



INTERDISCIPLINARY DOCTORAL SCHOOL

Faculty of Silvicultural and Forest Engineering

Ibrahim Odinga OSEWE

Tools for livelihood improvement in tropical rain forest. Case study of Kakamega forest in Kenya.

SUMMARY

Scientific supervisor

Prof.Dr. Eng Bogdan POPA.

BRAŞOV, 2026

Contents

List of Figures	5
List of Tables	6
LIST OF ABBREVIATIONS	7
ACKNOWLEDGMENTS	8
CHAPTER 1: INTRODUCTION AND BACKGROUND	9
1.2 Conceptual framework	10
1.3 Research aim and questions.	11
1.4 Research design and analytical logic	12
1.5 Methodological approach.....	13
1.6 Case study justification.	14
1.7 Structure of the theses	15
CHAPTER 2: KNOWLEDGE BASE – PROVIDE KNOWLEDGE GAPS IN SYSTEM UNDERSTANDING THAT WAS UTILIZED IN THE THESIS.	17
1.1 Materials and Methods	17
1.2 Results and conclusion	18
CHAPTER 3: POLICY TOOLS (PES) – ASSESSED A COMBINATION OF FACTORS THAT CONTRIBUTES TO PES SUCCESS, WHICH IS CRUCIAL FOR IMPROVED LIVELIHOOD OUTCOMES.	20
3.1 Introduction	20
3.2 Methods	20
3.2 Results	21
3.2 Conclusion.....	23
CHAPTER FOUR: ES PERCEPTION AND SOCIO-ECONOMIC FACTORS – KEY SOCIO- ECONOMIC FACTORS SHAPING ES PERCEPTION, ACCESS, UTILIZATION, AND LAND USE DECISION.	24
4.1 Introduction	24
4.2 Method and results.....	24
4.2 Conclusion.....	27

CHAPTER FIVE: ES PERCEPTION AND SOCIO-ECONOMIC FACTORS – KEY SOCIO-ECONOMIC FACTORS SHAPING ES PERCEPTION AND LIVELIHOOD STRATEGIES.	28
5.1 Introduction	28
5.2 Method and results	28
5.3 Conclusion	30
CHAPTER SIX: THREATS AND PRESSURE – RECOGNIZE THE FEEDBACK TO FOREST SYSTEM SUCH AS PERCEIVED THREATS AND PRESSURES ON CONSERVATION.	31
6.1 Introduction	31
6.2 Method and results	31
6.3 Conclusion	33
CHAPTER SEVEN: COPING STRATEGIES – ASSESS THE RESPONSE TO SHOCKS AND THE INFLUENCE OF SOCIO-ECONOMIC FACTORS ON CHOICE OF COPING STRATEGIES TO SHOCKS.....	34
7.1 Introduction	34
7.2 Method and results	34
7.3 Conclusion	37
CHAPTER EIGHT: SYNTHESIS AND CONTRIBUTION – CONNECTION OF RESULTS ACROSS CHAPTERS AND ORIGINAL RESEARCH CONTRIBUTION.	38
8.1 Introduction to the synthesis	38
8.1.1 Cross cutting findings	38
8.1.2 Trade-offs and system dynamics	39
8.1.3 Policy implications	41
8.1.4 Synthesis conclusion	42
8.2 Overall conclusion	43
8.3 Original research contributions	44
8.4 Implications for policy and practice	45
8.5 Limitation of the research	45
8.6 Future research direction	46
8.7 Novelty of the research in region.	47

8.8 Dissemination of results.	48
8.8.1: Publications based on PhD thesis	48
8.8.2: Papers presented at national conferences.	48
8.8.3: Papers presented at international conferences	49
Reference (full list in included in PhD thesis).....	49

List of Figures

Figure 1: Socio-ecological conceptual framework

Figure 2: Study area map.

Figure 3: ROSES structure employed to retrieve the analysed research articles.

Figure 4: Frequency of the acknowledged ES among respondents (N = 453).

Figure 6. Factors influencing ES acknowledgement.

Figure 7: Perception of the challenges faced by local communities across the wealth categories

Figure 8: Household self-identified shocks and choice of coping strategies.

List of Tables

Table 1. Criteria used to analyse PES cases in Kenya. Uganda and Tanzania

Table 2. Analyzed PES schemes classification.

LIST OF ABBREVIATIONS

MEA – Millenium Ecosystem Assessment

ES – Ecosystem Services

PES – Payment for Ecosystem Services

KFE – Kakamega Forest Ecosystem

KFS – Kenya Forest Service

KWS – Kenya Wildlife Service

FGD – Focus Group Discussion

KII – Key Informant Interview

PELIS – Plantation Establishment for Livelihood Improvement Scheme

PFM – Participatory Forest Management

CFA – Community Forest Association

ANOVA – ANalysis Of Variance

NTFP – Non-Timber Forest Product

IGAs – Income Generating Activities

NF – Natural Forest

PF – Planted Forest

OL – Owned land

SLF – Sustainable Livelihood Framework

ACKNOWLEDGMENTS

I would like to extend my deepest gratitude to my scientific supervisor Prof. Dr. Eng Bogdan Popa for his valuable support, guidance, and encouragement throughout the research and writing process. His patience, expertise, and constructive feedback have been instrumental in shaping this research and helping me grow as a researcher. I am also grateful to the members of the supervisory committee, Prof Claudiu Coman, for his valuable insights during data collection in Kenya. Prof. Dr. Eng Aureliu Florin Hălălişan, and Prof. Dr. Eng. Ionescu Ovidiu, for their valuable insightful comments, suggestions, and encouragement, which have significantly improved quality of the research. Additionally, I would like to thank Dr Nicolea Talpa in the socio-economic and policy department for his support throughout the doctoral research.

I would also express my gratitude to Transilvania University of Brasov for supporting my doctoral research through the international graduates of UNITBV programs number DGRIAE-1445/III/8/CMJ/26.07.2022. Additionally, the support of Kenya Forest Research Institute (KEFRI) through a collaboration agreement REF: KEFRI/56/04/VOL.1(145) helped in field data collection in Kenya through international mobility program. Dr Joram Kagombe for hosting us at KEFRI and Dr Leila Ndalilo at KEFRI Kakamega for her guidance and field data collection assistance. I extend my appreciation to Kakamega Forest Community Forest Association in Lurambi, Shinyalu, Navakholo and Malava for their warm welcome and guidance within the local communities during field data collection. The doctoral research was approved by the Kenya National Commission for Science, Technology, and Innovation (NACOSTI) under license number NACOSTI/P/23/30073 and from Kenya Forest Service (KFS) under research license number REF: RESEA/1/KFS/VOL.VIII/89.

I am dedicating this work to my late mother, Catherine Atieno Osewe. Her love, strength, and unfailing faith in me continue to motivate and direct my life. I am also grateful for my family's love and support, especially Titus, Erick, and Dennis, whose encouragement, patience, and presence have been a source of strength throughout my journey. I treasure and love you all.

CHAPTER 1: INTRODUCTION AND BACKGROUND

Forest ecosystem services (ES) are the benefits human populations benefit from the ecosystems, and they are importance to human well-being (MEA, 2005). ES also play a vital role in supporting local livelihoods (Nizam et al., 2019). The forests provide provisioning ES such as firewood, water, food, sand, honey, and medicinal plants which are essential for the survival and income of local communities. They also offer regulating services, including erosion control, air quality, pollination, control of pest and diseases, and water purification, which reduce disaster risk and sustain agriculture. Furthermore, forests contribute to cultural services by supporting aesthetic value, spiritual, religious, and educational values, as well as recreation and ecotourism. In addition, they provide supporting services such as nutrient cycling and soil formation, which maintain ecosystem health (MEA, 2005).

Communities that rely heavily on forest for their livelihoods are often more vulnerable, especially when resources become limited and scarce (Mamo et al., 2007). People who rely significantly on forests for food, firewood, timber, and income are directly affected by policy changes, deforestation, and climate change (Saalu et al., 2020). This reliance can also put enormous pressure on forest ecosystems, as illegal logging, over harvesting and land conversion to agricultural land increase to meet expanding demands (Bösch, 2021). As a results, forest degradation reduces the availability of critical resources, creating a cycle where declining forest health deepens vulnerability and poverty, making it difficult for communities to adapt and sustain their livelihoods (Bonye et al., 2023).

Existing solutions aim to balancing livelihood needs with forest conservation while reducing pressure on forest and vulnerability. Payment for Ecosystem Service (PES) provides economic incentives to communities for protecting forests and maintaining service such as water regulation, biodiversity, and carbon storage, thereby creating alternative income generating sources (Sattler et al., 2013). Participatory forest management (PFM) involves local forest communities in sustainable use of forest resources and decision making, reducing overextraction and improving local stewardship (Tadesse et al., 2017). In addition, supportive forest regulations and policies promotes reforestation, conservation, and the controlled use of resources while recognizing community rights. Together, these approaches help ease pressure on forests, create more sustainable and equitable livelihood opportunities, and enhance resilience of forest dependent population (Angelsen et al., 2014).

A key challenge in addressing forest-based livelihoods is the fragmented understanding and implementation of these existing solutions. Although these approaches are designed to

balance livelihood needs with conservation and reduce pressure on forests and vulnerability, they are often applied in isolation rather than integrated strategies. This results in limited knowledge sharing, gaps in coordination, and inconsistent outcomes across communities and regions. Consequently, the full potential of these solutions is not fully realized, weakening their effectiveness in addressing the interconnected challenges of forest degradation, high dependency, and socio-economic vulnerability. Existing literature often examines ES, policy tools, and socio-economic factors in isolation, with limited integration of how these elements shapes livelihood outcomes and resilience in forest dependent communities.

1.2 Conceptual framework

The thesis presents a socio-ecological systems conceptual framework in which forest generate ES which is translated into livelihood outcomes shaped by interconnected processes. The framework integrates the four pillars such as ES, socio-economic context, shocks, and coping strategies, to demonstrate how they interact dynamically to determine both livelihoods and human well-being.

The first pillar is the socio-economic factors as conditioning filters – the framework posits that socio-economic context is not a static background but an active conditioner of how households interact with the forest.

The second pillar is shock as the catalyst for forest dependency – a key innovation of this conceptual model is the explicit integration of shocks and stressors.

The third pillar is pressure feedback loop (the resilience) – the framework conceptualizes livelihood outcomes (well-being and resilience) as the direct result of the interaction between ES use, livelihood strategies and coping mechanism.

The fourth pillar is advancing socio-ecological livelihood systems - by integrating these elements, the thesis advances a socio-ecological understanding that resilience is not just an ecological property but a household-level dynamic.

