

Research Article

Forest Based Enterprises for Livelihoods Improvement in Participatory Forest Management within Ol Bolossat Forest, Kenya

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Abstract

Forest resources are faced with challenges that range from mismanagement, overutilization, conflicts and competing claims. Consequently, this has given rise to legislation and policy to protect forests. However, many governments in developing countries have difficulties in implementing sustainable forest management (SFM). One of the strategies advocated to foster SFM is participatory forest management (PFM). The PFM approach has been practiced formally in Kenya since 2005. The aim of this study was to assess Forest Based Enterprises for Livelihoods Improvement in Participatory Forest Management within Ol Bolossat Forest. Semi-structured interviews with key informants were used in data collection. The activities in Ol Bolossat forest PFM which was widely practiced and registered more members was commercial tree growing business enterprises, Plantation Establishment and Livelihood Scheme (PELIS) cultivation projects, beekeeping, fish farming, tree nursery production and ecotourism which was done through camping. Other projects conducted in much smaller scale were medicinal plant extraction, briquette making, moringa tree project, mushroom farming and biogas production. The study established that there was a capacity building programmes on intensive commercial farm forestry, extension and advisory service, training the forest adjacent communities in commercial tree growing on farm, as well as Training on agronomy of non-wood products as well as training on raising seedlings. These initiatives have spurred economic, social and environment development of the area through improved sale of quality honey and provision of forest products like poles, firewood and timber.

Keywords

Forest Based Enterprises, Forest Restoration, Forest Conservation, Participatory Forest Management, Ol Bolossat Forest, Kenya

1. Introduction

Forest provide economic, environmental, social and cultural benefits to almost 2.4 billion people globally [1, 2]. The benefits include food, water, timber, poles, medicinal plants and cultural value which serve as an additional income or source of livelihoods for the forest adjacent dweller [3, 4]. The diverse use of the forests by the adjacent forest dwellers and

other stakeholders may lead to forest degradation if the utilization is not sustainable [5, 6]. Indeed several forest have reports of degradation in the wake of continued utilization without proper management [7-10]. To ensure that degradation of the forest is minimized and the forest resource is used sustainably, there is justification for sustainable forest man-

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agement [11, 12].

Sustainable forest management (SFM) of forest, is carried out to balance the economic, social, environmental and cultural values of forests for the benefit of present and future generations [13, 14]. In last century, fidelity in sustainable forest governance relied on a central authority such as national or local government without any consideration of the local communities, who were stakeholders in the forest resources [15-17]. This led to a 'rebellion' and campaigns by many local communities members to be incorporated into forest governance through participatory forest management (PFM) [18, 19]. PFM, as a management strategy, allow individuals to actively participate in the management of forest resources as part of the decision-making process for all facets of forest management, including the formulation of policies [20]. This management showed a new paradigm in forest management whose implementation fulfilled the interest, respecting of traditional users, and bottom-up approach, which encourages a sense of belongingness to communities around forests [21].

Following the World Forestry Congress, in Jakarta in 1978, themed "Forests for People", forest management strategies emerged that allowed local communities in conjunction with central authority to manage forests [22]. Involvement of the local communities to manage forest resources is gaining increasing significance over the years and is currently identified as a successful approach in the management of forest sources in several countries across the world [23, 24]. Kenya's forests have been managed under command and control beginning with the East Africa Forest Regulations of 1902 which was later expanded into Forest Ordinance of 1911 [25]. The evolution saw the forest legislation undergo several amendments from 1941 to 1954 to capture the Constitutional changes in the then Kenya Colony. In 1964 further reviews resulted in the Forest Act Cap 385 which provided for the establishment, control and acquisition of forests in independent Kenya [26]. Communities participated in forestry matters as forest workers on a paid basis or as cultivators who were instrumental in the establishment of industrial plantations under the Shamba System (now PELIS – Plantation Establishment through Improved Livelihood System) [27]. The increased forest destruction in the 1970s, 80s and 90s was mostly blamed on inappropriate and non-inclusive forest governance policy and legislation [28]. There was a general trend of decline of forest land from 1990 to 2000 due to the degazettement of forestland to open up areas for agriculture, especially in the Mau ecosystem [29]. Consequently, in 2005 the Government of Kenya ratified a new Forests Act replacing Cap 385 [30]. The act, generally referred to as the Forest Act 2005 introduced a new paradigm shift in participatory forest management (PFM) where, community participation is provided for through participatory forest management (PFM) as a major tool [28]. Forest Act 2005 was repealed and replaced by Forest Conservation and Management Act 2016 which upheld PFM. Since then there are over 177 Participatory Forest Manage-

ment Plans (PFMPs) [31].

