Environmental Ethics & Law
https://journals.zycentre.com/eel

ARTICLE

The Socioeconomic Roots of Biodiversity Loss in Lesotho: A Critical Analysis

Thabang Sekamane

Department of Geography and Environmental Science, National University of Lesotho, Maseru P.O. Box 100, Lesotho

ABSTRACT

This research investigates the correlation between human dependence on natural resources, instances of their unsustainable use, and the subsequent decline in plant and animal biodiversity. The central argument posits that unsustainable resource extraction methods degrade the ecosystem, leading to a reduction in species diversity within the affected region. The study aims to evaluate local perceptions and knowledge of biodiversity, assess the socio-economic impacts of biodiversity loss on employment, income, and identify sustainable resource management strategies that prioritize environmental protection while actively engaging local communities. The research methodology involved direct engagement with residents through surveys, questionnaires, discussions, and group activities to capture a comprehensive understanding of their perspectives on biodiversity, its significance, and lived experiences. Quantitative data from surveys and questionnaires were complemented by qualitative insights from discussions and group activities, revealing the tangible impacts of environmental degradation on livelihoods and economic opportunities. Findings indicated a strong reliance on biodiversity for employment and sustenance within local communities, highlighting the vulnerability of basic needs such as food, water, medicine, and income to resource depletion and environmental damage. The study underscores a critical gap in understanding the intricate links between human activities and environmental consequences, particularly concerning the adoption of sustainable resource management practices that promote community involvement in environmental stewardship. To bridge this gap, the study proposes a comprehensive strategy encompassing educational initiatives, collaborative workshops, and accessible platforms for continuous dialogue and feedback. Future research should focus on the complex interplay between human actions and

*CORRESPONDING AUTHOR:
Thabang Sekamane, Department of Geography and Environmental Science, National University of Lesotho, Maseru P.O. Box 180, Lesotho;
Email: thabangsekamane@gmail.com

ARTICLE INFO
Received: 2 September 2025 | Revised: 20 October 2025 | Accepted: 27 October 2025 | Published Online: 5 November 2025
DOI: https://doi.org/10.63385/eel.v1i2.347

CITATION
Sekamane, T., 2025. The Socioeconomic Roots of Biodiversity Loss in Lesotho: A Critical Analysis. Environmental Ethics & Law. 1(2): 19–36.
DOI: https://doi.org/10.63385/eel.v1i2.347

environmental outcomes with an emphasis on identifying effective resource management.

Keywords: Inequality and Poverty; Governance and Policy; Technological Change; Cultural Values and Beliefs; Conservation Strategies; Sustainability Transitions; Market Failures; Economic Growth Paradigms

1. Introduction

Biodiversity, the variety of life on Earth at all its levels, is under unprecedented threat. This loss extends beyond mere ecological concern, deeply intertwined with socioeconomic activities that sustain human societies. According to Kopnina[1], the unsustainable exploitation of natural resources driven by economic imperatives poses a significant challenge to the planet's ecosystem and the services it provides. Despite growing awareness of the environmental crises, a critical gap persists in understanding the intricate links between human actions and their ecological consequences. Bunch et al.[2] observe that this disconnect is particularly evident in the limited adoption of sustainable resource management practices, which are essential for mitigating biodiversity loss, and promoting long-term ecological health.

Effective conservation strategies necessitate a shift towards community-based approaches that empower local populations to become active stewards of their environment. Shackeroff and Campbell[3] indicate that local communities often possess invaluable traditional knowledge about their surrounding ecosystems, making their involvement crucial for the success of conservation efforts. However, integrating local perspectives and knowledge into environmental management plans requires a thorough understanding of their perceptions of biodiversity, the socioeconomic impacts of its loss and the management practices.

This study addresses the critical need for a holistic understanding of the relationship between biodiversity loss and socioeconomic activities with a specific focus on Lesotho. According to Turner et al.[4], this small mountainous kingdom in Southern Africa is highly dependent on its natural resources for livelihoods, particularly agriculture and livestock herding. The country's rich biodiversity is increasingly threatened by factors such as overgrazing, deforestation, soil erosion, and climate change, leading to significant socioeconomic consequences for its predominantly rural population. To address these challenges, this research aims to: evaluate local perceptions and knowledge of biodiversity; assess the socioeconomic impacts of biodiversity loss on employment and income, and identify sustainable resource management strategies that prioritize environmental protection while actively engaging local communities.

The study employed a research approach that involved direct engagement with residents through surveys, questionnaires, discussions and group activities to capture a comprehensive understanding of their perspectives on biodiversity, its significance and lived experiences. Quantitative data from surveys and questionnaires were complemented by qualitative insights from discussions and group activities, revealing the tangible impacts of environmental degradation on livelihoods and economic opportunities. By combining this survey and questionnaires data, the approach allows for the cross-referencing of information, which, as noted by Creswell and Creswell[5] strengthens the credibility and consistency of the findings.

The findings of this study shed light on the extent of biodiversity loss in Lesotho and its primary drivers. Data indicated a significant decline in native plant and animal's species, coupled with widespread land degradation and water scarcity. The primary drivers of biodiversity loss were identified as unsustainable agricultural practices, overgrazing, deforestation for fuel wood, and the impacts of climate change increased drought frequency and intensity. The study likely focused on above mentioned primary drivers of biodiversity loss in Lesotho due to their direct and significant impact on the local environment and ecosystems. These factors are also closely linked to the socioeconomic activities of the communities in Lesotho, making them key areas for targeted interventions and policy development.

2. Literature Review: Key International Studies

The intergovernmental Science-Policy Services-IPBES is an international body established in 2012 to provide policymakers with scientific assessments about the state of biodiversity, ecosystems and the essential services they provide

to society. Vadto[6] notes that IPBES functioning under the umbrella of the United Nations Environment Programme (UNEP) aims to connect scientific understanding with practical policy-making. These assessments serve as critical resources for governments, organizations, and the public, guiding strategies and actions to protect and restore the natural world. Díaz et al.[7] state that its reports play a vital role in policy development, influencing global agreements and promoting environmentally responsible practices.

The 2019 IPBES report *Global Assessment Report on Biodiversity and Ecosystem Services*[7] marked a significant milestone in understanding the extent and causes of biodiversity loss worldwide. This comprehensive report, compiled by 145 expert authors from 50 countries, synthesized data from thousands of scientific studies, government reports, and indigenous and local knowledge sources. According to Pörtner et al.[8], the report delivered a stark warning: biodiversity is declining at rates unprecedented in human history with severe consequences for economies, livelihood, food security, and quality of life.

One of the key findings of the IPBES 2019 report[7] was that around one million animal and plant species are now threatened with extinction, many within decades. Jareguiberry et al.[9] suggest that this alarming rate of species loss is driven by several direct and indirect factors. The direct drivers include habitat destruction and degradation, overexploitation of resources, pollution, invasive species and climate change. He et al.[10] highlight that the primary reason for habitat loss is the expansion of agriculture, urban development, and infrastructure projects. Overexploitation, such as unsustainable fishing and hunting practices, also contributes significantly to the decline of many species. Kolawole and Iyiola[11] point out that pollution from industrial activities, agriculture and waste disposal contaminants ecosystems, harming biodiversity. Invasive species, introduced intentionally or intentionally, can outcompete native species and disrupt ecological balance. Hulme[12] further explains that climate change exacerbates these threats, altering habitats, shifting species ranges, and increasing the frequency of extreme weather events.

The report also identified several indirect drivers of biodiversity loss, which are the underlying societal factors that exacerbate the direct drivers. Hald-Mortensen[13] indicate that these include population growth, ineffective governance, and excessive consumption habits. Population growth increases the demand for resources, leading to greater habitat destruction and overexploitation. Economic development when pursued unsustainably, can drive deforestation, pollution, and resource depletion. Andersson[14] highlights that government failures, such as weak environmental regulations and a lack of enforcement, allow unsustainable practices to continue unchecked. Unsustainable consumption patterns, particularly in wealthy nations drive demand for products that contribute to biodiversity loss, such as palm oil, beef, and timber.

The 2019 IPBES report[7] emphasized the interconnectedness of biodiversity and human well-being. Scholes[15] notes that essential ecosystem services such as pollination, water purification, and climate regulation are indispensable for human survival and prosperity. The loss of biodiversity undermines these services, threatening food security, water availability, and human health. The report also highlighted the dispassionate impact of biodiversity loss on indigenous peoples and local communities who often depend directly on ecosystem for their livelihoods and cultural survival.

