The Influence of Participatory Forest Monitoring on Natural Forest Management and Community Welfare: A Case Study in Kibale National Park, Western Uganda

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The paper presents findings from a Study on Participatory Forest Monitoring (PFM) and Natural Forest Restoration (NFR) in Uganda, a case of communities bordering Kibale National Park (KNP), western Uganda. The study involved 394 respondents who were interviewed from June to August 2024. The study adopted a cross-sectional research design to determine the perceived effect of Participatory Forest Monitoring Activities at the household level and examine the relationship between Participatory Forest Monitoring Activities and Natural Forest Restoration while involving communities bordering Kibale Forest. Almost half (54.4%) of the communities bordering Kibale National Park (KNP) work with UWA rangers during forest monitoring patrols in restored areas (M=2.25, SD = 1.95). Participation in PFM improved income at the household level directly addressing household needs especially income for school fees and other needs by 79.9% (r=0.799, P<0.05). PFM can restore natural forests, increase revenue and better community livelihoods.

1. INTRODUCTION

Participatory Forest management also known as participatory management is a key strategy for natural resource conservation and management that has been adopted in many countries. It recognizes the need to address social and environmental concerns collectively, as one affects the other. Theoretically, the participatory approach would lead to a "win-win" result: environmental sustainability and social development. However, its on-site implementation encounters constraints and yields unsuccessful outcomes [1]. Providing benefits and incentives for local communities is also problematic and calls for improvement [2].

Worldwide forest governance has adopted participatory approaches in the belief that this strategy would lead to environmental sustainability while also accounting for social concerns [3]. Previous studies concluded that long-standing strict and exclusionary conservation caused pressure on local communities such as displacement and restrictions on the use of resources. Meanwhile, participatory management, a more people-centred approach, would, in theory, produce "win-win" results: a strategy for resource protection and conservation and for delivering benefits to local communities [4].

Local communities, as the cornerstone of the participatory approach, play a vital role in the success of this management strategy, hence strengthening their participation is highly important. However, local people's participation is contingent on the incentives and benefits they will receive [2]. In contrast, receiving no benefits means the social objective of participatory forest management is neglected, consequently discouraging local people from participating. The studies of Cao et al. [4] stressed that sudden and untimely discontinuation of benefits could cause local people to revert to their former unsustainable practices in forest resource utilization. However, it is important to understand that a perpetual supply of benefits for people is irrational and inefficient. The outcome of participation should function as a means to improve people's capabilities to achieve self-reliance and self-governance and thus, realize sustainability.

The same situation can be observed in the Philippines, where a community-based approach serves as the main strategy for managing forests [5]. Hence, this study was designed to contribute to improving natural resource management through strengthening local people's participation. This study examined social capital as an incentive and impact of people's participation in mangrove restoration projects and its implications to their livelihoods, while most studies consider social capital as an enabling condition for participation in collective actions for common pool resources [6].

For this study, the research problems were framed based on two propositions. First, there is a cause-and-effect relationship between the environmental and social components, therefore resource management strategies should cover both environmental and social aspects to achieve sustainability. Second, the benefits for local people who participate in resource management motivate them to continue engaging in participatory management. In particular, two research questions were addressed in this study.

First, what are the effects of people's participation on social capital? Second, what are the implications of changes in social capital to people's livelihoods? Building social capital may have a greater impact compared to other tangible incentives, in terms of improving people's overall well-being, as its development also enhances the accumulation of other forms of capital [7]. From the perspective of the poor, increased access to and ownership of assets provides better means and more alternatives to get resources for meeting people's needs and supporting subsistence. These conditions are favourable for environmental protection, as they diminish people's dependency on natural resources, which has been identified as a major driver of deforestation and forest degradation [8].