In Kenya, PFM has resulted in empowerment of marginalized groups through recognition of rights and responsibilities, increased involvement of the forest adjacent communities and other stakeholders in creation of opportunities for local people, and support of sustainable forest-based livelihoods in poor rural communities [32-34]. Within the realm of PFM in Kenya, the regulation allows for a number of forest based enterprises for livelihoods improvement in participatory forest management. These may include ecotourism, recreational activities, collection of forest produce for community based industries, development of community wood and non-wood forest based industries as well as scientific and educational activities, among others [28, 35]. However, information is absent in several regions of Kenya concerning the forest based enterprises (FBEs) for livelihoods improvement within PFM. Therefore, the aim of this study was to assess forest based enterprises for livelihoods improvement in participatory forest management within Ol Bolossat Forest. Forest Based Enterprises is defined as activities that adjacent communities are involved in while carrying out PFM implementation in Ol Bolossat forest.

This study applies the Sustainable Livelihoods Approach (SLA) as a framework to comprehend the contribution of community-based enterprises and sustainable forestry to improved livelihoods, among those dependent on forest resources [36]. The SLA a comprehensive understanding how the community-based enterprises (e.g., commercial tree growing business enterprises, beekeeping, eco-tourism, forest product projects) can improve the economic opportunities while increasing the income and livelihood opportunities for local people relying on the forest resource [37]. There the framework help in understanding the influence of sustainable forestry practices through forest based enterprises on community livelihoods, ensuring that forest management benefits local communities and contributes to their overall well-being. Analysis of the community context, assets, and strategies allow SLA to identify opportunities of enhance livelihoods while promoting sustainable forest management.

2. Methodology

2.1. The Study Area

The study was carried out at Ol Bolossat forest which is a catchment protection area for Lake Ol Bolossat and is part of the larger Aberdares Ecosystem located in Nyandarua County, Kenya (Figure 1). Ol Bolossat forest lies between latitude 0°01" North and 0°05" South of the Equator and between longitudes 36°17" East and 36°22" East at an altitude of 2400 m asl. It is located near Nyahururu town and is on the western side of the Aberdares Ranges. Temperature range from a minimum of 6.0 °C during the night and 23 °C during the day. Rainfall distribution is between 750 mm and 1500 mm with long rains in April to July and short rains in November to

December. Population density was 130 to 910 persons per km² [38] with many residents practicing both subsistence and

commercial farming. It occupies an area of approximately 3,328 hectares.

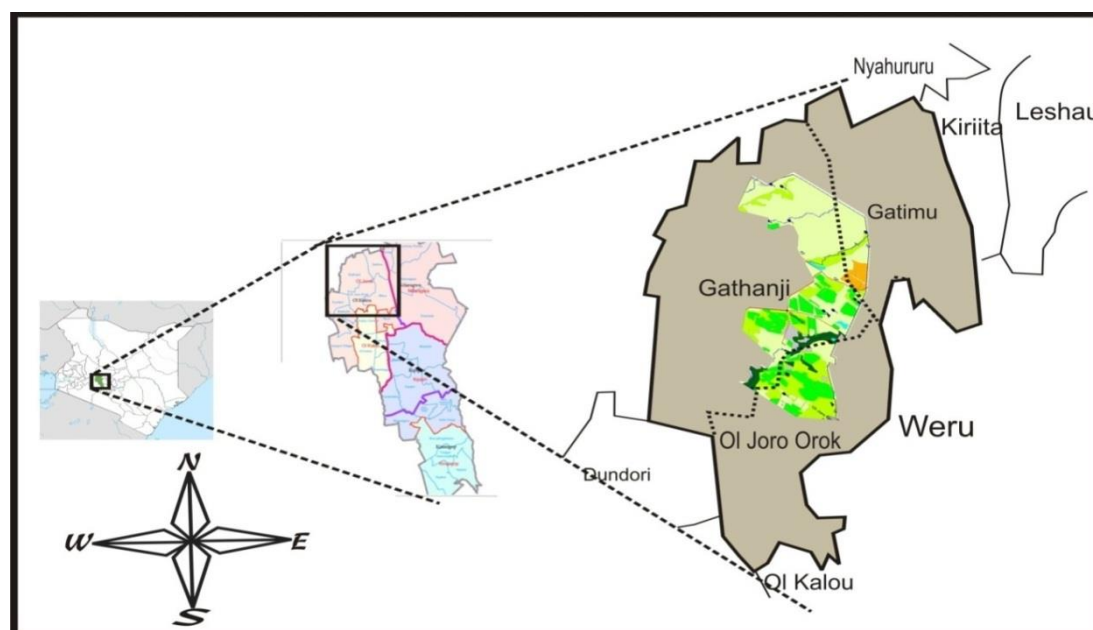


Figure 1. Map of Ol Bolossat Forest within Nyandarua County (Source: Department of Resource Survey and Remote Sensing; Lands at satellite image (27 Jan 2000, 169/060).