In response to these alarming findings, the 2019 IPBES report[7] called for transformative change across all sectors of society. Voulvoulis et al.[16] clarify that such transformative change entails a fundamental system-wide reorganization encompassing technological, economic, and social elements, including underlying paradigms, goals and values. The report outlines several pathways to achieve this change, including integrated land and water management, sustainable agriculture, reduced consumption and waste, and strengthened environmental governance. Elder[17] further indicates that it stresses the need to transition from a narrow focus on economic expansion to a more comprehensive approach that prioritizes nature and the benefits it provides.

The 2022 IPBES service on the sustainable use of wild species provided further insights into the sustainable use of wild species, emphasizing its importance for both biodiversity conservation and human well-being[18]. Christie et al.[19] state that this assessment, which involved 85 specialists, investigated the utilization of wild plants, animals, fungi, and algae for sustenance, healthcare, energy, leisure, and other applications. The report found that the sustainable use of wild species is essential for the livelihoods of millions of people worldwide, particularly in rural areas and developing countries. However, Ayyad[20] argues that non-renewable methods

are causing the reduction of numerous wild species, imperiling both the variety of life and the communities reliant on them.

The 2022 IPBES report[18] identified several factors that contribute to the unsustainable use of wild species including illegal harvesting, habitat degradation, lack of regulation and climate change. Goboro et al.[21] note that illegal harvesting, such as poaching and unauthorized logging, reduces wild populations and disturbs ecosystems. Habitat degradation driven by deforestation, agriculture, and urbanization, reduces the availability of wild species and their habitats. O'Higgins[22] asserts that inadequate rules and enforcement permit detrimental practices to continue unchecked. Climate change alters habitats, shifts species range, and increases the vulnerability of wild populations to overexploitation.

The 2022 report[18] emphasized the need for integrated and adaptive management approaches to ensure the sustainable use of wild species. Kothari[23] states that this includes strengthening rules and their implementation, promoting conservation efforts led by local communities, supporting sustainable ways for people to earn a living, and addressing climate change. Community-based conservation involves empowering local communities to manage and protect wild species and their habitats, recognizing their traditional knowledge and practices. Bhushan et al.[24] explain that supporting sustainable livelihoods provides alternative income opportunities for communities that rely on wild species, thereby reducing pressure on wild populations. Addressing climate change through mitigation and adaptation measures is essential for protecting wild species and their habitats from the impacts of climate change.

The 2024 IPBES Nexus Assessment[25] investigates the connected problems of climate change, the decline in natural variety, land degradation, and water shortages. King et al.[26] their evaluation explore the intricate relationships among these issues and their consequences for human welfare. It emphasizes that addressing these challenges in isolation is insufficient and that integrated approaches are needed to achieve sustainable development.

A recent evaluation from 2024 points out several critical areas where the issues of climate change, the reduction of diverse species, soil deterioration, and a lack of water converge. According to Cramer et al.[27], the clearing of forests contributes to shifts in climate by emitting carbon dioxide into the air, simultaneously resulting in the loss of biological diversity and the decline of land quality. Unsustainable agriculture contributes to water scarcity through excessive irrigation and pollution while also driving biodiversity loss and land degradation. Furthermore, Dai et al.[28] observe that changes in climate intensify water scarcity by modifying rainfall distribution and elevating the speed at which water evaporates.

The document advocates for comprehensive strategies to address the interrelated issues. For instance, it suggests promoting sustainable land management practices that enhance carbon storage, preserve natural diversity, and improve water access. It further underscores, as noted by Tyagi and Pandya[29], the necessity for consistent policies across various areas, ensuring that regulations concerning climate change, biological diversity, land use, and water resources are harmonized and mutually beneficial. The assessment highlights the importance of stakeholder engagement, involving governments, businesses, civil society and local communities in the development and implementation of integrated solutions.

The IPBES evaluations from 2019, 2022 and 2024 present a thorough and concerning overview of the reduction in life on Earth and the factors causing it. As noted by Edwards et al.[30], these studies highlight the pressing requirement for significant changes across all parts of society to safeguard and restore the environment. The IPBES reports serve as critical resources for policymakers, organizations and the public, guiding strategies and actions to conserve biodiversity and promote a sustainable future.

2.1. Biodiversity Loss in Southern Africa: Socio-Economic Drivers

The article uses case studies of southern African countries experiencing biodiversity loss due to socioeconomic as to understand common drivers, impacts and potential solutions in a similar context to Lesotho. Case studies from Botswana, Namibia and Zimbabwe reveal common drivers such as agricultural expansion, overgrazing, deforestation and illegal wildlife trade, all exacerbated by poverty, population growth and weak governance. Richardson[31] suggests that these actions stem from the necessity of providing for one's life, ensuring a stable food supply and promoting economic advancement, all of which put considerable strain on natural resources.

According to Matopote et al.[32], livestock farming, a key economic activity in Botswana, contributes to excessive grazing and environmental degradation. Byers[33] notes that Namibia suffers from a decline in biological variety due to mining ventures and the unsustainable exploitation of natural assets. Furthermore, Dhliwayo[34] indicates that Zimbabwe's challenges include the removal of forests for agricultural purposes and energy provision, alongside unlawful hunting fueled by economic hardship. Lesotho, a high-altitude, mountainous kingdom, presents a unique scenario. According to Maro[35], the reduction in its biological diversity stems from soil erosion caused by excessive grazing and environmentally damaging farming methods on steep inclines. Unlike its neighbors, Lesotho's mountainous terrain and limited arable land intensify the pressure on its fragile ecosystems. This article will enrich existing literature by offering localized insights into the intricate relationship between socio-economic factors and biodiversity loss in a distinct environment, uncovering specific challenges and opportunities not apparent in broader regional studies.

2.2. Theoretical Framework

Integrated Assessment Models-(IAM) and the Actual Application of the Model in Lesotho

Integrated Assessment Models-IAMs are valuable tools for analyzing complex environmental issues like biodiversity loss, offering a structured approach to integrate diverse factors and exploring future scenarios. However, Liu and Panagiotakos[36] point out that their practical use demands careful consideration of data limitations, their inherent complexity, potential biases and the computational resources required. In Lesotho, the application of IAMs can be tailored to address the specific drivers of biodiversity loss within the country's unique environmental and socioeconomic context. To effectively apply IAMs in Lesotho, the initial step involves identifying the key drivers of biodiversity loss. Maja and Ayano[37] suggests these may include the destruction of natural habitats due to expanding agriculture and urban development, excessive grazing, the impacts of climate change like more frequent droughts and the unsustainable collection of natural resources. Data on these drivers will be obtained from government reports, scientific studies conducted in Lesotho and local surveys.

Once the primary contributing factors have been determined and measured, Spangenberg[38] indicates that the subsequent step is to establish the links between these factors and various biodiversity indicators. This may involve utilizing existing environmental simulations or constructing simpler relationships based on specialized knowledge and local information. For example, Oliveira Fiorini et al[39] propose that an IAM could predict the consequences of land degradation on plant cover and the variety of species or the impacts of climatic changes on the geographical distribution of important plant and animal populations. These IAMs can then be utilized to forecast the results of different management strategies on biodiversity in Lesotho. Branca et al.[40] suggest that this could involve comparing hypothetical future scenarios with varying levels of habitat preservation, sustainable land management practices and measures to reduce climate change effects. As an illustration, Pamuk et al.[41] note that such a model could evaluate the effectiveness of community-led conservation efforts, tree-planting initiatives or the adoption of climate-resilient agricultural techniques.

A key advantage of AIMs is their ability to comprehensively consider the interconnectedness of different factors contributing to biodiversity decline. In Lesotho, as noted by Richardson[31], this is particularly vital because ecological problems are frequently linked with socioeconomic factors, including economic hardship, food security and access to natural assets. An AIM can integrate these aspects, providing a more complete understanding of the problem's complexity and the trade-offs involved in conservation efforts. As Azimi et al.[42] demonstrate, an AIM could simulate the impacts of animal grazing on pasture deterioration and water supply while also taking into account the financial importance of livestock to resident groups and potential governmental measures such as grazing regulation schemes and alternative income sources. This allows for a more detailed and realistic appraisal of conservation approaches in Lesotho, ensuring they are both beneficial for the environment and fair to society.

3. Methods

3.1. Study Area

The study focused in biodiversity loss in the eastern part of Maseru, Lesotho, as it is a critical area of study due

to its unique ecological significance and the specific threats it faces. This region, characterized by its varied topography and proximity to urban development, likely harbors a concentration of endemic and endangered species adapted to its particular environmental conditions. Investigating biodiversity loss in this area allows for a focused understanding of the impacts of habitat destruction, pollution and climate change on a sensitive ecosystem. As noted by Schwartz[43], this kind of investigation can highlight specific conservation necessities and inform targeted strategies to protect vulnerable flora and fauna, along with their natural settings.

