DEVELOPMENT OF A SUSTAINABLE LAND AND ECOSYSTEM SERVICES DECISION SUPPORT FRAMEWORK FOR THE MPHAPHULI TRADITIONAL AUTHORITY, LIMPOPO PROVINCE, SOUTH AFRICA

by

KHANGWELO DESMOND MUSETSHO

Submitted in accordance with the requirements
for the degree

DOCTOR OF PHILOSOPHY IN ENVIRONMENTAL MANAGEMENT

in the

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

DEPARTMENT OF ENVIRONMENTAL SCIENCES

at the

UNIVERSITY OF SOUTH AFRICA
FLORIDA CAMPUS

SUPERVISOR: PROF. M. CHITAKIRA
CO-SUPERVISOR: PROF. W.A.J. NEL

MAY 2021

DEDICATION

I dedicate this work to my family, Thabelo Mulaudzi-Musetsho, Ronewa Musetsho, and Phuluso Musetsho, who endured my long absence from home while working on this research.

DECLARATION

I, Khangwelo Desmond Musetsho, hereby declare that the thesis, with the title "Development of a Sustainable Land and Ecosystem Services Decision Support Framework for the Mphaphuli Traditional Authority, Limpopo Province, South Africa", which I hereby submit for the degree of a doctorate in Environmental Management at the University of South Africa, is my own work and has not previously been submitted by me for a degree at this or any other institution.

I declare that the thesis does not contain any written work presented by other persons, whether written, pictures, graphs, data, or any other information, without acknowledging the source.

I declare that where words from a written source were used, the words were paraphrased and referenced and where exact words from a source were used, the words were placed inside quotation marks and referenced.

I declare that I have not copied and pasted any information from the Internet without specifically acknowledging the source and have inserted appropriate references to these sources in the reference section of the dissertation.

I declare that during my study I adhered to the Research Ethics Policy of the University of South Africa, received ethical approval for the duration of my study prior to the commencement of data gathering, and have not acted outside the approval conditions.

I declare that the content of my thesis was submitted through an electronic plagiarism detection program before the final submission for examination.

Student signature: ______________________________ Date: 15 November 2020

ACKNOWLEDGEMENTS

Undertaking research such as this provides an opportunity for reflection on the influences on one's research career and an opportunity to thank those who have helped along the way. Although the number of people who shaped and focused my research work is too great to enumerate, a few contributed immensely:

- I am deeply indebted to the Mphaphuli Royal Council, the Mphaphuli Traditional Council, the Mphaphuli Development Trust, the Vhembe District Municipality, and the Thulamela Local Municipality for allowing me to study them.
- I am also indebted to Prof. M. Chitakira and Prof. W.A.J. Nel, whose encouragement, nurturing advice, critical comments, and patience made this research a worthwhile end product.
- Prof. T.A. Saidi laid an excellent foundation for the work carried out throughout my junior-level training.
- A special thanks to my parents, M.E. Musetsho, N.M. Musetsho, as well as D. Nepfumbada, who have always encouraged me to work hard at school, and for the essential financial assistance from the time of my junior-level training.
- The financial aid from Naledzi Environmental Consultants (Pty) Ltd towards this research is hereby acknowledged.
- The compilation of this research would have been impossible without the willing and often understanding help from my colleagues, Prof. K.A. Nephawe, Dr P.T. Govender, Dr R.N. Magoba, Dr A. Ramoelo, Ms S. Ncube, and Dr F.L. Mutuvhi. Thank you for the many useful hours we spent together discussing relevant topics and the approach to this research.
- The South African Weather Services, for climatic data.
- The Co$ting Nature Policy Support System, for the software platforms.
- The South African National Space Agency, for land-cover data.
- The University of South Africa, for funding the editing of this thesis.

EDITING

10 November 2020

I, Marlette van der Merwe, hereby certify that both the text and list of references of the doctoral thesis titled “Development of a sustainable land and ecosystem services decision support framework for the Mphaphuli Traditional Authority, Limpopo province, South Africa” have been edited by me, according to the Harvard referencing method as used by the University of South Africa.

Marlette van der Merwe

BA (English) HDipLib (UCT)

ABSTRACT

This study aimed to investigate the spatial extent of Land-Use Land-Cover (LULC) change and the implications for ecosystem services in order to develop a sustainable land-use management framework for traditional authorities in South Africa. Effectively, this study undertook an insightful examination of the impacts that arise from policy decisions and practices, which unfortunately were found to be ineffective. The methodologies and approaches used in this study included both quantitative and qualitative techniques. The critical quantitative method employed in this research was the use of survey questionnaires to collect primary data. Qualitative approaches, such as one-on-one and key informant interviews, were used to triangulate the findings. Remote sensing and geographic information system (GIS) methods were used to investigate changes in LULC from 1990 to 2018 through the use of data obtained from the South African National Land-Cover project. Stochastic models were used to predict future LULC changes from 2018 to 2050. The Co$ting Nature Policy Support System was used to identify and undertake economic valuation of services provided by ecosystems. Statistical analysis using the Statistical Package for the Social Sciences was used to identify correlations and the reliability of the data, while graphs and tables were generated to identify patterns and lessons from the research. Between 1990 and 2018, significant changes in land cover were noticed for thickets and dense bush, woodlands, waterbodies, subsistence agriculture, and built-up areas. Woodlands changed by over 1 000 hectares (ha) per year, while thickets decreased by over 900 ha per year. Drivers of these changes include deforestation, among others. Future predictions for LULC revealed that between 2018 and 2050, almost 500 ha of woodlands would be lost to built-up areas. The aggregate value of the services flowing from ecosystems was found to be R9 509 044 608.00. A significant issue was that 90% of the traditional leaders interviewed could not positively respond to whether they knew the extent of the land they presided over, which raised questions regarding the effectiveness of their management systems. Recommendations were made in this study to address the limitations identified in the land-use management practices by adapting elements of the main theoretical frameworks, namely the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services framework; the Drivers, Pressures, States, Impacts and Responses framework; the sustainability theory; and the hierarchy of plans, into a new framework designed specifically for traditional leaders, titled the "Traditional leaders land-use decision support framework".

Keywords: Ecosystem services, biodiversity, rural livelihoods, economic valuation, land-cover change, land-use planning, traditional authority.

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LIST OF ABBREVIATIONS

ARIES	Artificial Intelligence for Ecosystem Services
CA	Cellular Automata
DEA	Department of Environmental Affairs
DPSIR	Drivers, Pressures, States, Impacts, and Responses
DRDLR	Department of Rural Development and Land Reform
GDP	Gross domestic product
GIS	Geographic information system
ha	Hectare(s)
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
IPBES	Intergovernmental Panel on Biodiversity and Ecosystem Services
LULC	Land-Use Land-Cover
m	Metre(s)
MDB	Municipal Demarcation Board
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
mm	Millimetre(s)
MODIS	Moderate Resolution Imaging Spectroradiometer
MTA	Mphaphuli Traditional Authority
MTC	Mphaphuli Traditional Council
NLC	National Land-Cover
PES	Payment for ecosystem services
SANLC	South African National Land-Cover
SDGs	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
Stats SA	Statistics South Africa
TEEB	The Economics of Ecosystems and Biodiversity
TESSA	Toolkit for Ecosystem Service Site-based Assessment
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development
USD	United States dollar
V3	Version 3 [Co$ting Nature]

DEFINITIONS OF KEY TERMS

Biodiversity:	The variety of living organisms found within a specified geographic region (Pullanikkatil, Palamuleni & Ruhiiga, 2016).
Ecosystem:	Dynamic complex of living organisms and the non-living environment that interact as a purposeful unit (Ntshane, 2016).
Ecosystem services:	The circumstances and methods through which the natural environment and its systems sustain and satisfy human life (Milligan & Mehra, 2018; Murata, Mantel, De Wet & Palmer, 2019).
Leadership:	The ability to influence individuals or a group towards the achievement of common goals or achievements; the art of getting things done through others (George & Jones, 2012; Sithole, 2012).
Payment for ecosystem services (PES):	An approach used to pay people for them not to alter a particular ecosystem so that it can continue to provide certain services (Farley & Costanza, 2010).

CHAPTER ONE:
INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

This chapter presents an introduction to the study. It also provides the background, the statement of the research problem, the rationale, the research aim and attendant objectives, the research questions, the research design and methods, and the layout of the thesis.

1.2 BACKGROUND

The world's population is anticipated to increase to ten billion by 2050, which is an increase of two billion people (United Nations [UN], 2019a). This population increase comes with associated impacts on the environment; ranging from environmental degradation, climate change and increased ecological resource consumption, to waste generation and increased pollution of land, air, and water (Costanza, De Groot, Sutton, Van der Ploeg, Anderson, Kubiszewski, Farber & Turner, 2014). Such a rapid population increase points to the need for accelerated development, which also puts environmental resources at risk. This situation calls for widespread coordinated efforts by human beings to limit and manage these impacts, and to ensure that development activities are sustainable.

According to Gibbes, Hopkins, Díaz and Jimenez-Osornio (2020), sustainable development requires that human beings all over the world change how natural resources are used and recognise their value to livelihoods, societal progress, and economic growth, for both current and future generations. This implies that there is an urgent need for the value of natural resources, inclusive of land and associated ecosystem services, to be determined and communicated so that decisions about development activities can be made from an informed perspective.

To be able to understand the changes in the environment and the value associated with the services humans derive from the environment, a need exists to determine the rate at which Land-Use Land-Cover (LULC) changes are taking place. Geographic information system (GIS) and remote sensing techniques have been introduced all over the world to deal with the issue of LULC change mapping (Kumar, Radhakrishnan & Mathew, 2014; Chaudhary & Kumar, 2017). It is thus crucial to continuously monitor and evaluate the implications of human actions for the environment.

The former president of the United Republic of Tanzania, Ali Hassan Mwinyi, stated the following: “Poverty and environmental problems are both children of the same mother, and that mother is ignorance” (1998, in Noring, 2014). Any management of an asset is reliant on the level of value understanding that the one who manages it, possesses (Schwartz, 1998).

The majority of people comprehend economic ideals as articulated in commercial units (money), which are, in many instances, a fitting denominator for articulating the contributions of the various systems of capital, including natural capital. It is basically what people feel comfortable using, depending on whom they are interacting with at the time (Costanza *et al*., 2014), especially when it relates to the development of land and the environment.

Since the publication of an article that questioned the value of the services derived from nature by Westman in 1977, there has been exponential growth in the amount of research work conducted on issues surrounding ecosystem services (Pullanikkatil, 2014). Both Noring (2014) and Pullanikkatil (2014) note that in around 1938, Arthur Tansley coined the ecosystem concept and defined it as the collaborative system between non-living and living things, which happens naturally without any human intervention. This understanding strengthened the general agreement among scholars that the environment cannot be perceived as being made up of individual ecological units that work in silos. Instead, it is an all-encompassing structure with chemical, biological, physical, and other components that are related, that influence, and that are influenced by, one another (Díaz *et al*., 2015; Pullanikkatil *et al*., 2016). Critical to these observations was the realisation that human beings are entirely dependent on functional ecosystems that provide many services, such as food, shelter, energy, climate regulation, and aesthetic appeal (Noring, 2014).

The Millennium Ecosystem Assessment (MEA) describes ecosystem services as regulating, cultural, provisioning, and supporting services (Mullin, 2019). Provisioning services are physical products such as food, feed, fibre, and fuels. Regulating services are the processes that occur in nature, such as water cleansing, nutrient filtration, and climate regulation (MEA, 2005).

Cultural services are often intangible services such as aesthetics, a sense of place, and religious worship. It also includes direct uses such as recreation, ecotourism, and education. Supporting services are all the underlying, long-term processes in nature, such as net primary products, soil formation, and climate stability, which secure the provision of direct services to humans (Costanza *et al.*, 2014).

The Economics of Ecosystems and Biodiversity (TEEB, 2010) and Small, Munday and Durance (2017) point out that many ecosystems are so degraded that they are approaching their tipping points; in other words, the thresholds where their capacity to provide services is threatened. A study of land and ecosystem services is therefore critical and necessary where there is a need for understanding the rate at which LULC changes are taking place and implications for the ability of ecosystem services to continue to provide such services.

It is for these reasons that scholars Turner *et al*. (2015) and Abson and Termansen (2011) consider the assessment of ecosystem services as a field of ecological economics, which should be of interest to all humans, as economic activities affect everyone's daily activities. If ecosystems are degraded, mainly through LULC changes, the services obtainable from these ecosystems would also be affected. When ecosystems are affected, they are unable to optimally provide essential services to human beings, which often leads to increasing poverty (Pullanikkatil *et al*., 2016).

In the South African context, government institutions, traditional leaders, and citizens are facing unprecedented pressure from population growth and the triple challenges of poverty, inequality, and unemployment (Van der Berg, Louw & Du Toit, 2012). According to Wood, Tappan and Hadj (2004), the dominant environmental and economic priority in developing countries such as South Africa is to ensure that people have access to sanitation and clean water, without compromising the integrity of key ecosystems and also without undermining economic growth. Inevitably, understanding the natural environment and its processes becomes vital, and one of the components of understanding the environment has much to do with LULC changes and ecosystem services valuation.

The study of the relationship between LULC changes and ecosystems worldwide points to the fact that land use and land services from ecosystems are somehow connected and interdependent. What happens to one of these influences the other, just as with the understanding of the actual components of the natural environment (air, water, soils/rocks, plants, animals, etc.) (Miller & Spoolman, 2011).

This principle also applies to the South African land and ecosystem context, as it could be inferred that what happens to the LULC and ecosystem services in one area could have implications for surrounding areas as well. The same could be true of land-use activities in the urban landscape, which could have implications for the surrounding rural landscapes as well (Musetsho, 2014).

The management of rural area land is in the spotlight, with various national debates about the need for more development activities to take place in rural areas (Mandela, 2019). The president of the Republic of South Africa, Mr Cyril Ramaphosa, in his 2019 State of the Nation Address, pointed out that through spatial interventions such as special economic zones and reviving local industrial parks, business centres, digital hubs, townships, and village enterprises, there is a strong will by the government to take economic development to local areas, townships, and rural areas (South African Government, 2019). Commitments such as these require careful consideration of the manner in which accelerated development activities are likely to impact on land and ecosystem services, especially in rural areas. It is essential to determine from current land-use activities whether such interventions would be successful or not.

It is in the context of the above, which links the development of rural areas with what the Sustainable Development Goals (SDGs) seek to achieve and what South Africa has done in reporting to the UN, that many of those in rural areas still need to be involved. In the same vein, the level at which people in rural areas participate in the achievement of the SDGs leaves much to be desired. This non-achievement is not because they do not want to be involved, but because decisions are made without consultation, and implementation options are considered without their involvement (Dhlamini, 2019).

Accelerated development takes place on land, which may have long-term implications for LULC changes. LULC changes are closely tied to modifications to the ecosystem and the associated services they provide to human beings. The study of understanding the rate at which LULC changes, and the related ecosystem services' value, becomes critical if human beings are to achieve sustainable development, especially in rural areas.

Rural development in the South African context ordinarily takes place on land owned and controlled by traditional leaders (Musetsho, 2014). The same holds true for the land and associated ecosystem services for land controlled by traditional authorities.

Continuing to ignore the importance of determining the extent of LULC changes, the sustainable utilisation of land, and associated ecosystem impacts, could be equal to the ignorance to which the former president of Tanzania, Mwinyi, referred.

The Mphaphuli Traditional Authority (MTA) has a serious task of managing land and ecosystem services. The knowledge gathered from this area may therefore be relevant to other traditional authorities in the future across Africa and the world. The MTA's land is located in the Limpopo province, which is the northernmost province in South Africa. The province is considered a rural area where poverty levels are relatively high. There is a considerable need for developmental activities in poverty-stricken regions, and governments should prioritise such areas (World Atlas, 2018). Dependence on natural capital and ecological infrastructure is still very high, and any negative impacts that result in the reduced provision of such services have severe economic and environmental implications for the people of Limpopo.

The underlying need to determine the rate at which change is happening cannot be overemphasised. LULC changes, and the implications for ecosystem services, along with the determination of benefits derived by the communities, are critical for future decision making. All these contribute to better decisions by ensuring that policy appraisals take into account the benefits and costs to the natural environment (Price, 2007, in Department for Environment, Food & Rural Affairs, 2007).

1.3 STATEMENT OF THE RESEARCH PROBLEM

Land planning through the detection of LULC change and consideration of ecosystem services value is critical for sustainable rural land development. This research considered the interconnectedness between LULC change, the valuation of ecosystem services, and implications for the long-term management options taken by traditional authorities. The people considered to be central to the LULC are the respondents of this research. The study area of this research is the MTA's land, where the frameworks or systems that the traditional leadership uses to manage land are subject to this study.

A baseline economic valuation of select ecosystem services identified using the Co$ting Nature platform was the subject of the investigation. The limited knowledge and understanding of the rate at which LULC change is taking place, together with the associated implications for ecosystems and ecosystem services, are a cause for concern (Aldana-Dominguez, Palomo, Gutierrez-Angonese, Arnaiz-Schmitz, Montez & Narvaez, 2019).

This concern warrants a deep understanding of the current rate of LULC change and policy directions by those charged with managing natural capital through comprehensive research. Without this understanding, policy choices in the administration of land use and services from ecosystems may be made that are not aligned with the practical realities on the ground and the anticipated SDGs (Clemens, Mark, Markus & Markus, 2018; Intergovernmental Panel on Biodiversity and Ecosystem Services [IPBES], 2018).

While several kinds of research have been undertaken relating to the valuation of ecosystem services and changes in LULC over time, by scholars such as Mathivha, Kundu and Singo (2016), Munthali, Davis, Adeola, Botai, Kamwi, Chisale and Orimoogunje (2019), Odiyo, Phangisa and Makungo (2012), and Pullanikkatil *et al.* (2016), very little has been associated with the activities at the level of traditional leadership as a key stakeholder in the governance of land. Traditional authorities in South Africa are responsible for vast tracts of land, as demonstrated recently by the panel that was established to investigate the possibility of changing section 25 of the South African Constitution (South Africa, 1996).

While traditional authorities are not government as such, they are still responsible for the allocation and management of land. Whether they do that correctly or not is a matter of great concern, as such approaches have significant implications for the sustainability of ecosystems and their services. This area has received very little attention from scholars in the past. The MTA is one of the traditional authorities recognised and regarded as being in charge of individual pieces of land in South Africa.

The land under the MTA is considered rural and a target for accelerated rural development, as alluded to by President Ramaphosa (South African Government, 2019). These accelerated development activities could be responsible for a great many changes in LULC and the value of ecosystem services, among others.

Understanding the rate at which LULC and the value of ecosystem services have been changing would be critical in advising how many accelerated development activities could be undertaken sustainably. The associated land-use regulations and the frameworks that advise such become vital to evaluate, because allocating land is one thing, but the associated regulation of the approved usage is another.

As a result of increases in the population and associated developments in the Vhembe District Municipality, the MTA's land has been subjected to considerable land-use changes over the past decades, which are accelerating environmental degradation (Mathivha *et al*., 2016). Unfortunately, this has never been quantified or researched in detail, to advise on policy or regulatory frameworks, backed by hard scientific facts around the rate of change, future predictions, and declines in ecosystems, or ecosystem services and their value.

Scholars such as Batabyal and Dasgupta (2002) and Miller and Spoolman (2011) assert that if ecosystem services are consumed sustainably, the capital value can be retained. If the land is used in a manner that compromises ecosystem services, then it is likely that there could be implications for people living in rural areas, such as those under the MTA.

Investigations of the state of ecosystem services in the Mphaphuli area have previously been undertaken. Notwithstanding, linking these studies with the decision makers and users of land to advise on policy directions now and in the future has never been done. Filling these gaps will contribute significantly to knowledge of how traditional leaders and those groups considered to be outside government structures, such as the lost tribes in the Amazon, deal with environmental assets. This study focused more on creating a baseline determination of the decision support systems that the traditional authority uses in the allocation, utilisation, and regulation of land, through proper LULC change-detection techniques. Land-use management practices were evaluated, and ecosystem services valuation was conducted to advise on policy directions.

1.4 MOTIVATION FOR THE STUDY

The rate at which LULC changes could have a direct relationship with the way that land is allocated for various uses, the way such use is regulated in a particular area, or with associated policies or lack thereof around such activities. Understanding this rate of change and the implications for ecosystems, ecosystem services, and their values is critical for sustainable development (Dhlamini, 2019).

Similar research that links the grassroots decision makers, such as traditional leaders, has never been undertaken in the area, and conducting it in a setting such as the MTA area may guide traditional authorities elsewhere on how to approach the study's findings in the future.

South Africa has adopted the District Development Model as a model for unlocking development potential at the grassroots level. The idea is that this development approach ensures that planning and spending by national, provincial, and local spheres of government are integrated and aligned with the interests and input of communities, and taken into account up front. The MTA area is under tremendous pressure from rapid economic development (Mathivha *et al.*, 2016). Some researchers have already pointed out the challenges relating to land-cover changes (Mathivha *et al.*, 2016; Masupha & Moeletsi, 2018).

It is evident from these studies that much still must be done to understand the complex nature of the implications of LULC changes. A significant portion of the gross domestic product (GDP) contribution in former homeland areas such as those in Mphaphuli is represented by advanced government incomes, rather than improved manufacturing of goods and commercial services (Ngomane & Flanagan, 2003).

Ngomane and Flanagan (2003) observe that rural areas in South Africa are a consumer society of products and services. Almost 96% of rural people in South Africa acknowledged shops as a source of food supply, which is a situation that requires a radical shift in mindset because it is not correct (Statistics South Africa [Stats SA], 2017). Just over half of households in the previous homeland areas rely on social allowances for their livelihoods, although these are not purposefully used to sustain the rural economy (Ngomane & Flanagan, 2003).

The rate of change in LULC threatens ecosystems, as indicated by various research findings. The value of ecosystem services is a developing area of research. Many ecosystem services, especially in rural and remote areas, have not been subjected to valuation. By implication, people are not aware of the value they may be losing when ecosystems and their services are lost. To the researcher's knowledge, no study has placed traditional leaders under the spotlight concerning how their governance activities influence the sustainable use of the land and related ecosystem services at the same time. An in-depth investigation and evaluation of how traditional authorities manage land use and associated ecosystem services could be a catalyst for better development or alternative approaches at the grassroots level. These are the areas that this research investigates.

Additionally, it is critical to understand some of the driving forces behind any fluctuations in LULC and ecosystem services in the area. This understanding will assist the Mphaphuli community and provide possible options for similar traditional authorities and even government structures elsewhere.

The Mphaphuli land, in general, forms part of the Soutpansberg mountain range, which has been identified as a strategic water source in South Africa. Although the land itself falls within the jurisdiction of the Thulamela Local Municipality, the MTA still play a vital role in the management of land.

This research is vital for the following reasons, among others:

- The changing political, economic, and administrative environment requires traditional leadership to align with such changes, mainly because they are in charge of large tracts of land.
- Stakeholders, such as the government, investors, and communities, are becoming increasingly concerned about the capacity, commitment, and accountability of leadership regarding sustainable social and economic development initiatives.
- There could be many issues surrounding the expropriation of land without compensation, which may affect traditional authorities. This is a crucial concern, particularly from an investment point of view in rural areas. The frameworks that traditional authorities use in the management or regulation of land use need to be evaluated to ascertain and predict the future state of land and the environment once traditional authorities are allocated more land to look after.
- Effective land-use regulation is critical for the security of investing in land. Investors will be concerned about any uncontrolled land-use activities that could threaten other land-use activities where investment has been made. This is critical for stable economic development. Where proper planning and land-use schemes are in place, such certainty can create confidence.
- Sustainable land management leads to appropriate management of environmental assets such as ecosystem services, which are beneficial for human beings, especially in rural areas where people are more reliant on the environment for the provision of essential services.

The practical implementation of land-use regulations, combined with social and economic development, has the potential to improve conditions of life, ensure sustainable development, and enhance the provision of service delivery to communities, even at the traditional leadership level.

However, the policy directions for land should be based on sound decision-making processes that take the views of the community, environmental impacts, and ecosystem services into consideration. Understanding the existence of ecosystem services on land that is managed by traditional authorities would be helpful for its effective management.

This understanding could include economic incentives, such as those used where payment for these services is designed into a scheme for the local people (Costanza *et al.*, 2014; Hejnowicz & Rudd, 2017).

It is only through concrete scientific evidence relating to the extent of the spatial distribution of the land, LULC changes, ecosystem services, and the associated land-use management that proper decisions can be made even at the level of the traditional authority. Actions could also be taken to correct what may have gone wrong before appropriate systems are in place. The research questions outlined below focus on the activities that specifically affect the MTA land, leaders, and users.

1.5 RESEARCH QUESTIONS

This study intended to answer the following research questions under four thematic areas, namely:

(a) LULC changes

i. What is the extent of LULC changes during 28 years (1990 to 2018) in the study area?
ii. What would land cover look like in 2050?
iii. What are the driving forces behind any changes in LULC?

(b) Economic valuation of ecosystem services

i. What are the different ecosystem services in the study area, and to what extent have they been impacted by LULC change trends?
ii. What is the baseline value of the identified ecosystem services in the area?

(c) Land-use regulation practices

i. How effective are the current land-use regulation practices?
ii. To what extent do the land-use regulations influence LULC changes, including implications for ecosystems and their services?

(d) Decision support framework

i. What land-use decision framework can be developed for the traditional authority?

1.6 AIM AND OBJECTIVES OF THE STUDY

This study aimed to investigate the spatial extent of LULC changes and the implications for ecosystem services in order to develop a sustainable land-use management framework for traditional authorities. Effectively, this meant investigating the scientific, indigenous, and traditional aspects prevalent in the area to develop a land-use decision support system.

The objectives of this study were:

- to establish LULC in the MTA area using existing land-cover data from 1990 to 2018 and to predict future land cover (i.e., 2050);
- to perform a baseline valuation of different ecosystem services in the area;
- to evaluate land-use regulation practices in the area to determine the effectiveness of land-use regulation practices; and
- to develop a framework for sustainable land use and decision support in the area.

1.7 SCOPE OF THE STUDY

The study was conducted only on land under the jurisdiction of the MTA in the Vhembe District Municipality in the Limpopo province of South Africa. The scope of the ultimate findings focused strictly on developing land decision support mechanisms associated with the Mphaphuli community. Additionally, the combined data-collection methods concentrated only on the Mphaphuli area, the traditional leaders, land users, and beneficiaries.

Despite its focused scope, the study was not adversely affected in that the final recommendations and guidelines (see Chapter Eight) are universal and not confined to the MTA alone or traditional leaders only. The validity, reliability, trustworthiness, and generalisability of the study could therefore still be sustained (Shenton, 2004; Connelly, 2016).

1.8 LIMITATIONS OF THE STUDY

Despite the best efforts of the researcher, the following were identified as some of the limitations of this research:

- Due to time constraints and financial and access challenges, the research could not make comparisons with other traditional authorities as an alternative governing body in Africa or other parts of the world.
- The COVID-19 pandemic regulations and the government-enforced lockdown during this research presented serious movement challenges during data collection. The study used telephonic conversations since one-on-one discussions with some respondents and meeting in groups were not allowed. Focus group meetings, although planned initially, could not be held as a result of the lockdown regulations.
- Ecosystem services know no human-made boundaries; there may therefore be influences that emanate from other areas. These influences were not the subject of this research.
- There was no validation of the Co$ting Nature Version 3 (V3) software valuation metrics used in this study.

1.9 CHAPTER OUTLINE

For logical coherence and structure, this thesis is organised into eight sequential and thematically linked chapters.

Chapter One provides the introduction, background, and statement of the research problem. The rationale, research aim and attendant objectives, as well as the research questions, research design and methods, and the layout of the chapters, are also presented.

Chapter Two discusses the literature review, which examined local, national, and international literature relating to LULC changes. It further synthesises literature, such as theoretical frameworks, and compares it to the area under study.

The scope of the literature review for this type of research is described by Mugenda and Mugenda (1999, in Govender, 2018) as involving "the systematic identification, location, and analysis of documents containing information related to the research problem being investigated". The importance is underscored by Sekaran and Bougie (2016), who claim that such a review sets the stage for a sound conceptual framework.

Chapter Three presents the mixed-methods research design approach adopted by the study. The study setting and its sampling domain are also presented and discussed, including the data-collection procedures. This chapter ends with relevant ethical reflections applied to this study.

Chapter Four presents and analytically discusses the collected qualitative and quantitative data around LULC change, as well as the prediction of the future LULC state. The main focus of this chapter is the analysis or interpretation of the collected data, to allocate a degree of intelligibility to the data concerning the problem to be solved.

Chapter Five presents and analytically discusses the collected qualitative and quantitative data related to ecosystem services and their economic valuation. The main focus of this chapter is the analysis or interpretation of the collected data, to allocate a degree of intelligibility to the data concerning the problem to be solved.

Chapter Six presents and analytically discusses the collected qualitative and quantitative data from the sampled research participants. The main focus of this chapter is the analysis or interpretation of the collected data relating to the effectiveness of land-use practices in the area.

Chapter Seven presents and analytically discusses the existing land management practices, and proposes a new decision support framework for traditional leaders.

Chapter Eight focuses on the centrality and efficacy of the study objectives and findings as the most compelling factors for the main conclusions and recommendations.

1.10 CHAPTER SUMMARY

This chapter presented an outline of the study and its logically interrelated sub-units, which are discussed in more detail in the ensuing chapters.

The outlined sub-units included the research problem, the motivation for the study, the research aim and objectives, the research design and methods, data collection, sampling, ethical considerations, as well as the layout of the chapters of the entire study. Such a sequential organisation and arrangement of the chapters present the entire research process as a continuum between the research topic, the problem being researched, the collection of data, and the scrutiny processes.

In other words, the continuum itself represents an attempt to narrow the space between theory and practice in terms of LULC changes and associated management or responses by human beings.

The next chapter presents the range of literature reviewed as background to understanding the critical aspects of the theoretical frameworks, LULC mapping, ecosystem services and valuation, and land-use management practices around decision making.

CHAPTER TWO:
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents a review of literature relating to the study. A literature review is a written argument that promotes the position of a thesis and builds logical reasoning from a variety of comprehensively accumulated credible sources (Brown, 2008; Ravhura, 2019). The literature reviewed involved relevant national, international, and local perspectives obtained from academic books, search engines and databases, published and unpublished academic studies, peer-reviewed scientific journals, as well as conference proceedings.

In this chapter, the theoretical and conceptual frameworks on whose basis the philosophical premises of LULC, ecosystem services, and land-use management going into the future could be established are reviewed and presented under topical headings. Four major theories are recognised and identified as relevant. These are the IPBES framework, the Drivers, Pressures, States, Impacts, and Responses (DPSIR) framework, the hierarchy of plans, and the sustainability theory. Official government policy documents on land cover, land-user rights allocations and traditional leadership, as well as records of land-use rights holders are reviewed and analysed.

This chapter is structured into four main topics: theoretical frameworks, LULC change mapping, ecosystem services, and land-use management practices. Under these main topics, there are sub-topics that are of particular interest, namely the following: understanding LULC change mapping, remote sensing and GIS application in LULC change mapping, the ecosystem services concept in society, economic valuation, LULC management, the concept of rural development, traditional authorities, and land management together with the sustainable development concept.

2.2 THEORETICAL FRAMEWORKS

A detailed review of four frameworks (IPBES, DPSIR, the sustainability theory, and the hierarchy of plans) is undertaken in this chapter. These frameworks are reviewed in order to draw similarities between the current or prevailing conditions at Mphaphuli, with a view to either improving the current situation or adopting some of these frameworks.

This chapter reviews the theoretical frameworks that form the basis or foundation for the development of a decision support framework around ecosystem services and land use at the level of traditional leadership. These frameworks are in no way exhaustive, but were chosen as they contain elements that are the subject of the study, or could be easily related to the framework intended as an outcome of the research, or else could be adapted to inform the end product of the research. These frameworks are explained in detail, by investigating their origin and their elements, and how they may have been used elsewhere. These theories have been identified and are presented in this study as they contain elements that relate to what the study aimed to achieve; they therefore are relevant to the framework being developed in this study.

2.2.1 The Drivers, Pressures, States, Impacts, and Responses (DPSIR) framework

Common problems such as urban decay, water pollution, general environmental degradation, climate change, and resource depletion are complex problems that require complex solutions. These challenges often transcend spatial and temporal scales, and there is a need for systems thinking in attempting to address them (Bradley & Yee, 2015).

A framework exists that advances a systems perspective of investigating the complexity of environmental challenges. The framework consists of the driving forces, pressures, states, impacts, and responses. Many scholars describe this DPSIR framework as a valuable tool for arranging and communicating multifaceted environmental problems (Bradley & Yee, 2015). Because of its versatility in addressing serious environmental challenges, the DPSIR framework has since been adopted by many organisations worldwide, including the UN and the United States Environmental Protection Agency.

The DPSIR assumes influential tendencies in and between the various components of the natural-environmental, economic, and social platforms (see Figure 2.1). Due to its versatility, it has been used in many applications; ranging from water resources, agricultural systems, to biodiversity, soil resources, and marine resources (Fisher, Patenaude, Meir, Nightingale, Rounsevell, Williams & Woodhouse, 2013). The DPSIR follows an adaptation of the drivers, pressures, states, impacts, and responses framework, which is commonly used in industrialised-world applications (IPBES, 2018).

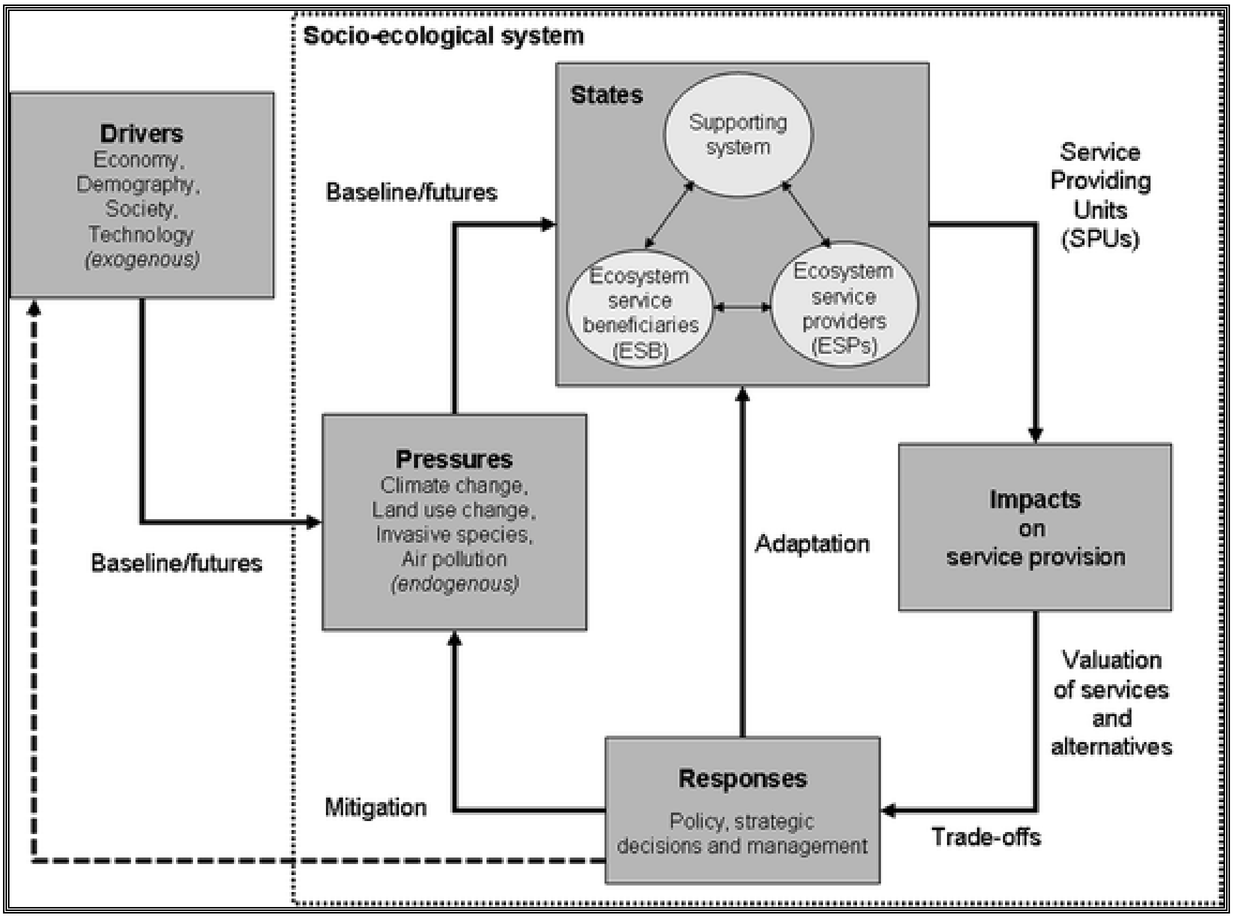

Figure 2.1: The DPSIR framework

Source: Fisher *et al.* (2013)

The DPSIR framework describes a socio-ecological system, in which pressures, states, impacts, and responses are internal to the system and drivers are external. Pressures act upon states, which are composed of the supporting system land-use practices, although, arguably, socio-ecological systems produce ecosystem services and ecosystem service beneficiaries (Pullanikkatil *et al*., 2016).

In attempting to modify or refine the framework, several scholars, such as Díaz *et al.* (2015), Kristensen (2004), and Patrício, Elliott, Mazik, Papadopoulou and Smith (2016), have attempted to break down the DPSIR framework into components, some of which are described below.

2.2.1.1 Drivers

A driving force is a phenomenon or a need that fuels something to happen. The need for shelter is a driving force behind people clearing or gathering building material from the forest, for example (Kristensen, 2004).

Piet, Jongbloed and Paijmans (2012) highlight that a driving force could merely be a need to be profitable at low cost, which falls within the ambit of commercial driving forces. These commercial driving forces fulfil individual requirements to obtain trading instruments, such as money, as a stepping stone towards access to food, water, security, health, shelter, and infrastructure (Bradley & Yee, 2015). When individuals access usable resources such as water and food, they start sharing with others, or create a market for such resources where they interact with one another. That interaction creates specific patterns in society, where individuals start organising themselves into groups, where culture develops and norms and traditions emerge, which ultimately lead to social driving forces.

2.2.1.2 Pressures

When the needs of individuals have been met, interests sometimes go beyond those of just individuals, and extend to a larger group of people. Pressure comes about where there is a need to cater for the needs of a larger group; human beings exert pressure on the environment to provide for many. Examples here would be areas of food production, drinking water, and firewood for cooking. There are two distinct pressure categories: pressure generated by the environment itself, and pressure emanating from human activities that impact the environment (Hughes & Vadrot, 2019).

2.2.1.3 States

When pressure is exerted on the environment, it is said that the environment is affected. Typically, there is always a balance in nature, where the components of the natural environment (water, plants, animals, air, and soil) are in perfect balance, and can restore natural pressure. However, when excessive pressure is exerted, mainly through anthropogenic elements, the state or character of the environment changes for the worse. The environmental properties, summarised as physical, chemical, and biological, reach a point where their limits of tolerating pressure are challenged. The state of the environment then changes.

2.2.1.4 Impacts

The perfect balance that exists in an environment where there are no anthropogenic influences determines the ability of the environment to provide services. When the physical, chemical, and biological stability of the environment changes as a result of human interferences, it is said that there are impacts. When the environment is no longer able to provide the services that it ordinarily could, there have been impacts. The environment can still provide some services to human beings, but the quality of such services is not the same as when the environment was in a perfect state. These impacts are the driving forces behind continuous research, so that solutions can be found that lead to either reversal or minimising of such impacts.

2.2.1.5 Responses

Human beings usually realise the impacts of their actions on the environment, and when they start attending to it, that process is regarded as a response. As an example, policies are designed to influence a particular direction that could lead to environmental recovery and enhance the capacity to continue providing services to human beings.

The state of any system leads to impacts on service provision, which, in turn, initiate responses. Responses are separated into adaptation, which leads to change in the properties of the state, and mitigation, through which pressures change. The terminology of the framework relates closely to other frameworks; for example, “drivers” within this framework are equivalent to the “indirect drivers” of the MEA, and “pressures” are comparable to the “direct drivers” of the MEA (Fisher *et al*., 2013).

The DPSIR framework, as used extensively in the literature, aims to act as an instrument that links applied science and management of human uses with associated impacts on the environment (Patrício *et al*., 2016). Due to these various intended uses, Patrício *et al.* (2016) suggest that it is necessary to define the framework to indicate how it has been used and to exhibit its benefits, as well as its disadvantages and anomalies.

If successful, the DPSIR framework presents a simplified visualisation and means of interrogating and managing complex cause-and-effect relationships between human activities, the environment, and society (Patrício *et al*., 2016).

According to Niemeijer and De Groot (2008) and Tscherning, Helming, Krippner, Sieber and Paloma (2012), it can be used to communicate between disciplines to address the different aspects of environmental management (research, monitoring, mitigation, policy, and society) and scientists, policymakers, and the public.

According to Patrício *et al.* (2016), the DPSIR framework has several advantages, such as being a commonly used instrument that is adaptable for use in almost all types of environmental problems, risk assessment, and ecosystem communication platforms.

Pullanikkatil *et al.* (2016) used the DPSIR framework to study the provisioning ecosystem services of the Likangala River catchment in Malawi, which was quite successful, especially given the fact that this was in a rural setting.

Even though there are many advantages, as explained above, the DPSIR framework also has disadvantages and anomalies. Patrício *et al.* (2016) summarise some of them as follows:

- Restricted coverage and application;
- Non-standard use of terms; and
- Oversimplifies problems.

It is based on the above anomalies and disadvantages that researchers such as Elliott, Burdon, Atkins, Borja, Cormier, De Jonge and Turner (2017), Gregory, Atkins, Burdon and Elliott (2013), and Wolanski and Elliott (2015) have suggested amendments or, at best, clarity when it comes to its terminologies, among others. That being the case, the DPSIR framework has been used over many years to formulate other published frameworks, some of which are summarised in Figure 2.2.

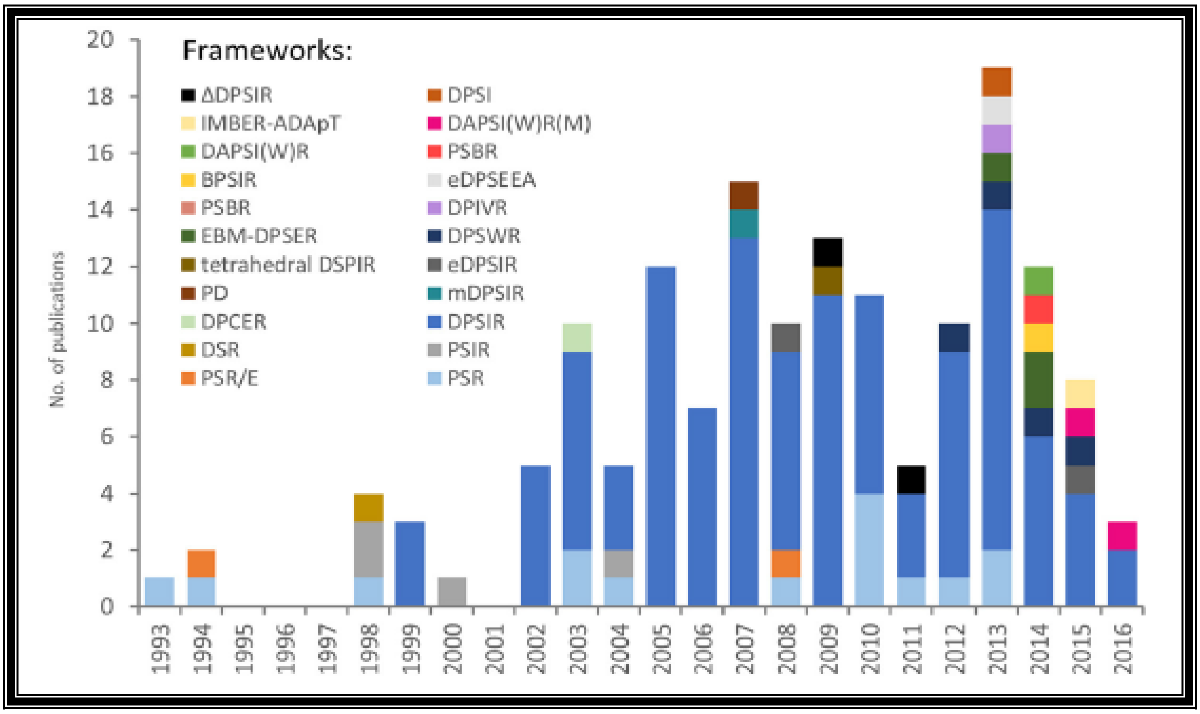

Figure 2.2: Frameworks developed from the DPSIR

Source: Patrício *et al.* (2016)

In South Africa's Western Cape province, Tizora, Le Roux, Mans and Cooper (2016) used the DPSIR framework to successfully investigate LULC changes. Not only was the DPSIR framework found to be useful, but it was also used to develop a modified DPSIR LULC change framework for the Western Cape province (Ogra, Nkoane, Lodi, Mohan & Minyuku, 2016).

It was against the backdrop of the above advantages and disadvantages that the DPSIR framework was identified for use as the basis, and not necessarily to take everything from it, to build a new framework for the land use, environment, and practices at the level of traditional leaders for this study.

2.2.2 Conceptual hierarchy of plans

The deficiencies of the DPSIR framework point to a need for other frameworks to be identified and adopted if environmental, social, and economic challenges are to be addressed continuously. The most visible form of governance institution in many rural areas, apart from that of traditional leadership, is the municipal system.

According to Amponsah and Forbes (2012), municipalities are required to have a hierarchy of plans, ranging from a broad strategic municipality plan to a detailed plan where land-use rights are assigned. Development planning and land-use allocation assume that land must be adequately planned for it to be used effectively (Musetsho, 2014). Traditional authorities and local municipalities should have plans in place for the proper use of land.

Amponsah and Forbes (2012) state that these plans should consist of a long-term development strategy, an integrated development plan, a spatial development plan, and land-use schemes, as illustrated in Figure 2.3. In areas such as the Thulamela Local Municipality, where almost 87% of the land is under the jurisdiction of traditional authorities, one would expect that the said traditional authorities adopt the hierarchy of plans, as explained by Amponsah and Forbes (2012), by combining several programmes into one (integrated land-use models or programmes).