2.2. Data Collection Tools

The data was gathered through document analysis of records within the Community Forest Association (CFA) office and further information obtained from oral interview with the three user group officials of the CFA purposively selected. Oral informed consent was obtained from the officials. The researcher also strengthened the response of the data by survey of the farmers in the study area to observe the activities and obtained information on economic earnings.

2.3. Data Analysis

Data were analyzed descriptively, which involved the use of means $\pm$ SD and frequency distributions for categorical data sets.

3. Results and Discussion

3.1. Forest Based Enterprises for Livelihoods

Types, number and estimated annual economic contribution of forest of forest based enterprises under CFA in Ol Bolossat Forest is shown in Table 1. The activities in Ol Bolossat forest CFM which was widely practiced and registered more members was commercial tree growing business enterprises, PELIS cultivation projects, beekeeping, fish farming, tree nursery seedlings production and ecotourism which was done through camping. Other projects conducted in much smaller scale were medicinal plant extraction, briquette making, moringa tree project, and biogas production.

Table 1. Types, number and estimated annual economic contribution of forest based enterprises registered under CFA in Ol Bolossat Forest.

Forest based enterprises	Number members	Estimated annual economic contribution (USD) [†]
Commercial tree growing business enterprises	1245	1,006,000
PELIS Cultivation	785	1,700, 000
Beekeeping	761	831,700
Aquaculture	664	450,000

Forest based enterprises	Number members	Estimated annual economic contribution (USD) [†]
Tree nursery seedlings production	502	750,000
Eco-tourism	495	475,000
Medicinal plant extraction and moringa tree project	315	340,000
Briquettes making	230	525,000
Biogas production	16	21,000

[†]Estimated from the records available in the CFAs offices, and earning from individual members based on survey

Commercial tree growing business enterprises was the main forest based project encouraged for over 80% of the members with an annual earning of over 1 million USD to the locals. It was found that investment in private commercial farm forestry had become a profitable venture in the study area with over 90% of respondents having woodlot in their own farms due to increased demand for wood products that has outstripped supply. The area has three categories of industrial firewood consuming sectors that motivate farmers to venture into economic forestry investment. These are tea processing factories affiliated to the Kenya Tea Development Authority (KTDA), transmission poles treatment plants and food processing industries that requires wood fuel. Most of grain farmers in the study area are investing in commercial farm forestry because they consider it as being more profitable compared to maize or wheat production. Growth of tree as commercial enterprise has been reported in several community forest associations such as those registered in Java, Indonesia [39], Uganda [40, 41], Tanzania [42], Kericho in Kenya [43], and Loita in Kenya [44].

The Establishment and Livelihood Improvement Scheme (PELIS) cultivation in Ol Bolossat CFA was another major milestone within the region with 785 members practicing earning a total of 1.7 million USD from the practice. Formerly the Shamba system or *Taungya*, a modified form of non-residential cultivation method of forest plantation establishment [45, 46]. It involves planting plantation tree species in combination with food crops in forestland over a defined period of time in exchange for cheap labour for planting and tending the plantation [47, 48]. By allowing farmers to utilize the forest land for cropping while tending for the young plantations during establishment, potential land use conflicts with local communities that rely on forestland for their subsistence needs are minimized. The adoption of PELIS system also conferred the forest adjacent communities the moral obligation to fulfill corporate social responsibility (CSR) of forest management [46]. PELIS, when well-managed, has been shown to have good potential in some areas of Kenya [49]. In the current study earnings from PELIS was the highest at 1.7 million USD within the region. Studies have found that PELIS participation leads to a substantial improvement in the welfare of participating households, with some studies estimating the impact at between 15.09% and

28.14%. Furthermore, PELIS has been found to increase forest cover by an estimated 5.53% to 7.94% [45].

Beekeeping was the third most important project in the Ol Bolossat CFA with a total of 761 members earning approximately 831,700 USD. Beekeeping is a common activity in most of the CFA including in Same District in Tanzania [51], regions around Ruaha National Park in Tanzania [51], adjacent Kamaki Forest in Kitui Kenya [52], in Ethiopia [53], Mau Forest in Kenya [54]. Aquaculture was practiced in the area by 664 people. Fish farming as an enterprise has been reported in several CFAs such as Kakamega Kenya [55], in Arabuko-Sokoke Forest [35, 50], in areas adjacent to Aberdare Forest [56], adjacent Eastern Arc Mountain Tanzania [57]. Tree nursery seedlings production was important activity in the region and benefited 502 members. Tree seedling growing business enterprises has been reported in several community forest associations such as those registered in Java, Indonesia [39], Uganda [40, 41], Tanzania [42], Kericho in Kenya [43], and Loita in Kenya [44].