Focusing on the eastern part of Maseru, rather than other areas in Lesotho, is justified by several factors. First, its location near the capital city exposes it to intense anthropogenic pressure, making it a bellwether for the broader environmental challenges facing the country. Scanes[44] indicates that urban development, more intense agricultural practices and the extraction of natural resources are likely to be most pronounced in this specific area, resulting in the division and deterioration of natural habitats. Second, the eastern part of Maseru may possess unique geological or hydrological features that support distinct biological communities not found elsewhere in Lesotho. Studying this area allows researchers to identify and protect these unique ecosystems before they are irreversibly damaged. The findings from this study served as a model for understanding and addressing biodiversity loss in similar peri-urban environments throughout Lesotho and other developing countries. By concentrating efforts on this critical zone, researchers maximized the impact of their work and contributed to more effective conservation strategies.

3.2. Data Collection

3.2.1. Research Approach

To thoroughly investigate the decline of natural variety in eastern Maseru, Lesotho, it is necessary to employ a mix of research techniques for a comprehensive understanding. Numerical information, collected through surveys, quantified the extent of damage to natural living spaces, the decrease in plant and animal numbers and contamination levels. These surveys targeted randomly chosen homes and businesses across the eastern region. Structured questionnaires were used to gauge environmental awareness, resource usage habits and perceived effects of biodiversity loss. Descriptive information, obtained through interviews and group discussions, provided insights into local communities' perspectives, experiences and traditional wisdom concerning natural diversity. Interviews included key individuals such as local leaders, agricultural workers and environmental experts to explore their understanding of the causes and outcomes of biodiversity decline. Group discussions assembled diverse community members to converse about their observations, concerns and potential remedies.

3.2.2. Sampling Method

Biodiversity, the variety of life at all levels of biological organization, is essential for ecosystem stability and human well-being. However, human activities, particularly the exploitation, harvesting and overuse of natural resources, are major drivers of biodiversity decline worldwide. That is why this study employed snowball and convenience sampling methods to investigate the relationship between human exploitation, harvesting and overuse of natural resources and biodiversity decline. Parker et al.[45] explain that snowball sampling involves identifying an initial set of participants who then refer additional potential individuals, while convenience sampling entails selecting participants who are readily available. Snowball sampling has been useful for reaching populations that are difficult to access. Nonetheless, Drury and Stott[46] suggest it can introduce bias as participants are often connected and may hold similar viewpoints. On the other hand, convenience sampling was used because it was relatively easy and inexpensive, though it may not be representative of the population as a whole.

Even with their drawbacks, certain non-probability sampling methods, such as snowball and convenience, sampling have provided valuable understanding of the intricate connection between human actions and the reduction of biological diversity. According to Mace[47], comprehending the primary causes of this ecological loss allows for the development of more effective approaches to nature preservation and responsible resource use.

3.2.3. Study Population

The study on biodiversity loss in eastern Maseru, Lesotho, involved interviews with 30 out of 40 participants. The interviewees comprised 10 local farmers, 10 household representatives and 10 environmental experts. This compo-

sition aims to capture diverse perspectives on the causes and impacts of biodiversity loss within the community.

3.2.4. Data Collection Methods

To investigate biodiversity loss in eastern Maseru, Lesotho, data collection employed interviews and focus groups targeting local farmers, household representatives and environmental experts. The study also conducted a comprehensive review of documents, including scientific reports, policy papers and global databases, to gather contextual information on biodiversity loss in Lesotho and globally. Gupta et al.[48], this supplementary data is expected to offer insights into prevailing patterns, contributing factors and consequential effects, thereby informing the study's analytical processes and proposed recommendations. A researcher and a helper conducted questionnaires. Prior to engaging with individuals, the research emphasized ethical conduct by adhering to rigorous guidelines. Explicit consent was obtained from all participants, ensuring their full comprehension of the study's objectives and their personal entitlements. Confidentiality was strictly maintained to safeguard participants' privacy. Substantive feedback will be provided to participants and cultural awareness was consistently observed throughout the study to acknowledge varied backgrounds and beliefs, thus protecting their welfare and rights.

Interviews, conducted with key informants like the chief, farmers and environmental experts, explored their understanding of the causes and consequences of biodiversity loss. For the 10 local farmers, interviews focused on their agricultural practices, observed changes in crop yields and plant diversity and perceptions of soil health and water availability. They were asked about their use of pesticides and fertilizers, traditional farming methods and any challenges they face due to biodiversity loss, such as increased pest infestations or reduced access to wild plants for food or medicine.

Interviews with 10 environmental experts aimed to gather scientific perspectives on the extent and drivers of biodiversity loss in the area. They were asked about their research findings, monitoring data and assessment of the effectiveness of conservation interventions. Their insights into the ecological impacts of habitat destruction, pollution and climate change were crucial. Focus groups, comprised diverse community members, provided a platform for discussing observations, concerns and potential solutions related to biodiversity loss. These discussions explored local knowledge, identified common challenges and generated ideas for community-based conservation initiatives. The data collected from these sources provided a comprehensive understanding of biodiversity loss in eastern Maseru, informing targeted conservation strategies and promoting community engagement in environmental stewardship.

3.2.5. Data Validation and Triangulation

To ensure the validity of findings, this study employed data validation and triangulation. Data validation involved rigorous checks for accuracy and consistency within each data source. Triangulation compared and contrasted data from different sources and methods, including surveys, interviews and observations. This process involved cross-checking information, seeking corroboration across sources to confirm key themes and addressing any discrepancies through further investigation and analysis. Ahmed[49] indicates that this multifaceted approach strengthens the reliability and trustworthiness of the study's conclusions.

3.2.6. Data Analysis

Content data analysis was employed to analyze qualitative data collected from interviews and focus groups in the eastern part of Maseru, Lesotho, to understand biodiversity loss. The primary goal was to identify recurring themes, patterns and narratives that emerge from the data, complementing statistical analysis of quantitative data to provide a holistic assessment. The data, gathered from 10 local farmers, 10 household representatives and 10 environmental experts, was analyzed to reveal common perceptions and experiences related to biodiversity loss. Interviews with key informants like local chiefs, farmers and environmental experts provided insights into their understanding of the cause and consequences of biodiversity loss. Focus groups with diverse community members offered a platform to discuss observations, concerns and potential solutions.

The content analysis involved a systematic coding process to categories and classify the data. Themes such as deforestation, overgrazing, climate change impacts and unsustainable agricultural practices emerged. By identifying these themes, the analysis helped in understanding the drivers of biodiversity loss and its impact on local communities. The narratives provided context to the statistical data, enriching the overall assessment and informing targeted conservation strategies.

3.2.7. Methodological Transparency

A comprehensive research plan is vital for a study on biodiversity decline in eastern Maseru, Lesotho to ensure its methods are clear, reliable and reproducible. The investigation began by precisely outlining its goals, boundaries and the specific questions it aimed to answer concerning biodiversity loss. The geographic borders of the study area were accurately defined and the justification for selecting this location was provided, considering factors like its ecological importance and ease of access. Sample collection techniques were thoroughly detailed, including the methods used to choose sampling sites. The size and number of sample plots were specified along with the rules for their positioning. Methods for gathering information to evaluate biological diversity were fully explained and consistent guidelines were adhered to. Consequently, Sivathanu et al.[50] emphasize that data handling and storage procedures should be established to guarantee data accuracy and availability.

To enhance transparency, the study documented any limitations or potential sources of errors, such as observer bias or incomplete species identification. According to Winkfield et al.[51], quality assurance measures, such as inter-observer calibration and data validation, should be implemented and reported. Finally, the study adhered to ethical guidelines, including obtaining necessary permits and respecting local communities and their knowledge. Such comprehensive documentation, Closa[52] notes, allows other researchers to comprehend, appraise and reproduce the methodologies, thereby fostering methodological openness and enhancing the credibility of the findings.

4. Presentation of Collected Data

4.1. Qualitative Data Collection

The study on biodiversity loss in eastern Maseru, Lesotho, employed a mixed-methods approach, combining qualitative and quantitative data collection techniques for a comprehensive investigation. Semi-structured interviews were conducted to gather in-depth perspectives from local communities and experts on the perceived impacts and drivers of biodiversity loss. Recognizing the challenges of accessing specific populations, the study utilized snowball sampling, where initial participants referred other knowledgeable individuals. Convenience sampling was employed to capture readily available data from accessible locations and participants. As noted by Hunter and Brehm[53], this integrated sampling approach ensured the inclusion of a wide array of perspectives, thereby enriching the comprehension of biodiversity reduction in the area. The integration of interview data with quantitative ecological surveys provided a holistic assessment of the issue.