Participatory management for natural forest restoration ensures that forests are restored for higher carbon intake as the forest develops into high conservation ecosystems (PMMP-Participatory Management and Management Partnership, 2015). Participatory management and forest restoration have been implemented since 1994 around Kibale National Park (Constantino et al., 2012). About 4,195 hectares since 1995 (170 hectares during this management period) of Kibale Forest, the restored areas have developed into a closed canopy forest, providing a habitat for important forest species which include 13 primate species and several ungulates [9]. Most of the restoration efforts are taking place in the Mainaro sector which was established as part of the wider Kibale National Park landscape that holds a High Conservation Value Forest. The number of tree species in the planted forests and the regeneration of climax species have both increased with increased management efforts that involve communities. Reed et al., [10] observe that participatory processes that engage multiple stakeholders are more likely to lead to success than top-down approaches.

This study utilizes tenets of the planned, multifunctional, and multi-stakeholder theory as applied by Chazdon et al, [11] to enhance forest-landscape restoration (FLR) to restore forests and create awareness about the value of natural forest regeneration to enhance the many goods and services forests provide to people [11].

Incorporating communities and their local knowledge can enhance the effectiveness of conservation strategies (Riley and Moyer, 2024). Participatory Forest Monitoring (PFM) around Kibale National Park aims to involve communities in forest monitoring and management. Established in 1932, has long been a hotspot for biodiversity but faced substantial threats from human activities before the introduction of Participatory Forest Monitoring (PFM). By the late 20th century, encroachment and deforestation were significant concerns. Local communities often engaged in activities such as agriculture and logging that led to habitat loss [12].

The participatory forest monitoring (PFM) triangle in Fig. 1, envisages that sustainable forestry governance should focus on developing participatory institutions, training, and monitoring. Communities can participate at the
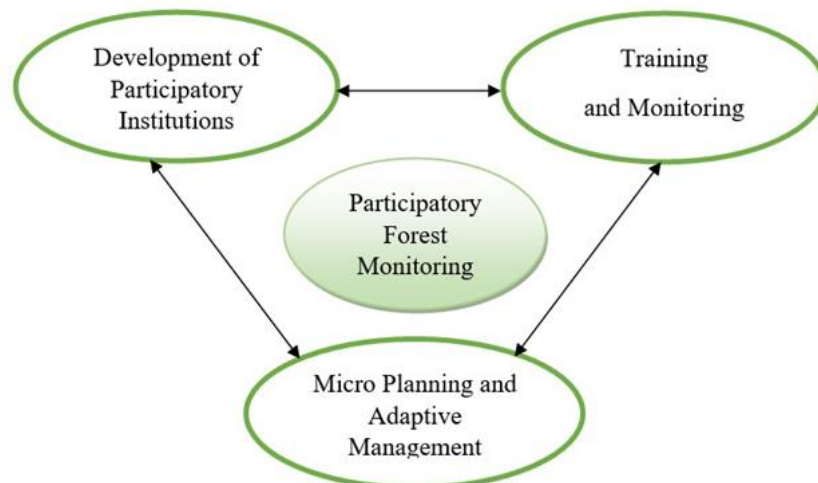

Fig. 1. The participatory forest monitoring triangle (author, 2024)

micro-planning level and in adaptive management. Community inclusion in the management of protected areas and their resources is a common practice Schreckenberg et al., [13] and is a determinant of good forestry management [14]. Participatory Forest Monitoring should be a cyclic process involving the development of participatory institutions, micro-planning and adaptive management, as well as training and monitoring of activities of management entities (Fig. 1).

2. THEORETICAL FRAMEWORK

Local communities, as the cornerstone of the participatory forest monitoring approaches, play a vital role in the success of forest management strategies, hence strengthening their participation is highly important [13]. However, local people's participation is contingent on the incentives and benefits they will receive from resource managers. In contrast, receiving no benefits means the social objective of participatory forest management is neglected, consequently discouraging local people from participating. The studies of Cao et al. [4]. stressed that sudden and untimely discontinuation of benefits could cause local people to revert to their former unsustainable practices in forest resource utilization. However, it is important to understand that a perpetual supply of benefits for people is irrational and inefficient. The outcome of participation should function as a means to improve people's capabilities to achieve self-reliance and self-governance and thus, realize sustainability [4].

