around the Soutpansberg Mountain Range	174	45%
The Mapungubwe National Park	171	44%
The Kruger National Park	120	31%

3.5 Community Perceptions of Landscape Initiatives

We explored local perceptions of corridors, revealing strong community support for their implementation. A substantial 75% of participants expressed their support for linking nature reserves in the Vhembe District, with 77% expressing that this would yield direct benefits for them. Perceived benefits are highlighted in Figure 6, with 42% of participants mentioning job creation, while only 11% cited environmental benefits. Interestingly, 77% of participants stated they would be open to working in the tourism or environmental sectors if jobs became available.

While most participants can envision perceived benefits from landscape initiatives, some locals harbor concerns. Some participants had no interest in reserves, were apprehensive about the possibility of an increase in entry costs, doubted the logistics of the corridor or network, and were skeptical about whether the locals or the government would benefit (*Fig*. 6). Notably, a high proportion of participants did not answer the question.

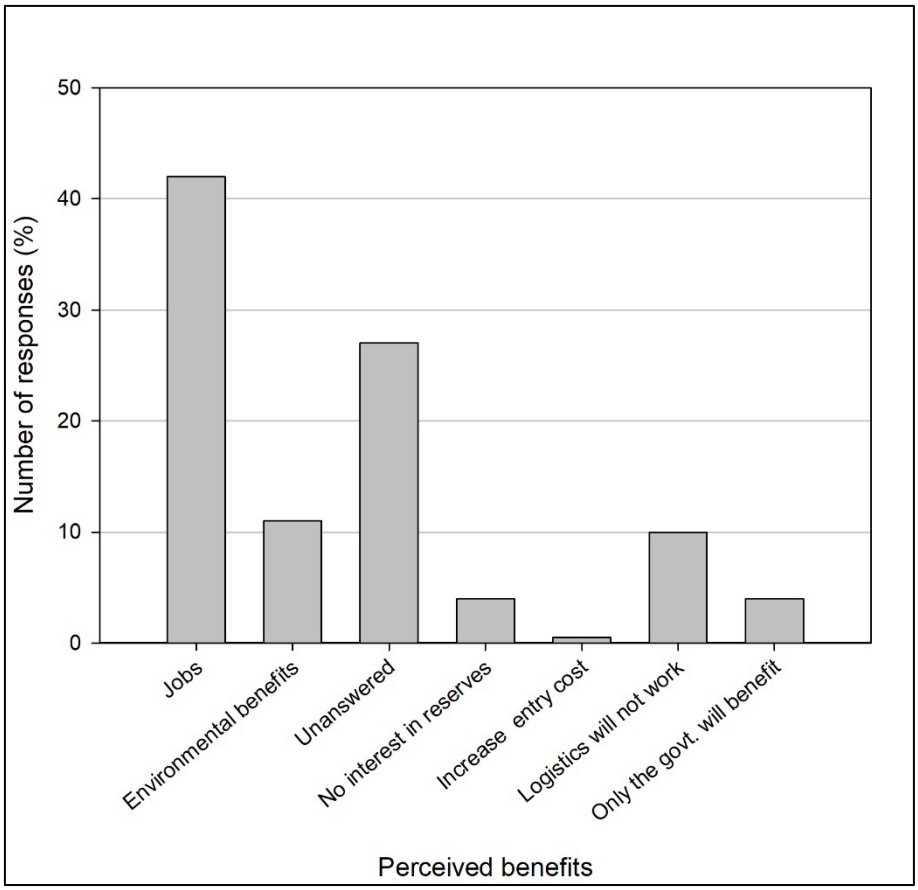


Figure 6: Community members' perceived benefits of landscape initiatives in the Vhembe District (*n* = 384).

4. Discussion

4.1 Factors Affecting Landscape Initiatives Establishment

Several studies have presented criteria, checklists, models, and proposals for corridor and network expansion and creation (see, for example, Beier & Loe, 1992; Chen *et al.,* 2024; Fleury & Brown, 1997; Gregory *et al*., 2021; Shafaghat *et al.*, 2022; Travers *et al.,* 2021). Our study employs a systematic approach integrating insights from interviews and surveys to gauge community perceptions and determine what variables warrant consideration. Our emphasis focused on understanding the social considerations of corridors.

The results suggest a clear preference for landscape initiatives over traditional protected areas. However, considering several critical factors is essential before implementing

landscape initiatives. While the specifics may vary across landscapes, corridors, and networks should encompass four or more protected areas (Table 2). While there is a consensus on the number of protected areas included, the optimal corridor width is less apparent, as 33% of the respondents stated that corridors should be over 2 km wide. However, 20% felt 300-500 meter widths would suffice (Table 2). Ideal corridor width also varies in the literature. Corridors for voles can be as small as 1-3 meters (Andreassen *et al.,* 1996), while the ideal width for insects is over 280 m (van Schalkwyk *et al.,* 2020). Other literature points to wider corridors, anywhere from 400 to 6000 m (Beier, 2018; Ford *et al.,* 2020). Respondents' perceived desirable width of corridors aligns with sentiments in the literature that corridor width is landscape-specific. Nevertheless, these physical parameters imply that landscape initiatives can cover extensive areas across landscapes, making contact with infrastructure inevitable. The Vhembe District is densely populated, with the latest figures estimating a population of 1.4 million (Limpopo Provincial Government, 2023). While large sections of the region are natural, human settlements are prevalent along the district's southern region and near Musina. The many roads in the area, as shown in Figure 1, contribute to landscape fragmentation and impede future protected area connections. Roads may block wildlife movement and increase the number of vehicle-animal collisions (Garrah *et al.,* 2015). The presence of roads between protected areas in the district poses a significant challenge to expanding and linking protected areas. Constructing underpasses would be beneficial, but they are costly. Therefore, policymakers and planners must account for the impact of road mortality and consider linking protected areas where connectivity is uninterrupted by developments or roads (Shafaghat *et al.,* 2022).

In addition to the challenges posed by developments in the Vhembe District, funding constraints present another hurdle to establishing corridors and networks (*Fig*. 2). Corridor creation involves resource-intensive activities such as possible land acquisition, placing or removing fences or boundaries, planning, managing, and monitoring possible poaching, and developing recreational facilities (Brammer, 2022). Funders or landowners may not see a return on their investment, mainly since the efficacy of corridors can only be determined 10-50 years after their establishment (Gregory & Beier, 2014). Funding

constraints are not unique to the Vhembe District and will likely pose challenges when establishing conservation corridors elsewhere. However, directing funds toward conservation initiatives may prove impractical in rural areas with high levels of unemployment and poverty. Rural areas and regions experiencing significant unemployment rates should exercise caution before undertaking conservation endeavors that may incur more significant costs than benefits.

The fundamental principles of property rights underlie terrestrial conservation practices. Such practices often require partial property acquisition, which can be complex given potential disputes over land ownership (Rissman, 2013). The Vhembe District poses an interesting case study, as 46 of the 68 protected areas in Vhembe are privately owned (Dalziel & Evans, 2024). Consequently, corridors and networks in Vhembe may involve private and national partnerships, an endeavor that failed to garner interest in any of the three landowners interviewed.

Complicating matters, South Africa lacks legislation or policies that encourage, support, or guide conservation corridors (Dalziel & Evans, 2023). This dearth of regulatory framework means corridors are not yet a well-established tool in South Africa, and practitioners may face hurdles when implementing them. The absence of supportive, guiding legislation, coupled with possible funding constraints, infrastructure and connectivity limitations, and land rights and jurisdiction complexities, collectively exacerbate the challenges in establishing corridors or networks.

4.2 Accessibility and Land Use

Throughout the study, the theme of accessibility emerged in two fundamental forms. Firstly, community members emphasized the importance of having access to nature reserves. Only a minority of the participants perceive conservation as synonymous with isolation. A total of 85% of the participants expressed a desire for nature reserves to remain accessible to locals. Secondly, the findings underscored the significance of considering access to land utilized by local communities. In regions like the Vhembe District, where 87% of the participants use the land, isolating land may alienate the

community from the environment and conservation efforts, tarnishing views of conservation practices. Landscape initiatives may limit the ability of the locals to collect wood for fires and plants and herbs used for medicine. As one of the primary land uses in the area (*Fig*. 4), the community may have to curtail these practices if nearby land is incorporated into a network or corridor.

Around half the participants visit nature reserves in Vhembe (Table 3), signifying a notable interest in environmental engagement. Additionally, findings indicate that residents are interested in nature reserves. Factors that create the desire to travel are known as travel motivations. Residents may visit nature reserves due to cultural significance, relaxation, recreation, experiencing wildlife, and socializing (Ma *et al.,* 2018; Scholtz *et al.,* 2013). Moreover, community members believe that nature reserves possess the potential to develop communities, upgrade infrastructure, attract tourists, alleviate poverty, and create jobs.

However, accessibility is limited as it seems they are not the target market for some of the existing nature reserves in Vhembe, especially the private reserves. Anthony (2007) focused on the Kruger National Park. The results show that neighboring communities had no interaction with the park and had negative associations due to unfulfilled promises and a lack of interaction (Anthony, 2007). Further, locals surrounding the Kruger National Park receive few benefits and are often the recipients of the costs (Swemmer *et al.,* 2017). Isolation and accessibility are already prevalent in the area. Our findings show that only 31% of participants have visited the Kruger National Park, and only 44% visited the Mapungubwe National Park (Table 3). Considering the entry fees of nature reserves is essential, given that most of the population is in the Upper-Bound Poverty Line. Presently, the entry fees for these reserves stand at $6 and $3, respectively. When coupled with transportation expenses, visiting these reserves becomes prohibitive, considering that most people live on just over $2 a day. This financial burden renders visits to nature reserves a luxury for the community, excluding potential customers and residents. Corridors wield the potential to either involve or alienate communities from the land they once accessed. Without considering community perspectives, corridors may inadvertently reinforce the dominance of private

landowners in the region. A paradigm shift is imperative in upcoming initiatives as locals facilitate effective long-term conservation (Clerici *et al.,* 2018; Goldman, 2009; Mehta & Kellert, 1998; Neelakantan *et al.,* 2019).

4.3 Corridors and Socio-economic Development

Previous research suggests that conservation corridors have the potential to create employment opportunities (see Bleyer *et al.*, 2016; Landry & Chirwa, 2011). Corridors may attract tourists, creating employment in the retail and hospitality sectors. Moreover, corridors also require monitoring and management, which may create jobs, provide educational experiences, and improve local resources. Additionally, nature reserves that promote trophy hunting or focus on anti-poaching surveillance often employ local community members (Zafa-Calvo & Moreno-Penaranda, 2018). Infrastructure development, including fences and information centers, will create short-term employment opportunities.

In addition to job creation, conservation corridors might improve development in the area. Where roads do not interfere with linking protected areas, improved roads may facilitate connectivity and transportation (Ryan & Hartter, 2012). In turn, this could stimulate economic activity and facilitate access to essential services and nature reserves. Corridors may spark increased education and environmental interest among locals as they serve as valuable educational resources. Establishing training centers will require trainers, operators, and tour guides. Encouraging engagement between locals and the environment can further cultivate support for future projects—however, realizing these potential benefits hinges on whether locals can access these sites.

It remains challenging to precisely quantify the economic contribution and job creation facilitated by conservation corridors. Despite evidence suggesting potential social benefits, measuring the full extent of their impact remains elusive. Around a quarter of the participants were unemployed, underscoring the significance of potential job creation associated with corridor development. Furthermore, our study revealed that respondents are open to work in the tourism or environmental sector. Given the

prevailing conditions of extreme unemployment in the region, the prospect of job creation is appealing to locals.

However, the employment opportunities generated by corridors tend to be seasonal and limited, often engaging only a small portion of the population. Creating many jobs akin to those seen in major parks like the Kruger National Park requires large-scale corridors. Hinging on tourism for job creation is idealistic. Consequently, expecting a substantial surge in tourism numbers solely due to corridor establishment may be unrealistic. Given the persistently high unemployment rates in the region, the impact of corridors on employment in Vhembe may be limited. Areas with lower unemployment rates may garner more support for corridors due to their higher potential to increase employment rates.

5. Conclusion

On paper, the Vhembe District is an ideal site for corridor and network establishment due to its numerous nature reserves, relatively unspoiled landscapes, and enthusiastic community. In addition, the Soutpansberg is earmarked as essential for conservation, with a preference for corridor-based approaches.

The participants romanticize corridors due to their potential to create jobs and aid regional development. However, the employment opportunities created might not align with the locals' expectations. Some jobs created will be seasonal or limited to once-off construction jobs, offering only marginal relief to the current unemployment figures.

Additionally, findings suggest that establishing corridors necessitates careful consideration of other essential factors. Extensive road networks and densely populated towns pose obstacles to corridor creation. Infrastructure is not unique to Vhembe but is applicable wherever practitioners seek to establish corridors. Further, funding presents a significant challenge, as their creation demands investment in fencing, ecological planning, and monitoring. These expenses may not be easily justified, particularly when more pressing social issues take precedence. Moreover, the absence of clear legislative

guidance in South Africa complicates matters further. Furthermore, participants emphasized the importance of accessibility. Any network created must consider the community as its primary target market. Failure to do so may result in community alienation, potentially damaging future support for environmental-related issues.

Landscape initiatives hold immense potential in the region. Corridors could protect vulnerable Key Biodiversity Areas, boost tourism, spur development, and offer employment opportunities. However, corridor proponents lack the necessary legislative support and guidance. Evaluating the above factors before establishing corridors or networks is imperative. As a result, we advocate for comprehensive corridor legislation and policies to guarantee successful long-term conservation. These policies must require public participation in landscape initiative planning. Community involvement is particularly vital in rural areas, where residents anticipate that new opportunities may bring jobs to the area.