4.2. Focus Group Discussion

The study employed focus group discussions to gather in-depth insights from participants about their experiences. Three focus group discussions were conducted, each comprising 8-10 participants representing diverse community members, including farmers, women, youth and elders. Participants were selected using a combination of snowball and convenience sampling methods. Snowball sampling was utilized to reach individuals with specific experiences or characteristics relevant to the study's objectives. Convenience sampling was employed to recruit participants who were readily accessible and willing to participate. A structured focus group discussion guide was developed to ensure consistency across all focus group sessions. The guide included open-ended questions and prompts designed to stimulate discussion and encourage interaction among participants. The guide covered key topics like:

- They share their observations of change in plant and animal populations, habitat conditions and ecosystem services over time;
- Their concerns about the impacts of biodiversity loss on their livelihoods, food security, water resources, cultural heritage and overall well-being.
- Local knowledge and practices related to biodiversity conservation: i.e., they share their traditional knowledge, practices and beliefs related to biodiversity conservation and sustainable resource management.
- Provide solutions for biodiversity conservation, including community-based conservation initiatives, sustainable agriculture practices and policy recommendations.

4.3. Document Review

This study employed a comprehensive review of relevant documents to gather contextual information and sec-

ondary data on biodiversity loss in Lesotho and globally. Sources included IPBES reports, especially the 2019 *Global Assessment Report on Biodiversity and Ecosystem Services*, the 2022 *Assessment Report on the Diverse Values and Valuation of Nature* and any forthcoming reports in 2024. As highlighted by Díaz et al.[7], these publications evaluate the global status of biodiversity encompassing the factors contributing to its decline, its impacts on human well-being and potential approaches for conservation and sustainable use. National Biodiversity Strategies and Action Plans (NBSAPs) provided insights into Lesotho's particular conservation priorities, objectives and methods. Environmental policies and legislation outlined the legal framework governing biodiversity protection. Scholarly literature furnished empirical data and research outcomes from peer-reviewed articles, research papers and academic texts on biodiversity decline in Lesotho and similar ecological systems. Concurrently, grey literature offered valuable local knowledge and unpublished data from government bodies, Non-Governmental Organizations (NGOs) and international agencies engaged in biodiversity preservation in Lesotho. Data extraction and synthesis were utilized to pinpoint key patterns, causes and effects of biodiversity loss, enabling a comparative examination between Lesotho's situation and global trends.

4.4. Data Discussion

The research investigated local perceptions and knowledge of biodiversity in eastern Maseru, assessed the socioeconomic impacts of biodiversity loss on employment and income, and identified sustainable resource management strategies that prioritize environmental protection while actively engaging local communities. The discussion is structured around the status of biodiversity in eastern Maseru and the drivers of biodiversity loss.

4.4.1. Status of Biodiversity in Eastern Maseru

Regarding the status of biodiversity, the research included a baseline assessment of the current status of biodiversity including the diversity and abundance of plant and animal species, the extent and conditions of natural habitats and the provision of ecosystem services. Skivington et al.[54] assert that comprehending the current situation is vital before analyzing alterations or formulating conservation strategies. The research also examined trends in biodiversity loss over time, identified the species and habitats most valuable to decline and analyses the spatial distribution across eastern Maseru, identified areas of high biodiversity value and areas most affected by biodiversity loss. Butchart et al.[55] indicate that assessing trends in biodiversity decline involves identifying susceptible species and habitats which should then be contrasted with contemporary observations to highlight the pace and character of this loss. Therefore, Salem[56] suggests that Geographic Information System (GIS) tools and spatial analysis are beneficial for visualizing and interpreting the geographical configuration of biological diversity.

4.4.2. Drivers of Biodiversity Loss

Regarding the drivers of biodiversity loss, the research studied the relationship between livelihood activities and biodiversity loss, examining how agricultural practices, livestock grazing and resource extraction contribute to habitat degradation and species decline. Natarajan et al.[57] emphasize that understanding these interconnections is essential for creating sustainable economic options. The study also evaluated the effectiveness of governmental frameworks and regulations in safeguarding biodiversity. Seidenfeld[58] notes that this assessment includes pinpointing deficiencies in policy implementation, collaborative efforts and public involvement. Bull et al.[59] further suggest that proposed policies ought to prioritize reinforcing these particular areas.

The research also explored cultural attitudes and beliefs that influence people's relationship with nature, examining how traditional knowledge and practices contribute to biodiversity conservation. According to Hannah et al.[60], incorporating these elements into conservation plans can enhance their effectiveness. Furthermore, it considered the economic and social conditions that drive biodiversity loss, including market incentives that promote unsustainable practices, population growth, urbanization and migration patterns. Nijkamp et al.[61] assert that scrutinizing these incentives and proposing alternative economic frameworks that acknowledge the value of biodiversity is fundamental. Concurrently, O'Sullivan[62] highlights that comprehending demographic pressures is beneficial for formulating sustainable development plans. The research also assessed the impact of environmental factors on biodiversity, including climate change, pollution, and invasive species, significantly impacting biodiversity. Tallis et al.[63] emphasize that evaluating these effects and formulating strategies to reduce their harm is

vital for conserving biodiversity.

4.4.3. Impacts of Biodiversity Loss

The collected data revealed that biodiversity reduction significantly endangered livelihoods and food security. The decline in plant and animal populations reduced agricultural productivity, impacting crop yields and livestock production. Pinstrup-Andersen and Pandya-Lorch[64] highlight that access to wild edibles which are crucial for many communities, is also compromised. Data added that this disruption can lead to malnutrition and economic instability, particularly in regions heavily reliant on natural resources. The data further indicated that this disturbance can lead to poor nutrition and financial instability, particularly in areas heavily dependent on natural assets. Couceiro et al.[65] note that extensive tree felling and habitat destruction impair water purity by augmenting sedimentation and contaminants. The quantity and availability of water are also affected, as forests play a vital role in regulating water cycles and ensuring a consistent supply. Naiman and Dudgeon[66] contend that these environmental alterations can lead to water deficits, negatively impacting farming, public health and overarching human prosperity.

Information also showed that ecosystem deterioration from biodiversity decline had severe repercussions for water sources. According to Pretty[67], many communities have deep-rooted connections with their natural surroundings and the vanishing of essential species has diminished inherited customs and understanding. Additionally, Clark et al.[68] pointed out that this decline can have profound social and emotional consequences, eroding social cohesion and cultural strength. Data showed human health at risk due to biodiversity loss. Changes in ecosystem services have affected disease transmission, air and water quality and access to medicinal plants. According to Dasgupta[69], a reduction in natural predators can result in more disease-carrying organisms, while the deterioration of water supplies can subject populations to dangerous contaminants. The loss of medicinal plants has limited access to traditional healthcare, particularly in rural areas.

4.4.4. Potential Solutions for Biodiversity Conservation

Information indicated that environmentally friendly farming methods present a hopeful way to lessen agriculture's adverse effects on biodiversity. Fahad et al.[70] state that practices like agroforestry, conservation tillage and integrated pest management can improve soil quality, decrease pesticide application and enhance the variety of life within cultivated lands. Shah and Wu[71] add that these approaches can boost agricultural output while simultaneously protecting the environment. Evidence showed that local conservation efforts had enabled residents to oversee and preserve their natural assets. By involving residents in these efforts, Naughton-Treves et al.[72] explain that such initiatives can cultivate a sense of ownership and responsibility, leading to more successful and lasting conservation results. Supporting these initiatives can help protect biodiversity while improving the livelihoods of local communities.

Information revealed that policy actions are key to advancing biodiversity preservation. Reinforcing environmental rules, establishing protected zones and offering incentives for sustainable land management can help guard biodiversity more broadly. Schwartz et al.[73] suggest that these interventions form a foundational structure for conservation, ensuring that biodiversity is acknowledged and protected in all decision-making processes. Information indicated that public awareness campaigns are vital for informing people about biodiversity's significance and the necessity for preservation. Novacek[74] explains that by utilizing various communication platforms, including workshops, radio programs and social media, these initiatives can effectively highlight threats to biodiversity and motivate collective action. Reddy et al.[75] further observe that enhanced public understanding contributes to increased support for conservation efforts and encourages more environmentally sound behaviors.