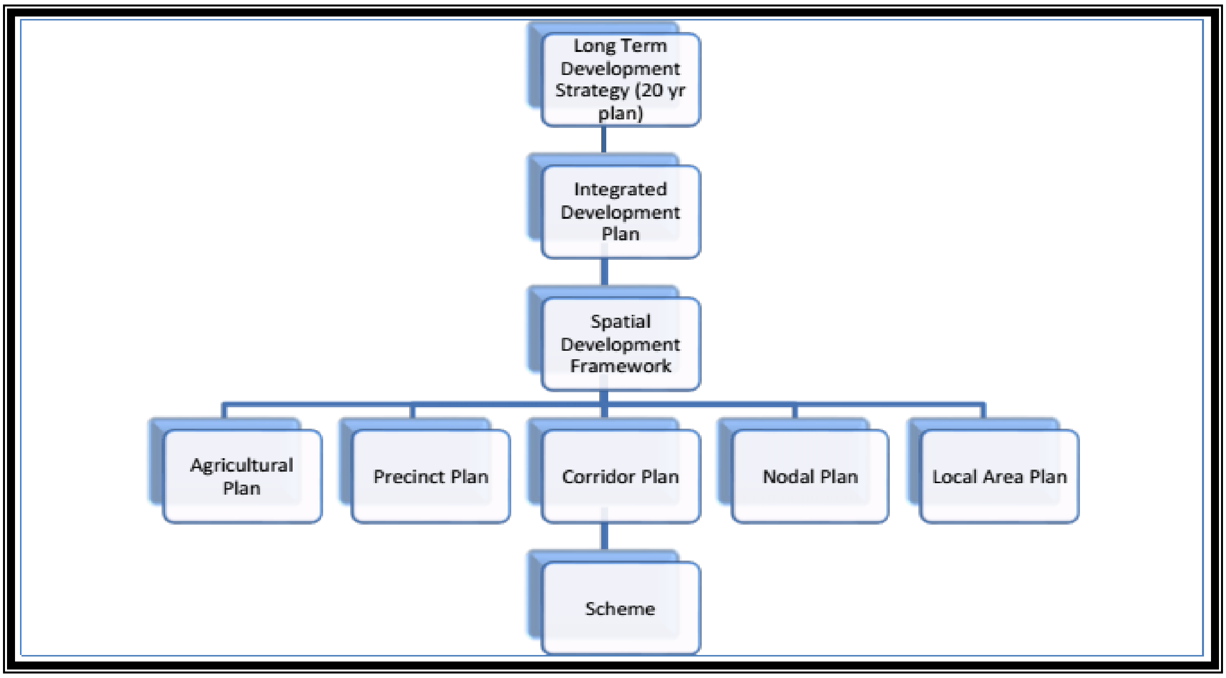

Figure 2.3: Conceptual hierarchy of plans

Source: Amponsah and Forbes (2012)

Integrated land-use models comprise a combination of other modelling capabilities using an approach that is best for solving land-use and environmental challenges (Lambin, Rounsevell & Geist, 2000).

Additionally, integrated models could be statistical, econometric, natural science, GIS, or Markov chain-based models. Some of the main land-use change models as adapted from Briassoulis (2001) are briefly elucidated in Table 2.1.

Table 2.1: Main categories of land-use change models

Category	Characteristics	Representative models
Statistical and econometric models	Mostly comprise linear regression models. Econometric models estimate changes in some determinants of land use such as population and then converts estimates to land-use requirements.	Linear regression models Econometric models Multinomial logit models Canonical correlation Analysis models
Spatial interaction models	Based on the law of gravity in physical science. It involves modelling interactions or movements caused by human activities; for example, migration. Interactions between land-use types are derived from interactions of human activities. Land-use change is modelled based on accessibility changes and changes in the origin and destination zones.	Potential models Intervening opportunities models Gravity models
Optimisation models	Aim to produce solutions that optimise decision makers' objectives. Mostly used in land-use planning applications.	Linear programming models Dynamic programming models Goal programming Utility-maximisation models Multi-objective models
Integrated models	Relate interactions, relationships, and linkages between two or more components of a spatial system to land use and land-use changes. Mostly large-scale models: from urban to global spatial levels.	Econometric-type integrated models Gravity and Lowry integrated models Simulation integrated models, namely urban level, regional level, and global level Input-output-based integrated models
Other modelling approaches	Natural sciences modelling approaches originate from disciplines such as ecology, forest science, soil science, and environmental science and mostly focus on biophysical factors of land-use change without incorporating socioeconomic, institutional, or political factors. Markov modelling belongs to the analytical methods of stochastic processes, combined with GIS for visualising and projecting the probabilities of land-use change. GIS-based modelling focuses on visualisation and spatial analysis and modelling.	Markov modelling of changes in land use GIS-based modelling of changes in land use Natural sciences-orientated modelling approach

Source: Briassoulis (2001)

Just like with the DPSIR framework, the hierarchy of plans approach has its advantages and disadvantages, where its components could be taken and adapted to achieve a particular need for specific areas. This approach, however, leaves room for the use of other frameworks, which could also contribute to the list of those elements that are useful from one framework that could be combined to develop a new model or framework. It is for this reason that the IPBES framework was also examined in this study.

2.2.3 The Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) framework

The DPSIR and the hierarchy of plans frameworks discussed above do not explicitly deal with governance issues, which is also a central theme in the success in the management of environmental, social, and economic challenges. The IPBES framework explicitly covers ecosystem services and governance, which are useful to supplement/add to the DPSIR framework for this research.

The IPBES framework was initiated in 2012 by the UN, with an understanding that it would act as an entity responsible for investigating the finer details around the contribution that ecosystem services provide to society (Clemens *et al*., 2018; Dunkley, Baker, Constant & Sanderson-Bellamy, 2018). The platform was established with the understanding that it would strengthen policymaking around ecosystem services and sustainable development (Granjou, Mauz, Louvel & Tournay, 2013; UN Environment Programme, 2013; Stenseke, 2016).

Pascual *et al.* (2017) point out that there is enough evidence of how some developing states and indigenous actors are drawing on cultural understandings of authoritative knowledge to contest and identify alternative definitions for global environmental objects. It is this contestation that brings the IPBES to the fore. IPBES is an independent intergovernmental body, established by member states in 2012, which aims to fortify policy matters surrounding ecosystem services (Díaz *et al*., 2015; Clemens *et al*., 2018; Dunkley *et al.*, 2018).

While alternative forms of knowledge, often defined as “indigenous and local knowledge”, such as those possessed by people in rural areas such as Mphaphuli, are not recognised as equivalent to scientific knowledge, Gustafsson and Lidskog (2018), Hughes and Vadrot (2019), Obermeister (2019), and Hill *et al*. (2020) argue that they are increasingly shaping the outputs of IPBES. IPBES acknowledges that different types of values should be promoted for making decisions (Pascual *et al*., 2017).

According to Clemens *et al.* (2018), IPBES was specified in the Busan Outcomes at a specially constituted meeting in the Republic of Korea in 2010. The meeting agreed that a number of interventions were necessary, including planning, scientific studies, and the involvement of as many stakeholders as possible.

This framework assists with the identification of the driving forces behind the demand for land and what impacts arise from that as pressure is exerted on ecosystem services. The motivation for the identification of this framework was centred on the potential for traditional leadership, government officials, and others who are responsible for land use and land-use regulation to be able to benefit from its use. Beneficiaries of land-allocation practices become involved in answering questions about whether they see the effects of the different land-use activities on ecosystems and land cover, including understanding their responses to such observations. The IPBES framework is shown in Figure 2.4.

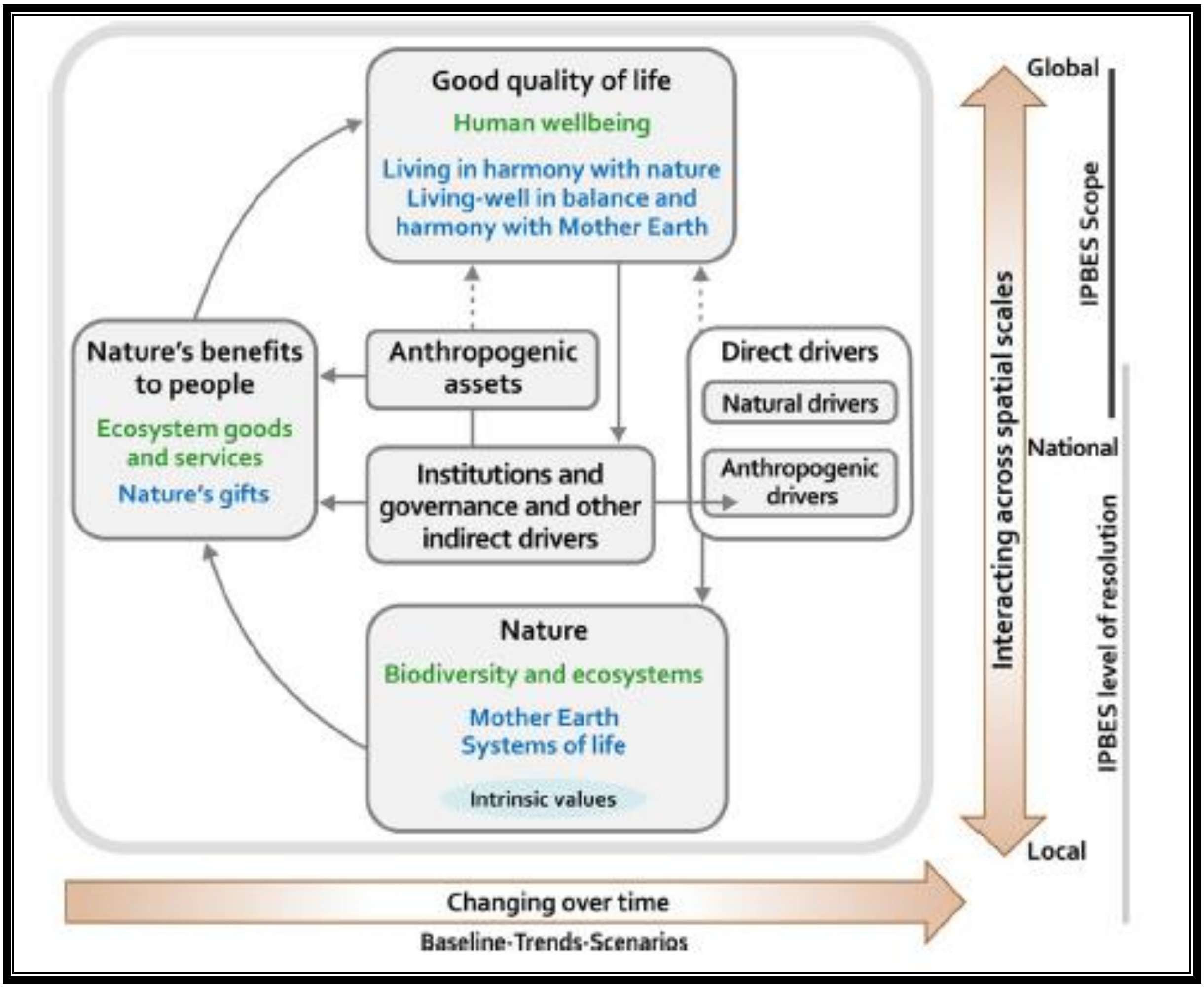

Figure 2.4: IPBES framework

Source: Fisher *et al.* (2013)

In summary, the IPBES conceptual framework includes the following primary interlinked elements that represent the natural and social structures that function at several scales in space and time: anthropogenic assets, nature's benefits to people, organisations and administration structures and other direct drivers of change, indirect drivers of change, and decent value of life (Gustafsson, 2018).

The issue here is incorporating environmental or ecosystem services into governance and the implications over time, even at a local scale such as the Mphaphuli dynasty. The work of the IPBES can generally be categorised into four related themes, namely policy support, assessment, capacity building, and knowledge management (IPBES, 2018).

Traditional leaders could benefit a great deal from adopting the various objectives of the IPBES, because if these objectives are adopted, the policy directions would eventually be strengthened, and ecosystem services would be maintained and protected. When all of these happen, human beings and the environment can live in perfect harmony.

2.2.4 Sustainability theory

"Our world as we know it and the future we want are at risk" (UN, 2019b).

The fact that the notion of sustainability has so many viewpoints from which it can be defined is a challenge often faced by researchers. The multitude of definitions that are not effective, diverse, and occasionally inconsistent signify difficulty in the selection of an appropriate notion of sustainability (Salas-Zapata & Ortiz-Muñoz, 2019).

Scholars increasingly emphasise the importance of sustainability science as an interdisciplinary field that engages in and seeks to foster transformation towards sustainable development through activities that include the generation of scientific evidence and theory, education, practices of knowledge co-production, critical thought, and integration of alternative perspectives (Fang, Zhou, Tu, Ma & Wu, 2018; Obermeister, 2019).

Sustainability should be viewed as a broader term than just sustainable development because sustainability concerns itself mainly with issues beyond human beings, such as ecosystems. In contrast, sustainable development places human beings at the centre of its components (Harrington *et al.*, 2010).

The World Commission on Environment and Development (1987) defines sustainable development as “prosperity in society that takes care of present generations needs without negatively diminishing the ability of future generations to meet their own”. It contains within it two key concepts: the concept of needs, in particular the essential requirements of the world’s poor, to which overriding priority should be given, and the idea of limitations imposed by the state of technology and social organisation on the environment’s ability to meet present and future needs (Ashby, Smith & Leat, 2013).

This view is supported by scholars such as Ibanez, Austin and Garnett (2016), who outline the benefits that human beings derive from sustainable development initiatives. Owen and Videras (2008) observe that while the sustainability concept is of interest, many describe it from their own point of view. This opinion is additionally reinforced by Supriyatiningsih, Lelle, Dewi, Sundari, Sugiyo and Nugroho (2017), who caution that before one considers the opinions of different stakeholders, it is essential to decipher their standpoint.

It is from the varying opinions expressed by stakeholders that Jacobs (2012) and Gallie (2019) concluded that this concept would continue to be contested terrain for many years to come. The development of policies related to sustainable development would thus continue for now from these varying interpretations until common ground is found (Jacobs, 2012).

There are several closely related core components of the sustainable development concept. Jacobs (2012) summarises them as follows:

- Environmental protection, leading to the imperative of economic/environmental integration in planning and implementation;
- Equity both within current populations and between present and future generations – the latter is also known as futurity;
- Improving the quality of life, recognising that human wellbeing is not defined by increasing income and the material standard of living; and
- Participation by all groups in society in achieving sustainable development.

Sustainability is not just environmentalism. Entrenched in most characterisations of sustainability are aspirations for economic development and social equity (UN, 2019b). This embedment of social, environmental, and economic issues gives rise to what is commonly known as the three pillars of sustainability, as shown in Figure 2.5.

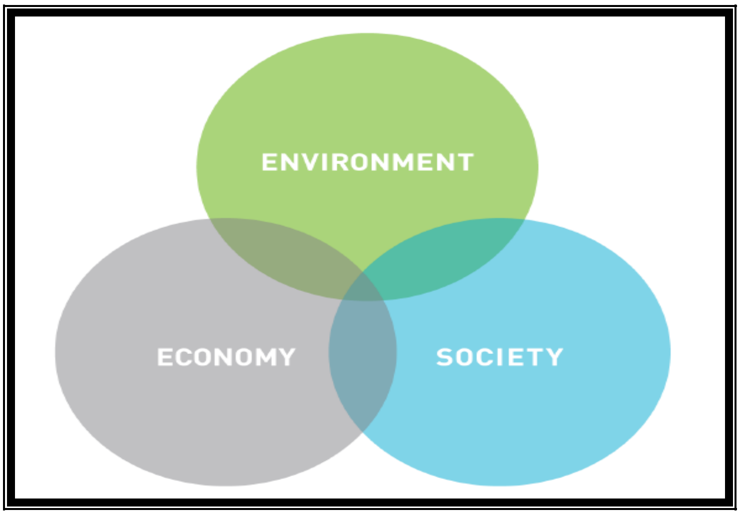

Figure 2.5: Three pillars of sustainability

Source: Kuhlman and Farrington (2010)

2.2.4.1 Environmental sustainability

Environmental integrity is upheld, all of earth's environmental systems are kept in balance, while humans consume natural resources within them at a rate at which they can replenish themselves.

2.2.4.2 Economic sustainability

Communities all over the world can uphold conventionality and have access to the resources they need to meet their desires.

2.2.4.3 Social sustainability

Universal human rights and necessities are attainable by everybody. Vigorous societies have impartial administrators who ensure that people's rights are protected. What is critical in modern-day discussion is the application of the sustainability context to impoverished areas, such as the Mphaphuli community, who are the subject of this research.

The resilience of rural communities to environmental change and rural economic development based on the sustainable use of ecological infrastructure is an essential ingredient of sustainability (Pullanikkatil *et al.*, 2016; Hules & Singh, 2017).

The concept of sustainability is grounded in several assumptions (Harrington *et al.*, 2010; Jacobs, 2012). The first one suggests that sustainable development is concerned with the future of human beings. The second and third assumptions relate to the fact that environmental or ecological thresholds could always be resolved as human beings are capable of addressing these challenges through research. These are conceptually related to scientism and environmental realism (Redcliff, 2013).

A principle has emerged, as advocated by scholars such as Patrício *et al.* (2016), which suggests that sustainable humanity is one in which people's capability to do what they have a decent motive to value, is repeatedly improved. This opinion is reinforced by Costanza *et al.* (2014), who state that the principle of sustainability would have been achieved if the rate of growth in per capita real incomes is achieved without depleting the national capital asset stock or the natural-environmental asset stock.

Many scholars have had a great deal to say about the concept of sustainability; at times conflating it with sustainable development in understandable ways. The following are some of their views around the idea:

- "Like motherhood, and God, it is difficult not to approve of it. At the same time, the idea of sustainable development is fraught with contradiction" (Redcliff, 2013).
- "It is indistinguishable from the total development of society" (Elliott, 2013).
- "Its very ambiguity enables it to transcend the tensions inherent in its meaning" (Elliott, 2013).
- "Sustainable development appears to be an over-used, misunderstood phrase" (Mawhinney, 2002:5, in Elliott, 2013).
- "Sustainability means maintaining environmental assets, or at least not depleting them" (Goodland, 1995).

Gibson, Martin and Singer (2005) suggest that "out of the great diversity of the theoretical formulations and applications, an essential commonality of shared concerns and principles can be identified". Gibson *et al.* (2005) argue that the concept of sustainability is about the following:

- A challenge to conventional thinking and practice;
- Long-term and short-term wellbeing;
- Comprehensiveness, covering all the core issues of decision making;
- Recognition of the links and interdependencies, especially between humans and the biophysical foundations for life;

- Embedded in a world of complexity and surprise, in which precautionary approaches are necessary;
- Recognition of both inviolable limits and endless opportunities for creative innovation;
- An open-ended process, not a state; and
- Intertwined means and ends – culture and governance, as well as ecology, society, and economy.

Poverty, hunger, disease, and debt have been familiar words within the lexicon of development ever since formal development planning began, following World War II. In the past decades, they have been joined by sustainability (Elliott, 2013). For poor communities living in rural areas such as Mphaphuli, who still rely heavily on natural resources for their daily needs, the concept of sustainability inspires debate. It becomes the cornerstone of future frameworks, which is the subject of this research.

Goodland (1995) remarks:

> We do not have time to dream of creating more living space or more environment, such as colonising the moon or building cities beneath the ocean. We must save the remnants of the only environment we have and allow time for and invest in the regeneration of what we have already damaged. We cannot 'grow' into sustainability.

It is from words such as these that sustainable development, as an element of sustainability, is thrust forward when dealing with communities such as in Mphaphuli, the land users, decision makers, and those in government charged with the responsibility of future planning.

The world community adopted sustainable development over many years in the following order:

- 1979: First World Climate Conference opens up the science of climate change.
- 1987: *The Brundtland Report* consolidates decades of work on sustainable development.
- 1992: The Rio Earth Summit rallies the world to take action and adopt Agenda 21.
- 1993: The Convention on Biological Diversity puts the precautionary principle to work.

- 1997: The Kyoto Protocol takes the first step toward stopping dangerous climate change.
- 2000: With the Millennium Development Goals (MDGs), social justice meets public health and environmentalism.
- 2006: Al Gore brings climate change to the mainstream with *An Inconvenient Truth*.
- 2012: Rio+20 takes stock of over two decades of sustainable development efforts (UN, 2019b).

In support of worldwide sustainability, the global community, under the auspices of the UN, agreed on a set of SDGs, which were drafted in 2014 and put into effect in early 2016 (Govender, 2018).

According to Hajer *et al*. (2015) and Betti, Consolandi and Eccles (2018), the SDGs are an enhancement of the original UN MDGs of 2000. Des Marais, Bexell and Bhadra (2016) maintain that the SDGs were developed mainly to tackle global poverty. In total, there are 17 key goals that target specific areas to be addressed globally (Izutsu, Tsutsumi, Minas, Thornicroft, Patel & Ito, 2015; Getenda, 2018), as shown in Table 2.2.

Table 2.2: The 17 Sustainable Development Goals (SDGs)

SDG	**Target**
SGD 1	End poverty in all its forms everywhere.
SGD 2	End hunger, achieve food security, improve nutrition, and promote sustainable agriculture.
SGD 3	Ensure healthy lives and promote wellbeing for all, at all ages.
SGD 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
SGD 5	Achieve gender equality and empower all women and girls.
SGD 6	Ensure availability and sustainable management of water and sanitation for all.
SGD 7	Ensure access to affordable, reliable, sustainable, and modern energy for all.
SGD 8	Promote sustained, inclusive, and sustainable economic growth and full and productive employment and decent work for all.
SGD 9	Build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation.
SGD 10	Reduce inequality within and among countries.
SGD 11	Make cities and human settlements inclusive, safe, resilient, and sustainable.
SGD 12	Ensure sustainable consumption and production patterns.
SGD 13	Take urgent action to combat climate change and its impacts.
SGD 14	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
SGD 15	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.
SGD 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
SGD: 17	Strengthen the means of implementation and revitalise the global partnership for sustainable development.

Source: Izutsu *et al*. (2015)

One cannot talk of sustainability these days and omit the SDG components. This research relied on these goals to establish if the area under investigation or those in positions of leadership knew anything about the SGDs, and if they knew about them, what were they doing to achieve them. If they did not know, this was used to strengthen the research findings and as a position to infuse this into the framework proposed in this study, as well as to make arguments about why development affects ecosystems. SDGs 2, 5, 6, 12, 13, and 15 are critically important for this study.

Almenhali (2019) notes that in the context of external scrutiny, many companies are reviewing their sustainability approach to determine what changes may be required in the long run. In a report by Ernst & Young (2009), the participants described a three-stage journey that companies go through when they decide to embed sustainability into their corporate cultures, which would not be too far off from the structure of the MTA. The three stages are as follows:

- Ensuring they comply with regulations;
- Focusing and reporting on economic benefits; and
- Integrating the sustainability principles into the core strategy and culture of the community.

Regardless of who interprets it in what way, sustainable development suggests that the current generation must always consider that other generations will want to enjoy the benefits of ecosystem services the same way as the current generation.

2.3 LAND-USE LAND-COVER (LULC) CHANGE MAPPING

2.3.1 Understanding LULC change

The definition and description of LULC differ, depending on the context of their use, and the fact that these concepts are closely interrelated (Turner, Lambin & Reenberg, 2007; Echtaie, 2008; King, Gurtner, Firdaus, Harwood & Cottrell, 2016). The land supports all human activities and provides goods and services, including dignity (Meyer & Turner, 1994; Di Gregorio & Jansen, 1998; Cihlar, 2000; Steffen *et al*., 2004; Briassoulis, 2008; Ngcofe, Hickson & Singh, 2019).

These assertions have also been pointed out in years gone by when people such as Fanon (1963) had started pointing out that without land, there is no dignity (Arunyawat & Shrestha, 2016). Although the terms “land use” and “land cover” seem related, the actual meanings are quite different. Land cover refers to the surface cover on the ground, which ranges from urban infrastructure, vegetation, to bare soil, water, or other (Arunyawat & Shrestha, 2018; IPBES, 2018). Land use, on the other hand, relates to what people, and possibly animals, do on the land cover in search of services that the land cover provides. Identifying and mapping the cover of land is crucial for effective monitoring, resource governance, and associated development creativities. Documentation and mapping of the land cover enable the formulation of initial scenarios from which follow-up actions can become possible (Clemens *et al*., 2018; Mucova, Filho, Azeiteiro & Pereira, 2018; Potschin-Young, Haines-Young, Görg, Heink, Jax & Schleyer, 2018).

The detection of LULC change is the process used to identify variances in the state of land at different time intervals, which allows for the monitoring and management of natural resources. When information about LULC change is gathered, it makes it easier to control the land and influence the future outlook of the LULC than when such information is not known. All this leads to managing environmental resources, which are essential for human wellbeing (Liang *et al*., 2017; Song & Deng, 2017; Xu & Ding, 2018).

The United Nations Convention to Combat Desertification (UNCCD) defines land as the bio-productive and terrestrial system that includes vegetation, soil, ecological and hydrological processes, and other biotas that function in unison (Clemens *et al*., 2018; Briassoulis, 2019).

Land is not considered only by looking at its surface topography; whoever looks at it should have a deeper understanding of everything that happens beyond the physical eyes – the bigger picture around all the natural processes, as well as interactions between living and non-living things (Wu, 2014). Land in modern administration contexts includes resources, the marine environment, buildings, and all things attached to and under the surface (Williamson, Enemark, Wallace & Rajabifard, 2008; Baumgartner & Cherlet, 2015).

LULC change has developed into an essential field of study that has generated a great deal of interest among scientists worldwide (Briassoulis, 2008; Dewan & Yamaguchi, 2009; Turner *et al*., 2015; Hejnowicz & Rudd, 2017; Chaudhary & Kumar, 2018; Aldana-Dominguez *et al*., 2019; Munthali *et al*., 2019).

2.3.2 Remote sensing and geographic information system (GIS) application in LULC change mapping

Before the advent of computer-based tools such as GIS and satellite-based remote sensing, human beings depended on physical fieldwork to identify LULC changes. This form of LULC change detection meant that human, time, and financial resources had to be used for fieldwork. The traditional fieldwork took much longer to undertake, which meant that the rate of understanding these changes was at a much slower pace (Seidel, Dourte & Diamond, 2019). For communities such as the Mphaphuli, LULC change detection has always been based on indigenous knowledge systems, coupled with community-based practices, for natural resource management. Mapping has relied on large piles of paper-based information stored in files. Numbers were allocated according to regions, which took time to retrieve whenever such information was needed for decision making.

Remote sensing and GIS applications, on the other hand, have revolutionised the way that LULC change detection is carried out and have become a valuable tool from which LULC change information can be extracted efficiently. Data can be retrieved at the click of a button, and large areas can be modelled in a matter of minutes, which might be done by very few people as well (Chaudhary & Kumar, 2017).

Multi-temporal remote sensing datasets, conveniently processed and explained, allow for proper analysis of changes, which enables a much better planning exercise (Dewan & Yamaguchi, 2009; Chaudhary & Kumar, 2017). It is because of the efficiency with which remote sensing and GIS data-application tools operate that many scholars, scientists and policymakers have decided to use them (Giri, 2016; Barton *et al*., 2018).

According to Hejnowicz and Rudd (2017) and Salata, Garnero, Barbieri and Giaimo (2017), mapping changes in LULC increases the understanding of ecosystem asset value, which leads to a heightened sense of confidence in making long-term decisions. There has recently been a great deal of interest in mapping, and many scientists are moving into this area (Bagstad, Villa, Batker, Harrison-Cox, Voigt & Johnson, 2014).

In a study on brownfield regeneration in Trento, Italy, Cortinovis and Geneletti (2018) found that mapping contributes to policy and decision making. The same observations were made by Posner, McKenzie and Ricketts (2016), who state that mapping and assessment of ecosystem services could have enormous implications for decision making at different levels, including making communities aware of how they can be involved in influencing such decisions.

Remote sensing techniques make it easy and practical for users to obtain land-cover overview information in a short time, even for large areas. It is possible to obtain even minute details about phenomena using remote sensing data, such as changes in plant phenology throughout the growing season (Kala, Bhavsar, Roy & Rawat, 2017). For regional mapping, continuous spatial coverage over large areas is essential. It would be challenging to detect local trends with point source data. The techniques used in remote sensing have made it possible for scientists to conduct mapping exercises, which mainly result in accurate classification of LULC classes (Chaudhary & Kumar, 2017; Aldana-Dominguez *et al*., 2019). The same could be said for military reconnaissance, as well as for rural and urban planning (Dewan & Yamaguchi, 2009; Briassoulis, 2019; Zhang, Sargent, Pan, Li, Gardiner, Hare & Atkinson, 2019).

Land-cover mapping is a vital component of several environmental and socioeconomic applications. Earth observation datasets are a significant source for deriving land-cover information (Ngcofe & Thompson, 2015).

A study that quantified and mapped ecosystem services in West Africa also reported a general deterioration in ecosystem services value between 2000 and 2009 (Kim, 2016), which is critical in indicating the importance of mapping LULC changes (Negussie, Wu, Alemayehu & Yirsaw, 2019).

Additionally, international and national policies for reporting on the environment frequently require detailed, accurate, up-to-date LULC information. In their study of LULC changes between 1979 and 2017, Mucova *et al.* (2018) concluded that desktop analysis, fieldwork, and a literature review provide a historical analysis of LULC. The study was conducted at the Quirimbas National Park in Mozambique, which was useful in serving as a basis for future LULC analysis, as well as guiding the preparation of concrete local plans for the use and exploration of resources, area sustainability, and the protection of forests and animals.

The history of land-cover mapping in South Africa, through the application of earth observation systems, can be traced back to 1994. The land cover was mapped using Landsat imagery of 1994 to 1995, termed National Land-Cover (NLC) 94. Since then, the country has been mapped through collaboration by various government organisations and the private sector, at the national and provincial level (Ngcofe *et al.*, 2019).

Land-use change is a dilemma for policymakers, especially for those involved at the coalface of delivering essential services and establishing mitigation plans. This dilemma is because land-use change is critical for human development, yet the resulting negative impacts present potential challenges for the achievement of such an event (Foley *et al.*, 2005).

The Mphaphuli area has seen a tremendous increase in population over recent years (Stats SA, 2017). Pressure has been mounting on the local municipality and the traditional leaders for access to land for both residential and institutional development purposes. While both the municipality and the traditional leadership have endeavoured to allow for such land-use activities to take place, there is no information available to assist decision making around LULC change detection.

This study used current GIS and remote sensing applications, and used the knowledge or participation of traditional leaders to point out areas that are subject to change. These leaders are usually sidelined in the formal planning, regulation, and decision making on land matters, together with land users, who are affected by decisions in pointing out some of the drivers of change. This study attempted to map the LULC change of the Mphaphuli area between 1990 and 2018, with a view to detecting the changes and identifying the influencing factors of such changes.

The analysis of land-use change revolves around two central and interrelated questions: what drives/causes the use of land, and what are the economic, social, and environmental impacts of changes in land use? (Gashaw, Tulu, Argaw & Worqlul, 2017). It is for this reason that the study also attempted to predict the expected LULC changes for the future. Land-use change emanates from various influencing factors, of which some are direct and others are indirect. Some of these factors include economic, natural, technological, and institutional factors; in addition to cultural factors (Arunyawat & Shrestha, 2016; Hejnowicz & Rudd, 2017).

Research on LULC dynamics, together with understanding the elements responsible for the changes, is essential for demonstrating future changes in LULC and the advancement of feasible land-use governance options and decision support tools (Hejnowicz & Rudd, 2017; Munthali *et al*., 2019).

LULC change detection, or mapping, has been done at the national level but has never been done at the local level where people, led by traditional leaders, could be involved as well (Thompson, 2019). National-level LULC change detection is proper, as it allows for general management of such changes. Still, this must also be done at the local level, especially involving the directly affected communities in the process. The outcomes and recommendations are much more useful than when done in silos; hence the push towards the use of local solutions to solve local problems.

Many scholars in LULC change detection in and around the Mphaphuli area have focused on identifying the changes, but it ended there. Masupha and Moeletsi (2018) argue that such studies should at least go beyond just reporting results. This study not only goes further to identify drivers, but it also does this by using local knowledge. The findings are not based solely on computer applications but also on evidence gathered on the ground, from those who interact with the environment on a daily basis.

2.4 ECOSYSTEM SERVICES AND VALUATION

2.4.1 The ecosystem services concept

Ecosystem services have been described by many scholars such as Haines-Young and Potschin (2017), Hejnowicz and Rudd (2017), and Gallie (2019) as rewards that people receive from ecosystems; whether such rewards are direct or indirect inputs of ecosystem services to human beings.

More recent publications define ecosystem services as gifts from the functioning ecosystem structure and function to humanity (Haines-Young & Potschin, 2017). The MEA framework (2005) lists ecosystem services such as provisioning, regulating, cultural, and supporting services.

Provisioning services are physical products such as food for use by people (Mullin, 2019). Regulating services are processes that occur in nature, such as water cleansing, nutrient filtration, and climate regulation, while cultural services are often referred to as intangible services such as aesthetics, sense of place, and religious worship, but also direct uses such as recreation, ecotourism, and education. Supporting services are all the underlying, long-term processes in nature such as net primary products, soil formation, and climate stability that secure the provision of direct services to humans (Costanza *et al*., 2014). These services are summarised in Table 2.3.

Table 2.3: The Millennium Ecosystem Assessment (MEA) classification of ecosystem services

Category of service	Characteristics and examples
Provisioning services	Water and food Fuelwood and timber Genomic resources Natural medicines, biochemicals, and pharmaceuticals Decorative resources
Regulatory services	Regulation of air quality and climate Water regulation (timing and scale of runoff, flooding) Natural hazard regulation (i.e., storm protection) Disease regulation, pest regulation, and erosion regulation Purification of water, pollination, and waste management
Cultural services	Recreation, cultural heritage, and tourism Spiritual, aesthetic, and religious value Folklore, the inspiration of art, and architecture
Supporting services	Creation of soil, nutrient cycling, and primary production Photosynthesis, water recycling, and habitat provision

Source: Vieira da Silva, Everard and Shore (2014)

Everard and Waters (2013), Ambrey and Fleming (2014), Aldana-Dominguez *et al.* (2019), and Masupha and Moeletsi (2018) identified some studies that sought answers to the concept of ecosystem services and LULC changes similar to the issues that confront the Mphaphuli area, where these studies have already been undertaken, which shed light on the importance of ecosystem services. Some of these are summarised below.

2.4.1.1 The Hlabathi wetlands ecosystems in South Africa

The findings indicate that the entire community obtains some benefits from wetlands, most notably regulating ecosystem services (Pantshwa & Buschke, 2019). The high dependence on ecosystem services by community members, when combined with gender-based power imbalances and the propensity to blame others, could jeopardise the sustainable use of communal wetlands.

The study points out that strong leadership could nurture a sustainable, socio-ecological system by integrating ecological information and social empowerment into a multi-level governance system.

2.4.1.2 Tamar 2000

The Tamar 2000 project sought to stabilise farm incomes by improving agricultural practices and farm diversification in the predominantly rural River Tamar catchment in the southwest of England (Everard & Noble, 2010; Vieira da Silva *et al*., 2014). It did so by recommending farm interventions to protect or enhance the river ecosystem, including farm business diversification.

2.4.1.3 Managed realignment at Alkborough Flats

This was a degraded flood bank at Alkborough Flats on the Humber estuary in northeast England, created after World War II to regain arable land that had become uneconomical to renew (Everard & Waters, 2013).

Managed realignment was undertaken instead, which allowed tidal flooding of more than 400 hectares (ha) of the floodplain to form mudflats, saltmarshes, reedbeds, and other intertidal territories. The exercise satisfied intertidal habitat mitigation responsibilities under the European Union Habitats Directive and reduced flood risk elsewhere in the estuary.

2.4.1.4 Sea trout restoration on the River Glaven

Restoration of habitat and improvement of access for sea trout recolonisation on the River Glaven in eastern England brought together a range of legal and voluntary stakeholders with related interests towards the rehabilitation of the river ecosystem (Everard & Waters, 2013).

2.4.1.5 The delivery of nature's services: The ecosystem services pilots

These projects saw delivery plans being agreed upon and management actions set up to bring about service changes. The project included economic valuation and participatory approaches to reaching consensus on future management (Everard & Waters, 2013).

Another study used the MEA guidance to assess likely outcomes of managed realignment at the Steart Peninsula, on the mouth of the River Parrett in northern Somerset. Multiple benefits were deduced, which advanced benefit-transfer methods.

From the above, it is possible to argue that ecosystem services are a powerful concept that renders visible the gifts of nature to humanity and strengthens the argument that society would find it daunting to exist without the benefits derived from ecosystems (Chan *et al.*, 2012; Isbell *et al.*, 2017).

2.4.2 Society and ecosystem services

Ecosystems cannot provide any benefits to people without the presence of people, their communities, and their built environment (Costanza & Kubiszewski, 2016). Ecosystem services should be perceived as a contribution of the natural capital to human wellbeing, which forms only by interaction with humans, society, and built capital (Villoslada, Vinogradovs, Ruskule, Veidemane, Nikodemus, Kasparinskis, Sepp & Gulbinas, 2018).

According to TEEB (2010), many ecosystems are so degraded that they are approaching their tipping points, which are the thresholds where their capacity to provide services is threatened. It is for this reason that scholars such as Costanza *et al.* (2014) consider the assessment of ecosystem services as a field of ecological economics that must be of interest to almost everyone, as economic activities affect everyone's daily activities. If ecosystems are impacted upon and degraded, the services obtainable from them would also be affected, which affect humans in many ways, including an increase in poverty (Pullanikkatil *et al.*, 2016). The human race is at risk, because transforming the stable ecological conditions that existed for many years would in a way result in indirect impacts on humanity (Dasgupta, Morton, Dodman, Karapinar, Meza, Rivera-Ferre, Sarr & Vincent, 2014; Steffen *et al.*, 2015).

Based on NLC information, 81% of South Africa (985 559 km^2) was in its natural state in 1990 (Thompson, 2019). By 2014, natural areas were estimated to have declined to 79% (961 010 km^2). Habitat loss, as a result of historical (1750 to 1990) and recent (1990 to 2014) clearing of natural habitat for field crops, horticultural crops, and planted pastures, is the most significant pressure on terrestrial ecosystems and biodiversity in South Africa and has affected 16% of the land surface (Skowno *et al.*, 2019).

Some scientists have called for the consideration of not only the good that comes from ecosystems, but also the negative aspects (disservices) for a more balanced picture of human-nature relationships (Shackleton *et al*., 2016; Schaubroeck, 2017; Cruz-Garcia *et al*., 2019).

The language used in ecosystem services discussions appears to be so technical that it leads to some people feeling excluded from such discussions and decision making; many people, especially at the local level, therefore end up not participating when decisions are made (Luck, Chan, Eser, Gómez-Baggethun, Matzdorf, Norton & Potschin, 2012; Krasny, Russ, Tidball & Elmqvist, 2014). Luck *et al*. (2012) reiterate that the language used in ecosystem services should not be viewed as a barrier for others not to participate; instead, the language should be an enabler of fruitful engagements.

However, ecosystem disservices have not been prevalent in previous studies, compared to ecosystem services (Lyytimäki & Sipilä, 2009; Ntshane, 2016; Campagne, Roche & Salles, 2018; Pantshwa & Buschke, 2019). It is as a result of this phenomenon of low interest that ecosystem disservices are hardly incorporated into planning (Escobedo, Kroeger & Wagner, 2011). Rodríguez-Echeverry, Echeverría, Oyarzún and Morales (2018) observed, in a study of the Chilean temperate forests, that the more deforestation takes place, the more ecosystem services disappear in the process. Similar observations were reported in other landscapes that saw transformation as a consequence of anthropogenic interferences (Qi, Ye, Zhang & Yu, 2014).

The study of land and ecosystems points to the fact that land and ecosystems are connected, and what happens to one component of the ecosystem influences what happens to other ecosystem components (Miller & Spoolman, 2011; Masupha & Moeletsi, 2018). This principle also applies to the South African land and ecosystem context, where it could be inferred that what happens concerning the land use and implications for ecosystem services in one area could have repercussions on surrounding areas as well.

The same could be said of activities that take place in one catchment, which may influence the outcomes in another catchment. The same could be said of land-use activities in one traditional leadership area, which could have implications for the surrounding traditional leaders as well.

Ecosystem services stakeholders should be regarded as individuals who have a two-way relationship with ecosystems, in that they affect, and are affected by, ecosystem services (Hein, Van Koppen, De Groot & Van Ierland, 2006). Ecosystem services beneficiaries derive value from ecosystem goods and services, even from minor elements such as merely appreciating the beauty of the environment (Harrington *et al*., 2010; Nahlik, Kentula, Fennessy & Landers, 2012). The difference between a stakeholder and recipient is the ability to influence or be influenced by ecosystem services processes. Each recipient of ecosystem services should be considered a stakeholder, but not all stakeholders are necessarily beneficiaries, and the sense of value derived from ecosystem services differs, depending on subjective value judgements (Hein *et al*., 2006; Rastogi, Badola, Hussain & Hickey, 2010).

2.4.3 The valuation of ecosystem services

Valuation is simply a process to aid decision making because it involves trading off the worth of one thing against another (Peh *et al*., 2014). Valuation also translates to a measure of what someone is willing to give up in other goods and services to obtain excellent service.

Since the publication of an article (Westman, 1977) that questioned the worth of nature's services to human beings, there has been a heightened need for further research around the issue of ecosystem services and their valuation (Westman, 1977; Pullanikkatil, 2014). Regardless of what progress has been made in understanding the ecosystem services concept, a great deal still needs to be established around the valuation of ecosystem services and how it contributes to sustainable development, especially in rural areas (Pandeya, Buytaert, Zulkafli, Karpouzoglou, Mao & Hannah, 2016).

Ecosystem services valuation is one element of the call for forging ahead on a path to a justifiable and necessary future. There is a growing realisation that some existing forms of economy, fixated only with growing the GDP, are excessively narrow and fail to recognise that there are other elements that could improve human wellbeing as well (Fioramonti, Coscieme & Mortensen, 2019).

Arthur Tansley coined the ecosystem concept in 1938 and defined it as a complex system that incorporates elements of both living and non-living objects that interact with one another (Pullanikkatil, 2014). Human beings are entirely dependent on functional ecosystems that provide many services, such as food, shelter, energy, climate regulation, and aesthetic appeal (Noring, 2014; Hasselström, Håkansson, Noring, Soutokorva & Khaleeva, 2017).

In the contemporary economy, in which people recognise money as the most important form of currency, other forms of trading instruments have taken a back seat. While this is the case for many areas across the world, reasons for not adopting alternative forms of currency, such as those related to environmental assets, stem from limited information and the fact that people are thriving using the existing currencies, among others (Department of Environmental Affairs [DEA], 2012; World Atlas, 2018; Fioramonti *et al*., 2019).

This thriving has, unfortunately, resulted in people turning their backs on basic environmental concepts or resources, which are the backbone of everything that humans do or depend on (DEA, 2012). Ottomano Palmisano, Govindan, Boggia, Loisi, De Boni and Roma (2016) agree with the above assertion by also observing that human detachment from nature, unfortunately, leads to severe challenges such as soil erosion, loss of species, and global warming, among others. Such a situation requires coordinated effort, not only from individual nations or interest groups operating in silos, but rather as allies all over the world.

The UN General Assembly has made a point of involving stakeholders worldwide in protecting the diversity of life on earth and declared the decade 2011 to 2020 as the decade of biodiversity (Negussie *et al.*, 2019; UN, 2019a). The snowballing connection between biodiversity conservation, economics, and ecosystem valuations in the achievement of sustainable development has developed into an essential issue.

The global ecosystem services value of $33 trillion suggested in years gone by appears to have been an underestimation of the welfare benefits of natural capital (Westman, 1977; Odum & Odum, 2000; Carpenter *et al.*, 2009; Costanza *et al.*, 2014). This underestimation appears to have stimulated a considerable surge of interest in this topic over the years (Costanza *et al*., 2014). The total net loss due to LULC change globally has been valued at $20.2 trillion per year between 1997 and 2011 (Costanza *et al.*, 2014; Kubiszewski, Marais & Costanza, 2017).

The valuation of ecosystem services is a global phenomenon, and many scholars are currently grappling with the concept (Costanza *et al.*, 2014). It is critical to generate research inputs from all over the world that can contribute to proper, concrete, evidence-based decision-making processes around ecosystem services (Costanza & Kubiszewski, 2016).

Evidence-based decisions would contribute to the fight against poverty, inequality, and unemployment, which are persistent problems facing South Africa at the moment (Anderson, Ankor & Sutton, 2017). Twelve million people live in poverty in South Africa on less than $1.25 a day, which places South Africa in the world's top ten for revenue disparity, according to its Gini coefficient (Stats SA, 2017).

South Africa has one of Africa's most noteworthy gaps between GDP per capita and the Human Development Index. Acknowledging this challenge, together with the realisation that ecological infrastructure could contribute positively to addressing some of these challenges, would go a long way (Anderson *et al.*, 2017). Hein *et al.* (2006) and Jacobs *et al.* (2016) reiterate that valuation requires that the ecosystem object to be evaluated is identified to enable clear consideration of the cause-and-effect relationship between land use and the provision of services.

Researchers such as Kubiszewski, Costanza, Anderson and Sutton (2017) and Negussie *et al.* (2019) agree that changes in LULC result in modifications of the value of ecosystem services. Others believe that LULC change contributes to certain ecosystems' ability to provide more valuable services, while at the same time these changes diminish the strength of others to provide the same (Costanza *et al*., 2011; Kindu, Schneider, Teketay & Knoke, 2016).

Studies have suggested that South Africa will continue to be an emerging market for some time, and that given its heterogeneous status as an emerging market, the country would do well to quantify the value of its ecological assets and continuously unpack the related services (Musango, Brent & Bassi, 2014; Musvoto, Nortjé, De Wet, Mahumani & Nahman, 2015; Clemens *et al*., 2018).

Environmental wealth and the services obtainable from natural processes are considered by humanity as an inherent right without monetary value (DEA, 2012; Häyhä & Franzese, 2014; Rawlins, De Lange & Fraser, 2018). Any attempt to associate a quantitative economic value with ecosystem services is generally considered a complicated and potentially misleading process (Schröter, Van der Zanden, Van Oudenhoven, Remme, Serna-Chavez, De Groot & Opdam, 2014). Ecosystems and the services they provide to humanity should be recognised as an essential service without which most other services may not be possible to provide (Rawlins *et al*., 2018).

The proper assessment and valuation of the variety of ecosystem services form part of cost-benefit analysis, or is related to project alternatives determination. These exercises require that there be the proper estimation of their monetary value, followed by the incorporation of such monetary values into the overall economic transactions that define economies all over the world (DEA, 2012).

Costanza *et al.* (2014) point out that attempting to attach monetary units to ecosystem services has a critical role to play in intensifying awareness around the overall level of ecosystem service importance relative to and in combination with other contributors to sustainable development.

Ecosystems can be characterised as environmental assets that, as other capital assets, provide a flow of services over time. If these services are consumed sustainably, the capital value can be retained (Batabyal & Dasgupta, 2002). If land is used in such a way that consideration for ecosystem services is compromised, then there could be more implications for those who live in remote and rural areas, such as those under the MTA.

Most people understand value as expressed in monetary units, which is often a convenient denominator for expressing the relative contributions of other forms of capital, including natural capital. Other units are undoubtedly possible, such as land, energy, time, etc. The choice is mainly about which units communicate best with different audiences in a given decision-making context (Costanza *et al*., 2014).

Knowing that the existence of ecosystem services on land is being managed by traditional authorities is useful, if such land and the services are to be managed effectively. Effective management serves as the basis for incentives for better returns, such as those that can be obtained in payment schemes around ecosystem services (Farley & Costanza, 2010; Hejnowicz & Rudd, 2017).

The significant share of GDP contribution in former homeland areas is characterised by colossal government salary payments rather than improved manufacturing of goods and commercial services (Ngomane & Flanagan, 2003). Rural South Africa is a consumer society of goods and services. Bagstad *et al.* (2014) assert that because ecosystem services are by definition an anthropocentric concept, beneficiaries (or users) must be spatially connected to regions that provide a service for that service to have value; except for global services such as carbon sequestration or some non-use values.

Cruz-Garcia *et al.* (2019) found that in valuing ecosystem services, gender issues should be taken into consideration, which is strongly supported by Pantshwa and Buschke (2019). Many studies have been undertaken that add to the growing body of evidence that ecosystem services benefits are not gender neutral (Martín-López *et al*., 2012; Fisher *et al*., 2013; Brown & Fortnam, 2018). The results, for example, show that representatives of both indigenous men and women in the Colombian Amazon identify a similar number of ecosystem services, value many of the same services similarly, and share some of the criteria for prioritising ecosystem services. There are significant gender differences, with men and women mentioning different ecosystem services, identifying different rules for valuing ecosystem services' importance, and ascribing different values to different ecosystem services. Besides, men and women may agree that a particular ecosystem service is significant, but disagree on the reasons why it is essential (Small *et al*., 2017).

