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Climate and Development

ISSN: 1756-5529 (Print) 1756-5537 (Online) Journal homepage: www.tandfonline.com/journals/tcld20

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To cite this article: Seongmin Shin, Yurim Nam, Steven Wolf, Mi Sun Park, Ojok Okello, Edward Mabaya & Chuan Liao (23 Oct 2025): Adding value to the voluntary carbon market through small-scale agroforestry, Climate and Development, DOI: 10.1080/17565529.2025.2574074

To link to this article: https://doi.org/10.1080/17565529.2025.2574074

CLIMATE AND DEVELOPMENT
https://doi.org/10.1080/17565529.2025.2574074

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RESEARCH ARTICLE

Adding value to the voluntary carbon market through small-scale agroforestry

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ABSTRACT

While the voluntary carbon market (VCM) has gained significant global attention as a dual solution for climate change and community development, critiques and adverse effects of carbon projects have been raised in the large-scale VCM initiatives, including displacement, unequal benefit sharing and marginalization. This research explores the potential of bottom-up approaches for both climate action and local development by examining small-scale carbon projects in Uganda. Fifty-four interviews and three focus group discussions were conducted with diverse stakeholders, including carbon project participants, community members, NGOs, cooperatives, governments, academics, international organizations and private actors. The finding shows that community-based and NGO-led carbon projects with traditional agroforestry practices foster decentralized governance, equitable benefit sharing, inclusive participation and ecosystem services. Smallholder farmers gain added revenue from both agroforestry practices and additional income generated through carbon sequestration. However, structural and operational challenges remain, such as low accessibility, risk of double-counting, profit-oriented implementation and economic insecurity. Nevertheless, this study suggests that small-scale initiatives hold the promise to add value in VCM by bridging local communities and the carbon market, thus contributing to equitable and inclusive climate solutions.

ARTICLE HISTORY
Received 6 February 2025
Accepted 7 October 2025

KEYWORDS
Small-scale carbon projects; agroforestry; climate justice; voluntary carbon markets; carbon credits; Uganda; environmental governance; natural climate solution (NCS)

1. Introduction and background

Over the past decades, large-scale tree planting initiatives have been promoted as a mechanism for carbon sequestration as well as a broad range of environmental, social and resilience co-benefits (Brancalion & Holl, 2020). Major initiatives include The Bonn challenge (IUCN), Trillion Trees Campaign (United Nations Environmental Program, Plant for the Planet) and 1t.org (World Economic Forum). Moreover, national forest restoration programmes are expanding in response to global commitments such as the Paris Agreement, UN SDGs and the Decade on Ecosystem Restoration (2021–2030). In the coming decade, tree planting will undoubtedly be given substantial financial, societal and political support, and this presents opportunities and risks. Over time, efforts to mobilize forests and agricultural landscapes as 'Natural Climate Solutions (NCS)' (Griscom et al., 2017) have come to recognize the importance of integrated approaches to planning and analysis capable of addressing socioecological spillovers and feedbacks (Ellis et al., 2024; Seddon et al., 2020). However, tree planting is not a stand-alone solution. The key is to realize climate change mitigation benefits and co-benefits while addressing potential tradeoffs including compromising ecosystem services elsewhere, driving biodiversity loss, decreasing water availability, warming the atmosphere, threatening rural livelihoods, burdening global south and dispossession of politically marginalized people (Fleischman et al., 2020).