4.4.5. Integration of IPBES Findings

The study's findings are closely aligned with the global trends highlighted in the IPBES reports, particularly concerning biodiversity loss and ecosystem degradation. In eastern Maseru, the observed declines in indigenous plant species, reductions in pollinator populations and the degradation of wetland ecosystems wetland ecosystem mirror the broader global pattern of biodiversity erosion documented by IPBES. This local context underscores the relevance and applicability of IPBES's global assessments at the regional level, demonstrating that the challenges identified by IPBES are not merely theoretical but are actively unfolding in specific locales like eastern Maseru. The study reinforces the urgent

need for concerted action to address these interconnected environmental issues.

Furthermore, the study applies the IPBES framework for transformative change to identify potential pathways for achieving sustainable development and biodiversity conservation in eastern Maseru. By analyzing the drivers of biodiversity loss, such as urbanization, agricultural expansion and pollution, the study pinpoints leverage points for intervention. These include promoting sustainable land-use practices, implementing stricter environmental regulations and fostering community engagement in conservation efforts. The application of the transformative change framework allows for the development of targeted strategies that address the root causes of environmental degradation, aligning local actions with global sustainability goals. This approach not only enhances the effectiveness of conservation initiatives but also contributes to building a more resilient and ecologically balanced urban environment.

The study contributes to the IPBES knowledge base by providing local-level data and insights that can inform future assessments and policy recommendations. The detailed ecological surveys, socio-economic analysis and stakeholder consultations conducted in eastern Maseru offer a rich source of empirical evidence that can be used to refine and validate IPBES's global models and projections. By highlighting the specific challenges and opportunities present in eastern Maseru, the study adds nuance and context to the broader understanding of biodiversity loss and ecosystem services. This localized knowledge is invaluable for tailoring policy interventions to the unique needs and circumstances of different regions, ultimately enhancing the effectiveness of global conservation efforts. The study thus serves as a critical link between global assessments and local action, enriching the IPBES knowledge base and supporting evidence-based decision-making.

4.4.6. Data Validation and Triangulation

Data triangulation was central to ensuring the validity of this study's findings. The research employed multiple methods, including interviews, focus groups and document reviews to gather comprehensive data. Cross-checking information across these sources revealed both convergence and divergence. For instance, initial interviews suggested a particular trend which was subsequently supported by findings from the focus groups. Document reviews, such as policy reports and internal communications further corroborated this trend, strengthening the evidence base.

Seeking corroboration involved verifying findings with independent sources. Scientific data, government statistics and expert opinions were consulted to validate the primary data collected. In cases where discrepancies arose, further investigation was conducted. For example, if statistical data contradicted interviews responses, additional interview were carried out to explore the reasons for the divergence. This iterative process helped in refining the interpretations and ensuring a more accurate representation of the phenomenon under study.

Addressing discrepancies was crucial for maintaining the integrity of the research. When inconsistencies were identified, the research team revisited the original data, conducted additional data collection or refined the analytic approach. This rigorous process of comparing and contrasting data from different sources and methods enhanced the trustworthiness and reliability of the study's conclusions. The triangulation process not only validated the findings but also provided a more nuanced and comprehensive understanding of the research topic.

4.4.7. Ethical Consideration

The research adhered to rigorous ethical considerations to protect participants' rights and well-being. The study was conducted in accordance with the Declaration of Helsinki, and approved by UNISA Institutional Review Board (approval No. IRB-2015-017, 15 May 2015). Prior to conducting interviews and focus groups, informed consent was obtained from all participants. This process, as noted by Pollock[76], ensured that each person fully grasped the study's aim, potential risks and advantages; and their freedom to withdraw at any point without repercussions. Confidentiality was meticulously maintained throughout the research. Participants' data were anonymized to prevent identification and all data were stored securely to protect against unauthorized access. After the data analysis, the findings will be shared with participants and relevant stakeholders, providing them with an opportunity to review the results and offer their comments. Furthermore, the research was conducted with a deep respect for the cultural values and beliefs of the communities involved. Research methods were adapted to ensure cultural sensitivity, promoting inclusively and minimizing the risk of causing offense or harm.

4.5. Results

IPBES reports have consistently presented quantitative data illustrating the alarming trends in biodiversity loss across the globe. The 2019 IPBES Report [7] highlighted critical indicators revealing a severe degradation of the ecosystem and escalating extinction rates. This assessment pointed out that approximately 1 million animal and plant species are threatened with extinction, rate tens to hundreds of times higher than the average over the past 10 million years. Terrestrial ecosystems have experienced a 47% reduction in natural habitats globally relative to estimated baselines, while wetlands have suffered a drastic 87% loss since 1700. Furthermore, populations of wild vertebrate species have substantially declined, with native species in terrestrial biomes falling by 20%. Agricultural biodiversity is also diminishing with over 9% of all domesticated breeds of mammals used for food and agriculture having become extinct and at least 1000 more threatened.

The 2022 IPBES report [18] identified five primary drivers of biodiversity loss, ranked by their relative global impact, as shown in **Figure 1** below. Land-use change involving the conversion of natural habitats such as forests, grassland and wetlands to agriculture, urban areas and infrastructure are the most significant drivers. Direct exploitation, including overfishing, hunting, logging and harvesting of species, directly reduces populations and disrupts ecosystems. Climate change with rising temperature altered precipitation patterns and increased frequency of extreme weather events, impact species distribution and ecosystem functions. Pollution from industrial, agricultural and urban sources contaminates habitats, harms species and disrupts ecological processes. Invasive alien species, through introduction and spread, outcompete native species, alter habitats and transmit diseases.

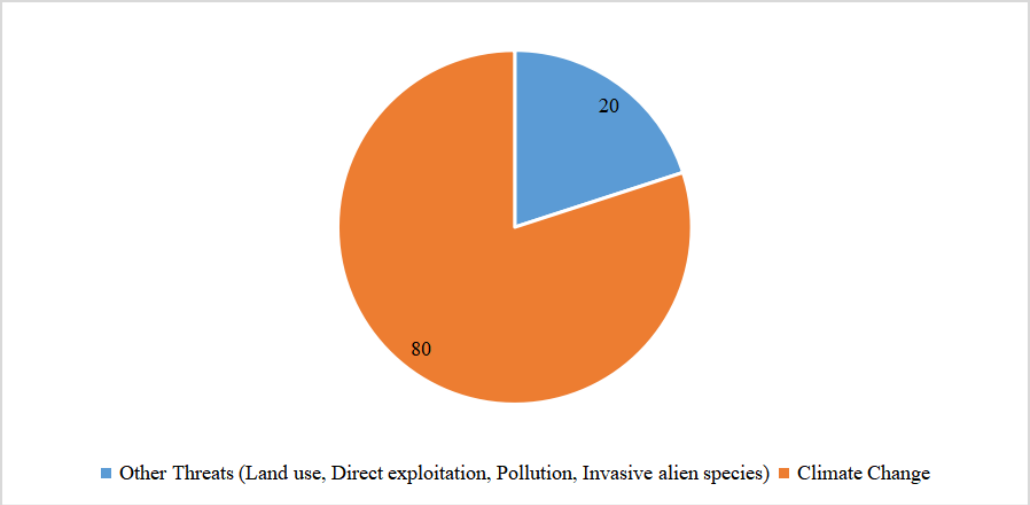

Figure 1. Threats to Biodiversity.

Source: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [18].

4.5.1. Impacts of Biodiversity Loss

Biodiversity loss has profound ecological and human societal impacts as follows:

Ecological Impacts

Ecologically, the reports highlighted the decline in ecosystem functioning. For example, the 2019 report estimated that global pollination services, crucial for 75% of food crops, have declined by up to 40% in some regions due to pollinator loss. This directly impacts agricultural yields, with potential economic losses reaching hundreds of billions of dollars annually. Furthermore, the reports quantify the disruption of food webs through metrics such as the trophic level index, which shows a decline in higher-level predators in many ecosystems, indicating a simplification of food web structure. The 2022 report [18] emphasizes the reduced resilience of simplified ecosystems, noting a correlation between species diversity and ecosystem stability in the face of climate change. Quantitative models predict that ecosystems with low biodiversity are significantly more

likely to undergo abrupt shifts in responses to environmental stressors.

The human societal impacts of biodiversity loss are equally concerning. The IPBES reports present data on food security, indicating a decline in crop yields due to the loss of pollinators and soil organisms. For instance, the 2024 report[25] estimates that soil degradation driven by biodiversity loss has reduced agricultural productivity by 20% in some regions. Water scarcity is also threatened with the degradation of watersheds and wetlands, leading to reduced availability of clean water. Quantitative assessments show a direct link between wetland loss and increased water treatment costs for human consumption. In terms of human health, the report highlights the increased risk of zoonotic diseases due to biodiversity loss, with models predicting a higher frequency of disease outbreaks in areas with degraded ecosystems. The economic impacts are substantial with the loss of ecosystem services affecting industries such as agriculture, fisheries, tourism and forestry. The 2019 report[7] estimates that the economic value of lost ecosystem services could reach trillions of dollars annually, underscoring the urgent need for biodiversity conservation.