The trend of changes in values emanating from ecosystem services points to concerning declines in many regions, which is confirmed by several studies. Kindu *et al.* (2016, in Negussie *et al*., 2019) report that in the Munessa-Shashemene landscapes, a decline in ecosystem services value between 1973 and 2013 was observed. Gashaw *et al*. (2017, in Negussie *et al*., 2019) projected a significant loss of ecosystem services value of approximately 21.7% between 1986 and 2015 due to deforestation in the Andessa watershed of Ethiopia.

Tolessa, Senbeta and Kidane (2017) point out an overall reduction in the value of ecosystem services of 40% between 1973 and 2015 in the Chilimo Forest in Ethiopia, as a result of deforestation. Almost 68% of ecosystem services value was lost between 1973 and 2014 in the Toke Kutaye district of Ethiopia, from the same driving force, namely deforestation. Many parts in West Africa also reported escalations around deforestation, which led to a significant reduction in ecosystem services value between 2000 and 2009 (Leh, Matlock, Cummings & Nalley, 2013; Negussie *et al*., 2019).

Negussie *et al.* (2019) also elaborate on further studies relating to the decline in ecosystem services values by indicating findings by Li, Dong, Cui, Zhang, Cui and He (2007) in the Pingbian County of China, where a 19% reduction in ecosystem services value between 1973 and 2004 was recorded. In San Antonio (Texas), Kreuter, Harris, Matlock and Lacey (2001) pointed out a wide-ranging decline in the service values derived from ecosystems between 1976 and 1991.

It is not always the decline of ecosystem services values that scholars are observing, however, because, for example, in the same study by Negussie *et al.* (2019), Wang, Gao, Wang and Qiu (2014), Gashaw *et al.* (2017), and Li *et al*. (2018) observe significant increases in the value of ecosystem services in Ningxia (14%) and Chengdu (22%) in China, and Gedeo-Abay in Ethiopia (14%) between 1986 and 2015, 2000 and 2010, and 2000 and 2015, respectively.

According to the UN (2012, in Turpie, Forsythe, Knowles, Blignaut & Letley, 2017), the creation of a common method to value and classify ecosystem services is deemed essential to advancing sustainable development strategies and remains a severe challenge globally. Ecosystem services and other environmental resources are categorised into services and goods that could be traded in the market and provide immense livelihood value to poor communities (Kulindwa, 2006; Fisher *et al.*, 2011).

The following seven valuation methods of policy frameworks have been identified:

1) The MEA: This was among the first initial significant international attempts to comprehend the relationship between human beings and services from ecosystems. The MEA framework was established to gain insights into the finer details around ecosystem services, inclinations in their flows and production, as well as significant threats, pressures, policy formulations, and management decisions (IPBES, 2018). It has received accolades from scientific circles and policy communities. Because of this acceptance, the framework has been used as a launchpad for alternative ways of appreciating ecosystem services values (Pandeya *et al*., 2016).

2) TEEB: This system appears to have been an addition or extension of the MEA, in that it promotes collaboration among scholars from both economics and ecology to understand the value of ecosystem services (TEEB, 2010). Arguments have been made that any valuation of ecosystem services should take into consideration the biophysical generation of services to provide a concrete ecological underpinning to the economic valuation (Pandeya *et al*., 2016).

3) IPBES: This tool brought about inclusive interlinkages among diverse scientific disciplines, knowledge systems, and stakeholder interests (Díaz *et al*., 2015; Hill *et al*., 2020). The framework focuses on knowledge generation and sharing, as well as

the character of organisations responsible for making decisions and how they are equipped to deal with decision making.

4) Toolkit for Ecosystem Service Site-based Assessment (TESSA): This toolkit is a collection of approaches used in identifying various ecosystem services and their values. This toolkit is suitable for such valuation, as well as for mapping at the level of a landscape (Peh *et al*., 2014; Jacobs *et al*., 2016).

5) Co$ting Nature: This is a web-based application that takes into consideration many more ecosystem services, and value them at either local, national, or international level. Unlike other tools, it examines the provisioning, supporting, and regulating of ecosystem services (Mulligan, 2018). It is thus instrumental in scenario planning for land-use activities.

6) Artificial Intelligence for Ecosystem Services (ARIES): This framework is appropriate for the assessment of ecosystem services and can be combined with local procedures that influence decisions, such as payment for ecosystem services (PES) schemes. The concerning element about this tool, however, is that it has limited functionality for scenario planning exercises (Raymond, Bryan & MacDonald, 2011; Villa, Ceroni, Bagstad, Johnson & Krivov, 2009).

7) Integrated Valuation of Ecosystem Services and Trade-offs (InVEST): This instrument is a web-based application. It is a well-developed tool that is useful for estimating quantities and generating maps for many ecosystem services. It is used extensively in water and land-use policymaking exercises (Richardson, Loomis, Kroeger & Casey, 2015; Friedrich, 2017).

As part of improvements towards some of the identified methods of valuation, Gómez-Baggethun *et al*. (2014) argue that for success in valuing ecosystem services, an integrated approach may be better, instead of using many individual tools that work in silos. The natural environment should be respected as a useful form of asset that underwrites the commercial development and advancement of people the world over (IPBES, 2018).

Environmental goods include several products, ranging from medicinal plants and material for shelter to drinking water, among others. Environmental services, on the other hand, include ecological roles such as carbon sequestration and storage, microclimatic regulation, filtration of effluent, soil conservation, watershed protection, recreational amenities, and habitat for valuable biological resources (Rawlins *et al*., 2018).

Environmental services usually do not have a marketplace, as is the case with other commodities, because they are not traded as such. This phenomenon is regarded as the "missing markets", and they are not usually included in private and public development decisions. Even though these environmental goods and services are not traded in a defined market, they have economic value, which is fundamental to human existence (Fisher *et al.*, 2011; Ambrey & Fleming, 2014).

The rationale behind valuing ecological capitals is to safeguard their wise use, which in turn ensures continuous flows to humanity. Many ecological resources are sophisticated and have multiple ecological functions. Baumgartner and Cherlet (2015) argue that difficulties in valuation methodologies arise because the complexities of ecosystem services make them difficult to measure. Trading in ecosystem services is not as simple as many would think, because the complexities make it difficult for the real value to be isolated in the way conventional economic goods and services are traded (Ambrey & Fleming, 2014).

It is desirable to keep these ecological assets in their natural state, as opposed to diminishing or degrading them; just like any other asset in the marketplace. Economic valuation provides humanity with tools to assist with the difficult decisions involved in the use of these ecological resources. The primary application of economic valuation is thus to avoid the loss of ecological resources, especially those with irreversible outcomes (Kulindwa, 2006).

The South African DEA (2012) revealed that while some ecosystem services have received attention, the regulatory service has serious or key gaps that need to be filled through continued research. Functions such as the regulation of air quality and the alteration of life-threatening weather events have received no consideration when it comes to associating them with economic or monetary value.

South Africa will continue to be an emerging market for some time (DEA, 2012). Given that the country is a developing third-world economy, it is imperative to determine the value of biodiversity and unpack the services from ecosystems on an ongoing basis in line with local value systems and global trade regimes. This determination has the potential to turn the tables in the future and make the country a top market in the trade of ecosystem services, such as around carbon trading.

Natural capital locked up in ecosystems and the services derived from such capital are usually considered negligible by society, as a result of limited understanding of the value in global markets. Due to the trading in ecological assets as a growing market, many people still consider its marketplace as a bit problematic and potentially highly misleading (DEA, 2012). Accounting value for ecosystem services in monetary units has a critical role to play in heightening awareness and estimating the overall level of importance of ecosystem services relative to, and together with, other contributors to society (Costanza *et al.*, 2014).

Understanding ecosystem services value is essential if they are to be managed effectively. This understanding of the values should be for both the economic and social benefits (Farley & Costanza, 2010; Hejnowicz & Rudd, 2017). A study conducted in Lesotho by Turpie *et al.* (2017) established that the locals were not happy to receive even a comparatively high reward as a substitute for the anticipated degradation of rivers, which would result in them losing their cultural value.

In a related setting, the South African government's expenditure in the area of tourism associated with natural ecosystem services was valued at R52.2 billion per year (Guerbois, Brady, De Swardt & Fabricius, 2019). Almost half of this was attributable to conservation areas, which cover only 8% of South Africa's land surface (Turpie *et al*., 2017).

The economic value contributed by vegetation's ability to control soil erosion and retain sediment was estimated at R2.1 billion in a year, which averages to R27/ha. Aggregate economic benefits from ecosystems in 2017 were estimated at approximately R275 billion per annum.

Guerbois *et al.* (2019) further argue that if natural systems are maintained and kept in their optimal state, they can generate a substantial economic value of at least 7% of the country's GDP. Provisioning services from nature contribute approximately R47 billion annually, which is far higher than other economic sectors in the country, some which are well established for that matter. These provisioning services are critical inputs, both economically and socially, because, in 2019, South Africa's unemployment rate was well over 29%, and poverty levels at almost 60% (Stats SA, 2017).

Turpie *et al.* (2017) assert that a developing state such as South Africa would do well to ramp up the incorporation of ecosystem economic values into its general financial records. If this incorporation were to be implemented correctly, it could be beneficial to many of those living in rural areas, who are heavily reliant on the primary environmental assets for essential services.

2.5 LAND-USE MANAGEMENT PRACTICES

Nelson Mandela once said:

> Our people are bound up with the future of the land. Our national renewal depends upon the way we treat our land, our water, our sources of energy, and the air we breathe … Let us restore our country in a way that satisfies our descendants as well as ourselves (Skowno *et al.*, 2019).

2.5.1 LULC management

Management involves the planning, organising, leading, and controlling of human and other resources to achieve organisational goals efficiently and effectively (George & Jones, 2012). It is so that in any society or culture where resources are valuable and scarce, the more efficient and effective use that communities can make of those resources, the higher the relative wellbeing and prosperity of the people in that society. Environmental resources could be grouped with general resources that require management. This management trickles to land-use changes that many scientists have pointed out as being critical for human wellbeing.

Any land-use change that takes place has a significant impact on livelihoods. It is high time that the issue of land-use change is fully integrated into the policy discourse, and appropriate measures put in place to address the issue (Locher & Sulle, 2014). According to Hall (2012), policy formulation around the very sensitive and complex issue of land has been based on perception, rather than fact, for far too long. Land-administration systems are the cornerstones of proper recognition of user rights, limitations, and inherent responsibilities placed on people, all of which constitute management (Williamson *et al*., 2008; Noring, 2014).

Enemark (2012) argues that almost everybody must concern themselves with the management of the land. This is because nearly anything or everything that anyone does is dependent on land. In some way or the other, anyone would deal with elements of land use, land value, land tenure, and land development.

The former president of the United Republic of Tanzania, Ali Hassan Mwinyi (1998, in Noring, 2014) stated: "Poverty and environmental problems are both children of the same mother, and that mother is ignorance." For anyone to be able to manage anything or any commodity, that person must understand the value of such a commodity. The same holds for the land and associated ecosystem services across the MTA.

The driving force behind the evolution of management theory is the search for better ways of using resources, which saw the emergence of the so-called classical management theories around the turn of the 20th century (George & Jones, 2012). These include scientific management, administrative management, behavioural management, management science, and organisational environment theory. The management of environmental attributes, resources, and assets, of which LULC and ecosystems are part, appears to combine the various forms of these theories as they relate to how human beings interact with the environment and among themselves when it relates to the environment overall.

The management of land is a complicated or involving process that encompasses putting resources together for better use of the land. Put simply, the management of land includes all processes associated with the planning, allocation, monitoring, and governance geared towards sustainable environmental resources (Williamson *et al.*, 2008; Enemark, 2012). Figure 2.6 depicts the best practice land-use planning process, as proposed by Lawlor, Lawlor and Swan (2014).

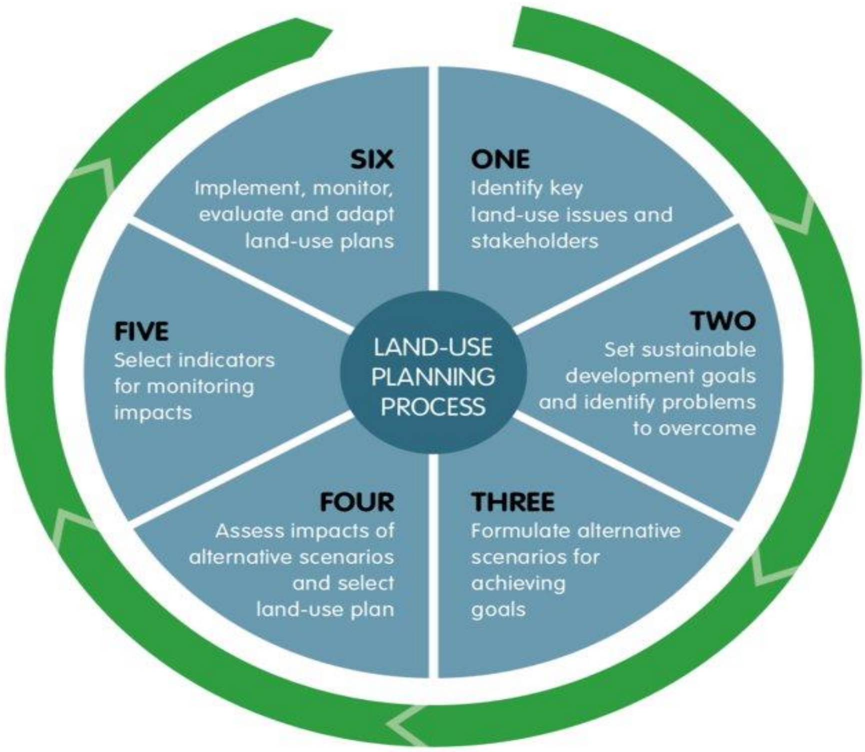

Figure 2.6: Best practice land-use planning process

Source: Lawlor *et al.* (2014)

Continuing to ignore the importance of determining the extent of planning for LULC change and associated ecosystem impacts could be tantamount to the ignorance that Mwinyi (1998, in Noring, 2014) referred to. Williamson *et al.* (2008) emphasise the point by arguing that proper management systems should be the basis for policy formulation, allocation of rights, and long-term planning. All these elements that refer to the need for land cover and management stem from the hierarchy of land issues proposed by Williamson *et al.* (2008), as shown in Figure 2.7.

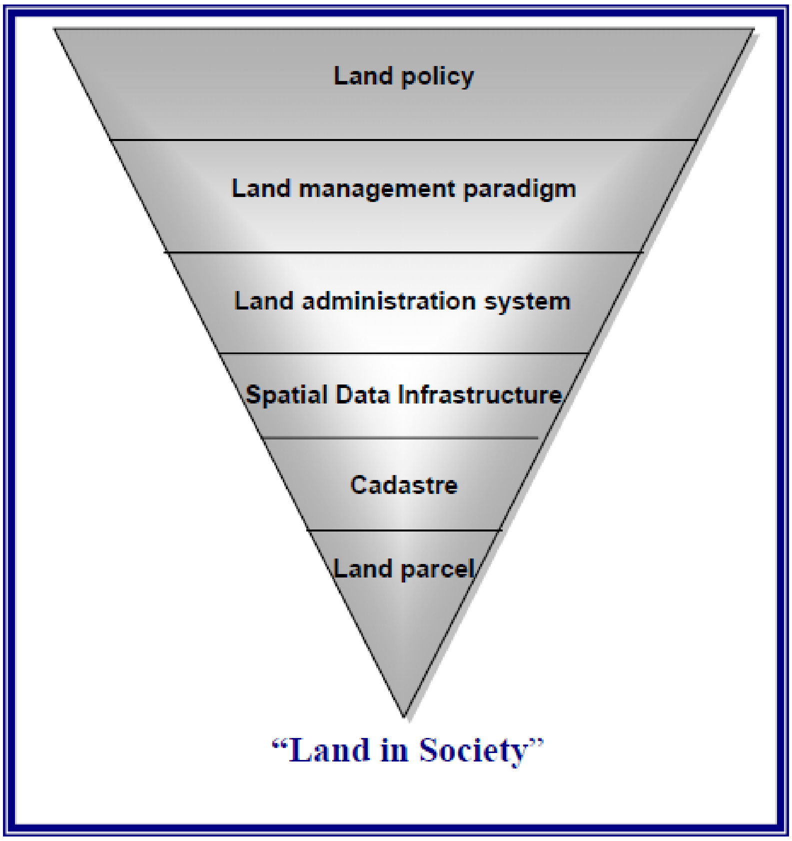

Figure 2.7: Hierarchy of land issues

Source: Williamson *et al.* (2008)

The hierarchy depicted in Figure 2.7 represents the complicated environment in which various role players from multiple organisations that represent multiple interests are all included in terms of how to deal with LULC change in society. It also shows the required level of order fit for such complex processes. The outlined process provides global guidance for building proper systems of checks and balances in any society, regardless of how developed such a community is or could be; by implication, achieving what the hierarchy requires leads to better environmental management (Williamson *et al.*, 2008).

Martinovska Stojcheska, Kotevska, Bogdanov and Nikolić (2016) observe that regardless of the abundant natural resources, rich biodiversity, and favourable conditions for agriculture, the agricultural sectors and rural areas in Macedonia, Serbia, Bosnia, and Herzegovina are faced with numerous challenges. Some of these challenges include slow progress of structural reforms, low competitiveness, technological backwardness, and intense depopulation, which in turn result in damage to environmental capital.

Williamson *et al.* (2008) remark that until such time that society arranges its priorities in the form of the land issues hierarchy as suggested, these challenges will continue in perpetuity. Management is thrust to the fore, as it is expected to guide decisions and processes for better planning and regulation, which Costanza *et al.* (2011) refer to as a management spiral.

Anyone who is involved in the management of land should understand that there are two sides to such management: firstly, the conservation part, and secondly, the land development part. To strike a balance between these two parts, community involvement in decision making or policy development is critical. This argument is because the provision of ecosystem services to human beings does not discriminate between poor and rich, between politicians and economists, or between rural and urban.

What becomes critical is the consideration that the present use of the land should be mindful of the sustainability of such land. The said sustainable use of the land could be achieved through improved integrated decision-making protocols. An essential element of this integrated decision-making process is access to information and technology and enhancing the ability to use them (Mullin, 2019).

Mundia (2015) comments on the issue of information and technology by stating that if communities, particularly the poor and the vulnerable, are not empowered through the use of technology and information, it will be difficult for anyone to impose decisions on them. For anyone to be successful in the management of land, capacity building, even in such aspects as information and technology, is essential; otherwise it becomes a self-defeating exercise to impose decisions or programmes that are not integrative of the views of communities.

Munthali *et al.* (2019) agree that if one management approach succeeds in one area, it does not necessarily follow that it will succeed in another. Circumstances are always different from one area to the other. How people interact with their land differs from one area to the next. These differences call for more significant care in allowing land-management approaches to be as flexible as possible to consider varying interests. Understanding, historical events, culture, and customs all come to the fore when a particular community is engaged in the management of land. It is for this reason that for anyone to effectively develop a perfect land-management system, gathering information about the land users is critical.

From a theoretical point of view, and if one were to look at the conceptual hierarchy of plans, development planning and land-use allocation assume that land must be adequately planned for it to be used and managed effectively. The traditional authorities and the local municipalities should have plans in place for the proper use of land, which would be measurable and with accountability checks and balances in place. According to Amponsah and Forbes (2012), Pullanikkatil *et al.* (2016), and Ruhiiga (2014), municipalities are required to have a hierarchy of plans, ranging from a broad strategic municipality plan to a detailed plan, where land-use rights and obligations are assigned. These plans consist of a long-term development strategy, an integrated development plan, a spatial development plan, and land-use schemes.

In areas such as the Thulamela Local Municipality, where almost 87% of the land is under the jurisdiction of tribal authorities, who are also in charge of land-use rights allocations, one would expect the said tribal authorities to adopt better management plans that are arranged appropriately (Ruhiiga, 2014).

At times, hierarchies of plans may not be enough to address all the challenges relating to the management of land, and this is where other programmes may be required to complement the hierarchy approach suggested by Amponsah and Forbes (2012). Combining several plans seems to be an acceptable or better approach, which is why an integrated land-use model may be the panacea to many challenges. Mixed models are made up of a combination of modelling capabilities using an approach that is best at answering management questions (Lambin *et al*., 2000).

Integrated models could be statistical, econometric, natural science, GIS, and Markov chain-based models. Good governance or management is at the heart of proper land administration (Williamson *et al.*, 2008). The land degradation situation is taking place globally, and Africa, in particular, is worsening and has become a challenge for many governments, which are grappling with conditions such as urbanisation. This challenge is partly due to weak land-management regimes, while increasing population growth has put pressure on land and natural resources, as well as contributing to land degradation and desertification (United Nations Economic Commission for Africa [UNECA], 2017).

The UN Committee of Experts on Global Geospatial Information Management, at its eighth session in August 2018, encouraged the Expert Group on Land Administration and Management to continue its advocacy and to raise awareness of the merits and benefits of effective and efficient land administration and management systems (Musa, Hashim & Reba, 2019). Land administration informs the "how", "what", "who", "when", and "where" of land tenure, land use, land value, and land development (Solís, McCusker, Menkiti, Cowan & Blevins, 2018).

The challenges for urban sustainability, according to Burger *et al.* (2012) and Wu (2014), require the integration of issues such as LULC, community interests, and ecosystem services into land-use planning (Albert, Aronson, Fürst & Opdam, 2014; Aldana-Dominguez *et al.*, 2019). Ecosystem services have been influenced for many years by human activities associated with land allocation, governance, planning, and management decisions (Crouzat, Mouchet, Turkelboom, Byczek, Meersmans, Berger, Verkerk & Lavorel, 2015).

Enemark (2012) sums this up by providing insight into governance, which relates well to the concepts of land, LULC, and land-use management, by pointing out that governance is how those in positions of responsibility exercise power. If anyone were to think that a one-way approach, such as only engaging via formal processes, will yield any results, such a person would have to think twice because, at times, even informal channels are essential in influencing decision making. Governance of land should, if at all possible, integrate formal as well as informal stakeholders in making decisions.

Governance of land, as in any other governance, includes several characteristics, which, Mutuvhi (2011) reckons, if implemented correctly, could have lasting impacts. These include sustainability, equity, fairness, transparency, accountability, and consequence management.

In short, sustainable LULC management would not be possible where sound land-administration systems or, more broadly, sound land-management and governance systems are not in place. Discussions of governance generally involve seeking to understand how organisations are managed at the highest level and the systems for doing so. The governance arrangements that prevail determine who has power, who makes decisions, how other actors make their voices heard, and how accounting is rendered (Potschin-Young *et al*., 2018).

The results of a study of Colombia's Barranquilla Metropolitan Area's ecosystem services and the land use suggest that land-use planning must act not only in the spatial location of land uses but also in the socioeconomic aspects that foster ecosystem services and disservices (Aldana-Dominguez *et al*., 2019).

Change detection is the process of identifying non-similarities in an object at different times (Chaudhary & Kumar, 2017). LULC change has become one of the most critical components in the present scenario to manage natural resources and to monitor environmental changes (Aldana-Dominguez *et al*., 2019). Monitoring LULC changes is necessary for continuous amendments of coping mechanisms and advice on future policy directions (Cumming, Shackleton, Förster, Dini, Khan, Gumula & Kubiszewski, 2017).

The use of multiple planning and management methods highlights the need for transdisciplinary efforts to link ecological values with social benefits (Potschin-Young *et al*., 2018). This approach offers a structured way to explore different stakeholder perspectives and related objectives, and balancing diverse and sometimes competing interests rationally and transparently (Adem Esmail & Geneletti, 2018).

Governance, representing a shift from hierarchical top-down government to structures that include non-statutory actors as decision makers in local development processes, is increasingly prominent in development policy worldwide (Furmankiewicz & Macken-Walsh, 2016). In the South African context, traditional leaders often view themselves as a third child whose interests come later on planning and management (Musetsho, 2014).

A study was conducted in Northern Thailand, whose outcomes point to land-use change that took place over 24 years until 2016, which was as a result of the economic development policy positions taken by the government. Land-use change plays an influencing role around the services that ecosystems can provide, usually over an extended period and, at times, over extensive areas (Hejnowicz & Rudd, 2017).

Projected land-use changes by 2050 will likely enhance the provision of some ecosystem services, such as carbon sequestration and timber harvests, owing to the increase of woodlands under baseline situations being considered in the United States of America, for example. These projections show what long-term planning can achieve when done appropriately (Lawler *et al*., 2014).

The observed decline of ecosystems, which is taking place in various regions of the African continent, exposes the vulnerability of the wellbeing of future generations (Negussie *et al*., 2019). Anderson *et al.* (2017) state that these declines are seriously concerning in countries such as Ethiopia, which lost approximately 18% of its overall terrestrial ecosystem services values due to LULC change. This situation calls for greater awareness and putting systems in place to manage these, even at the local level.

Better management systems have seen an increase in ecosystem services values; for example, there were substantial surges in the value of ecosystem services in Gedeo-Abay (Ethiopia) and China in recent years that many researchers (Gashaw *et al*., 2017; Wang *et al.*, 2014, in Negussie *et al*., 2019) noticed. In Chengdu, China, a 14% increase was observed during 1986 and 2015, 23% during 2000 and 2010, and 75% during 2000 and 2015.

It is critical for policymakers and scientists to promote conservation and protection of LULC classes that show signs of increasing in ecosystem services values. This promotion is essential for the formulation of land-management processes and for the betterment of human beings (Temesgen, Nyssen, Zenebe, Haregeweyn, Kindu, Lemenih & Haile, 2013; Negussie *et al*., 2019). This will ensure that sustainable development is achieved since the high ecosystem services value would assist in maintaining some sense of stability between economic development and ecosystem health in the future (Sawut, Eziz & Tiyip, 2013).

That being the case, others argue that governance and management could be considered soft approaches to coercing others to buy into specific objectives or goals. In contrast, people may not necessarily fall in line at the same time, which calls for hard approaches such as regulation, enforcement, monitoring, and control (Mutuvhi, 2011).

Management and governance are the soft skills required to deal with environmental issues. Other elements include the participation of as many stakeholders as possible, transparency in decision making, responsiveness when concerns are raised or emerge, effectiveness and efficiency, and consensus and inclusiveness. Key to the above is accountability and the rule of law, which also deal with consequences where there is wrongdoing in terms of an agreed set of goals or objectives.

Those in positions of influence exercise control to ensure that responsibilities and key performance areas are carried out efficiently and competently to attain objectives (Mthethwa, 2017). Control culminates in meeting the criterion of "open to public scrutiny" that forms the climax of the process of administration. In support of enforceable procedures, authorities are expected to be answerable for their deeds; measures for detecting any wrongful actions are therefore put in place (Mutuvhi, 2011).

Mutuvhi (2011) identifies six formal aids for exercising control, namely budgeting, auditing, reporting, inspection, procedural prescriptions, and organisational arrangements, and emphasises that for monitoring, inspections could be regarded as one of the most useful means. In the end, where LULC and ecosystem services changes are identified, it remains the role of those in government or positions of influence, including community leaders such as traditional leaders, to plan and provide leadership, which include inspections and regulations to deal with such changes.

2.5.2 The concept of rural development

Defining rural areas in a way that is acceptable to many is still a challenge because many define "rural" with the interpretation of "urban" (Dasgupta *et al.*, 2014). Depending on who is identifying rural areas, there seems to be consensus that such an area constitutes extensive land parcels that have not been developed, with sparse communities and a lack of infrastructure. Many attempts at defining rural areas in policy and literature are still part of arguments being advanced from many quarters (International Fund for Agricultural Development, 2011).

The following principles define rural areas:

- Low density of population and buildings, with a prevalence of landscape features;
- Prevalence of agricultural areas, woodlands, and pastures;
- Inhabitants' lives take place in small urban centres, and they have a very close relationship with the surrounding environment; and
- Specific identity and self-representation influenced by rural backgrounds (Boggia, Rocchi, Paolotti, Musotti & Greco, 2014).

Some of the areas defined by many as rural, harbours many people, all over the world. Some estimations suggest that approximately 70% of those living in developing countries live in areas considered as rural (Dasgupta *et al.*, 2014). These people rely on the natural environment for their wellbeing. Depending on who is defining these people's living conditions, many consider such people as poverty-stricken, neglected, and in need of proper development interventions. Due to limited infrastructure, or so it is believed, the poor are exposed to environmental hazards such as climate change.

The level and intensity of the use and exploitation of natural resources, especially forest, land, water, animal diversity, and vegetation, in the world have led to significant changes in the environment and degradation of resources, with severe consequences in terms of the reduction of ecosystem services and resources and weak food production, especially in rural areas (Mucova *et al*., 2018). A well-thought-out observation around the relationship between LULC changes and rural livelihoods, along with how communities cope with such changes, is essential for planners and decision makers (Kamwi, Chirwa, Manda, Graz & Kätsch, 2015; Hejnowicz & Rudd, 2017; Munthali *et al*., 2019).

In their research on LULC changes in the Dedza area of Malawi, Munthali *et al.* (2019) established that poverty was among the significant contributing factors to LULC fluctuations in the area. As a result of poverty, many in rural areas are not able to access agricultural inputs. The poor end up relying on natural resources as the only source of their materials, due to a lack of alternatives. Consequently, the over-reliance on natural resources and associated over-extraction lead to other environmental challenges such as erosion of soil, loss of biodiversity, and pollution of air and water, *inter alia* (Hejnowicz & Rudd, 2017).

The results of the study in the Dedza area in Malawi corroborate other findings from similar studies conducted in Africa, such as in Tanzania, Ethiopia, Namibia, and Mozambique, where poverty has been acknowledged as among the significant drivers of changes in LULC (Ariti, Van Vliet & Verburg, 2015; Kindu, Schneider, Teketay & Knoke, 2015; Hejnowicz & Rudd, 2017). If substantial rural advancement is to be attained, there is a need to investigate alternative land-use approaches that promote the conservation of sensitive ecological infrastructure. Land-use options and planning programmes have been used worldwide to contribute to sustainable development (Xue & Zhen, 2018; Hill *et al*., 2020).

Historically, South Africa has faced many disparities, such as high levels of poverty among rural and semi-urban groups and high levels of unemployment and crime (Locher & Sulle, 2014). The South African Human Rights Commission (2018) supports this view by pointing out that 55% of South Africans live in poverty and that the country is among the most unequal in the world. Sadly, it is the deprived majority of rural groups who depend heavily on ecological resources and who carry the added burden (Locher & Sulle, 2014).

Rural development in the South African context points to development activities that ordinarily take place on land owned and controlled by traditional leaders (Musetsho, 2014). The South African Human Rights Commission (2018) points out that the developmental and poverty alleviation goals of restitution process have not been realised, and emphasises that a great deal of developmental work is still required in rural areas.

Locher and Sulle (2014) remark that, in South Africa, the majority of rural communities practise land-based livelihoods. Rural communities earn their livelihoods from a variety of sources, including remittances from family members, off-farm activities (small business, casual labour), and farming activities (livestock keeping and small-scale agriculture). They also depend on a variety of natural resources for food security, medicine, building materials, and fuelwood/charcoal.

2.5.3 Traditional authorities and land development

In the African context, the institution of traditional leadership has developed over many years (Mthethwa, 2017). It has assisted African people through periods of slavery, wars, freedom struggles, hunger, economic and political restructuring, and apartheid. The traditional leadership institution is revered by many, to the extent that ordinary Africans have internalised its customs, culture, identity, and origin, which they identify with (Mthethwa, 2017; Capps, 2018; Koenane, 2018).

Among some of the core pillars of the traditional leadership institution are traits, traditions, and cultural and traditional practices. These pillars form the basis of the norms to which rural communities relate, and which they pass on from one generation to the next (Mthethwa, 2017). Selepe (2009) asserts that every community led by traditional leaders has a specific territorial boundary known and respected by community members and other traditional leaders.

In these communities, the communal form of land ownership is the cornerstone of people's economic prosperity in rural areas (Mthethwa, 2017). Since the institution of traditional leadership comprises certain practices in which everything is guided by norms, values, beliefs, and meanings, it could be argued that this indigenous system of governance is complex in nature (Cilliers, 1998).

Koenane (2018) unpacks the intricacy of the traditional leadership institution by identifying two complexities:

1) The system manifests in many forms from country to country; in that there is no one particular way or model of the system that is considered to be the perfect system according to which the traditional leadership institution must be or is.
2) The term "traditional leadership" is an all-embracing concept because it includes several categories in the governance of traditional rural African communities. In the system itself, there is a king, who in the local language is referred to as the *Amakhosi*/*Mahosi* (traditional hereditary leaders), appointed traditional leaders, and an entire council of elders and advisors.

Understanding the complexities surrounding the traditional leadership institution is of vital importance, because by following these complexities, it clarifies any misconceptions involved in the system, as well as how the system deals with issues of land and ecosystem services. The history of the traditional leadership institution throughout Africa dates back to beyond memory and beyond the recall of the stories that have been passed from generation to generation (Shamase, 2019).

Dansoh, Frimpong and Oppong (2020) remark that in Africa, generally, before colonisation, the governance systems were symbolised by traditional leadership rule, and traditional institutions managed a variety of matters that impacted directly on their communities. Six out of nine South African provinces – KwaZulu-Natal, Eastern Cape, Free State, Mpumalanga, Limpopo, and North West – have Houses of Traditional Leaders. These Houses are almost like quasi-government in the rural areas; that is, in terms of indigenous law (Selepe, 2009).

Ordinarily, traditional leaders and their administrative assistants carry out a variety of responsibilities, and some of these responsibilities are included in the administration of the land. Traditional leaders look after the wellbeing of their people by providing them with land for agriculture and grazing sustenance needs (Mthethwa, 2017).

While the traditional leader is the central figure in the traditional authority system, an inner council of advisors also assists the leader (Dansoh *et al.*, 2020). Decision making is supposed to be by consensus at all levels. Decision making in traditional African life and governance was, as a rule, by consensus (Wiredu, 1995).

According to Chapter 12 of the South African Constitution (South Africa, 1996), the various functions of the traditional leadership institution are recognised. Traditionally, most of the rural areas in South Africa are under the jurisdiction of traditional leaders. As a result, land distribution is, by default, a function of the traditional leaders. In other words, in terms of customary law, it is recognised that traditional authorities have the power to control land use and allot portions to members of their community (Koenane, 2018).

The issue of land boundaries and jurisdictions between traditional authorities and municipalities is a serious one (Selepe, 2009; Ngcofe *et al*., 2019). According to section 155(3)(b) of the South African Constitution, the body that has the legal responsibility of drawing up or demarcating municipal boundaries is the Municipal Demarcation Board (MDB). The South African Local Government Association established the MDB, which led to the enactment of the Municipal Demarcation Act (No. 27 of 1998).

It must follow that the MDB would demarcate municipalities on land controlled by traditional authorities, especially in rural areas. Where issues of land are not appropriately addressed, especially by those at the MDB, who in most cases are not even residents of areas they demarcate, traditional authorities have often accused the structure of not consulting them. By extension, the management of land becomes a contested issue.

These issues point to the difficulties of both the traditional leadership and the communities when it comes to the administration and management of land, which, by default, also have implications for the management of LULC and ecosystem services on land administered by traditional authorities. The government acknowledged how important the traditional leadership institution is in South Africa through the enactment of the Traditional Leadership and Governance Framework Act (No. 41 of 2003), which outlines the various responsibilities that traditional leaders are expected to discharge (Mthethwa, 2017). Secondly, the Communal Land Rights Act (No. 11 of 2004) was also promulgated, with the intention to resolve land tenure problems in predominantly rural areas.

According to section 19 of the Traditional Leadership and Governance Framework Act, any traditional leader is expected to perform the various tasks provided for in terms of acceptable customs and traditions of the concerned community.

Section 20 of the Communal Land Rights Act outlines the guiding principles for the allocation of responsibilities to traditional leaders. The national government, or a provincial government, as the case may be, may, through legislative or other measures, outline the various functions of traditional councils in respect of culture, customary marriages, and management of natural resources, among others.

It is deduced from the above that traditional leadership plays an essential supporting role to the government concerning the management of LULC and services from ecosystems, as part of the roles defined and expected in line with the regulations in the country. In several African countries, there is a new recognition that traditional leadership cannot just be overlooked as if they do not have responsibilities that are recognised and respected by society, such as rural development (Reddy, 2016). Some of these improvements suggest a growing trend away from foreign institutional models to structures more suited to conditions in Africa.

The role of traditional leadership differs considerably from one country to another. In some countries, such as Ghana, Kenya, Tanzania, and Namibia, the role of traditional rulers is limited to customary and tribal affairs. It does not seem to be expanding into the area of relationships with governmental structures (Locher & Sulle, 2014; Reddy, 2016).

There are also land boards, which are constituted by traditional leaders, among others. In Zimbabwe, the current situation is that the Zimbabwean Constitution provides for a National Council and Provincial Houses of Chiefs. Traditional leaders are also represented in rural district councils (Reddy, 2016).

In Botswana, for example, the Constitution provides for an advisory body to the National Assembly and the Executive, called the House of Chiefs. Although this House does not have legislative powers, it is expected of the Executive and the National Assembly to consult the House on individual, specific bills. There are also land boards, which are constituted by traditional leaders, among others (Mthethwa, 2017).

It is expected that, as part of their responsibilities, traditional leaders allocate land and control the various land-use activities. The land-use rights application process commences at the level of the tribal authority, where a traditional leader is expected to be a central figure. The next step in the process is handled by the Botswana Land Board, which handles the administration and registration duties (Mthethwa, 2017).

The Modjadji Tribal Authority, as another example of a traditional leadership structure, has a long-held tradition and community policy that communal land would never be for sale. It is the expectation of the community that traditional leaders should be able to allocate land, through an all-inclusive and transparent process, to members of the community, at all times, without even involving the government.

The Royal Bafokeng Administration allocates land only to the Bafokeng, unless an outsider is married to a local Mofokeng. The land is considered a sacred resource that cannot be priced and easily sold to outsiders, no matter how rich the outsiders may be (Wicomb, 2016; Mthethwa, 2017; Matebesi & Matebesi, 2020).

On a macro level, land that fell under tribal authority areas could either have been retained by the government, transferred to national parks, transferred to previously disadvantaged individuals, sold to individuals or organisations, or transferred to municipalities. Furthermore, municipalities could have sold the land to individuals or organisations (Capps, 2018).

One of the fundamental arguments against the legality and acceptability of the traditional leadership institution is how it relates to the government (Koenane, 2018). The government comprises officials usually elected through open electoral processes, whereas the traditional leaders inherit their positions. These two institutions thus find themselves at loggerheads when it comes to managing the interests of those they lead, to the extent that many have now accepted that the two should co-exist. In the South African context, government institutions, tribal leaders, and citizens are facing unprecedented pressure from population growth and the triple challenges of poverty, inequality, and unemployment (Gómez-Baggethun *et al.*, 2014).

The dominant environmental and economic priority in South Africa, as in many other countries, is to ensure that people have access to clean water and sanitation without compromising the integrity of critical ecosystems, as well as without undermining economic growth (Dhlamini, 2019). Inevitably, understanding the natural environment and its processes becomes vital, and one of the components of the environment has a great deal to do with land use and ecosystem services.

Although many people in urban areas consider traditional leadership as an anomaly in the current democratic or political dispensation, it is true that they preside over vast tracts of land – the majority of which are in rural areas where minimal development has taken place. It is imperative that their presence should not be overlooked.

This is the reason, according to Ntonzima and Bayat (2012), that many in rural areas acknowledge them and their authority. The traditional leadership structures or traditional authorities no longer operate in a vacuum. Such authorities now operate within a global system of governance that requires that their actions and decisions be aligned with global trends (Ngomane & Flanagan, 2003).

The success of land development, and the ability of the land to withstand pressure, both natural and anthropogenic, depends on the land-management strategies in use. For example, where a community depends on agriculture for its daily needs, one needs to put in place land-management systems that maintain a healthy population that would not unnecessarily put a strain on the land – lest the land fails to support the community (Costanza & Kubiszewski, 2016). If the population increases unchecked, the chances are that it would have a ripple effect on the ability of the environment to sustain it in the long term.

There is a great deal of interest in the role of the ecosystems and their ability to satisfy human needs. This phenomenon has been receiving attention throughout the world. It is for this reason that institutions such as the World Bank have already started suggesting that ecosystem services valuations be conducted regularly, to advise decision-making processes (UN, 2019a).

Communities that lack proper security around land tenure and recognised rights to the use of land experience a severe loss of biodiversity and ecosystem services, and a general decline in the value of natural resources (United States Agency for International Development [USAID], 2013). Where these rights are poorly defined or enforced, natural resources and ecosystems can quickly be degraded, because incentives for protection or sustainable use are weak or absent. This insecurity can lead to overgrazing, poaching, deforestation, and all manner of adverse developments, such as soil erosion, among others (USAID, 2017).

The above-mentioned implications for natural resources limit prospects for long-term economic prosperity for many, especially in rural areas. Communities where there is security of tenure and the allocation of land follows proper channels of deeds registry and preliminary assessments of ecosystem sensitivity, among others, have better resource management.

Recognising and securing rights to land and natural resources foster stewardship (USAID, 2013). When communities, investors, and other kinds of developers have secure rights to land, their behaviour towards short-term gains from the land changes, and they start looking at longer-term management. Having recognised land-use rights provides people and institutions with incentives to use resources sustainably, because they are better able to capture future investment returns.

Substantial resource rights, combined with more economic return prospects or incentives, contribute positively to improving livelihoods and local governance. Solís *et al*. (2018) summarise this view by stating that consideration must be given to ensuring that women's land and resource rights are protected, as they play significant roles in food security, conservation, natural resource management, conflict mitigation, and household livelihoods. Their rights to these resources are often limited (USAID, 2017), which results in the identification of the following critical elements that should be observed, which are central to the present-day experiences with property rights and natural resource management:

- Community-based customs, traditions, and practices;
- Grassroots-based decision making and rights recognition;
- Limiting decision-making powers from individuals to communities;
- Community-based natural resource administration practices; and
- Investors being considerate of the rights of the locals.

Mathonsi and Sithole (2017) note that when it comes to the powers of traditional leaders over land, section 21(2) of the Communal Land Rights Act of 2004 limits such powers to some extent. It stipulates that when a particular community has a well-established traditional council, the powers and functions of the land-administration committee for that community may be exercised by a traditional council, not the traditional leader alone.

This view is supported by Reddy (2016) and Tshela (2016), who point out that the stipulations provide the traditional councils with a great deal of power, which may be enough to curtail the powers of individual traditional leaders, who at times behave as though the land belongs to them as individuals.

Kompi and Twala (2014), Tshehla (2016), and Mathonsi and Sithole (2017) agree and conclude that traditional leaders are re-establishing themselves properly and exerting enough pressure to be noticed in the new South Africa, compared to the times of apartheid.

Such leaders are here to stay, and their actions are to be taken seriously. Land-use management, ecosystem services, and all other environment-related issues would thus continue to linger around the presence of traditional leaders.

2.5.4 The concept of sustainable development

There is recognised agreement among many scholars that unless something drastic is done, development advances, as currently practised, would not be sustainable. Although this agreement cannot be considered unanimous, it is overwhelming. Evidence and data that support the assertions of the majority of scholars come from a pool of stakeholders, which range from climate scientists, ecologists, social scientists, oceanographers, geographers, politicians, economists, the broader public, and even to faith-based organisations (Goldin, Botha, Koatla, Anderson, Owen & Lebese, 2019).

Sustainable development was described for the first time by the Brundtland Commission in 1987 as development that helps to cater for the wishes of present generations, without undermining the interests of forthcoming generations to also enjoy the same needs (UNECA, 2017; Clemens *et al*., 2018).

Ottomano Palmisano *et al*. (2016), along with other scholars such as Pašakarnis, Morley and Maliene (2013) and Dhlamini (2019), observe that in recent years, sustainable development has become a central topic in rural areas, due to multifaceted connections between agricultural production, natural resources, and communities at the grassroots level.

The world population is expected to increase by two billion persons in the coming 30 years; from eight billion currently to ten billion by 2050 (UN, 2019a). This increase comes with associated impacts on the environment, which range from environmental degradation, climate change, to increased waste generation and pollution, among others. The prospects of such a population increase point to the need for accelerated development, which also puts environmental resources at risk. This calls for well-coordinated efforts by human beings to deal with these impacts by ensuring that such development activities are sustainable.

Locher and Sulle (2014) intimate that, unfortunately, humans depend on land-based natural resources such as food, shelter, water, medicine, and freshwater. The unsustainable use of these resources results in their degradation, which leads to resource scarcity. Hajer *et al*. (2015) and Hill *et al*. (2020) also remark that human life is heavily dependent on forests, water, and agriculture as significant economic resources and influencers of development.

According to Dhlamini (2019), sustainable development implies that human beings all over the world should change the way natural resources are used, and must recognise their value to livelihoods, societal progress, and economic growth, for both current and future generations. This recognition implies that there is an urgent need for the value of natural resources, inclusive of land and associated ecosystem services, to be determined and communicated, so that decisions about development activities are made from an informed perspective.

The management of land in rural areas has been brought into the spotlight, with various debates across the country pointing to the need for many more development activities to take place in rural areas. In his 2019 State of the Nation Address, President Ramaphosa pointed out that economic development could be ramped up through spatial interventions such as special economic zones, as well as reviving local industrial parks, business centres, digital hubs, and township and village enterprises (South African Government, 2019).

Assertions such as these evoke the need for careful consideration of the way that accelerated development activities would impact on land and ecosystem services, especially in less-developed areas. It is important to deduce from the current land-use activities whether such interventions would be successful or not.

It is in the context of the above that one links the development of rural areas with what the SDGs seek to achieve and what South Africa as a country has done in reporting to the UN. In the same vein, Dhlamini (2019) argues that the level at which people in rural areas participate in the achievement of the SDGs leaves much to be desired – not because rural communities do not want to be involved, but because decisions and implementation options are made without their involvement.

The sustainable development and effective land administration and management framework depicted in Figure 2.8 summarises the expectations concerning land policy, land tenure, land value, integrated geospatial information, land development, and land use.

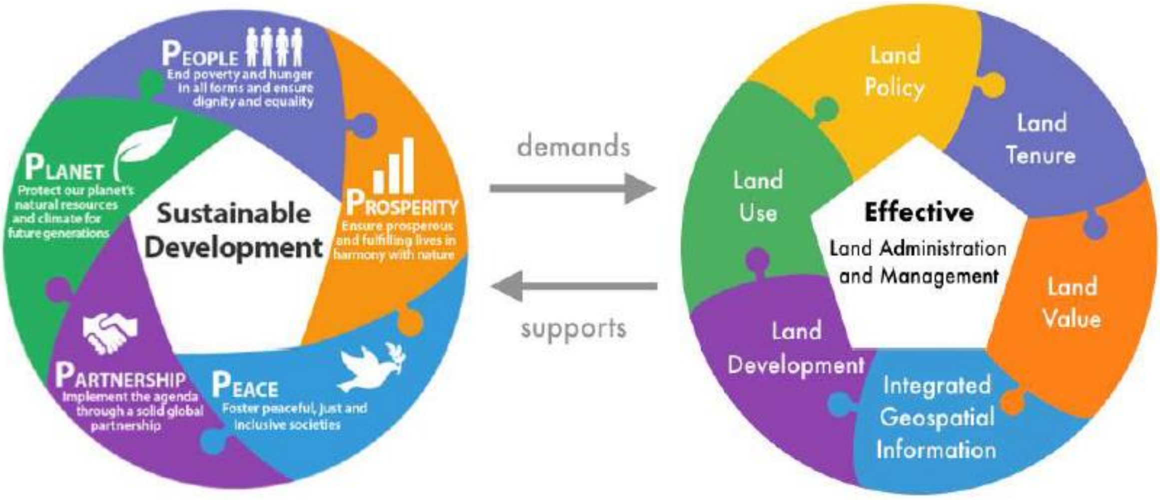

Figure 2.8: Sustainable development and effective land management

Source: UN Global Geospatial Information Management (2019)

The SDGs that were released by the UN in 2016 prioritise many issues, but right at the top lies the challenging problem of sustainable land use (UNECA, 2017). If aspects of land use and associated management of changes in LULC throughout the world were to be attended to as suggested by the UNCCD, many of the SDGs would be attained as a result (Hejnowicz & Rudd, 2017; Cowie *et al*., 2018; Briassoulis, 2019).