Voluntary Carbon Market (VCM) as market-based mechanism offers an opportunity for financial benefits in return for sequestering carbon in vegetation and soils. VCM has grown and attracted over $$11 billion based on traded credit value from pre-2005 to 2024 (Ecosystem Marketplace, 2025). Credits from forest-based carbon projects are currently priced at approximately $$10/ton (Ecosystem Marketplace, 2025), but are expected to increase to $$224/ton by 2030 (BloombergNEF, 2023). The market is expected to grow to $$50 billion by 2030 (Blaufelder et al., 2021). This interest has led to the development of a range of carbon projects worldwide, attracting substantial private and public sector investment. Although environmentalists have acted to prevent large-scale investors and industries from carbon market since Kyoto Protocol negotiations (Boyd et al., 2007), land owners and large-scale companies have implemented 'carbon farming' (Lin et al., 2013) and the majority of carbon projects have been implemented in large forests (over 4,000 acres) due to transaction cost, market uncertainty and cost-effectiveness (White et al., 2018). However, some of the projects in the carbon finance have turned into small projects. One such example was the launch of the Africa Carbon Markets Initiative (ACMI) at COP27 in Egypt, which aims to improve micro-carbon credits with direct payment, especially for 33 million smallholder farmers who farm 80 per cent of cropland and generate 70% of food in Africa (ACMI, 2022).

However, many debates are ongoing around VCM, including accessibility, benefit-sharing, scalability and climate justice. Historically, market-based solutions such as eco-certification (i.e. Fairtrade) and Payment for Ecosystem Services (PES) schemes faced similar critical concerns and we observe

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efforts to develop 'pro-poor' strategies and expand social inclusion (Pagiola, 2007; Wunder, 2008). Many scholars argue that carbon markets perpetuate practices of 'green grabbing' (Fairhead et al., 2014) or 'green extractivism' (Bruna, 2022), rather than true climate solutions (Cormier-Salem & Panfili, 2016; Saxena, 2019). Political ecologists also point out that this market-based solution as 'neoliberal nature' (Heynen & Robbins, 2005), commodifies natural resources, creating benefits for powerful actors at the expense of nature and local communities (Lyons & Westoby, 2014). Rapid market growth also requires rigorous monitoring, reporting and verification (MRV) for credibility, transparency and long-term sustainability (Bellassen et al., 2015). Carbon projects indeed give rise to important questions regarding climate additionality (i.e. evidence of benefits relative to business-as-usual), leakage (i.e. risks of conservation actions stimulating expanded economic activity elsewhere) and permanence (i.e. risks of benefits dissipating over time) (Delacote et al., 2024; Paustian et al., 2019).

Examining carbon projects through the lens of environmental governance sheds light on how to avoid socially regressive approaches to climate change mitigation and reshape the markets for both climate goals and local development objectives (Lyons & Westoby, 2014; Mathur et al., 2014; Paavola & Adger, 2005). Defined as a set of rules, processes and institutions that shape and potentially transform behaviour on environmental issues (Lemos & Agrawal, 2006), environmental governance is not a centralized structure where the national government has monopoly power over environmental resources, but rather one where a range of stakeholders, including states, communities, businesses and NGOs, interact with each other. The environmental governance framework has three critical elements, particularly relevant to small-scale carbon projects in terms of decentralization, market and agent orientation and cross-scale (Lemos & Agrawal, 2006). First, decentralization involves the shift of decision-making authority from central governments to rural and local communities, which can enhance autonomy and improve natural resource management. In this context, local knowledge and cultural perspectives play a crucial role in designing effective projects and climate policies because different communities understand and practice diverse forms of market-based governance (Knox-Hayes et al., 2020). Second, Market and Agent Focused Instruments (MAFIs) offer straightforward and powerful market incentives to encourage environmentally friendly behaviour among stakeholders (Lemos & Agrawal, 2006). For instance, activities such as planting trees or conserving forests can generate an alternative income source through VCM. However, Ventura et al. (2015) indicate that MAFIs do not promote sustainable development, as such instruments prioritize short-term economic returns rather than long-term environmental benefits. Finally, cross-scale governance provides opportunities to align local objectives with global goals (Lemos & Agrawal, 2006). As market fragmentation compromises the integrity of carbon trading, the Paris Agreement describes the importance of transparency of the carbon market across all scales (Ahonen et al., 2022). In the context of VCM governance with decentralized decision-making processes, cross-scale coordination allows actors to respect local contexts while achieving global climate mitigation and local development (Knox-Hayes et al., 2020).