4.5.2. 2022–2024: Evolving Understanding and the 2024 Thematic Assessment (Nexus and Transformative Change)

IPBES reports provide crucial quantitative data illustrating the alarming trends in biodiversity loss. Examining the IPBES reports alongside the evolving understanding presented in the 2022–2024 assessments reveals a deepening crisis and the urgent need for transformative change. The IPBES reports[7, 18, 25] presented stark figures on species extinction rates, habitat loss, and ecosystem degradation, as shown by **Figures 2–4**. The reports highlighted that around one million animal and plant species are now threatened with extinction, many within decades, a rate unprecedented in human history. The 2019 report[7] quantified habitat loss, noting that over 85% of wetlands had been lost globally, see **Figure 4**. Forest areas have also declined significantly, with substantial losses in tropical regions due to agricultural expansion and logging. Furthermore, the report provided quantitative data on the decline of pollinators essential for crop production with significant implications for food security. **Figures 1–4** underscore the severe impact of human activities on biodiversity and ecosystems worldwide.

The IPBES assessment from 2022–2024 has built upon these findings emphasing the interlinkages between biodiversity loss, climate change, land degradation and sustainable development. These assessments have adopted a nexus approach, highlighting the need for integrated solutions that address multiple environmental challenges simultaneously. For instance, the assessments have quantified the impact of land degradation on biodiversity, showing how deforestation and unsustainable agricultural practices lead to habitat fragmentation and species decline. They have also provided data on the contribution of biodiversity loss to climate change, emphasizing the role of forest and other ecosystems in carbon sequestration. The 2024 thematic assessments further stress the need for transformative change across all sectors of society. This includes strengthening environmental regulations, promoting sustainable land use planning and fostering international cooperation to protect biodiversity. Reforming subsidies that harm biodiversity, promoting environmental education and fostering a sense of stewardship for nature are also identified as key strategies.

Social and cultural change is another critical aspect highlighted in the IPBES assessments. Empowering local communities, promoting environmental education and fostering a sense of stewardship for nature are essential for achieving transformative change. Quantitatively, this can be measured through indicators such as increased participation of local communities in conservation initiatives, improved environmental literacy rates and changes in consumption patterns towards more sustainable products and services.

Quantitative data from these reports also shed light on the economic dimensions of biodiversity loss. The assessments have quantified the economic value of ecosystem services such a pollination, water purification and climate regulation, demonstrating the significant costs associated with their degradation. They have also highlighted the economic benefits of investing in biodiversity conservation and sustainable development, such as increased agricultural productivity, improved water quality and enhanced resilience to climate change. By providing this quantitative evidence, the IPBES reports make a compelling case for integrating biodiversity consideration into economic decision-making.

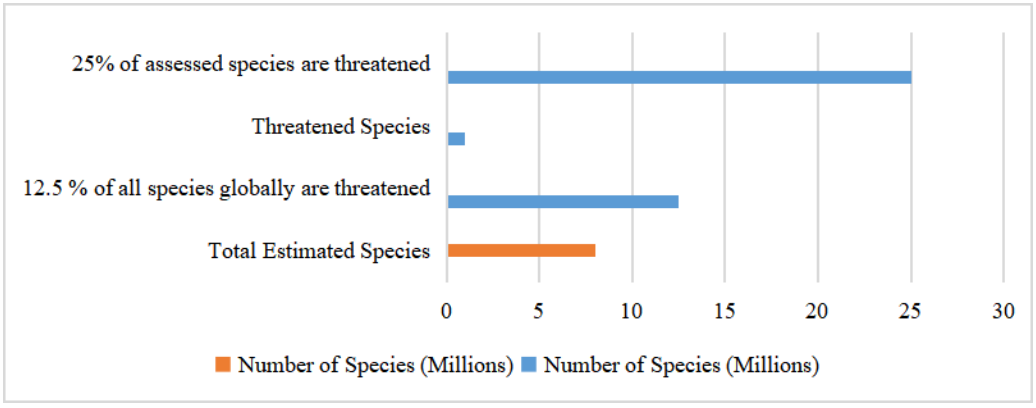

Figure 2. Global Species: Total vs Threatened.

Source: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [18].

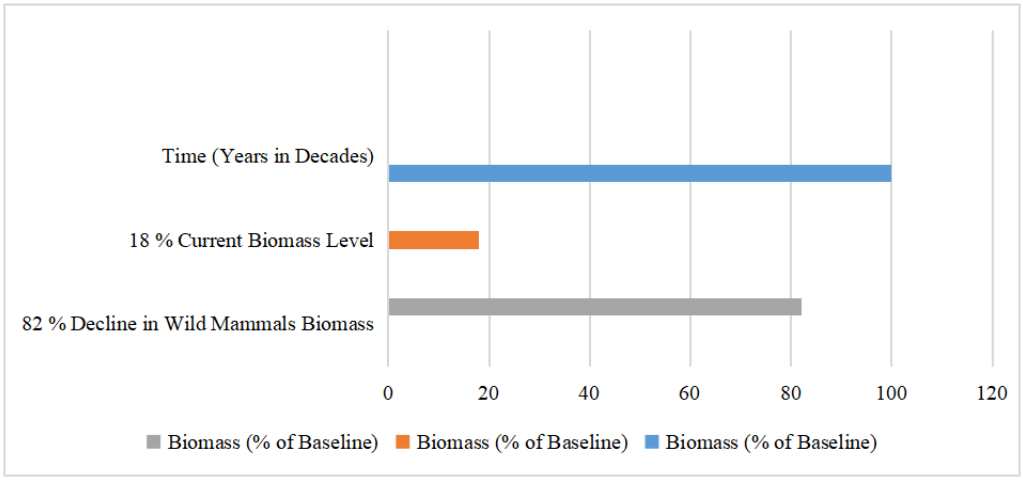

Figure 3. Decline in Wild Mammals Biomass Over Time.

Source: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [18].

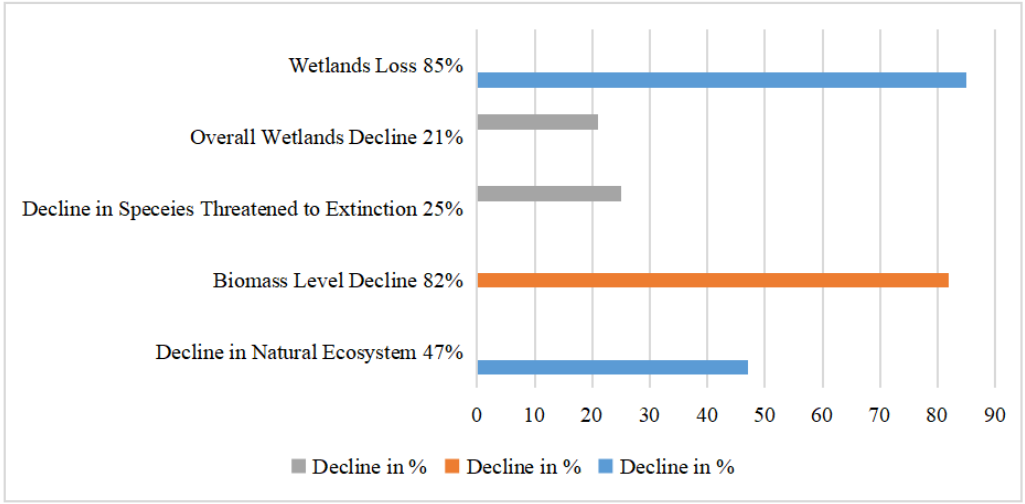

Figure 4. Ecosystem Condition Decline.

Source: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2019, 2022, 2024 [7, 18, 25]).

5. Future Research

Future research should focus on conducting more detailed ecological survey to assess the status of specific species and ecosystems, investigating the economic value of biodiversity and ecosystem services and evaluating the effectiveness of community conservation initiatives. Ultimately, effective biodiversity conservation requires a collaborative and integrated approach involving local communities, government agencies, NGOs and the private sector. Empowering local communities to participate in decision-making processes and benefit from the sustainable use of natural resources is paramount. By working together, communities can protect the biodiversity of the eastern part of Maseru and ensure a sustainable future for its people.

6. Conclusions

This study underscores the critical importance of biodiversity conservation and sustainable development in the eastern part of Maseru. The findings highlight the urgent need to address the drivers of biodiversity loss, mitigate their impacts and promote sustainable resource management practices. While this research provides valuable insights, it is essential to acknowledge its limitations.