This study on Participatory Forest Monitoring and Natural Forest Management in Uganda – A case of communities bordering Kibale National Park, Uganda was based on the theory of social forestry intervention (SFI), focusing on the issues of current thinking on community involvement in forestry restoration practices. The first of these issues concerns the cause of deforestation where communities involved are minimal or not involved at all. The view is that deforestation is a gradual process driven by community-based factors, whereas the community view is that deforestation is a stochastic process driven by external, political-economic factors [15].

The second issue concerns how and when social forestry interventions are carried out, and how local communities get involved in forest monitoring. The concept of a 'window-of-opportunity' for intervention reflects a widespread

belief that it is important *when* interventions are carried out with the support of local communities — with both the costs and benefits of intervention increasing as it is timed earlier and decreasing as it is timed later. A key determinant of the best time for intervention is the receptivity of the Uganda Wildlife Authority and how communities perceive forest monitoring.

A third issue is whether the focus of community participation in forestry monitoring practices and activities continuously involves all community members or selected ones. Whatever the focus, effective community participation in forest monitoring requires attitudinal change in communities and those mandated to organize communities to actively participate in forest monitoring practices. Otherwise, a lack of sociological perspectives and incorporating their views and desires to promote sustainable forest governance practices is crucial. The final issue involves the unintended consequences of community participation in forestry monitoring, the active involvement of communities in forest monitoring must not overshadow or override the forest management and conservation aspirations, and community participatory forest management activities must be supervised and monitored.

3. MATERIALS AND METHODS

The study was conducted across 15 parishes surrounding Kibale National Park in Uganda, focusing on Participatory Forest Monitoring (PFM) and Natural Forest Restoration (NFR). A cross-sectional design employing both qualitative and quantitative methods was utilized. Data were collected through household questionnaires, interviews, and informal communication.

A random sample of 400 households was selected from a population of 5,731, using Slovin's formula, and interviews were successfully conducted with 394 households. The semi-structured questionnaire involved both closed and open-ended questions in the questionnaires. Data analysis was carried out using descriptive and correlational techniques with SPSS software, while photography and observation provided additional insights.

The researcher and team conducted interviews using a household questionnaire for 394 households from the 14 parishes, purposively selecting between 19 to 43 households per parish depending on the total number of

households in the parish. The researcher used household registers from the parish leaders and these lists were randomized using Microsoft Excel to select the participants. Both male and female-headed households were selected. After selecting the participants, the researcher worked with local council leaders (who were not part of the targeted members) to inform the selected households ahead of time, and these same leaders introduced the research team to the selected household members.

Once the research team reached the household, they interviewed the household head, and in case the household head was not present, they interviewed the oldest household member present, as long as they were above the age of 18. In case the researcher does not find anyone present at the home, they go back to the original list and substitute the selected household with another household that follows on the randomized list; and where there is no right person to interview on the transect, the next household was selected (Unknown, 2019). This helped the research team to enlist in detail how individuals or their households participate in forest management and management around Kibale National Park.

From the 5,731 households, a sample of 400 respondents was selected for the study using Slovin's formula of 1960, Ryan [16] encourages the use of Slovin's formula since it extracts a representative sample from a bigger population of the sample with ease. The formula is stated as follows:

$$n = N / 1 + N (e)^2$$

N = Population

n = Number of samples

e = Tolerance level or Error at 95% Confidence limit.

Therefore, based on the number of households in selected parishes (5731), the sample size was calculated as follows:

$$n = N / 1 + N (e)^2$$

$$n = 5,731/1 + 5,731(0.05)^2$$

$$n = 5,731 / 1 + 5,731 (0.0025)$$

$$n = 5731 / 1 + 14.3275$$

$$n = 5,731 / 14.3275$$

$$n = 400$$

Therefore, a sample size of 400 respondents was targeted for the administration of the questionnaire for interviews. A total of 394 out of 400 targeted households were interviewed representing a 98.5% response level by the households to the survey interviews and of those interviewed.