Eco-tourism was reported in the study area and benefited 495 members contributing 475,000 USD. The main eco-tourism activities carried out included bird watching in the indigenous natural forest along the nature trails, picnic camping at the camp sites developed to take advantage of Nyahururu Thomson Waterfalls Tourists Circuit, fishing, visit to historical Mau Mau Caves and high altitude athletics training camps. These findings concurred with those of local community in Arbegona and Nensebo Woredas, Southern Ethiopia who practiced ecotourism as forest based enterprise [58], members of Community Forest Association in the Upper Imenti Forest, Meru County, Kenya [59] as well as community participation in ecotourism at Ulu muda forest reserve, Malaysia [60]. Three natural caves around Mweja-Chamuka River, Gatothua and Gitwe are found within the Ol Bolossat forest and are being exploited as tourist attraction sites. Two waterfalls along Chamuka River near Ol Bolossat KFS Forest Station and near Gitwe/Kamwan Dam act as tourism attraction sites besides being tapped for small hydro power projects. Lake Ol Bolossat is known to have a lot of avifauna, which supports migration of birds. Adjacent to the lake are also other scenic sites that attracts tourist in the area.

Medicinal plant extraction was another viable project in the study area. There was processing of stinging needles for me-

dicinal purposes which was estimated to generate 240,000 USD in revenue. Stinging nettle leaves and greenish flower were used as a vegetable, very rich in minerals, vitamins and medicinal value. It is beneficial in treatment of various complaints including joint pains, skin roughness, blood sugar, high blood pressure and problems of diuretic [61]. Stinging nettles are used in various ways by forest-adjacent communities globally, encompassing food, and medicine. This was established among the Shina tribe in Figurez valley of Northwestern Himalayas who used stinging nettles for supporting healthcare and livelihood [62]. In Ol Bolossat forest, stinging nettle leaves are dried in locally made solar drier where they are turned often to prevent browning and maintain the nutrients. They are then crashed using hands into powder form which is then weighed and packed into polythene bags of different sizes and dispatched to the market. In addition there was moringa tree project whose leaves pods and flowers are rich in protein, iron and a host of micro-nutrients and amino acids that are consumed as vegetables. The bark and roots have medicinal properties and are used for a variety of ailments and infections. Moringa tree planting at Ol Bolossat forest are focused on the rehabilitation of the environment and women empowerment through the production, processing and marketing of Moringa based products. Processing of Moringa leaves into powder can be used to make a beverage or additives to food. The current study finding concur with another study in Senegal, where cultivation of moringa trees is used to combat malnutrition by providing enriched food and by treating drinking water [63].

At Ol Bolossat forest it was found that the CFA had acquired manual briquette machine to address the demand on charcoal and reduce forest tree cutting. Similar activities have been reported in Maasai-Mau forest adjacent community, Kenya [64] as well as in Community Forest Associations in Ngong' Road forest in Nairobi City County and Kiptuget forest in Baringo-a section of Mau Complex [65]. Utilising briquettes as an alternative form of fuel makes use of a waste product and reduces pressure on forestry resources. Charcoal briquette production in Kenya is well documented, with about 82% of briquette producers in the country using manual machine presses, 25% using electricity, and 10% using other means [66]. The briquettes are used at homes, food kiosks, and hotels, institutions such as schools, chicken hatcheries, and bakeries.

Biogas was found to be used as an alternative source of affordable fuel to reduce on the demand for wood fuel at house hold level it contributed 21,000 USD. Similar projects have been reported in in self help group using methane gas (biogas) management as renewable energy in Indonesia [67] as well as in Nepal [68]. KFS, livestock department and CFA user group were promoting the use of cow dung to generate cooking gas to reduce harvesting of trees and increase the forest and tree cover at Ol Bolossat. The farmers were encouraged to keep quality dairy animals as a source of dung to produce biogas, manure bio-slurry to increase food crop

yields and improved soil fertility. Six farmers had benefitted from the Ol Bolossat CFA and dairy farmers neighboring Ol Bolossat forest were ready to install more biogas plants. The CFA were requesting the government to subsidize the cost of cooking gas and fund such program like biogas production to contain deforestation to boost forest cover owing to the resultant decline demand for wood fuel.

3.2. Forest Based Capacity Building Programmes for Livelihoods Improvement

The capacity building programmes, coordinators and number of members are show in in Table 2. The study established that there was a capacity building programmes on intensive farm forestry extension service conducted by KFS staff in collaboration with other government officers from agriculture, livestock, water, youth and gender. The current finding compares well with another study the role of forestry extension agents in community empowerment farmers group Pasar Village, Forest Management Unit Balige District Toba Regency [69] as well as in forest adjacent communities in Northern Ghana [70]. Forestry sector extension service plays a key role in disseminating knowledge, technology and forestry information and in linking farmers with other actors in the economy.