As VCM gains momentum, Uganda has become one of the pioneer countries for sustainable development in Africa and has been implementing carbon projects through the Clean Development Mechanism (CDM), REDD+ and Nationally Determined Contribution (NDC) (Edstedt, 2017). The government has been ambitious to host small-scale agroforestry projects to attract the carbon market, as farmers have historically adopted agroforestry systems with coffee and shea trees (Boffa, 2015; Davis et al., 2023). Moreover, Uganda is primarily an agricultural country where 68% of the population is employed in the agricultural sector and nearly 90% of them are smallholder farmers (FAO, 2018; International Trade Administration, 2023). Politically, Uganda has committed to the NDC and the Third National Development Plan (NDP III) under the 2021 Climate Change Act, in which its emission is promised to be reduced by 24.7% by 2030 (Ministry of Water and Environment, 2022). However, the Ugandan government is highly dependent on international support, with 85% being contingent on the NDC (UNDP, 2023), and legal inconsistencies between the Land Use Policy and Local Government Act hinder more inclusive carbon markets in Uganda (Namaalwa & Byakagaba, 2019).

Despite years of efforts to include small-scale carbon projects in VCM since the Kyoto Protocol (Boyd et al., 2007), most of the existing literature has critically studied the limitations and problems of large-scale VCM projects (Bruna, 2022; Cormier-Salem & Panfili, 2016; Delacote et al., 2024; Fairhead et al., 2014; Lyons & Westoby, 2014; Paustian et al., 2019). Few researchers have explored small-scale carbon projects in Africa, with examples being Siedenburg et al. (2016) examining land tenure issues, knowledge gaps and transaction costs, and Lee (2017) investigating participatory governance of the Kenya Agricultural Carbon Project. However, knowledge regarding the benefit-sharing, accessibility, scalability and permanence of community-based carbon projects remains a gap. Accordingly, this article aims to explore whether and how small-scale carbon projects can serve as a solution to both climate change and local/national development. Our specific objectives are to (1) investigate the potential of small-scale projects focused on traditional agroforestry practices to produce more inclusive, equitable and ecological benefits compared to the larger-scale market-based carbon approach; and (2) identify the structural and operational challenges of VCM in the cross-scale governance perspective.

2. Methods

The research sites were across three key small-scale carbon project sites in Uganda known for agroforestry practices: Kapchorwa town in Kapchorwa district, Bududa town in Manjiya district and Okere town in Otuke District (Figure 1(A)). We selected these regions as our cases of small-scale agroforestry projects for a couple of reasons. First, local communities have planted traditionally trees and practised agroforestry in three regions with smallholder farmers, such as the combination of banana, coffee and shade trees in Eastern Uganda (Figure 1(B)) and root vegetables with shea trees (Vitellaria