This study's significance exceeds its regional context, offering insights of global relevance, especially in rural areas. Community engagement emerges as a critical factor regardless of where corridors are established. While challenges may vary from site to site, robust community engagement facilitates proactively identifying possible issues. This study offers actionable insights applicable to corridor endeavors worldwide and underscores the necessity of planning that prioritizes community engagement.

CHAPTER 6: DISCUSSION

6.1 Introduction

This chapter presents a comprehensive discussion, divided into four overarching themes across the research papers documented in Chapters 2 through 5. It integrates and expands on findings and connections between each research paper. Initially, the discussion presents a brief history of conservation in South Africa, highlighting the challenging past marked by exclusionary conservation practices and underscoring the necessity of accessibility and comprehensive legislation. Subsequently, the discussion shifts to the absence of such comprehensive legislation and examines the limited literature on landscape initiatives in the country, providing reasons as to why this could be. These initial sections contextualise landscape initiatives within the South African context.

Following this, the study explores the potential efficacy of these initiatives within the Vhembe District. First, attention is directed towards how landscape initiatives can meet global and local targets. Then, the discussion presents the environmental advantages of corridors and networks in ensuring coverage of Key and Critical Biodiversity areas. Additionally, the social facets and community perceptions of conservation are explored. Finally, the discussion presents the factors essential for establishing landscape initiatives, which emerged throughout the study.

6.2 South Africa's Conservation History: An Issue of Accessibility

Colonialism and Apartheid are significant features in South Africa's conservation history as they shaped early protected areas and impacted how people view conservation today. As discussed in Section 2, Chapter 3, conservation practitioners in the 1920s and 1930s emphasised minimal human intervention when managing protected areas. The running of the parks was unsuccessful, as individuals lacking expertise oversaw the parks (Goosen & Blackmore, 2019). Apartheid entailed the forced removal and exclusion of citizens to establish protected areas, a precedent set by colonialism (Brooks, 2005; Carruthers, 2008; Gewald *et al*., 2018). Political tension escalated during the 1940s,

characterised by ‘‘double exclusion,’’ coined by Cock and Fig (2000), where the majority of the citizens were unable to visit reserves and were marginalised from decision-making. National parks continued to serve as symbols of exclusion.

However, there was a greater emphasis on participation in post-Apartheid South Africa, with newer conservation initiatives focusing on community-based protection and joint management, aiming to move away from previous conservation practices (Kepe, 2008; Ngubane & Brooks, 2013; Olivier, 2013). Community-based conservation does not apply to national parks or privately practised conservation. Despite this, these methods are criticised and labelled unsuccessful (Carlos-Bezerra & Paphitis, 2021; Kepe *et al.*, 2005; Kepe, 2008; Ngubane & Brooks, 2013). Public participation, which aims to incorporate affected parties in development outcomes, is mandated by the National Environmental Management Act of 1998 (RSA, 1998), which ushered in an era of social inclusion.

South Africa’s historical context has been detrimental to the perception and implementation of conservation practices, necessitating a cautious approach that avoids replicating past methods. Conservation methods, especially those lacking legislative guidance, must consider the community carefully. Results from Chapter 5, *Fig*. 5, show that only a minority of the participants in the Vhembe District associate conservation with isolation, with 85% expressing a desire for accessible nature reserves. Only half of the participants visited nature reserves, with entry fees identified as a possible reason for the low local attendance (Chapter 5, Table 3). Despite the past, community members associate conservation with the potential to benefit the environment and increase development in the area.

Additionally, community members heavily support the creation of corridors in the Vhembe District. However, given that over 80% of the participants use the land in the area, accessibility is paramount, and any isolation may lead to conflict or tarnished conservation views. Preventing ‘‘double exclusion’’ is crucial to corridor establishment. Access to nature reserves is crucial, and community members must be involved in

decision-making. South Africa's protected area history emphasises the imperative for any new conservation approach to involve the community. Additionally, legislation facilitating public engagement must underpin corridors so they become a tool of inclusion rather than exclusion.

6.3 Geographical Limitations and Policy Constraints

Across the plethora of literature, landscape initiatives are praised as an effective conservation tool for mitigating the effects of biodiversity loss (see Joubert-van der Merwe et al., 2019; Kietzka *et al*., 2015; Pryke *et al.,* 2015; Pryke & Samways, 2012; Samways *et al.,* 2010; Theron *et al.,* 2022; van Schalkwyk *et al.,* 2019). Corridors and networks are studied globally from China to Brazil and the United Kingdom to Peru (see Table 1, Chapter 2). Notably, South Africa contributed significantly to this body of literature, although this research focuses predominantly on KwaZulu-Natal (KZN), a province in South Africa. Only five of the nine provinces have been studied, with only three provinces, the Western Cape, the Eastern Cape, and KZN, receiving extensive research (Table 3, Chapter 2). Studies consistently show that ecological networks and conservation corridors are highly successful and practical in conserving fauna and flora (Bullock & Samways, 2005; Di Minin *et al.,* 2013; Joubert *et al.,* 2016; Joubert & Samways, 2014; Joubert-van der Merwe *et al.*, 2019; Joubert-van der Merwe *et al.*, 2020; Kietzka *et al.,* 2015; Kietzka *et al.*, 2021; Pryke *et al*., 2015; Pryke & Samways, 2015; Rouget *et al.*, 2006; Theron *et al.,* 2022). These studies collectively underscore the critical role of ecological networks and corridors in biodiversity conservation efforts, particularly within South Africa's diverse ecosystems. One study also stressed the necessity of a shared corridor vision and detailed social assessments before the landscape initiative establishment (Lombard *et al.,* 2010), echoing the sentiments mentioned in section 6.2.

However, the literature on landscape initiatives in South Africa is limited geographically, partially due to the funding provided by the Mondi Group. This paper producer owns over 200,000 ha of plantations in KZN (Mondi, 2023). However, the lack of geographical

range may also stem from the fact that corridors are not as prevalent in other provinces, possibly due to a lack of guidance. A comprehensive legislative review (see Table 2, Chapter 3) showed that no existing laws reference, endorse, or mandate creating connected landscapes. Even the National Environmental Management Act (NEMA) of 1998 (Republic of South Africa, 1998), South Africa's principal environmental legislation, fails to mention landscape initiatives. Additionally, two of its auspices, the Protected Areas Act (Republic of South Africa, 2003) and the Biodiversity Act (Republic of South Africa, 2004), assume a parochial approach to landscape conservation. An analysis of the environmental policies under the various laws yielded the same results. Policies may encourage landscape-based approaches but are non-statutory and provide no tangible plans.

The only remnants of landscape-based approaches are in the National Environment Management Protected Areas Act, Act 57 of 2003 (NEMPA) (Republic of South Africa, 2003). The Act aims to establish a network of state and private protected areas (see Chapter 3, section 5.5). Merging private and national protected areas holds considerable potential and could offer an economical means to expand South Africa's conservation estate (Holmes, 2013). However, a lack of transparent jurisdictional practices and guiding policies impedes this attempt. In the Vhembe District, 67% of the protected areas are privately owned, most declared in the 1960s when the National Parks Board's budget increased from R300 000 to R3 million in 1966 (see Figure 3, Chapter 4). These private reserves represent a vital asset holding significant potential for conservation in the region. However, despite the importance of private areas, none of the landowners interviewed in Chapter 5 expressed interest in linking their private reserves with state-owned ones. This reluctance of landowners to engage in such partnerships raises questions on property rights and jurisdictions.

6.4 Landscape Initiatives' Environmental and Social Potential

There is a growing need for countries to increase their protected area estate after ratifying the Kunming- Montreal Global Biodiversity Framework (KMGBF). As a

signatory, South Africa must meet the 23 targets to maintain and restore biodiversity. Target 3 stipulates that 30% of the global land and sea area must be conserved by 2023 (CBD, 2022; Obura, 2023; Schroter *et al.,* 2023). The South National Protected Area Expansion Strategy (NPAES) established national targets in 2016, aiming to protect 16% of South Africa's land in 20 years (RSA, 2016, p. 22). However, as shown in Chapter 4, protected areas cover only 11% of South Africa's terrestrial landmass. As discussed in Chapter 3, South Africa's national policies are outdated and do not align with global targets. Nevertheless, the impending revision of the National Biodiversity Framework (NBF), mandated by the National Biodiversity Act (Republic of South Africa, 2004), offers an opportunity for alignment with global conservation goals. The NBF informs other policies, such as the NPAES and the National Biodiversity Strategy and Action Plan, which is also due for revision (see Figure 1, Chapter 3). The forthcoming update is anticipated to raise South Africa's national targets and delineate strategies for achieving them, mainly through landscape connectivity methods.

Landscape initiatives have demonstrated substantial environmental benefits, often surpassing those of conventional traditional protected areas. Connecting pre-existing reserves may be feasible for countries to expand their conservation estate, protect vulnerable ecosystems, and meet ambitious global targets. The case of the Vhembe District exemplifies how linking reserves can protect at-risk species and increase the protected area coverage. Although the 68 protected areas in Vhembe cover 9,811 km^2 or 38% of the landscape, over 10,000 km^2 of Key and Critical Biodiversity Areas are unprotected. The current network proves insufficient, with protected area establishment stagnating in the region, with only one protected area declared since 2020 (see Figure 3, Chapter 4). Other findings state that an additional area of 11 556 km^2 is required in Limpopo to safeguard biodiversity adequately (Desmet *et al.*, 2013). However, in Chapter 4, it is argued that this area pertains solely to the Vhembe District and could be achieved through landscape initiatives. Corridors and networks enhance habitat connectivity and ecological functions (Battisti, 2023; Bennett & Mulongay, 2006;

Crooks & Sanjayan, 2006; Haddad *et al.,* 2014; Hanski & Ovaskainen, 2000; Hilty *et al.,* 2019; Hilty *et al.,* 2020; Joubert van der Merwe *et al.,* 2019).

Additionally, corridors and networks can connect and benefit surrounding communities, but this is contingent upon thorough community involvement (Goldman, 2009; Kikoti *et al*., 2010; Townsend & Masters, 2015). These initiatives could create employment opportunities (Bleyer *et al*., 2016; Landry & Chirwa, 2011), attract tourists, provide educational experiences, and improve local infrastructure (Ryan & Hartter, 2012). However, it is challenging to precisely quantify the economic contribution of corridors and networks, as some jobs may be temporary. Studies on corridors and networks in South Africa primarily focus on the environmental benefits of networks focusing on using insects to determine corridor efficacy (Bazelet & Samways, 2011; Kietzka *et al.,* 2021; van Schalkwyk *et al*., 2017) (see Chapter 2). However, more studies on the social impacts of corridors are required. Despite the absence of quantifiable social benefits, the community fully supports the establishment of a corridor due to its perceived potential to create jobs and increase development in the area. Landscape initiatives hold promise not only for environmental conservation but also for generating social benefits. However, their full potential remains underutilised and warrants greater attention and implementation.

6.5 Moving Forward

While landscape initiates harbour tremendous social and environmental potential, they are in their early phase in South Africa. Chapters 3, 4 and 5 exposed crucial factors to consider regarding landscape initiatives. The first was discussed in detail in section 6.2 and revolves around the issue of accessibility and community involvement. Accessibility and thorough community engagement help prevent future conflicts and ensure long-term conservation success. The efficacy of corridors also hinges upon their placement, physical parameters, and location. Chapter 4 shows how Key and Critical Biodiversity Areas can be used to highlight deficiencies in protected area networks. Corridors and networks can only successfully conserve vulnerable fauna and flora if placed within their

habitat. Another factor to consider is the size and width of the corridor. The ideal corridor width is debated to be around one kilometre. However, this will change depending on the species. Location and physical parameters must have optimal conservation in mind prior to establishment. When doing so, development and roads may interfere. Corridors are often placed near natural habitats, but this is increasingly difficult in today's landscape. The Soutpansberg was identified as an ideal site as it is not only home to Key and Critical Biodiversity Areas, but the region is in a reasonably natural state. The site is also home to only private reserves, which may make linking areas easier as private landowners are not partnering up with the government. While linking private reserves may be more accessible, local accessibility is at the discretion of the landowners. The acquisition of land, land rights, and community accessibility and involvement in decision-making processes would be made easier with legislation. Thorough legislation would ensure that land is protected and divided accordingly. Currently, land ownership under a network is a grey area, and public participation is not a requirement.

The final factor to consider is funding. Corridor and network creation involves placing and removing fences, planning, monitoring, management, and possibly developing recreational facilities. Funding constraints must be considered wherever proponents wish to establish corridors or networks. If corridors and networks involve national reserves, diverting money to conservation efforts might be unlikely, considering the residents' social issues and poverty. However, the government could incentivise landowners to link their reserves, which will increase the area of protected land and have a ripple effect, leading to more landscape initiatives in the country.

Additionally, NGOs should be bought on board and can help establish regional corridors and networks. NGOs, like Peace Parks, are actively involved in Transfrontier Conservation Areas (TFCAs) across southern Africa. TFCAs are another landscape initiative that spans regions and boundaries, aiming to conserve biodiversity (Metcalfe & Kepe, 2008). Similarly to the landscape initiatives discussed in this thesis, TFCAs are

only successful when local communities are involved, areas of high biodiversity are correctly identified and prioritised, and sustainable financing mechanisms are developed (Munthali, 2007). Studies on TFCAs show that they do not contribute to a country's socio-economic development as politics emerge over access to resources and the challenges of integrating private land into large, connected networks (Duffy, 2006; Sinthumule, 2017). In addition to TFCAs, Biosphere Reserves are another form of landscape conservation. Recognised under UNESCO, Biosphere Reserves aim to integrate conservation and sustainable development (Jauro *et al.,* 2020). These reserves typically encompass a core area surrounded by buffer and transition zones. The South African Strategy for the Biosphere Reserve Programme (2016-2020) supports, promotes, and provides strategic direction and objectives for South Africa's eight Biosphere Reserves, including the Vhembe Biosphere Reserve (VBR). The VBR was designated by UNESCO in 2009 and covers 30,000 km^2 of the region (Evans, 2017). Despite their comprehensive approach, the designation of a biosphere reserve does not always equate to formal legal protection from activities such as development. Nevertheless, Biosphere Reserves and TFCAs provide additional avenues for landscape conservation.