Capacity building for tree growing on farm was also conducted by KFS and conjunction with county government. Similar initiatives have been reported in Cameroon [71] and Paru Village Forest, Sijunjung Regency, West Sumatera [72]. The services aimed at building capacity of the forest adjacent communities through training and sensitization. Capacity building helps in the transformation of subsistence forestry to enable it increase goods like fuel wood, poles, posts and timber to a modern business and commercial forestry venture.

There was also the beekeeping training programme supported by Green Zones Development Support Project (GZDSP), Friends of Lake Ol Bolossat (FOLO). Similar training programmes have been reported in other forests in Kenya such as Karura Forest adjacent areas [73], Zambia [74] as well as communities adjacent to Kalinzu forest, Western Uganda [75]. The transformations promote household income and consequently reduce poverty through sale of forests products. Training forest-adjacent communities in beekeeping offers a multitude of benefits, including economic empowerment, enhanced food security, and improved forest conservation. Beekeeping provides a sustainable income source for communities, promotes pollination, and can lead to the restoration of degraded land through bee activity [76].

Training on agronomy of non-wood products as well as training on raising seedlings which are both supported by KFS, Community Development Trust Fund (CDTF) supported Ol Bolossat CFA with certified tree seeds from Kenya Forestry Research Institute (KEFRI) seed centre.

Similar studies have been reported in Cameroon, Equatorial Guinea and Rwanda [77] and among Forest-adjacent Communities in Mau Forest, Kenya [78]. Training forest-adjacent communities in tree production can foster

sustainable forest management and provide livelihood benefits. It empowers communities to manage forests responsibly, contributing to environmental conservation and economic development.

Table 2. Forest based capacity building programmes, coordinators and number of members in registered under CFA in Ol Bolossat Forest.

Forest based training programmes	Coordinators	Number members benefiting
Farm forestry extension training programmes	KFS and ministry of agriculture and Livestock, Ministry of Youth and Gender	845
Capacity building for tree growing on farm	KFS, County government	266
Beekeeping training programme	Green Zones Development Support Project (GZDSP), Friends of Lake Ol Bolossat (FOLO)	34
Training programme on agronomy of non-wood products	KFS	45
Training programme on raising tree seedlings	Kenya Forestry Research Institute (KEFRI), Community Development Trust Fund (CDTF)	51

4. Conclusions

The study established that the activities in Ol Bolossat forest CFM which was widely practiced and registered more members was commercial tree growing business enterprises, PELIS cultivation projects, beekeeping, fish farming, tree nursery production and ecotourism which was done through camping. Other projects conducted in much smaller scale were medicinal plant extraction, briquette making, moringa tree project, mushroom farming and biogas production. The study established that there was a capacity building programmes on intensive commercial farm forestry extension and advisory service, training the forest adjacent communities in commercial tree growing on farm, as well as Training on agronomy of non-wood products as well as training on raising seedlings. These initiatives have spurred economic, social and environment development of the area through improved sale of quality honey and provision of forest products like poles, firewood and timber

5. Recommendations

The community requires training and capacity building on development, processing technologies and marketing for the Non Wood Forest Products (NWFP) and provision of sufficient economic incentives to promote potential nature based enterprises. Training Ol Bolossat CFA community members on emerging issues pertaining to group dynamics that improve governance, transparency and accountability on participatory natural resources management will help them become more

successful in forest management.

There is need to ensure economic benefits to the forest adjacent communities through value addition chain and encourage sustainable utilization of natural resources. In order to identify the challenges and opportunities to PFM implementation in forests, adjacent communities should be aware of local structures, PFM enterprises, PFM activities and forest management and conservation policies towards effective conservation of the forests.

It is recommended that group representatives of the community that are involved in cultivation of the plant need to be given an intensive course on various stinging nettle based products and processing methods such as drying, packaging and marketing using simple techniques at home.

Abbreviations

CDTF	Community Development Trust Fund
CFA	Community Forest Association
CSR	Corporate Social Responsibility
FBEs	Forest Based Enterprises
FOLO	Friends of Lake Ol Bolossat
GZDSP	Green Zones Development Support Project
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
KTDA	Kenya Tea Development Authority
NWFP	Non Wood Forest Products
PELIS	Plantation Establishment and Livelihood Scheme
PFM	Participatory Forest Management
PFMPs	Participatory Forest Management Plans
SFM	Sustainable Forest Management

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Author Contributions

Benjamin Kinyili is the sole author. The author read and approved the final manuscript.