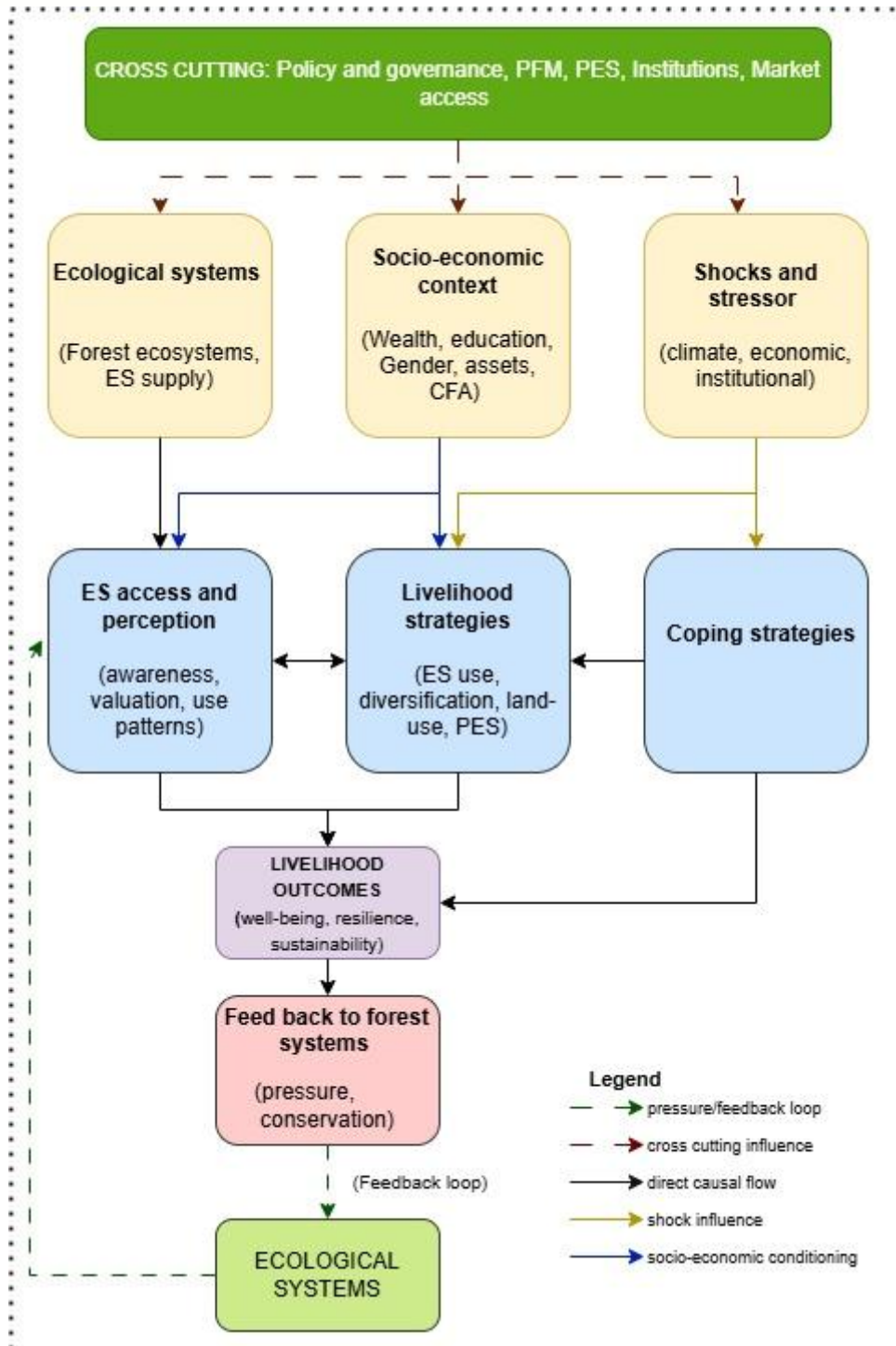


Figure1: Socio-ecological conceptual framework

1.3 Research aim and questions.

The aim of this thesis is to analyse how ES, socio-economic factors, and institutional mechanisms interact to shape livelihood outcomes and resilience in forest-dependent communities.

The research question is: How do ES, socio-economic factors, and institutional mechanisms interact to shape livelihood outcomes and resilience in forest dependent communities?

To address this research question, the objective of the thesis are as follows:

1. To carry out extensive literature review of the socio-ecological system understanding.
2. To determine the factors affecting the success of Payment of Ecosystem Services (PES) as a policy instrument to improve livelihood.
3. To analyse how socio-economic context shape ecological systems for improving PFM and ensuring mutual benefits for both the forest and the community.
4. To investigate how socio-economic factors influence the ecological system acknowledgment among communities living around Kakamega Forest.
5. To explore the feedback to forest systems to KFE across the socio-economic factors.
6. To investigate households coping strategies and how socio-economic factors and their interactions influence coping strategies in face of multiple and overlapping shocks.

1.4 Research design and analytical logic

Each aspect of the conceptual framework is analysed through one study as follows:

1. Literature review of the system understanding: This study presents a comprehensive review to identify research gaps using ROSES framework, laying the groundwork for the thesis research. It identifies knowledge gaps through the lens of key elements of sustainable livelihood framework, and the research methods utilized in the identified case studies.
2. PES models as policy tools: This study presents a critical analysis of PES across three East African countries through a comparative approach. It highlights the key elements of the PES models that affect the success of PES model. The study provides a useful benchmark for decision makers on PES performance, and the model presented may serve as a tool for improving livelihoods and supporting the achievement of sustainable development goals.
3. ES perception on access and valuation: This study identifies the ES utilized by the local community in KFE, along with their associated contribution to well-being, their perceived importance, and the land uses that support the ES flows, disaggregated by socio-economic factors. The study also highlights the importance of management strategies that incorporate diverse community perspectives and promote the equitable and sustainable use of forest resources.
4. Socio-economic factors differentiation: This study examines how human/social capital, spatial/institutional access, and economic capital influence the acknowledgement of the forest ES. It employs descriptive statistics and binary logistic regression for analysis. Additionally, the study identifies critical areas for intervention, including livelihood enhancement.

5. Socio-ecological system pressures and threats: This study explores perceived changes in ES, forest condition, and the significance of threats to Kakamega forest, as well as the challenges faced by local communities across different socio-economic groups. Additionally, it provides valuable policy insights on community outreach, agricultural practices, forest harvesting, and the monitoring of PFM.
6. Shocks coping mechanisms: This study investigates the types of shocks experienced by the KFE local communities, the coping strategies they employ, and the how the socio-economic characteristics and their interactions influence the choice of these strategies. Regression models are used in the analysis. Additionally, the study demonstrates the importance of forest resources as a safety net and highlights the need for enhanced forest governance to avoid poverty traps and foster community resilience.

All taken together, these components offer a comprehensive analysis of the ES-livelihood systems and its effects on livelihood improvement.

1.5 Methodological approach

Doctoral research employed a mixed methods approach, integrating both qualitative and quantitative research methods to capture the complexity of both human experience and measurable outcomes. Qualitative research approaches seek to explore and explain social phenomena by examining participants' experiences, perceptions, and the meaning they place on various aspects of their lives. These approaches emphasize context and rely on descriptive patterns, data, and themes identified by the researcher (Creswell, 2009; Patricia, 2014).

While quantitative research is a systematic approach used to quantify variables and generalize results. Its primary objective is to establish relationships and predict outcomes through statistical analysis (Creswell, 2009). Qualitative research methods, particularly statistical analyses, are crucial for validating hypothesis.

The qualitative methods utilized in data collection included the following:

Focus group discussions (FDG) – This method was used to identified the types of ES utilized by the local communities, the reason for their preference, the land use practices supporting the ES flow, use of the identified ES, threats facing KFE, challenges faced by the local communities, shocks experienced by the community, and coping strategies employed to identified shocks. The FGD was conducted in three research locations in KFE, each consisting of 8-10 participants selected purposively.

Key Informant Interviews (KIIs) –The KIIs covered similar aspects addressed in the FGDs. Their main aim was to add and verify the aspects derived from the FGDs. The participants included

participants with specialized knowledge and experience relevant in the research area. The outcome also informed the household survey.

Wealth ranking focus groups – The approach was utilized to identify KFE socio-economic indicators to classify households. The approach uses community knowledge to gain a better understanding of socio-economic processes that traditional quantitative metrics, such as asset and income evaluations, may overlook. The focus groups were conducted in each research location and included five participants chosen through snowball sampling, such as local leaders, senior community members, and CFA executives.

Household survey – The questionnaire for the survey was based on data from KII and FGD. The questionnaire was pretested by CFA members to identify any potential issues, such as misinterpretation and time requirement. Testing concluded when no further issue was identified. The questionnaire consisted of four sections: (1) profile of the respondents. (2) wealth and income of the households. (3) shocks experienced, (4) benefits obtained from the forest, as well as threats and pressures affecting socio-ecological systems.

Prior to the data collection, ethical approval was obtained from the university. Participants were informed about the objectives of the study, their right to withdraw at any time without any consequences, and the confidentiality of their responses.

1.6 Case study justification.

KFE provides an ideal case study to analyze the interaction between ES, livelihood strategies, and socio-economic factors within the proposed socio-ecological framework (see figure 2). KFE is located in the western part of Kenya (34°52' E; 0°19 N), with a total protected area of 133km² comprising of grasslands, bushland, near natural forest, and tea plantation at the forest edge (Mitchell et al., 2009).

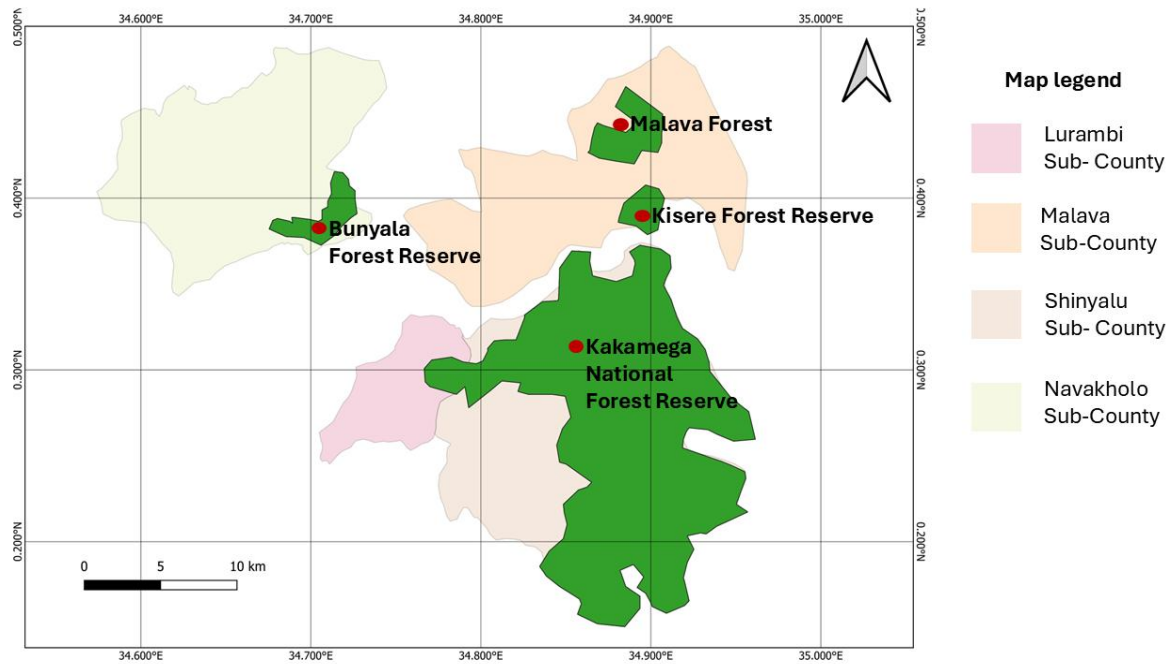


Figure 2: Study area map.

KFE is distinguished by its high dependence on forest resources for both income and subsistence needs, making the forest ES central to local livelihoods (Saalu et al., 2020). Similarly, differences in the socio-economic profiles of household, shaped by constraints and capacities. The complexity of governance – particularly the coexistence of approaches such as PFM and PES – further allows assessment of how institutional arrangements mediate access to, and benefit from, ES.

Furthermore, the regions exposure to economic and environmental shocks, such as inflation and climate variability, makes it possible to examine how adaptation strategies and resilience are shaped within ES-livelihood system. Together, these key features make KFE a critical case study for applying the socio-ecological framework to understand how social, ecological, and institutional dynamics interact to affect livelihood outcomes.

1.7 Structure of the theses

The PhD thesis is structured into manuscript-format chapters, each focusing on a distinct subject as follows:

Chapter 2: Knowledge base – provide knowledge gaps in system understanding that was utilized in the thesis.

Chapter 3: Policy tools (PES) – assessed a combination of factors that contributes to PES success, which is crucial for improved livelihood outcomes.

Chapter 4-5: ES perception and socio-economic factors – identified key socio-economic factors shaping ES perception, access, utilization, land use decisions, and livelihood strategies

Chapter 6: Threats and pressure – recognize the feedback to forest system such as perceived threats and pressures on conservation.

Chapter 7: Coping strategies – assess the response to shocks and the influence of socio-economic factors on choice of coping strategies to shocks.

Chapter 8: Synthesis and contribution – connection of results across chapters and original research contribution.

Each chapter contributes to specific aspects of the socio-ecological conceptual framework in figure 1.

CHAPTER 2: KNOWLEDGE BASE – PROVIDE KNOWLEDGE GAPS IN SYSTEM UNDERSTANDING THAT WAS UTILIZED IN THE THESIS.

1.1 Materials and Methods

The aim of the chapter was to identify the research gaps in the area of the relationships between local communities and KFE. Whereby the chapter present the relevant country and local context to identify knowledge gaps, identify topics approached in the literature relative to the relationship between local communities and ES.

The Web of Science data base (<https://www.webofscience.com/>) was used to derive peer reviewed articles between 2013-2023 containing the terms “ecosystem services” and “local community” in the abstract, title or keywords. Google scholar data base (<https://scholar.google.com/>) was also used to search for articles containing our keywords in the title. To obtain our target articles we used Reporting standards for Systematic Evidence Syntheses (ROSES). ROSES is a flow diagram and proforma used in a systematic review and maps in the field of environmental management and conservation (Haddaway et al., 2018). The criterion used to exclude the research article are shown in figure 3. The case studies were categorized using spatial scale (Global, Other, Africa, Kenya, Kakamega), then Scoones et al (Scoones, 1998) key element of livelihood framework was used to disaggregate further the case studies to derive a count of element of SLF and determine the frequency. Similarly, the research methods utilised in these identified case studies was divided into nine categories, then a count of each method was done to determine the frequency.