The reliability and validity of the data were ensured by pre-testing the questionnaire and conducting semi-structured interviews. Ethical considerations were rigorously adhered to, including obtaining informed consent, maintaining confidentiality, and ensuring the anonymity of participants. Data were coded, cleaned, and processed using the spreadsheet (MS EXCEL) and SPSS, with findings presented in graphical and descriptive forms. The study followed strict ethical protocols, including obtaining approvals from relevant authorities and securing research materials.

4. RESULTS

4.1 Perceptions of Participatory Forest Monitoring Activities and Practices Around Kibale National Park

Of the 394 respondents surveyed, 79.2% strongly agreed that they engaged in selecting tree species to raise for restoration activities within Kibale National Park (M=1.88, SD = 1.97). Almost half (54.4%) of the communities bordering Kibale National Park (KNP) work with UWA rangers during forest monitoring patrols in restored areas (M=2.25, SD = 1.95) as indicated in Table 1. Results from perceptions indicate that PFM is practiced around KNP involving communities.

4.2 The Effect of Participatory Forest Monitoring Activities at the Household Level Around KNP

Communities around Kibale National Park were actively involved in PFM activities, projects and programmes. This resulted in an improvement of income at the household level among 394 respondents directly addressing household needs especially income for school fees and other needs by 79.9% (r=0.799, P<0.05) as illustrated in Table 2.

Table 1. Perceptions of participatory forest monitoring activities and practices around Kibale National Park

Variable	N	SD	D	N	A	SA	Min	Max	Mean	SD
Communities are involved in raising Indigenous tree seedlings	394	2.7	27.2	16.3	0.5	53.1	1	5	2.28	1.94
Involvement in the planting of Indigenous tree seedlings	394	0	0	25.5	14.1	60.4	2	5	2.21	2.01
Communities are engaged in the selection of tree species to raise	394	0	0	11.2	9.6	79.2	1	5	1.88	1.97
Communities are engaged in propagating seedlings and management	394	0	0	25.5	14.1	60.4	2	5	2.21	2.01
Communities are engaged in selecting areas for nursery management	394	0	0	14.1	20.5	65.4	1	5	2.15	2.03
Communities raise income from the sale of seedlings on restoration projects	394	4	2	3.5	11.0	79.5	1	5	1.09	1.12
Women are prioritized for community benefits under the restoration projects	394	0	0	9.5	11.3	79.2	1	5	1.87	1.96
Communities participate in carbon monitoring	394	2.4	26.2	17.3	0.5	53.4	1	5	2.27	1.93
Communities work with rangers during patrols for forest monitoring	394	1.4	27.2	16.3	0.5	54.4	1	5	2.25	1.95

Source: Primary survey, 2024

Table 2. Correlational statistics on PFM Engagement and Household Income at the household level

		Are you involved in PFM activities?	Does PFM address your household needs (income)?
Are you involved in PFM activities?	Correlation Coefficient	1.000	.799[**]
	Sig. (2-tailed)	.000	.000
	N	394	394
Does PFM address your household needs (income)?	Correlation Coefficient	.799[**]	1.000
	Sig. (2-tailed)	.000	.000
	N	394	394

Source: Primary Survey 2024

4.3 Type of Skills Transferred through PFM Training around Kibale National Park

Regarding knowledge and skills transfer during PFM, tree planting and agroforestry practices topped the list with 26.16% and 13.92% respectively followed by Nursery bed management and tree maintenance both at 10.97% while Monitoring (i.e. GIS/use of tablet) and operating maize milling/threshing machine came last with 0.84% as shown in Table 3. Other skills/training received included; making handcrafts, tailoring, tour guiding, vegetable growing and benchmarking exchange visits.

4.4 Change in Vegetation Cover due to PFM Efforts

Plate 4 indicates increasing vegetation cover due to participatory forest monitoring around KNP. An observation of the map in Plate 4 shows increasing forest cover after restoration efforts.