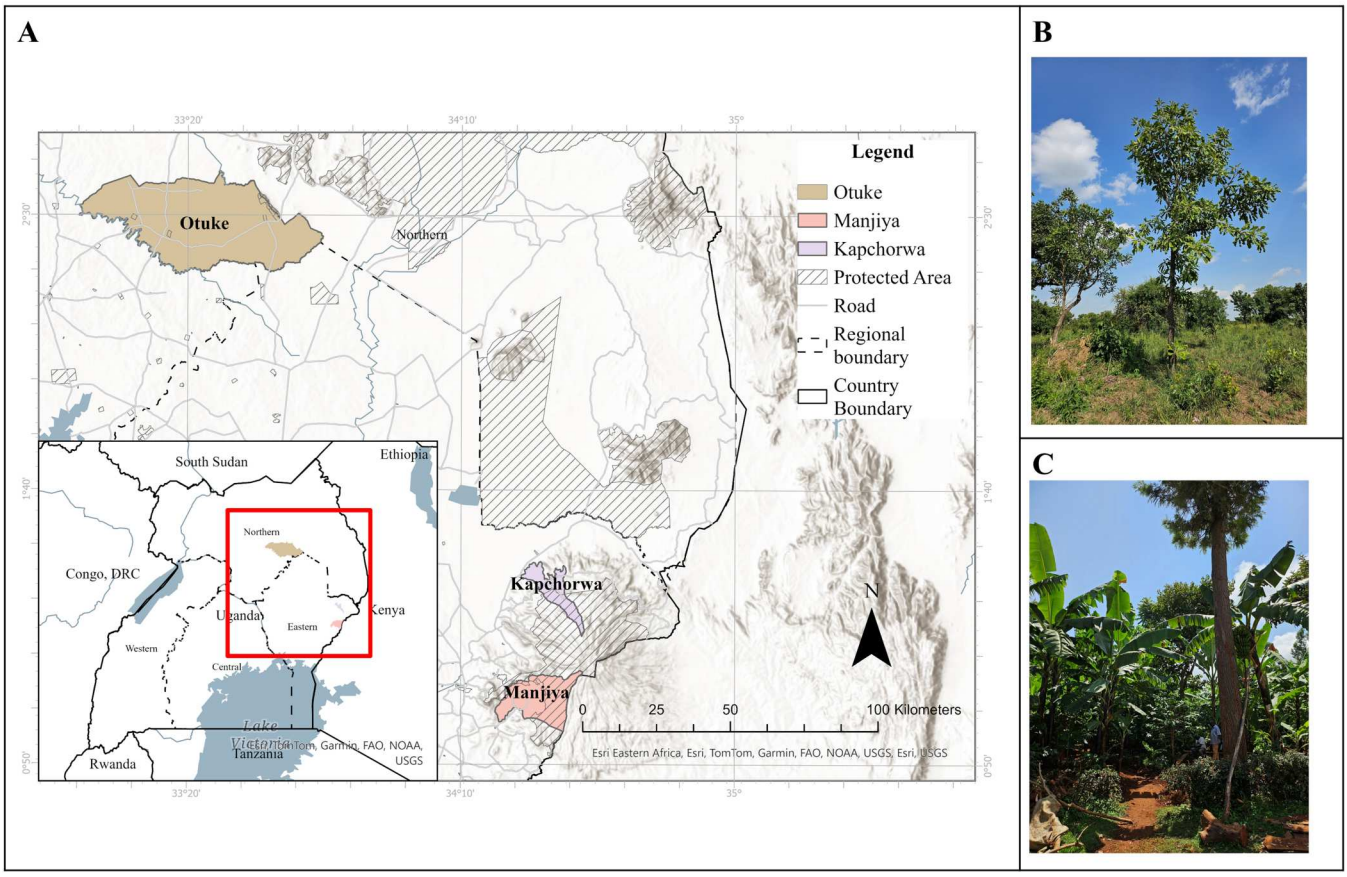

Figure 1. Research area (A) and agroforestry system in eastern (B) and northern (C) Uganda.

paradoxa) in Northern Uganda (Figure 1(C)). Second, NGOs have implemented carbon projects on a small scale for several years in Kapchorwa and Bududa towns and compensated individual farmers who joined carbon project and achieved carbon sequestration. In Okere, local communities and NGO have conducted multiple projects related to climate solutions and started developing carbon projects.

This research aims to ensure the reliability and broad inclusion of key stakeholders in small-scale carbon initiatives (Lincoln & Guba, 1986). We conducted 54 interviews and three focus group discussions in total, including farmers participating in carbon projects and non-participating farmers, farmers' cooperatives, four NGOs, government officials, scholars, international organizations, private sector entities and research organizations (Table 1). Especially, participants and non-participants in the carbon project joined our research as a comparative analysis to uncover similarities, differences and gaps in current policies and practices. Interview questions include participation motivations, benefit-sharing mechanisms, perceived challenges, governance structures, ecosystem services, policy implications and other aspects of carbon projects (Appendix 1) to capture who wins and loses in the system, and whether it is exploitative or beneficial. While visiting households, interview participants were purposively selected to guarantee diversity and variations among participants in farm size, gender, age and socio-economic characteristics. One team conducted interviews with participants who were selected with the assistance of a local coordinator, while the other team also randomly added interview participants encountered during our travels to capture a broader range of perspectives. We hired a local translator who speaks both English and local languages fluently to minimize translation bias because different tribes in our research site use their local languages, including English, Lugisu, Lango and Sabin. All interviews were recorded, transcribed and thematically analysed. Based on the environmental governance framework, we used a thematic analysis with an inductive coding approach to capture the diverse perspectives of stakeholders. Data from all transcripts were coded using a structured system of texts,

Table 1. Interview and focus group discussion participants.