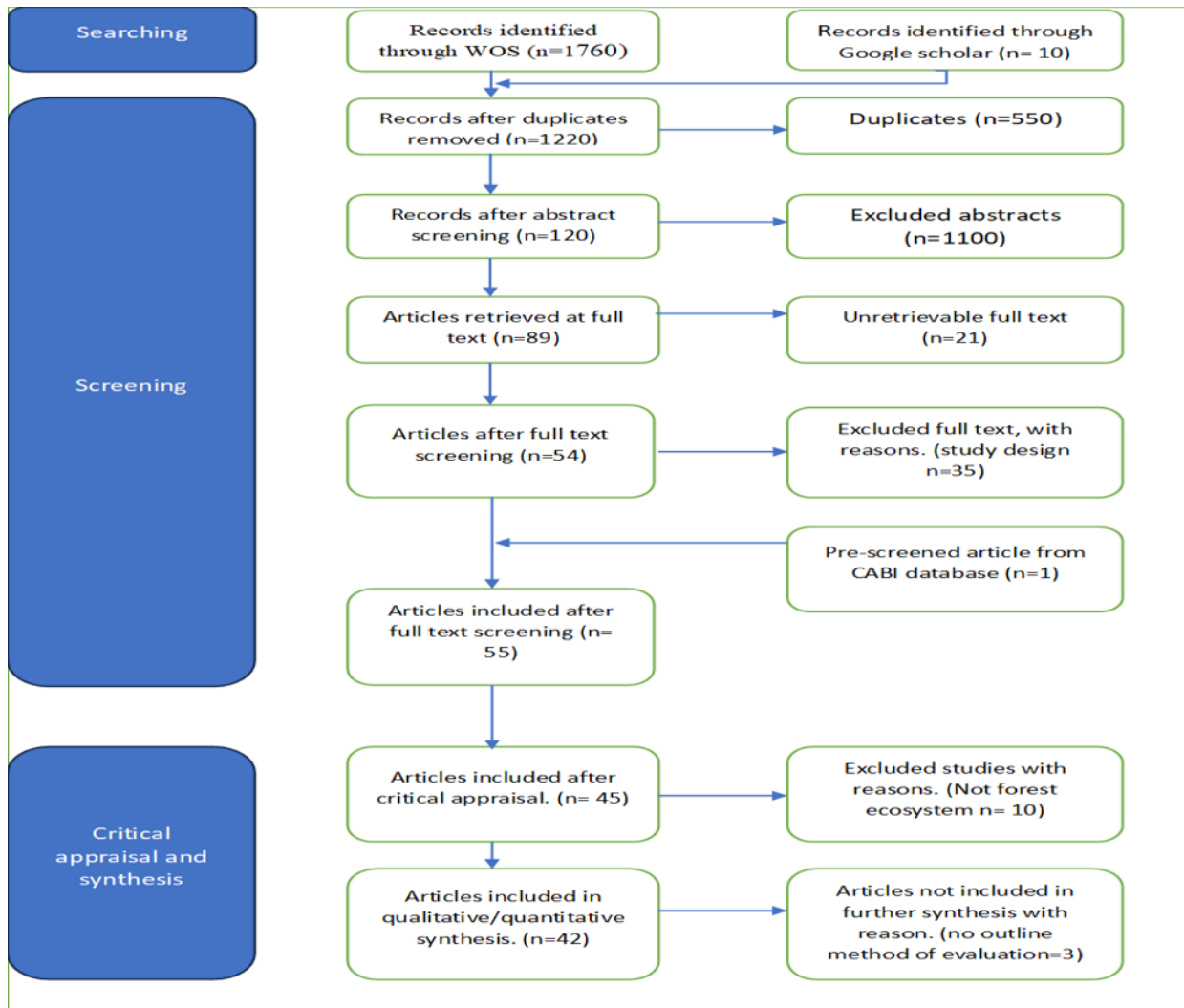


Figure 3: ROSES structure employed to retrieve the analysed research articles.

1.2 Results and conclusion

The results identified 6 thematic areas of critical knowledge gaps main research gaps in KFE. The first, on forest dependency and income, no studies have examined the income levels and forest reliance across wealth groups in KFE, nor the socio-economic and demographic factors influencing dependency between the wealth categories. Second, regarding shocks, safety nets and season gap filling, it remains unknown whether KFE functions as a safety nets net during shocks or serves as a seasonal income gap filler, including how livelihood strategies shift before and after shocks and what insurance mechanisms are available to households. Third, on ES perception and land use supporting flow of ES and well-being, there is a gap in understanding importance, relative benefits across all household choices across wealth groups in KFE, including which land use types of best support well-being and how land ownership shapes these preferences. Fourth, concerns local communities and PES implementation in the East African context remain poorly defined, limiting policy guidance on PES design and its livelihood benefits for local communities. Fifth, landscape change,

landscape use, and climate change, KFE lacks studies on how households respond to climate-induced natural disasters, particularly regarding livelihood diversification strategies such as labour emigration, off-farm enterprises, and agricultural adaptation during drought periods. Sixth, regarding the ES and forest management, two gaps persist i.e. the effectiveness of governance institutions (KFS and KWS) in implementing their forest management mandate, and the differential livelihood impacts on participants versus nonparticipants in PFM within KFE. While regarding the methodology utilized, majority of the case studies utilized interviews the most followed by regression analysis, and GIS analysis.

The identified knowledge gaps were used to enable a better understanding of the relationship between ES and the local community. From this knowledge gaps we can form tools that can be used to improve the livelihood of local communities, thus reducing dependency on the forest ecosystem. The perception of the local communities is equally important in design of the management of KFE. Based on the identified research methods utilized in the case studies, the research established a tentative methodological framework utilized throughout the thesis.

CHAPTER 3: POLICY TOOLS (PES) – ASSESSED A COMBINATION OF FACTORS THAT CONTRIBUTES TO PES SUCCESS, WHICH IS CRUCIAL FOR IMPROVED LIVELIHOOD OUTCOMES.

3.1 Introduction

The concept of PES emerged to bridge environmental and social sciences, highlighting the societal benefits of nature to address the growing crisis of biodiversity loss (Ehrlich & Ehrlich, 1981). Because many of these vital services exist outside traditional markets, PES have evolved as an incentive-based, modern alternative to conventional government “command and control” regulations (Kemkes et al., 2010). While PES was initially designed for developing countries to integrate conservation with poverty reduction, it faces ongoing criticism regarding technical implementation and ethical pricing (Muradian et al., 2010). This study focuses on three East African regions (Kenya, Uganda, Tanzania) where underfunded institutions often struggle with conservation. By analysing 25 forest-based case studies through a framework of interconnected environmental and social criteria, the research seeks to identify the specific factors that determine where PES is unsuccessful, partially successful, and successful in a developing nations context.

3.2 Methods

The primary data was collected using closed ended questionnaire sent to the partners that implemented the PES success schemes in the region. The questionnaire contained questionnaires that determined the expert’s perception on criterion influencing PES success (Table 1), using Likert scale to evaluate respondents’ perception.

Table 1. Criteria used to analyse PES cases in Kenya. Uganda and Tanzania (Grima et al., 2016)

Criteria	Option
1.Scale	
Spatial	Regional, National, Local
Temporal	Short term. Mid-term. Long term
2.Ecosystem service traded	Carbon, Water, Landscape, Biodiversity, Bundled
3.Transaction types	In-kind, Cash, both cash and In-kind

4. Actors involved	
Buyer	Public, Private, both public and private
Seller	Public, Private
Intermediaries	Yes, no

The secondary data was collected from using computerized searches in January 2023 through Science Direct and Google Scholar search engines. PES implementation, PES, PES case study, PES report, and PES project were among the searched phrases in the title, abstract, or keywords, and anywhere in the text. Using filters to identify case studies since 1993 and peer-reviewed papers. Additionally, grey literature from the donors and implementing partners from the website was used as a data source. Finally, 25 case studies settle upon after filters and verifications.

3.2 Results

Out of 25 PES case studies, 13 were categorized as successful, 10 classified as partially successful, and 2 were classified as unsuccessful. Table 2 below indicates the analyzed PES schemes derived from the secondary data.

Table 2. Analyzed PES schemes classification.

Criteria	Option	N	F**(%)	Success ful	Partial ly success ful	Un success ful	% Success ful	% Un success ful
Ecosystem services being traded	Biodiver sity	7	28	4	3	0	57	0
	Landsca pe	2	8	1	1	0	50	0
	Water	2	8	1	1	0	50	0
	Carbon	1 0	40	4	4	2	40	20
	Bundled	4	16	3	1	0	75	0

Scale Spatial	National	2	8	1	1	0	50	0
	Regional	1 3	52	8	4	1	62	8
	Local	1 0	40	4	5	1	40	10
Temporal	Long-term:>30 years	3	12	3	0	0	100	0
	Mid-term:10–30 years	9	36	4	4	1	44	11
	Short-term:<10 years	1 3	52	6	6	1	46	8
Transaction types	Cash	5	20	1	2	2	20	40
	In Kind	1 2	48	7	5	0	58	0
	Cash and In Kind	8	32	5	3	0	63	0
Actors involved Buyer	Private	1 5	60	9	6	0	60	0
	Public	4	16	2	2	0	50	0
	Public and Private	6	24	2	2	2	33	33

Seller	Private	1 1	44	3	6	2	27	18
	Public	1 4	56	10	4	0	71	0
Intermedia ries	Yes	1 9	76	10	7	2	53	11
	No	6	24	3	3	0	50	0

The primary data utilized in this chapter were 16 respondents: 11 from Kenya, 2 from Uganda, and 3 from Tanzania. Regarding the traded ES, there was a contrast in the perception of which ES traded would be more successful. Carbon had the highest level of perception at 4.1 out 5, contrasting to our secondary data analysis. Regarding the spatial and temporal scale there was alignment in the perception data with our secondary data analysis both indicating regionally and long term implemented PES would be more successful with a 4.0 out of 5, and 4.13 out 5 respectively. Similarly, there aligned in the secondary and primary analysis regarding transaction type where cash and in-kind transaction type perception had a 3.9 out 5. Regarding the actors, PES implementation had a perception of being more successful it had intermediaries 4.4 out of 5, which aligned with the secondary data analysis.

3.2 Conclusion

The for a successful PES, there should be bundled ES traded, with middle to long term regionally implementation, with use of cash and in-kind transaction type involving private buyer and public seller of ES. These criteria are crucial for policy makers for PES design and implementation, creating a premise for improved sustainable management of sustainable resources and enhancing improved poverty alleviation in the region.

CHAPTER FOUR: ES PERCEPTION AND SOCIO-ECONOMIC FACTORS – KEY SOCIO-ECONOMIC FACTORS SHAPING ES PERCEPTION, ACCESS, UTILIZATION, AND LAND USE DECISION.

4.1 Introduction

Forest ecosystems provide a wide range of ES i.e. provisioning, regulating, supporting, and cultural. They are fundamental to human well-being and economic development, yet how communities' access, use, and perceive these services differ significantly across socio-economic factors (Plieninger et al., 2013). Key factors such as age, wealth, gender, and land use patterns shape both utilization of provisioning ES and perception of their importance, yet these dimensions remain underexplored in existing research. Local community perceptions are frequently overlooked in forest management strategies, leading to inequitable outcomes and management conflicts (Ahammad et al., 2023). This study focuses on Kenya's Kakamega Forest Ecosystem the country's last Guineo-Congolian rainforest (see figure 4), managed under a participatory forest management model. To examine how diverse socio-economic groups recognize, perceive, and utilize forest ES, and how land-use preferences vary across these groups, with the goal of informing more equitable and sustainable forest management strategies.

4.2 Method and results

The data was collected using FGD, KII, household survey, and wealth ranking focus groups (section 1.5) to capture the ES community benefit from, reason for preference, land use supporting ES, the use of provisioning ES, and the socio-economic profile of the respondents. A one-way ANOVA was used to determine if there was significant difference in ranking of importance of the acknowledged ES in Likert scale. The Kruskal-Wallis test assessed wealth-based differences in provisioning ES use and land use supporting ES flow. While Mann-Whitney U test was employed to assess gender differences in the perceived importance of each ES. A chi-square test was used to examine the difference in the use of provisioning ES and land use across four age categories.