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares no conflicts of interest

References

- [1] Malik, A. Y. 2024. in *Sustainable Forest Resources Management* (Apple Academic Press, 2024), pp. 93-108.
- [2] Sinha, A. 2025. in *Textbook of Forest Science* (Springer, 2025), pp. 3-21.
- [3] Singh, V. 2024. in *Textbook of Environment and Ecology* (Springer, 2024), pp. 143-153.
- [4] Xu, P., Zhang Y., Li Q. and Sun C. 2025. *Science of The Total Environment* 965, 178612 (2025).
- [5] Haneda, L., HS Brancalion P., Valle D., Silva C. A., G örgens E. B., Prata G. A., *et al.*, presented at the Denis and Silva, Carlos Alberto and G örgens, Eric Bastos and Prata, Gabriel Atticciati and Kamimura, Renan Akio and Gomes, Silvio Henrique Menezes and Sanchez, Arthur and Almeida, Danilo RA, Assessing Forest Degradation Impacts on Amazon REDD+ Projects Using Uav-Lidar System, 2025 (unpublished).
- [6] Jaiswal, R., Sharma A., Prakash D., Choudhary A. and Verma S. 2025. *Environmental Earth Sciences* 84 (3), 1-11 (2025).
- [7] Kyere-Boateng, R. and Marek M V. 2021. *Forests* 12 (4), 409 (2021).
- [8] Shukla, J., Dhyani S., Pujari P., Mishra A. and Verma P. 2022. *Land Degradation & Development* 33 (16), 3103-3117 (2022).
- [9] Chaudhry, S. 2021. in *Handbook of Climate Change Management: Research, Leadership, Transformation* (Springer, 2021), pp. 1-17.
- [10] Osewe, E. O., Niță M. D. and Abrudan I. V. 2022. *Forests* 13 (12), 2127 (2022).
- [11] McDiarmid, D., John M. and Wilson S. 2025. in *The Routledge Handbook of Global Sustainability Education and Thinking for the 21st Century* (Routledge India, 2025), pp. 664-675.
- [12] Wuepper, D., Crowther T., Lauber T., Routh D., Le Clec'h S., Garrett R. D., *et al.* 2024. *Global Environmental Change* 84, 102770 (2024).
- [13] Bosela, M., Larocque G. R., Baycheva T., Valbuena R. and Lier M. 2024. in *Ecological Forest Management Handbook* (CRC Press, 2024), pp. 356-385.
- [14] Burton, P. J. 2025. *Resilient Forest Management*. (Oxford University Press.
- [15] Kim, T. H., Lee H., Lee H. and Park M. S. 2023. *Forest Policy and Economics* 154, 103021 (2023).
- [16] Gauld, R. 2000. *Development and change* 31 (1), 229-254 (2000).
- [17] Acharya, K. P. 2005. *Mountain research and development* 25 (3), 269-277 (2005).
- [18] Wei, S., Xiang Y. and Li Z. 2024. *Journal of Selvicoltura Asean* 1 (4), 187-197 (2024).
- [19] Masuda, H., Kawakubo S., Okitasari M. and Morita K. 2022. *Sustainable Cities and Society* 82, 103883 (2022).
- [20] Robinson, T., McGrann J., Kadir A., Jim énez-Ontiveros I. and Barton U. A. 2021. PEFA Research Paper. Washington, DC: Public Expenditure and Financial Accountability (PEFA) (2021).
- [21] Mbeche, R., Ateka J., Herrmann R. and Grote U. 2021. *Forest Policy and Economics* 129, 102507 (2021).
- [22] Pulhin, J. M., Ramirez M. A. M., Garcia J. E., Pangilinan M. J. Q., Evaristo M. B. S., Catudio M. L. R. O., *et al.* 2024. *Trees, Forests and People* 16, 100589 (2024).
- [23] Tebkew, M. and Atinkut H. B. 2022. *Trees, Forests and People* 10, 100346 (2022).
- [24] Muluneh, A. and Sime G. 2024. *Journal for Nature Conservation* 78, 126580 (2024).
- [25] Fanstone, B. P. 2016. (2016).
- [26] Chisika, S. N. and Yeom C. 2024. *Forestist* 74 (3), 278-288 (2024).
- [27] Kamau, J. K., Gikonyo S. W. and Ming'ate F. L. 2023. *International Journal of Research and Innovation in Social Science* 7 (12), 926-937 (2023).
- [28] Mogoi, J., Obonyo E., Ongugo P., Oeba V. and Mwangi E. 2012. *Conservation and Society* 10 (2), 182-194 (2012).
- [29] Ongugo, P. O., presented at the Proceedings: International conference on poverty reduction and forests, 2007 (unpublished).
- [30] Mutune, J. M. and Lund J. F. 2016. *Forest Policy and Economics* 69, 45-52 (2016).