Recommendations

The recommendations stemming from the biodiversity loss study in eastern Maseru, Lesotho, outline a multi-faceted approach targeting policymakers, conservation practitioners and local communities. These recommendations, designed to be Specific, Measurable, Achievable, Relevant and Time-bound (SMART) are grounded in scientific evidence and tailored to the local context. Firstly, the study emphasizes policy and institutional reforms advocating for stronger environmental laws and regulations, enhanced enforcement capabilities for government agencies, and improved coordination among stakeholders. Secondly, it champions community-based conservation programs empowering local communities through resource access, training, and technical assistance to actively manage and conserve biodiversity. Thirdly, the adoption of sustainable resource management practices is recommended to mitigate the drivers of biodiversity loss, including the promotion of sustainable agriculture, pollution reduction and invasive species control. Fourthly, the study underscores the importance of environmental education and awareness programs to increase public understanding of biodiversity conservation through educational materials, workshops and community events. Finally, the establishment of a research and monitoring program is proposed to track biodiversity changes and evaluate the effectiveness of conservation efforts, involving regular surveys of plant and animal populations, water quality monitoring, and climate change impact assessments.

Funding

All the funding comes from Zhongyu International Education Centre.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by UNISA Institutional Review Board (approval No. IRB-2015-017, 15 May 2015).

Informed Consent Statement

Prior to conducting interviews and focus groups, informed consent was obtained from all participants.

Data Availability Statement

The data will be available on request from the author.

Acknowledgments

I would like to appreciate the support from Zhongyu International Education Centre.

Conflicts of Interest

The author declares no conflict of interest.

References

[1] Kopnina, H., 2016. The victims of unsustainability: A challenge to sustainable development goals. International Journal of Sustainable Development and World Ecology. 23(2), 113–121.

[2] Bunch, M.J., Morrison, K.E., Parkes, M.W., et al., 2011. Promoting health and well-being by managing for social–ecological resilience: The potential of integrating ecohealth and water resources management approaches. Ecology and Society. 16(1), 6. DOI: https://doi.org/10.5751/ES-03803-160106

[3] Shackeroff, J.M., Campbell, L.M., 2007. Traditional ecological knowledge in conservation research: Problems and prospects for their constructive engagement. Conservation and Society. 5(3), 343–360.

[4] Turner, S.D., Calder, R., Gay, J., et al., 2001. Livelihoods in Lesotho. CARE Lesotho: Maseru, Lesotho.

[5] Creswell, J.W., Creswell, J.D., 2018. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications: Thousand Oaks, CA, USA.

[6] Vadrot, A.B.M., 2016. The birth of a science-policy interface for biodiversity: The history of IPBES. In: Hrabanski, M., Pesche, D. (Eds.). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). Routledge: London, UK. pp. 53–89.

[7] Díaz, S., Settele, J., Brondízio, E.S., et al. (Eds.), 2019. Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services. IPBES Secretariat: Bonn, Germany. DOI: https://zenodo.org/records/3553579

[8] Pörtner, H.O., Scholes, R.J., Agard, J., et al., 2021. IPBES–IPCC Co-Sponsored Workshop: Report on Biodiversity and Climate Change—Workshop Report. IPBES and IPCC: Bonn, Germany.

[9] Jaureguiberry, P., Titeux, N., Wiemers, M., et al., 2022. The direct drivers of recent global anthropogenic biodiversity loss. Sci Adv. 8(45), eabm9982.

[10] He, C., Liu, Z., Tian, J., et al., 2014. Urban expansion dynamics and natural habitat loss in China: A multiscale landscape perspective. Global Change Biology. 20(9), 2886–2902.

[11] Kolawole, A.S., Iyiola, A.O., 2023. Environmental pollution: Threats, impact on biodiversity, and protection strategies. In: Izah, S.C., Ogwu, M.C. (Eds). Sustainable Utilization and Conservation of Africa's Biological Resources and Environment. Springer Nature Singapore: Singapore. pp. 377–409.

[12] Hulme, P.E., 2005. Adapting to climate change: Is there scope for ecological management in the face of a global threat? Journal of Applied Ecology. 42(5), 784–794.

[13] Hald-Mortensen, C., 2023. The main drivers of biodiversity loss: A brief overview. Journal of Ecology and Natural Resources. 7(3), 000346.

[14] Andersson, T., 1991. Government failure—The cause of global environmental mismanagement. Ecological Economics. 4(3), 215–236.

[15] Scholes, R.J., 2016. Climate change and ecosystem services. Wiley Interdisciplinary Reviews: Climate Change. 7(4), 537–550.

[16] Voulvoulis, N., Giakoumis, T., Hunt, C., et al., 2022. Systems thinking as a paradigm shift for sustainability transformation. Global Environmental Change. 75, 102544.

[17] Elder, M., 2025. Integration versus prioritization in the Sustainable Development Goals: An argument to prioritize environmental sustainability and a just transition. Sustainable Development. 33(1), 465–477.

[18] Fromentin, J.-M., Emery, M.R., Donaldson, J., et al. (Eds.), 2022. Summary for Policymakers of the Thematic Assessment of the Sustainable Use of Wild Species of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). IPBES Secretariat: Bonn, Germany. DOI: https://doi.org/10.5281/zenodo.6425599

[19] Christie, M., Martín-López, B., Church, A., et al., 2019. Understanding the diversity of values of "Nature's contributions to people": Insights from the IPBES Assessment of Europe and Central Asia. Sustainability Science. 14(5), 1267–1282.

[20] Ayyad, M.A., 2003. Case studies in the conservation of biodiversity: Degradation and threats. Journal of Arid Environments. 54(1), 165–182.

[21] Goboro, E.M., Mbise, F.P., Ngongolo, K., 2025. The effects of illegal wildlife activities on biodiversity in few selected African countries. African Journal of Ecology. 63(3), e70055.

[22] O'Higgins, E.R., 2006. Corruption, underdevelopment, and extractive resource industries: Addressing the vicious cycle. Business Ethics Quarterly. 16(2), 235–254.

[23] Kothari, A., 2006. Community conserved areas: Towards ecological and livelihood security. Parks. 16(1), 3–13.

[24] Bhushan, S., Dincă, I., Shikha, S., 2024. Evaluating local livelihoods, sustainable forest management, and the potential for ecotourism development in Kaimur Wildlife Sanctuary, India. Frontiers in Forests and Global Change. 7, 1491917. DOI: https://doi.org/10.3389/ffgc.2024.1491917

[25] McElwee, P.D., Harrison, P.A., van Huysen, T.L. (Eds.), 2024. Summary for Policymakers of the Thematic Assessment Report on the Interlinkages among Biodiversity, Water, Food and Health of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat: Bonn, Germany. DOI: https://doi.org/10.5281/zenodo.13850289

[26] King, M.F., Renó, V.F., Novo, E.M., 2014. The concept, dimensions and methods of assessment of human well-being within a socioecological context: A literature review. Social Indicators Research. 116(3), 681–698.

[27] Cramer, W., Bondeau, A., Schaphoff, S., et al., 2004. Tropical forests and the global carbon cycle: Impacts of atmospheric carbon dioxide, climate change and rate of deforestation. Philosophical Transactions of the Royal Society B: Biological Sciences. 359(1443), 331–343.

DOI: https://doi.org/10.1098/rstb.2003.1428

[28] Dai, A., Zhao, T., Chen, J., 2018. Climate change and drought: A precipitation and evaporation perspective. Current Climate Change Reports. 4(3), 301–312.

[29] Tyagi, S.P., Pandya, M.H., 2024. Legal Frameworks for Sustainable Water Resource Management: Integrating Land, Mineral, and Biodiversity Conservation. International Journal of Law Management & Humanities. 7(5), 1687–1706. DOI: https://doij.org/10.10000/IJLMH.118421

[30] Edwards, P., Juhola, S., Saxena, P., et al. (Eds.), 2024. Towards Sustainable Transformation: Research Priorities in Climate Change and Biodiversity. Office of the European Union: Luxembourg, Luxembourg.

[31] Richardson, R.B., 2010. Ecosystem services and food security: Economic perspectives on environmental sustainability. Sustainability. 2(11), 3520–3548.

[32] Matopote, G., Joshi, N.P., Manatsha, B.T., 2025. Agricultural production, its challenges and state intervention in Botswana: A historical perspective. Cogent Social Sciences. 11(1), 2480726. DOI: https://doi.org/10.1080/23311886.2025.2480726

[33] Byers, B.A., 1997. Research Discussion Paper Number 21: Environmental Threats and Opportunities in Namibia: A Comprehensive Assessment. Directorate of Environmental Affairs, Ministry of Environment and Tourism:Windhoek, Namibia.