CHAPTER 7: CONCLUSION

7.1 Introduction

This chapter consolidates the key findings of the thesis, as per the research objectives. Subsequently, the chapter presents recommendations and avenues for future research and the research limitations.

7.2 Key Outcomes

This thesis explored the emergence and potential of landscape initiatives in South Africa. This study is the first to explore the opportunity presented by landscape initiatives in South Africa and the Vhembe District. Moreover, it was the first to review the literature and legislative and policy frameworks supporting these newer conservation methods. The study aimed to determine how landscape initiatives can be applied in the Vhembe District of Limpopo. Additionally, the study sought to analyse the National legislative and policy frameworks guiding conservation. Furthermore, this study aimed to assess the current protected area network in the Vhembe District and evaluate community perceptions to determine whether landscape initiatives can promote sustainable conservation and contribute to the socio-economic transformation of the Vhembe District.

The research objectives in section 1.2 of Chapter 1 help address the aims above. The objectives of the study and how they were achieved are below.

Research Objective 1: Review the literature on South Africa's landscape initiatives, assess their success, and examine their geographic distribution.

This objective required a comprehensive literature review of landscape initiatives' global and local distribution and their key findings in South Africa. The outcomes of this objective are in Chapter 2. The results show that landscape initiatives are effective conservation tools, and the global distribution of these studies is presented. The discussion around the efficacy and distribution of landscape initiatives in South Africa

includes details regarding South Africa's contribution to global literature and the possible reasons for the location bias in KwaZulu-Natal, leaving the rest of South Africa's numerous biomes and biodiversity hotspots unexplored. Nevertheless, the literature shows that corridors and networks effectively aid species migration, facilitate gene flow, and protect vulnerable fauna and flora.

Research Objective 2: Assess the current institutional and policy frameworks and strategies that promote environmental conservation and landscape initiatives in South Africa.

Fulfilling this objective required a thorough review of South Africa's legislative and policy frameworks, presented in Chapter 3. The review explores legislation dating back to 1976 and traces how contemporary legislation has not evolved. The discussion section of Chapter 3 provides a detailed analysis of seven acts and eleven policies. These policies are established well after deadlines and repeat the ambit of their predecessors, offering no new suggestions. This Chapter also delves into South Africa's conservation history, underlining the importance of involving communities and utilising conservation methods for inclusion. Additionally, this Chapter exposed private land and land rights as a hindrance to corridor establishment. This Chapter is a crucial contribution to the discourse surrounding landscape initiatives in South Africa as legislation and policies dictate how and where to implement conservation methods.

Research Objective 3: Determine the extent of the current protected area network in the Vhembe District and assess its contribution towards South Africa's protected area estate.

The outcomes of this objective are in Chapter 4. Fulfilling this objective required the use of Geographic Information Systems (GIS). Multiple datasets, including the protected areas listed under South Africa's National Protected Area Database, allowed for analysing and comparing the Vhembe District's protected areas with South Africa's. The introduction of Chapter 4 presents the global targets outlined in the KMGBF and the local targets articulated in the NPAES. The results revealed that 11% of South Africa's

terrestrial landmass is protected, with 7% of national protected area coverage originating from the Vhembe District.

Moreover, protected areas cover an impressive 38% of the Vhembe District. Chapter 4 explores how Vhembe's protected area coverage can be improved and the role of private protected areas. Building upon the findings from Chapters 2 and 3, this chapter extends the discourse by exploring the potential of landscape initiatives to meet global and local targets.

Research Objective 4: Determine whether the current protected area network of Vhembe effectively conserves crucial areas by using Key and Critical Biodiversity Areas as indicators.

This objective required using GIS with multiple datasets, including global Key Biodiversity Areas (KBA) and local Critical Biodiversity Areas (CBA). These indicators helped identify gaps in the protected area network and at-risk ecosystems requiring immediate intervention. The results of this objective, detailed in Chapter 4, underscore notable findings. While 38% of the Vhembe District is protected, only 28% of CBAs receive similar protection. As a result, over 10,000 km^2 of unique biodiversity warrants immediate protection in the Vhembe District. The subsequent discussion presents the Soutpansberg as an ideal site for a corridor or network. Such initiatives could augment the protection of both KBA and CBAs, thereby addressing the identified gaps in conservation coverage. These results reiterate the significance of landscape initiatives' potential in South Africa, specifically in the Vhembe District.

Research Objective 5: Explore community perceptions and establish whether landscape initiatives can and should be used in the Vhembe District to improve conservation and benefit the community.

The outcome of this final objective is in Chapter 5. The introduction underscores the pivotal role of community engagement in ensuring long-term sustainable conservation. It also references the results from Chapter 5 by stressing the potential of a corridor in the region, particularly along the Soutpansberg. The results indicate that the community members positively associate with conservation, and only a minority of participants see conservation methods as a tool to exclude the community. Participants encourage establishing corridors and networks in the region. The discussion section explores this enthusiasm and investigates the anticipated socio-economic benefits stemming from corridor establishment. Once again, this chapter stresses the fundamental themes of private land and accessibility. Additionally, the chapter presents possible hindrances to landscape initiative establishment, including development, roads, and funding. This chapter provides a comprehensive analysis of the social facets of corridors before establishment.

7.3 Recommendations for Future Research

While exploring landscape initiatives' discourse, legislation, and potential, this thesis identified several essential research gaps and areas warranting further exploration. Although this study did not aim to identify an exact site for corridor implementation or monitor its social and environmental success, such endeavours present promising avenues for future research. The Soutpansberg is marked as an ideal site for corridor implementation, and research should focus on exploring this further. Furthermore, expanding research efforts to encompass other provinces within South Africa would enrich the existing body of knowledge. As highlighted in Chapter 2, there is a notable absence of literature on corridors and networks across the country, underscoring the importance of examining community perspectives on conservation methodologies in diverse regional contexts.

Communities apprehensive about conservation may provide valuable insights into how this can be amended.

This thesis cites the absence of legislation throughout. Establishing robust legal frameworks is imperative to guide practitioners through various challenges associated with corridor implementation, including public participation, land rights, and funding allocation.

Additionally, this thesis employed KBAs and CBAs to identify gaps in a protected area network. This methodology should be adopted elsewhere to identify valuable ecoregions lacking protection. Studies can also use other indicators, such as the Global 200. Future studies can also use GIS tools such as GRASS and the Least Cost Corridor to identify possible sites in South Africa. The National Biodiversity Act also mandates updating the National Biodiversity Framework in 2025. Exploring any differences and shifts in conservation practices would be interesting, especially considering the framework was last updated in 2021, as shown in Chapter 3.

Future research could also examine Transfrontier Conservation Areas and Biosphere Reserves and compare their efficacy to corridors and networks.

In conclusion, this thesis serves as a pioneering exploration into landscape initiatives in South Africa, laying the groundwork for further research to delve into their application, effectiveness, identification, potential, and social benefits. Continued scholarly inquiry in these domains is essential for fostering sustainable conservation practices and promoting biodiversity conservation.

7.4 Research Limitations

This paper employed multiple methods, including a systematic literature review, policy analysis, spatial analysis using GIS, interviews, and distributing surveys. As a result, the research encountered several limitations. Chapter 5 details that the number of stakeholders interviewed was 15, a relatively small sample size primarily due to data collection challenges during the COVID-19 pandemic. Many potential participants were

approached but declined to participate or did not respond to emails and phone calls. The study would have benefitted from a larger dataset.

Additionally, fieldwork in the Vhembe District experienced delays due to the pandemic, though it was fortunately completed in 2023. Accessibility issues also posed significant limitations. Specific datasets, which would have enriched the analysis in Chapter 4, were inaccessible due to restrictions. Furthermore, some articles essential for Chapter 3 were unobtainable because of prohibitive journal access fees or language barriers, as they were unavailable in English.

The limitations related to dataset accessibility in Chapter 4 underscore the challenges researchers often face in obtaining comprehensive data. Restricted access to specific datasets limited the scope of the spatial analysis. Similarly, the inability to access some crucial articles due to journal fees or language barriers in Chapter 3 constrained the literature review.

REFERENCES

Adhikari, B., Williams, F., & Lovett, J. C. (2007). Local benefits from community forests in the middle hills of Nepal. *Forest Policy and Economics*, *9*(5), 464–478. https://doi.org/10.1016/j.forpol.2005.11.002

Ambal, R. G. R., Duya, M. V., Cruz, M. A., Coroza, O. G., Vergara, S. G., de Silva, N. A. A. M. A. L., Molinyawe, N & Tabaranza, B. (2012). Key biodiversity areas in the Philippines: priorities for conservation. *Journal of Threatened Taxa*, *4*(14), 2788-2796.

Andreassen, H. P., Halle, S., & Ims, R. A. (1996). Optimal width of movement corridors for root voles: not too narrow and not too wide. *Journal of Applied Ecology*, 63–70. https://doi.org/10.2307/2405016

Anthony, B. (2007). The dual nature of parks: attitudes of neighbouring communities towards Kruger National Park, South Africa. *Environmental Conservation*, *34*(3), 236-245. https://doi.org/10.1017/S0376892907004018

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

Báldi, A., & Vörös, J. (2006). Extinction debt of Hungarian reserves: A historical perspective. *Basic and Applied Ecology*, *7*(4), 289-295. https://doi.org/10.1016/j.baae.2005.09.005

Barendse, J., Roux, D., Currie, B., Wilson, N., & Fabricius, C. (2016). A broader view of stewardship to achieve conservation and sustainability goals in South Africa. *South African Journal of Science*, *112*(5-6), 1-15. http://dx.doi.org/10.17159/sajs.2016/20150359

Barnosky, A.D., Matzke, N., Tomiya, S., Wogan, G.O., Swartz, B., Quental, T.B., Marshall, C., McGuire, J.L., Lindsey, E.L., Maguire, K.C., & Mersey, B. (2011). Has the Earth's sixth mass extinction already arrived? *Nature*, *471*(7336), 51–57. https://doi.org/10.1038/nature09678

Battisti, C. (2023). Ecological networks as planning tools for African fragmented landscapes: Overcoming weaknesses for effective connectivity conservation. *African Journal of Ecology*. https://doi.org/10.1111/aje.13186

Baum, K. A., Haynes, K. J., Dillemuth, F. P., & Cronin, J. T. (2004). The matrix enhances the effectiveness of corridors and stepping stones. *Ecology*, *85*(10), 2671–2676. https://doi.org/10.1890/04-0500

Bazelet, C. S., & Samways, M. J. (2011). Identifying grasshopper bioindicators for habitat quality assessment of ecological networks. *Ecological Indicators*, *11*(5), 1259-1269. https://doi.org/10.1016/j.ecolind.2011.01.005

Beier, P. (2018). A rule of thumb for widths of conservation corridors. *Conservation Biology,* 1–3. https://doi.org/10.1111/cobi.13256

Beier, P., & Loe, S. (1992). In my experience: a checklist for evaluating impacts to wildlife movement corridors. *Wildlife Society Bulletin (1973-2006)*, *20*(4), 434-440.

Belote, R.T., Dietz, M.S., McRae, B.H., Theobald, D.M., McClure, M.L., Irwin, G.H., McKinley, P.S., Gage, J.A., & Aplet, G.H. (2016). Identifying corridors among large protected areas in the United States. *PLoS One*, *11*(4), 1-16. https://doi.org/10.1371/journal.pone.0154223

Bennett, G., & Mulongoy, K. J. (2006). Review of experience with ecological networks, corridors and buffer zones. *Secretariat of the Convention on Biological Diversity, Montreal, Technical Series,* 23, 100.

Beresford, A. E., Buchanan, G. M., Donald, P. F., Butchart, S. H. M., Fishpool, L. D. C., & Rondinini, C. (2011). Poor overlap between the distribution of protected areas and globally threatened birds in Africa. *Animal Conservation*, *14*(2), 99–107.

Bezerra, J., & Paphitis, S. (2021). Epistemic Injustice and Land Restitution in the Case of Protected Areas: From Policy to Practice in South Africa. *Society & Natural Resources*, *34*(7), 906-924. https://doi.org/10.1080/08941920.2021.1900962

Bienen, L. (2002). Informed decisions on conservation corridors and the spread of infectious disease. *Conservation in Practice*, *3*(2), 10–19. https://doi.org/10.1111/j.1526-4629.2002.tb00028.x

Birch, J. C., Thapa, I., Balmford, A., Bradbury, R. B., Brown, C., Butchart, S. H., ... & Thomas, D. H. (2014). What benefits do community forests provide, and to whom? A rapid assessment of ecosystem services from a Himalayan forest, Nepal. *Ecosystem Services*, *8*, 118–127. https://doi.org/10.1016/j.ecoser.2014.03.005

BirdLife International (2022). World Database of Key Biodiversity Areas. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Rewild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. September 2022 version. http://keybiodiversityareas.org/kba-data/request

Bleyer, M., Kniivilä, M., Horne, P., Sitoe, A., & Falcão, M. P. (2016). Socio-economic impacts of private land use investment on rural communities: Industrial forest plantations in Niassa, Mozambique. *Land Use Policy*, *51*, 281-289. https://doi.org/10.1016/j.landusepol.2015.11.011

Blignaut, J., & Moolman, C. (2006). Quantifying the potential of restored natural capital to alleviate poverty and help conserve nature: a case study from South Africa. *Journal for Nature Conservation*, *14*(3-4), 237-248. https://doi.org/10.1016/j.jnc.2006.04.001

Bluwstein, J. & Lund, J. F. (2018). Territoriality by conservation in the Selous–Niassa Corridor in Tanzania. *World Development,* 101, 453 465. https://doi.org/10.1016/j.worlddev.2016.09.010

Bologna, S.A., & Spierenburg, M. (2015). False Legitimacies: The Rhetoric of Economic Opportunities in the Expansion of Conservation Areas in Southern Africa. In: van der Duim, R., Lamers, M., van Wijk, J. (eds) Institutional Arrangements for Conservation, Development and Tourism in Eastern and Southern Africa. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9529-6_7

Boon, R., Cockburn, J., Govender, N., Ground, L., Slotow, R., Mclean, C., Douwes, E., Rouget, M., & Roberts, D. (2016). Managing a threatened savanna ecosystem (KwaZulu-Natal Sandstone Sourveld) in an urban biodiversity hotspot: Durban, South Africa. *Bothalia-African Biodiversity & Conservation*, *46*(2), 1–12. https://dx.doi.org/10.4102/abc.v46i2.2112

Brammer, T. (2022). Using Land and Water Conservation Fund Money to Protect Western Migration Corridors. *Wyoming Law Review*, *22*, 61.