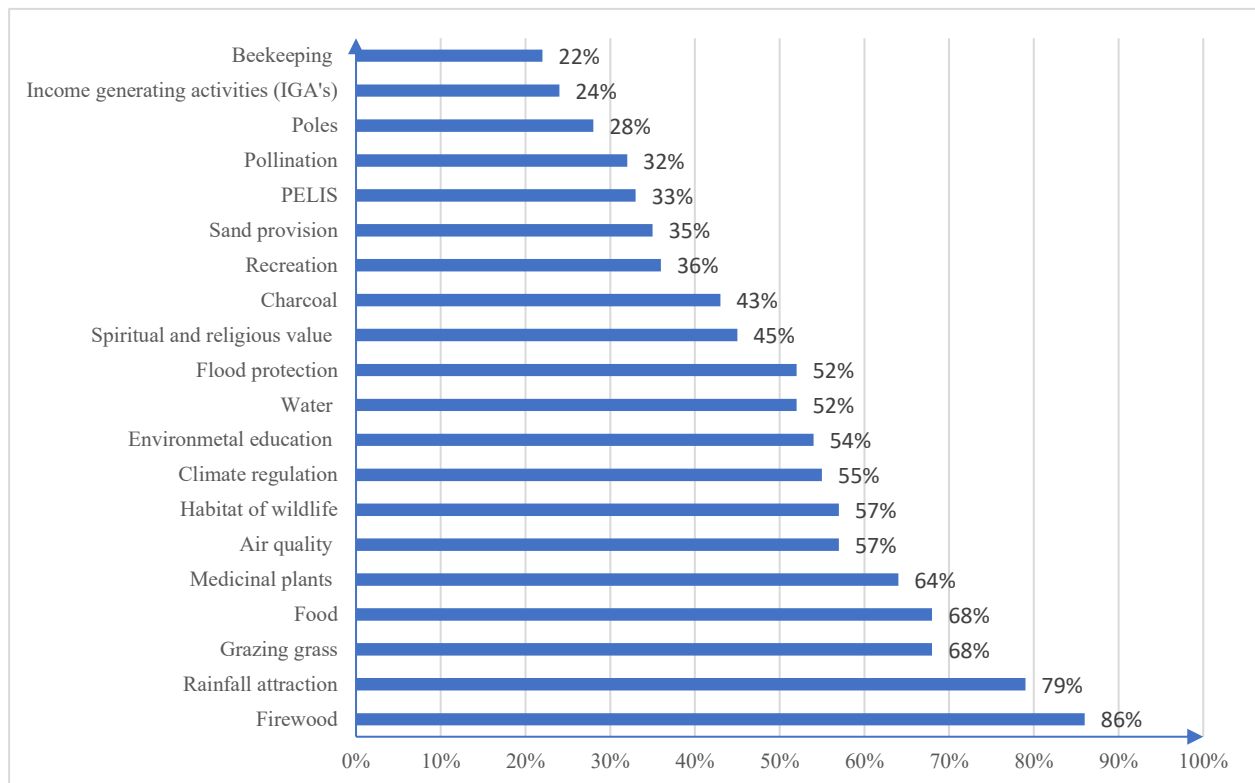


Figure 4: Frequency of the acknowledged ES among respondents (N = 453)

Firewood was the most acknowledged ES derived from KFE (see figure 4). With surprising low acknowledgement for IGA and beekeeping, indicating training requirements and CFA membership fee problems.

From the Figure 5. We can see that firewood had the highest importance rank among the respondents, with significant difference between the rich and middle-income households and also between the rich and the poor households. No significant difference was observed for age categories and gender. This indicates the nuance importance wealth places on households' capacity to derive forest resources. There was significant difference in the between the male and the female households regarding beekeeping where more of the male households acknowledged more of this benefit.

Regarding the use of the ES, ten provisioning ES was analysed across wealth, age, and gender categories of the ES. Firewood, medicinal plants, and water emerged as the most widely used resources overall for domestic purposes, while PELIS products (maize and beans), firewood, and sand dominated commercial use. Wealth status significantly influenced resource utilization; middle-income households generally exhibited the highest reliance on domestic provisions like firewood, charcoal, and sand, whereas rich households favoured commercial PELIS products, and poor households uniquely led commercial medicinal use.

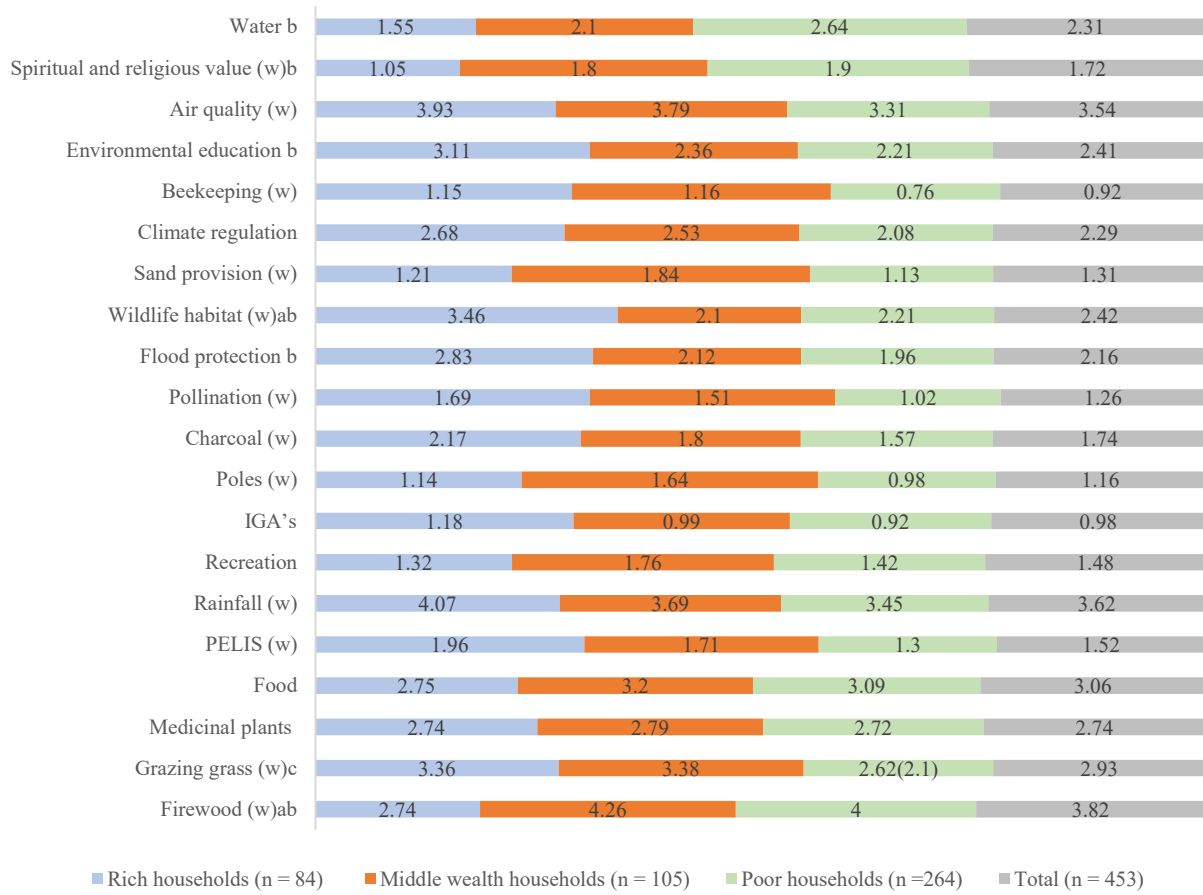


Figure 5: Perceived importance of acknowledged ES across the wealth categories. a – indicates a significant difference between rich and middle household, b – indicates a significant difference between rich and the poor households and c – indicates a significant difference between the middle and the poor households at $p < 0.05$. (w) – denotes welch ANOVA. The length of each wealth group section corresponds to the proportion of perception responses.

Demographic analysis revealed that middle-aged respondents (36-48 years) accounted for the highest domestic and commercial acknowledgment of ES. furthermore, while men recognized a broader variety of domestic resources than women, commercial resource acknowledgement remained evenly distributed across genders, with distinct preferences emerging only for grazing grass (domestic) and beekeeping (commercial).

Analysis of land use and ES across wealth, age, and gender categories revealed notable patterns in how different socio-economic groups recognize the contributions of various land uses. Natural forests were the most broadly valued land use across all groups, particularly for regulating, supporting, and cultural ES, while rich households showed the highest overall acknowledgement across land use types. PELIS and planted forests were more prominently

recognized by middle- and low-income households for provisioning and regulating ES. Across age groups, the 36-48 cohort demonstrated the broadest recognition of natural forest and PELIS land uses, while the oldest groups (49-80) most frequently acknowledged planted forest, and the youngest (18-26) placed greater emphasis on owned land and natural forest for cultural and regulating ES. Gender differences were also evident, with male respondents consistently reporting higher acknowledgment of natural forest, planted forest, and owned land across nearly all ES categories, while female respondents most distinctly recognized PELIS land use for provisioning ES and planted forest for supporting ES. Significant differences across groups were most pronounced for natural forest-linked ES, underscoring the importance of accounting for socio-economic diversity in participatory forest management planning.

4.2 Conclusion

The finding demonstrated that communities have varying levels of recognition regarding the ES provided by the KFE. Interestingly, young adults aged 18-26 placed the greater value on cultural and regulating ES, while middle-income households valued provisioning ES the most. Additionally, older, wealthier groups would place greater value on ES supporting land-use preferences. The research offered policy recommendations such as quota-based allocation system that prioritizes poorer households with young adults, combined with agricultural extension services, could enhance land management efficiency and promote more equitable access. Value addition to and sustainable harvesting for medicinal plants and honey. affirmative action to curb elite capture indicated by most benefits being acknowledged by rich and middle-income households.

CHAPTER FIVE: ES PERCEPTION AND SOCIO-ECONOMIC FACTORS – KEY SOCIO-ECONOMIC FACTORS SHAPING ES PERCEPTION AND LIVELIHOOD STRATEGIES.

5.1 Introduction

Forest ES are vital to human well-being, and community perception of these services plays a central role in shaping conservation behavior and informing effective forest management (Wangchuk et al., 2021). Socio-economic characteristics such as income, age, gender, education, land ownership, and CFA membership significantly influence how communities recognize and value ES, yet most existing studies examine these factors in isolation and focus on single ES categories, leaving considerable knowledge gaps. Notably, the growing phenomenon of labor migration and its effects on ES perception remains underexplored in rural African contexts. The KFE in western Kenya presents a particularly relevant and complex case, where population pressure, an electric fence installation, a national charcoal ban, and uneven benefit distribution within CFA have collectively reshaped local ES access and use patterns. Against this backdrop, this study investigates how a range of socio-economic factors influence ES acknowledgment among communities surrounding Kakamega Forest, with the dual aim of identifying which services communities recognize and understanding what drives variation in that recognition across all four ES categories.

5.2 Method and results

FGD, KII, and household survey were used to collect data about the ES acknowledged and respondent socio-demographic information. Binary logistic regression in SPSS was used to assess the impact of various socio-economic factors on the likelihood of acknowledging ES.