Category	Stakeholder	Number
Farmers	Participants	14
	Non-participants	18
Farmers' Cooperative	Local farmers' cooperatives	2
Non-Governmental Organizations (NGOs)	NGO 1 in Kapchorwa	3
	NGO 2 in Bududa	2
	NGO 3 in Otuke	1
International Organizations	Food and Agriculture Organization (FAO)	1
	International Bamboo and Rattan Organization (INBAR)	2
	Global Green Growth Institute (GGGI)	1
Government Representatives	Ministry of Finance (MoF)	1
	Ministry of Water (MoW)	1
	National Forestry Authority (NFA)	1
Private Sector	Total Energies	1
Academic and Research Institutions	Makerere University	5
	World Agroforestry Centre (ICRAF)	1

themes and subthemes to identify recurring patterns within the dataset. The first author led the coding process and reviewed the themes through several rounds of coding with five randomly selected transcripts to ensure consistency and coherence. Ugandan researchers cross-checked the coded results to ensure the reliability of the coding framework. We conducted the interviews in accordance with the principles of the Declaration of Helsinki, and the study received ethical approval from the Institutional Review Board of Cornell University (IRB approval no. IRB0148614) on May 30, 2024. Prior to the interviews, all participants received detailed information and signed an informed consent form about project objectives, their rights and data security procedures following IRB protocol.

3. Results

3.1. Governance structure of small-scale carbon market in Uganda

While diverse stakeholders work in a collaborative institutional arrangement of VCM with their own interests (Figure 2), small-scale carbon projects show bottom-up and participatory governance compared to the top-down and centralized structure in large-scale programmes. NGOs play a central role from project design to implementation, including resource mobilization, extension services and monitoring and evaluation (*NGO 1 and NGO 2*). During the initial phase of project implementation, NGOs with local cooperatives hold workshops to introduce their project objectives and activities and to ask potential participants about their willingness to join the projects. NGOs give farmers several options to choose which activities to adopt in their farms for carbon sequestration, including boundary planting, woodlot and agroforestry with local tree species (i.e. *Cordia* and *Albizia*) (*NGO 2 and Farmer 12*). With such information, farmers voluntarily decide to join the projects as the main implementors and beneficiaries of small-scale projects with direct financial incentives. After signing the contract, the enumerators (local NGO staff or cooperative members) verify land tenure status and map the project plots with GPS at the individual farm level for data accuracy and farm-level credit compensation (*Farmer 10 and NGO 2*). At the same time, farmers' cooperatives (i.e. local coffee cooperatives, Ibushika Integrated Area Cooperative Enterprise) identify and mobilize project participants throughout their network and in-person visits (*NGO 1*). Additionally, cooperatives provide free seedlings in certain conditions and banking services to project participants. Local coordinators and/or farmer leaders offer training and extension services about practical knowledge on tree planting and soil management (*Farmer 6 and Farmer 12*). Farmers' leaders and cooperative members serve as a local focal point and solve local challenges to ensure participation and project implementation (*NGO 1 and NGO 2*).