Brandt, F. & Spierenburg, M. (2014). Game fences in the Karoo: reconfiguring spatial and social relations. *Journal of Contemporary African Studies*, *32*(2), 220-237. https://doi.org/10.1080/02589001.2014.925300

Brooks, S. (2005). Images of 'Wild Africa': Nature Tourism and the (Re) Creation of Hluhluwe Game Reserve, 1930–1945. *Journal of Historical Geography*, *31*(2), 220–240. https://doi.org/10.1016/j.jhg.2004.12.020

Brownlie, S., von Hase, A., Botha, M., Manuel, J., Balmforth, Z., & Jenner, N. (2017). Biodiversity offsets in South Africa–challenges and potential solutions. *Impact Assessment and Project Appraisal*, *35*(3), 248–256. https://doi.org/10.1080/14615517.2017.1322810

Buchanan, G. M., Butchart, S. H., Chandler, G., & Gregory, R. D. (2020). Assessment of national-level progress towards elements of the Aichi Biodiversity Targets. *Ecological Indicators*, *116*, 106497. https://doi.org/10.1016/j.ecolind.2020.106497

Bullock, W. L., & Samways, M. J. (2005). Conservation of flower-arthropod associations in remnant African grassland corridors in an afforested pine mosaic. *Biodiversity & Conservation*, *14*(13), 3093–3103. https://doi.org/10.1007/s10531-004-0379-7

Büscher, B. (2013). *Transforming the Frontier: peace parks and the politics of neoliberal conservation in Southern Africa*. Duke University Press. https://www.dukeupress.edu/transforming-the-frontier

Büscher, B., & Schoon, M. (2009). Competition over conservation: Collective action and negotiating transfrontier conservation in Southern Africa. *Journal of International Wildlife Law & Policy*, *12*(1-2), 33-59. https://doi.org/10.1080/13880290902938138

Cadman, M., Petersen, C., Driver, A., Sekhran, N., Maze, K., & Munzhedzi, S. (2010). *Biodiversity for Development: South Africa's landscape approach to conserving biodiversity and promoting ecosystem resilience*. South African National Biodiversity Institute, Pretoria.

Carroll, C., Noss, R. F., Paquet, P. C., & Schumaker, N. H. (2004). Extinction debt of protected areas in developing landscapes. *Conservation Biology*, *18*(4), 1110-1120. https://doi.org/10.1111/j.1523-1739.2004.00083.x

Carruthers, J. (2008). Conservation and wildlife management in South African national parks, 1930s–1960s. *Journal of the History of Biology*, *41*(2), 203–236. https://doi.org/10.1007/s10739-007-9147-3

Carruthers, J. (2017*). National Park Science: A century of research in South Africa*. Cambridge University Press.

Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M., & Palmer, T.M. (2015). Accelerated modern human-induced species losses: Entering the sixth mass extinction. *Science Advances*, *1*(5), 1-5. https://doi.org/10.1126/sciadv.1400253

Chaudhary, S., Uddin, K., Chettri, N., Thapa, R., & Sharma, E. (2022). Protected areas in the Hindu Kush Himalaya: A regional assessment of the status, distribution, and gaps. *Conservation Science and Practice*, *4*(10). https://doi.org/10.1111/csp2.12793

Chen, R., Carruthers-Jones, J., Carver, S., & Wu, J. (2024). Constructing urban ecological corridors to reflect local species diversity and conservation objectives. *Science of The Total Environment*, *907*, 167987. https://doi.org/10.1016/j.scitotenv.2023.167987

Chettri, N., Thapa, R., & Shakya, B. (2007). Participatory conservation planning in Kangchenjunga transboundary biodiversity conservation landscape. *Tropical Ecology*, *48*(2), 163–176.

Chrystal, R. A., & Scharler, U. M. (2014). Network analysis indices reflect extreme hydrodynamic conditions in a shallow estuarine lake (Lake St Lucia), South Africa. *Ecological Indicators*, *38*, 130-140. https://doi.org/10.1016/j.ecolind.2013.10.025

Clerici, N., Salazar, C., Pardo-Díaz, C., Jiggins, C. D., Richardson, J. E., & Linares, M. (2019). Peace in Colombia is critical for Neotropical connectivity and conservation: Save the northern Andes–Amazon biodiversity bridge. *Conservation Letters*, *12*(1), e12594. https://doi.org/10.1111/conl.12594

Cock, J., & Fig, D. (2000). From colonial to community-based conservation: environmental justice and the national parks of South Africa. *Society in Transition*, *31*(1), 22–35. https://doi.org/10.1080/21528586.2000.10419008

Cockburn, J., Cundill, G., Shackleton, S., & Rouget, M. (2019). The meaning and practice of stewardship in South Africa. *South African Journal of Science, 115(5-6),* 1–13. http://dx.doi.org/10.17159/sajs.2019/5339

Convention on Biological Diversity. (2022). Kunming-Montreal Global Biodiversity Framework. Montreal, Canada. https://www.cbd.int/gbf/

Crooks, K. R., & Sanjayan, M. (Eds.). (2006). *Connectivity conservation* (Vol. 14). Cambridge University Press

Dalziel, A., & Evans, M. (2023). Conservation corridors and ecological networks in South Africa: shortcomings of environmental legislation and policies. *South African Geographical Journal*, 1-20. https://doi.org/10.1080/03736245.2023.2190154

Dalziel, A., & Evans, M. (2024). The Emergence of Landscape Initiatives as a Method for Biodiversity Conservation in South Africa. *Reviewed and under correction.*

Dalziel, A., & Evans, M. (2024). Using Key and Critical Biodiversity Areas to Identify Gaps in the Protected Area Network. *Conservation Science and Practice,* In press.

Darkoh, M.B.K. (1997). Environmental impacts of urban-industrial development in the developing world. *Journal of African Research and Development*, *27*,127-137. https://www.jstor.org/stable/24326360

de Castro-Pardo, M., Martín, J. M. M., & Azevedo, J. C. (2022). A new composite indicator to assess and monitor performance and drawbacks of implementing Aichi Biodiversity Targets. *Ecological Economics*, *201*, 107553. https://doi.org/10.1016/j.ecolecon.2022.107553

de Oliveira Roque, F., Uehara-Prado, M., Valente-Neto, F., Quintero, J.M.O., Ribeiro, K.T., Martins, M.B., de Lima, M.G., Souza, F.L., Fischer, E., da Silva Jr, U.L., & Ishida, F.Y. (2018). A network of monitoring networks for evaluating biodiversity conservation effectiveness in Brazilian protected areas. *Perspectives in Ecology and Conservation*, *16*(4),177-185. https://doi.org/10.1016/j.pecon.2018.10.003

De Vos, A., Clements, H. S., Biggs, D., & Cumming, G. S. (2019). The dynamics of proclaimed privately protected areas in South Africa over 83 years. *Conservation Letters*, *12*(6), e12644. https://doi.org/10.1111/conl.12644

Deacon, C., Samways, M. J., & Pryke, J. S. (2018). Artificial reservoirs complement natural ponds to improve pondscape resilience in conservation corridors in a biodiversity hotspot. *PloS One*, *13*(9), 1-17. https://doi.org/10.1371/journal.pone.0204148

DeFries, R., Hansen, A., Newton, A.C., & Hansen, M.C. (2005). Increasing isolation of protected areas in tropical forests over the past twenty years. *Ecological Applications*, *15*(1),19-26. https://doi.org/10.1890/03-5258

Delta Built Environmental Consultants. (2021). Musina-Makhado Special Economic Zone designated site environmental impact assessment report final report revision 02. https://deltabec.com/wp-content/P17102/00_DRAFT/P17102_REPORTS_25_REV%2002-FINAL%20EIA.pdf

Denzin, N.K. (1970). The research act: A theoretical introduction to sociological methods. Chicago: Aldine

Department of Forestry, Fisheries, and the Environment. (2002). Guiding principles for projects on biosphere reserves, 22 March 2002. https://www.dffe.gov.za/legislation/guidelines

Department of Forestry, Fisheries, and the Environment. (2023). South Africa Protected Areas data 2023, Quarter 1. Data accessed September 2023. https://egis.environment.gov.za/protected_and_conservation_areas_database.

Department of Forests, Fisheries, and the Environment. (2022). Acts and regulations. Retrieved from https://www.dffe.gov.za/legislation/actsregulations. Accessed March 1, 2022.

Desmet PG, Holness S, Skowno A, Egan V. (2013). Limpopo conservation plan. Contract Number LEDET/2216/2012.

Di Minin, E., Hunter, L. T., Balme, G. A., Smith, R. J., Goodman, P. S., & Slotow, R. (2013). Creating larger and better-connected protected areas enhances the persistence of big game species in the Maputaland-Pondoland-Albany biodiversity hotspot. *PloS One*, *8*(8),1–14. https://doi.org/10.1371/journal.pone.0071788

Donald, P. F., Buchanan, G. M., Balmford, A., Bingham, H., Couturier, A. R., de la Rosa Jr, G. E., Gacheru, P., Herzog, S.K., Jathar, G., Kingston, N., & Marnewick, D. (2019). The prevalence, characteristics, and effectiveness of Aichi Target 11' s "other effective area-based conservation measures" (OECMs) in Key Biodiversity Areas. *Conservation Letters*, *12*(5). https://doi.org/10.1111/conl.12659

Dudley, N. (Editor) (2008). *Guidelines for Applying Protected Area Management Categories*. Gland, Switzerland: IUCN. WITH Stolton, S., P. Shadie and N. Dudley (2013). *IUCN WCPA Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types*, Best Practice Protected Area Guidelines Series No. 21, Gland, Switzerland: IUCN.

Duffy, R. (2006). The potential and pitfalls of global environmental governance: The politics of transfrontier conservation areas in Southern Africa. *Political Geography*, *25*(1), 89–112. https://doi.org/10.1016/j.polgeo.2005.08.001

Eken, G., Bennun, L., Brooks, T. M., Darwall, W., Fishpool, L. D., Foster, M., Knox, D., Langhammer, P., Matiku, P., Radford, E., & Salaman, P. (2004). Key biodiversity areas as site conservation targets. *BioScience*, *54*(12), 1110-1118.

Evans, S. W. (2017). An assessment of land cover change as a source of information for conservation planning in the Vhembe Biosphere Reserve. *Applied Geography*, *82*, 35–47.

Farooq, H., Antonelli, A., & Faurby, S. (2023). A call for improving the Key Biodiversity Areas framework. *Perspectives in Ecology and Conservation*, *21*(1), 85-91.

Feng, Y., Wang, Y., Su, H., Pan, J., Sun, Y., Zhu, J., Fang, J., & Tang, Z. (2021). Assessing the effectiveness of global protected areas based on the difference in differences model. *Ecological Indicators*, *130*, 108078. https://doi.org/10.1016/j.ecolind.2021.108078

Fleury, A. M., & Brown, R. D. (1997). A framework for the design of wildlife conservation corridors with specific application to southwestern Ontario. *Landscape and Urban Planning*, *37*(3-4), 163–186. https://doi.org/10.1016/S0169-2046(97)80002-3

Floigl, K., Benedetti, Y., Reif, J., Voříšek, P., & Morelli, F. (2022). Assessing protected area network effectiveness through the temporal change in avian communities' composition. *Journal for Nature Conservation*, *68*, 126222. https://doi.org/10.1016/j.jnc.2022.126222

Ford, A. T., Sunter, E. J., Fauvelle, C., Bradshaw, J. L., Ford, B., Hutchen, J., ... & Teichman, K. J. (2020). Effective corridor width: linking the spatial ecology of wildlife with land use policy. *European Journal of Wildlife Research*, *66*, 1-10. https://doi.org/10.1007/s10344-020-01385-y

Franklin, A. B., Noon, B. R., & George, T. L. (2002). What is habitat fragmentation? *Studies in Avian Biology*, *25*, 20–29.