Table 3. Skills transfer during UWA-FACE PFM Activities at the household level

Skills/training received during PFM	%
Tree planting	26.16%
Training in agroforestry practices	13.92%
Nursery bed management	10.97%
Tree maintenance	10.97%
Apiary	5.91%
Soil conservation	5.91%
Making reusable sanitary pads	4.64%
Animal husbandry	7.60%
Making Eco-charcoal	3.80%
Usage of energy-efficient stoves	3.38%
Fire management	7.61%
Forest carbon monitoring	1.27%
Monitoring (i.e. GIS/use of tablet)	0.84%
Operating maize milling/threshing machine	0.84%

Source: Primary Survey 2024

Plate 1. Goats are given to different households by the UWA-FACE project in Kyabandara, Rugonjo and Kiziba parishes
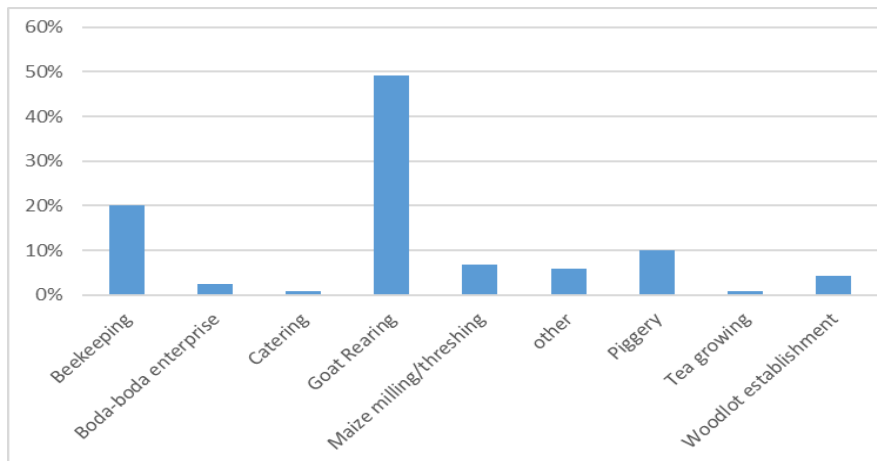

Plate 2. A maize milling machine donated by UWA-FACE to a PFM Group, Kajumiro C in Bunyangabu District

Plate 3. Threshing machine for PFM Group in Kyabandara II, Kyabandara Parish, Kamwenge Sub-County, Kamwenge District

Plate 4. Kibale National Park Land Cover Trend 1995 to 2019
(Source: UWA-FACE, 2024)

Fig. 2. Livelihood projects supported under PFM under UWA-FACE

4.5 Participatory Forest Monitoring and Livelihoods Around Kibale National Park

The UWA-FACE PFM activities supported several livelihood projects to reduce dependence on KNP resources. Among the 394 respondents, goat rearing topped the list of the livelihood groups with 49%, while tea growing and catering were the least with 1% each as shown below in Fig. 2. The other livelihood programmes included; cattle rearing, coffee growing, rice growing and drama.

5. DISCUSSION

Participatory Forest Monitoring (PFM) is a key strategy in conservation, where local communities actively engage in the management and monitoring of forests. Around Kibale National Park in Western Uganda, PFM has had a notable impact on both the environment and the community. One of the primary perceived effects is enhanced forest protection and biodiversity conservation, especially preventing endangered species from escaping the forest such as birds and chimpanzees. Through PFM, local people gain a sense of ownership over conservation efforts, which fosters a proactive attitude toward preventing illegal activities such as poaching and deforestation. The local knowledge of forest dynamics combined with community vigilance has led to the early detection of illegal logging and more effective law enforcement [17].

In addition to environmental benefits, PFM has contributed to the socioeconomic well-being of communities around Kibale. By involving locals in conservation activities, PFM provides employment opportunities, education, income, and skills development, particularly for marginalized groups. The direct involvement in forest monitoring helps mitigate conflicts between park authorities and residents, which historically arose due to restrictions on resource use. People feel more connected to conservation efforts, and this inclusiveness reduces tensions, leading to improved relationships between the Uganda Wildlife Authority (UWA) and local communities.