NGOs or third parties (i.e. Acorn) are responsible for monitoring and evaluating tree-planting activities. MRV processes include assessing the number of trees planted during the first two years, survival rate in the third year and tree growth indicators such as diameter at breast height and stem growth in subsequent years (*NGO 1*). Third party monitoring organizations utilize remote sensing technology with satellite images to reduce time and labour demands, but this innovation still faces credibility critique because the resolution of satellite images remains insufficient to accurately measure the exact amount of carbon stock, especially the understory biomass (*NGO 1 and NGO 2*). Then, carbon registries, such as Plan Vivo, Verra and Gold Standard, certify carbon credits based on MRV reports and the international carbon market

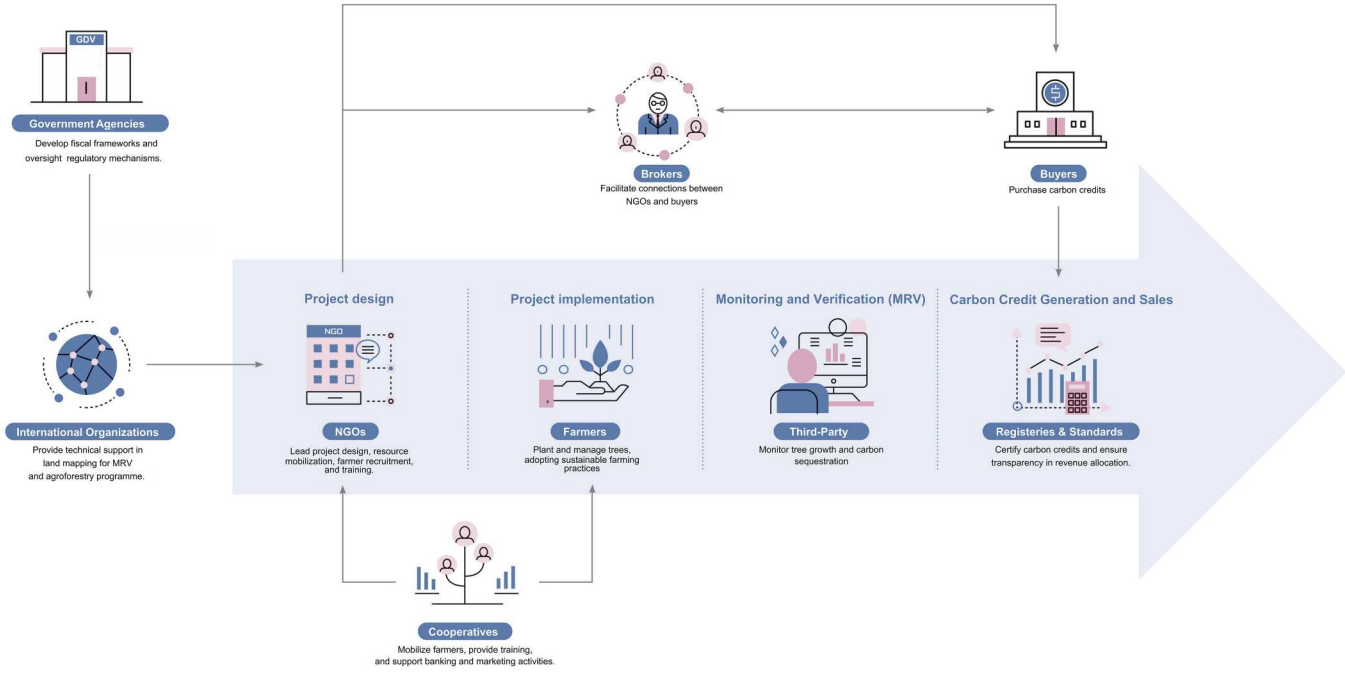

Figure 2. Institutional arrangement diagram of small-scale carbon projects in Uganda (Source: The first author).

standards. Brokers facilitate credit transactions between NGOs and buyers, including governments, corporations (i.e. Microsoft), international organizations (i.e. the International Fund for Agricultural Development,IFAD), financial institutions (i.e. Rabobank), and other private actors. NGOs distribute carbon credits to farmers through fintech platforms according to each farmer's performance on carbon credit generation. In this process, Savings and Credit Cooperatives (SACCOs) are responsible for managing financial transactions securely and transparently. Farmers can use their carbon credit contracts to access loans from SACCOs, as NGOs generate certification and ensure farmers' participation over a fixed period (i.e. 10 years). This continuous income generation and additional loans from SACCOs enable farmers to invest further in purchasing more seedlings or expanding their agroforestry operations (*NGO 1 and NGO 2*).