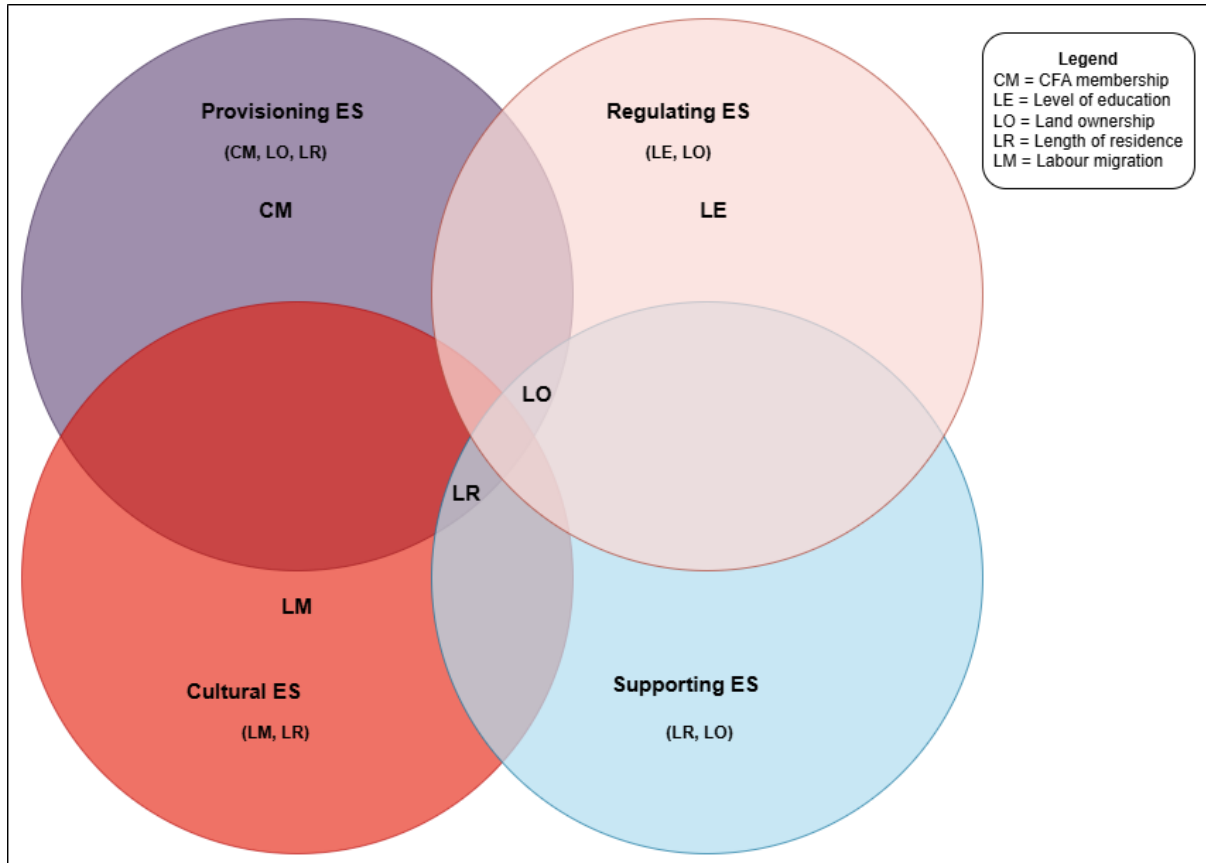


Figure 6. Factors influencing ES acknowledgement.

The findings demonstrate that ES acknowledgement among households surrounding Kakamega Forest is strongly shaped by socio-economic characteristics, with considerable variation across provisioning, regulating, supporting, and cultural ecosystem services. Provisioning services were the most recognized, particularly firewood, food, and grazing resources, reflecting households' direct dependence on forest resources for subsistence and livelihoods. In contrast, services that could enhance long-term economic resilience, such as beekeeping, PELIS, and income-generating activities, were less acknowledged, suggesting potential inequalities in resource access and the influence of elite capture within CFAs. Among the socio-economic factors examined, CFA membership, length of residence, education level, land ownership, and labor migration emerged as the most influential predictors of ES acknowledgement (see figure 6). CFA membership generally enhanced recognition of provisioning services but had limited influence on regulating, supporting, and cultural services, indicating a governance focus primarily centered on economic benefits rather than broader ecosystem functions. Education strongly increased awareness of regulating services, while longer residence promoted the recognition of cultural and supporting services through accumulated ecological knowledge and stronger social ties. Conversely, labor migration tended to reduce acknowledgement of provisioning, regulating, and cultural services by weakening households' dependence on and engagement with forest resources, although it also improved

access to educational opportunities through remittances. Overall, the findings highlight the complex interplay between livelihoods, governance structures, and socio-economic inequalities in shaping ecosystem service perceptions, underscoring the need for more inclusive and equitable forest governance approaches that broaden community awareness beyond provisioning services and strengthen the recognition of the full spectrum of ecosystem benefits essential for long-term sustainability.

5.3 Conclusion

This chapter examined the relationship between ES and local communities in the Kakamega Forest Ecosystem to support improved PFM. The findings show that ES acknowledgement is strongly influenced by socio-economic factors, particularly CFA membership, length of residence, education, labor migration, and land ownership. Firewood, rainfall attraction, air quality, and wildlife habitat were the most recognized provisioning, supporting, regulating, and cultural ecosystem services, respectively, reflecting the multiple ways communities depend on forests for their livelihoods and well-being. While CFA membership mainly influenced provisioning services, education enhanced the recognition of regulating services, and longer residence strengthened awareness of cultural and supporting services through accumulated ecological knowledge. The study also highlights the dual role of labor migration, which may weaken traditional ecological knowledge while supporting educational opportunities through remittances. These findings emphasize the need for inclusive forest governance that recognizes both tangible and intangible ecosystem benefits. Promoting nature-based enterprises, preserving cultural heritage, and strengthening community outreach programs could enhance sustainable forest stewardship and support broader conservation and social equity goals.

CHAPTER SIX: THREATS AND PRESSURE – RECOGNIZE THE FEEDBACK TO FOREST SYSTEM SUCH AS PERCEIVED THREATS AND PRESSURES ON CONSERVATION.

6.1 Introduction

This chapter highlights the importance of understanding local community perspectives to improve PFM and the sustainable use of ES in the KFE. Forests provide essential provisioning, regulating, supporting, and cultural services that underpin local livelihoods and well-being, making community involvement crucial for effective forest governance (Yami & Mekuria, 2022). Although PFM through CFAs has strengthened local participation and decentralized forest management in Kenya, challenges such as elite capture, limited inclusivity, increasing population pressure, and policy changes continue to constrain its effectiveness (Ongugo, 2007). Existing studies have largely overlooked how socio-economic differences shape local perceptions of forest conditions, threats, and ecosystem service provision. This research addresses this gap by examining how household wealth influences perceptions of changes in ecosystem services, forest conditions, threats, and community challenges. By recognizing the diverse experiences and priorities of local communities, the study provides evidence to support more inclusive, equitable, and context-specific forest policies that strengthen community ownership, improve decision-making processes, and promote sustainable forest management in Kakamega Forest and similar forest-dependent regions.

6.2 Method and results

Data from this chapter was collected using FGD, KII, wealth ranking focus groups, and household survey. The data collected included a comprehensive list of what the participants see as threats to KFE, what are the benefits (ES) derived from KFE, as well as a list of the challenges the FGD participants identify as being faced by local forest communities. A one-way ANOVA was used to assess the relative importance of threats to the forest and challenges faced by local communities across the wealth categories. Additionally, A correlation matrix was also generated to determine the correlation between perceptions of ES changes and the forest conditions in the KFE across the wealth categories.

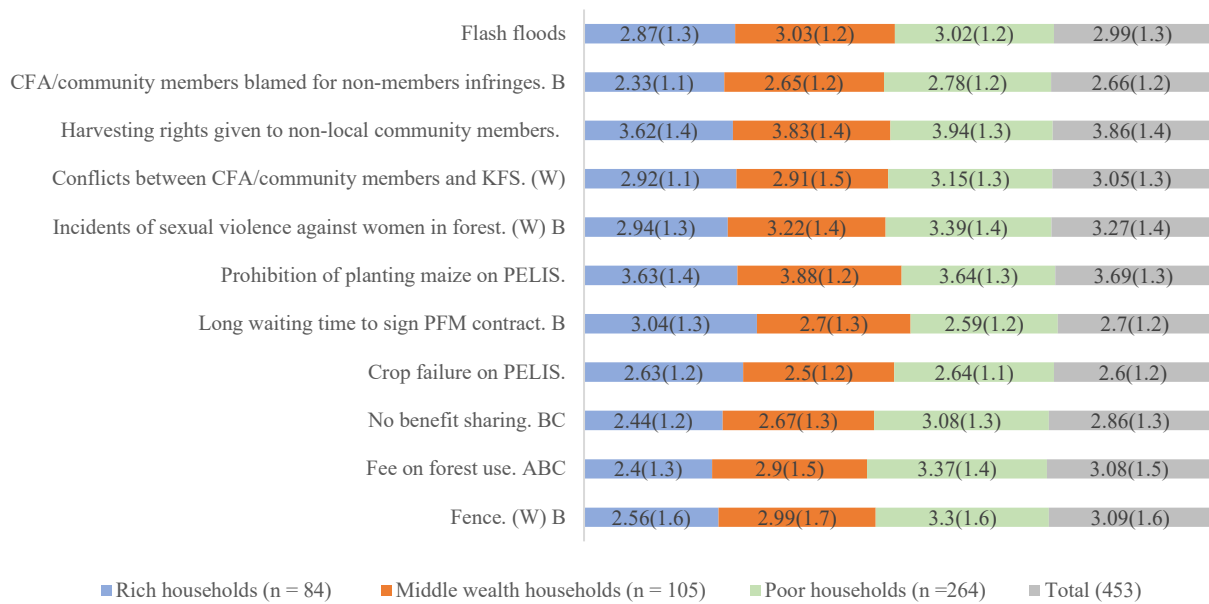


Figure 7: Perception of the challenges faced by local communities across the wealth categories (Numbers outside of the brackets are the means, while numbers inside the bracket indicate the standard deviation. A denotes a significant difference between rich and middle households, B denotes a significant difference between rich and poor households, and C denotes a significant difference between the middle and the poor households, at $p < 0.05$. (W) indicates performance of the Welch one-way ANOVA test).

This chapter demonstrates that wealth significantly shapes local perceptions of ES, forest conditions, threats, and community challenges within the KFE, although these relationships are often nuanced and context dependent. Wealthier households generally perceived ES provision and forest conditions as unchanged, reflecting their lower dependence on forest resources and greater access to alternative livelihoods and services. In contrast, poorer households were more sensitive to changes in ES and forest conditions due to their direct reliance on forest resources for subsistence, while middle-income households occupied an intermediate position, exhibiting mixed perceptions. Education, income, and land ownership also influenced perceptions by affecting environmental awareness, livelihood diversification, and dependence on forest resources. Across all wealth categories, illegal logging, overpopulation, climate change, invasive species, unsustainable harvesting of non-timber forest products, and limited conservation awareness were identified as major threats to KFE, with wealthier households generally expressing higher levels of concern due to greater awareness and longer-term perspectives on environmental change. The study also revealed substantial socio-economic disparities in the challenges experienced by local communities. Poorer households were disproportionately affected by forest access restrictions, unequal

benefit sharing, sexual violence risks, and flooding, whereas wealthier households were better positioned to absorb these impacts. Delays in signing PFM agreements, restrictions on maize cultivation under the PELIS program, conflicts between CFAs and the KFS, and the allocation of harvesting rights to non-local actors emerged as key governance concerns. Overall, the findings highlight the importance of incorporating wealth-based differences into forest governance and policy design to ensure more inclusive, equitable, and effective participatory forest management strategies that address the diverse needs and vulnerabilities of local communities.

6.3 Conclusion

This chapter explored how socioeconomic status shapes local community perceptions regarding ES, forest conditions, threats, and challenges within KFE. While the local community generally perceived an improvement in forest conditions across all wealth groups, disparities emerged in resource accessibility and threat sensitivity. Wealthier and more educated households, who owned larger plots of land, tended to perceive stable or increased ES provision. Conversely, poorer households reported a decline in ES provision despite noticing improved forest conditions, highlighting severe barriers to resource access, a challenge further exacerbated by the unequal socioeconomic constraints imposed by conservation measures like electric fencing. Furthermore, while middle-income groups relied heavily on forest grazing and underestimated its ecological threat, wealthy households engaged in economic activities that drove degradation. To mitigate these competing interests between biodiversity conservation and community livelihoods, the chapter emphasizes the need for wealth-sensitive policies, enhance community outreach, the promotion of alternative buffer crops to prevent crop failure, and stronger institutional monitoring of PFM.

CHAPTER SEVEN: COPING STRATEGIES – ASSESS THE RESPONSE TO SHOCKS AND THE INFLUENCE OF SOCIO-ECONOMIC FACTORS ON CHOICE OF COPING STRATEGIES TO SHOCKS.

7.1 Introduction

Rural communities in developing countries are highly vulnerable to shocks unexpected events that disrupt livelihoods and well-being due to their limited resources and adaptive capacity (Ellis, 2000; Scoones, 1998). These shocks can be classified as *idiosyncratic*, affecting individual households (e.g., illness, death, unemployment, asset loss, wildlife predation, or costly social ceremonies), or *covariate*, impacting entire communities or regions (Paumgarten et al., 2020). To cope with the shocks, the strategies are categorized into reactive (*ex-post*) and preventive (*ex-ante*) (Abid et al., 2020). This chapter focus on reactive strategies which we broadly categorized into assistance, costly, consumption reduction, non-costly, forest harvest, and productive asset sale strategy. While socio-economic characteristics play a critical role in shaping how forest-dependent households cope with shocks, as they influence access to resources, information, and opportunities (Gao & Mills, 2018; Paumgarten & Shackleton, 2011). Factors such as wealth, education, household size, gender, age, and social capital determine the range and effectiveness of coping strategies. Despite extensive research on shocks and coping mechanisms, few studies have examined how socio-economic factors interact to shape coping strategies under multiple, compounding shocks. This study addresses this gap by investigating rural households in the KFE, exploring how they respond to diverse shocks and how their socio-economic characteristics influence their adaptive strategies.