Freitag, S., Biggs, H., & Breen, C. (2014). The spread and maturation of strategic adaptive management within and beyond South African national parks. *Ecology and Society*, *19*(3). https://dx.doi.org/10.5751/ES-06338-190325

Gaigher, R., Pryke, J. S., & Samways, M. J. (2019). Divergent fire management leads to multiple beneficial outcomes for butterfly conservation in a production mosaic. *Journal of Applied Ecology*, *56*(6), 1322–1332. https://doi.org/10.1111/1365-2664.13357

Galli, A., Wackernagel, M., Iha, K., & Lazarus, E. (2014). Ecological footprint: Implications for biodiversity. *Biological Conservation*, *173*,121-132. https://doi.org/10.1016/j.biocon.2013.10.019

Garrah, E., Danby, R. K., Eberhardt, E., Cunnington, G. M., & Mitchell, S. (2015). Hot spots and hot times: Wildlife road mortality in a regional conservation corridor. *Environmental Management*, *56*, 874–889. https://doi.org/10.1007/s00267-015-0566-1

Geldmann, J., Deguignet, M., Balmford, A., Burgess, N. D., Dudley, N., Hockings, M., ... & Watson, J. E. (2021). Essential indicators for measuring site-based conservation effectiveness in the post-2020 global biodiversity framework. *Conservation Letters*, *14*(4). https://doi.org/10.1111/conl.12792

Gewald, J.B., Spierenburg, M., & Wels, H. (Eds.). (2018). Nature conservation in Southern Africa. Morality and marginality: Towards sentient conservation? Brill. https://brill.com/display/title/39072

Goble, B. J., Lewis, M., Hill, T. R., & Phillips, M. R. (2014). Coastal management in South Africa: Historical perspectives and setting the stage of a new era. *Ocean & Coastal Management*, *91*, 32–40. https://doi.org/10.1016/j.ocecoaman.2014.01.013

Goldman, M. (2009). Constructing connectivity: Conservation corridors and conservation politics in East African rangelands. *Annals of the Association of American Geographers*, *99*(2), 335–359. https://doi.org/10.1080/00045600802708325

Google Scholar. (2022). https://scholar.google.com/. Accessed February 21, 2022.

Goosen, M., & Blackmore, A. C. (2019). Hitchhikers' guide to the legal context of protected area management plans in South Africa. *Bothalia-African Biodiversity & Conservation*, *49*(1), 1–10. https://dx.doi.org/10.4102/abc.v49i1.2399

Graham Bennett. (2004). *Integrating Biodiversity Conservation and Sustainable Use: Lessons Learned From Ecological Networks.* IUCN, Gland, Switzerland, and Cambridge, UK.

Gregory, A. J., & Beier, P. (2014). Response variables for evaluation of the effectiveness of conservation corridors. *Conservation Biology*, *28*(3), 689-695. https://doi.org/10.1111/cobi.12252

Gregory, A., Spence, E., Beier, P., & Garding, E. (2021). Toward best management practices for ecological corridors. *Land*, *10*(2), 140. https://doi.org/10.3390/land10020140

Haddad, N. M., Brudvig, L. A., Damschen, E. I., Evans, D. M., Johnson, B. L., Levey, D. J., & Weldon, A. J. (2014). Potential negative ecological effects of corridors. *Conservation Biology*, *28*(5), 1178-1187. https://doi.org/10.1111/cobi.12323

Haddad, N. M., Rosenberg, D. K., & Noon, B. R. (2000). On experimentation and the study of corridors: response to Beier and Noss. *Conservation Biology*, *14*(5), 1543–1545. https://www.jstor.org/stable/2641807

Hahn, N. (2019). Indigenous vascular plants of the Soutpansberg, South Africa. *Bothalia-African Biodiversity & Conservation*, *49*(1), 1–5.

Hamann, R., Booth, L., & O'riodan, T. (2000). South African environmental policy on the move. *South African Geographical Journal*, *82*(2), 11–22. https://doi.org/10.1080/03736245.2000.9713689

Hansen, S., Roets, F., Seymour, C. L., Thébault, E., van Veen, F. F., & Pryke, J. S. (2018). Alien plants have a more significant impact than habitat fragmentation on native insect flower visitation networks. *Diversity and Distributions*, *24*(1), 58-68. https://doi.org/10.1111/ddi.12656

Hanski, I., & Ovaskainen, O. (2000). The metapopulation capacity of a fragmented landscape. *Nature*, *404*(6779), 755–758. https://doi.org/10.1038/35008063

Hayes, T. M. (2006). Parks, people, and forest protection: an institutional assessment of the effectiveness of protected areas. *World Development*, *34*(12), 2064-2075. https://doi.org/10.1016/j.worlddev.2006.03.002

Hemp, A., & Hemp, C. (2018). Broken bridges: The isolation of Kilimanjaro's ecosystem. *Global Change Biology*, *24*(8), 3499–3507. https://doi.org/10.1111/gcb.14078

Hernández-SaintMartín, A. D., Rosas-Rosas, O. C., Palacio-Núñez, J., Tarango-Arambula, L. A., Clemente-Sánchez, F., & Hoogesteijn, A. L. (2015). Food habits of jaguar and puma in a protected area and adjacent fragmented landscape of Northeastern Mexico. *Natural Areas Journal*, 35(2), 308-317.

Hilty, J. A., Keeley, A. T., Merenlender, A. M., & Lidicker Jr, W. Z. (2019). *Corridor ecology: linking landscapes for biodiversity conservation and climate adaptation*. Island Press.

Hilty, J., Worboys, G. L., Keeley, A., Woodley, S., Lausche, B., Locke, H., Carr, M., Pulsford, I., Pittock, J., White, J.W., & Theobald, D.M. (2020). Guidelines for conserving connectivity through ecological networks and corridors. *Best practice protected area Guidelines Series*, *30*. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2020.PAG.30.en.

Holmes, G. (2013). What role do private protected areas have in conserving global biodiversity? *SRI Working Papers*, (46). https://eprints.whiterose.ac.uk/76968/

Hoveka, L.N., van der Bank, M., & Davies, T.J. (2020). Evaluating the performance of a protected area network in South Africa and its implications for megadiverse countries. *Biological Conservation*, *248*, 1-9.

Hu, Y., Wang, M., Ma, T., Huang, M., Huang, G., Zhou, W., ... & Wei, F. (2022). Integrated index-based assessment reveals long-term conservation progress in implementing the Convention on Biological Diversity. *Science Advances*, *8*(1). https://doi.org/10.1126/sciadv.abj8093

Hudgens, B. R., & Haddad, N. M. (2003). Predicting which species will benefit from corridors in fragmented landscapes from population growth models. *The American Naturalist*, *161*(5), 808-820.

IPBES.(2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.3553579

IPCC. (2014). *Climate Change 2014: Synthesis Report*. *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151. https://www.ipcc.ch/report/ar5/syr/

IUCN (2016). A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition. Gland, Switzerland: IUCN.

Izakovičová, Z., & Świąder, M. (2017). Building ecological networks in Slovakia and Poland. *Ekológia*, *36*(4), 303-322. https://doi.org/10.1515/eko-2017-0025

Jauro, T. I., Tesfamichael, S. G., & Rampedi, I. T. (2020). Tracking conservation effectiveness in the Vhembe Biosphere Reserve in South Africa using Landsat imagery. *Environmental Monitoring and Assessment*, *192*(7), 469. https://doi.org/10.1007/s10661-020-08416-w

Jongman, R. H., Külvik, M., & Kristiansen, I. (2004). European ecological networks and greenways. *Landscape and Urban Planning*, *68*(2-3), 305-319. https://doi.org/10.1016/S0169-2046(03)00163-4

Jongman, R.H. (2019). Connectivity and ecological networks. *Encyclopaedia of Ecology, 1,* 366–376. https://doi.org/10.1016/B978-0-12-409548-9.10619-0

Joubert, L., & Samways, M. J. (2014). Equivalence of grasslands in an ecological network and a World Heritage Site. *Biodiversity and Conservation*, *23*(10), 2415-2426. https://doi.org/10.1007/s10531-014-0730-6

Joubert, L., Pryke, J. S., & Samways, M. J. (2016). Positive effects of burning and cattle grazing on grasshopper diversity. *Insect Conservation and Diversity*, *9*(4), 290-301. https://doi.org/10.1111/icad.12166

Joubert-van der Merwe, L., Pryke, J. S., & Samways, M. J. (2019). Well-managed grassland heterogeneity promotes butterfly conservation in a corridor network. *Journal of Environmental Management*, *238*, 382-395. https://doi.org/10.1016/j.jenvman.2019.03.021

Joubert-van der Merwe, L., Samways, M. J., & Pryke, J. S. (2020). A new protocol for monitoring operational outcomes of environmental management in commercial forestry plantations. *Journal of Environmental Management*, *271*, 110922. https://doi.org/10.1016/j.jenvman.2020.110922

Kamal, S., Grodzińska-Jurczak, M., & Brown, G. (2015). Conservation on private land: a review of global strategies with a proposed classification system. *Journal of Environmental Planning and Management*, *58*(4), 576-597.

Kamuti, T. (2014). The fractured state in the governance of private game farming: the case of KwaZulu-Natal Province, South Africa. *Journal of Contemporary African Studies*, *32*(2), 190–206. https://doi.org/10.1080/02589001.2014.936678

Karlsson, T. M., Arneborg, L., Broström, G., Almroth, B. C., Gipperth, L., & Hassellöv, M. (2018). The unaccountability case of plastic pellet pollution. *Marine Pollution Bulletin*, *129*(1), 52-60. https://doi.org/10.1016/j.marpolbul.2018.01.041

Keeley, A. T., Beier, P., Creech, T., Jones, K., Jongman, R. H., Stonecipher, G., & Tabor, G. M. (2019). Thirty years of connectivity conservation planning: An assessment of

factors influencing plan implementation. *Environmental Research Letters*, *14*(10), 103001. https://doi.org/10.1088/1748-9326/ab3234

Kennedy, C. M., Oakleaf, J. R., Theobald, D. M., Baruch-Mordo, S., & Kiesecker, J. (2019). Managing the middle: A shift in conservation priorities based on the global human modification gradient. *Global Change Biology*, *25*(3), 811-826. https://doi.org/10.1111/gcb.14549

Kepe, T. (2008). Land claims and co-management of protected areas in South Africa: exploring the challenges. *Environmental Management*, *41*(3), 311–321. https://doi.org/10.1007/s00267-007-9034-x

Kepe, T., Wynberg, R., & Ellis, W. (2005). Land reform and biodiversity conservation in South Africa: complementary or in conflict? *The International Journal of Biodiversity Science and Management*, *1*(1), 3–16. https://doi.org/10.1080/17451590509618075

Kettunen, M., Dudley, N., Gorricho, J., Hickey, V., Krueger, L., MacKinnon, K., Oglethorpe, J., Paxton, M., Robinson, J.G., & Sekhran, N. (2021). *Building on Nature: Area-based conservation as a key tool for delivering SDGs*. IEEP, IUCN WCPA, The Nature Conservancy, The World Bank, UNDP, Wildlife Conservation Society and WWF.

Kidd, M. (1999). The national environmental management act and public participation. *South African Journal of Environmental Law and Policy*, *6*(1), 21–31.

Kietzka, G. J., Pryke, J. S., & Samways, M. J. (2015). Landscape ecological networks are successful in supporting a diverse dragonfly assemblage. *Insect Conservation and Diversity*, *8*(3), 229-237. https://doi.org/10.1111/icad.12099

Kietzka, G. J., Pryke, J. S., Gaigher, R., & Samways, M. J. (2021). Webs of well-designed conservation corridors maintain river ecosystem integrity and biodiversity in plantation mosaics. *Biological Conservation*, *254*, 108965. https://doi.org/10.1016/j.biocon.2021.108965

Kikoti, A. (2010). Where Are the Conservation Corridors for Elephants in Saadani National Park and the Lower Wami-Ruvu River Basin of Eastern Tanzania? *Summary Report of Elephant Collaring Operation. Narragansett: Coastal Resources Centre, University of Rhode Island*, 10.

King, N.D., Strydom, H.A., & Retief, F.P. (2018). *Environmental Management in South Africa* 3rd edition, Juta, Cape Town. https://juta.co.za/catalogue/fuggle-rabies-environmental-management-in-south-africa-3e-print_24846

King, S., Ginsburg, A., Driver, A., Belle, E. M. S., Campos, P., Caparrós, A., Zaman, H., & Brown, C. (2023). Accounting for protected areas: Approaches and applications. *Ecosystem Services*, *63*. https://doi.org/10.1016/j.ecoser.2023.101544

Knight, A.T., & Cowling, R.M. (2012). Towards a True Ecology: Exploring the Implications for Conservation of the Human and Social Dimensions of Fencing in the Subtropical

Thicket Biome, South Africa. In: Somers, M., Hayward, M. (eds) *Fencing for Conservation*. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-0902-1_11

Kolipakam, V., Singh, S., Pant, B., Qureshi, Q., & Jhala, Y. V. (2019). Genetic structure of tigers (Panthera tigris tigris) in India and its implications for conservation. *Global Ecology and Conservation*, *20*, 1-12. https://doi.org/10.1016/j.gecco.2019.e00710

Kullberg, P., Di Minin, E., & Moilanen, A. (2019). Using key biodiversity areas to guide effective expansion of the global protected area network. *Global Ecology and Conservation*, *20*. https://doi.org/10.1016/j.gecco.2019.e00768

Laborda, Á., de Oca, L. M., Pérez-Miles, F., Useta, G., & Simó, M. (2018). The spider fauna from Uruguay River islands: understanding its role in a biological corridor. *Biodiversity Data Journal*, (6). https://doi.org/10.3897/BDJ.6.e27319

Landry, J., & Chirwa, P. W. (2011). Analysis of the potential socio-economic impact of establishing plantation forestry on rural communities in Sanga district, Niassa province, Mozambique. *Land Use Policy*, *28*(3), 542–551. https://doi.org/10.1016/j.landusepol.2010.11.001

Langhammer, P. F. (2007). *Identification and gap analysis of key biodiversity areas: targets for comprehensive protected area systems* (No. 15). IUCN.