Pullanikkatil *et al.* (2016) point out that the complexity around the services generated by an ecosystem in any society should be of interest. The implications of ecosystem structure changes for human beings are fundamental. Such implications and changes call for policymakers and community-based resource managers to be aware of and to aid conservation and governance of ecological services and land.

The matters of population explosion, environmental degradation, and ecosystem services require further understanding, based on the full knowledge of the drivers of change, such as pressure on the environment, LULC changes, and how institutions charged with the responsibility of planning around these issues are equipped to deal with them. Tizora *et al.* (2016) state that for the above to be possible, the focus should always be on the underlying causes, which consist of political, demographic, economic, technological, cultural, and environmental variables, because, unlike proximate factors, underlying factors operate at regional levels, which coincide with the scale of MTA land and the associated study.

Globalisation has resulted in many changes to production networks, increased urbanisation, and changed the character of many rural areas. The general forces that work together to integrate and connect economic, political, and social systems across countries, cultures, or geographical regions have increased so much that they have replaced resource extraction and agriculture as the dominant economic drivers predominantly practised in rural areas. These rural communities are therefore, in many ways, being forced to approach development from a wider perspective than they have always been used to (Ngomane & Flanagan, 2003; George & Jones, 2012). The adoption of technology is one area that communities are forced to look to for survival.

Technology alone, however, cannot be the solution to the myriad of challenges that communities face; a key factor is the role of human institutions and land-use policies that must be adopted to face the challenges posed by these rapidly changing conditions (Di Gregorio & Jansen, 1998).

The challenges for urban sustainability in the future will be so severe that almost everybody would be expected to help find ways of mitigating any unsustainable practices (Burger *et al*., 2012; Wu, 2014). Emerging alterations to the ability of the land to provide for human beings, exacerbated by drivers such as long-term global climate change, is a significant issue but is poorly recognised (Tedela, 2017).

Achieving the policy and practice shifts needed to secure ecosystem services and sustainable development is hampered by the inherent complexities of ecosystem services and their management. Methods for the participatory production and exchange of knowledge offer an avenue to navigate this complexity, together with the beneficiaries and managers of ecosystem services, including those in rural areas (Pielke, 2005; Steffen *et al.*, 2015).

2.6 CHAPTER SUMMARY

This chapter presented a systematic review of the literature regarding theoretical frameworks, LULC change mapping, ecosystem services, ecosystem services valuation, and land-use management practices, including the concept of traditional leadership. The main areas of focus addressed the sustainability of land, particularly in rural areas. These critical aspects were presented from both local and international contexts.

In the context of this study, the analysis of the existing literature afforded the researcher the opportunity to understand trends and practices, as well as dominant theoretical orientations regarding the critical phenomena being studied, namely LULC mapping, ecosystem services valuation, land-management practices in rural communities, and decision support frameworks.

The next chapter discusses the research design and methods adopted by this study, in which the data-collection framework of the study was firmly situated.

CHAPTER THREE:
RESEARCH METHODS

3.1 INTRODUCTION

This chapter focuses on the research design and methods adopted for this study. Based on the core units of analysis articulated in Chapter One, and supported by the consulted literature and the study's theoretical framework, this chapter outlines the research design and methods; the data-collection, -management, and -analysis processes; the sampling context; and the reliability and validity of the study and its related findings.

3.2 RESEARCH DESIGN

Research design is a strategy that is opted for in the organisation and management of the whole process of research, so that it is practicable and responds to the research questions and objectives based on credible research instruments (Cohen, Manion & Morrison, 2018). A significant decision in research design is the choice to be made regarding the research approach since it determines how relevant information for a study will be obtained. To this end, logistical aspects such as resources and time available are essential for a good research design (Robson & McCartan, 2016; Clark & Ivankova, 2018; Creswell & Creswell, 2018).

Understanding a research problem more thoroughly, and responding to research questions, must be based on credible research instruments (Cohen *et al*., 2018), which also involve the use of mixed methods, often referred to as triangulation. Triangulation is a process of data collection and analysis through mixing both quantitative and qualitative procedures within a single study (Fielding, 2012). Research designs can take the form of quantitative, qualitative, or both (mixed methods).

A qualitative research design is concerned with establishing answers to the why and how of the phenomenon in question (unlike quantitative research). Quantitative design, on the other hand, is concerned with the systematic empirical investigation of observable phenomena via mathematical, statistical, or computational techniques.

This study assumed a mixed-methods approach that involved convergent design to collect, integrate, and interpret data simultaneously before the categorisation as the findings or results (evidence) of the study (Creswell & Creswell, 2018). The researcher opted for mixed methods based on the assumption that multiple data sources and methods were more advantageous than a single-method approach for a better and more comprehensive understanding of the phenomena and their various manifestations (Gale, Heath, Cameron, Rashid & Redwood, 2013).

The study adopted a convergent mixed-methods design due to the advantage of facilitating the simultaneous analysis and interpretation of both qualitative and quantitative data and their results (Leedy & Ormrod, 2018; Lee, 2019). Each qualitative and quantitative dataset was analysed separately, and the findings were merged convergently at the level of thematically organised discussions (Terrell, 2012).

3.2.1 Quantitative research approach

The quantitative strand was employed to map the extent of LULC changes and to predict their future state. It was used to identify and perform a valuation of ecosystem services in the area and to explore and describe the inner workings of the traditional authorities and their records of land use, land-use rights allocation, and monitoring, among others.

Quantitative research mainly focuses on statistically inclined analysis and is planned deductively, with the consulted literature serving as the main point of reference for planning and executing research (Lee, 2019; Wilson, 2019). A quantitative research design was used in this study due to the large numbers of land users and beneficiaries of the ecosystem services in the Mphaphuli area (Braun, Clarke, Hayfield & Terry, 2019).

Quantitative research studies are advantageous for large samples and their objective interpretation, which makes it possible for generalisations of the findings to be made to other research settings that demonstrate similar conditions, characteristics, or contexts as those of the original site(s) of research (Creswell & Creswell, 2018; Leedy & Ormrod, 2018).

3.2.2 Qualitative research approach

Whereas the quantitative aspect of this study yielded secondary numerical information and data, the qualitative design approach was useful for the acquisition of empirical data from the primary sources (land users and other informants), with emphasis on exploration and description of the participants' experiences without any manipulation of variables (Adams & Cox, 2016; DePoy & Gitlin, 2016).

The explorative, descriptive, narrative, and analytical aspects of the qualitative mode of research complement one another, which mitigates to a certain extent against bias and prejudices of both the researcher and the research participants (Johnson & Onwuegbuzie, 2007; Halcomb & Hickman, 2015; McCusker & Gunaydin, 2015; McKim, 2017). Moreover, qualitative research methods are recognisable by their independence from the sample (Terrell, 2012).

3.2.3 Mixed-methods approach/triangulation

A broad research approach was adopted in this research, which included a case study and triangulation, or mixed methods, which involved both qualitative and quantitative approaches. The mixed-methods approach was preferred in this research due to its advantage of facilitating the simultaneous analysis and interpretation of both quantitative and qualitative data and their results (Cozby & Bates, 2015; Lee, 2019), which allowed a certain degree of triangulation of the findings, underlined their interconnectedness, and ensured a comprehensive approach (Fielding, 2012; Govender, 2018; Turner, Cardinal & Burton, 2017).

Other scholars also point out that mixed-methods designs are based on the triangulation (combination) of both qualitative and quantitative research methods to achieve the maximum level and amount of information, knowledge, and data pertinent to the specific intentions of a study (Leedy & Ormrod, 2018; Ravhura, 2019). It is on account of this optimisation and complementarity of methods that this study on LULC change mapping, ecosystem services valuations, and land-use management practices opted for the mixed-methods approach to address different questions and issues relating to sustainability (Leedy & Ormrod, 2018).

Notwithstanding its strengths, triangulation, or mixed methods, may be time consuming and costly in some instances (Creswell & Creswell, 2018). There is also the possibility that the quantitative and qualitative results could reflect some inconsistency. Given the nature of this study, the qualitative and quantitative approaches were used to conduct and to produce convergent findings. The convergence of these two approaches was useful in comparing and contrasting the understandings of the traditional authorities on the land-allocation process with that of the actual land users. Each qualitative and quantitative dataset was analysed separately, and the findings were merged convergently at the level of thematically organised discussions.

3.3 DATA COLLECTION AND PROCEDURES

Data collection refers to the systematic process of identifying and gathering data based on the study design and measurement methods (Ravhura, 2019; Voleti, 2019). Data collection is the fundamental basis of generating findings and evidence of a study in its totality. Congruent with mixed methods and convergent research designs, the systematic collection of data in this study entailed both qualitative and quantitative aspects, which were enhanced by exploratory and descriptive elements.

3.3.1 Qualitative data collection

Qualitative data were collected using a combination of one-on-one, face-to-face, and telephonic interviews across the different groups of participants. Telephonic interviews were conducted with eight government employees representing departments that deal with land-use matters in the Vhembe district and in the Limpopo province. Interviews were also conducted with 12 headmen or traditional leaders from the Mphaphuli Traditional Council (MTC). The main focus of the interview sessions was to obtain the leaders' perspectives, knowledge, and experiences regarding the broader aspects of their work in dealing with land issues.

In terms of the eight government employees interviewed, the interest was in the relationship between them and the traditional authorities and the various kinds of regulations that govern how land, land use, land planning, and monitoring should be approached. For traditional leaders, the issue was mainly their policies that guide how land is managed, as well as the relationship with various land-use stakeholders such as land users and beneficiaries.

Interviews were conducted with 48 individuals from the Mphaphuli area who play various roles; ranging from land users, traditional authorities (headmen from the communities who act in their communities on behalf of the senior traditional leader), advisors to the MTC, to government officials who work in government departments and municipalities on issues that affect traditional leaders and land use.

Structured questions for the quantitative approach and semi-structured questions for the qualitative approach were used to guide the collection of information from the participants, which highlighted the challenges associated with land use, legal frameworks, and protocols, as well as the sustainability of ecosystems as natural resources that provide various ecosystem services to the Mphaphuli community (see Appendix D).

Interviews were conducted, and questionnaires were used as the standard tools to guide the questioning of the participants on the various issues regarding land use, land cover, legal frameworks, and policies. This method of data collection enabled transparency between the interviewer and the participants, and elaboration of unclear issues was provided to allow the participants to freely express their views on the questions asked. The questions posed to the participants were those prepared beforehand, as well as follow-up questions to clarify any misunderstandings, with the view of achieving the outcomes of the research objectives.

The respondents were mainly interviewed telephonically, some in person, while some respondents such as government officials and the Mphaphuli Development Trust advisors were contacted and/or received their questionnaires/questions via email. This procedure was in line with the requirements of the approved ethical clearance as the respondents were provided with a consent form before they participated in the study and informed of their right to withdraw from the research at any time they wished to do so.

Since some of the consultations were telephonic rather than face-to-face interviews, time was a limiting factor compared to site visits, where enough time was made available for deeper engagement. Given the COVID-19 pandemic movement restrictions at the time, telephonic interviews were deemed feasible as all the targeted participants responded to the request to participate in this research.

3.3.2 Quantitative data collection

Secondary data were used instead of collecting new data for mapping exercises. Other data were obtained from 24 land users who have permission from the MTC to use the land. During this phase, the records kept by the administrative office of the MTC were obtained, reviewed, and analysed. The primary focus of this quantitative phase was to determine the characteristics of the land users, the form of user rights, the processes followed in obtaining such rights, and the extent of the land in use compared to what was initially granted, after which a convergent analysis was conducted simultaneously with the results of the one-on-one interviews. Satellite data were obtained from the South African National Space Agency, and land-cover data were obtained from the South African National Land-Cover (SANLC) database, from which maps relating to the LULC changes were generated.

The quantitative data collection of this mixed-method study focused on the statistical/numerical gathering of information to test the relationship among variables (Ghofar & Islam, 2015; Leedy & Ormrod, 2018). Quantitative research studies are based on deductive logic and are more structured to allow for generalisations (Ravhura, 2019). Quantitative data-collection processes also provide an audit trail of the study, with clear explanations of the techniques or strategies employed in generating the results, including the rationale for the selected method (Ghofar & Islam, 2015).

In this mixed-methods study, the quantitative aspect of the study was facilitated using systematic consulting, review, and analysis of official land users' records, NLC databases, and satellite images. The rationale for this approach was based on the fact that the qualitative data were already obtained from the traditional leaders and government officials by means of one-on-one interviews (mainly telephonic). The records of land users and beneficiaries therefore yielded quantifiable data and information.

3.3.2.1 Mapping LULC change between 1990 and 2018

The NLC products of South Africa for the period between 1990 and 2018 were used as data sources (Thompson, 2019). The 1990 NLC data were derived from Landsat images at 30 m spatial resolution.

The land-cover product's accuracy is 80%. For the 2018 period, land-cover information was obtained from Sentinel-2 images at a spatial resolution of 20 m. The said 20 m spatial resolution images were then resampled at 30 m for compatibility and comparability with that of the 1990 NLC.

The land-cover maps both had 72 classes, which were grouped by the researcher into 11 classes, based on the objectives of the study (see Table 3.1; see both land-cover map reports and legend at https://egis.environment.gov.za/). Since the land cover was done using different satellite imagery, the legend was harmonised and standardised to enable possible comparison (see Table 3.1). Triangulation was used to arrive at these driving forces, with evidence gathered through GIS mapping, ground-truthing, and through interviews with participants who were knowledgeable about the area under study.

Table 3.1: Standardised land-cover classes for changes between 1990 and 2018

Land-cover types	New classes	NLC 1990	NLC 2018
Waterbodies	1	1-2	14-21
Wetlands	2	3	22-23, 73
Indigenous forest	3	4	1
Thicket and dense bush	4	5	2, 24
Woodlands	5	6	3-4, 42-43
Grassland	6	7	12 ,13, 44
Commercial agriculture	7	10-12, 26-31	32-40
Subsistence agriculture	8	23-25	41
Forest plantations	9	32-34	5-7
Bare areas	10	40-41	25-31, 45
Built-up areas	11	35-39, 42-72	47-72

Source: Researcher

When the land-cover maps and legends were harmonised, a post-classification method for land-cover change analysis was used and implemented in ArcGIS 10x (see Figure. 3.1), which outlined the schematic representation of how the data analysis was implemented. Post-classification is a simple method for determining land-cover changes, involves a comparison of extent and areas of land-cover classes between two periods or points in times, and is also known as bitemporal change detection (Serra, Pons & Sauri, 2003; Chen, Chen, Shi & Yamaguchi, 2012; Chand, 2014; Giri, 2016; Wu, Du, Cui & Zhang, 2017).

The post-classification provides the direction of change, i.e., “from” this point in time “to” another point. In this study, the years of comparison were 1990 and 2018. The change detection matrix and statistics were derived from or using a ha/year formula. Meshesha, Tripathi and Khare (2016) describe the rate of change (ha/year) formula as follows:

$$R\Delta = (t_2 - t_1)/z \text{ ------------------------------------(1)}$$

Where: $R\Delta$ is a rate change and t is an area (ha) time in years.

The amount of alteration in the area of land-cover class type from the initial (t_1) and later time (t_2), z is a time interval between t_1 and t_2 in years. In this study, z is 28 years.

The data obtained from the interviews and questionnaires were analysed through the Statistical Package for the Social Sciences (SPSS) software. These data were mostly related to the perceptions of the traditional leaders and knowledge around the drivers of LULC change in the area.

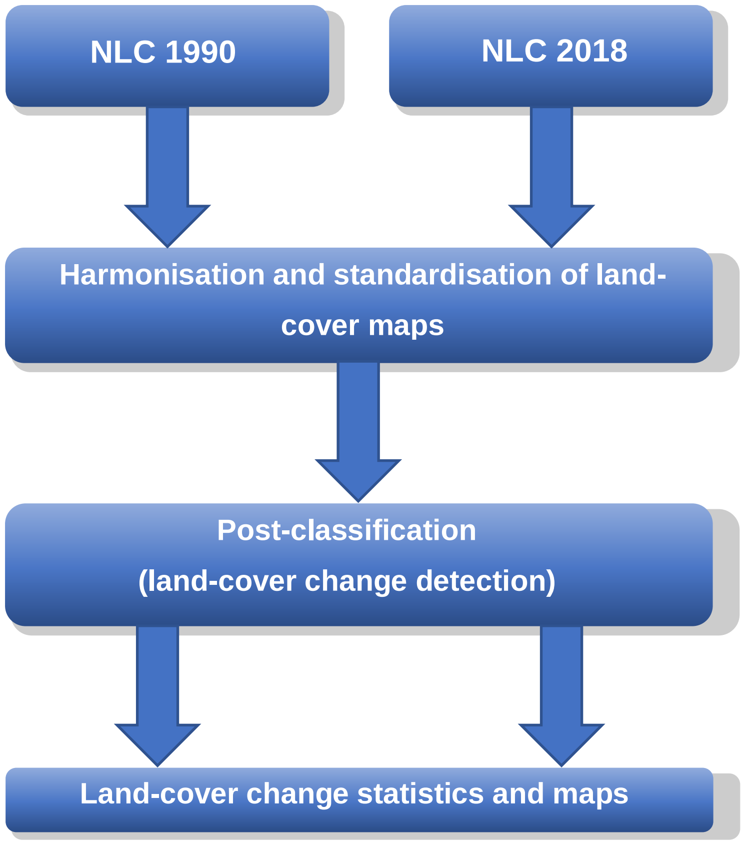

Figure 3.1: Schematic representation of the land-cover change-analysis process

Source: Adapted from Borana and Yadav (2017)

3.3.2.2 Predicting future land cover

(a) The use of stochastic models

Predictions of future changes of land cover were made using the 1990 and 2018 interval products using stochastic models. It should be noted that no additional variables were used to predict future land cover due to the paucity of good and spatially explicit data.

The future prediction for land cover in Mphaphuli for the year 2050 was based on the Cellular Automata (CA) Markov chain model, which, according to Lu, Wu, Ma and Li (2019), combines the capability of the Markov chain, CA, and multi-criteria analysis. This 2050 prediction was built from the land-cover data of 1990 and 2018. The first step was to derive the transition probabilities or rate of changes using the Markov chain (Cai, Shi, Hao, Zhang & Gao, 2018; Lu *et al*., 2019). The Markov chain is a stochastic model used to simulate complex processes such as land use or cover change.

Markov chain analysis determines the quantity of expected land-cover change from each existing class to each other class in the next time period (Zhen, Kim, Takada & Kohno, 2010; Fathizad, Rostami & Faramarzi, 2015). The Markov model learns from the transition probability between the earlier date (initial state) and the later date (final state) to determine the transition trend between LULC states (Zhen *et al*., 2010), while the CA model is a bottom-up dynamic model for making robust spatiotemporal calculations (Sinha & He, 2007; Cai *et al*., 2018).

The land allocation for predicting future land cover in 2050 was achieved through the CA Markov chain, which integrates the capability of the Markov chain, CA, and multi-criteria analysis. The approach adds an element of spatial contiguity, as well as knowledge of the potential distribution of transition to the Markov chain analysis (Kala *et al*., 2017; Wang, Lei, Elmore, Jia & Mu, 2019). It also integrates the CA model's ability to simulate spatial variation in complex systems and the advantages of the long-term prediction of the Markov chain (Cai *et al*., 2018; Wang *et al*., 2019).

The Markov chain model element controls the temporal dynamics among the land-cover classes based on transition probabilities. In contrast, the local rules determined by CA spatial filter or transition potential maps control the spatial dynamics (Cai *et al*., 2018). Because of the iterative nature of CA, the spatial prediction accuracy is effectively simulated simultaneously (Zhang, Cooper, Selch, Meng, Qiu, Myint, Roberts & Xie, 2014; Chen *et al*., 2015). After the future land-cover map was derived, the change-detection protocol was applied.

(b) The use of Co$ting Nature V3 software

To identify ecosystem services and perform economic valuation, Co$ting Nature V3 was used. Mulligan (2018) summarises the inner workings of the tool/software by explaining the datasets that were used in the setting up of the tool.

Co$ting Nature incorporates ecosystem services provision and benefits information into the conservation prioritisation and planning. It focuses on water, carbon, and tourism-related services and on defining the magnitude and geographic pattern of these as potential services and as those realised (used) by local and global beneficiaries (Pandeya, 2013).

Co$ting Nature starts by mapping 13 ecosystem services, and then combines them with analyses of current pressure, future threats, biodiversity, and Delphic conservation priority to produce an assessment of priority areas for conservation and careful (sustainable) management based on all these factors.

This mapping is done first by using baseline datasets representative of the current situation. Users may then apply scenarios of land use or valuation and examine the impacts – in terms of change in ecosystem services – and implications for beneficiaries (Sanderson & Galliford, 2018).

By default, all outputs are expressed in normalised biophysical units in relative terms as indices from 0-1 locally within the study area; the higher the values, the greater the index. The user may also set these to scale globally, which would represent priority across the world. Normalisation ensures that very different services and preferences can be combined in aggregate indices, to which the user can then apply specific weights under a policy option (by default, the individual inputs for all combined indices are equally weighted) (Pandeya, 2013). Users may also conduct economic valuation by using economic valuation customisation and completing the economic valuation matrix. In relative units, Co$ting Nature maps 13 potential and 13 realised services. In economic units, Co$ting Nature maps 22 potential and 22 realised ecosystem services values.

For ecosystem services' identification and valuation, the following process was followed in Co$ting Nature. The system was accessed after permission was granted for the Hyperuser account and followed the steps outlined below:

- **Step 1: Define area:** Choose degree tile, clip the study area from two tiles. Provide a short name for the run.
- **Step 2: Prepare data:** Prompt the system to obtain all the data for the site. Copy the data to a workspace on the computer. Download data for use in simulation. (The variables and associated values used are described in Table 3.2.)
- **Step 3: Start simulation:** Run the simulation.
- **Steps 4, 5, and 6: View results:** Step 4 involves viewing the results interactively to start getting some outcomes of the simulation. Step 5 involves generating maps from the simulation, which were downloaded in zipped folders in GIS Arc ASCII grid format. Maps were viewed through six-button in geobrowsers, Google Earth, Google Maps, change colour schemes, show frequency distributions, and popping maps in separate windows to compare side by side with other maps. The generated maps were then depicted in averages or totals for the year.
- **Step 6** involves generating statistical data, mainly in time-series.
- **Step 7** involves creating a narrative report of the model outcome. The outlined steps also included the valuation of the identified ecosystem services, where the table presented in Appendix E formed part of the valuation matrix.

The valuation of ecosystem services undertaken was based on the default values of the valuation matrix (default values are supplied, representing the economy of Bhutan in 2018). Appendix E indicates the ecosystem services valuation matrix used in this study. The latter forms part of the prepared data step used for the analysis of the data. No external datasets were used during the model simulation stage because pre-processed and pre-loaded data were comprehensive and useful for achieving the objectives of the study. The current (2020) land-cover map was used to summarise the aggregate economic values.

For the post-processing and GIS mapping section, the major component of the results is maps that show spatial-explicit information about the ecosystem services valuation results, e.g., total economic value, contribution to local communities, and relative pressure and threats, among others. The modelling of ecosystem services was done using a specific predefined grid and summarised per the Zone of Interest. The resulting maps from Co$ting Nature were further processed using the ArcGIS tool. The ArcGIS extraction tools were used to clip the ecosystem services valuation products to the extent of the study area, and layouts or maps were created.

The second part was to summarise two aggregate economic values per current land-cover classes: (1) the total economic value representing the sum of all 22 valued ecosystem services, and (2) the local value contribution to the poor's livelihoods. This value represents a ratio of the ecosystem services value to the fraction of beneficiaries who were poor and the GDP of the poor, expressed as a percentage.

It is thus the percentage contribution of ecosystem services value to the total economic GDP of the poor. Where the value is >100%, nature provides greater value than the GDP of the poor. This value is a hidden subsidy that underpins the livelihoods of the poor (Mulligan, 2018). These aggregate economic values were summarised from the current land-cover map, using zonal statistics tool in ArcGIS, as shown in Table 3.2.

Table 3.2: Biophysical variables and economic value required for valuation

Service	Mapped variable	Value required
Water (rural)	Map: per capita fractional natural capital footprint to rural populated areas	Value: amount willing to pay per capita per year
Carbon	Map: tonnes per year above ground storage + sequestration for forests only	Value: per-tonne carbon market price, recognising that stored carbon also produces benefits annually
Nature-based tourism	Map: fractional density of tourists	Value: total annual spend of all nature-based tourists in the study area
Fuelwood (hardwood)	Map: tonnes per year	Value: substitute cost per tonne at market price
Domestic timber (softwood)	Map: tonnes per year	Value: market price per tonne
Livestock (grazing)	Map: tonnes per year	Value: substitute cost at market price or opportunity cost per tonne of fodder diverted from the market sale to cattle
Cultural/heritage/spiritual	Map: fractional density of culture-based tourists	Value: total annual spend of all culture-based tourists in the study area

Source: Mulligan (2018)

3.4 THE STUDY AREA

The setting of a study refers to the real geographical place at which research was conducted (James, Randall & Haddaway, 2016; Ravhura, 2019). The setting also applies to the timing of the survey, as well as the political, historical, cultural, social, economic, and other significant developments that take place at the time of undertaking a study. This study was conducted on the MTA's land. The review of land-user records was conducted at the MTC's offices in the Mbilwi village. One-on-one discussions with traditional leaders, advisors, administrators, headmen, government officials, and other stakeholders were mainly through telephonic conversations, virtual meetings via Zoom and Microsoft Teams, and in person.

The study was conducted during the height of the COVID-19 pandemic, which forced many countries to implement a lockdown process. South Africa was on lockdown levels five and four, respectively, at the time. South Africa had declared a National State of Disaster (Dlamini-Zuma, 2020), which restricted movements across the country.

While this was happening, severe environmental challenges continued unabated; ranging from water shortages to ecological degradation, which have never been quantified. It was against this background that this study was conducted; hence, the belief that the value and importance of this study are based on its contribution to the development of a decision support system to improve the performance of traditional authorities in terms of managing land, land use, user rights allocation, and overall environmental sustainability.

The Mphaphuli land is situated in the Thulamela Local Municipality of the Vhembe District Municipality, Limpopo province of South Africa (see Figure 3.2). The area is under the watchful eye of the MTC, which is the leadership structure responsible for 76 villages, where a headman leads each of the 76 villages.

The Kruger National Park forms the boundary to the east. Some sections of the land under the jurisdiction fall within the Thulamela Local Municipality, but almost 87% is under traditional leadership authority. The area has a very high unemployment rate, estimated at 44% (Stats SA, 2017), with almost 54% of households headed by women and an average household size of five people. Only 12% of the population has piped water inside their dwellings. Mphaphuli is a very rural community, which still relies heavily on natural resources for basic needs.

The relief of the area consists of undulating terrain, with plains, hills, and mountains that cover an area of approximately 67 000 ha. The climate of the area is primarily influenced by the Intertropical Convergence Zone (Mathivha *et al.*, 2016). Rainfall distribution in the area is classified as unimodal, with the rainy season predominantly between October and January (Reddy, 1985). The average annual rainfall of the area is 200 to 400 mm (Lombaard, Badenhorst & Van Schalkwyk, 2018).

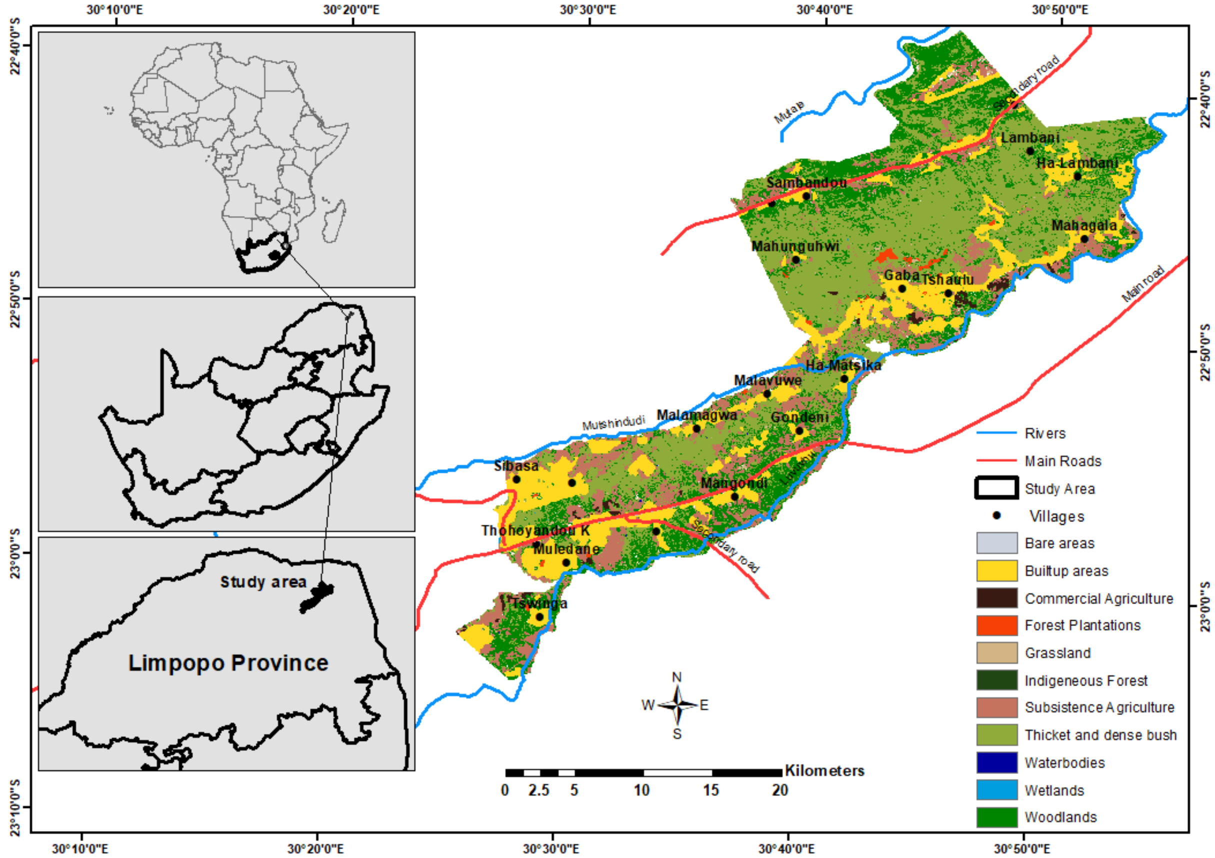

Figure 3.2: Location map of the Mphaphuli area

Source: Researcher

3.5 The sampling context

Sampling refers to the selection of representative groups, units, or cases, on account of the similarity of characteristics or traits to a larger group from which it (the sample) is selected (Bickman, Rog & Henry, 2014; Singh & Masuku, 2014; Benoot, Hannes & Bilsen, 2016). The sampling context refers to a structured framework that guides the processes by which the selected participants were selected. For the qualitative data collection, the participants were chosen according to predetermined measures. For the quantitative aspect, the selection of land-use records and policy documentation was guided by the documents present at the MTC and other repositories. By taking both the qualitative and quantitative impetus of the study's multiple forms and sources of data into consideration, the sampling context was structured so that the following critical variables could be identifiable: study setting, study population and sample size, sampling strategy or technique, and selection criteria.

3.5.1 Study population and sample size

The study population refers to all members of the superordinate group that resemble all or most of the selection standards or criteria determined in advance of the data-collection phase. It is from the study population that the characteristic qualities or traits of representativity are determined. This study's population consisted of traditional leaders acting in their capacity as village heads of the 76 villages and who work as a unit for the MTC.

The other population group consisted of land-use rights holders who all went through the same application process with the MTC. Government officials formed another group, who represent municipalities and specific government departments that deal with land, land use, and regulation. Sample size refers to the actual number of individuals, cases, or units that take part in a study due to their representative attributes (James *et al*., 2016; Ravhura, 2019). In this study, the sample consisted of 12 traditional leaders and 24 land-use rights holders (land users).

3.5.2 Sampling procedures and strategies

Govender (2018) and Ravhura (2019) both summarise probability sampling as a sampling technique where the subjects of the population have an equal opportunity to be selected as a representative sample. Non-probability sampling, on the other hand, is a method of sampling where it is not known which individual from the population will be chosen for a sample.

Non-probability purposive sampling was used to assess and select traditional leaders and government officials who were knowledgeable and could articulate their experiences with the management of land-use rights allocation and policy frameworks that guide such practices. Purposive sampling is the selection of participants according to the researcher's discretion, as determined by the extent to which the researcher is familiar with the environment and the realities of the participants (Gray, 2014; Ravhura, 2019). Gray (2014) and Ravhura (2019) explain that purposive sampling is a type of non-probability sampling method that involves a conscious selection of participants for inclusion in a study.

Purposive sampling is commonly used in qualitative research, based on the researcher's judgement regarding the participants' representative qualities or specialised knowledge of the phenomenon being studied (Robinson, 2014).

A qualitative researcher does not articulate a specific population to whom the results are intended to be generalised but establishes the eligibility of participants in the research, with the prime criterion being whether the participant has experienced the phenomenon under investigation or not.

For traditional leaders, the MTC members were preferred as they have a general understanding of land-use allocation and regulation. Other group members were purposely chosen to represent various zones across the study area; including the east, west, south, and north zones, to fairly cover the study area.

A list of land users with official permission to use the land was obtained from the MTC office administrators. The selection was also carried out purposively to cover all four zones of the study area, and all land users from the list were approached to respond to the questionnaires. The participants were asked to indicate their preferred interview method, and those that chose one-on-one interviews were then included in this approach.

3.5.3 Sampling of sites

Purposive sampling was used in the qualitative strand of the study, as many more participants would have increased the complexity of the data-analysis processes. One-on-one discussions were held with government officials, traditional leaders, and land users in the Mphaphuli area, particularly those who indicated their preference for this form of discussion when initially contacted.

3.5.4 Sampling of participants

The eligibility of the participants subscribed to the following criteria:

- All categories of traditional leaders in the area who hold a village leadership position.
- All types of traditional leaders who form part of the MTC.
- Government officials who work with land matters; ranging from planning to policy and regulations.
- Land users who have a portion of land in the Mphaphuli area, who, in one way or the other, have permission to use the land, or subscribe to the prevailing Mphaphuli land-use practices.
- All categories of subjects of the Mphaphuli traditional leadership structures.

Any participant who did not comply with the above criteria was not chosen for participation in this study. The semi-structured, open-ended questionnaires in this study were used to gather information from the following groups of participants:

- Land users;
- Traditional authorities; and
- Government officials.

The semi-structured, open-ended questionnaires for land users used in this study sought to address the following issues/themes:

- The demographic background of the participants;
- Land use;
- Land cover;
- Ecosystem services; and
- Legal framework.

A semi-structured, open-ended questionnaire was used for traditional authorities and government officials in this study to address the following issues:

- The demographic background of the respondents; and
- Land use and land-use regulations.

3.6 ETHICAL CONSIDERATIONS

Ethics is the collective body of guidance regarding questions of doing what is morally correct, and taking action and making decisions accordingly (Mulvey, 2015). The ethical decision-making process involves identifying, evaluating, and choosing among the options regarding the issue at hand (Bird & Scholes, 2013). Ignorance of ethical considerations on the part of the researcher may hold adverse consequences for participants, communities, institutions, researchers, and the scientific community (Christians, 2005; Mulvey, 2015).

Equally so, a researcher's non-compliance with ethical regulations of research may increase the potential for physical, social, or psychological harm to the participants. All persons involved in a study should therefore comply with all ethical rules and protocols.

Ethical clearance was obtained from the University of South Africa's Research Ethical Committee (see Appendix A). Permission to conduct research was also granted by the MTC, Vhembe District Municipality, Thulamela Local Municipality, and the Mphaphuli Development Trust (see Appendix B). The Co$ting Nature tool developers (Mulligan, 2018) also granted access to use their Policy Support System.

A basic risk-benefit analysis was conducted as part of the ethical clearance process to protect the research participants from harm, and it was found that there was no anticipated risk involved in the study. The participants were given sufficient time to decide whether to participate or not. Their participation was voluntary and without any coercion, and they were free to stop participating in the research without any penalty at any time during the research process.

For participation in any study to be genuinely voluntary, the participants must understand and realistically evaluate what will happen to them during the research and the anticipated risks and benefits of participation (Nijhawan, Janodia, Muddukrishna, Bhat, Bairy, Udupa & Musmade, 2013; Robinson, 2014). The participants were provided with comprehensive information regarding the study and their participation. To ensure that the participants were fully informed and able to provide informed consent, the full research title, confidentiality clause, and an explanation about whom to contact if any clarification was required were provided to the participants (see Appendix C).

Confidentiality involves protecting the identity of participants and avoiding unauthorised disclosure (Kapp, 2006; Dhai & Payne-James, 2013). Data become anonymous when they cannot be linked to any participant's identity (Dhai & Payne-James, 2013). Privacy and confidentiality were ensured by keeping all documents anonymous. Identifying information was removed from the documents, and numbers were assigned to the documents. Access to documents was restricted, except to the *bona fide* assistant researchers.

Three research assistants assisted with the research process. One assistant was chosen because of similar research interests, while the other two were locals seconded by the traditional authority. These research assistants were responsible for data collection along with the principal researcher. All research documents were kept in a safe place in a lockable cabinet. The records will be disposed of in line with legal and other requirements.

3.7 DATA MANAGEMENT AND ANALYSIS

In quantitative research, data analysis is the reduction, organisation, and statistical testing of data obtained during the data-collection process. Analysis was first performed on pre-existing sociodemographic data, then using other statistical tests (Sheard, 2018).

Descriptive statistics are used to explain and summarise data, and indicate what datasets look like. This is achieved by converting and condensing collected data into an organised, visual representation in different ways so that meaning can be attached to the data (DePoy & Gitlin, 2016; Lee, 2019). The data were carefully verified and checked, and errors were eliminated before the data were captured. Data coding was conducted, and the participants' answers captured and entered into Microsoft Excel to create datasheets.

The data were protected by ensuring that no identifying information appeared on the data-collection forms. Only the subjects' participant identification number appeared (Gray, 2014). Forms were kept in folders in a lockable cabinet. With the help of a statistician, all completed questionnaires were captured in a Microsoft Excel spreadsheet. Closed-ended questions were analysed using IBM's SPSS version 26. Frequency tables and bar charts were used to present data in percentages and numbers. The researcher received assistance from the statistician to analyse and interpret the data using frequencies and graphs. The participants' demographic data were calculated using descriptive statistics and graphs generated from the computed percentages that were obtained from the answers.

SPSS is an extensively used statistical package for the analysis of research data, as it offers the ability to compile parametric, non-parametric, and descriptive statistical analysis, as well as geographical depictions of results through graphical user interfaces (Arkkelin, 2014). Through this software, a set of statistical methods was used in the analysis of data, which led to a frequencies procedure for summarising data with descriptive statistics.

3.7.1 Data analysis

Qualitative and quantitative data were analysed separately and independently by using their relevant analytic procedures. Quantitative strands were analysed using computer-based analysis tools such as ArcView (LULC change mapping), stochastic modelling (predicting future LULC change), Co$ting Nature (economic valuation of ecosystem services), and analysis of variance (testing for significant variance between total economic value and LULC types). Descriptive statistics and qualitative strands were analysed using thematic analysis.

The data were organised in table formats, with each variable identified, the associated ranks according to the number of responses provided by the respondents, frequency calculated from the number of counts in terms of frequent answers provided by the respondents, and with some variables measured for their priority level.

The graphs were generated from the calculated percentages of the variables' responses provided. Some figures presented for some variables were not created through the use of proportions but through the use of means calculated for those variables.

A range of variables was obtained through the interviews conducted with the traditional authorities and land users, and the selection procedure was done with caution. The variables obtained were too many for them to be included in all the models, and some of them were considered non-essential to meet the objectives under investigation, and including them in the study would substantially overestimate their true effect. Furthermore, the variables included in this study were of particular interest to the model and assisted in reporting the estimated impacts even if they were not statistically significant at some level. Tables 3.3 to 3.6 outline some of the variables investigated in this study.

Table 3.3: The variables investigated in this study

The demographic background of the respondents		
Variable	**Description**	**Type of variable**
Age	Actual age in years	Continuous, Numerical
Gender	Whether male or female	Categorical, Nominal
Race	Actual race of respondent	Categorical, Nominal
Ethnicity	Actual ethnicity of respondent	Categorical, Nominal
Education level	Formal schooling attended	Categorical, Ordinal
Household size	Actual number of household members	Continuous, Numerical
Employment status	Whether unemployed/employed or retired	Categorical, Nominal
Number of dependants	Actual number of people depending on the head of the house	Continuous, Numerical

Table 3.4: The LULC variables investigated in this study

LULC variables – mainly the understanding of the respondents		
Variable	**Description**	**Type of variable**
Size of the land	Actual hectares in number	Continuous, Numerical
Farming method	Whether livestock or crop production	Categorical, Nominal
Source of funding	Whether funded or not	Categorical, Nominal
Climate change	Whether known or not	Categorical, Nominal
Proximity to sensitive environments	Distance in metres	Continuous, Numerical
Activity allocated for land	Actual name of activity	Categorical
Process followed	Actual process followed	Categorical
Existing policy/framework	Whether available or not	Categorical
SDG	Whether known or not	Categorical
Land-cover state	Whether natural or modified	Categorical
Sensitivity of current land use	Whether sensitive or not	Categorical
State of the current cause of land-cover changes	Whether natural or modified	Categorical

Table 3.5: The ecosystem services variables investigated in this study

Ecosystem services variables – mainly around water and wetlands		
Variable	**Description**	**Type of variable**
Wetland name	Actual name if known	Categorical
Location of wetland	Actual area of location	Categorical
Wetland size	Actual size in hectares	Categorical
Wetland	The name of the wetland	Categorical
Benefit	List of benefits	Categorical
Period of benefitting	Periods in months or years	Continuous
Threats to wetlands	Listed threats	Categorical
Severity of threats	How severe are the threats	Categorical
Length of threats experienced	Periods in months or years	Continuous
Conservation need	State "yes" or "no"	Categorical
Wetland protection measures	List the available measures	Categorical
Current state of wetlands	Rate the condition	Categorical
Past state of wetlands	Whether natural or modified	Categorical
Future state of wetlands	Whether it will be modified or natural	Categorical

Table 3.6: The land-use management variables investigated in this study

Land-use and management practices and regulations (traditional authorities)		
Variable	**Description**	**Type of variable**
Responsibility for land evaluation	Types of tools	Categorical
Land-use right	Type of permission	Categorical
Revoking of land rights	Access to land rights	Categorical
Legal provisions, policies, or frameworks	Whether available or not	Categorical
Significant types of land-use applications	Existing application system	Categorical
Relationship between MTA and respondents' organisation	The actual relationship	Categorical
Relationship-governing mechanisms of MTA	State the type of relationship	Categorical

Land-use and management practices and regulations (traditional authorities)		
Variable	**Description**	**Type of variable**
Environmental sensitivity-determinant tools	Types of tools	Categorical
Challenges encountered in land-use regulations	List the challenges	Categorical

3.7.2 Document analysis

Records are an essential source of data; however, documents may contain bias, facts may be distorted or omitted, and data collection may be halted due to other reasons, including confidentiality reasons (Brink, Van der Walt & Van Rensburg, 2018).

Based on approval from the MTC, whose permission was sought, land users' information was collected and analysed to determine the extent of the land, the location, and the form of permission granted for the use of the land.

3.8 VALIDITY AND RELIABILITY OF THE RESEARCH INSTRUMENTS

Scientific research is a rigorous process, which requires careful monitoring and evaluation, as well as quality assurance mechanisms (Leung, 2015). These aspects of scientific research ensure the trustworthiness of the study relating to the validity and reliability of the research instruments. Any unmitigated flaws in the research instrument are likely to render the findings and the instrument used to obtain such findings unreliable. Validity and reliability are therefore two of the foremost considerations in determining the trustworthiness of the research processes and their outcomes.

3.8.1 Validity

Validity denotes the degree to which a study's conclusions effectively and accurately reflect the reality of research participants as the primary providers of a study's information (Noble & Smith, 2015; Ravhura, 2019). As such, validity means that a researcher had observed, identified, or measured what was initially intended to be measured; to the extent that generalisation of the results to other settings is possible (Thyer, Franklin, Cody & Ballan, 2019).

The validity of a study is often associated with the operationalisation of variables, which means that variables can be identified, observed, and measured, in line with whether the validity is aligned with either of the four types of validity, i.e., face, construct, content, and predictive validity. The validity of the research instrumentation was ensured in that the samples were chosen by following predetermined inclusion criteria, and that the data were recorded and preserved in their original format to prevent alteration (Lecompte & Goetz, 1982; Creswell & Creswell, 2018).

3.8.2 Reliability

Reliability refers to the uniformity or stability of the measure of behaviour (Cozby & Bates, 2015). Four types of reliability can be identified, namely inter-rater (different people, same test), test-retest (same people, different times), parallel forms (different people, same time, different test), and internal consistency (different questions, same construct) (Leedy & Ormrod, 2018).

In this study, reliability was ensured by the centralisation of the main question around land-use policy and decision-making processes across the traditional leaders and the land users, including the benefits derived from the ecosystems. This ensured that there was consistency and non-deviation from the originally stated objectives of the study. The preliminary findings and conclusions were also presented to the interview and one-on-one discussion participants to ensure that they could either agree or disagree with the findings.

3.9 CHAPTER SUMMARY

This chapter provided a detailed background of the methodological approaches used in this study. Both the quantitative and qualitative methods were explained in detail. The techniques implemented for the study to overcome some potential flaws and to ensure robust scrutiny of the data were discussed.

The next chapter entails the data analysis and the presentation and interpretation of the findings for both the quantitative and qualitative data. As stated, this study used a convergent mixed-methods research design. The next chapter explicitly examines LULC change mapping.

CHAPTER FOUR:
LAND-USE LAND-COVER CHANGE (LULC) MAPPING

4.1 INTRODUCTION

This chapter focuses on the data presentation and analysis of the findings for both the quantitative and qualitative data. The chapter explicitly examines the LULC change mapping results obtained from the GIS tools and from the interviews with locals regarding what they thought were the drivers behind the observed changes. The chapter also presents the outcomes of the stochastic modelling of future LULC predictions until 2050.

4.2 KEY RESULTS AND DISCUSSIONS

4.2.1 Mphaphuli LULC distribution

The data presented here were obtained from the NLC products of South Africa for the period between 1990 and 2018. The data were analysed by means of GIS techniques. In 1990, the dominant land cover was thickets and dense bush, followed by woodlands and built-up areas, which covered a proportion of 40%, 24%, and 18% of the total land-cover area respectively (see Table 4.1). Bare and forest areas were the least dominant classes during this time. In 2018, the dominant land cover was woodlands, followed by built-up areas, with 71% and 20% of the total areas respectively. Subsistence agriculture is one of the land-cover classes with relatively higher areas, as compared with waterbodies, wetlands, and others (see Figures 4.1 and 4.2 and Table 4.1).