7.2 Method and results

The data was collected using FGD, KII, wealth ranking focus group, and household survey. The data collected the types of shocks experienced by households over the previous two years and to examine the coping strategies adopted in response to these shocks. Chi-square tests assessed differences in shock acknowledgment between CFA members and non-members, and between male- and female-headed households, with statistical significance set at $p < 0.05$. For analyses involving wealth categories, one-way Analysis of Variance (ANOVA) tested for significant differences between groups. Since households often employed multiple coping strategies in response to a single shock, Poisson regression was used to estimate the likelihood of adopting each coping strategy category in relation to specific shocks. Poisson regression was also applied to assess the influence of socio-economic factors on the likelihood

of adopting each coping strategy category. If overdispersion was detected ($p < 0.05$), models were re-estimated using Negative Binomial regression with a log-link function.

An analysis of 453 surveyed households and 46 interviewees in forest-adjacent communities revealed that economic distress was the most prevalent shock (79.9%), driven by high inflation, rising fuel prices, and stagnating incomes. Other frequent shocks included illness (49.7%), death (38%), and unemployment (29.1%). The perception and impact of these shocks varied significantly across socio-economic strata: poor households were more susceptible to illness, middle-income groups were better buffered against economic distress, and rich households reported higher rates of animal disease outbreaks due to greater livestock ownership. Additionally, CFA members reported lower levels of illness and unemployment than non-members, likely due to income diversification from forest enterprises and access to traditional medicine, though they faced higher rates of wildlife predation near forest boundaries. Gender also played a distinct role, with female-headed households showing greater vulnerability to flooding, while male-headed households were heavily affected by animal disease outbreaks due to their primary role in livestock management.

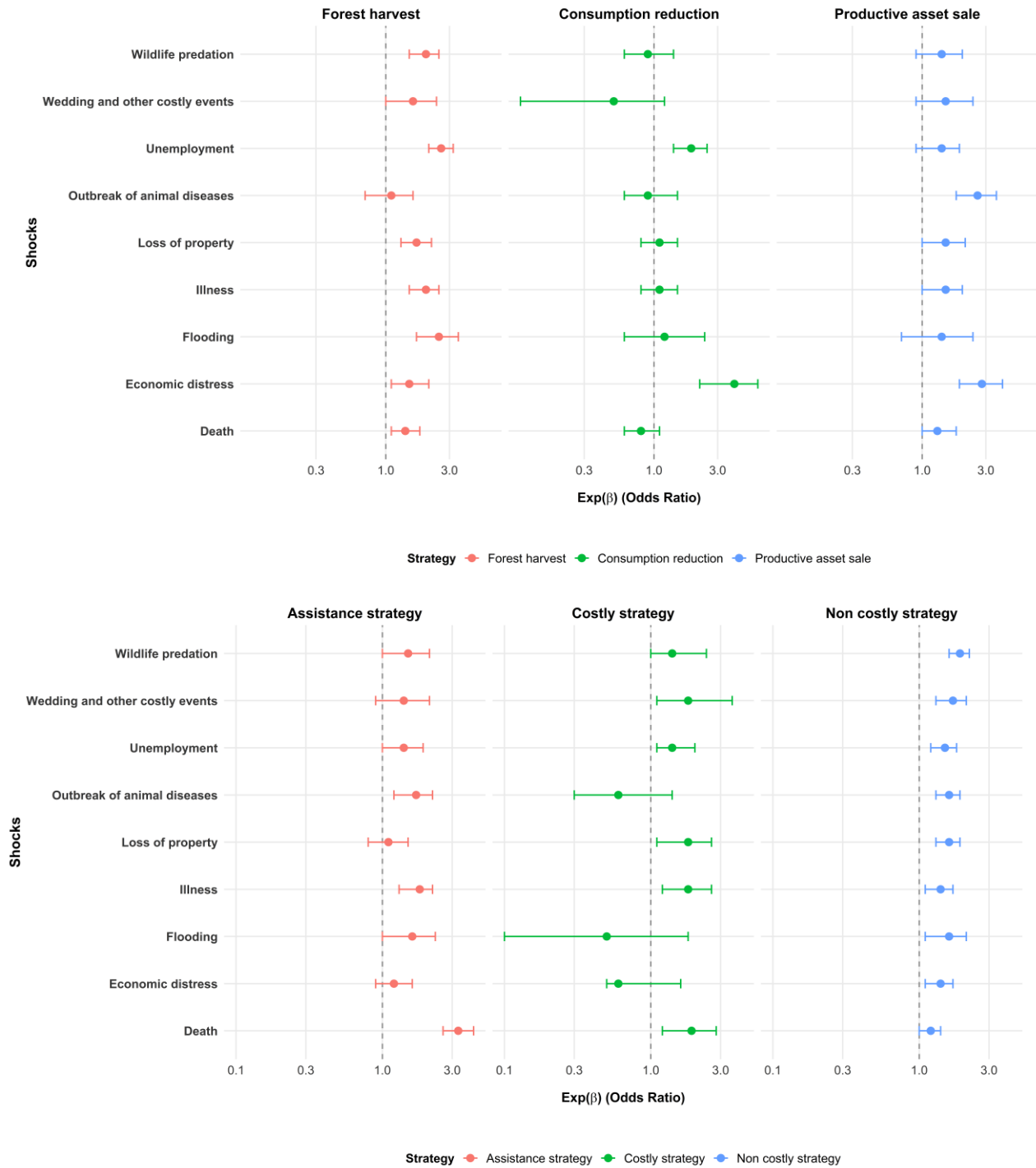


Figure 8: Household self-identified shocks and choice of coping strategies.

In response to these shocks, 78% of affected households turned to forest harvesting as an ex-post coping mechanism, acting as a reactive insurance buffer that was especially common among female-headed households and larger families. For income-related shocks like economic distress and unemployment, households frequently resorted to consumption reduction (see figure 8). When managing more severe or acute shocks like illness and livestock losses, households often relied on asset sales, though rich households and CFA members were substantially less likely to liquidate productive assets due to superior alternative buffers. While personal and acute shocks (such as death and illness) strongly prompted households to seek

informal community assistance or adopt costly strategies like borrowing, forest-adjacent families generally favored non-costly, less erosive strategies when dealing with gradual financial squeezes or partial agricultural damage. Ultimately, these findings indicate that household coping capacity is deeply stratified by wealth, gender, household size, and institutional access, leaving poor and female-headed households highly vulnerable to long-term resource depletion.

7.3 Conclusion

This study provides a multidimensional analysis of how forest-adjacent households in the KFE navigate multiple compounding shocks based on their socio-economic characteristics. While economic distress and illness emerged as the most widely recognized shocks, forest harvesting was revealed to be the most prevalent reactive coping strategy, serving as an informal, short-term insurance mechanism primarily for vulnerable groups like larger, low-income, and female-headed households. In contrast, wealthier households and those affiliated with CFAs demonstrated greater resilience, utilizing diversified income streams to avoid erosive options like asset sales or consumption reduction. Tightening forest access, highlighted by the 2023 installation of an electric fence, threatens to increase household vulnerability. To build equitable resilience and protect ecological sustainability, the study recommends strengthening social protection and health systems, expanding financial inclusion through cooperatives, and formalizing CFA structures. Additionally, interventions must support livelihood diversification (such as agroforestry and beekeeping) and incorporate culturally sensitive resilience planning that accounts for local gender dynamics and the high socioeconomic costs of major life-cycle events.

CHAPTER EIGHT: SYNTHESIS AND CONTRIBUTION – CONNECTION OF RESULTS ACROSS CHAPTERS AND ORIGINAL RESEARCH CONTRIBUTION.

8.1 Introduction to the synthesis

This section reintroduces the socio-economic framework that supports the research. It connects ecological systems, ES, the socio-economic context, and shocks and stressors to livelihood outcomes. Based on this framework, the section combines outcome from all empirical chapters.

8.1.1 Cross cutting findings

There is a strong connection between what people value and what they actually use, especially for tangible ES (chapter 4 and 5). Provisioning services, such as firewood and grazing grass, are the most recognized and used because they directly meet immediate needs. Firewood, for example, is the most acknowledged service at 86% and the most used at 66%. This connection between perceived importance and use is especially strong among middle-income households, which place a high value on provisioning ES and rely on them for domestic needs. However, this connection can be complex. In some cases, elite capture disrupts access: some households may value high potential services such as beekeeping or PELIS but are unable to use them due to barriers like membership fees or exclusion from decision-making groups.

The findings from chapters 4,5, and 7 show that socio-economic factors such as education, CFA membership, wealth, and labour migration, are fundamental in shaping how ES benefits reach local households. These factors influence how people perceive forest resources, determine what they can legally access, and shape how they use these services to respond to shocks and support their livelihoods. First, education plays a key role in building awareness. People with more education can better understand indirect and long-term ES. Whereas those with less schooling often concentrate on immediate benefits needed for survival. Second, CFA membership serves as an institutional filter that regulate access to forest resources. It enhances awareness of available services and strengthens resilience by providing diverse livelihoods opportunities; however, it can also deepen inequalities if benefits are not distributed equitably. Third, wealth and household size influence access and utilization. Wealthier households are more likely to engage in commercial activities rather than relying solely on subsistence, while larger households can mobilize labour to take advantage of resource-heavy opportunities. Fourth, labour migration introduces a complex dynamic: while remittances can reduce dependence on forest resources, migration may also weaken traditional knowledge and cultural ties to the forest. Overall, these interacting socio-economic

factors produce varied outcomes: some households effectively benefit from and manage ES, while others face limited access, greater dependency, and increased vulnerability.

Findings from chapter 6 and 7 jointly illustrate how the KFE functions as a vital socio-economic safety net while simultaneously experiencing increasing ecological pressures driven by households and community level shocks. In situations where formal social protection systems are limited or absent, the forest operates as a form of natural insurance, providing accessible resources that buffer rural livelihoods against shock. Forest harvesting emerges as the most prevalent coping strategy, widely adopted in response to a broad range of shocks such as illness, unemployment, death, and floods. Households often intensify extraction to meet immediate subsistence and income needs. This pattern highlights a central dynamic in which socio-economic shocks translate directly into ecological stress: financial hardship, inflation, and climate-induced crop failures push communities to depend more heavily on forest resources, often resulting in unsustainable practices such as illegal logging.

However, dependence on forest resources is not uniform, it's mediated by socio-economic characteristics. Poorer households, with limited assets and fewer alternatives, are more likely to engage in erosive extraction, whereas wealthier households tend to rely on diversified income sources and financial coping mechanism. Gender also shapes vulnerability, with female-headed households showing higher dependence due to organizational constraints in access to land and capital. At the same time, institutional factors such as CFA strengthen resilience by providing regulated access to forest-based livelihood opportunities. Notably, some conservation interventions may generate unintended consequences; restrictions on access can exacerbate inequalities and intensify pressures on remaining resources, particularly during periods of crisis.

Overall, the evidence reveals a vital paradox; while forest support livelihoods in times of need, repeated reliance during shocks has the potential to undermine ecological sustainability. This underscores the importance of integrating social protection measures and inclusive governance into forest conservation approaches.

8.1.2 Trade-offs and system dynamics

The integration of research chapters highlights a socio-ecological system characterized by significant trade-offs, illustrating how the KFE and PES programs emphasize the crucial role of socio-economic factors in determining whether forest management efforts result in conservation success or community exclusion.

At the core of this system lies a constant conflict between conservation and livelihood requirement, often referred to as the “natural insurance paradox”. KFE serves as an important safety net for vulnerable households that depend on this forest ecosystem to respond to shocks such as unemployment and illness. Although stringent enforcement measures, such as electric fencing, may improve ecological outcomes, these initiatives can simultaneously weaken the forest’s function as a coping mechanism. For many households, restricted access increases vulnerability, shifting the focus from long term sustainability to short term survival. Without adequate safety nets, this situation can create a harmful feedback loop, where illegal exploitation arises from growing hardship, ultimately threatening the very forest ecosystem these policies aim to protect.

Efforts to align conservation with livelihoods through PES schemes add another layer of complexity, particularly regarding compensation and access issues. While PES is intended to offset the costs associated with restricted resource use, its effectiveness largely depends on the design and delivery of incentives. Payments based solely on cash transfer often fail to compensate for access or are undermined by governance challenges, thereby reducing their impacts. In contrast, integrated approaches that combine cash with in-kind transactions such as health services, infrastructure or technical education, have proven more effective by providing additional forms of security that reduce dependence on forest harvesting. Nevertheless, even well-intentioned initiatives can generate inequalities, as seen in the case of electric fence.