- [31] Musingo, M. T. E., Ndalilo L. A. and Gacheru P. 2023. *Participatory forest management in Kenya: Lesson learned after twenty years of implementation (1997-2018)*. (KEFRI/Nature Kenya Nairobi, Kenya).
- [32] Gichuki, L. 2018. Open Access Te Herenga Waka-Victoria University of Wellington, 2018.
- [33] Musyoki, J. K., Ming L. F. M., Muriithi J., Musingo M. T. E. and Kagombe J. 2024. Open Journal of Forestry 14 (3), 183-196 (2024).
- [34] Ngome, C. S. and Yeom C. 2024. Asia-Pacific Journal of Convergent Research Interchange (APJCRI), 227-245 (2024).
- [35] Matiku, P., Caleb M. and Callistus O. 2013. Conservation and Society 11 (2), 112-129 (2013).
- [36] Tambe, S. 2022. Sustainable livelihoods approach. In Teaching and learning rural livelihoods: A guide for educators, students, and practitioners (pp. 45-56). Cham: Springer International Publishing.
- [37] Molnar, A., Liddle, M., Bracer, C., Khare, A., White, A. and Bull, J. 2007. Community-based forest enterprises in tropical forest countries: status and potential. RRI, Washington DC.
- [38] Kenya National Bureau of Statistics. 2019. Nairobi: Kenya National Bureau of Statistics (2019).
- [39] Kurniasih, H., Ford R. M., Keenan R. J. and King B. 2021. World development 139, 105319 (2021).
- [40] Mawa, C., Babweteera F., Tabuti J. and Tumusiime D. 2020. International Forestry Review 22 (3), 323-338 (2020).
- [41] Mawa, C., Tumusiime D. M. and Babweteera F. 2021. Forests, Trees and Livelihoods 30 (2), 133-150 (2021).
- [42] Degnet, M. B., van der Werf E., Ingram V. and Wesseler J. H. 2020. Forests 11 (7), 782 (2020).
- [43] Jepng'etich, K. S., presented at the 2020 International Conference and Utility Exhibition on Energy, Environment and Climate Change (ICUE), 2020 (unpublished).
- [44] Mbuvi, M. T. E. and Kungu J. B. 2021. Heliyon 7 (6) (2021).
- [45] Agevi, H. 2016. American Journal of Agriculture and Forestry 4 (5), 128-135 (2016).
- [46] Pommerening, A. 2024. *Continuous Cover Forestry: Theories, Concepts and Implementation*. (John Wiley & Sons).
- [47] Mwatika, N. M. 2013. University of Nairobi, 2013.
- [48] Van Der Meer Simo, A. 2020. Forests 11 (11), 1162 (2020).
- [49] Waruingi, E., Mbeche R. and Ateka J. 2021. Global Ecology and Conservation 26, e01514 (2021).
- [50] Lusiru, S. N. 2022. (2022).
- [51] Mmassy, E., Ntiniwa K., Lesio N., Keyyu J., Bukombe J., Mjinga E. E., et al. 2024. Journal of Apicultural Research, 1-9 (2024).
- [52] Gassimu, B.-S., Dorcas K. G. and Elliud M. M. 2024. International Journal of Science and Research Archive 12 (2), 969-975 (2024).
- [53] Kassa Degu, T. and Regasa Megerssa G. 2020. Bee World 97 (4), 98-104 (2020).
- [54] Zocchi, D. M., Volpato G., Chalo D., Mutiso P. and Fontefrancesco M. F. 2020. Journal of ethnobiology and ethnomedicine 16, 1-22 (2020).
- [55] Ogada, M. J. 2012. (2012).
- [56] Wambugu, E. W., Obwoyere G. O. and Kirui B. K. 2017. (2017).
- [57] Zozimus, S. A. 2017. Agriculture, Forestry and Fisheries 6 (4) (2017).
- [58] Gezahegn, B., Girma, Z., and Debele, M. 2024. Local community attitude towards forest-based ecotourism development in Arbegona and Nensebo Woredas, southern Ethiopia. International Journal of Forestry Research, 2024(1), 4617793.
- [59] Musyoki, J. K., Ming'ate, F. L. M., and Muriithi, J. K. 2022. Factors Determining Household Membership to Community Forest Association for Participation in Management of Upper Imenti Forest, Meru County, Kenya. Open Access Library Journal, 9(10), 1-18.
- [60] Samdin, Z., Abdullah, S. I. N. W. and Subramaniam, T. 2022. Assessing the community participation in ecotourism at Ulu muda forest reserve, Malaysia. In Tropical Forest Ecosystem Services in Improving Livelihoods For Local Communities (pp. 155-178). Singapore: Springer Nature Singapore.
- [61] Kamicha, W., Karanja R. N. and Ngaruiya G. W. 2023. Journal of Environmental Science and Public Health 7 (1), 25-30 (2023).
- [62] Atta, U., Islam, M., Kaif, M., Nazir, I., Rather, A. M. and Ishneiwa, R. M. 2023. Non-timber forest products (NTFPs) supporting healthcare and livelihood among the Shina tribe in Figurez valley of Northwestern Himalayas. Ann. Phytomed, 12, 918-929.
- [63] Horn, L., Shakela, N., Mutorwa, M. K., Naomab, E., and Kwaambwa, H. M. 2022. Moringa oleifera as a sustainable climate-smart solution to nutrition, disease prevention, and water treatment challenges: A review. Journal of Agriculture and Food Research, 10, 100397.
- [64] Mokaya, D. C., Koske, J. K., Gichuki, C., Ngare, I. O., Kariuki, C. N., Kipkemai, I. and Gickuki, L. 2020. Hindrances to adoption of biomass Briquettes technology as a climate change mitigation measure-case study of Maasai-Mau forest adjacent community, Kenya. International Journal of Renewable Energy Sources, 5.
- [65] Boiyi, V. K., Mutheu, J. M. and Karatu, K. 2018. Appraisal of community forest associations in advancing livelihood and conservation agenda. A Comparative Study of Urban and Rural Forests in Kenya. World Journal of Innovative Research, 4(3), 262484.
- [66] Njenga, M. M. 2013. University of Nairobi, 2013.