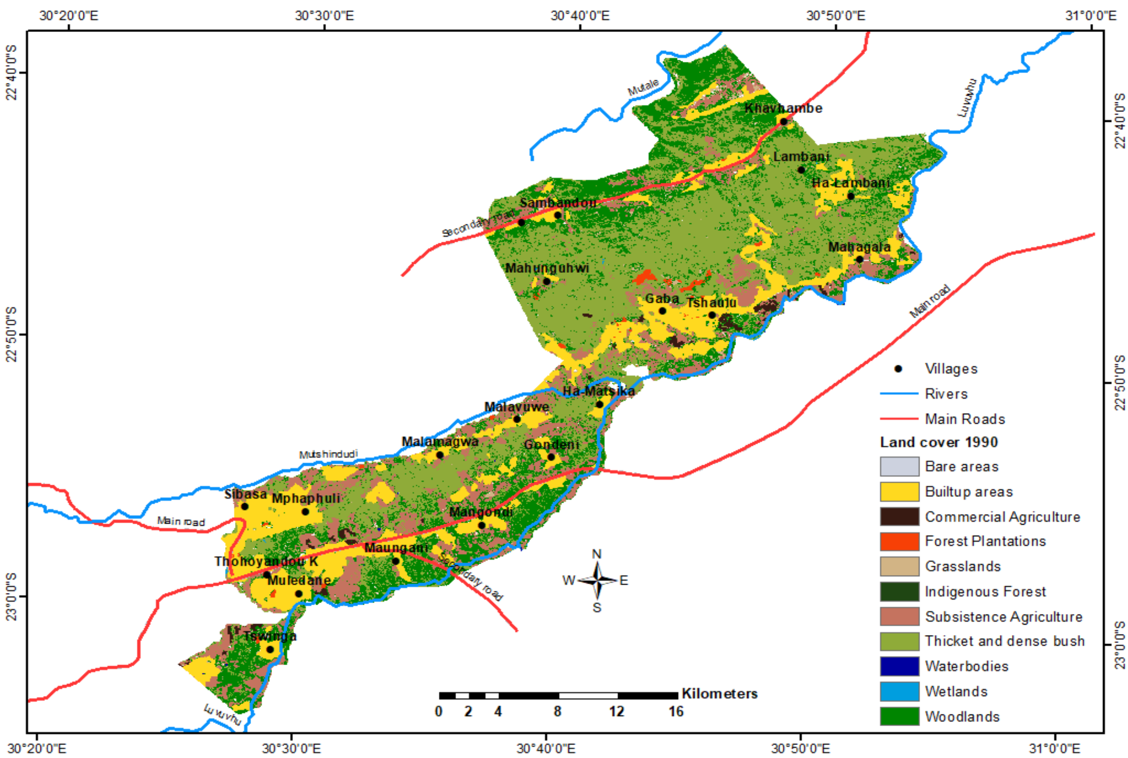

Figure 4.1: Mphaphuli land-cover map from the South African National Land-Cover (SANLC) Project: 1990

Source: Researcher

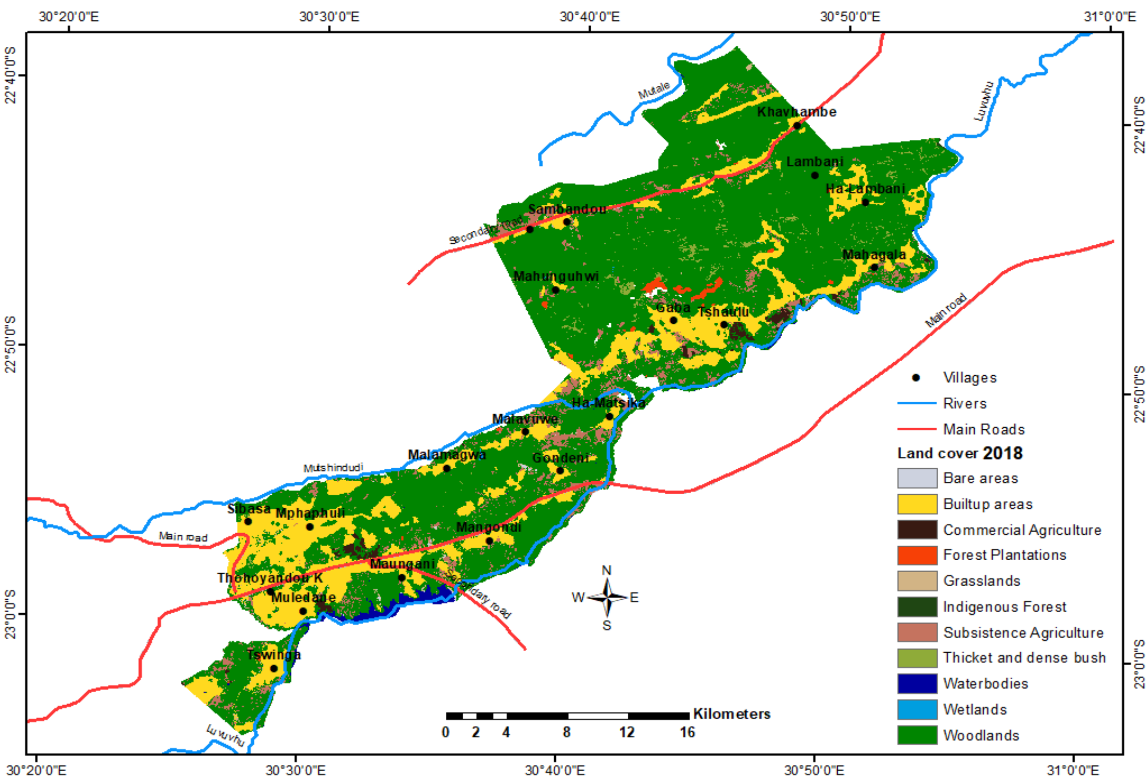

Figure 4.2: Mphaphuli land-cover map from the SANLC Project: 2018

Source: Researcher

4.2.2 Mphaphuli LULC detected

Between 1990 and 2018, significant changes in land cover were noticed for the classes of thickets and dense bush, woodlands, waterbodies, subsistence agriculture, and built-up areas (see Table 4.1 and Figure 4.3). Woodlands changed by over 1 000 ha per year, while thickets and bush class decreased by over 900 ha per year (see rate of change in Table 4.1). Critical determinants of change, especially for thickets and dense bush, are the proliferation of the woodlands, which is also known as bush encroachment, and fuelwood relating to braai/selling, while the development of a vast waterbody (Nandoni Dam) led to the loss of over 500 ha of thickets and dense bush, woodlands, and grasslands. Built-up areas increased by 733 ha, which translates to 26 ha per year since 1990. Wetland areas declined by 25 ha, which translates to almost 1 ha per year. Bare areas increased by 91 ha, which translates to 3 ha per year since 1990. Table 4.2 presents post-classification results, which show the drivers or causes of the observed changes using a “from-to” two-way table.

Table 4.1: Area for each land-cover type in 1990 and 2018, and corresponding change-analysis results

Land-cover types	Value	1990 (ha)	1990 (%)	2018 (ha)	2018 (%)	Change (ha)	RΔ (ha/year)
Waterbodies	1	24	0.04	679	1.01	655	23
Wetlands	2	46	0.07	21	0.03	-25	-1
Indigenous forest	3	6	0.01	9	0.01	3	0
Thicket and dense bush	4	26 862	39.89	743	1.10	-26 119	-933
Woodlands	5	16 299	24.21	47 906	71.15	31 607	1 129
Grassland	6	801	1.19	256	0.38	-545	-19
Commercial agriculture	8	554	0.82	528	0.78	-26	-1
Subsistence agriculture	9	9 713	14.42	3 360	4.99	-6 352	-227
Forest plantations	10	332	0.49	310	0.46	-22	-1
Bare areas	11	7	0.01	98	0.15	91	3
Built-up areas	12	12 690	18.85	13 423	19.94	733	26
		67 333	100	67 333	100		

RΔ = rate of change (ha/year)

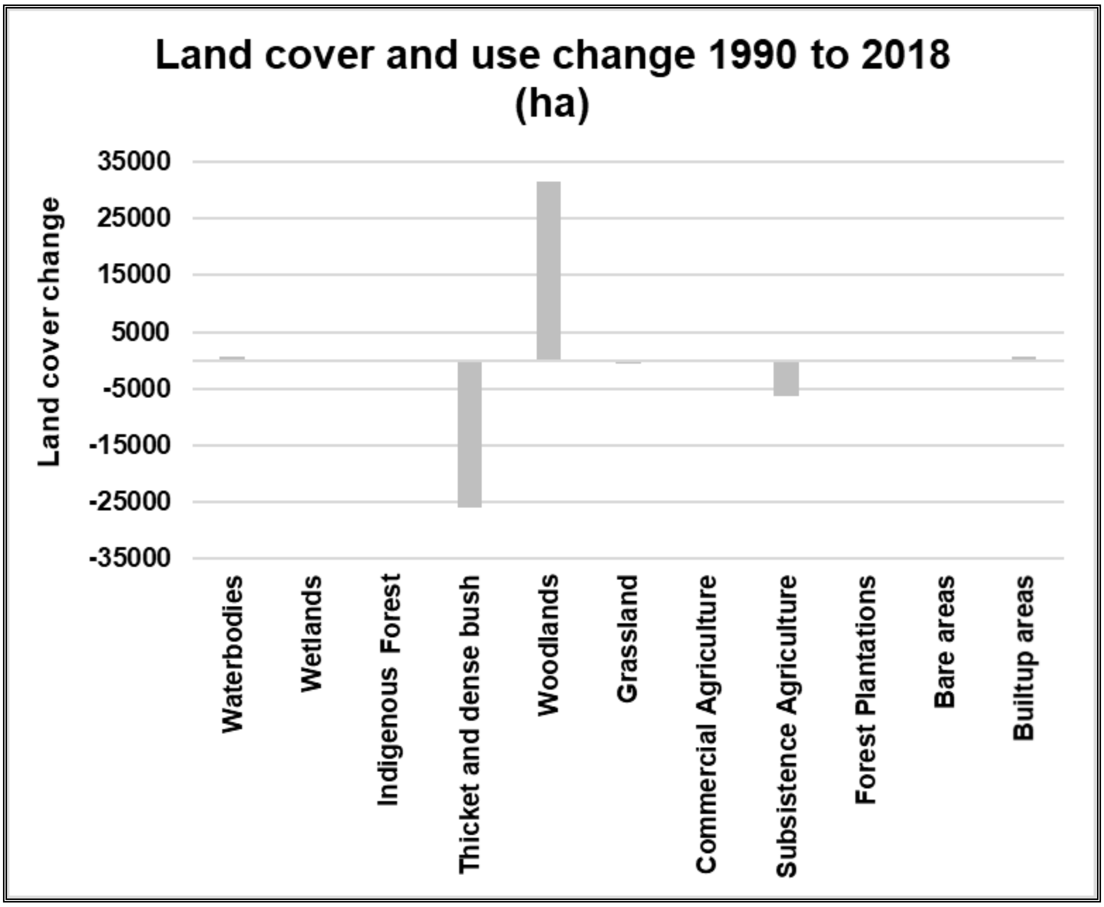

Figure 4.3: Land-cover change statistics: 1990 to 2018

Table 4.2: Post-classification results for changes using a "from-to" two-way table

		NLC 2018											
	Land-cover types	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total area (ha)**
NLC 1990	**1. Waterbodies**	**8**	0	0	0	14	0	0	0	0	1	0	**24**
	2. Wetlands	10	**2**	0	3	27	0	0	0	0	0	4	**46**
	3. Indigenous forest	0	0	**0**	3	3	0	0	0	0	0	0	**6**
	4. Thicket and dense bush	192	8	5	**669**	24 613	62	25	427	28	26	806	**26 862**
	5. Woodlands	442	3	4	30	**14 445**	130	27	228	45	55	891	**16 299**
	6. Grassland	22	0	1	2	635	**17**	3	19	11	7	84	**801**
	7. Commercial agriculture	0	0	0	4	171	0	**342**	33	0	0	3	**554**
	8. Subsistence agriculture	4	7	0	27	6 947	12	116	**2 488**	2	5	105	**9 713**
	9. Forest plantations	0	0	0	1	56	2	1	4	**224**	0	45	**332**
	10. Bare areas	0	0	0	0	5	1	0	0	0	**0**	2	**7**
	11. Built-up areas	0	0	0	3	991	32	15	161	0	3	**11 485**	**12 690**
	Total area (ha)	**679**	**21**	**9**	**743**	**47 906**	**256**	**528**	**3 360**	**310**	**98**	**13 423**	**67 333**

4.2.3 Drivers of LULC changes

Trends in land-cover changes have been established over time. Changes in the use of land take place at various spatial and temporal levels (Gashaw *et al*., 2017). These changes have been found to be beneficial, and at other times to have detrimental impacts, just as other scholars have found elsewhere (Briassoulis, 2019). Anthropogenic factors are the main cause that affect the structure and functioning of ecosystems (and, ultimately, the earth system), as well as human wellbeing (Turner *et al.*, 2007). It has been observed that LULC change is considered one of the main drivers that influence change throughout the world. This view is also supported by the assertions of other researchers such as Pandit, Sodhi, Koh, Bhaskar and Brook (2007), Karki, Thandar, Uddin, Tun, Aye, Aryal, Kandel and Chettri (2018), and Hill *et al*. (2020).

Lawler *et al.* (2014) support the assertions on land-use change by arguing that land-use change has serious implications for the world's ecosystems. Understanding the effect of LULC changes on the ability of ecosystems to provide value to landowners is an essential precondition for finding efficient land-use patterns that maximise net social benefits (Chettri & Sharma, 2016).

The data presented below originated from the questionnaires and interviews conducted with the research participants. It mainly reflects the perceptions of the respondents on what could be behind the changes in LULC. Several drivers were omitted from the discussions, as their rate of change and implications were found to be negligible, while the following LULC drivers were of interest to the research outcomes, and more so as they related to the outcomes of the GIS and remote sensing exercises reported on earlier:

- Forests and woodlands;
- Wetlands and waterbodies;
- Grasslands;
- Built-up areas;
- Bare lands; and
- Subsistence agriculture.

The prioritisation of the drivers was based on the interviewees' responses to the questions put to them. The responses to the drivers of change were ranked according to how the respondents perceived the severity of the drivers.

If the management of the LULC change is to be successful, it must be grounded in the understanding of the factors responsible for such changes. To this end, evidence of previous drivers, as well as current and future factors, should be taken into consideration (Munthali *et al*., 2019). Various parts of the African continent face a great deal of pressure from an accelerated need for economic development. This change is now jeopardising the established protection of the considerable natural resources in these areas (Mwampamba *et al.*, 2016). Concrete evidence, such as the data gathered by Arunyawat and Shrestha (2016), is critical, even though the mapping is critical for proper planning around land-use change and ecosystem services.

4.2.3.1 Forests and woodlands

Forests are a critical ecosystem that provide an array of valuable services to human wellbeing. These ecosystems are known for some very distinctive roles, which range from their ability to sustain biodiversity, being a habitat for various species of fauna and flora, as well as growth sequesters and carbon sinks, to their regulatory role in climate change mitigation. More like wetlands, forests also have soil conservation and stream flow stabilising roles, which are functions to prevent water runoff (Fagerholm, Torralba, Burgess & Plieninger, 2016; Jenkins & Schaap, 2018).

The Mphaphuli area is one of the most impoverished communities in the country, where the majority of people are still very much reliant on nature for the provision of services, including fuelwood for their energy sources. Although this has been changing, as almost 87% of the population has electricity (Stats SA, 2017), the level of poverty remains very high, and because of this, reliance on the forests for fuelwood persists. Of late, there is a trend of cutting firewood for sale to upmarket areas, which continues unabated. This is one of the driving forces behind the high rate of conversion from forests to woodlands. According to the locals, deforestation is the biggest threat to the forests/thickets in the area, followed by agricultural activities and, eventually, mining on a small scale.

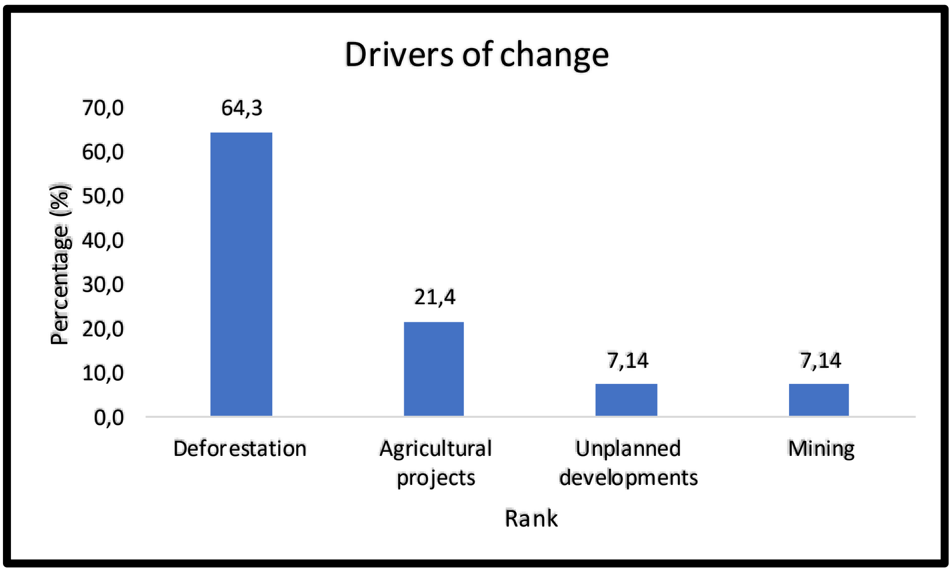

Figure 4.4: Perceptions of drivers of change in forests

The respondents identified deforestation as a significant factor that drives change for forests in the Mphaphuli area. Deforestation in the area was perceived by 63.4% of the respondents as a major driver of change (see Figure 4.4). Agricultural projects and related activities were identified by 21.4% of the respondents as drivers of change in the Mphaphuli area. Agricultural projects are among the drivers that compete with grasslands and forests for space, as forests are transformed for agricultural projects.

Unplanned developments, in many cases, are a result of poor governance, lack of adequate land-allocation management strategies, and ineffective policies around enforcement on land use (Williamson *et al*., 2008; Zevenbergen, Augustinus, Antonio & Bennett, 2013). Unplanned developments, however, could arise in an area as a result of other factors such as overpopulation and urban expansion. In this study, 7.14% of the respondents identified unplanned developments as another driver of change.

Mining activities have contributed to economic development in many parts of the world (Clemens *et al*., 2018). Mining projects contribute to employment opportunities and infrastructure development, such as roads and access to water, but they are also responsible for major environmental impacts such as acid mine drainage that leads to impacts on terrestrial and aquatic ecosystems (Clemens *et al*., 2018). In this study, 7.14% of the respondents identified mining, albeit on a small scale, as a driver of change.

4.2.3.2 Wetlands and waterbodies

The mapping of LULC change through GIS revealed that surface areas of waterbodies have increased in the area between 1990 and 2018, which was almost an anomaly until confirmation that a huge dam that was built by the Department of Water and Sanitation in South Africa opened in 2005. This change marked a positive trend in the changes of waterbodies, which, otherwise in many cases, are on a downward trend.

A downward trend was identified through remote sensing, as wetlands were found to have declined by 25 ha, which translates to almost 1 ha per year over the period under investigation. This finding was also in line with what the respondents observed and complained about regarding waterbodies, rivers, and wetlands.

Wetlands and rivers are pivotal aquatic ecosystems known for their distinctive roles in supporting various fauna and flora. Despite their multiple purposes of supporting numerous forms of life, they are facing unprecedented pressure related to modifications and extreme levels of degradation due to the demands of human-induced activities. Such alterations to aquatic ecosystems have tremendous impacts on the flow magnitudes, flow regimes, and water accumulation. Rivers and fountains have been modified to be compatible with human needs. Such disturbances to these aquatic ecosystems render them susceptible to poor management. The disturbances are poorly quantified, which results in their ecological states being poorly understood (Hollis, 1990; Walters, Kotze & O'Connor, 2006).

The research respondents identified wetlands and rivers as among the most critical ecosystems affected by the various activities. For example, the wetlands in Sambandou have been subjected to indiscriminate clearing, cultivation, and sand mining for some time. The Makwarela wetlands have also been subjected to intense residential developments right inside their boundaries. The same goes for the Tshifudi and Tshaulu wetlands, which are being transformed into grazing and agricultural lands. Figure 4.5 summarises the number of responses on this matter. Residential development is the most cited driver, raised by 41.2% of the respondents, followed by wetland destruction activities such as clearing and draining, as indicated by 29.4% of the respondents. At the same time, poverty and overpopulation were cited by 11.8% of the respondents as a driving force.

The respondents identified residential development as the primary driver of change around wetlands and waterbodies. As identified by the respondents, residential developments contributed significantly to the changes in the landscape of the Mphaphuli area. Residential development was identified by 41.2% of the respondents as a driving force behind changes in wetlands and waterbodies. Residential development has the potential to undermine the integrity of sensitive ecosystem services. Some developments have been placed in buffer zones of rivers and wetlands, and these placements negatively impact these ecosystems, as pollution, erosion, and habitat fragmentation are often the end result.

Wetland destruction is another driver of change identified by 29.4% of the respondents in the area. The respondents' views confirm the point raised by Leibowitz, Wigington, Schofield, Alexander, Vanderhoof and Golden (2018) that many wetlands have been destroyed worldwide.

The respondents also identified grazing and use of wetlands as cultivating lands among the main drivers of changes in the area, as shown in Figure 4.5. Closely associated with impacts on wetlands is the drying-up of springs, called *zwisima*, in the Mphaphuli area. It may be that only 17.6% of the respondents identified this factor, but the drying-up of fountains is an issue that could easily be related to the rest of the other unplanned development activities reflected on earlier.

Poverty and overpopulation in sensitive areas were identified by 11.8% of the respondents as drivers of change around rivers and springs in the area. Many rural poor communities rely heavily on the wetlands and river ecosystem services for survival and sustaining their livelihoods, which could be why so many of them end up occupying parcels of land inside or nearby sensitive ecosystems. The over-reliance of poor rural communities on the wetlands and rivers, where no proper regulation is in place, contributes to over-use.

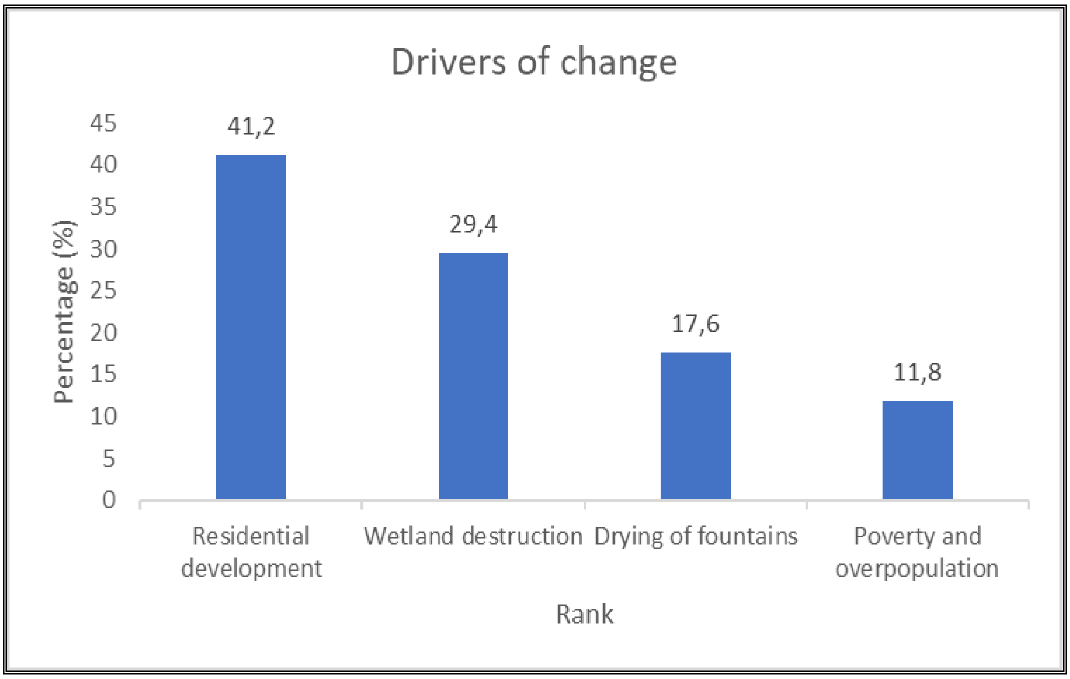

Figure 4.5: Perceptions of wetlands/waterbodies drivers of change

Not only did the participants identify the drivers reflected in Figure 4.5, but they also identified other additional variables behind the declining state of rivers and wetlands in the area, as shown in Figure 4.6.

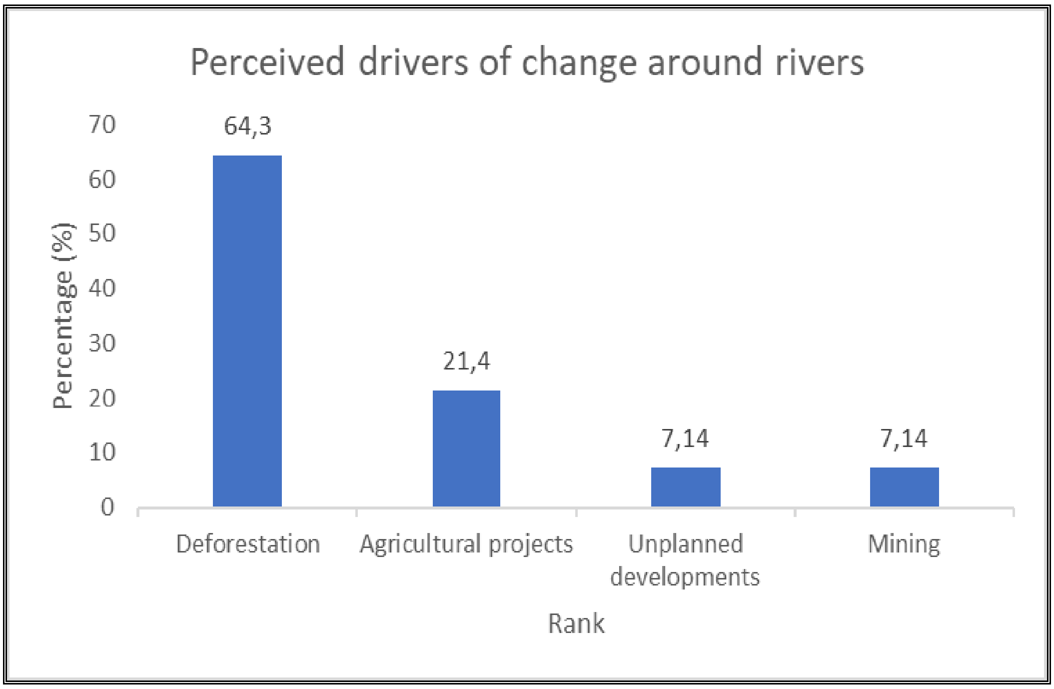

Figure 4.6: Additional variables perceived to be drivers of change around rivers

Deforestation was identified by 64.3% of the respondents as an additional driver of change for rivers, while agricultural projects were listed by 21.4% as a factor that drives change. Unplanned developments and small-scale mining were identified by 7.14% of the respondents, respectively, as some of the additional drivers of change for rivers in the area.

According to the respondents, the Mphaphuli area's rivers are deteriorating at an alarming rate. Although water quality analysis was not part of this research, one could infer that it could be a casualty of the deteriorating state of rivers in the area. There are villages in the Mphaphuli area that do not have any water source other than the local rivers and springs. These include communities such as Sambandou and Gunda, which have hardly any water flowing through installed standpipes.

Rivers in closer proximity to these communities could suffer from pollution. Pollution in the Mphaphuli area was evident during fieldwork, as pollutants such as disposable diapers and litter were observed in and around rivers. This calls for improvements in the management and monitoring of rivers to ensure that rivers remain pollution free.

4.2.3.3 Grasslands

The respondents identified overgrazing and soil erosion as the significant drivers of change relating to grassland, followed by road construction, business development activities, and other municipal infrastructure, as shown in Figure 4.7. The respondents perceived four main factors as drivers of change around grasslands. Overgrazing was identified by 35.7% as a major driver, road construction activities were identified by 28.6%, general business development activities were identified by 21.4%, and municipal infrastructure activities, in general, were identified by 14.3% of the respondents as a driver behind changes in grassland ecosystems.

Grasslands are one of the major ecosystems that occupy one-third of the world's terrestrial landscapes, and are recognised globally as being rich in biodiversity (Habel, Dengler, Janišová, Török, Wellstein & Wiezik, 2013). Grasslands are declining at an accelerated level due to conversion into arable land for agriculture (Mwampamba *et al*., 2016). At Mphaphuli, LULC mapping through GIS revealed that 545 ha of grasslands were lost between 1990 and 2018.

More than 20% of the grasslands have reached irreversible states of damage due to transformation to accommodate other land uses (Fairbanks, Thompson, Vink, Newby, Van den Berg & Everard, 2000). Grasslands are also transformed into rangeland for livestock (Bengtsson *et al*., 2019). They may occur as semi-natural, natural, and improved grasslands. These three types of grassland are known for their distinctive roles, as highlighted in Table 4.3.

Table 4.3: Types of grasslands and their characteristics

Grassland type	Characteristics	References
Natural grasslands	They form one of the biomes. They are favoured by processes related to climate, fire, and wildlife grazing.	Parr, Lehmann, Bond, Hoffmann and Andersen (2014)
Semi-natural grasslands	A product of human management well known for their ability to be encroached by shrubs and trees if not involved in the production, and used mainly for livestock grazing or hay cutting for their maintenance.	Queiroz, Beilin, Folke and Lindborg (2014)
Improved grasslands	Used for ploughing and sowing non-native grasses for fodder production potential. Require intensive fertilisation and management.	Morrison (2006); Pilgrim *et al.* (2010)

The health and productivity of global land resources such as grasslands are declining, while demand for these resources is increasing (Orr *et al*., 2017). Although they have the ability to support various forms of large stock units of game and livestock, grasslands are known for being susceptible to overgrazing and soil erosion. These drivers are also area specific, and areas with low rainfall and poor soil qualities are more vulnerable to erosion and overgrazing, while grasslands with high rainfall and good soil qualities are susceptible to leaching and the sour veld type of grass, which is a more unpalatable type for grazing.

Although roads are known for their connectivity and movement roles, they negatively affect a considerable amount of landscape covered by grasslands. The impacts of roads on grasslands are highly evident in areas such as Tshaulu, Tshifudi, and Dimani, where grasslands once thrived.

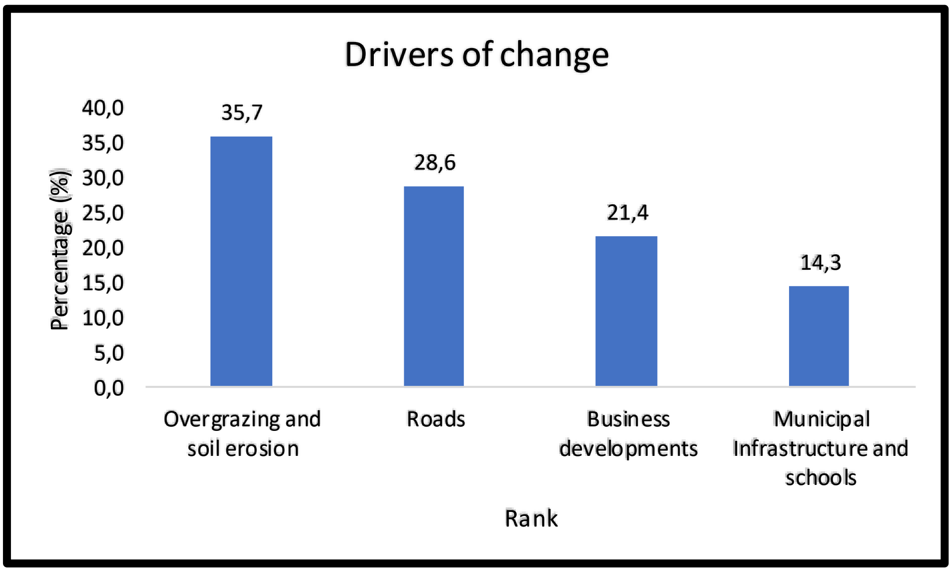

Figure 4.7: Perceptions of grasslands drivers of change

4.2.3.4 Bare lands

It was found through GIS mapping that there has been an increase in bare lands across the Mphaphuli area. In 1990, only 7 ha of bare lands were observed; however, in 2018, this increased to 91 ha. While interviewing the respondents, it emerged that sand mining and deforestation are driving this change from land covered by either forests/woodland to bare lands. Agricultural activities are also behind some of these marked observations. A glance over the Tshidzini, Gaba, Tshifundi, and Sambandou mountainous areas reveals this bare land incidence.

4.2.3.5 Built-up areas

Issues that drive land-use studies include the removal or disturbance of productive land, urban encroachment, and the depletion of forests (Mucova *et al.*, 2018). Demand for residential sites due to the increase in population has been identified as a driver of change in this respect. From 12 690 ha in 1990, there has been an addition of 733 ha of built-up areas.

Land-cover change due to urban expansion negatively affects biodiversity by causing degradation, loss of habitat, and fragmentation (Elmqvist, Zipperer & Güneralp, 2016; Aldana-Dominguez *et al.*, 2019). Some of the drivers of change include agriculture, siltation, and the concentration of chemicals in the form of bioaccumulation, which affects the world's threatened flora, fauna, and organisms (Karki *et al.*, 2018).

4.2.4 Projected land cover for 2050 and change detection from 2018 to 2050

The future land-cover prediction for the year 2050 was based on the CA Markov chain model deployed in this study. The 2050 prediction was built on the land-cover data of 1990 and 2018. Projected land cover for 2050 and change detected from 2018 to 2050 are depicted in Figures 4.8 to 4.10. All other land-cover classes are increasing, except for woodlands and indigenous forest. There will be a decrease in woodlands in 2050 (500 ha). The indigenous forest and thickets or dense bush seem to be stable between 2018 and 2050. Forest plantation will increase by over 100 ha.

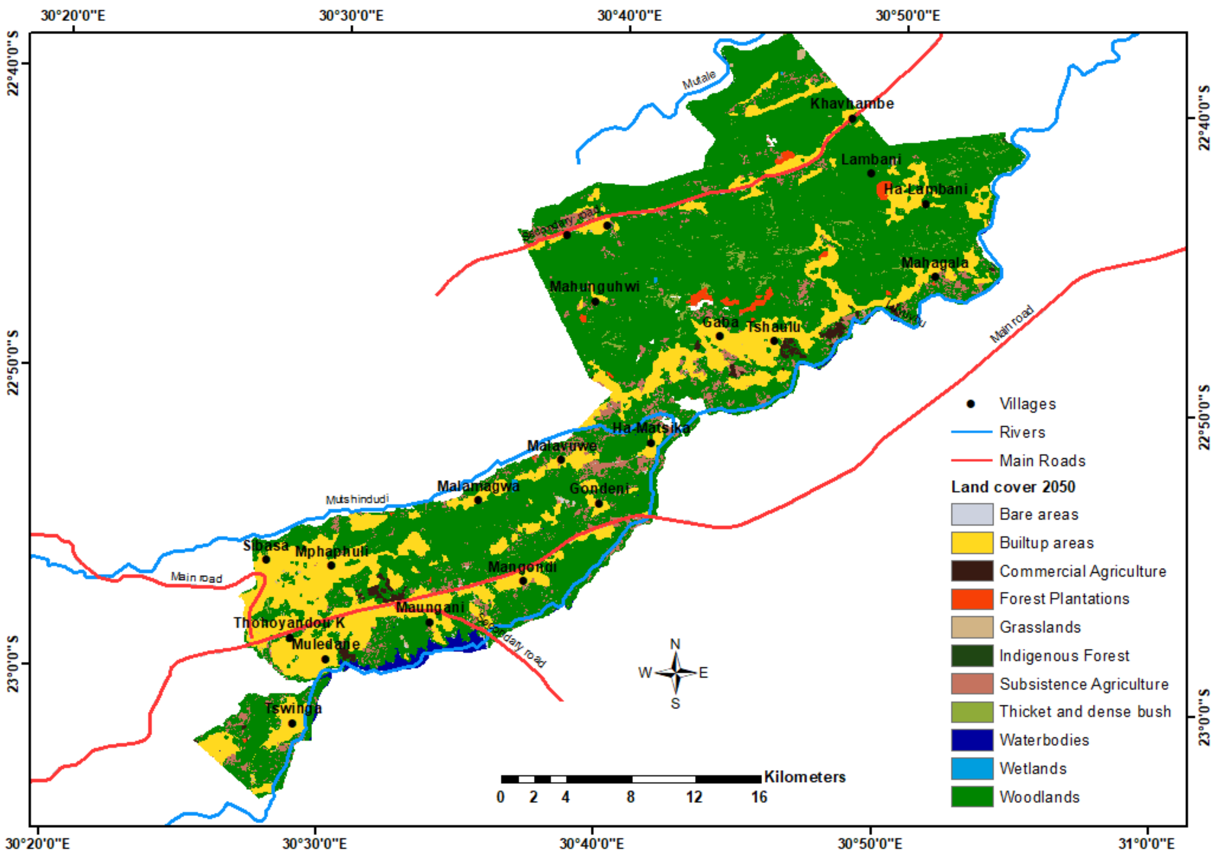

Figure 4.8: Mphaphuli projected land cover for 2050

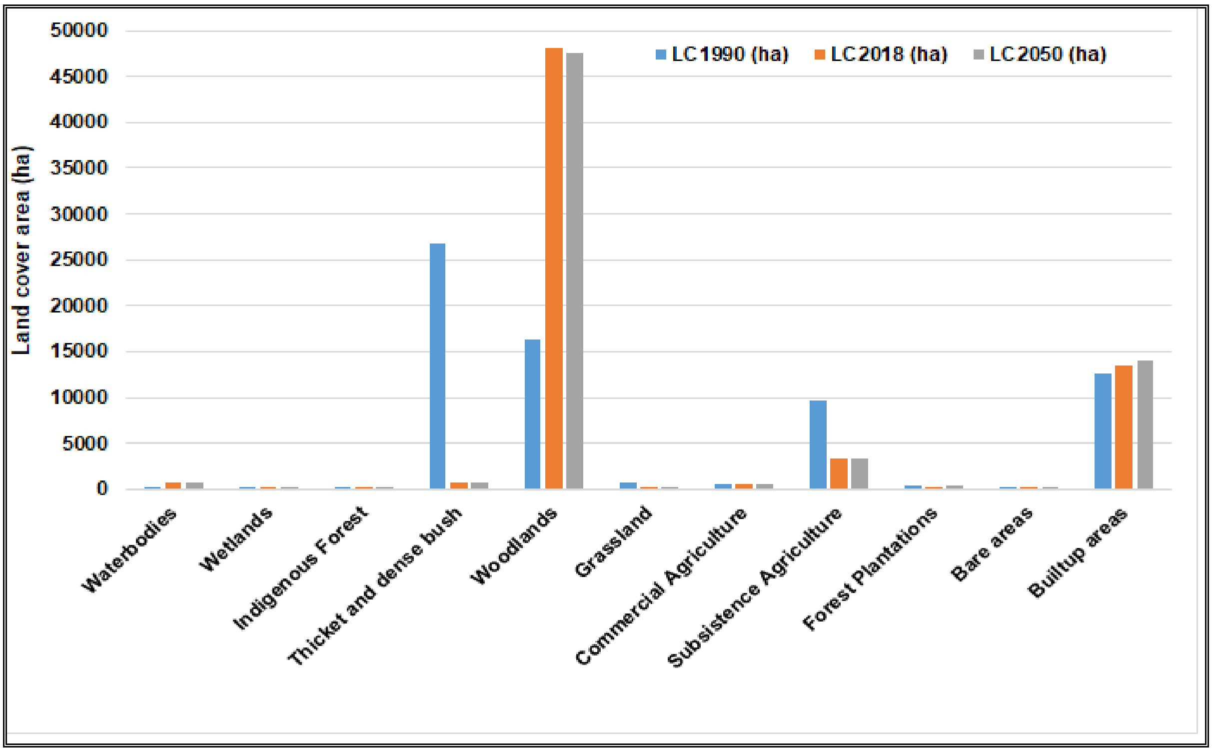

Figure 4.9: Area under different land cover in hectare in 1990 and 2018, and predicted for 2050

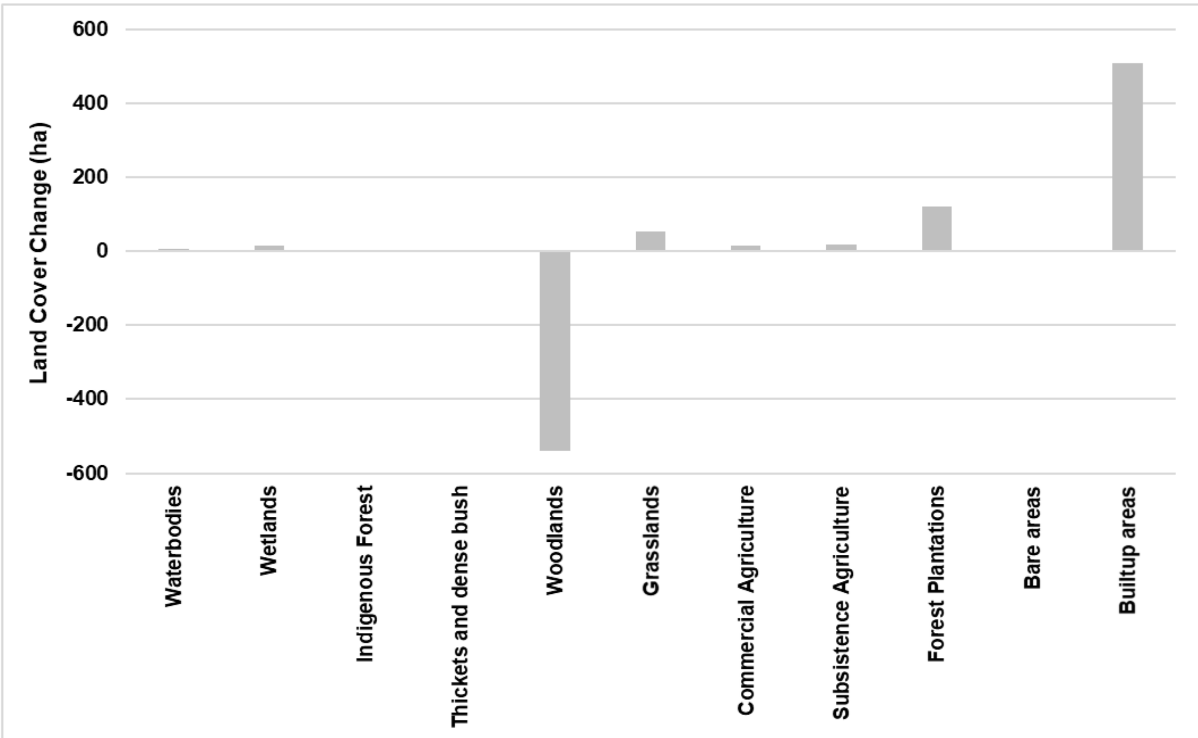

Figure 4.10: Land-cover change detection between 2018 and projected for 2050

4.3 CHAPTER SUMMARY

This chapter presented the mapped and quantified LULC changes that took place across the Mphaphuli land from 1990 to 2018. There were marked changes in land cover during the period under investigation; ranging from forests/thickets changing to woodlands, the addition of waterbodies, and a decline in wetlands and bare lands, among others. The natural process of change is anticipated in nature because natural processes are dynamic; however, where anthropogenic factors interfere, changes happen faster.

The drivers behind the changes in LULC were identified through a rigorous two-way process of ground-truthing and interviews with local people. The interviews sought to solicit their views and perceptions around the LULC changes. There are similarities in terms of what the GIS mapping showed and what the community observed.

The predicted outlook for LULC of the Mphaphuli area points to possible loss of woodlands by almost 500 ha, along with other changes. It is critical that systems are put in place to analyse the implications of the observed changes in LULC on ecosystems and their services because, ultimately, the impacts on the environment will be felt by the people in the long term. The concept of ecosystems and their valuation are the next chapter's subject, which reports on identified ecosystems and their associated valuation.

CHAPTER FIVE:
ECOSYSTEM SERVICES AND VALUATION

5.1 INTRODUCTION

The previous chapter mainly presented the LULC change mapping conducted for this study, identified drivers of such changes, and predicted the future outlook of the LULC in the Mphaphuli area. This chapter presents the data analysis and associated discussions around the identification and valuation of ecosystem services.

5.2 KEY RESULTS AND DISCUSSIONS

5.2.1 Identified ecosystem services

Co$ting Nature V3 software uses global valuation units used during its development, and no additional external or local data were used by this study. The study identified 13 ecosystem services in the area (shown in Table 5.1), both potential and realised. In relative units, Co$ting Nature maps 13 potential and 13 realised services. In economic units, Co$ting Nature maps 22 potential and 22 realised ecosystem services values (Mulligan, 2018).

Table 5.1: Co$ting Nature-identified ecosystem services

Category of service	Characteristics and examples
Provisioning services	Freshwater, food Fuelwood and fibre Fodder and grazing
Regulatory services	Regulation of air quality Regulation of climate (precipitation, temperature, and sequestration of greenhouse gas) Regulation of water (scale of run-off, timing, and flooding) Regulation of natural hazard Disease, pests, and erosion regulation Purification of water, pollination, and waste management
Cultural services	Recreation, cultural heritage, and tourism Spiritual, aesthetic, and religious value Inspiration of art, folklore, architecture
Supporting services	Formation of soil, nutrient cycling, primary production, photosynthesis, water recycling, and habitat provision

From the identified services, economic valuation returned results for the following services: hazard mitigation, wildlife services, non-wood forest products, commercial timber, domestic timber, artisanal fisheries, fuelwood, grazing/fodder, nature-based tourism, culture-based tourism, forest carbon, water quality in rural areas, and water quality intakes and water quantity intakes. One ecosystem disservice, i.e., wildlife disservices, was also identified for valuation.

The choice of selection was based on service concentration and the intended benefits from such valuation, especially for a poor community such as that of Mphaphuli. A previous valuation of ecosystem services was performed on the Vhembe Biosphere Reserve by scholars such as Ntshane and Gambiza (2016), which included portions of the Mphaphuli area. Only two services were valued by this previous study. This study is an improvement on earlier valuations, which were conducted using a different tool, which was InVEST, compared to Co$ting Nature used by this study. The current valuation valued services from the three categories of services: provisioning, regulation, and cultural. A summary of a selection of these services follows.

5.2.2 Ecosystem services' economic values

Economic valuation for the identified ecosystem services across the Mphaphuli land returned a total economic value of $528 280 256.00. No specific local units were used in the study, except for the general international figures that were used and then converted to local units as presented in this study. Table 5.2 summarises the economic values of services. Each of the valued ecosystem services and their associated biophysical units or metrics are described in detail in the ensuing paragraphs. It is worth noting that hazard mitigation was top of the valued services, with a value of $765 598 080.00. The value of hazard mitigation appears to be higher than the total economic value. Still, it should be noted that while identifying ecosystem services, some ecosystem disservices were also identified and valued, which reduced the overall economic value (see the local economic value and wildlife disservices in Table 5.2). Commercial timber ($791 300.50), non-wood forest products ($362 623.31), and artisanal fisheries ($5 577.54) were found to be the least valued ecosystem benefits.