Le Saout, S., Hoffmann, M., Shi, Y., Hughes, A., Bernard, C., Brooks, T.M., Bertzky, B., Butchart, S.H., Stuart, S.N., Badman, T., & Rodrigues, A.S. (2013). Protected areas and effective biodiversity conservation. *Science*, *342*(6160), 803–805. http://doi.org/10.1126/science.1239268

Limpopo Provincial Government. (2023). Limpopo Spatial Development Framework Phase 2: Spatial Analysis Report.*Part C: Socio-Economic Analysis. https://www.limpopo.gov.za/webDocs/SDF/C_LSDF_Spatial_Analysis_Socio-Economic_Environment.pdf*

Lindenmayer, D. B., & Hobbs, R.J. (2007). *Managing and designing landscapes for conservation: moving from perspectives to principles*. John Wiley & Sons.

Lipsey, M. K., & Hockey, P. A. (2010). Do ecological networks in South African commercial forests benefit grassland birds? A case study of a pine plantation in KwaZulu-Natal. *Agriculture, Ecosystems & Environment*, *137*(1-2), 133-142. https://doi.org/10.1016/j.agee.2010.01.013

Lombard, A. T., Cowling, R. M., Vlok, J. H., & Fabricius, C. (2010). Designing conservation corridors in production landscapes: assessment methods, implementation issues, and lessons learned. *Ecology and Society*, *15*(3).

Lopes, M. S., Veettil, B. K., & Saldanha, D. L. (2021). Buffer zone delimitation of conservation units based on map algebra and AHP technique: A study from Atlantic Forest Biome (Brazil). *Biological Conservation*, *253*. https://doi.org/10.1016/j.biocon.2020.108905

Ma, A. T., Chow, A. S., Cheung, L. T., Lee, K. M., & Liu, S. (2018). Impacts of tourists' sociodemographic characteristics on the travel motivation and satisfaction: The case of protected areas in South China. *Sustainability*, *10*(10), 3388. https://doi.org/10.3390/su10103388

Malanson, G. P. (2002). Extinction-debt trajectories and spatial patterns of habitat destruction. *Annals of the Association of American Geographers*, *92*(2), 177-188. https://doi.org/10.1111/1467-8306.00285

Martínez-Alier, J. (2001). Wilderness Versus the Environmentalism of South Africa's Poor? *Capitalism Nature Socialism*, *12*(3), 99-103. https://doi.org/10.1080/104557501101245153

Mathur, P. K., & Sinha, P. R. (2008). Looking beyond protected area networks: a paradigm shift in approach for biodiversity conservation. *International Forestry Review*, *10*(2), 305–314. https://doi.org/10.1505/ifor.10.2.305

Mbane, J. O., Chira, R. M., & Mwangi, E. M. (2019). Impact of land use and tenure changes on the Kitenden wildlife corridor, Amboseli Ecosystem, Kenya. *African Journal of Ecology*, *57*(3), 335-343. https://doi.org/10.1111/aje.12611

Mehta, J. N., & Kellert, S. R. (1998). Local attitudes toward community-based conservation policy and programmes in Nepal: a case study in the Makalu-Barun Conservation Area. *Environmental Conservation*, *25*(4), 320-333. https://doi.org/10.1017/S037689299800040X

Mirza, S. R., Thomsen, J. M., Wurtzebach, Z., Oppler, G., & Halvorson, S. J. (2023). Examining factors influencing the governance of large landscape conservation initiatives. In *Parks Stewardship Forum* (Vol. 39, No. 3). https://doi.org/10.5070/P539362014

Mondi Group. (2023). How we monitor the biodiversity value of our South African forestry landholdings. https://www.mondigroup.com/news-and-insight/2023/how-we-monitor-the-biodiversity-value-of-our-south-african-forestry-landholdings/. Accessed January 2024.

Mora, C., & Sale, P. F. (2011). Ongoing global biodiversity loss and the need to move beyond protected areas: a review of the technical and practical shortcomings of protected areas on land and sea. *Marine Ecology Progress Series*, *434*, 251-266. https://doi.org/10.3354/meps09214

Munthali, S. M. (2007). Transfrontier conservation areas: Integrating biodiversity and poverty alleviation in Southern Africa. *Natural Resources Forum, 31*(1), 51-60. https://doi.org/10.1111/j.1477-8947.2007.00130.x

Nagendra, H. (2008). Do parks work? Impact of protected areas on land cover clearing. *AMBIO: A Journal of the Human Environment*, *37*(5), 330–337.

Nazeer, M., Tabassum, U., & Alam, S. (2016). Environmental pollution and sustainable development in developing countries. *The Pakistan Development Review*, *55,* 589–604. https://www.jstor.org/stable/44986005

Neelakantan, A., DeFries, R., & Krishnamurthy, R. (2019). Resettlement and landscape-level conservation: Corridors, human-wildlife conflict, and forest use in Central India. *Biological Conservation*, *232*, 142–151. https://doi.org/10.1016/j.biocon.2019.01.033

Nel, J.L., Le Maitre, D.C., Roux, D.J., Colvin, C., Smith, J.S., Smith-Adao, L.B., Maherry, A., & Sitas, N. (2017). Strategic water source areas for urban water security: Making the connection between protecting ecosystems and benefiting from their services. *Ecosystem Services*, *28*, 251–259. https://doi.org/10.1016/j.ecoser.2017.07.013

Neva, S. M. (2021). Learning from experience: Special Economic Zones in Southern Africa (WIDER Working Paper No. 2021/124). The United Nations University World Institute for Development Economics Research (UNU-WIDER). https://doi.org/10.35188/UNU-WIDER/2021/064-1

Newmark, W. D. (1996). Insularization of Tanzanian Parks and the local extinction of large mammals. *Conservation Biology, 10*, 1549–1556. https://doi.org/10.1046/j.1523-1739.1996.10061549.x

Newmark, W. D. (2008). Isolation of African protected areas. *Frontiers in Ecology and the Environment*, *6*(6), 321–328. https://doi.org/10.1890/070003

Ngubane, M., & Brooks, S. (2013). Land beneficiaries as game farmers: conservation, land reform and the invention of the 'community game farm in KwaZulu-Natal. *Journal of Contemporary African Studies*, *31*(3), 399–420. https://doi.org/10.1080/02589001.2013.811790

Noor, S., Tajik, O., & Golzar, J. (2022). Simple random sampling. *International Journal of Education & Language Studies*, *1*(2), 78-82. https://doi.org/10.22034/ijels.2022.162982

Oberosler, V., Tenan, S., Zipkin, E. F., & Rovero, F. (2020). Poor management in protected areas is associated with lowered tropical mammal diversity. *Animal conservation*, *23*(2), 171-181.

Obura, D. (2023). The Kunming-Montreal Global Biodiversity Framework: Business as usual or a turning point? *One Earth*, *6*(2), 77–80.

Olivier, L. (2013). Bossiedokters and the challenges of nature co-management in the Boland area of South Africa's Western Cape. *Journal of Contemporary African Studies*, *31*(3), 361–379. https://doi.org/10.1080/02589001.2013.804246

Ortega-Cisneros, K., Scharler, U. M., & Whitfield, A. K. (2016). Carbon and nitrogen system dynamics in three small South African estuaries, with particular emphasis on the influence of seasons, river flow and mouth state. *Marine Ecology Progress Series*, *557*, 17-30. https://doi.org/10.3354/meps11870

Palfrey, R., Oldekop, J. A., & Holmes, G. (2022). Privately protected areas increase global protected area coverage and connectivity. *Nature Ecology & Evolution*, *6*(6), 730-737.

Perkin, J. S., & Gido, K. B. (2012). Fragmentation alters stream fish community structure in dendritic ecological networks. *Ecological Applications*, *22*(8), 2176-2187. https://doi.org/10.1890/12-0318.1

Petersen, L., Reid, A. M., Moll, E. J., & Hockings, M. T. (2017). Perspectives of wild medicine harvesters from Cape Town, South Africa. *South African Journal of Science*, *113*(9-10), 1–8. https://dx.doi.org/10.17159/sajs.2017/20160260

Pierce, S. M., Cowling, R. M., Knight, A. T., Lombard, A. T., Rouget, M., & Wolf, T. (2005). Systematic conservation planning products for land-use planning: interpretation for implementation. *Biological Conservation*, *125*(4), 441–458. https://doi.org/10.1016/j.biocon.2005.04.019

Pievani, T. (2014). The sixth mass extinction: Anthropocene and the human impact on biodiversity. *Rendiconti Lincei*, *25*(1), 85-93. https://doi.org/10.1007/s12210-013-0258-9

Pili, S., Serra, P., & Salvati, L. (2019). Landscape and the city: Agro-forest systems, land fragmentation and the ecological network in Rome, Italy. *Urban Forestry & Urban Greening*, *41*, 230-237. https://doi.org/10.1016/j.ufug.2019.04.016

Potts, A. J., Hedderson, T. A., & Cowling, R. M. (2013). Testing large-scale conservation corridors designed for patterns and processes: comparative phylogeography of three tree species. *Diversity and Distributions*, *19*(11), 1418–1428. https://doi.org/10.1111/ddi.12113

Pryke, J. S., & Samways, M. J. (2012). Ecological networks act as extensions of protected areas for arthropod biodiversity conservation. *Journal of Applied Ecology*, *49*(3), 591-600. https://doi.org/10.1111/j.1365-2664.2012.02142.x

Pryke, J. S., & Samways, M. J. (2015). Conserving natural heterogeneity is crucial for designing effective ecological networks. *Landscape Ecology*, *30*(4), 595-607. https://doi.org/10.1007/s10980-014-0096-x

Pryke, J. S., Samways, M. J., & De Saedeleer, K. (2015). An ecological network is as good as a major protected area for conserving dragonflies. *Biological Conservation*, *191*, 537-545. https://doi.org/10.1016/j.biocon.2015.07.036

Pulsford, I., Worboys, G. L., Gough, J., & Shepherd, T. (2004). The Australian Alps and the great escarpment of eastern Australia conservation corridors. In *Harmon, D., and Worboys, G.(Eds.)*, *A Potential New Continental-scale Conservation Corridor for*

Australia: Combining the Australian Alps and the Great Escarpment of Eastern Australia Conservation Corridors (pp. 105–119). https://doi.org/10.1659/0276-4741(2003)023[0291:APNCCC]2.0.CO;2

Quinlan, T. (1993). South Africa's integrated environmental management policy at the crossroads of conservation and development. *Development Southern Africa*, *10*(2), 229–238. https://doi.org/10.1080/03768359308439685

Qureshi, M.I., Rasli, A.M., Awan, U., Ma, J., Ali, G., Alam, A., Sajjad, F., & Zaman, K. (2015). Environment and air pollution: health services bequeath to grotesque menace. *Environmental Science and Pollution Research*, *22*(5),3467-3476. https://doi.org/10.1007/s11356-014-3584-2

Rabie, A. (1989). Rationalisation of environmental legislation. *SA Public Law*, *4*(2), 272-278. https://hdl.handle.net/10520/AJA02586568_613

Rahman, M. F., & Islam, K. (2021). Effectiveness of protected areas in reducing deforestation and forest fragmentation in Bangladesh. *Journal of Environmental Management*, *280*. https://doi.org/10.1016/j.jenvman.2020.111711

Ramutsindela, M. (2004). *Parks and people in postcolonial societies: experiences in southern Africa* (Vol. 79) Springer. https://link.springer.com/book/10.1007/1-4020-2843-1

Regional Office for Southern and Eastern Africa. (2023). South Africa Subnational Administrative Boundaries. Data accessed in August 2023. https://data.humdata.org/dataset/cod-ab-zaf

Ren, Z., & Gao, H. (2019). Ecological networks reveal contrasting patterns of bacterial and fungal communities in glacier-fed streams in Central Asia. *PeerJ*, *7*. https://doi.org/10.7717/peerj.7715

Republic of South Africa. (1976). National Parks Act (Act No. 57 of 1976). In Government Gazette, 130 (5096).

Republic of South Africa. (1982). Environmental Conservation Act (Act 100 of 1982). In Government Gazette, 2587.

Republic of South Africa. (1989). Environmental Conservation Act (Act 73 of 1989). In Government Gazette, 288 (11927).

Republic of South Africa. (1996). The Constitution of the Republic of South Africa (Act 108 of 1996). In Government Gazette, 378 (17678).

Republic of South Africa. (1998). National Environmental Management Act (Act 107 of 1998). In Government Gazette, 401 (19519).

Republic of South Africa. (2003). National Environmental Management Act: Protected Areas Act (Act 57 of 2003). In Government Gazette, 464 (26025).

Republic of South Africa. (2004). National Environmental Management: Biodiversity Act (Act 10 of 2004). In Government Gazette, 467, (26436).

Republic of South Africa. (2005). Department of Environmental Affairs and Tourism, National Biodiversity Strategy and Action Plan 2005.

Republic of South Africa. (2008). Department of Environmental Affairs, National Protected Areas Expansion Strategy.

Republic of South Africa. (2009). The National Environmental Management Act: Biodiversity Act: National Biodiversity Framework. In Government Gazette 32474.

Republic of South Africa. (2015). Department of Environmental Affairs, National Biodiversity Strategy and Action Plan 2015- 2025.

Republic of South Africa. (2016). Department of Environmental Affairs, National Protected Areas Expansion Strategy.

Republic of South Africa. (2021). The National Environmental Management Act: Biodiversity Act: National Biodiversity Framework. In Government Gazette 44229.

Reyers, B., O'Farrell, P. J., Nel, J. L., & Wilson, K. (2012). Expanding the conservation toolbox: conservation planning of multifunctional landscapes. *Landscape Ecology*, *27*(8), 1121-1134. https://doi.org/10.1007/s10980-012-9761-0

Riemann, H., & Ezcurra, E. (2005). Plant endemism and natural protected areas in the peninsula of Baja California, Mexico. *Biological Conservation*, *122*(1), 141–150. https://doi.org/10.1016/j.biocon.2004.07.008

Rissman, A. R. (2013). Rethinking property rights: a comparative analysis of conservation easements for wildlife conservation. *Environmental Conservation*, *40*(3), 222-230. https://doi.org/10.1017/S0376892913000015

Roberto, I. J., Oliveira, C. R. D., ARAÚJO, J. A. D., Oliveira, H. F. D., & Ávila, R. W. (2017). The herpetofauna of the Serra do Urubu mountain range: a key biodiversity area for conservation in the Brazilian Atlantic Forest. *Papéis Avulsos de Zoologia*, *57*, 347-373.