The socio-ecological system thus reflects a persistent trade-off between long-term ecological sustainability and short-term coping strategies. Forest ecosystems provide immediate liquidity to cope with shocks, but this often comes at the expense of resource depletion. Policy interventions can inadvertently trigger socio-economic shocks. For example, the maize ban cultivation under PELIS, although necessary to preserve soil fertility for reforestation, contributed to food insecurity and rising prices within local communities. This illustrates how sustainability initiatives, if poorly designed, can increase vulnerability. Poor household often rely on erosive coping, such as such as resources depletion or intensified forest extraction, while rich households are better equipped to absorb shocks through savings and access to credit. In the absence of targeted support, this disparity can trap vulnerable households in cycles of poverty, where survival depends on degrading the very resource essential for future well-being.

Central to these dynamics are issues of access and equity, shaped by institutional mechanisms that determine who benefit from ES and governance arrangements. CFA, designed as participatory mechanism to democratise resource management, often fail in practice, with benefits disproportionately accruing to better-connected, predominately male, and affluent members. This results in unequal access to PELIS plots or income generating opportunities, marginalizing households that are most dependent on KFE. Furthermore, households with higher levels of education are more likely to recognize intangible ES, while others tend to focus primarily on tangible benefits. Socio-economic processes such as labour migration introduce additional trade-offs: although remittances can reduce dependence on forest resources, they may also weaken cultural ties and traditional ecological knowledge that support long term stewardship.

Overall, these outcomes demonstrate how ecological, socio-economic, and institutional dynamics are interconnected and, at times, conflicting within the system. Initiatives such as PES, electric fencing, and PFM offer clear benefits, but they also involve trade-offs that must be carefully managed. Policy success depends not only on ecological objectives but also on how well interventions align with local needs, capacities, and existing inequalities. Understanding these interconnections is crucial for designing strategies that balance sustainable and equitable livelihood outcomes with conservation goals.

8.1.3 Policy implications.

The thesis chapters provide a clear and comprehensible roadmap for sustainable forest management in East Africa, emphasizing policy initiatives that address the social and economic realities influencing how communities interact with the forest ecosystems.

Crucial to this is the recognition that effective conservation outcomes depend not only on ecological consideration but also on long-term financial commitment, well-targeted socio-economic strategies, and strong institutional support. For example, PES are most effective when designed around bundled ES, achieving higher success rate. These PES schemes are further strengthened by long-term funding (30 years), which allows for shifts in community attitudes, as well as by incorporating in-kind transactions such as technical training. Equally crucial is the CFA, which is an institutional buffer that improves ES awareness and improves socio-economic shocks resilience through livelihood diversification opportunities such as tree nurseries and beekeeping. Policies that are sensitive to socio-economic diversity also contribute to safeguarding cultural and spiritual ES.

The thesis outcome also reveals importance shortcomings of the current approaches. Poorly designed, generic policies often fail because they don't account for the lived experiences of the forest dependent communities. For instance, short term, cash only PES schemes tend to have high rate of failure due to corruption, inadequate compensation for lost access to forest resources, and inequitable benefit distribution. Furthermore, policies with a narrow focus on the biophysical outcomes often overlook how local communities' perception shape their interaction with ES. For example, households with lower levels of education may be less likely recognize the intangible ES, leading them to rely more heavily on tangible resources, which can conflict with conservation outcomes. Additionally, PFM frameworks are susceptible to elite capture, where more powerful members of the communities - typically male, better educated and wealthy- gain greater access to high value benefits and dominate decision making process, thereby marginalizing poor households.

The research highlights several targeted interventions to better align conservation outcomes with livelihood needs. First, educational initiatives and community outreach are essential to raise awareness of intangible ES, using locally relevant approaches such as experiential learning and storytelling to strengthen cultural continuity and understanding. Second, promoting diversified livelihoods and energy saving technologies can significantly substantially reduce reliance on forest resources, especially firewood. Third, more targeted and inclusive PES mechanism, combined with social protection measures such as subsidized health insurance, can help reduce household vulnerability and prevent environmentally harmful coping strategies during times of crisis. Finally, improving governance structures is important, including strengthening CFA leadership, enhancing transparency, promoting the inclusion of marginalized groups, and improving coordination with government agencies such as KFS to improve accountability and community access to conservation related benefits.

Together, these insights underscore the importance of context-sensitive, integrated approaches that simultaneously address socio-economic well-being and ecological sustainability.

8.1.4 Synthesis conclusion

In synthesis, this research reveals that ES presence alone doesn't automatically translate to improved livelihoods. Rather, the extent to ES contribute to well-being is shaped by socio-economic context in which local households operate, the nature of shocks and stressors they face, and the inclusiveness of institutional arrangements. Access to and benefits from ES are

mediated by factors such as education, gender, wealth and asset ownership, which influence how different groups use, perceive, and depend on ecosystem resources.

At the same time, institutional mechanisms - such as policy tools (PES), government structures, and community-based organizations – help reconcile these interactions by shaping incentives, rights, and benefits distribution. External pressures, including economic instability and climate variability, further complicate these dynamics by influencing household adaptation and coping strategies.

Consequently, improved livelihoods can't be achieved through isolated policy or ecological intervention alone. Instead, they emerge from the dynamics and interconnected relationships among socio-economic conditions, ecological systems, and institutional framework. Effective strategies must therefore adopt integrated approaches that simultaneously enhance ecosystem sustainability, strengthening governance systems, and address social inequalities. Only by recognizing and engaging with these interdependencies can interventions advance equitable, resilient, and sustainable livelihood outcomes.

8.2 Overall conclusion

The forest functions as a critical yet fragile safety net for resilience; forest resources serve as the main form of natural insurance, or "mobile money," for rural households by providing immediate liquidity to buffer against idiosyncratic shocks. This role is highly wealth dependent and is also gendered. While such reliance improves short term resilience, it creates a negative feedback loop in where socio-economic pressures drive illegal logging, identified by the community as the greatest threat to the KFE.

Socio-economic factors act as cognitive filters for ES perception: a household's socio-economic status serves as a lens that determines which ES are valued and recognized, directly influencing conservation behaviour. Level of education is a significant predictor of the perception of intangible ES. Similarly, length of residence functions as a filter for traditional ecological knowledge, with long term residence more likely to perceive and preserve supporting and cultural ES.

Institutional mechanisms and elite capture shape equitable access: structures such as PELIS and CFA are intended to decentralize governance, yet they often act as a barrier to the most vulnerable households. This mechanism frequently suffers from elite capture, where more influential, wealthy and male members secure high value benefits. Furthermore, restrictive

measures such as maize ban or electric fence installation protect ecological health but exacerbate social inequalities by cutting off key safety nets for land poor households.

Effective incentive design and bundling are essential for sustainable livelihood outcome: the success of institutional incentives such as PES is contingent upon specific design criteria that address both social and ecological needs. Findings indicate that PES schemes are more successful when bundled services incorporates a mix of in-kind and cash payments. Long term institutional commitment (more than 30 years), along with the involvement of intermediaries, is essential to ensure transparency and equity, thereby preventing communities from withdrawing when short-term economic alternatives arise.

8.3 Original research contributions

The thesis makes a significant contribution by moving beyond linear conservation models to propose a holistic socio-ecological framework. This framework integrates four distinct pillars - ES, socio-economic context, shocks, and coping strategies - to illustrate how they interact dynamically in shaping both human wellbeing and livelihood outcomes.

It also provides a methodological contribution by moving beyond isolated data collection techniques to a synergistic mixed method framework. This approach combines qualitative narratives with quantitative rigor and bridges multiple scales – from individual households to regional policy landscapes - to uncover the socio-economic filters that govern ES.

KFE case study offers critical empirical insight into how socio-economic factors, ES, and institutional mechanisms influence livelihood outcomes. The findings reveal that provisioning ES are primarily recognized due to their role in meeting immediate survival needs; that middle-income household show higher dependency; and that education influence the valuation of non-tangible ES. Additionally, the PES success depends on bundled ES, while forest function as a form of natural insurance – though this is often unequal and can lead to erosive coping strategy. These findings reflect broader challenges in the Global South, such elite capture within participatory governance structure. Furthermore, labour migration presented a complex trade-off; it reduced forest dependence while simultaneously eroding cultural ties and the transfer of traditional ecological knowledge.

Policy contributions of the thesis outlines both what works and what is required to build a resilient system. Effective practices including key drivers of PES success in the East Africa region, such as designing PES schemes around bundled services and long-term sustainability, utilizing hybrid payment structures, implementing programs at a regional scale, and involving

intermediary. To improve governance and resilience, the thesis highlights the need to combat elite capture through reforms, formalize legal frameworks and contracts (e.g PFM contracts), prioritize locally based resource harvesting, and implement targeted land allocation under PELIS. Additionally, the thesis proposes actionable strategies for livelihood diversification and social protection to shield household from shocks that would otherwise force them into extraction.

8.4 Implications for policy and practice

The research provides a robust framework that recognizes the complex influences of education, wealth, and institutional membership. By identifying the forest's role as a form of natural insurance, the findings enable policymakers to better predict and mitigate ecological pressures driven by household level shocks.

Forest governance: Strengthening CFA and PFM – PFM, implemented through CFA, is the main mechanism for decentralized governance; however, it is currently limited by elite capture. Policy actions should include the implementation of transparent CFA elections processes and affirmative action quotas for female headed and low-income households to ensure equitable benefit sharing. Operational reforms are also needed to address the prolonged delays in signing PFM contracts between KFS and CFAs. Without the signed agreements, communities lack the legal standing to manage alternative livelihood projects.

Livelihood strategies: Reducing dependency and buffering shocks – KFE serves as a reactive safety net for households facing idiosyncratic shock. Since households experiencing medical emergencies are more likely to extract forest resources, conservation outcome is directly linked to social protection. Expanding financial and health insurance for forest adjacent communities to decouple medical shocks from illegal harvesting. Additionally, promoting sustainable energy alternatives and encouraging the cultivation of non-palatable crops under PELIS can help reduce crop losses caused by wildlife such as monkeys and baboons.

PES design: Conditions for success – Effective PES schemes should include bundling of ES, long-term funding to sustain behavioural change, and regional-scale implementation. Furthermore, the use of both in-kind and cash-based transactions, along with the involvement of intermediaries, significantly contribute to PES success in the region.

8.5 Limitation of the research

The primary empirical findings are restricted to KFE which limits the generalizability of the results to other tropical regions with different socio-ecological and cultural contexts. While a

regional review of 25 PES scheme was included, data in these developing countries are often insufficient to meet broad evaluative requirements.

The research relies heavily on perception based and self-reported data, which are subject to participants recall bias and the potential underreporting of coping behaviours perceived as harmful. There is also a risk of CFA dominated response bias, where the perspectives of institutional members may be overrepresented compared to non-members. Additionally, the studies lack a formal economic valuation for provisioning ES, relying on qualitative rankings and Likert scales to assess importance.

The cross-sectional nature of the household surveys provides only a "snapshot" of the system, preventing the establishment of clear causal relationships. This one-time survey design fails to capture how community perceptions and adaptive strategies evolve as recent interventions, such as the electric fence, move toward completion. Furthermore, the two-year recall period for identifying shocks may affect the accuracy of reporting regarding the frequency and severity of livelihood disruptions. Future research would require longitudinal approaches to track the dynamic evolution of these socio-ecological systems over time.

8.6 Future research direction

Based on the research conclusion, future research should explore further:

- Quantification of the economic valuation of the ES provided KFE, specifically for the identified regulating ES using stated preference methods/production function method, and the provisioning ecosystem service (income from charcoal versus firewood).
- More in depth quantitative analysis of the factors influencing PES success is required. Such as statistical correlation and other methods to better understand the dynamics of criterion of PES.
- Longitudinal approach is needed to capture the shifting dynamics and adoptative strategies of the community's perception in relation to recent interventions such as electric fence, changing government structure influence on evolving changes of CFA.
- Consideration of short call period for the coping strategies adapted by households and communities in response to shocks, plus a combination of longitudinal approach could provide more insight into the adaptive capabilities.