Table 5.2: The economic value for selected ecosystem services

Mphaphuli ecosystem services' economic values		
Economic value	**United States dollar (USD)**	**South African rand**
Total economic value	528 280 256.00	9 509 044 608.00
Global economic value	1 000 003.69	18 000 066.38
National economic value	1 134 667 776.00	20 424 019 968.00
Local economic value	-607 553 024.00	-10 935 954 432.00
Mean % ecosystem services contribution to GDP of the poor	-1 300 000 000 000.00	-1 300 000 000 000.00
Hazard mitigation	765 598 080.00	13 780 765 440.00
Wildlife services	38 720 851 968.00	696 975 335 424.00
Wildlife disservices	-39 763 148 800.00	-715 736 678 400.00
Non-wood forest products	362 623.31	6 527 219.63
Commercial timber	797 300.50	14 351 409.00
Domestic timber	6 084 366.00	109 518 588.00
Artisanal fisheries	5 577.54	100 395.79
Fuelwood	2 472 220.75	44 499 973.50
Grazing/fodder	58 344 568.00	1 050 202 224.00
Nature-based tourism	107 998 664.00	1 943 975 952.00
Culture-based tourism	254 993 408.00	4 589 881 344.00
Forest carbon	1 000 003.69	18 000 066.38
Water (all)	368 468 864.00	6 632 439 552.00
Water (quality, rural)	1 185 155.88	21 332 805.75
Water (quality, intakes)	128 340 240.00	2 310 124 320.00
Water (quantity, intakes)	239 621 920.00	4 313 194 560.00

5.2.2.1 Hazard mitigation

Environmental hazards affect people differently, with poor communities being more susceptible to impacts than the rich (Fisher *et al.*, 2014). It is critical for the Mphaphuli community to realise that even though the area is considered rural and poor, ecosystem services do not discriminate based on financial resources. Nature provides the resources, free of charge, for the community to be protected should there be adverse environmental hazards. This hazard mitigation potential, however, will only be realised where LULC is managed effectively. There is a silent code of reciprocity required between nature and human beings.

5.2.2.2 Water provisioning

The potential economic service value related to water overall in the Mphaphuli area is \$368 468 864.00.

Water quality for rural areas ($1 185 155.87), water quality intake ($128 340 240.00), and water quantity intake ($239 621 920.00) are the three water services that were subjected to valuation in this study. Clean water provision is a vital provisioning service.

The water services value depends on the intensity of downstream use measured as the normalised area of irrigation, number of people, and number of dams. The results point to a massive potential for continued water provisioning and regulation services by the environment – once again, for free. Nandoni Dam and rivers such as Luvuvhu, Mutshindudi, Tshinane, and Mbwedi are the major sources of water in the area. This water provisioning and regulation service will continue to exist in the area, provided that policy positions around LULC remain focused on ensuring that there are no adverse or unnecessary disturbances to the ecosystems that feed these water reservoirs, such as wetlands and springs.

Mphaphuli is considered a very rural place, where many households still rely heavily on natural water sources such as rivers and springs for their daily water source. Many of the communities do not have sanitation infrastructure, and the primary use of the water is for drinking and livestock. Water provision and regulatory service are intertwined with the survival of the community in the long run. If the service were to cease, the poor, such as the Sambandou and Madandila communities, would be affected in a negative way. Ecosystems that provide this valuable resource (water), such as rivers, wetlands, and springs, must be protected at all costs.

The level of LULC change noted in this research also points to the urgent need for acute policy interventions to protect water resources. While this is identified in this valuation exercise as a potential service, water quality could be under potential future threat due to changes in LULC in the area. The future trajectories of LULC change point to the need for serious policy changes because ecosystems such as wetlands, that are responsible for cleaning water, are declining.

5.2.2.3 Culture-based tourism

Culture-based tourism ranked third in the most valuable potential services that the Mphaphuli community could tap into, with a value of $254 993 408.00. This community is rooted in its cultural beliefs and norms, which are unique to the area. The untapped potential of tourism associated with the area needs further exploration.

As an example, the Sundarbans Mountain Reserve in Bangladesh was found to have an enormous economic estimation of the provisioning of cultural services, which was tapped into and realised (Uddin, De Ruyter van Steveninck, Stuip & Shah, 2013). The famous Domba, Tshikona, Tshigombela, and Malende cultural dances, endemic only to this area of the Venda (Mphaphuli), are just some examples of activities that could lead to serious returns in the area if they were tapped into.

The reed dances that the Zulu nation practises attract many people all over the world to the province of KwaZulu-Natal. The same could be true of those held in eSwatini under the watchful eye of King Mswati III. If culture-based tourism service were to be realised, a great deal of work is necessary to preserve and promote cultural activities. An exploration of traditional African rites and rituals reveals many customs that are in danger of disappearing (Roberts, Beckwith & Fisher, 2000; Fairer-Wessels, 2014).

5.2.2.4 Nature-based tourism

Nature-based tourism follows in the footsteps of culture-based tourism, and is valued at $107 998 664.00. This amount is for the potential that nature-based tourism can bring to the Mphaphuli area if it was pursued as an economic activity. There are currently several activities that may be considered tourism activities, but many of them are not nature based. The Mphaphuli Cycad Nature Reserve, a piece of a protected natural environment at the heart of the Mphaphuli land, is the only reserve that could be associated with nature-based tourism. This nature reserve, however, does not have data for payments of its services. Some of the values relating to the Mphaphuli Cycad Nature Reserve are summarised in Table 5.4. Nature-based and culture-based services are tightly linked. Both can be classed as cultural services and are often considered together as recreational services (Mulligan, 2018).

It is imperative to realise the potential of recreational services for places such as the Mphaphuli Cycad Reserve, the Dungudzivha pools, and Tshaulu Musununu, in and around the Mphaphuli area, if infrastructure, market development, and political barriers to tourism are attended to. This situation is actual for the Mphaphuli area, as there is currently no other infrastructure inside the nature reserve for use by tourists, and the payment methods for tourist activities are not well defined. It is only recently that the national DEA provided funding for the development of infrastructure at the nature reserve, which, if finalised as anticipated in 2020, could unlock the potential for nature-based tourism income.

The land around the Mphaphuli Cycad Nature Reserve remains relatively intact and potentially suitable for expansion of the reserve, from the current 1 080 ha to approximately 6 500 ha. The LULC mapping exercise carried out in this research revealed that the 6 500 ha referred to here is actually under threat as thickets are changing to woodlands. If this trend continues, the potential for nature-based tourism also dwindles.

5.2.2.5 Grazing and fodder

Grazing and fodder services' potential economic value in the area is $58 344 568.00. The Mphaphuli community, as with many other communities in South Africa, and the African continent at large, relies heavily on livestock rearing (Holden & Otsuka, 2014). Cattle, in particular, are a source or symbol of status in a community (Herrero, Grace, Njuki, Johnson, Enahoro, Silvestri & Rufino, 2013). The grazing and fodder service is a provisioning service that is fundamental to pastoralists who work with wildland grazers. Chickens and pigs are considered managed grazers (occurring in sheds on farms and often sustained on feed) (Mulligan, 2018).

For the grazing and fodder ecosystem service to continue flowing through the Mphaphuli community, the fodder that nature provides for free would have to be appropriately managed, lest the locals need to start purchasing such feed if none were to be found in the wild. As with nature-based tourism, it is critical for the Mphaphuli community to put in place measures to protect this service at all costs, as it is intertwined with cultural practices in the area. If this service ceases to flow through the community, some elements of traditions and customs would be severely affected.

Livestock, and grazing by extension, contributes significantly to rural livelihoods and the economies of developing countries. They are providers of income and employment for producers and others that work in sometimes complex value chains. They are a crucial asset and safety net for the poor, especially for women and pastoralist groups, and they provide an essential source of nourishment for billions of rural and urban households (Herrero *et al*., 2013). This assertion mirrors that of the Mphaphuli community.

5.2.2.6 *Domestic timber and fuelwood*

Domestic timber was valued at $6 084 366.00 and fuelwood at $2 472 220.75. Fuelwood is a provisioning service fundamental to energy security for cooking and heating, particularly for the poor. Fuelwood can overlap spatially with domestic and commercial timber use, given that domestic and commercial timber only consumes the main trunks, whereas fuelwood consumes branches and wastage. Timber is rarely disposed of in other ways than used as fuelwood. Fuelwood is considered only for domestic purposes and is not considered a commercialised ecosystem service. Fuelwood thus benefits local beneficiaries, which, in this case, is the Mphaphuli community.

It is argued that the Co$ting Nature tool may have undervalued this service in the area because the community is largely rural, and some villages such as Sambandou, Mahunguwi, and Ha-Lambani are still almost entirely dependent on fuelwood as a source of energy. Lately, the charcoal business has been thriving, which is reliant on fuelwood from forests. This uncertainty points to a much more lucrative value than calculated by the system. This value requires that alternative methods of valuing fuelwood services be determined to advise policy directions going forward. This assertion notwithstanding, it is vital for communities to have measures for ensuring that the service continues to flow to the community for as long as possible. This study revealed that thickets and woodlands are deteriorating and being replaced by built-up areas. There is a need for some of these areas to remain woodlands or thickets, unless alternative energy sources accessible to the poor were to be made available.

5.2.2.7 *Forest carbon services*

The forest carbon sequestration service's potential economic value was found to be $1 000 003.68. Carbon storage and sequestration are distinct regulation services that benefit all humanity (Mulligan, 2018). They may also provide opportunities for carbon finance that help national or local beneficiaries (Mulligan, 2018; Kay *et al.*, 2019). Carbon stored in vegetation is locked out of the atmospheric system for a period, and contributes to there being less carbon in the atmosphere (Zurita-Arthos, 2015). Carbon storage is not an active service of the ecosystem but rather a consequence of carbon sequestration and of the ecosystem remaining intact so that carbon accumulates (therefore a passive service) (Zurita-Arthos, 2015; Mulligan, 2018).

The potential economic value of the carbon sequestration service will continue to be realised where forests are conserved. The Mphaphuli area has seen a decline in thickets and forests between 1990 and 2018. Projections for 2050 emerging from this research point to potential losses in thickets and forests. There is a severe need for policy directions to shift if the carbon sequestration service were to continue flowing into the community. According to Govender (2018), the carbon in the atmosphere contributes to global climate change, which affects many in deprived areas, such as the Mphaphuli community.

5.2.3 Aggregate valuation outputs

Although many of the services mentioned above are considered to have potential economic values, the Co$ting Nature exercise also recognises the realised economic importance based on several activities that take place in the area under study, such as infrastructure, residential areas, and changes in land cover. These activities confirm that services have been realised.

In this case, the aggregated economic values are presented below (see Figure 5.1 and Table 5.3), followed by an indication of some relative threats to the ecosystem (see Figure 5.2), relative pressure on ecosystem services (see Figure 5.3), a development priority index (see Figure 5.4), a biodiversity priority index (see Figure 5.5), local value contribution to livelihoods (see Figure 5.6 and Table 5.5), and total conservation priority value (see Figure 5.7).

5.2.3.1 Total realised economic value

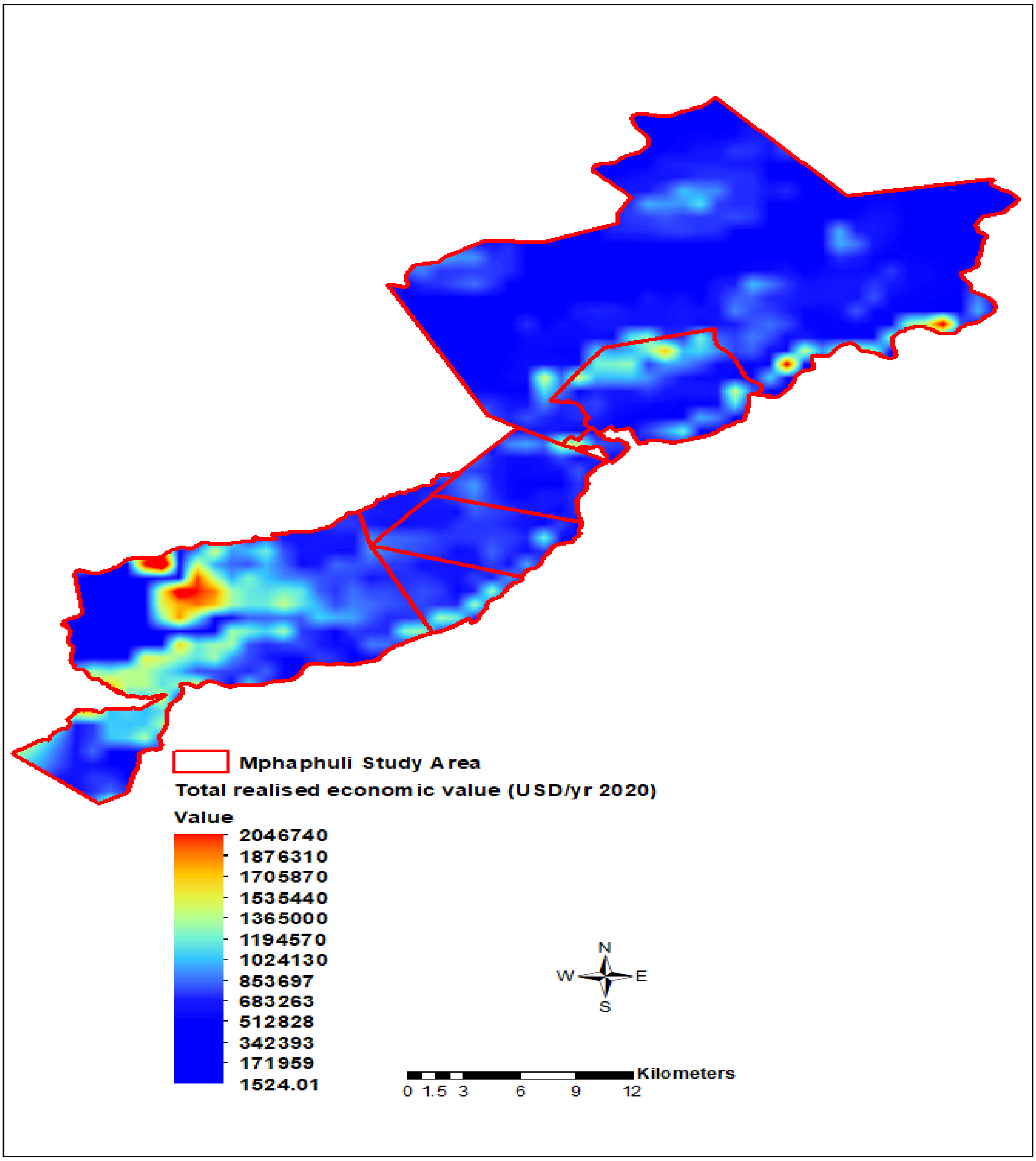

Figure 5.1: Total realised economic value map

This value represents the total value of all valued services to all beneficiaries in the area. The communities of Makwarela (Sibasa), Thohoyandou, Tshaulu, Tshifudi, Gaba, and Ha-Lambani appear to be the ones that benefit the most from the total realised ecosystem services values.

The red colour portions in Figure 5.1 indicate areas with the most realised economic values. This situation is conversely related to the least realised values represented in blue, for villages such as Lukalo, Mahunguwi, Mavunde, Lamvi, Tshidzini, Malavuwe, and Ha-Muraga.

Table 5.3: The economic value summarised per land-cover classes

Total economic value (USD/year) 2020				
Land-cover types	**Minimum**	**Land-cover types**	**Minimum**	**Land-cover types**
Waterbodies	2 392.14	651 166.81	132 550.10	1 192 950.88
Wetlands	43 105.57	43 105.57	43 105.57	43 105.57
Indigenous forest	8 737.92	8 737.92	8 737.92	8 737.92
Thickets and dense bush	10 832.87	30 422.47	24 863.77	124 318.86
Woodlands	2 250.15	2 046 738.63	134 780.06	79 789 794.60
Grasslands	13 601.17	756 037.00	365 242.50	1 460 970.00
Commercial agriculture	13 249.27	174 378.78	49 459.61	247 298.06
Subsistence agriculture	3 255.82	794 031.56	163 674.80	8 511 089.49
Forest plantations	21 558.40	582 474.25	302 016.32	604 032.65
Bare areas	22 746.18	110 374.60	65 803.44	197 410.33
Built-up areas	2 417.03	1 650 256.75	231 616.12	40 764 437.45

Beneficiaries of ecosystem services in the Mphaphuli area derive these benefits mainly from woodlands, built-up areas, subsistence agriculture, and waterbodies. The pressure that thickets and dense bush endured between 1990 and 2018 came full circle as per the realised economic values increasing. Woodlands gained 71% in terms of land-cover change by reducing thickets and dense bush. It is this woodland that is not increasing as providing the most significant value to the beneficiaries in 2020. This trend is not sustainable, as the said woodlands fall in areas that show the most intense pressure and are considered high in the conservation priority index. If these woodlands were to disappear entirely due to the current rate of deforestation, the community will eventually suffer the consequences.

Subsistence agriculture is taking place in areas such as Dimani, Tshaulu, and Ha-Lambani. Between 1990 and 2018, the agriculture land-cover class reduced by almost 5%. Even with the reduction of agricultural practices, this land cover still returned one of the highest economic values to the local beneficiaries in 2020. Built-up areas in Thohoyandou, Makwarela, Tshaulu, Mahagala, and Ha-Lambani also exhibit traits of returning top economic benefits, which are realised. The land has almost been fully used, which explains the recognised values to the beneficiaries.

Grasslands returned high economic values to the beneficiaries as well, which could be as a result of the change from dense thickets and woodlands to bare and open spaces, which render these areas easily accessible for grazing purposes. The trends between 1990 and 2018 were that grasslands reduced from 800 ha to 255 ha; however, this land cover managed to garner good economic values.

There are significant and insignificant variances between total economic value and LULC types, as reflected in Figure 5.2, which is a box plot that summarises the variances. Figure 5.2 is to be read together with Table 5.3.

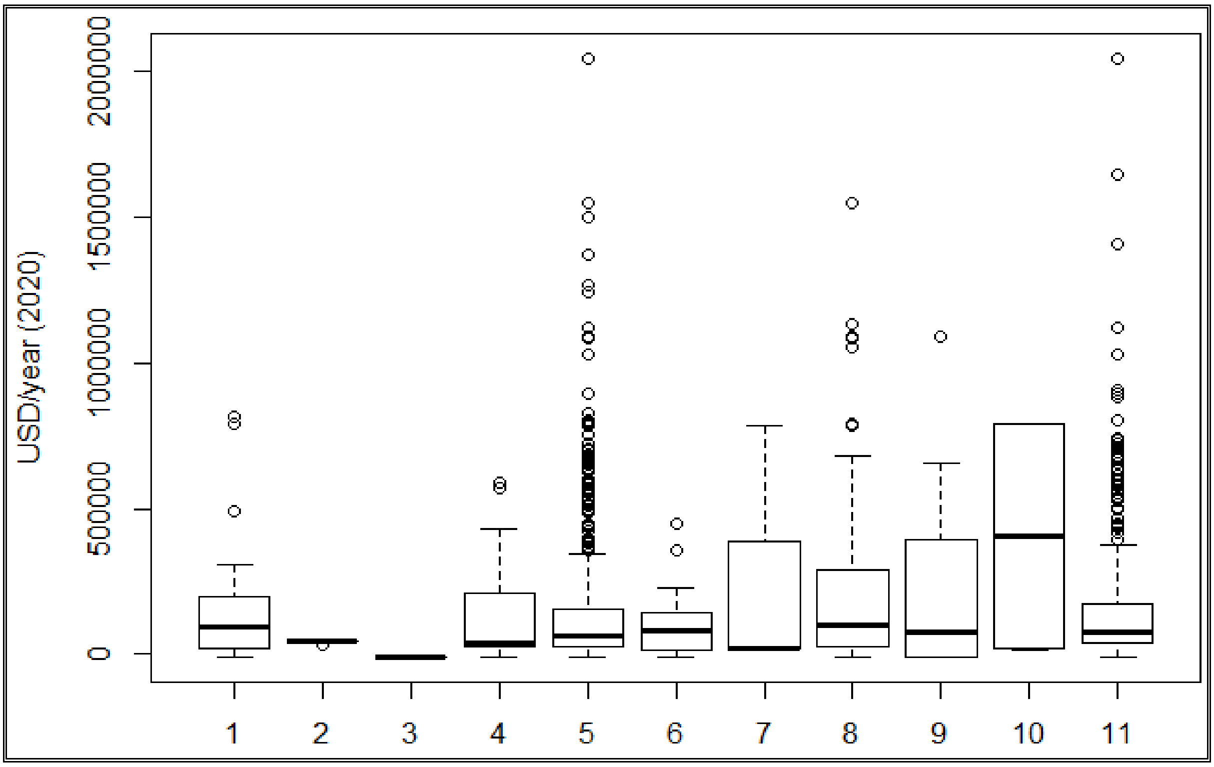

Figure 5.2: Box plot for the variance between total economic value and LULC types

Figure 5.2 shows the variations of the economic value between the 11 land-cover classes across the whole of Mphaphuli. The objective here was to deduce information about which land-cover classes contributed to which values. There is significant variability in economic values among the different land-cover classes. The woodlands class is associated with significantly higher economic value ($p<0.05$) than indigenous forests. Similarly, built-up areas show a significant economic value compared to wetlands. The grassland class is associated with significantly higher economic value than the thicket/dense bush class.

There is insignificant variability between bare areas and thickets. Since economic values vary between the different land-cover classes, the intensity of management efforts would differ. This assertion is also so because, as per Table 5.5, there is a very close relationship between economic values and contribution to livelihoods per different land-cover class.

5.2.3.2 Relative threat

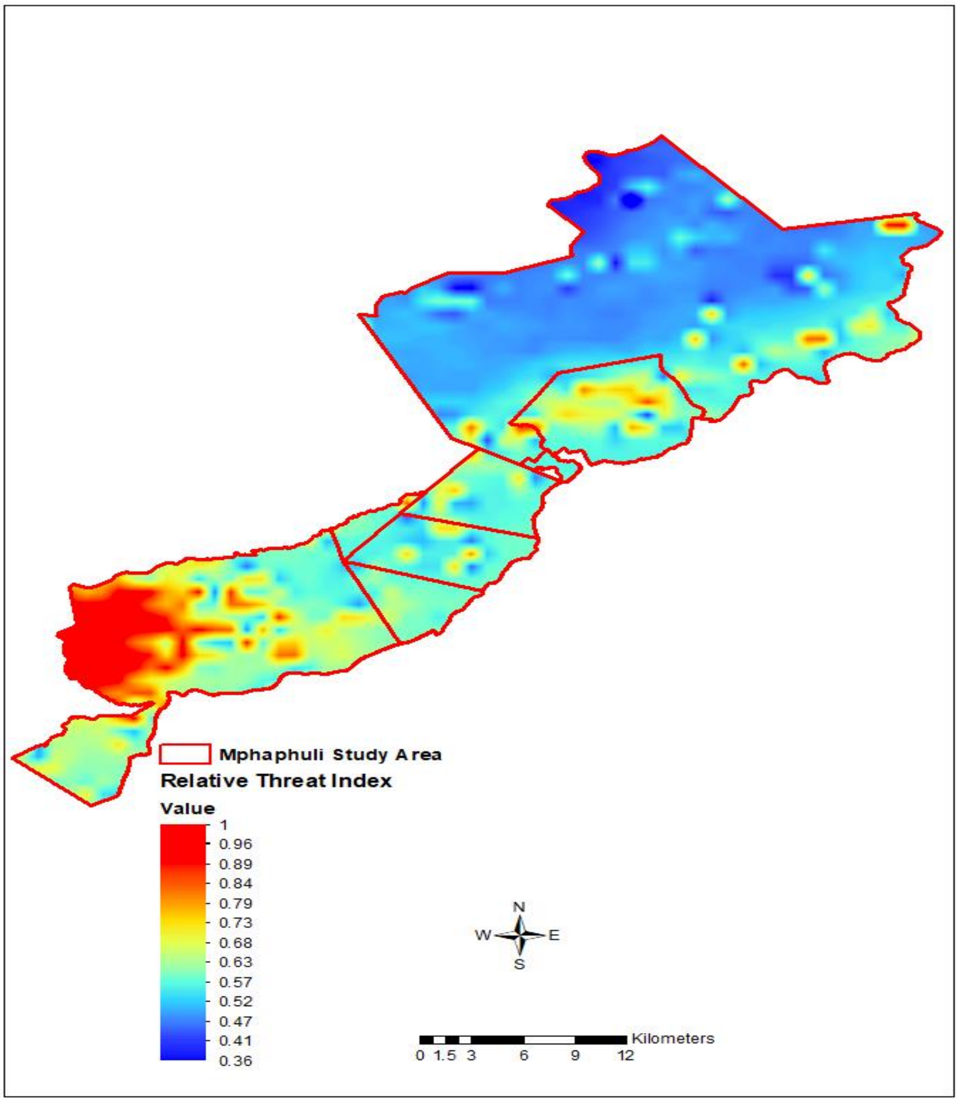

Figure 5.3: Relative threat index map

Future ecosystem services threats are determined according to ease of access, proximity to recent deforestation as observed through the Moderate Resolution Imaging Spectroradiometer (MODIS), predictable change in population and GDP, projected climate change, and the current distribution of night lights.

As with the total realised economic values, villages such as Thohoyandou, Makwarela (Sibasa), and Tshaulu exhibit a high relative threat index. These villages can be considered much more developed than the rest of the Mphaphuli villages, with good access roads and related infrastructure. This explains why the resources are much more accessible than in villages such as Mahunguwi, where roads are still not easy to use (gravel/dirt roads).

5.2.3.3 Relative pressure

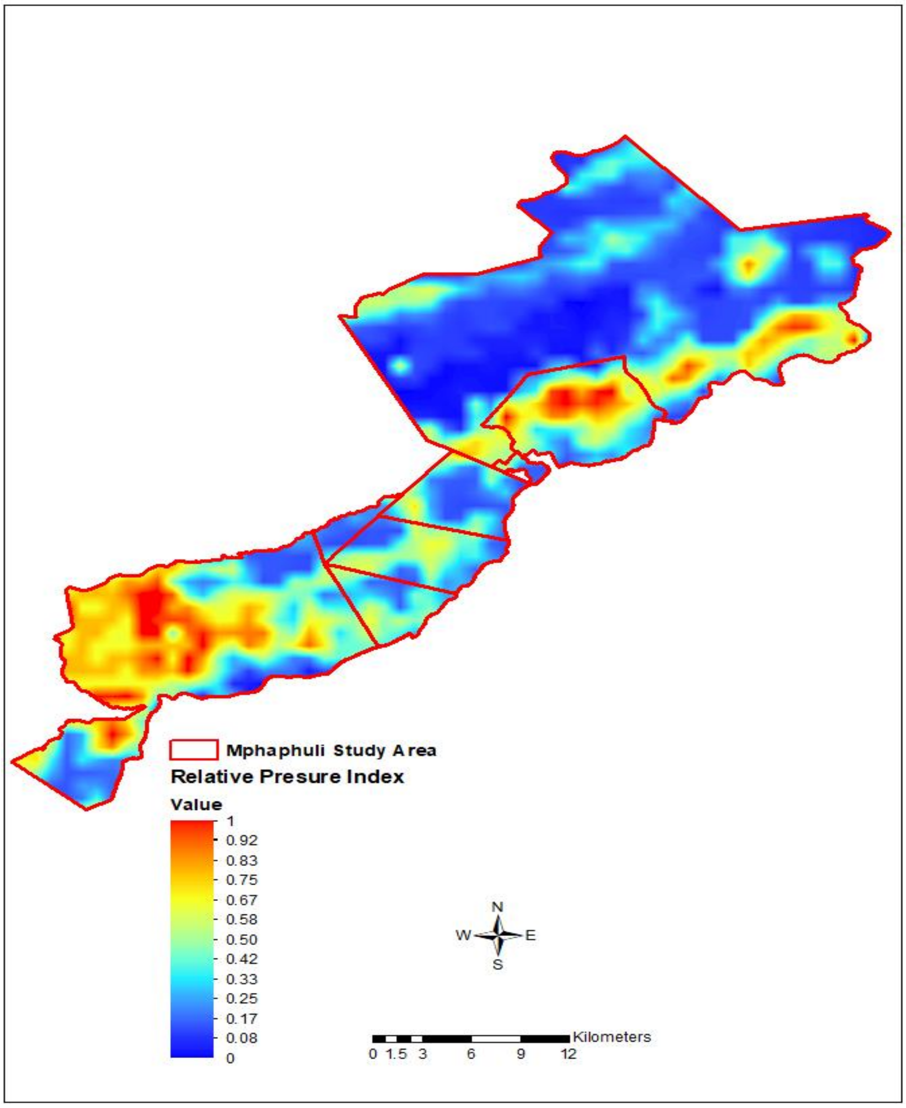

Figure 5.4: Relative pressure index map

Relative threat index outcomes are the same as those of the relative pressure index. The current pressure on ecosystem services is according to wildlife frequency, population, agricultural intensity, grazing intensity, dam density, and infrastructure density.

Thohoyandou, Makwarela, Tshaulu, and Dzingahe appear to be under pressure; they therefore appear in red, compared to blue for Mahunguwi and surrounding villages such as Mukhase.

5.2.3.4 Development priority index

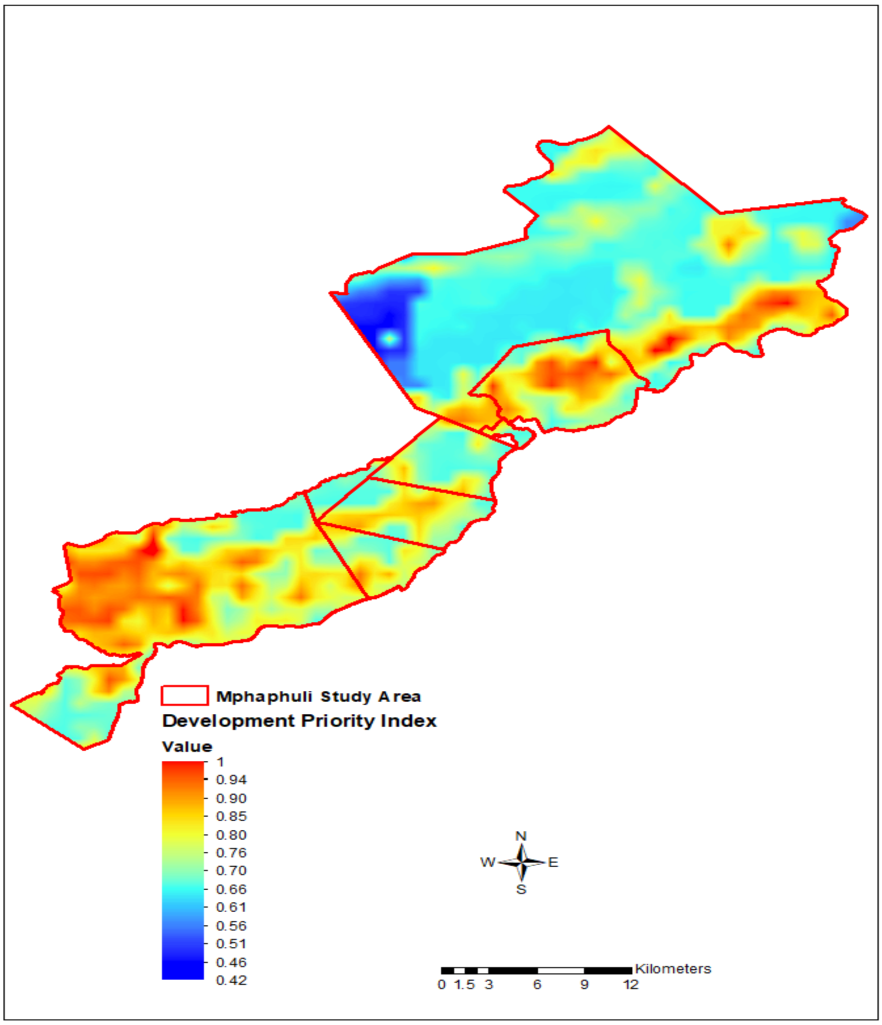

Figure 5.5: Development priority index map

The areas that exbibit relative pressure and threat, such as Thohoyandou, are good candidates for intensive development initiatives (see Figure 5.5). Policy positions should be taken and aligned with these trends to group pressure activities in areas that are already under pressure, as these are areas with very low conservation priority and realised service value.

It is essential to assess the extent to which development policy, planning, and practice are adequately responding to the inherent demographic and economic forces that underpin urbanisation that is taking place at any given time (Ruhiiga, 2014).

This view is supported by the assertions and findings of Davids, Rouget, Boon and Roberts (2016), based on their assessment of ecosystem services hotspots in environmental management in Durban, South Africa.

Development activities, especially in rural areas where the locals are almost entirely dependent on ecosystem services for their survival, should be prioritised, taking a cue from the spatial extent of the ecosystem services. Gone should be the days where decisions are made without fully understanding and prioritising the implications of such decisions for the environment at large.

5.2.3.5 Biodiversity priority index

Biodiversity priority indexing was based on relative endemism for reptiles, red-listed mammals and amphibians, and bird richness (Mulligan, 2018). There is a converse relationship between this index with development, relative pressure, and threat indices.

Biodiversity hotspots are in areas that are least developed, which, by implication, require protection. These are areas such as Mahunguwi, Sambandou, Tshitavha, and Gaba. These villages surround the Mphaphuli Cycad Nature Reserve. Most of the thickets and dense bush deterioration, or changing to woodlands, are concentrated in and around these villages. The red marks in Figure 5.6 point to priority areas for conservation.

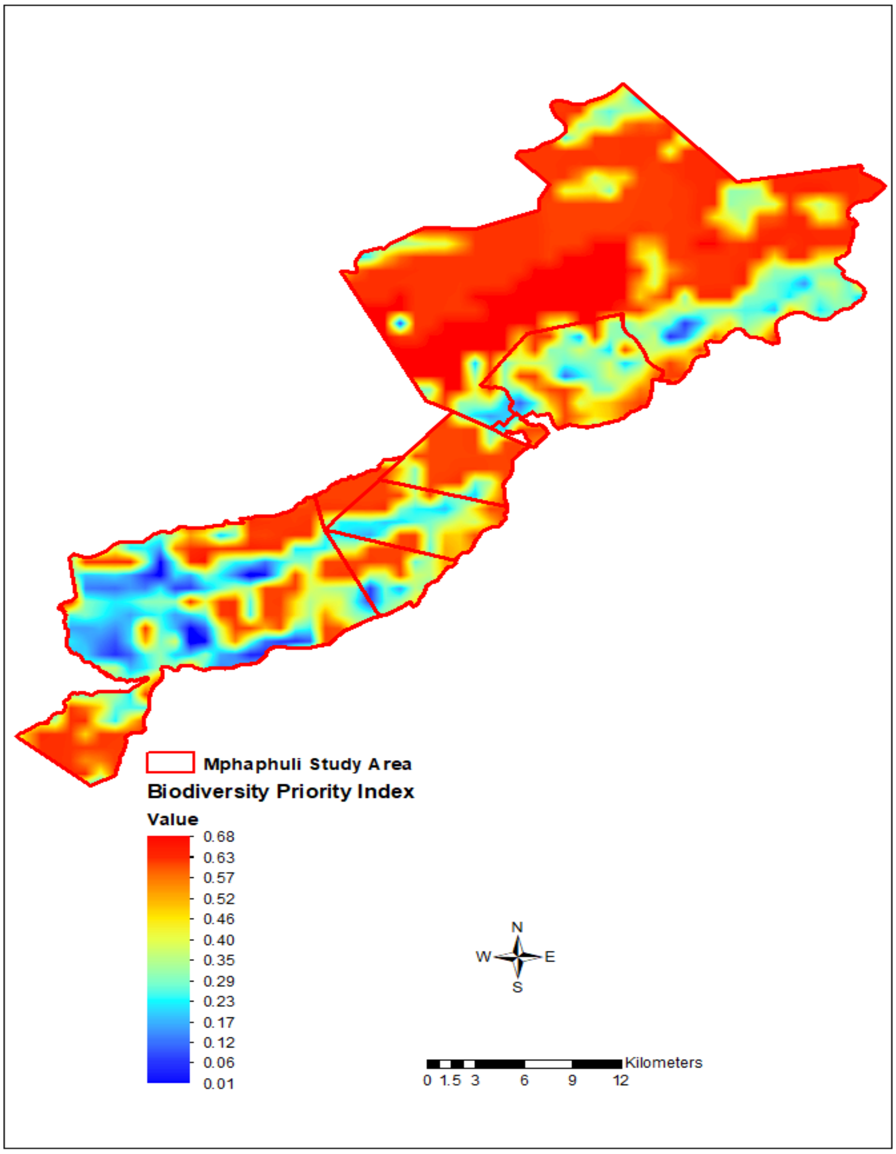

Figure 5.6: Biodiversity priority index map

The outcome of this assessment presents an opportunity for the locals, through their leadership structures, to realise that even though the poor are benefitting from mostly the woodlands in the area, the land parcels marked in red are perfect targets for biodiversity conservation. The said land parcels house many cycad species (*Encephalartos transvenosus*), which are threatened globally. Many of these specimens are located outside the Cycad Nature Reserve (Ravele & Makhado, 2010). The survival of *E. transvenosus* is uncertain due to various threats such as illegal collection, habitat destruction, fire, and grazing (Nefhere, 2019). A concerted approach is required to address this challenge.

5.2.3.6 Local value contribution to livelihoods

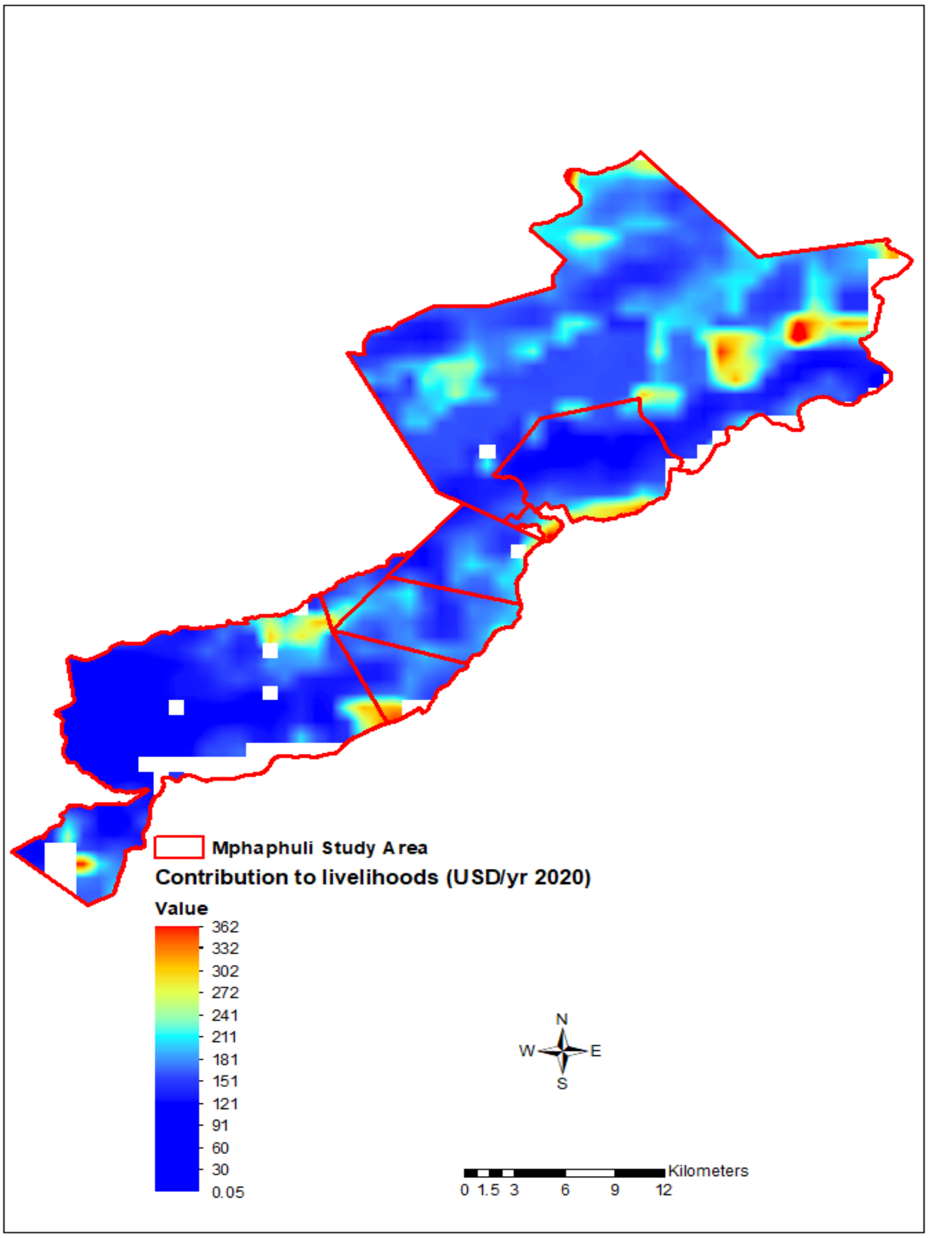

Figure 5.7: Local value contribution to livelihoods map

Villages such as Mutoti, Budeli, Dumasi, and Mphego seem to be among the ones from which the poor are benefitting from ecosystem services that are mainly aligned to the emergence of the Nandoni Dam. The Malamangwa, Mahunguwi, Mukomaasinanndu, and Tshamutilikwa villages appear to be the main beneficiaries of the services provided by the woodlands (see Table 5.5).

In the same vein, villages such as Dimani, Tshifudi, and Tshaulu appear to be the greatest beneficiaries from a subsistence agriculture point of view. The value is realised as a percentage contribution of local service value to the livelihood of the local poor (GDP of the poor) (see Tables 5.4 and 5.5).

Table 5.4: Total economic contribution to livelihoods value in the Cycad Nature Reserve

	Economic value (USD/yr 2020)	Contribution to livelihood (USD/yr 2020)
Min.	12 830.44	11.78
Max.	430 966.38	64.91
Mean	52 356.10	23.72
Sum	**732 985.33**	**332.08**

Table 5.5: Contributions to livelihoods summarised per land-cover classes

Contribution to Livelihoods (USD/yr) 2020				
Land-cover types	**Min.**	**Max.**	**Mean**	**Sum**
Waterbodies	26.94	69.54	48.24	96.48
Wetlands	57.42	57.42	57.42	57.42
Indigenous forest	177.37	177.37	177.37	177.37
Thickets and dense bush	12.41	39.74	25.77	128.84
Woodlands	0.11	298.24	43.31	24 597.53
Grasslands	4.65	39.71	18.10	54.31
Commercial agriculture	3.91	13.41	9.23	27.70
Subsistence agriculture	0.22	175.38	38.86	1,942.90
Forest plantations	27.12	77.01	52.06	104.13
Bare areas	14.52	32.29	23.41	46.82
Built-up areas	0.05	182.39	14.86	2 525.51

Table 5.5 highlights that the local communities, particularly those of Sambandou, Mahunguwi, Mavunde, and the surrounding villages, are the primary beneficiaries of ecosystem services aligned with woodlands, with values estimated at $24 597.53. Other services contribute immensely to the livelihoods of the poor in built-up areas, such as Thohoyandou and Makwarela, with values determined at $2 525.51. Services aligned with subsistence agriculture are realised mainly in Dimani, Tshaulu, Tshifudi, and Matsika villages, with values determined at $1 942.90.

According to Mucova *et al*. (2018), biodiversity conservation, management of protected areas, and sustainable development with strategies targeting rural populations are current challenges in Africa, in the context of exponential human population growth, over-exploitation of natural resources, forest destruction, and climate change.

Mucova *et al*.’s (2018) study of the Quirimbas National Park revealed that the protected area and its immediate surrounding areas were suffering from severe and constant threats that originated from different sources and changes in LULC, which unfortunately end up affecting the poor if not appropriately managed. The same holds true for the poor rural communities around the Mphaphuli Cycad Nature Reserve, with its surrounding areas suffering tremendous pressure from deforestation.

The fact that the rural poor are benefitting immensely from woodlands does not count for anything if such use of the woodlands is not controlled, or is not taking place under sustainability principles. The woodland resources would be depleted, and the same communities would be up in arms, requiring intervention from the traditional leadership and the central government in meeting them halfway financially.

Reyers, Nel, O’Farrell, Sitas and Nel (2015) argue that it is possible to achieve what Mucova *et al.* (2018) identified as challenges, as indicated above. They observe that while attaining the policy and practice shifts needed to secure ecosystem services is hampered by the inherent complexities of ecosystem services and their management, co-production of knowledge and agreements could be valuable in steering policy directions. Local communities have lived in the environment for many years, and they understand the intricacies that define the ecosystem services in their area. What ought to happen is that their knowledge should be recognised when decisions are made, instead of using top-down approaches that force decisions on local people.

This view is supported by what Murata *et al*. (2019) found while analysing communities and ecosystem services around the Eastern Cape province of South Africa. The assertions were also observed and supported by Langhans, Jähnig and Schallenberg (2019), who suggest multi-criteria decision analysis to formally integrate community values into ecosystem-based management.

5.2.3.7 Total conservation priority value

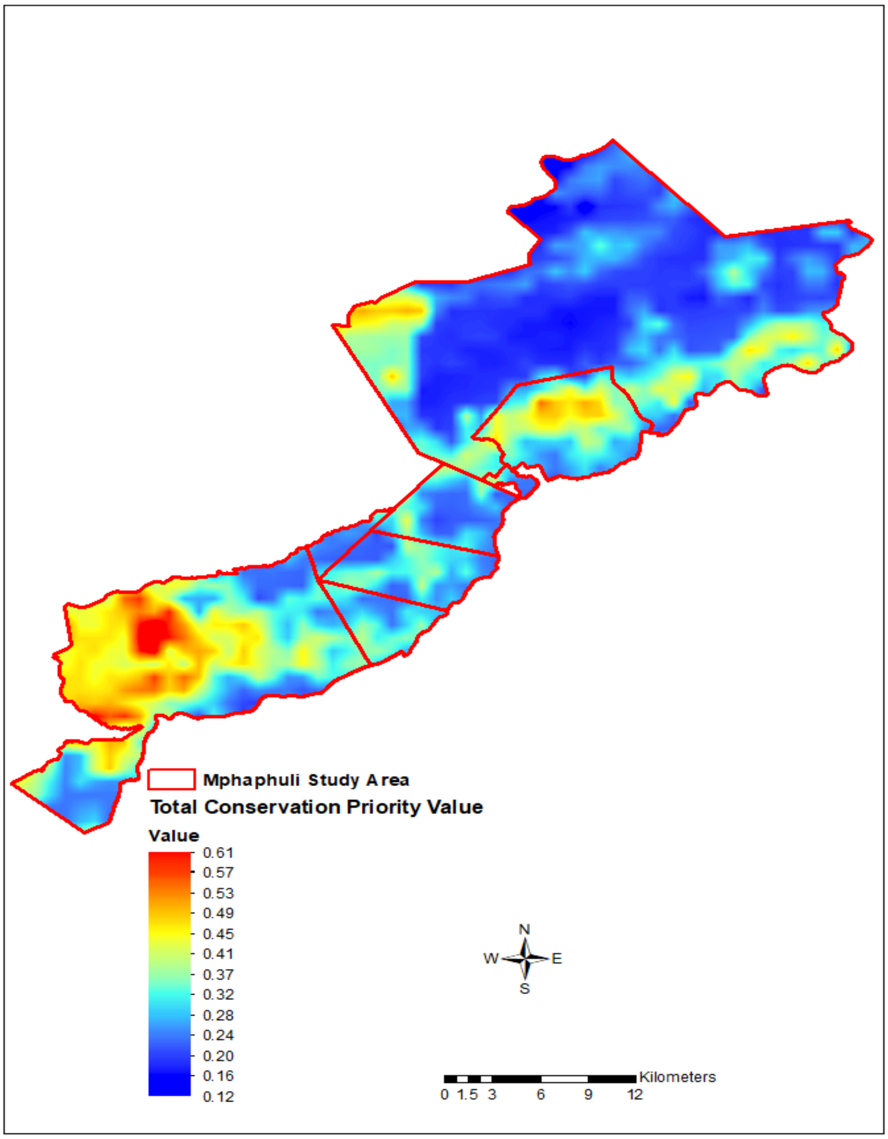

Figure 5.8: Total conservation priority value map

Conservation priority is considered by the overlap of endemic bird areas, Global200 Ecoregions according to the World Wildlife Fund, Last of the Wild according to the Centre for International Earth Science Information Network, and important bird areas (birdlife) and critical biodiversity areas according to the International Union for Conservation of Nature (Clemens *et al*., 2018; Mulligan, 2018).