- [67] Prayitno, G., Hakim, A. N. and Meidiana, C. 2021. Community participation on the self help group of methane gas (Biogas) management as renewable energy in indonesia. *International Journal of Energy Economics and Policy*, 11(1), 200-211.
- [68] Pradhan Shrestha, R., Jirakiattikul, S., Chapagain, B., Katuwal, H., Gyawali, S. and Shrestha, M. 2024. Biogas adoption and its impact on women and the community: evidence from Nepal. *International Journal of Environmental Studies*, 81(2), 537-553.
- [69] Damanik, S. E., Astuti, T., and Wibiandra, A. 2022. The role of forestry extension agents in community empowerment farmers group Pasar Village, Forest Management Unit IV Balige District Toba Regency. *International Journal Of Humanities Education and Social Sciences*, 2(1).
- [70] Bonye, S. Z., Alfred, K. B., and Jasaw, G. S. 2012. Promoting community-based extension agents as an alternative approach to formal agricultural extension service delivery in Northern Ghana. *Asian Journal of Agriculture and Rural Development*, 2(1), 76-95.
- [71] Minang, P. A., McCall, M. K., and Bressers, H. T. A. 2007. Community capacity for implementing Clean Development Mechanism projects within community forests in Cameroon. *Environmental management*, 39, 615-630.
- [72] Yeny, I., Octavia, D., Ginoga, K. L., & Suharti, S. 2021. The impact of community capacity building on forest management at Paru Village Forest, Sijunjung Regency, West Sumatera. In *IOP Conference Series: Earth and Environmental Science* (Vol. 914, No. 1, p. 012010). IOP Publishing.
- [73] Nthuku, J. S. (2018). *An Assessment Of The Role Of Community Forest Associations In The Management Of Karura Forest Kenya* (Doctoral dissertation, University of Nairobi).
- [74] Lowore, J. 2021. *Forest beekeeping in Zambia: Analysing the nexus of sustainable forest management and commercial honey trade* (Doctoral dissertation, University of Huddersfield).
- [75] Kalanzi, F., Nansereko, S., Buyinza, J., Kiwuso, P., Turinayo, Y., Mwanja, C. and Mujuni, D. 2015. Socio-economic analysis of beekeeping enterprise in communities adjacent to Kalinzu forest, Western Uganda. *International Journal of Research on Land-use Sustainability*, 2(1), 81-90.
- [76] Mutune, J. M., Hansen, C. P., Wahome, R. G., and Mungai, D. N. 2017. What rights and benefits? The implementation of participatory forest management in Kenya: The case of Eastern Mau Forest Reserve. *Journal of sustainable forestry*, 36(3), 230-249.
- [77] Gross-Camp, N. D., Few, R. and Martin, A. 2015. Perceptions of and adaptation to environmental change in forest-adjacent communities in three African nations. *International Forestry Review*, 17(2), 153-164.
- [78] Mwangi, S., Kirui, B. K. and Kibue, G. W. 2022. Awareness and Perceptions of Climate Variability Adaptation among Forest-adjacent Communities in Mau Forest, Kenya. *East African Journal of Forestry and Agroforestry*, 5(1), 302-329.