Another significant perceived effect is the increased biodiversity conservation. Kibale National Park is home to rich biodiversity, including chimpanzees, elephants, and numerous bird species. With active community monitoring, wildlife populations are better protected from poaching and habitat loss. Local monitors are more likely to report sightings of endangered species or instances of habitat destruction. This collaborative effort helps conservation authorities prioritize actions and allocate resources efficiently, ensuring a sustainable future for Kibale's wildlife.

Despite these positive outcomes, PFM around Kibale has faced challenges. One key issue is the sustainability of the initiative. The success of PFM often hinges on external funding and the commitment of community members. If financial support dwindles or if local interest fades, the effectiveness of monitoring may decline. Moreover, there are concerns about unequal benefit-sharing, where some community members might feel excluded from decision-making processes or the economic advantages of PFM, which could lead to internal conflicts.

Nevertheless, PFM around Kibale National Park has been perceived as a valuable approach to forest conservation and community engagement. PFM involves local communities in the process of monitoring forest resources, helping to bridge the gap between conservation authorities and local populations. This collaborative approach is especially significant in areas where human populations rely on forests for livelihood resources, such as fuelwood, medicinal plants, and bushmeat [17].

One of the primary benefits of PFM is the enhancement of forest conservation outcomes. Involving local communities in monitoring efforts around Kibale National Park has led to better forest management, with more eyes on the ground to detect illegal activities such as poaching, illegal logging, and encroachment. By empowering local community members with the knowledge and tools to track forest health and wildlife, PFM creates a sense of ownership over conservation goals. This increases vigilance and deters destructive practices, as locals often have a vested interest in the long-term health of the forest ecosystem. Studies conducted in other parts of Uganda [18], such as the Bwindi Impenetrable Forest, show that involving local communities in conservation activities led to a reduction in illegal activities in the park. A similar effect has been observed around Kibale, where community members work with park authorities to identify and report environmental violations, fostering better protection of forest resources.

PFM fosters trust between local communities and conservation authorities. In many instances, conservation efforts in Uganda have been characterized by tension between authorities and local communities, especially where traditional land rights and livelihoods have been restricted. However, PFM offers a more inclusive approach, which helps to build positive relationships. This collaborative effort allows local people to feel respected and valued in conservation processes, reducing conflict. Around Kibale, local communities have long had a contentious relationship with the Uganda Wildlife Authority (UWA) due to strict anti-poaching and anti-encroachment measures that affect their traditional land-use practices. By involving these communities in forest monitoring, there is an opportunity to foster cooperation and reduce friction, as people become active participants rather than passive bystanders or adversaries to conservation efforts.

Participatory Forest Monitoring (PFM) is a collaborative conservation approach that involves local communities in the monitoring and management of forest resources. Around Kibale National Park in Western Uganda, PFM is considered an effective strategy for addressing the challenges of forest degradation, biodiversity loss, and human-wildlife conflicts [19]. This discussion explores the perceived benefits of PFM in this context. One of the most significant perceived benefits of PFM is its positive impact on forest conservation. By involving local communities, PFM increases surveillance of forest areas and curtails illegal activities such as poaching, illegal logging, and encroachment. Local people have an intimate knowledge of the landscape, which enables them to detect changes and identify threats more effectively than external agents.

PFM helps build trust and reduce tension between local communities and conservation authorities. Historically, conservation in Uganda, including around Kibale National Park, has been marked by conflict between communities and the Uganda Wildlife Authority (UWA). Strict enforcement of conservation laws often restricts access to resources that local populations depend on for their livelihoods, such as fuelwood, medicinal plants, and agricultural land [20]. Therefore, the PFM model is a strategic tool for forest restoration, eco-tourism and community enhancements around the KNP.

The participatory approach of PFM shifts the dynamic from confrontation to collaboration. In Kibale, community members who are involved in monitoring activities develop better relationships with park authorities. This collaboration promotes mutual respect and reduces resentment, as local people feel they are contributing to the decision-making process rather than being excluded from it. By engaging in forest monitoring, local communities have a greater sense of ownership over conservation efforts, leading to reduced conflicts with authorities and more harmonious coexistence [21].