The results, as reflected in Figure 5.8, show that at a global level, areas marked in red, such as Thohoyandou, Tshaulu, and Ha-Lambani, are considered high biodiversity hotspots; however, these areas have been subjected to intense development activities, to the extent that the ecosystems that support such diversity have disappeared.

This disappearance points to the need for areas marked in blue, such as Mahunguwi, Sambandou, and the surroundings, to have the most significant potential for conservation. Figure 5.6 highlighted the need for the marked blue areas to be considered a high priority for the preservation of biodiversity.

According to Duarte, Ribeiro and Paglia (2016), policymakers and conservationists find it difficult to motivate the prioritisation of conservation areas where they cannot show how much human beings will benefit. In this case, the financial values associated with the ecosystem services and potential that biodiversity has should be motivation enough in deciding to protect the area.

5.3 CHAPTER SUMMARY

This chapter identified and valued ecosystem services across the whole of the Mphaphuli area, using the Co$ting Nature tool. There is both realised and potential economic value in the area. Specific areas where realised economic values benefit poor local communities were identified and areas with the highest conservation priority were also identified. The total potential economic value for aggregated ecosystem services in the Mphaphuli area amounts to $528 280 256.00. The ecosystem services values from the Co$ting Nature exercises were briefly analysed against the land-cover classes identified in Chapter Four, and some of the outcomes were found to correlate with one another.

It is critical that ecosystem services are maintained or improved where possible through various intervention or management strategies. The concept of land management and regulation practices, which, by implication, affects ecosystem services, is the subject of the next chapter, which evaluates the land-management practices of the Mphaphuli community.

CHAPTER SIX:
LAND-USE MANAGEMENT AND REGULATION PRACTICES

6.1 INTRODUCTION

The previous chapter presented ecosystem services identification and economic valuation outcomes from a scientific point of view. This chapter deals with land-use management and regulation practices, mainly through analysing the perceptions of the traditional leaders, land users, and government officers. The chapter also discusses some correlations among the demographic factors and other land-use contributing factors across the Mphaphuli area.

6.2 KEY RESULTS AND DISCUSSION

Demographic factors are among various factors that have multiple direct and indirect impacts on LULC changes. While investigating these factors, correlations between certain demographic factors and other variables were identified, which have a bearing on decisions that affect land allocation, policy understanding, land-use regulations, and factors that lead to LULC change. These factors affect not only LULC change but also impact land ownership patterns and the rates and use of ecosystem services. Understanding, assessing, and analysing the demographic profile of the participants were crucial in this study, as it outlined the elements that influence views, perceptions, culture, level of experience, and attitudes when dealing with issues of LULC, legal frameworks, and protocols.

6.2.1 Influence of demographic factors on management practices

The data used for the demographic factors discussed in the following sub-sections emanated from the questionnaires, interviews, and face-to-face discussions conducted for this research.

6.2.1.1 Age of the respondents

The age group >45 years dominated the number of participants in this research, as 35 of them fell in this category (83.33%), with the remaining seven (16.67%) being in the age group 35 to 45 (see Figure 6.1).

Decisions on land allocation are taken by mature people who understand the traditions and customs of the area. Age plays a critical part in, and influences the level of, decision making, especially in rural settings such as the Mphaphuli area.

Cultural belief systems, norms, and culture embedded in communities become absorbed and practised through generations. Indigenous knowledge systems of traditional people emanate from intimate connection and relations with natural resources. The unique part of the indigenous traditions is that they created cultures, belief systems, and dynamic behaviours that are used appropriately in the management of land uses and natural resources (Schoneveld, 2014; Shisanya, 2017).

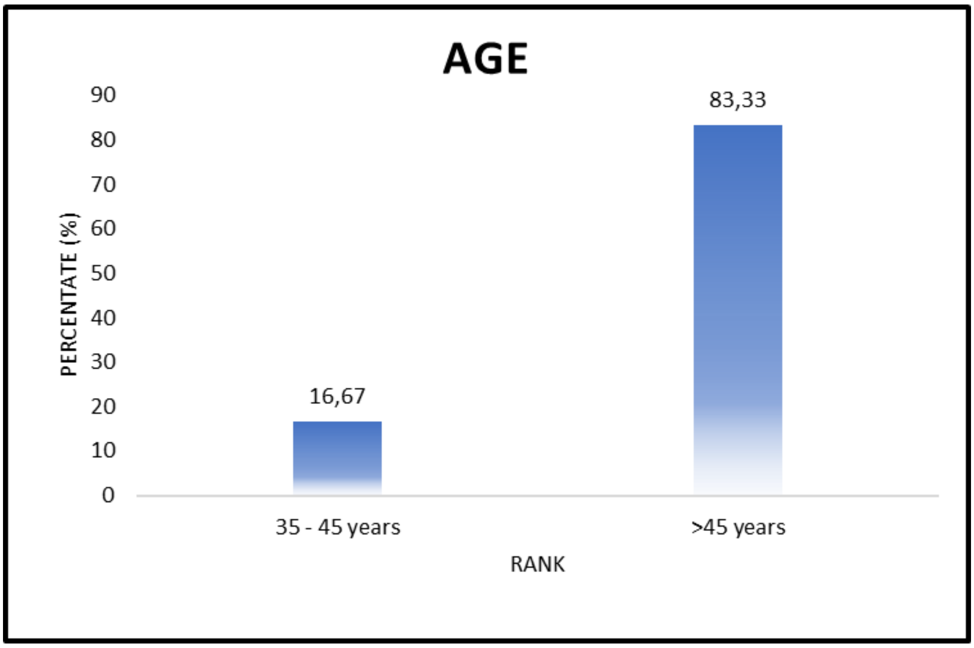

Figure 6.1: Age distribution of the respondents

6.2.1.2 Gender

The majority of the respondents (32 or 76.2%) were found to be men, while women constituted only 23.8% of the sample (ten) (see Figure 6.2). Gender is one critical factor that shapes the involvement, determination, and interest in land use. It also determines the distribution of natural resources and influences decision making and access to natural resources, as well as control and management in society (Villamor, Van Noordwijk, Djanibekov, Chiong-Javier & Catacutan, 2014; Brown & Fortnam, 2018).

The roles played by the different gender groups are skewed, favouring the male gender, and putting the role of women as subservient to that of men. Men are, for instance, involved in agriculture for commercial purposes, while women mainly practise it for subsistence purposes. In contrast, women, in particular, who lead single-parented households, are also at the coalface of supporting their families through agricultural and natural resources means.

The role of women as managers is in most cases unexplored, while there are arguments that their involvement could contribute positively to sustainable development (Villamor *et al.*, 2014; Hules & Singh, 2017; Djurfeldt, Hillbom, Mulwafu, Mvula & Djurfeldt, 2018). Djurfeldt *et al.* (2018) raised eyebrows when they intimated that families conduct subsistence farming activities together, but that the decisions are made by men. This situation looks almost the same for Mphaphuli.

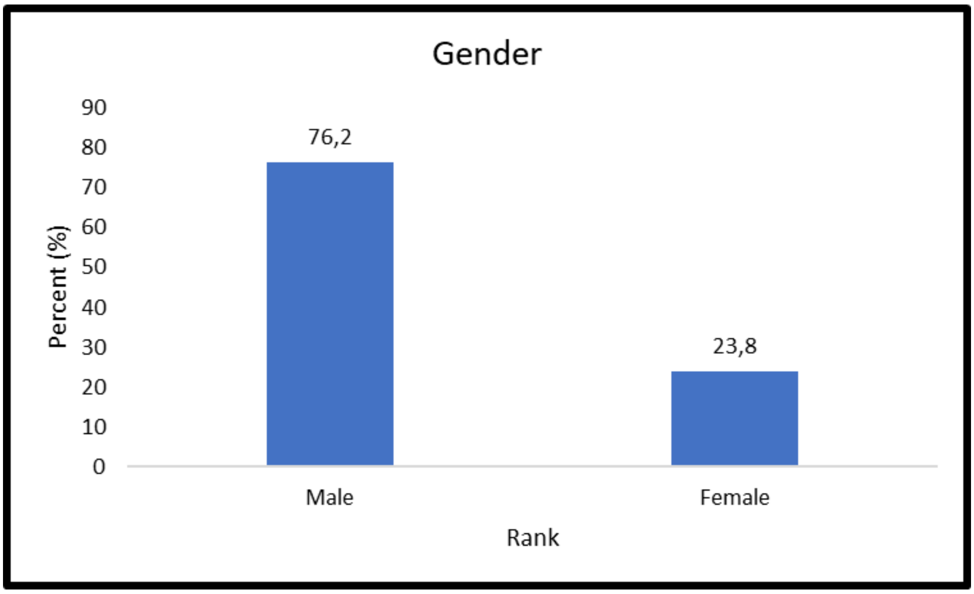

Figure 6.2: Gender distribution of the respondents

6.2.1.3 Education level

The majority of the respondents were educated, with 16 or 38.1% (16) possessing a university qualification and 7% (three) a college qualification. In comparison, the remaining 23.81% (ten) only had qualifications up to Grade 12. There was also a large group (30.9% or 13) that did not have any qualifications beyond Grade 10 (see Figure 6.3).

Improved educational levels of communities enhance livelihoods, and human wellbeing attitudes and preferences towards life are viewed positively. As highlighted in the SDGs and MEA framework, poverty and hunger eradication, as well as improved social wellbeing, can be achieved through education in rural areas (Ford, 2015; Hajer *et al.*, 2015). The majority of the respondents in the Mphaphuli area are educated, and one would expect that changes to LULC and associated practices could have been different under the circumstances.

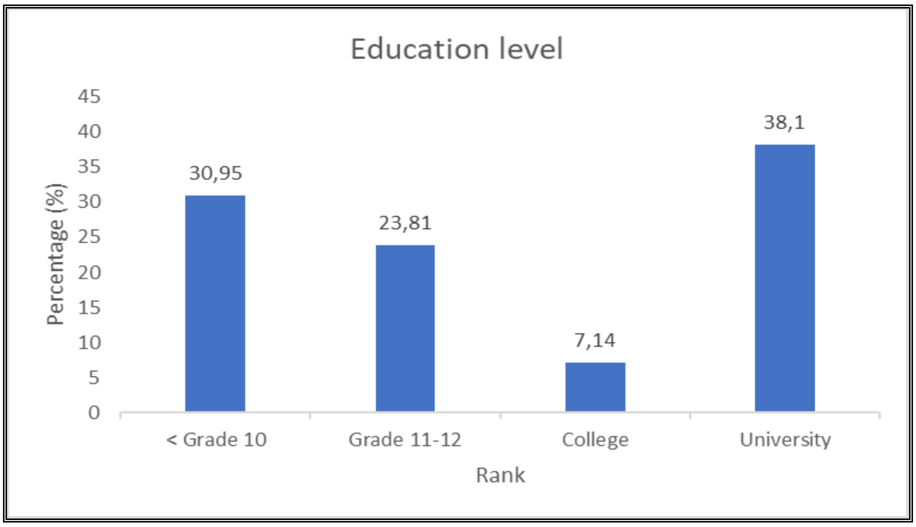

Figure 6.3: Education level of the respondents

6.2.1.4 Household size

The results of the analysed household size indicated different sizes and percentages, as shown in Figure 6.4, where 52% (22) of households had more than five individuals each, followed by 28.57% (12) with between three and five individuals. Approximately 4.76% (two) of the households had only a single member, and 14.29% (six) consisted of a household size of one to two members.

According to Pinstrup-Andersen (2009), household size is a significant driver of many societal issues. The household size issue is also closely associated with the distribution and usage of environmental resources (Meinzen-Dick, Quisumbing, Doss & Theis, 2019).

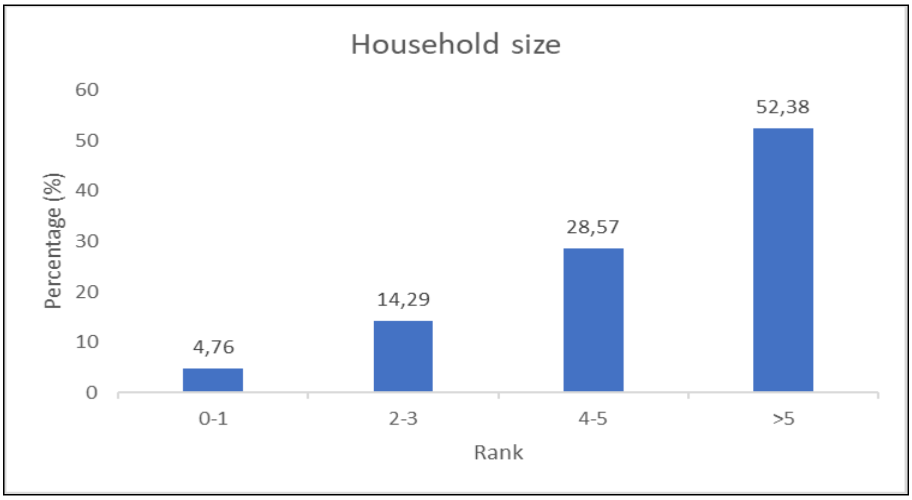

Figure 6.4: Household sizes of the respondents

6.2.1.5 Number of dependants

Seventeen (50%) households were found to have more than five dependants each, followed by 12 (35.3%) with between three and five dependants. Three households (8.82%) comprised two to three dependants, while only two households (5.88%) had between one and two dependants (see Figure 6.5).

The number of household dependants can be considered a critical factor that contributes to how society interacts with its natural resources (Doss & Meinzen-Dick, 2015). The number of dependants also impacts the level of education that individual members of families can attain and, by implication, how they interact with others in decision making around environmental issues that affect society. It is prevalent in communities where households have so many dependants that the older dependants are forced to take care of the younger ones. As a result, most of the older dependants are forced to look for job prospects at a younger age, which causes them to drop any chances of attaining education at an early stage (Donohue & Bornman, 2014).

Rural communities are most likely to have a high number of dependants due to the unavailability of population control measures and lack of awareness when compared to urban areas (Pateman, 2011). Together with household size, the number of dependants often leads to environmental issues such as the over-exploitation of natural resources, which is very similar to what is currently happening in the Mphaphuli community.

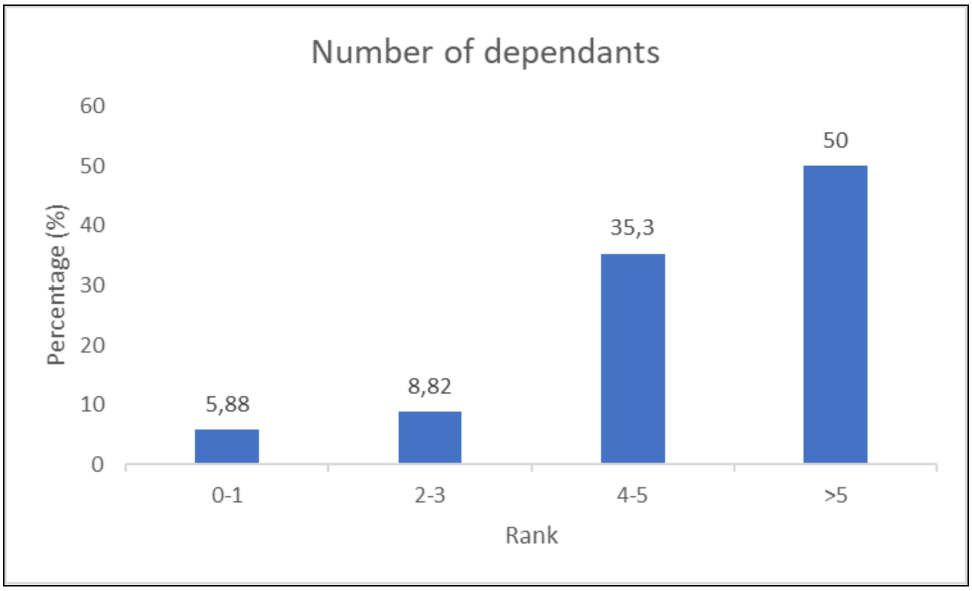

Figure 6.5: The respondents' number of dependants

6.2.1.6 Employment status

The majority of the respondents (54.76% or 23) were employed, followed by 17 (40.48%) unemployed respondents, with two (4.76%) in the retired group, as reflected in Figure 6.6. This outcome seems to be an anomaly; considering the other factors such as number of dependants and household size.

The expectation was that because of the high rate of employment, pressure on the environment would not be as prevalent as it was found to be. That notwithstanding, both Mideksa (2013) and Lisk (2013; 2017) argue that when those in rural areas have employment opportunities, it creates an opportunity for them to access and work on more land, and they employ others to further their land interests. Employment or job availability has a direct bearing on the rate at which extraction of resources takes place.

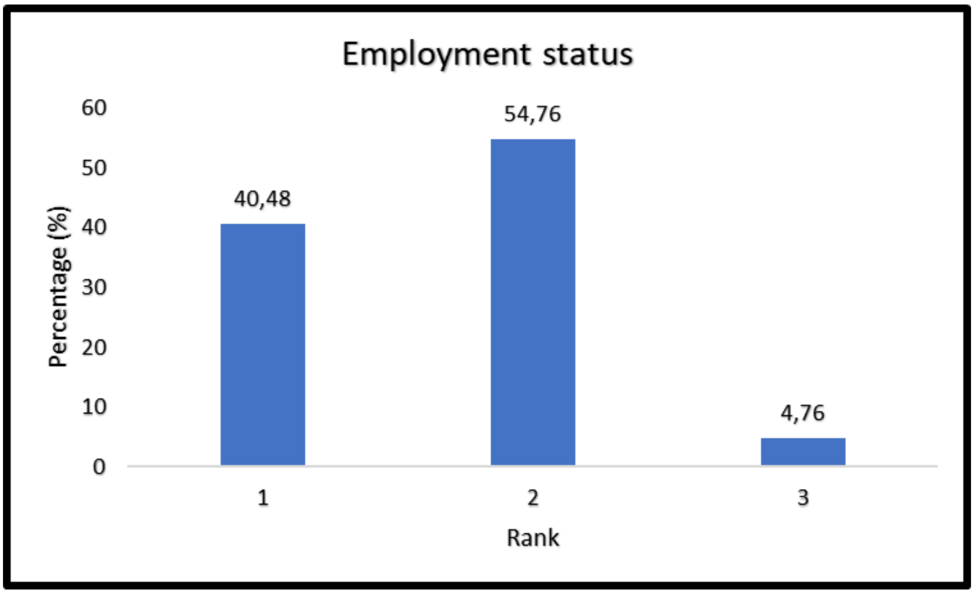

Figure 6.6: The employment status of the respondents

6.3 EFFECTIVENESS OF LAND-USE MANAGEMENT AND REGULATION PRACTICES

If land-use management strategies are to be successful, both the land users and managers should act in unison, from both a governance and a transparency point of view. When proper systems are in place, it is assumed that natural resources would also be used sustainably. In communities where such governance principles are missing, it follows that there could be challenges of natural resource over-exploitation, degradation of ecosystems, and disappearance of ecosystem services.

The findings relating to the effectiveness of land-use management and regulation practices are grouped into five themes:

1) Land size and user rights allocated;
2) The discrepancy between allowed use and actual use on the ground;
3) Ownership/security and type of tenure;
4) Financial resources and land-use rights allocation; and
5) Land availability.

The themes highlighted in Sections 6.3.1 to 6.3.3 were found to be critical for a synopsis of the current land-use regulations and management in the Mphaphuli area. Included in Sections 6.3.4 to 6.3.5 are those that determine the land-user rights allocation by the traditional leaders. Land management involves various elements that are dependent on one another to be effective. Isolating these components, and finding an equilibrium for all of them to function in unison and optimally, is a daunting task (Burns & Dalrymple, 2008).

6.3.1 Land size and land-user rights allocated

Eleven out of 12 (90%) of the traditional leaders interviewed in this research indicated that they did not know the extent of the land of the village they preside over. The 12th leader could only guess the size of the land. This lack of knowledge is a considerable indictment of the traditional leaders in the area. Abuaddous, Al Sokkar and Abualodous (2018) believe that knowledge of any asset being managed is an asset in itself, as anyone who is in charge of an asset is expected to have insight about that asset. In this case, the leaders regularly allocate land, but they are not aware of the size of the land. This leaves them at a disadvantage because the size of the land should determine the value over the rights allocated to someone or should be used in deciding whether to continue allocating land or not. At the same time, information about the exact number and details of the land-use rights already allocated was not found to be forthcoming or, simply put, not readily available.

6.3.2 Discrepancy between allowed use and actual practice (deviation)

The effectiveness of land-use regulation practices in rural areas is hindered by a variety of factors. Land-allocation rights and permission are granted through oral agreements without adequate documentation of formal agreements between the leadership and land occupants.

The management of the allocated land is conducted verbally, and the evaluation of the land is through memory and reference, using natural features such as rivers, trees, fences, and other features. As a result, many irregularities creep in, as there is no evidence of the boundaries of the land. These methods of allocating land have previously been effective because there was a great understanding of the norms and practices that ensured good governance (Pandit *et al.*, 2007; Dansoh *et al*., 2020).

This system is currently challenged by various factors such as the lack of equal allocation of land, variations in household size, illegal occupation of land, and unmonitored land allocation and land use by various community members.

Land users with rights allocated and assigned certain uses were assessed in the Mphaphuli area. Table 6.1 presents the discrepancies in the use of land for what it was allocated against its use for what it was not allocated. Deviations of the activities initially allocated for land were also assessed with the participants in this study, and ranked in the following manner: 1 = Land is currently used for the initial land-use activity, and 2 = Land is not currently used for the initial activity, as presented in Table 6.1.

Table 6.1: Discrepancies between allocated use and actual practice

Variable	Rank	Frequency	Percentage
Use of land for what it was allocated for	1 = Yes	2	8.00
Alternative use, which it was not allocated for	2 = No	22	92.00

Sample size n = 24

Only 8% of the land users are still using the land for what it was initially allocated for, while 92% are using the land for something else not initially assigned for. Land users who have deviated from using the land for what it was allocated for indicated that there was no absolute process of permission that they followed, prior to the deviation and use of land for other activities.

The switch between the initial allocated right and new activities has detrimental impacts on the governance of land use. Land management and regulation processes are among the complex social systems that require an understanding of the norms, practices, culture, behaviour, attitude, and preferences of stakeholders. It can be deduced that these deviations are a result of complex circumstances associated with a lack of monitoring, evaluation, and appropriate regulations in the area.

The land users' choice to switch between the use of land for various activities other than the initially allocated use could be one of the reasons why most of the land users are using some sensitive environments, including wetlands, for incompatible uses such as the building of houses. This points to a general lack of adequate and operational policies that govern the use and allocation of land in the Mphaphuli area.

6.3.3 Ownership and security of tenure

Approximately 15 (62%) of the land users had permission to occupy the land provided by the traditional leadership. In comparison, seven (38%) did not have any formal means or documents to indicate that they had the right to occupy the land (see Figure 6.7). Ownership of land or security of tenure is a critical element for any human being (Payne, 2002; Holden & Otsuka, 2014).

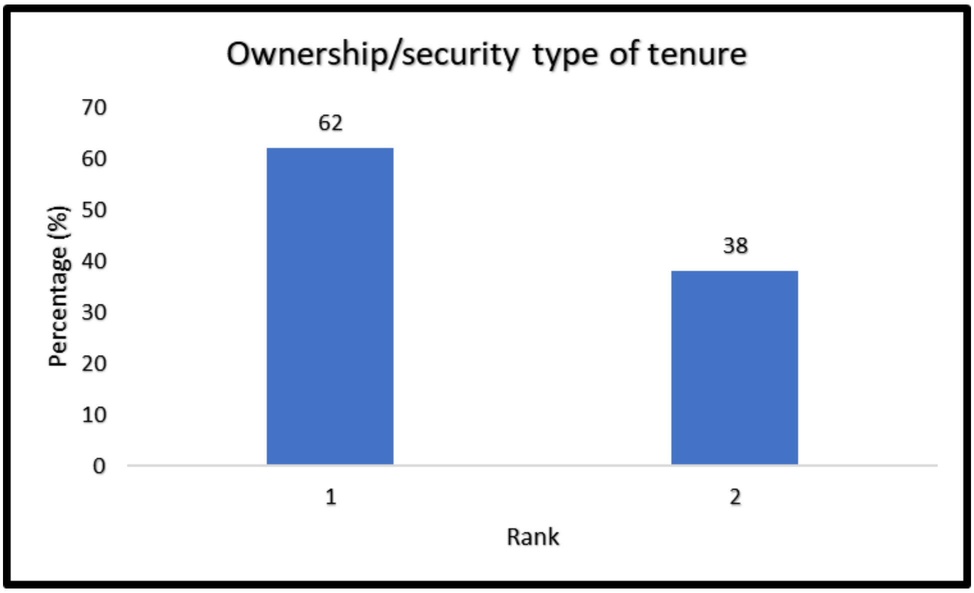

Figure 6.7: Ownership/security type of tenure in the Mphaphuli area

The fact that 38% of the land users did not have formal land-use rights is another factor that points to the ineffectiveness of land-use regulations by the traditional leadership. The absence of official land-user rights, even for just 38% of the land users, further raises concern in terms of unknown size allocated to both the rightful land users (with permission to occupy), as well as those without the right to occupy the land.

Effective management of resources such as land requires robust policies and frameworks in an area that strives towards good governance and equitable sharing of resources (Holden & Otsuka, 2014).

The current policy or framework in the Mphaphuli area that states that "the land is not up for sale, but belongs to the community" is not strong enough or sufficient to enable effective management of land and other land-use regulations.

When analysed statistically and summarised (see Appendix F), it was found that there was a statistically significant relationship between pairs of variables that affected effective land-use regulations and management, as revealed by the respondents in the Mphaphuli area and initial land use (p=0.000), namely the reason for deviating (p=0.000), permission for varying (p=0.000), policy or framework for land allocation (p=0.000), and form of tenure (p=0.000).

Questions were posed to both the land users and the traditional leaders. The assessed variables were ranked, counted for frequency, and calculated for percentage distribution of the respondents, and the priority level was determined. The majority of the respondents indicated that land-user rights allocation was influenced by money, land availability, land-use compatibility, environmental sensitivity, and standing in society.

6.3.4 Financial resources and land-use rights allocation

The global land community has accepted that individual land titling on its own cannot deliver security of tenure in a complete or timely fashion, and that a continuum of land-rights approach needs to be used (Zevenbergen *et al.*, 2013). Individual preferences for certain portions of land, together with the financial "muscle" of the individual, appear to be among the influencing factors on land-use rights allocation in the area. The exchange of money (cash presented) was singled out by all the respondents as the dominating factor in deciding whether one obtains land-user rights or not.

Money presented in exchange for land allocation is the highest-priority method used by the traditional leaders in the Mphaphuli area. Approximately 66.70% of the respondents identified money exchanging hands as the main factor that influences access to land. At the same time, 25% of the respondents ranked the influence of money as the second-highest influencing factor, while only 8.3% ranked money in the third place.

The use of money as the leading factor in the allocation of land-use rights is a problem (Kalabamu, 2006). For instance, in rural communities such as the Mphaphuli area, a number of people are unemployed, some of whom are women with no access to large sums of money.

The end result is that land-use rights are allocated to external, financially stable individuals, rather than the locals.

The implication is that whoever has money can secure land-user rights assigned even on land parcels that are not suitable for intended development. The same could be said of sensitive areas that could be overlooked on the basis of money being presented. What is happening is almost the same as what McAuslan (2002) observed, namely that senior leaders and those who hold public office throughout the world manipulate legal systems around land-control issues to benefit themselves and their relatives.

In this regard, the traditional authorities need to develop mandates and robust policies that strive to achieve sustainable development through balancing the economic, social, and environmental spheres of sustainable development, while improving the lives and wellbeing of the communities.

6.3.5 Land availability

Land availability is also an essential factor when allocating land in the Mphaphuli area. Both the land users and traditional authorities ranked land availability according to how it is prioritised when land requisitions are made.

Land users and traditional authorities ranked land availability among the top factors considered for land allocation in the Mphaphuli area. The land users' responses to whether traditional leaders consider land availability when they allocate land to users indicated a trend that suggests that the availability of land is not important. On a scale of one to four, with one being important and four being less important, 66.7% of land users ranked land availability in third and fourth place. Only 8.3% and 25% ranked the importance of land availability in first and second places respectively. Conversely, the responses by traditional leaders showed that almost 70% of them ranked land availability as a crucial factor (30% and 40%).

When land availability was analysed statistically with other decisions/factors for land-use allocation, it was found to correlate in a negative direction, with money presented (r=-0.011 and p=0.958), business ideas (r=-0.368 and p=0.077), and standing in society (r=-549 and p=0.005). Land availability had a statistically significant relationship with environmental sensitivity, and was significant at (r=0.717 and p=0.000).

This implies that land availability has a significant impact on environmental sensitivity. In addition, although land may be available and allocated to many land users in the area, environmental sensitivity is one important factor that must be considered prior to land allocation.

6.4 IMPLICATIONS OF INEFFECTIVE LAND-USE MANAGEMENT PRACTICES

The respondents identified several issues considered to be implications of not managing land use and land allocation in the Mphaphuli area. Effective land-use regulations and practices have significant impacts on the sustainability of the land. Both the traditional leaders and the land users pointed out some challenges emanating from ineffective land-use regulation practices.

Soil erosion and associated impacts on wetlands were identified by 45.83% of the land users as an implication of poor land-management practices in the area. Soil erosion is a complex natural process that could be driven by a variety of factors, including the soil type, the erodibility of the soil, the soil properties, as well as the surface runoff regimes.

Soil erosion is a naturally occurring process that accelerates mostly in areas where soil structure has been disturbed by human and animal activities. Agricultural fields where new crop production is being practised are particularly susceptible to high soil erosion abilities due to the level of disturbance of the soil structure. Soil particles on disturbed sites are easily carried by run-off to areas of lower elevation, as long as the flow of the water and wind is sufficient to transport the soil particles. Deforestation was identified by 37.5% of the land users as an implication or outcome of the *laissez faire* land-management practices in the area.

As the world population increases at an alarming rate, so too does the increasing need for the provisioning of essential goods and services, as well as the demand for fertile agricultural soil to meet the requirements of population growth. These demands have seen the conversion of sensitive ecosystems, such as wetlands, into agricultural fields.

The destruction of wetlands also changes the riparian zones and other life forms that depend on the riparian zones for their survival (Dalu & Chauke, 2020). Twenty-five percent of land users identified draining of wetlands as another factor that is a threat to the wetlands (see Figure 6.8).

Draining organic soils results in a massive loss of aquatic ecosystem that is thriving through the support of wetlands (Clark, Lane, Chapman & Adamson, 2008; Ward & Cory, 2015).

Draining of wetlands holds implications for the chemical, biological, and physical characteristics of wetlands, as well as for its functioning and performance (Clemens *et al.*, 2018). Such activities can result in the complete loss of wetlands, as the draining of wetlands affects the dry and wet seasonal functions of the wetlands. It also negatively affects the aquatic fauna and flora that depend on wetlands for survival.

Both the land users and traditional authorities perceived natural and anthropogenic factors that contribute to the declining state of wetlands. Erosion was identified by 43.8% of the respondents as a major contributor to wetland conditions, while sand mining was singled out by 33.3% of the respondents as contributing to impacts on wetlands (see Figure 6.8). All these point to the need for stringent land-management measures by those in influential positions in society.

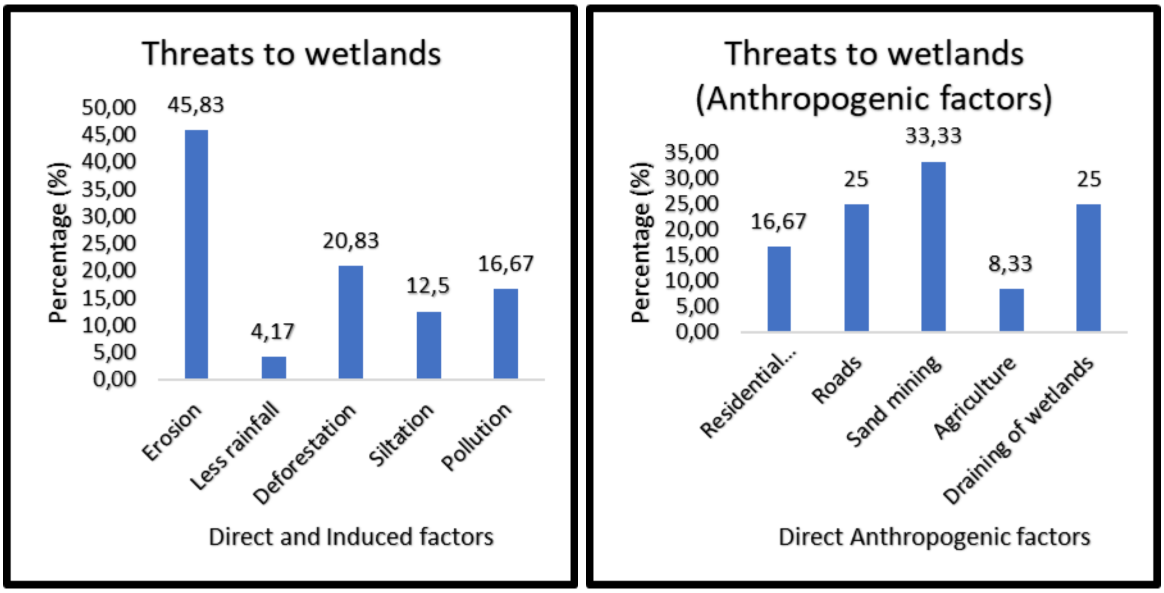

Figure 6.8: Perceptions of threats to wetlands in the Mphaphuli area

6.5 CHAPTER SUMMARY

This chapter found that perceptions point to land-use management and regulations practices as being ineffective. The ultimate implication of this ineffectiveness is the changes in LULC that are not well articulated, thought through, or regulated, and which threaten ecosystems and their associated services (Munthali *et al.*, 2019).

The traditional leaders and the land users themselves were aware of and could identify several challenges that emanate from the practices in the area. This requires that a new approach be adopted to deal with the issues identified; hence this research's attempt at a land-use decision support framework for traditional authorities grounded on existing frameworks. An examination of existing frameworks and the development of a new framework are the subject of the next chapter.

CHAPTER SEVEN:
PROPOSED DECISION SUPPORT FRAMEWORK

7.1 INTRODUCTION

This chapter presents the proposed decision support framework for land use and associated ecosystem services. The chapter reflects the current approaches that traditional leaders use in their decision-making process and then suggests a new approach. The proposed framework draws from the theoretical frameworks reviewed in Chapter Two; the perspectives from which both the theoretical and practical domains of the proposed framework were premised. The framework includes the investigations and outcomes that point to several key areas that need serious attention by the MTC.

Mitchell (2009) stated:

> Public policy issues normally are complex, occur in rapidly changing, and turbulent environments characterised by uncertainty, and involve conflicts among different interests. Thus, those responsible for creating, implementing, and enforcing policies must be able to reach decisions about ill-defined problem situations.

7.2 CURRENT TRADITIONAL AUTHORITY LAND-USE MANAGEMENT PRACTICES

The information used emanated from the literature review, the interviews conducted, and the questionnaires that were used to collect data. This information was synthesised to arrive at the suggestions presented in this chapter.

This study revealed the inner workings of the current land-use management and regulation practices, many of which were found to be ineffective. The Mphaphuli community’s existing way of doing things around land-use rights allocation and their process flow are reviewed and summarised in Figure 7.1.

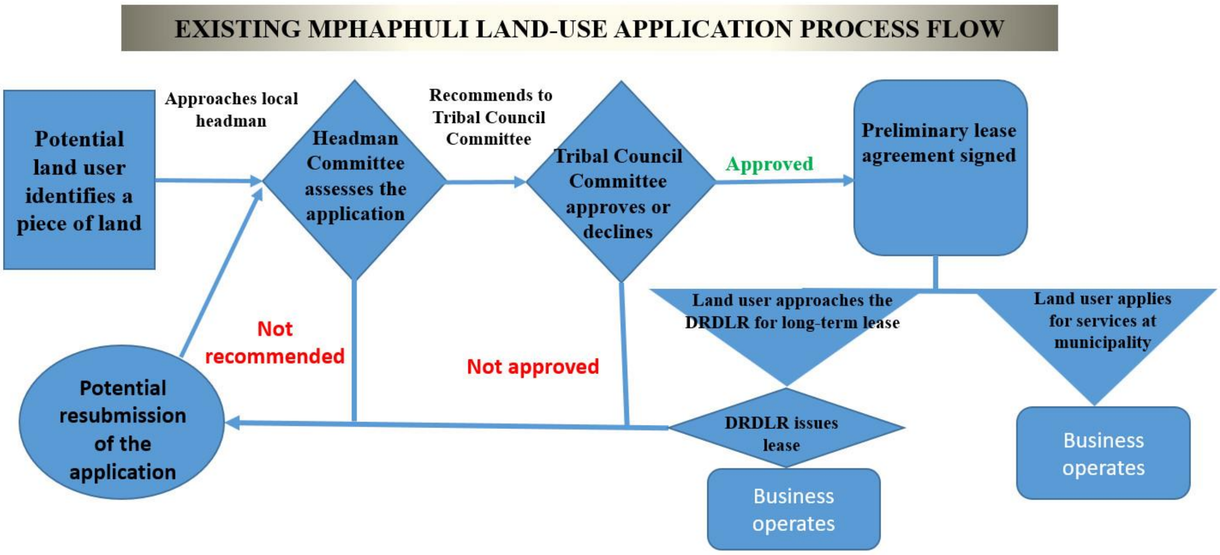

Figure 7.1: The shortened existing Mphaphuli land-use application process

The existing framework was found to have the following land-use and regulation process stages:

7.2.1 Identification of land-use potential by applicant

A potential land user (applicant) approaches the traditional leader of a village to seek permission to use the land. The traditional leaders do not have a system where they demarcate certain portions of land and reserve them for specific land-use activities; rather, the market (land users) are the ones who were found to dictate where they intended to use the land. Traditional leaders do not have either the land capability or suitability mechanisms in place to dictate what the land could be used for or not used for.

7.2.2 Village council meeting

The traditional leader convenes a meeting with the village council/*khoro*/community to introduce the applicant and the intended proposal to use the land. At this stage, the traditional leaders recommend the land user to the village council, usually with a request for endorsement of the intended use. No systems are in place to guide the village councils on decision making, other than to check against the charges the land users are expected to pay for the use of the land.

7.2.3 Written recommendation from the village

The community takes a resolution to allow the applicant permission to use the land, with a certain amount of payment. A letter is written to this effect, with a village stamp, to refer the applicant to Mbilwi (Mphaphuli headquarters) to obtain permission from the MTC.

7.2.4 Mphaphuli Traditional Council (MTC) recommendation

The MTC prepares a lease agreement and specific permission to occupy between the applicant and the MTC. An amount is charged for the applicant to pay. The council writes a cover letter for the applicant, who then takes it to either the Department of Agriculture (agriculture development) or the Department of Rural Development and Land Reform (DRDLR) (commercial or institutional use) and the local municipality for rates and services, depending on the nature of the land use. It is expected of the applicant to pay annual royalties to the MTC henceforth.

7.2.5 Issuance of permission to occupy

The DRDLR convenes a meeting with the community to obtain a community resolution for the issuance of a lease agreement. The Department of Agriculture's extension officers conduct site visits to take measurements and to issue a permission to occupy. The municipality follows its own processes for the supply of services to the development site.

This process has many loopholes, of which the following are some of most challenging:

- The traditional leadership has no proper land-use plan for potential land users from which to choose land parcels.
- Although there is a set amount for granting land-use rights for residential purposes, the practice on the ground is such that land users are charged different amounts.
- For business land-use applications, decisions are based on who the applicant is, their standing in society, and their financial muscle, whereas some locals, such as the poor and women, are overlooked.
- Once permission to use the land is granted, there are minimum follow-ups or monitoring to determine if the land is used for what it was approved.
- As a result of the above, land users push different development activities, and are even going to the extent of extending the land beyond what was granted.

- Land users are identifying environmentally sensitive land parcels for development purposes, and permission is granted regardless.
- Many land users do not approach the traditional leadership at all; they just go ahead and use the land without permission.
- Land users sell the land to third parties without the knowledge and permission of the traditional leaders.
- Traditional leaders are not held to account for the money they collect from potential land users. Traditional leaders pocket royalties and application fees as if the land belongs to them individually, while they earn a salary from the government for their roles as chiefs.
- Because of the above, traditional leaders are buoyed to continue allocating land to potential land users, even where it is unnecessary.

The issues identified above call for a new approach to LULC management at the level of the community; hence the new framework (or approach) being proposed. The new approach draws from existing structures, because many of the challenges that were identified can be addressed by changes in behaviour, more than by anything else.

7.3 PROPOSED TRADITIONAL AUTHORITY LAND-USE MANAGEMENT FRAMEWORK

LULC mapping exercises in this study revealed significant impacts by both natural and anthropogenic factors. The forecast of future LULC conducted also revealed that unless specific interventions are introduced, the future will be loaded with challenges. The ecosystem services valuation exercise conducted points to values that could be attached to ecosystems in the area. The absence of sound, effective land-management practices in the area does not, however, present good prospects for the sustainability of the land and the maintenance of ecosystem services value. These challenges call for immediate proposals on how they should be addressed.

If not attended to through proper planning such as those highlighted in the hierarchy of plans' principles, consequences will be felt for a very long time, which would be contrary to the much-needed sustainability that the sustainability theory advocates, especially for a poor community such as in Mphaphuli. The DPSIR framework reviewed in this study also provided evidence that several approaches have been designed before, which considered drivers of change, pressure on the environment, the state of affairs, impact, and how responses could be integrated into environmental management interventions. At the same time, the involvement of stakeholders from a governance perspective was showed through the IPBES framework. It is based on these frameworks that the researcher can point out that combining some aspects of these frameworks could result in positive changes in the Mphaphuli community. Figure 7.1 depicted the current arrangements in the Mphaphuli community, while Figure 7.2 is a proposed framework to counter the existing way of doing things. This framework combined several elements from the reviewed theoretical frameworks.

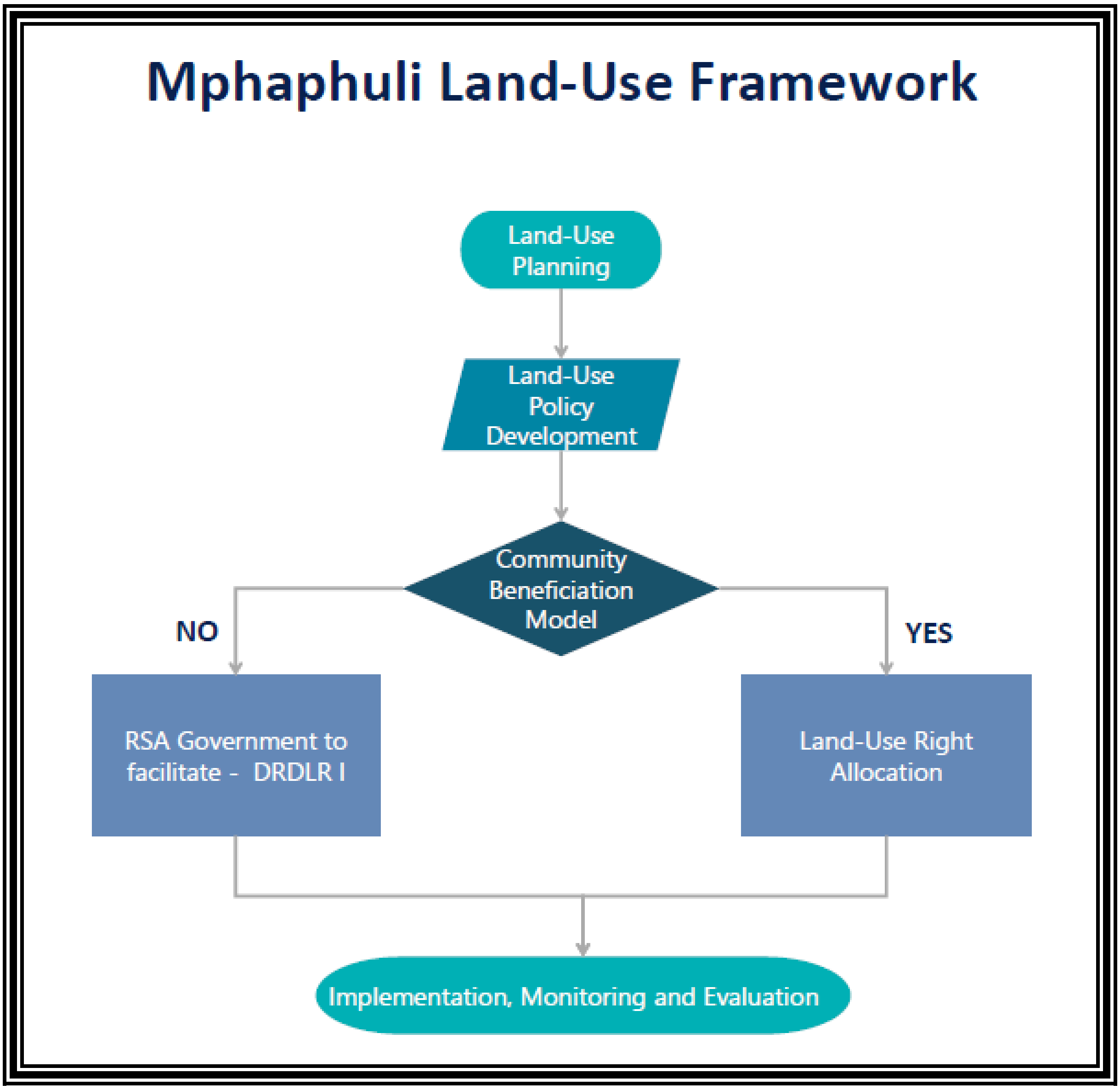

Figure 7.2: Traditional authority land-use governance framework

After considering the current practices around land-use management, land allocation, and all other processes, this study proposes a new framework to address land-use governance at the level of traditional authorities. The framework is rooted in the IPBES, DPSIR, hierarchy of plans, and the sustainability theory principles.

These cover planning and environmental issues, as well as social, economic, and cooperative governance principles and sustainable development. Some pillars were identified as anchors of the new framework. These encompass social problems, as well as economic and environmental issues. The framework is summarised below, followed by an explanation of how it could improve the state of affairs for the Mphaphuli community.

Burns and Dalrymple (2008) proposed a framework relating to governance in land administration and related aspects. They outlined some objectives critical to the success of land administration, which they believed could be associated with good governance, and able to deal with the implications relating to weak land-governance systems. This belief is because these scholars observed that weak governance in land administration contributes immensely to other issues going wrong where they ordinarily should not.