8.7 Novelty of the research in region.

The published research articles making up the thesis are making a significant contribution to the East African region where the empirical and community level in-depth research has notably been lacking. The third chapter of the thesis is a research paper exploring a regional scale gap by providing the first comparative critical analysis of 25 PES across Kenya, Uganda, and Tanzania, identifying that PES success in this region is substantially higher when the bundled ES is traded, implementation occurs at the regional scale, financing is medium to long term, combination of in-kind and cash transaction types are used, and both private and public sellers are involved. This evidence-based framework for PES is timely given the East African governments are increasingly turning to market-based conservation to meet sustainable goals, yet until this study, no comparative benchmark had been established for the region using completed schemes. Chapter four study focus on specific forest ecosystem Kakamega, where the article fills in a critical gap by simultaneously mapping 20 ES and disaggregating community perception of their use, importance, and supporting land use types across age, wealth, and gender groups. This is a level of granulated rarely attempted in broader East African and Kenyan forest research. Moving beyond the biophysical assessments that have dominated the literature, this socially stratified approach (chapter five) reveals dynamics such as wealthier households placed more value on cultural ES while poorer householders placed disproportionately on provisioning ES. Additionally, labour migration reduces cultural ES acknowledgment (traditional ecological knowledge). These findings have direct implications for how PFM should be designed to avoid elite capture. The sixth chapter novelty lies in how it further unpacks how wealth status shapes not only perceptions of ES provision but also perception on forest conditions, the challenges communities face, and threats, revealing a counterintuitive finding that poor households associated improved forest condition with decreased ES provision, pointing to an access problem rather than an ecological one. This wealth sensitive framework for understanding conservation-community tensions in Kenya's last Guineo-Congolian rainforest is largely absent from prior research in the region. The six-chapter novelty lies on how it unpacked the impact of socio-economic variables and their interaction on the choice of the coping strategies when households experience shocks. The outcome revealed that forest acts as an insurance mechanism to households when they experience 78% of the shocks identified, however the access is disproportionate to the households depending on their wealth status and their association with the CFA. This extensive outlook on the influence on the choice of coping strategy is a novel in the region as well as in Kenya. Collectively, these chapters advance the field by grounding ES research in real

community socioeconomics, offering policy relevant insights on the participatory governance, access equity, coping strategies to shocks, and conservation financing that are applicable not only to Kakamega Forest but to forest management challenges across the broader East African region.

8.8 Dissemination of results.

8.8.1: Publications based on PhD thesis

a. ISI articles form thesis.

1. Osewe, I., Coman, C., Hălălişan, A. F., Osewe, E. O., Ndalilo, L., Kagombe, J. K., Abrudan, I. V., & Popa, B. (2025). Local community perceptions on ecosystem services utilisation—implications for sustainable management of Kakamega Forest in Kenya. *Agroforestry Systems* 2025 99:8, 99(8), 219-. <https://doi.org/10.1007/S10457-025-01320-7>
2. Osewe, I., Coman, C., Osewe, E. O., Hălălişan, A.-F., Talpă, N., Kagombe, J. K., Vasile Abrudan, I., & Popa, B. (2025). Socio-Economic Drivers of Ecosystem Service Recognition in Kakamega Forest, Kenya. *Forests* 2025, Vol. 16, Page 889, 16(6), 889. <https://doi.org/10.3390/F16060889>
3. Osewe, I., Coman, C., Talpă, N., Osewe, E. O., Ndalilo, L., Kagombe, J. K., Abrudan, I. V., & Popa, B. (2025). Balancing conservation and community needs: challenges, threats, and socioeconomic disparities in Kakamega Forest, Kenya. *Frontiers in Forests and Global Change*, Volume 8-2025. <https://doi.org/10.3389/ffgc.2025.1554677>
4. Osewe, I., Hălălişan, A.-F., Talpă, N., & Popa, B. (2023). Critical Analysis of Payments for Ecosystem Services: Case Studies in Kenya, Uganda and Tanzania. *Forests*, 14(6). <https://doi.org/10.3390/f14061209>

b. BDI articles forming thesis

1. Osewe, I., Osewe, E. O., & Popa, B. (2023). Interconnection between ecosystem services and local communities: knowledge gap identification in the area of Kakamega forest. 16(65 Part 2), 37–68. <https://doi.org/10.31926/but.fwiafe.2023.16.65.2.3>

8.8.2: Papers presented at national conferences.

Osewe, I., Hălălişan, A.-F., Talpă, N., & Popa, B. (2023). Critical Analysis of Payments for Ecosystem Services: Case Studies in Kenya, Uganda and Tanzania. In: Book of Abstracts, Proceedings of the 6th Edition of the Integrated Management of Environmental Resources

Conference Suceava – Romania, 23-24 November 2023. Available online at: https://silvic.usv.ro/imer2023/proceedings_imer_2023.pdf

Osewe, I. (2024) Interconnection Between Ecosystem Services and Local Communities: Knowledge Gap Identification in the Area of Kakamega Forest. In DoCo 2024, available online at www.unitbv.ro/Detailed_Programme.pdf

Osewe, I. (2025) Socio-economic drivers of ecosystem service recognition in Kakamega Forest, Kenya available online at: https://www.unitbv.ro/documente/cercetare/DoCo2025_Detailed_Programme.pdf

Osewe, I., Talpa, N., Popa, B. (2025) Coping Mechanisms of Rural Households to Shocks: The Role of Socio-Economic Determinants and Strategies in Kakamega Forest, Kenya. In: Book of Abstracts, Proceedings of the 7th Edition of the Integrated Management of Environmental Resources Conference Suceava – Romania, 5 November 2025. Available online at: https://www.silvic.usv.ro/imer2025/book_of_abstracts_IMER_7.pdf

8.8.3: Papers presented at international conferences

Osewe, I., Popa, B. (2025). Local community perceptions on ecosystem services utilization – implications for sustainable management of Kakamega forest in Kenya. In: Book of Abstracts, A century of forest knowledge – education, innovations, challenges (CENFORKNOW 2025) Conference Sofia – Bulgaria, 08-09 May 2025. Available online at: <https://cenforknow2025.ltu.bg/book-of-abstracts/>

Reference (full list is included in PhD thesis)

1. Abid, M., Ali, A., Rahut, D. B., Raza, M., & Mehdi, M. (2020). Ex-ante and ex-post coping strategies for climatic shocks and adaptation determinants in rural Malawi. *Climate Risk Management*, 27, 100200. <https://doi.org/10.1016/j.crm.2019.100200>
2. Ahammad, R., Hossain, M. K., Sobhan, I., Hasan, R., Biswas, S. R., & Mukul, S. A. (2023). Social-ecological and institutional factors affecting forest and landscape restoration in the Chittagong Hill Tracts of Bangladesh. *Land Use Policy*, 125, 106478. <https://doi.org/10.1016/j.landusepol.2022.106478>
3. Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., Börner, J., Smith-Hall, C., & Wunder, S. (2014). Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development*, 64(S1), S12–S28. <https://doi.org/10.1016/j.worlddev.2014.03.006>
4. Bonye, S. Z., Yiridomoh, G. Y., & Nsiah, V. (2023). Our forest, our livelihood: Natural resources' use controversies and community livelihood sustainability in the Mole

- National Park, Ghana. *Land Use Policy*, 127, 106589.
<https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106589>
5. Bösch, M. (2021). Institutional quality, economic development and illegal logging: a quantitative cross-national analysis. *European Journal of Forest Research*, 140(5), 1049–1064. <https://doi.org/10.1007/S10342-021-01382-Z/TABLES/3>
6. Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches, 3rd ed. In *Research design: Qualitative, quantitative, and mixed methods approaches, 3rd ed.* Sage Publications, Inc.
7. Ehrlich, P., & Ehrlich, A. (1981). *Extinction: the causes and consequences of the disappearance of species*.
8. Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries. *Journal of Agricultural Economics*, 51(2), 289–302.
<https://doi.org/10.1111/J.1477-9552.2000.TB01229.X;CTYPE:STRING:JOURNAL>
9. Gao, J., & Mills, B. F. (2018). Weather Shocks, Coping Strategies, and Consumption Dynamics in Rural Ethiopia. *World Development*, 101, 268–283.
<https://doi.org/10.1016/J.WORLDDEV.2017.09.002>
10. Grima, N., Singh, S. J., Smetschka, B., & Ringhofer, L. (2016). Payment for Ecosystem Services (PES) in Latin America: Analysing the performance of 40 case studies. *Ecosystem Services*, 17, 24–32. <https://doi.org/10.1016/J.ECOSER.2015.11.010>
11. Haddaway, N. R., Macura, B., Whaley, P., & Pullin, A. S. (2018). ROSES RepOrting standards for Systematic Evidence Syntheses: pro forma, flow-diagram and descriptive summary of the plan and conduct of environmental systematic reviews and systematic maps. *Environmental Evidence*, 7(1), 7. <https://doi.org/10.1186/s13750-018-0121-7>
12. Kemkes, R. J., Farley, J., & Koliba, C. J. (2010). Determining when payments are an effective policy approach to ecosystem service provision. *Ecological Economics*, 69(11), 2069–2074. <https://doi.org/10.1016/J.ECOLECON.2009.11.032>
13. Mamo, G., Sjaastad, E., & Vedeld, P. (2007). Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics*, 9(8), 916–927.
<https://doi.org/10.1016/J.FORPOL.2006.08.001>
14. MEA, M. E. (2005). *Millennium ecosystem assessment*. Millennium Ecosystem Assessment. <https://www.millenniumassessment.org/en/index.html>
15. Mitchell, N., Schaab, G., & Wägele, J. W. (2009). Kakamega Forest ecosystem: An introduction to the natural history and the human context. *Karlsruher Geowiss Schr R A*, 17.

16. Muradian, R., Corbera, E., Pascual, U., Kosoy, N., & May, P. H. (2010). Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. *Ecological Economics*, 69(6), 1202–1208.
<https://doi.org/10.1016/J.ECOLECON.2009.11.006>
17. Nizam, U. M., Mosharraf, H. M., Yong, C., Wapakorn, S., & Jaruntorn, B. (2019). Stakeholders' perception on indigenous community-based management of village common forests in Chittagong hill tracts, Bangladesh. *FOREST POLICY AND ECONOMICS*, 100, 102–112. <https://doi.org/10.1016/j.forpol.2018.12.005>
18. Ongugo, P. (2007). *Participatory forest management in Kenya: Is there anything for the poor?* / *HimalDoc*. Kenya Forest Research Institute . <https://lib.icimod.org/record/13228>
19. Patricia, L. (2014). The Oxford handbook of qualitative research. In P. Leavy (Ed.), *The Oxford handbook of qualitative research*. Oxford University Press.
<https://doi.org/10.1093/oxfordhb/9780199811755.001.0001>
20. Paumgarten, F., Locatelli, B., Witkowski, E. T. F., & Vogel, C. (2020). Prepare for the unanticipated: Portfolios of coping strategies of rural households facing diverse shocks. *JOURNAL OF RURAL STUDIES*, 80, 91–100.
<https://doi.org/10.1016/j.jrurstud.2020.05.013>
21. Paumgarten, F., & Shackleton, C. M. (2011). The role of non-timber forest products in household coping strategies in South Africa: the influence of household wealth and gender. *Population and Environment*, 33(1), 108–131. <https://doi.org/10.1007/s11111-011-0137-1>
22. Plieninger, T., Dijks, S., Oteros-Rozas, E., & Bieling, C. (2013). Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy*, 33, 118–129. <https://doi.org/10.1016/J.LANDUSEPOL.2012.12.013>
23. Saalu, F. N., Oriaso, S., & Gyampoh, B. (2020). Effects of a changing climate on livelihoods of forest dependent communities. *International Journal of Climate Change Strategies and Management*, 12(1), 1–21. <https://doi.org/10.1108/IJCCSM-01-2018-0002>
24. Sattler, C., Trampnau, S., Schomers, S., Meyer, C., & Matzdorf, B. (2013). Multi-classification of payments for ecosystem services: How do classification characteristics relate to overall PES success? *Ecosystem Services*, 6, 31–45.
<https://doi.org/10.1016/J.ECOSER.2013.09.007>
25. Scoones, I. (1998). *Sustainable Rural Livelihoods: A Framework for Analysis*.
<https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/3390>

26. Tadesse, S., Woldetsadik, M., & Senbeta, F. (2017). Forest users' level of participation in a participatory forest management program in southwestern Ethiopia.
Http://Dx.Doi.Org/10.1080/21580103.2017.1387613, 13(4), 164–173.
<https://doi.org/10.1080/21580103.2017.1387613>
27. Wangchuk, J., Choden, K., Sears, R. R., Baral, H., Yoezer, D., Tamang, K. T. D., Choden, T., Wangdi, N., Dorji, S., Dukpa, D., Tshering, K., Thinley, C., & Dhendup, T. (2021). Community perception of ecosystem services from commercially managed forests in Bhutan.
Ecosystem Services, 50, 101335. <https://doi.org/10.1016/J.ECOSER.2021.101335>
28. Yami, M., & Mekuria, W. (2022). Challenges in the Governance of Community-Managed Forests in Ethiopia: Review. *Sustainability 2022, Vol. 14, 14*(3).
<https://doi.org/10.3390/su14031478>