Roever, C. L., Van Aarde, R. J., & Leggett, K. (2013). Functional connectivity within conservation networks: Delineating corridors for African elephants. *Biological Conservation*, *157*, 128-135. https://doi.org/10.1016/j.biocon.2012.06.025

Rosenthal, A., Stutzman, H., & Forsyth, A. (2012). Creating mosaic-based conservation corridors to respond to major threats in the Amazon headwaters. *Ecological Restoration*, *30*(4), 296-299.

Rouget, M., Cowling, R. M., Lombard, A. T., Knight, A. T., & Kerley, G. I. (2006). Designing large-scale conservation corridors for pattern and process. *Conservation Biology*, *20*(2), 549–561. https://doi.org/10.1111/j.1523-1739.2006.00297.x

Rouget, M., Cowling, R. M., Pressey, R. L., & Richardson, D. M. (2003). Identifying spatial components of ecological and evolutionary processes for regional conservation planning in the Cape Floristic Region, South Africa. *Diversity and Distributions*, *9*(3), 191–210. https://doi.org/10.1046/j.1472-4642.2003.00025.x

Ryan, S. J., & Hartter, J. (2012). Beyond the ecological success of corridors: integrating land use history and demographic change to provide a whole landscape perspective. *Ecological Restoration*, *30*(4), 320-328. https://doi.org/10.3368/er.30.4.320

Samways, M. J., & Pryke, J. S. (2016). Large-scale ecological networks do work in an ecologically complex biodiversity hotspot. *Ambio*, *45*(2), 161-172. https://doi.org/10.1007/s13280-015-0697-x

Samways, M. J., Bazelet, C. S., & Pryke, J. S. (2010). Provision of ecosystem services by large-scale corridors and ecological networks. *Biodiversity and Conservation*, *19*(10), 2949-2962. https://doi.org/10.1007/s10531-009-9715-2

Samways, M.J. (2007). Implementing ecological networks for conserving insects and other biodiversity. In: Stewart, A.J.A., New, T.R., Lewis, O.T. (Eds.), *Insect Conservation Biology.* CABI, Wallingford, UK, pp. 127–143.

Sandker, M., Campbell, B. M., Ruiz-Pérez, M., Sayer, J. A., Cowling, R., Kassa, H., & Knight, A. T. (2010). The role of participatory modelling in landscape approaches to reconcile conservation and development. *Ecology and Society*, *15*(2).

Saura, S., Bertzky, B., Bastin, L., Battistella, L., Mandrici, A., & Dubois, G. (2019). Global trends in protected area connectivity from 2010 to 2018. *Biological Conservation*, *238*, 108183. https://doi.org/10.1016/j.biocon.2019.07.028

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.L., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A.K., Day, M., Garcia, C., & Van Oosten, C. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences*, *110*(21), 8349-8356. https://doi.org/10.1073/pnas.1210595110

Sayer, J. A., Margules, C., Boedhihartono, A. K., Sunderland, T., Langston, J. D., Reed, J., ... & Purnomo, A. (2017). Measuring the effectiveness of landscape approaches to conservation and development. *Sustainability Science*, *12*, 465-476. https://doi.org/10.1007/s11625-016-0415-z

Scharler, U. M., & Baird, D. (2005). The filtering capacity of selected Eastern Cape estuaries, South Africa. *Water SA*, *31*(4), 483-490. https://doi.org/10.4314/wsa.v31i4.5139

Scholtz, M., Kruger, M., & Saayman, M. (2013). Understanding the reasons why tourists visit the Kruger National Park during a recession. *Acta Commercii*, *13*(1), 1-9.

Schröter, M., Berbés-Blázquez, M., Albert, C., Hill, R., Krause, T., Loos, J., Mannetti, L.M., Martín-López, B., Neelakantan, A., Parrotta, J.A. and Quintas-Soriano, C., & van Oudenhoven, A. (2023). Science on ecosystems and people to support the Kunming-Montreal Global Biodiversity Framework. *Ecosystems and People*, *19*(1). https://doi.org/10.1080/26395916.2023.2220913

SCOPUS. (2022). https://www.scopus.com/. Accessed February 11 and 21, 2022.

Shafaghat, A., Keyvanfar, A., & Ket, C. W. (2022). A decision support tool for evaluating the wildlife corridor design and conservation performance using an analytic network process (ANP). *Journal for Nature Conservation*, *70*, 126280. https://doi.org/10.1016/j.jnc.2022.126280

Sharma, E., Chettri, N., Gurung, J., & Shakya, B. (2007). The Landscape Approach in Biodiversity Conservation. In *A Regional Cooperation Framework for Implementation of the Convention on Biological Diversity in the Kangchenjunga Landscape. ICIMOD, Kathmandu, Nepal*.

Shikwambana, S., Malaza, N., & Shale, K. (2021). Impacts of rainfall and temperature changes on smallholder agriculture in the Limpopo Province, South Africa. *Water*, *13*(20), 2872. https://doi.org/10.3390/w13202872

Simberloff, D., & Cox, J. (1987). Consequences and costs of conservation corridors. *Conservation Biology*, *1*(1), 63-71. https://doi.org/10.1111/j.1523-1739.1987.tb00010

Sims, K. R. (2014). Do protected areas reduce forest fragmentation? A microlandscapes approach. *Environmental and Resource Economics*, *58*, 303–333.

Sinthumule, N. I. (2017). Resistance against conservation at the South African section of Greater Mapungubwe (trans) frontier. *Africa Spectrum*, *52*(2), 53-77. https://doi.org/10.1177/000203971705200203

South African National Biodiversity Institute. (2005). National Spatial and Biodiversity Assessment 2004. http://bgis.sanbi.org/Projects/Detail/55

South African National Biodiversity Institute. (2012). National Biodiversity Assessment 2011. http://bgis.sanbi.org/nba/project.asp

South African National Biodiversity Institute. (2018). Limpopo Province Map of Critical Biodiversity Areas and Ecological Support Areas. Data accessed August 2022. http://bgis.sanbi.org/SpatialDataset/Detail/5707

South African National Biodiversity Institute. (2019). National Biodiversity Assessment 2018. http://biodiversityadvisor.sanbi.org/planning-and-assessment/national-biodiversity-assessment-nba-2018/

South African Spatial Data Infrastructure. (2022). Land use and land cover in Limpopo. Data accessed August 2022. http://www.sasdi.net/sresults.aspx?text=Elevation&f_text=Limpopo&offset=0

Sowman, M., & Malan, N. (2018). Review of progress with integrated coastal management in South Africa since the advent of democracy. *African Journal of Marine Science*, *40*(2), 121–136. https://doi.org/10.2989/1814232X.2018.1468278

Sowman, M., Fuggle, R., & Preston, G. (1995). A review of the evolution of environmental evaluation procedures in South Africa. *Environmental Impact Assessment Review*, *15*(1), 45–67. https://doi.org/10.1016/0195-9255(94)00004-K

Sowno, A.L., Poole, C.J., Raimondo, D.C., Sink, K.J., Van Deventer, H., Van Niekerk, L., Harris, L.R., Smith Adao, L.B., Tolley, K.A., Zengeya, T.A., Foden, W.B., Midgley, G.F., & Driver, A. (2019). National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. 1–214.

Statistics South Africa. (2021). *Natural Capital Series 2: Accounts for Protected Areas, 1900 to 2020.* Discussion document D0401.2. Produced in collaboration with the South African National Biodiversity Institute and the Department of Forestry, Fisheries and the Environment. Statistics. South Africa, Pretoria.

Steyn, P. (2001). Environmental management in South Africa: twenty years of governmental response to the global challenge, 1972-1992. *Historia*, *46*(1), 25-53. https://hdl.handle.net/10520/EJC38020

Steyn, P., & Wessels, A. (2000). The Emergence of New Environmentalism in South Africa, 1988-1992. *South African Historical Journal*, *42*(1), 210–231. https://doi.org/10.1080/02582470008671375

Stoll-Kleemann, S., & O'Riordan, T. (2002). From participation to partnership in biodiversity protection: experience from Germany and South Africa. *Society & Natural Resources*, *15*(2), 161–177. https://doi.org/10.1080/089419202753403337

Stolton, S., & Dudley, N. (2010). *Arguments for protected areas: multiple benefits for conservation and use*. Routledge.

Strydom, H. A., & King, N. D. (2009). *Environmental Management in South Africa*. Juta and Company Ltd. Cape Town

Swemmer, L., Mmethi, H., & Twine, W. (2017). Tracing the cost/benefit pathway of protected areas: A case study of the Kruger National Park, South Africa. *Ecosystem services*, *28*, 162-172. https://doi.org/10.1016/j.ecoser.2017.09.002

Terblanche, R. F. (2018). Nectar plants, pollination and implications for dispersal corridors of the Critically Endangered Callioratis millari (Lepidoptera: Geometridae, Diptychini). *Metamorphosis*, *29*, 47-50.

Theron, K. J., Pryke, J. S., & Samways, M. J. (2022). Identifying managerial legacies within conservation corridors using remote sensing and grasshoppers as bioindicators. *Ecological Applications*, *32*(1). https://doi.org/10.1002/eap.2496

Tie, X., & Cao, J. (2009). Aerosol pollution in China: Present and future impact on the environment. *Particuology*, *7*(6), 426-431. https://doi.org/10.1016/j.partic.2009.09.003

Timmers, R., van Kuijk, M., Verweij, P. A., Ghazoul, J., Hautier, Y., Laurance, W. F., Arriaga-Weiss, S.L., Askins, R.A., Battisti, C., Berg, Å., & Daily, G.C. (2022). Conservation of birds in fragmented landscapes requires protected areas. *Frontiers in Ecology and the Environment*, *20*(6), 361–369.

Tolley, K.A., Weeber, J., Maritz, B., Verburgt, L., Bates, M.F., Conradie, W., Hofmeyr, M.D., Turner, A.A., Da Silva, J.M., & Alexander, G.J. (2019). No safe haven: protection levels show imperilled South African reptiles not sufficiently safe-guarded despite low average extinction risk. *Biological Conservation*, *233*, 61-72. https://doi.org/10.1016/j.biocon.2019.02.006

Topi, H., & Lucas, W. (2005). Mix and match: combining terms and operators for successful Web searches. *Information Processing & Management*, *41*(4), 801–817. https://doi.org/10.1016/j.ipm.2004.03.007

Townsend, P. A., & Masters, K. L. (2015). Lattice-work corridors for climate change: A conceptual framework for biodiversity conservation and social-ecological resilience in a tropical elevational gradient. *Ecology and Society*, *20*(2).

Travers, E., Härdtle, W., & Matthies, D. (2021). Corridors as a tool for linking habitats–Shortcomings and perspectives for plant conservation. *Journal for Nature Conservation*, *60*, 125974. https://doi.org/10.1016/j.jnc.2021.125974

Tshehla, C., & Wright, C. Y. (2019). 15 years after the National Environmental Management Air Quality Act: Is legislation failing to reduce air pollution in South Africa? *South African Journal of Science*, *115*(9-10), 1-4. http://dx.doi.org/10.17159/sajs.2019/6100

UNEP-WCMC. (2022, November). *November 2022 update of the WDPA and WD-OECM.* https://www.protectedplanet.net/en/resources/november-2022-update-of-the-wdpa-and-wd-oecm

Union of South Africa. (1913). The Natives Land Act (Act 27 of 1913).

Union of South Africa. (1936). The Natives Land Act (Act 18 of 1936).

University of the Witwatersrand. (2022). Environmental Affairs: Policy Documents/Acts. Retrieved from https://libguides.wits.ac.za/c.php?g=145459&p=952320. Accessed March 1, 2022.

van Schalkwyk, J., Kietzka, G. J., Pryke, J. S., Gaigher, R., & Samways, M. J. (2023). Enhancing semi-aquatic species representativeness beyond protected areas: dragonflies in networks of conservation corridors. *Biodiversity and Conservation*, 1-15.

van Schalkwyk, J., Pryke, J. S., & Samways, M. J. (2017). Wide corridors with much environmental heterogeneity best conserve high dung beetle and ant diversity. *Biodiversity and Conservation*, *26*(5), 1243-1256. https://doi.org/10.1007/s10531-017-1299-7

van Schalkwyk, J., Pryke, J. S., & Samways, M. J. (2019). Contribution of common vs. rare species to species diversity patterns in conservation corridors. *Ecological Indicators*, *104*, 279-288. https://doi.org/10.1016/j.ecolind.2019.05.014

van Schalkwyk, J., Pryke, J. S., Samways, M. J., & Gaigher, R. (2020). Corridor width determines the strength of edge influence on arthropods in conservation corridors. *Landscape Ecology*, *35*(5), 1175–1185. https://doi.org/10.1007/s10980-020-01008-6

Venter, O., Fuller, R.A., Segan, D.B., Carwardine, J., Brooks, T., Butchart, S.H., Di Marco, M., Iwamura, T., Joseph, L., O'Grady, D., & Possingham, H.P. (2014). Targeting global protected area expansion for imperilled biodiversity. *PLoS Biology*, *12*(6). https://doi.org/10.1371/journal.pbio.1001891

Venter, O., Magrach, A., Outram, N., Klein, C. J., Possingham, H. P., Di Marco, M., & Watson, J. E. (2018). Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. *Conservation Biology*, *32*(1), 127–134.

von Staden, L., Lötter, M. C., Holness, S., & Lombard, A. T. (2022). An evaluation of the effectiveness of Critical Biodiversity Areas, identified through a systematic conservation planning process, to reduce biodiversity loss outside protected areas in South Africa. *Land Use Policy*, *115*, 106044. https://doi.org/10.1016/j.landusepol.2022.106044

Watson, J. E., Dudley, N., Segan, D. B., & Hockings, M. (2014). The performance and potential of protected areas. *Nature*, *515*(7525), 67–73.