[34] Dhliwayo, I. Emerging threats and the socio-ecological resilience of local communities, South East Zimbabwe [PhD Thesis]. Chinhoyi University of Technology: Chinhoyi, Zimbabwe.

[35] Maro, P., 2011. Environmental Change in Lesotho: An Analysis of the Causes and Consequences of Land-Use Change in the Lowland Region. Springer Science & Business Media: Dordrecht, Netherlands.

[36] Liu, F., Panagiotakos, D., 2022. Real-world data: A brief review of the methods, applications, challenges and opportunities. BMC Medical Research Methodology. 22(1), 287.

[37] Maja, M.M., Ayano, S.F., 2021. The impact of population growth on natural resources and farmers' capacity to adapt to climate change in low income countries. Earth Systems and Environment. 5(2), 271–283.

[38] Spangenberg, J.H., 2007. Biodiversity pressure and the driving forces behind. Ecological Economics. 61(1), 146–158.

[39] Oliveira Fiorini, A.C., Rua Rodriguez Rochedo, P., Angelkorte, G., et al., 2023. Investigating biodiversity trends in different mitigation scenarios with a national integrated assessment model. Journal of Integrative Environmental Sciences. 20(1), 2239323.

[40] Branca, G., Lipper, L., McCarthy, N., et al., 2013. Food security, climate change, and sustainable land management: A review. Agronomy for Sustainable Development. 33(4), 635–650.

[41] Pamuk, H., van Asseldonk, M., Wattel, C., et al., 2022. Community-based approaches to support the anchoring of climate-smart agriculture in Tanzania. Frontiers in Climate. 4, 1016164.

[42] Azimi, M., Heshmati, G.A., Farahpour, M., et al., 2013. Modeling the impact of rangeland management on forage production of sagebrush species in arid and semi-arid regions of Iran. Ecological Modelling. 250, 1–14.

[43] Schwartz, M.W., 2012. Using niche models with climate projections to inform conservation management decisions. Biological Conservation. 155, 149–156.

[44] Scanes, C.G., 2018. Chapter 19—Human activity and habitat loss: Destruction, fragmentation, and degradation. In: Scanes, C.G., Toukhsati, S.R. (Eds.). Animals and Human Society. Academic Press: Cambridge, MA, USA. pp. 451–482.

[45] Parker, C., Scott, S., Geddes, A., 2019. Snowball sampling. In: Atkinson, P., Delamont, S., Cernat, A., et al. (Eds.). SAGE Research Methods Foundations. SAGE Publications Ltd.: London, UK.

[46] Drury, J., Stott, C., 2001. Bias as a research strategy in participant observation: The case of intergroup conflict. Field Methods. 13(1), 47–67.

[47] Mace, G.M., 2010. Chapter 19: Drivers of biodiversity change. In: Leader-Williams, N., Adams, W.M., Smith, J. (Eds.). Trade-Offs in Conservation: Deciding What to Save. Blackwell Publishing Ltd.: Oxford, UK. pp. 349–364.

[48] Gupta, A., Deokar, A., Iyer, L., et al., 2018. Big data and analytics for societal impact: Recent research and trends. Information Systems Frontiers. 20(2), 185–194.

[49] Ahmed, S.K., 2024. The pillars of trustworthiness in qualitative research. Journal of Medical, Surgical and Public Health. 2, 100051.

[50] Sivathanu, G., Wright, C.P., Zadok, E., 2005. Ensuring data integrity in storage: Techniques and applications. In Proceedings of the ACM Workshop on Storage Security and Survivability, Fairfax, VA, USA, 11 November 2005; pp. 26–36.

[51] Winkfield, B., Aubé, C., Burtin, P., et al., 2003. Inter-observer and intra-observer variability in hepatology. European Journal of Gastroenterology and Hepatology. 15(9), 959–966.

[52] Closa, C., 2021. Planning, implementing and reporting: Increasing transparency, replicability and credibility in qualitative political science research. European Political Science. 20(2), 270–280.

[53] Hunter, L.M., Brehm, J., 2003. Qualitative insight into public knowledge of, and concern with, biodiversity. Human Ecology. 31, 309–320.

[54] Skivington, K., Matthews, L., Simpson, S.A., et al., 2021. Framework for the development and evaluation of complex interventions: Gap analysis, workshop and consultation-informed update. Health Technology As-

sessment. 25(57), 1–132.
[55] Butchart, S.H.M., Walpole, M., Collen, B., et al., 2010. Global biodiversity: Indicators of recent declines. Science. 328(5982), 1164–1168.
[56] Salem, B.B., 2003. Application of GIS to biodiversity monitoring. Journal of Arid Environments. 54(1), 91–114.
[57] Natarajan, N., Newsham, A., Rigg, J., et al., 2022. A sustainable livelihoods framework for the 21st century. World Development. 155, 105898.
[58] Seidenfeld, M., 1999. Empowering stakeholders: Limits on collaboration as the basis for flexible regulation. William and Mary Law Review. 41, 411.
[59] Bull, F.C., Bellew, B., Schöppe, S., et al., 2004. Developments in national physical activity policy: An international review and recommendations towards better practice. Journal of Science and Medicine in Sport. 7(1), 93–104.
[60] Hannah, L., Midgley, G.F., Millar, D., 2002. Climate change–integrated conservation strategies. Global Ecology and Biogeography. 11(6), 485–495.
[61] Nijkamp, P., Vindigni, G., Nunes, P.A., 2008. Economic valuation of biodiversity: A comparative study. Ecological Economics. 67(2), 217–231.
[62] O'Sullivan, J.N., 2020. The social and environmental influences of population growth rate and demographic pressure deserve greater attention in ecological economics. Ecological Economics. 172, 106648.
[63] Tallis, H., Kennedy, C.M., Ruckelshaus, M., et al., 2015. Mitigation for one and all: An integrated framework for mitigation of development impacts on biodiversity and ecosystem services. Environmental Impact Assessment Review. 55, 21–34.
[64] Pinstrup-Andersen, P., Pandya-Lorch, R., 1998. Food security and sustainable use of natural resources: A 2020 vision. Ecological Economics. 26(1), 1–10.
[65] Couceiro, S.R., Hamada, N., Luz, S.L., et al., 2007. Deforestation and sewage effects on aquatic macroinvertebrates in urban streams in Manaus, Amazonas, Brazil. Hydrobiologia. 575(1), 271–284.
[66] Naiman, R.J., Dudgeon, D., 2011. Global alteration of freshwaters: Influences on human and environmental well-being. Ecological Research. 26(5), 865–873.
[67] Pretty, J., 2011. Interdisciplinary progress in approaches to address social-ecological and ecocultural systems. Environmental Conservation. 38(2), 127–139.
[68] Clark, N.E., Lovell, R., Wheeler, B.W., et al., 2014. Biodiversity, cultural pathways, and human health: A framework. Trends in Ecology and Evolution. 29(4), 198–204.
[69] Dasgupta, N., 2009. Control of diseases of the air and land. In: Nemerow, N.L., Agardy, F.J., Sullivan, P. (Eds.). Environmental Engineering: Prevention and Response to Water-, Food-, Soil-, and Air-Borne Disease and Illness. John Wiley & Sons, Inc.: Oxford, UK. pp. 99–173.
[70] Fahad, S., Chavan, S.B., Chichaghare, A.R., et al., 2022. Agroforestry systems for soil health improvement and maintenance. Sustainability. 14(22), 14877.
[71] Shah, F., Wu, W., 2019. Soil and crop management strategies to ensure higher crop productivity within sustainable environments. Sustainability. 11(5), 1485.
[72] Naughton-Treves, L., Holland, M.B., Brandon, K., 2005. The role of protected areas in conserving biodiversity and sustaining local livelihoods. Annual Review of Environment and Resources. 30, 219–252.
[73] Schwartz, M.W., Cook, C.N., Pressey, R.L., et al., 2018. Decision support frameworks and tools for conservation. Conservation Letters. 11(2), e12385.
[74] Novacek, M.J., 2008. Engaging the public in biodiversity issues. Proceedings of the National Academy of Sciences of the United States of America. 105(Suppl 1), 11571–11578.
[75] Reddy, S.M., Montambault, J., Masuda, Y.J., et al., 2017. Advancing conservation by understanding and influencing human behavior. Conservation Letters. 10(2), 248–256.
[76] Pollock, K., 2012. Procedure versus process: Ethical paradigms and the conduct of qualitative research. BMC Medical Ethics. 13(1), 25.