There are several impacts as a result of poor governance in land administration. When one considers the future where land administration and proper management must succeed for the Mphaphuli community, one is convinced that the following objectives adapted from Burns and Dalrymple (2008) and Payne (2002) must be implemented:

7.3.1 Objective 1: To develop land policies that are fair and equitable

Land policy is the bedrock upon which all governance protocols around land, controls around land, and administration of land development are built (Burns & Dalrymple, 2008). This speaks directly to the land-use planning process as well. It is said that poor governance emanates from insufficiencies in policy positions around exclusion from land and tenure insecurity for designated groups, illegal land transactions, corruption, and land quarrels. All of these were identified in the Mphaphuli community. The Mphaphuli community must adopt an all-encompassing stance on land administration through proper policy formulation. There is a policy that all Mphaphuli traditional leaders and land users are referred to when consulted, which states that the Mphaphuli land is not for sale, nor is it to be sold. This research found this to be mere rhetoric. The formulation of a new land policy should involve significant effort and consultation with the members of the community.

This effort has, however, often resulted in very little change in the formal recognition of tenure rights. In many parts of the African continent, for example, many challenges emanate from the difficulty of raising enough financial resources and implementing new policies (Burns & Dalrymple, 2008).

A planning process, as suggested by Lawlor *et al*. (2014), is recommended for the Mphaphuli community. Land-use planning is the process of setting sustainable development goals, and determining what conservation and development activities should be implemented and where to achieve them. Land-use planning therefore inherently focuses on achieving multiple (economic, environmental, and social) benefits for society while balancing their trade-offs. Although often conceptualised as a linear, sequential process that consists of several steps, in practice, land-use planning tends to be an iterative process, with goals revised and steps repeated as new information is gained through consultation and negotiation with stakeholders (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2011, in Lawlor *et al.*, 2014).

In order to achieve the above-mentioned objective and goal, a beneficiation model for land use must be adopted by the whole community. This beneficiation model should spell out who is responsible for planning, who will provide funding for development initiatives, from which financial and technical resources, and what happens with revenues generated from the use of the land.

7.3.2 Objective 2: To issue property rights that have legal standing

This objective centres around the lawful acknowledgement of ownership or land-use rights that are in line with the legal frameworks, and the rights on the ground being in line with the customs and traditions of affected communities. The rights referred to should be recognised, easy to enforce, and be able to stand in a court of law. The proper recognition of rights is very much associated with the levers of power in communities.

The use of land without permission, extending the land without the consent of the leadership, and passing land to third parties without the approval of the administration are critical symptoms of weak control in the Mphaphuli area. Where there is weak control over lawful matters around issues of land, gaps open up for land speculation, and lack of clarity in rights, which at times lead to land disputes and social unrest (Payne, 2002; Burns & Dalrymple, 2008).

The MTC must strive to implement programmes to register land-user rights. At present, the Mphaphuli community is involved initially when a land user applies for access to land, but that is the end of it. The process should have an opportunity for community members to be involved when the application process with the DRDLR, the Department of Agriculture, and the local municipality is finalised.

The community should also be informed of the commencement of the development, including various reporting and royalty payments. This process should be a transparent one for the whole community, which is not the case at the moment. This approach will provide an excellent platform for proper checks and balances of all involved.

Even though there is enough evidence of success in the formalised registration processes in many countries, few countries have succeeded in maintaining these formal systems. Some countries find themselves with uncertainties around these processes, leaving much of the decision making to individual discretion, which is almost the same for Mphaphuli. Communities must understand the land-rights processes to be acceptable in law, to give effect to the recognition it deserves. The DRDLR and the traditional leadership should embark on a massive drive to educate community members about land-use rights.

7.3.3 Objective 3: To formulate just, transparent, and efficient land-management instruments

The management of land, along with practices of LULC planning and land zoning, entails acceptable practices towards an effective and transparent plan. These administration systems and tools are, by default, foundational tools that support many natural resource-use rights for air, land, and water (Burns & Dalrymple, 2008).

The scientific approach used in this research, particularly as it relates to mapping LULC change and future predictions, should be the basis on which decisions are made. The said research outcomes are grounded in science, as well as being easy to understand and to communicate to everybody. Proper land management should be streamlined by well-formulated land-use planning based on scientific scenarios. Effective land-use planning should thus be in sync with the needs and aspirations of the community, and be undertaken in a community-empowering way (Jew, 2016). The Mphaphuli community as a whole should be approached to agree on a future land planning and beneficiation model at the strategic level.

Land-use capability assessment, land-use planning undertaken, and environmental sensitivity analysis conducted should culminate in a 50-year land-use master plan, which should be workshopped with government institutions such as the municipality, and the departments of tourism, environment, small business, and social development.

Each village must align its activities with the overall master plan. Each village should know and understand the potential, land size, and resources at its disposal. An example of a village undertaking this exercise that was developed for one of the 76 villages, i.e., Tshitanini, is presented in Figure 7.3. Since none of the 76 villages has ever calculated the size of their villages in hectares, the example given here of the Tshitanini village addresses key questions. The headman now understands that the village is precisely 800 ha, that the land has wetland ecosystems, and that the soil is quite fertile for agricultural activities.

It is based on these investigations at the village level that the community has decided that agriculture would be the bedrock of its economic development. Almost half the village has been designated a conservation area, which will incorporate tourism activities as well.

If each of the 76 villages were to conduct the same exercise of determining the size of the land, assessing land suitability, and developing a land-use plan, this will go a long way in ensuring that land is used efficiently. The Tshitanini village has now demarcated 20 land parcels on the agricultural scheme, and has called on potential business people to apply for the use of the land. The process to be followed will ensure that these individuals have security of tenure, are required to report every quarter on whether they are succeeding or not, and whether support or intervention is needed from the traditional leadership. This will also assist with potential royalties flowing into the traditional authority’s bank accounts, where the money could be used to support the poor with issues such as education of the children, among others.

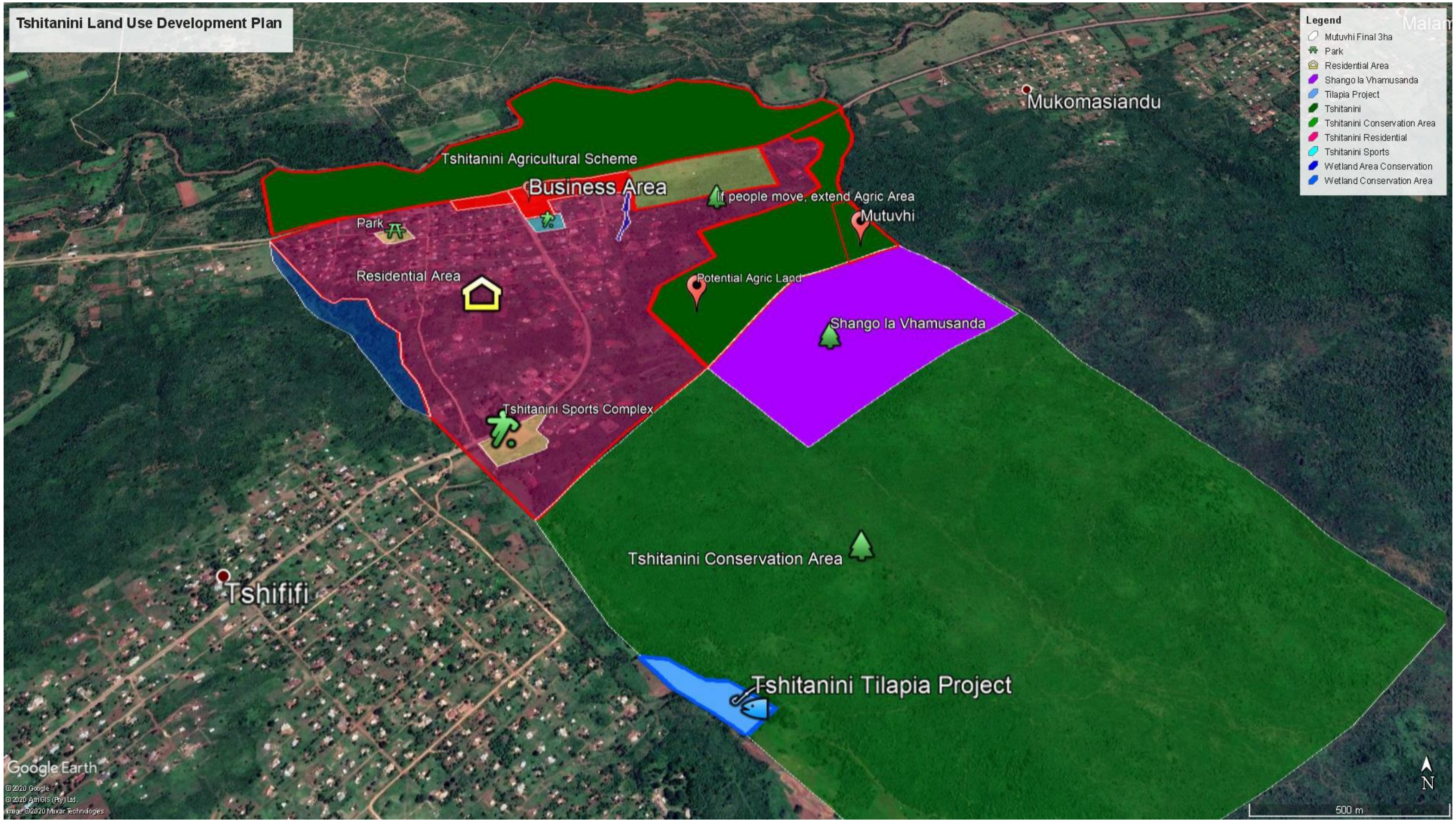

Figure 7.3: Model village-based land-use plan

Mphaphuli does not wait for land-use applicants, but sets aside pieces of land suitable for various development activities, and invites potential land users to apply for permission to use them, under strict conditions, such as developing a business plan, financial capability, and technical abilities demonstration.

At least 50% of the land is reserved for locals / the poor, who are in most cases women, to use the land without having to pay anything – provided that the use is in line with the plans in place, and they must also report and upscale themselves to become commercially viable and to start paying royalties. Those who would like to remain at subsistence level can be grouped together and be supported, and given smaller pieces of land.

A database should be developed for all these land uses and must have a central place where it is administered. An example is the use of Sage accounting software, where all land users are entered into a database and issued with invoices. These people should submit their business tax compliance documents every year for review; this should be done to determine the relevant revenue model.

The MTC holds at least four meetings annually to review applications, review usage, including royalties, and dispense revenues in line with the beneficiation model. There should be reporting to the whole of Mphaphuli on the outcomes of these meetings (governance, accountability, and transparency). As part of the database governance, traditional leaders and applicants should be held to account for any deviation from an agreed set of principles or guidelines. A ten-year review of all the plans and future planning should be included in future planning and reporting.

7.3.4 Objective 4: To build institutions with unambiguous community mandates

If adherence to the promotion of governance principles does not form part of the performance agreement and review process of those in positions of power, an organisation runs the risk of governance being seen as a nice-to-have, where non-conformance does not attract consequences (Von Eck, 2020).

People tend to focus on those elements that they know will directly and positively affect their image and pockets (Rustichini & Villeval, 2014). The more they are measured around their application of the governance principles, the greater effort they will generally put into adhering to them.

If the principles are not part of the organisation's roots, and imparted at onboarding to ensure assimilation, it does not have a fighting chance. Land administration will be regarded as efficient when community mandates and assigned roles are followed to the letter (Payne, 2002; Burns & Dalrymple, 2008). The current practice in the Mphaphuli community recognises traditional leaders as being responsible for land-user rights allocation; however, there are instances where the local municipality demarcates sites for residential purposes on land owned by the traditional authority, and usurps the ownership rights without the traditional leadership noticing.

Another area that should be strengthened has to do with the management of records, which is critical for upholding the integrity of land tenure rights through property rights registration at the level of the MTC. As things stand, the administrator at the office appears to be the only one with access to land registration data and should anything happen to him, no one would be able to access and retrieve such data. This situation points to the potential failure of the system. A standard operating procedure for records must be established, which will maintain business continuity for the MTC.

7.3.5 Objective 5: To place information availability at the centre of land administration

In the era of data mining, whoever has information is empowered; hence it is said that knowledge is power (Azamfirei, 2016). When information is accessible, informed decisions can be made all the time without fear or favour. When one is empowered through data, one becomes emboldened to participate and question decisions made by others, but with the potential to negatively impact on them (Burns & Dalrymple, 2008). Emphasis is made here on the deprived, such as the women of Mphaphuli, who do not have critical information, communication ability, or visibility to raise their challenges. When reliable and easily accessible land information is available to remote and disadvantaged communities such as those in far-flung villages such as Ha-Lambani, it will serve them well.

The Mphaphuli community's land information is not managed well. The information about land-use rights allocated and processes is currently disjointed and not very easy to access. Computerising this information through digitising, share points, and associated instruments could be useful to support information access.

This research proved that spatial data can be used to provide policy direction; it would therefore be critical to embark on computer hardware and software development strategies for information management purposes.

7.3.6 Objective 6: To recognise transparency as a pillar of land management

There has been finger-pointing across the Mphaphuli area when it comes to land-management processes, especially regarding the payment of royalties and rates. Communal land or land under traditional authorities is often considered cheap, which creates the impression that such land is not good, economically, compared to privately owned land (Burns & Dalrymple, 2008). This misconception makes it possible for land speculators and unethical leaders to believe that they can secretly and easily transfer land-user rights from one person to the next without major implications. There are instances where village councils/*khoro* become involved and are informed when average land transactions between traditional leaders and land users take place. Still, the more significant transactions are taking place behind closed doors without the knowledge of the community. The impact of unlawful selling of community land in the name of development processes and poverty eradication is a cause for concern. Economic, environmental, and social impacts, including social unrest and disputes, could escalate as a result of the illegal allocation, disposal, and use of communal land that take place behind closed doors.

7.3.7 Objective 7: To recognise land valuation as a central pillar of land management

The process of land valuation and royalty payments is critical for proper governance in land administration. The Mphaphuli land has never been subjected to proper economic valuation, except for the current research on ecosystem valuation. Land resources in all societies are finite. In this case, this study proved that there are fundamental changes in LULC that may hold implications for land values. It is essential to put together an easy-to-understand land valuation that is clear and advocates for the sharing of benefits to all in the Mphaphuli dynasty.

If the traditional land were to be subjected to proper valuation, as was done in the Royal Bafokeng Nation, Cook (2011) and Flomenhoft (2019) argue that a great deal could be achieved. When a chief or a village headman sells land or concludes a land transaction, it must be known by the community, as this will improve transparency and accountability.

7.3.8 Objective 8: To use both legal and non-legal mechanisms to address land disputes

Conditions in rural areas are quite complicated, especially where cadastral data are not central to the management of land. In such instances, the chances are that users may unknowingly encroach onto other land users' land. Where this happens, it would be in the best interest of the stakeholders that such disputes are resolved amicably. During the initial allocation of land-use rights, village councils have been instrumental, and civic organisations and other village ward committees should be encouraged to become involved. These structures should also be included in resolving farm and village boundary issues identified as critical in this research. In discharging their roles, these structures must adopt well-communicated and easy-to-understand conflict-resolution mechanisms around the land issue.

7.4 CHAPTER SUMMARY

Environmental challenges are complex, and require systems thinking if they are to be addressed satisfactorily. Upton (2020) argues that the environmental crisis is so massive that if not attended to as a matter of urgency, all future initiatives ranging from social justice, economic incentives, to political manoeuvring, *inter alia*, may find it challenging to reverse the situation.

Unfortunately, many people across the world rely heavily on the outcomes of systems and frameworks developed by scientists and policymakers, who continue to play a critical role. Research about the development of a decision support framework around land-use and ecosystem services falls squarely in the path of some of the already existing frameworks as described previously. What is critical is the continuation of the efforts to bring the best out of these frameworks so that the environment, the poor, and future generations could be protected from the ever-changing circumstances around development and regulations.

This chapter revealed several deficiencies in the existing decision support approaches that the traditional leaders use, and aligned these deficiencies with the theoretical frameworks reviewed in Chapter Two. It further developed a traditional leadership decision support framework that is expected to guide how land is to be managed going forward.

The next chapter presents the summary of the key findings, the main conclusions, recommendations, and suggested areas of further research.

CHAPTER EIGHT:
SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

8.1 INTRODUCTION

The previous chapters outlined and highlighted the most critical aspects relating to the literature and findings, as stated in the introduction and research design and methods chapters of the study. These findings were the product of both the mixed-methods and convergent research design of the study, which reflected on the separate data-collection processes and their concurrent analytic perspectives generated through the emergence of common themes. In this chapter, a summary of key findings and main conclusions are presented as interconnected aspects that address both the phenomenon of LULC change, ecosystem services valuation, and land-use management. The recommendations proposed here mainly reflect the more dominant outcomes or themes that emerged during the study.

8.2 SUMMARY OF THE KEY RESEARCH FINDINGS

The main findings of the research, according to the objectives, are summarised below. The summary indicates that the objectives were achieved and that the research questions that emanated from the objectives were addressed. The study attempted to achieve the research aim and objectives by addressing the following research objectives and questions:

8.2.1 LULC change mapping

Objective: To establish LULC in the MTA using existing land-cover data from 1990 to 2018 and predicting future land cover (i.e., 2050).

- What is the extent of LULC changes during 28 years (1990 to 2018) in the study area?
- What would land cover look like in 2050?
- What are the driving forces behind any changes in LULC?

Extensive land-cover changes between 1990 and 2018 were observed. Such changes are driven by deforestation, the need for increased residential development, and the creation of new waterbodies. Future predictions also point to built-up areas, commercial areas, and woodlands increasing in coverage. Thickets are predicted to decline in coverage by the year 2050.

8.2.2 Ecosystem services and valuation

Objective: To perform a baseline valuation of different ecosystem services in the area.

- What are the different ecosystem services in the study area, and to what extent have they been impacted by LULC change trends?
- What is the baseline value of the identified ecosystem services in the area?

Many ecosystem services were identified, which are under threat from a variety of factors, such as deforestation. Ecosystem services are disappearing as a result of poor land-use regulatory practices by traditional leaders. For the first time in the area, an economic value was attached to a variety of ecosystem services.

8.2.3 Land-use management and regulation practices

Objective: To evaluate land-use regulation practices in the area to determine the effectiveness of land-use regulation practices.

- How effective are the current land-use regulation practices?
- To what extent do the land-use regulations influence LULC changes, including implications for ecosystems and their services?

The MTC is not aware of the extent of its land in hectares; this is a significant indicator of the lacklustre performance in land-use management. Women are bearing the brunt of land-use rights allocations; most of them could be at risk of losing land-use rights as they did not apply for permission. Women and children are in many cases at the coalface of poverty, and the traditional authorities not considering this points to them not being aware of the plight of the women and children.

The management of communal land cannot be based purely on economic transactions; where those with financial muscle gain access to vast tracts of land and the majority of the poor end up not being able to access land. The leaders base their decision making on money presented to them for access to land-use rights. This situation will not lead to sustainability in the long term – for the community or the traditional leadership institution itself.

The traditional leadership does not have a land-development plan from which it can draw insight into land-use activities currently and in the future. This situation leads to them having to wait for land users to identify pieces of land that they are interested in for development.

When these potential land developers present money to the leaders, there is no proper land-use suitability assessment to guide their decision-making process. Some of the land-use activities end up taking place in sensitive ecosystems such as wetlands.

The land that the traditional leadership presides over is divided into farms, just like many other places where the deeds registry system is in use. It appears that these formal farms, such as the Mphaphuli 278 MT, were drawn by hand by someone sitting in an office without verification on the ground. There is a massive difference between land size on paper and that on the ground, where the farmland is smaller than the boundaries that the traditional leaders use. This situation has the potential to create conflict among traditional leaders; not only among the Mphaphuli village heads, but also the neighbouring traditional authorities such as the Tshivhase and Rammbuda.

Land boundaries is a significant issue, which, if the traditional leadership was on top of their land-use management and governance, they would have picked this up and resolved it with the deeds registry systems in the central government. To add to this issue of boundaries, this research found that, just like with such traditional authorities such as the Royal Bafokeng in the North West province, the Mphaphuli ancestors bought land for cash from the government. This land, however, is being treated the same way as any other piece of land in the area; this cannot be acceptable from leadership that is in control of land-use management. Development processes on land with title deeds cannot be the same as land owned by the state.

8.2.4 Land-use decision support framework

Objective: To develop a framework for sustainable land use and decision support in the area.

- What land-use decision framework can be developed for the traditional authority?

A decision support framework was prepared based on the theoretical frameworks and the outcomes from the three previous objectives. To summarise this point, there is a process that the traditional leadership relies on to make decisions on land-use management. Still, this process is not effective as it does not incorporate planning and monitoring. The current framework is quite an old system that requires a few additional steps in the process to make it more effective.

In short, the MTC has a defined land-use application and management process in place. Unfortunately, this process is purely based on waiting for potential users of land to approach them, pay certain amounts of money, and then be allocated land for use. Ideally, the traditional authority should plan well ahead of the potential land developers, so that they can influence where development should or should not take place. Based on these findings, various steps were added to the current land-use allocation and management process to substantiate the current method. These relate mainly to planning and monitoring. A village development model was initiated for one village (Tshitanini), which, if all other villages were to adopt it, a traditional authority development model could be established. This model could fit into the much-publicised District Development Model that could be initiated for the Vhembe District Municipality. This situation would be the first of its kind, where a traditional authority develops a development model to influence a District Development Model.

8.3 CONCLUSIONS FROM THE FINDINGS

The conclusions from the findings of the study are as follows:

- There is no proper land-use planning in the area.
- Security of land tenure and property rights are not adequately formalised.
- Ecosystem services' economic value associated with specific land cover is not central to land-use decision making.
- There are no sustainable land-governance practices in the area.

8.4 RECOMMENDATIONS

This section highlights and expands on some of the more critical recommendations that emanate from the study. The research objectives of the study guided the discussion, the survey questionnaire, the key informant interviews, and the one-on-one discussions, as well as the outcomes of the mapping of LULC changes, ecosystem services valuation, and land-use regulatory practices evaluation.

8.4.1 Management of LULC change and future planning

Traditional authorities should put a six months' moratorium on land-use allocation until proper land-use planning is finalised. Scenario planning using Co$ting Nature, building on the results of this study, should be undertaken, and must also use other tools and sources of data to observe differences or to confirm the current findings.

8.4.2 Formalise land-use rights and security of tenure

The traditional authority should formalise land-use rights for those who currently use the land without formal rights, within a period of a year. An extensive data-gathering exercise should be initiated to determine all the land users in the area. Anyone who uses the land without formal permission should be assisted to obtain such land-user rights. Anyone who currently uses land in a sensitive ecosystem should be assisted to move out and have land allocated elsewhere. As an example, the Sambandou wetland is currently under serious threat from people who cultivate maize on an unsustainable basis. These people must be grouped together into a small cooperative, allocated at least a 20-ha piece of land, and be supported to start a commercial enterprise. The Mphaphuli Development Trust should then assist by applying for funding to run the said enterprise.

8.4.3 Ecosystem services and valuation

The MTA, together with the Provincial Department of Economic Development, Environment and Tourism, should, within three years of this research, formalise the expansion of the Mphaphuli Cycad Nature Reserve. The formalisation should include increasing the nature reserve by at least 5 500 ha from the current 1 080 ha. This increase will assist in the protection of many cycads that are outside the reserve. This will also protect thickets that are under tremendous pressure from deforestation.

When the reserve has been proclaimed, a PES scheme should be established to support the poor, who would no longer be able to access fuelwood and other materials from the protected reserve. The Mphaphuli Development Trust should apply for such a scheme on behalf of the poor. The traditional authority should pursue alternative payments or rewards for maintaining ecosystem services, such as the sale of carbon credits.

8.4.4 Land-use management and regulation practices

There must be consequences from the Mphaphuli Royal Council for those in positions of authority who are not implementing tight land-use controls, which should be implemented with immediate effect. The MTA should determine proper land boundaries for each village, so that performance agreements can be put in place for each village head in the management of land. This should be done within a period of one year from the date of this research. The traditional council should incentivise those leaders and users who incorporate sustainability into their land-use practices. Traditional leaders must be held accountable for the money they receive from land-use applications, through the adoption of a beneficiation model for the wider community, with immediate effect.

8.5 CONTRIBUTION OF THE STUDY

This research filled gaps found in international, regional, country-level, and local literature. Internationally, the need to conduct research and understand how LULC changes over time, using remote sensing, has been established. The need to conduct research to understand how human beings benefit from ecosystem services has also been identified.

In South Africa, several studies have been undertaken on LULC change and ecosystem services valuation (Van Wilgen, Cowling & Burgers, 2014; Goldin *et al*., 2019; Pantshwa & Buschke, 2019). Issues around planning for land use have also been identified using remote sensing (Tizora *et al*., 2016). Studies were conducted on LULC change and ecosystem services at a regional level close to the Mphaphuli, i.e., for the Levubu catchment (Odiyo *et al*., 2012; Mathivha *et al*., 2016; Ntshane & Gambiza, 2016).

Unfortunately, none of these previous studies investigated how traditional leadership structures and their practices influence the issues around LULC changes and ecosystem services values.

This study provided information on a vast area where traditional leadership practices are responsible for the management of land – 76 villages in total. LULC change was mapped, and drivers of change in the area were identified. For the first time, an economic value has been established for some of the ecosystem services in the area.

These findings could be used as a bedrock for future planning. Not only were LULC change factors identified, but the study also produced predictions for future LULC in the area until 2050. This allows for better planning and policy directions geared towards improved management of the land and, by implication, ecosystem services.

The study ended by developing a decision support framework, specifically for traditional authorities, which considered their current practices. The study therefore provided a novel approach to the proper management of land use and ecosystem services, using an all-encompassing decision support framework developed for and with the community. This approach will enable the traditional authority to report on the SDGs, which will be the first of its kind from a traditional authority leadership structure in the Limpopo province, South Africa, if not globally.

8.6 AREAS OF FURTHER RESEARCH

With the economic value of ecosystem services established, it is recommended that a PES scheme be established in the area as an alternative to the exploitation of ecosystem services. A cost-benefit analysis scheme, as part of the PES scheme, would also be important to investigate.

The identification and evaluation of ecosystem services did not map beneficiaries in detail. This area is critical to investigate further, to incorporate their views into the formulation of future management options for LULC and ecosystem services.

A need exists for comprehensive research on the land-use rights holders through a full land-use audit across the whole of Mphaphuli. This audit will assist in the identification of land-use rights holders, determination of beneficiaries, and any assistance that may be required by these individuals. Land-use activities that take place without the blessing and knowledge of the traditional leaders can be identified and rectified through this process. A detailed investigation of land transactions taking place illegally in the area would also be critical.

Servitudes and wayleaves across Mphaphuli, as well as where the revenues associated with such servitudes go, need to be investigated. Resources that are meant to flow into the coffers of the traditional authorities may just be unearthed. The revenue could be used towards the PES schemes mentioned earlier, as well as the initiation of appropriate land-use plans.

Research is recommended for the identification of Mphaphuli land parcels to identify the development processes followed, and whether these were legal or not. Research should include the determination, and possible corrections, of discrepancies between land boundaries on paper compared to the boundaries on the ground.

Research on climate variability, which impacts ecosystems and the population, is recommended, and may just be the basis for motivating the community to approach environmental assets differently.

The recommendations emanating from this research may not be implemented or tested within a short period, due to time and cost implications. This research therefore provides the basis for additional research in this area.

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[1] **Editor's note:** (a) Citations with up to 8 authors are dealt with as follows:- **In-text**: All 8 authors are given. **Ref list**: All 8 authors are given. (b) Citations with more than 8 authors are dealt with as follows, with an example:- **In-text**: Barton *et al.*, 2018). **List of references**: The first 8 authors are cited with *et al*. and the number of authors (e.g. Barton, D.N., Kelemen, E., Dick, J., Martin-López, B., Gómez-Baggethun, E., Jacobs, S., Hendriks, C.M.A., Termansen, M. *et al.* [38 authors]. 2018.

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APPENDICES

APPENDIX A: ETHICS CLEARANCE FROM UNISA

UNISA university of south africa

UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 16/03/2020

Dear Mr Musetsho

NHREC Registration # : REC-170616-051
REC Reference # : 2020/CAES_HREC/039
Name : Mr KD Musetsho
Student #: 57661006

Decision: Ethics Approval from 12/03/2020 to completion

Researcher(s): Mr KD Musetsho
57661006@mylife.unisa.ac.za

Supervisor (s): Dr M Chitakira
chitam1@unisa.ac.za; 011-471-3220

Working title of research:

Development of a sustainable land and ecosystem services decision support framework for the Mphaphuli traditional authority, Limpopo Province

Qualification: PhD Environmental Management

Thank you for the application for research ethics clearance by the Unisa-CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is granted until the completion of the project, **subject to submission of yearly progress reports and further clarification. Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report has been submitted.**

Due date for progress report: 31 March 2021

Please note the points below for further action:

1. The researcher indicates that as a member of the Mphaphuli Development Trust he has access to the contact details of the targeted participants. However, the researcher is cautioned that he must still obtain permission from the Trust to approach these possible participants, and that they must have the right to refuse to participate. Furthermore, the researcher should stipulate how he will protect the confidentiality of participants and any personal information that could identify them.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

2. What is the motivation for the use of purposive sampling?
3. More detail is required on the statistical analysis. What is the motivation for the use of ANOVA? Which model of ANOVA will be used? The researcher must also provide the experimental design to which the ANOVA will be applied. What variables will be used?

*The **medium risk application** was **reviewed** by the UNISA-CAES Health Research Ethics Committee on 12 March 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:
*The reference number **2020/CAES_HREC/039** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Yours sincerely,

Prof MA Antwi

Chair of UNISA-CAES Health REC

E-mail: antwima@unisa.ac.za

Tel: (011) 670-9391

Prof MJ Linington

Executive Dean : CAES

E-mail: lininmj@unisa.ac.za

Tel: (011) 471-3806

URERC 25.04.17 - Decision template (V2) - Approve

APPENDIX B: PERMISSION TO CONDUCT STUDY

Dear Respondent

29 July 2019

Request for permission to conduct an academic research project

DEVELOPMENT OF A SUSTAINABLE LAND UTILISATION AND ECOSYSTEM SERVICES DECISION SUPPORT FRAMEWORK FOR THE MPHAPHULI TRADITIONAL AUTHORITY, LIMPOPO PROVINCE

I am a PhD student registered with the University of South Africa's Department of Environmental Sciences. I write to seek permission to conduct my research in your area as follows:

The purpose of the study is to develop a land utilisation and ecosystem services decision support framework for the Mphaphuli Traditional Authority (all 76 villages and community structures), Limpopo province. The results of the study will be used for academic purposes only and may be published in an academic journal. I will provide you with a summary of the findings on request. Please contact my supervisor, Prof. M. Chitakira (chiram1@unisa.ac.za) if you have any questions or comments regarding the study. Please sign below and return to my email address (dmusetsho@naledzi.co.za) to indicate your willingness to participate in the study, and to grant permission to study the Mphaphuli Traditional Authority.

Yours sincerely

Khangwelo Desmond Musetsho

I/We, ___________________________, herewith give my/our consent to participate in the study. I/we have read the letter and understand my/our rights with regard to participating in the research.

APPENDIX C: INFORMED CONSENT DOCUMENT

Dear Respondent

29 July 2019

Informed consent for participation in an academic research project

DEVELOPMENT OF A SUSTAINABLE LAND UTILISATION AND ECOSYSTEM SERVICES DECISION SUPPORT FRAMEWORK FOR THE MPHAPHULI TRADITIONAL AUTHORITY, LIMPOPO PROVINCE

You are herewith invited to participate in an academic research study conducted by Khangwelo Desmond Musetsho, a PhD student at the University of South Africa's Department of Environmental Sciences.

The purpose of the study is to develop a land utilisation and ecosystem services decision support framework for the Mphaphuli Traditional Authority (all 76 villages and community structures), Limpopo province.

All your answers will be treated as confidential, and you will not be identified in any of the research reports emanating from this research.

Your participation in this study is very important. You may, however, choose not to participate and you may also withdraw from the study at any time without any negative consequences.

You and other identified respondents will be presented with a questionnaire; please answer the questions in the said questionnaire as completely and honestly as possible. This should not take more than 15-20 minutes of your time.

The results of the study will be used for academic purposes only and may be published in an academic journal. I will provide you with a summary of the findings on request.

Please contact my supervisor, Prof. M. Chitakira (chitam1@unisa.ac.za) if you have any questions or comments regarding the study. Please sign below and return to my email address (dmusetsho@naledzi.co.za) to indicate your willingness to participate in the study, and to grant permission to study the Mphaphuli Traditional Authority.

Yours sincerely

Khangwelo Desmond Musetsho

I/We, ____________________________, herewith give my/our consent to participate in the study. I/we have read the letter and understand my/our rights with regard to participating in the research.

_____________________________   _____________________

Respondent's signature   **Date**

APPENDIX D: QUESTIONNAIRES

DEVELOPMENT OF A SUSTAINABLE LAND AND ECOSYSTEM SERVICES DECISION SUPPORT FRAMEWORK FOR THE MPHAPHULI TRADITIONAL AUTHORITY, LIMPOPO PROVINCE

Questionnaire for the Traditional Authority, for the degree of Ph.D. Environmental Management, College of Agriculture and Environmental Sciences, Department of Environmental Sciences, UNISA

KHANGWELO DESMOND MUSETSHO

Student Number: 57661006

Supervisors: Prof. M. Chitakira M and Prof. W. Nel

INSTRUCTIONS TO THE RESPONDENTS

The purpose of the study is to develop a land utilisation and ecosystem services decision support framework for the Mphaphuli Traditional Authority. The questions in this document are for use in directing discussions while gathering data for use in the above-mentioned research. All your answers will be treated as confidential, and you will not be identified in any of the research reports emanating from this research. Please answer all the questions as completely and honestly as possible. This should not take more than 15-20 minutes of your time. The results of the study will be used for academic purposes only and may be published in an academic journal. Should you feel that you cannot participate any longer, you are free to withdraw at any time.

Questionnaire #	**Interviewer's name**	**Date**	**Location (Village)**

1. Age of the respondent

<21 years	22 – 30 years	31 – 35 years	36 – 45 years	>45 years

2. Gender

Male	
Female	

3. Race

African	Indian	White	Other (specify)

4. Ethnicity

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

5. Education level

< Grade 10	Grades 10 – 12	College	University	Other

6. Household size

0	0 – 1	2 - 3	4 - 5	>5

7. Number of dependants

0	0 – 1	2 - 3	4 - 5	>5

8. Employment status

Not employed	Employed

9. What is the size of the land in hectares (ha) for your village, if you lead a village?

……………………………………………………………………………………………

Ecosystem Services

10. What is your understanding of ecosystem, ecosystem services, and ecosystem value?

……………………………………………………………………………………………………

11. What is your understanding of the Sustainable Development Goals?

……………………………………………………………………………………………………

12. Have you noticed any major changes in land cover and land use in your village during the past 20 years from 1998 and 2018?

Yes	No

13. If yes, what are the major driving forces behind the land-use and land-cover changes?

……………………………………………………………………………………………………….

14. What are the main environmental challenges in your village?

……………………………………………………………………………………………………

Legal Framework

15. What is the land-use allocation and regulation policy/framework for the Mphaphuli community?

……………………………………………………………………………………………………

16. Is the policy/framework stated above reduced in writing or is it just a verbal policy?

…………………………………………………………………………………………………….

17. What criteria do you or the village use to decide on the suitability of the land for various land-use applications?

……………………………………………………………………………………………………

18. What is the current number of land-use applications and allocations that have been decided on, and how much land does each one of these cover?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

19. What advises the extent/size of land in hectares (ha) that anyone can access or be permitted to use?

……

…….

20. What criteria do the village use in differentiating land-use applications and allocation between villagers and non-villagers?

……

21. How does the leadership ensure that the land is used for what was applied and allocated for?

……

22. Under what circumstances would the leadership review and revoke the land-use rights?

……

23. In granting permission to use the land, what do you consider critical in decision making? Rank on a scale of 1-6, where 1 is least priority while 6 is highest priority:

Land availability	Cash presented	Business idea presented	Other parcels of land given away already	Environmental sensitivity	Other, specify

24. What enforcement policies do you have?

……

25. Who is responsible for enforcement?

………………………………………………………………………………………....…………

26. Who is responsible for compliance in the area?

…………………………………………………………………………………………………......…

27. Who are the decision makers?

……………………………………………………………………………………......……………

28. What are some of the critical ecosystems in the village, and how are these protected or managed in light of demands on land for development activities?

……………………………………………………………………………………………………

29. What are the prospective legal frameworks that you wish to propose for the Mphaphuli Traditional Authority?

………

30. What do you think would be benefits of these frameworks on the Mphaphuli Traditional Authority's effectiveness?

………

The end

DEVELOPMENT OF A SUSTAINABLE LAND AND ECOSYSTEM SERVICES DECISION SUPPORT FRAMEWORK FOR THE MPHAPHULI TRADITIONAL AUTHORITY, LIMPOPO PROVINCE

Questionnaire for land users, for the degree of Ph.D. Environmental Management, College of Agriculture and Environmental Sciences, Department of Environmental Sciences, UNISA

KHANGWELO DESMOND MUSETSHO

Student Number: 57661006

Supervisors: Prof. M. Chitakira and Prof. W. Nel

INSTRUCTIONS TO THE RESPONDENTS

The purpose of the study is to develop a land utilisation and ecosystem services decision support framework for the Mphaphuli Traditional Authority. The questions in this document are for use in directing discussions while gathering data for use in the above-mentioned research. All your answers will be treated as confidential, and you will not be identified in any of the research reports emanating from this research. Please answer all the questions as completely and honestly as possible. This should not take more than 15-20 minutes of your time. The results of the study will be used for academic purposes only and may be published in an academic journal. Should you feel that you cannot participate any longer, you are free to withdraw at any time.

Questionnaire #	**Interviewer's name**	**Date**	**Location (Village)**

Demographic Data

1. Age of the respondent

<20 years	21 – 30 years	31 – 35 years	36 – 45 years	>45 years

2. Gender

Male	
Female	

3. Race

African	Indian	White	Other (specify)

4. Ethnicity

………………………………………………………………………………………………

5. Education level

< Grade 09	Grades 10 – 12	College	University	Other

6. Household size

0	0 – 1	2 – 3	4 – 5	>5

7. Number of dependants

0	0 – 1	2 – 3	4 – 5	>5

8. Employment status

Not employed	Employed

Land Use

9. The size of the land in hectares (ha)

0 – 1 ha	2 – 5 ha	– 7 ha	8 – 10 ha	>10 ha

10. Current land use of the land

Activity 1	Activity 2	Activity 3

11. If agriculture, name the farming method

Subsistence farming	Commercial farming

12. If livestock, indicate the total land used for grazing

0 – 5 ha (specify)	6 -10 ha (specify)	Other, e.g., communal grazing

13. If crop production, name the types of crops (List and rank 1-5 as preferred)

14. Source of funding for the activity listed above

No funding	Local cooperation	Loans from NGO	Department of Agriculture	Other (specify)

15. What do you know about climate change?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

16. What is the proximity of your land-use activities to the sensitive ecosystems such as wetlands and rivers (in m)

100 m	500 m	1 000 m	5 000 m

17. Are you currently using the land for what it was allocated for when you applied for permission to use?

Yes	No

18. If not, what is the reason?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

19. If you have deviated, what process did you follow to seek permission for such deviation?

…………………………………………………………………………………………………

………………………………………………………………………………

20. Under which policy/framework was the land allocated to you?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

21. What form of ownership/security of tenure do you currently have over the land that you occupy or use?

Permission to occupy	Title deed	None	Other (specify)

Land Cover

22. What do you understand by Sustainable Development Goals (SDGs)?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

23. What is the state of land cover in your area?

Eroded	No vegetation	Patches of vegetation	Dense vegetation	Natural state

24. What could be the cause of the current state of the land cover?

Drought	Poor soil conditions	Seasonal rainfall	Heavy rainfall	Other (specify)

25. Would you consider the land cover that you currently use as a sensitive environmental site?

Yes	No	Do not know

26. Ever since the land was allocated to you, has there been any review of the conditions of use? If yes, who conducted the review and how effective do you think that review was?

Yes	No	Do not know

Ecosystem Services

27. Name of the wetland or river closest to your site?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

28. Location of the wetland or river in terms of distance?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

29. Size of the wetland in hectares (ha), if any?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

30. What is a wetland?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

31. Do you benefit from it?

Yes		No	

- List the benefits

…………………………………………………………………………………………………

32. How long have you been benefitting from the wetland?

…………………………………………………………………………………………………

33. Are there any threats to the wetlands that you have noticed?

…………………………………………………………………………………………………

34. Severity of the threats

Extremely high		High		Medium		Low	

35. How long has the threat been experienced?

< year	1 – 3 years	4 –5 years	>5 years	Don't know

36. Is there a need to conserve the wetland?

Yes	No

37. Why if yes? And why if no?

…………………………………………………………………………………………………

38. Are there any possible or practical measures that can be used to protect the wetland? List them.

…………………………………………………………………………………………………

39. What is the state of the wetlands or river currently?

Very good	Good	Bad	Very bad	Extremely bad

40. What was the state of the wetlands or river in the past?

Very good	Good	Bad	Very bad	Extremely bad

41. What could be the state of the wetlands or river in the future?

Very good	Good	Bad	Very bad	Extremely bad

42. Any recommendation or comments on the wetlands or river?

…………………………………………………………………………………………………

43. Legal Framework

44. Entities that carry out the evaluation on land-use and ecosystems?

Mphaphuli Royal Council	Mphaphuli Traditional Council	Department of Agriculture and Rural Development	Department of Environmental Affairs	Other (specify)

45. In granting permission to use the land, what do you think matters most to the traditional authority in decision making? Rank on a scale of 1-6, where 1 is least priority and 6 is highest priority.

Land availability	Cash presented	Business idea presented	Other parcels of land given away	Environmental sensitivity	Other, specify

46. Under what circumstances would the traditional authority revoke the land-use rights that you have?

Non-payment of lease fees	Encroachment of other developments	Community resolution to revoke	Other (specify)

The end

APPENDIX E: VALUATION MATRIX USED FOR MODELLING ECOSYSTEM SERVICES

	Use value	Non-use value	Exclude for PAs	Max. attainable	
Water (intakes)	240000000	0	No	unlimited	?
Water (rural)	3	0	No	unlimited	?
Sediment (intakes)	1000000	0	No	unlimited	?
Carbon	2	0	Yes	1000000	?
Hazard mitigation	1	0	No	unlimited	?
Nature based tourism	108000000	0	No	unlimited	?
Environmental quality	10000	0	Yes	unlimited	?
Fuelwood (hardwood)	10	0	No	unlimited	?
Fuelwood (softwood)	6	0	No	unlimited	?
Commercial timber (hardwood)	98	0	Yes	unlimited	?
Commercial timber (softwood)	63	0	Yes	unlimited	?
Domestic timber (hardwood)	98	0	No	unlimited	?
Domestic timber (softwood)	63	0	No	unlimited	?
Commercial inland fisheries	1000	0	Yes	unlimited	?
Artesanal inland fisheries	1000	0	No	unlimited	?
Livestock (grazing)	110	0	No	unlimited	?
Cultural/heritage/spiritual	255000000	0	No	unlimited	?
Non-wood forest products	126	0	No	unlimited	?
Wildlife dis-services	1000	0	No	unlimited	?
Wildlife services	1000	0	No	unlimited	?
Species Richness	0	0	No	unlimited	?
Species Endemism	0	0	No	unlimited	?

Check and Submit

APPENDIX F: CORRELATION MATRIX OF VARIABLES

Correlations Matrix													
		Age	**Gender**	**Education**	**Household size**	**# of Dependants**	**Employment**	**Climate**	**Policy**	**SDG**	**State pre**	**State past**	**State fut**
Age	Pearson Correlation	1	0,147	-0,025	0,269	.511*	0,123	-0,079	0,063	0,209	0,120	-0,043	0,050
	Sig. (2-tailed)		0,492	0,909	0,203	0,011	0,565	0,714	0,770	0,328	0,575	0,840	0,818
Gender	Pearson Correlation	0,147	1	-.587**	0,365	0,347	-.419*	0,000	.426*	0,354	.816**	0,147	0,000
	Sig. (2-tailed)	0,492		0,003	0,079	0,097	0,042	1,000	0,038	0,090	0,000	0,492	1,000
Education	Pearson Correlation	-0,025	-.587**	1	-.664**	-.556**	0,383	-0,284	-0,250	-.514*	-.480*	-.421*	0,179
	Sig. (2-tailed)	0,909	0,003		0,000	0,005	0,065	0,179	0,238	0,010	0,018	0,041	0,403
Household size	Pearson Correlation	0,269	0,365	-.664**	1	.794**	-0,357	-0,033	0,234	0,258	.447*	0,269	0,020
	Sig. (2-tailed)	0,203	0,079	0,000		0,000	0,087	0,880	0,272	0,223	0,028	0,203	0,924
# of dependants	Pearson Correlation	.511*	0,347	-.556**	.794**	1	-0,255	-0,152	0,229	0,401	0,335	0,065	-0,074
	Sig. (2-tailed)	0,011	0,097	0,005	0,000		0,229	0,479	0,283	0,052	0,110	0,763	0,730
Employment	Pearson Correlation	0,123	-.419*	0,383	-0,357	-0,255	1	0,224	-0,179	-0,066	-0,342	-0,206	0,110
	Sig. (2-tailed)	0,565	0,042	0,065	0,087	0,229		0,293	0,404	0,760	0,102	0,335	0,610
Climate	Pearson Correlation	-0,079	0,000	-0,284	-0,033	-0,152	0,224	1	-0,342	0,378	-0,073	-0,079	-0,390
	Sig. (2-tailed)	0,714	1,000	0,179	0,880	0,479	0,293		0,102	0,069	0,736	0,714	0,060
Policy	Pearson Correlation	0,063	.426*	-0,250	0,234	0,229	-0,179	-0,342	1	-0,302	0,174	0,063	.502*
	Sig. (2-tailed)	0,770	0,038	0,238	0,272	0,283	0,404	0,102		0,152	0,416	0,770	0,012
SDG	Pearson Correlation	0,209	0,354	-.514*	0,258	0,401	-0,066	0,378	-0,302	1	0,385	-0,209	-0,397
	Sig. (2-tailed)	0,328	0,090	0,010	0,223	0,052	0,760	0,069	0,152		0,063	0,328	0,055
State pre	Pearson Correlation	0,120	.816**	-.480*	.447*	0,335	-0,342	-0,073	0,174	0,385	1	0,120	0,229
	Sig. (2-tailed)	0,575	0,000	0,018	0,028	0,110	0,102	0,736	0,416	0,063		0,575	0,282
State past	Pearson Correlation	-0,043	0,147	-.421*	0,269	0,065	-0,206	-0,079	0,063	-0,209	0,120	1	0,050
	Sig. (2-tailed)	0,840	0,492	0,041	0,203	0,763	0,335	0,714	0,770	0,328	0,575		0,818
State fut	Pearson Correlation	0,050	0,000	0,179	0,020	-0,074	0,110	-0,390	.502*	-0,397	0,229	0,050	1
	Sig. (2-tailed)	0,818	1,000	0,403	0,924	0,730	0,610	0,060	0,012	0,055	0,282	0,818	
*. Correlation is significant at the 0.05 level (2-tailed).													
**. Correlation is significant at the 0.01 level (2-tailed).													
a. Cannot be computed because at least one of the variables is constant.													