PFM offers opportunities for capacity building and skill development for local communities. Community members who participate in monitoring activities are trained in data collection techniques, species identification, and environmental management practices. These skills not only contribute to forest conservation but also improve the socioeconomic status of participants by making them more employable in conservation or related fields. In the case of Kibale National Park, training programs have equipped local monitors with the ability to track wildlife populations, identify signs of illegal activities, and contribute to data collection for research purposes [22]. This capacity-building element fosters local conservation leadership and empowers community members to take an active role in environmental stewardship. The knowledge gained from such programs can also be transferred to future generations, creating a long-term positive impact on conservation efforts. One of the critical perceived benefits of PFM is its potential to improve livelihoods. In many cases, participants in forest monitoring receive financial incentives or other benefits, such as access to alternative livelihood programs, employment opportunities, or increased access to forest resources through regulated use agreements. This is particularly important in regions like Western Uganda, where poverty is prevalent and communities rely heavily on natural resources for their livelihoods.

PFM programs around Kibale National Park have offered opportunities for local communities to benefit from conservation. For instance, some participants receive payments for their monitoring work, while others gain access to income-generating projects such as eco-tourism or sustainable resource extraction initiatives [20]. This financial benefit reduces the need for communities to engage in illegal activities, such as poaching or deforestation, as they can

generate income through legal, sustainable practices.

PFM enhances environmental awareness and promotes a sense of stewardship among community members. By directly involving locals in monitoring and data collection, PFM fosters a deeper understanding of the importance of forest ecosystems and the need for conservation. This increased awareness encourages behaviour changes and promotes sustainable resource use, reducing harmful practices that lead to forest degradation. Around Kibale National Park, PFM has contributed to a shift in community attitudes toward conservation. Local monitors, through their involvement in forest management, have developed a stronger appreciation for biodiversity and the ecological value of the forest [23]. As a result, they often become advocates for conservation within their communities, influencing others to adopt more sustainable behaviours. This shift in mindset is essential for ensuring the long-term success of conservation efforts in the region.

Another benefit of PFM is its contribution to scientific research and policy development. Community members who participate in monitoring activities collect valuable data on forest health, wildlife populations, and environmental changes. This data can be used by researchers to assess the effectiveness of conservation strategies and inform future policy decisions. In Kibale National Park, community monitors play an essential role in tracking trends in biodiversity and forest cover, which helps conservation authorities make informed decisions about resource management [22]. The data collected through PFM initiatives can also be used to support policy advocacy at the national level, ensuring that local perspectives are considered in conservation planning and decision-making [24].

Participatory Forest Monitoring around Kibale National Park is perceived as a highly beneficial approach to forest conservation, contributing to improved environmental outcomes, better community relationships with conservation authorities, capacity building, livelihood enhancement, increased environmental awareness, and valuable data for research and policy development. While challenges such as securing long-term funding and addressing socio-economic pressures persist, the overall impact of PFM on forest conservation in the region is positive and offers valuable lessons for other conservation areas in Uganda and beyond.

6. CONCLUSION

PFM activities, practices and projects can improve income at the household level through employment, supporting community projects and investing in community projects for PFM recipients. Income from PFM activities, projects, programmes and related initiatives helps to directly address household needs such as school fees and food. Further improvements to PFM activities, practices, programmes and projects require increased funding, creating more awareness and addressing human-wildlife conflicts through compensation for livelihoods lost due to crop foraging. Participatory forest monitoring must continuously aim at establishing and supporting community monitoring groups that are trained in forest monitoring and management techniques. Forest monitors can incorporate local ecological knowledge into forest management plans. Local communities often have valuable insights into forest dynamics and illegal activities. The need to develop mechanisms for equitable sharing of benefits derived from forest resources, such as ecotourism revenues or sustainable harvesting rights is imperative.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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