West, S., Cairns, R., & Schultz, L. (2016). What constitutes a successful biodiversity corridor? A Q-study in the Cape Floristic Region, South Africa. *Biological Conservation*, *198*, 183–192. https://doi.org/10.1016/j.biocon.2016.04.019

Whitelaw, G. S., & Eagles, P. F. (2007). Planning for long, wide conservation corridors on private lands in the Oak Ridges Moraine, Ontario, Canada. *Conservation Biology*, *21*(3), 675–683. https://doi.org/10.1111/j.1523-1739.2007.00708.x

Wilson, M.C., Chen, X.Y., Corlett, R.T., Didham, R.K., Ding, P., Holt, R.D., Holyoak, M., Hu, G., Hughes, A.C., Jiang, L., & Laurance, W.F. (2016). Habitat fragmentation and biodiversity conservation: key findings and future challenges. *Landscape Ecology,* 31, 219–227. https://doi.org/10.1007/s10980-015-0312-3

Woodley, S., Bertzky, B., Crawhall, N., Dudley, N., Londoño, J. M., MacKinnon, K., ... & Sandwith, T. (2012). Meeting Aichi Target 11: what does success look like for protected area systems? *Parks*, *18*(1), 23-36.

Wylie, D. K., Bhattacharjee, S., & Rampedi, I. T. (2018). Evaluating the quality of environmental impact reporting for proposed tourism-related infrastructure in the protected areas of South Africa: A case study on selected EIA reports. *African Journal of Hospitality, Tourism and Leisure, 7*(*3)*,1–14. https://www.ajhtl.com/uploads/7/1/6/3/7163688/article_21_vol_7_3__2018.pdf

Wynberg, R. (2002). A decade of biodiversity conservation and use in South Africa: tracking progress from the Rio Earth Summit to the Johannesburg World Summit on Sustainable Development. *South African Journal of Science*, *98*(5), 233–243.

Xu, H., Cao, Y., Yu, D., Cao, M., He, Y., Gill, M., & Pereira, H. M. (2021). Ensuring effective implementation of the post-2020 global biodiversity targets. *Nature Ecology & Evolution*, *5*(4), 411-418. https://doi.org/10.1038/s41559-020-01375-y

Zafra-Calvo, N., & Moreno-Peñaranda, R. (2018). Exploring local people's views on the livelihood impacts of privately versus community-managed conservation strategies in the Ruvuma landscape of North Mozambique-South Tanzania. *Journal of Environmental Management*, *206*, 853-862. https://doi.org/10.1016/j.jenvman.2017.11.065

Zhakata, E., Gundani, S. R., Chauke, V., & Odeku, K. O. (2016, October). *A critic of NEMA: Waste Act 59 of 2008, so many promises, little implementation and enforcement.* The 5th Annual Conference on "20 years of South Africa's Post-Apartheid Local Government Administration, Mokopane, South Africa. https://hdl.handle.net/10386/1652

APPENDICES

APPENDIX A

Interviews, surveys, consent form, and information sheet

Interview for the researchers in relevant fields and representatives from SANParks, PeaceParks, African Parks and Boundless Southern Africa.

1. What is your occupation?

   _____

2. Which organisation do you work for?

   _____

3. What research have you done or encountered focusing on South Africa conservation corridors?

   _____

   _____

4. What is your understanding of a conservation corridor?

   _____

   _____

   _____

5. Not including COVID-19, what do you think is the biggest challenge to conservation in South Africa?

   _____

   _____

   _____

6. Could conservation corridors be an effective tool to alleviate and manage this challenge? *Please elaborate*

   _____

   _____

   _____

7. Do you think private and national reserves can and should be linked through a corridor? *Please explain how or why*

   _____

   _____

   _____

8. What are the ideal conditions for establishing a corridor, and what factors would hinder its establishment?

_____

_____

_____

9. How many reserves should be in a conservation network?

Two connected reserves	Three connected reserves	Four connected reserves	More than four

10. What is the optimal width of a conservation corridor?

Around 50m	Around 100m	Around 200m	Around 1 km	Around 2 km	Other (please specify)

11. How do conservation corridors differ from Ecological Networks and Transfrontier Conservation Areas?

_____

_____

12. What do we currently know regarding conservation corridors in South Africa, and which aspects remain unexplored?

_____

_____

Survey distributed to community members.

1. How old are you? *(Please tick the appropriate box)*

18-30	31-40	41-50	51-60	61+

2. What is your gender? *(Please tick the appropriate box)*

Male	Female	I prefer not to say

3. What is your highest level of education? *(Please tick the appropriate box)*

Primary school	High school	Diploma	University degree	Other *(Please specify)*

4. What municipality do you live in? *(Please tick the appropriate box)*

Musina	Thulamela	Makhado	Collins Chabane	Not from Vhembe

5. Please fill in the table below. *(Tick all the things you do in Vhembe)*

Visit nature reserves	Collect wood from forests or the bush	Collect water from rivers	Farm	Hunt wildlife	Collect plants and herbs

6. What sector do you work in? *(Please tick the appropriate box)*

Manufacturing	Education/ student	Tourism	Agriculture	Mining	Transport	Unemployed	Other (Please specify)

7. What does conservation of the environment mean to you? *(Please tick one option)*
   - ☐ Protecting plants and animals.
   - ☐ Isolating land for the exclusive use of plants and animals.
   - ☐ People living in harmony with nature.
   - ☐ People using nature wisely.

8. Do you visit the area around the Soutpansberg Mountain Range? *(Please tick)*
   - ☐ Yes
   - ☐ No

9. If yes, why do you visit the area? *(Please tick)*
   - ☐ Tourism
   - ☐ Work
   - ☐ Other

10. Do you visit the Mapungubwe National Park? *(Please tick)*
    - ☐ Yes
    - ☐ No

11. If yes, why do you visit the area? *(Please tick)*
    - ☐ Tourism
    - ☐ Work
    - ☐ Other

12. Do you visit any other nature reserves? *(Please tick)*
    - ☐ Yes
    - ☐ No

13. If so, which ones are available, and what do you do?

    _____
    _____

14. Would you be willing to work in the tourism or environmental sector if jobs opened up? *(Please tick)*
    - ☐ Yes
    - ☐ No

15. Do you think nature reserves should be accessible to the local community? *(Please tick)*
    - ☐ Yes
    - ☐ No

16. Do you think nature reserves can be used to develop communities, improve infrastructure, attract tourists, create jobs, and reduce poverty in the community? *(Please tick)*
    - ☐ Yes
    - ☐ No

17. Do you think there should be large, combined private and public nature reserves in Vhembe? *(Please tick)*

☐ Yes
☐ No

18. Do you think expanding and linking nature reserves would benefit you? *(Please tick)*
    ☐ Yes
    ☐ No

Thank you for your participation.

Information form:

Research conducted under the clearance of the University of the Witwatersrand,
(011) 717 1000
1 Jan Smuts Avenue
Braamfontein 2000
Johannesburg, South Africa

Good day, Sir/Madam.

My name is Alexandra Dalziel, and I am a PhD student registered in the School of Geography, Archaeology and Environmental Studies, pursuing my studies in the Department of Geography and Environmental Studies. Part of the requirements for these studies entails the completion of a thesis, which a research process should inform. Under the supervision of Dr Mary Evans, I am currently investigating how conservation corridors, linked pieces of land that protect biodiversity, can promote sustainable environmental management in South Africa. My study site is the Vhembe District in Limpopo. My study has two aims. Firstly, to investigate the extent to which conservation corridors can be used as a mechanism for environmental management and conservation. Secondly, to establish whether implementing a corridor in the Vhembe District will promote sustainable conservation and contribute to the area's socio-economic development.

As part of this study, I would like to invite you, as an interested party, to fill in my survey. Please note that participation in the study is entirely voluntary. The interview will involve filling out a survey with questions about the area and its protected areas. It will take around 15 minutes to complete.

It is important to note that you will not receive any monetary or direct benefits from participating in this study. If you wish not to participate, please note that there are no disadvantages or penalties. Questions may be left out if you feel uncomfortable, and you may withdraw your participation anytime. The survey will be completely confidential and anonymous, and the information you give me will be held securely and not disclosed to anyone else.

If you have any questions afterwards, feel free to contact me.
If you have any concerns regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee, and you can find the contact details below.

Yours sincerely,
Researcher:
Alexandra Dalziel, 803031@students.wits.ac.za
Supervisor:
Dr Mary Evans, Mary.Evans@wits.ac.za, 011 717 6516

University Human Research Ethics Committee (non-medical) contact details:
Telephone, +27 (0)11 717 1408, email hrecnon-medical@wits.ac.za

Consent form:

Research conducted under the clearance of the University of the Witwatersrand,
(011) 717 1000
1 Jan Smuts Avenue
Braamfontein 2000
Johannesburg, South Africa

I agree to fill in the survey for the purpose of the research project named above.	YES	NO
I agree that my participation will remain anonymous.	YES	NO
I agree that the researcher may use anonymous quotes in her research report.	YES	NO
I agree that the information I provide may be used anonymously by other researchers, for academic purposes, after this project has ended.	YES	NO

Ethics protocol number: H21/04/07

Researcher: Alexandra Dalziel
Supervisor: Dr Mary Evans, Mary.Evans@wits.ac.za, 011 717 6516

I …… (Name) agree to participate in the research study as stated above. I acknowledge that the research was clearly explained to me. I understand what my participation will involve. I agree to the following (please highlight):

Participant signature.....

Researcher signature.....

Date.....

APPENDIX B

Ethics clearance certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Dalziel

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H21/04/07**
PROJECT TITLE	The Role of Conservation Corridors in Environmental Management and Sustainability in South Africa: A study of the Vhembe District, Limpopo Province, South Africa
INVESTIGATOR(S)	Miss A Dalziel
SCHOOL/DEPARTMENT	Geography, Archaeology and Environmental Studies/
DATE CONSIDERED	16 April 2021
DECISION OF THE COMMITTEE	Approved Risk Level: Low
EXPIRY DATE	21 July 2024

DATE 22 July 2021 **CHAIRPERSON** J. Knight
(Professor J Knight)

cc: Supervisor : Prof M Simatele and Dr M Evans

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. **I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.**

Signature **Date** 23 / 07 / 2021

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX C

Field data from surveys

	No. of responses	Percentage
1) How old are you?		
18-30	174	45%
31-40	100	26%
41-50	66	17%
51-60	44	11%

2) What is your gender?	No. of responses	Percentage
Male	189	49%
Female	195	51%
Prefer not to say	0	

3) What is your highest level of education?	No. of responses	Percentage
Primary School	12	3%
High School	214	56%
Diploma	95	25%
University degree	63	16%
Other	0	

4) What municipality do you live in?	No. of responses	Percentage
Musina	80	21%
Thulamela	67	17%
Makhado	224	58%
Collins Chabane	13	3%

5)Please tick all the things you do in Vhembe	No. of responses	Percentage
Visit Nature reserves	196	28%
Collect wood from forests and the bush	142	21%
Collect water from rivers	87	13%
Farm	106	15%
Hunt wildlife	44	6%
Collect herbs and plants	63	9%
No activities	52	8%

6) What sector do you work in?	No. of responses	Percentage
Manufacturing	52	14%
Education/student	105	27%

Tourism	20	5%
Agriculture	41	11%
Mining	14	4%
Transport	19	5%
Unemployed	96	25%
Other	37	10%

7) What does conservation of the environment mean for you?	No. of responses	Percentage
Protecting plants and animals	153	40%
Isolating land for the exclusive use of plants and animals	63	16%
People living in harmony with nature	59	15%
People using nature wisely	109	28%

8) Do you visit the area around the Soutpansberg Mountain Range?	No. of responses	Percentage
Yes	174	45%
No	210	55%

9) If yes, why do you visit the area?	No. of responses	Percentage
Tourism	109	63%
Work	45	26%
Other	20	11%

10) Do you visit the area around Mapungubwe National Park?	No. of responses	Percentage
Yes	171	45%
No	213	55%

11) If yes, why do you visit the area?	No. of responses	Percentage
Tourism	112	65%
Work	52	30%
Other	7	4%

12) Do you visit any other nature reserves?	No. of responses	Percentage
Yes	211	55%
No	173	45%

13) If yes, which ones?	No. of responses	Percentage
No answer	41	20%
Kruger National Park	120	57%
Nzhelele Nature reserve	10	5%

Footprint	17	8%
Other	22	10%

14) Would you be willing to work in the tourism or environmental sector if jobs became available?	No. of responses	Percentage
Yes	298	78%
No	86	22%

15) Do you think nature reserves should be accessible to the local community?	No. of responses	Percentage
Yes	327	85%
No	57	15%

16) Do you think nature reserves can be used to develop communities?	No. of responses	Percentage
Yes	343	89%
No	41	11%

17) Do you think there should be large, combined private and public nature reserves?	No. of responses	Percentage
Yes	290	76%
No	94	24%

18)Do you think expanding and linking nature reserves would benefit you?	No. of responses	Percentage
Yes	299	78%
No	85	22%
Please explain		
Jobs	161	42%
Environmental benefits	43	11%
Unanswered	104	27%
No interest in reserves	16	4%
Increase entry cost	2	1%
Logistics will not work	40	10%
Only the govt. will benefit	18	5%