International institutions provide MRV technical assistance for NGOs and international frameworks and regulatory oversight for government entities. For instance, the Food and Agriculture Organization (FAO) and World Agroforestry Centre (ICRAF) create land use and land cover (LULC) mapping for NGOs and third parties to use it for MRV of the projects (*FAO; ICRAF*). International organizations (i.e. United Nations Development Programme (UNDP) and Global Green Growth Institute (GGGI)) help national governments to refine and develop national policies and regulations (i.e. NDC and NDP III) according to international standards by seconding their staff to the Ministry of Finance (MoF) and the Ministry of Water and Environment (MoWE) (*MoF and MoW*).

For long-term sustainability, NGOs allocate security funding in local SACCOs for farmers to continue agroforestry activities beyond the project period, usually around 10 years. Moreover, NGOs not only concentrate on carbon credit generation, but also enhance livelihood in local communities through agroforestry practices. For example, farmers sell coffee beans grown under shade trees with higher market value and plant fruit trees or multipurpose trees (i.e. beekeeping, bamboo, medicinal plant cultivation and non-timber forest products) for additional income resources (*NGO 1 and INBAR*). Farmers no longer rely on carbon payments for long-term financial stability because these green business opportunities create sustained sources of income (*Farmer 12).*

3.2. VCM benefit sharing – market instruments

In small-scale carbon projects, 60–80% of credit value is transferred directly to farmers, while the remaining 20–40% utilized for project management and MRV activities. NGOs employing local staff for manual MRV tend to allocate a higher proportion of the budget (up to 40%) to administrative costs, while others that adopt remote sensing for MRV spend less (20%). There are several factors that influence how much farmers get paid directly for the credits they generate. Technically, the more trees farmers plant on their land, the more credits they receive. Different project activities that farmers choose have various capacities to capture carbon. For example, native species boundary planting sequestrates from 23.77 to 33.91 tCO2e per acre (net carbon benefits); agroforestry, 62.09–71.45 and woodlots, 82.02–94.70 (*NGO 2*). In addition, if farmers commit more land to the project, they would generate more creditsto plant trees. Project participants realize the benefits and decide to allocate more land and efforts for carbon projects (*Farmer 2*). For example, one farmer originally signed up to allocate half an acre for carbon farming, but added another acre after seeing 'a whole lot of benefits from that' (*Farmer 12*). Moreover, the quality of tree planting also influences the amount of returns. NGOs evaluate farmers' performance based on survival rate and tree growth at different stages of projects and distribute payment accordingly. It is essential to acknowledge that unpredictable weather events can hinder farmers from achieving the expected carbon benefits (*Farmer 12, Farmer 18 and Farmer 23*).

> Through this project, I received carbon payments and have been able to invest that money in various ways. First, I paid my children's school fees. I also bought more tree seedlings from the plants. I realized that if I plant more trees, I'll earn more money in the future from carbon payments. For my one acre of land with around 100 trees, I received 73,200 Ugandan shillings. I'd like to plant trees on my remaining land (Farmer 2)

On average, farmers gain $$10–25/acre per year based on their perfermance from carbon payment. Some large farmers receive income above $$800 as they have more than 20 acres. Given that the average monthly salary in rural Uganda is $$32/month (*NGO 3*), this additional income helps enhance the livelihood in the local communities. Farmers invest the extra earnings derived from participation in the carbon market to cover school fees and healthcare costs (*Farmer 2 and Farmer 25*). The projects also highlight the long-term and sustainable benefits. Farmers usually have 20-year contracts with NGOs, which continuously encourage farmers to manage planted trees to receive carbon credits. This long-term engagement promotes not just money, but also environmental stewardship (*Farmer 3 and NGO 2*). In addition, farmers can diversify their income from an agroforestry system. Main cash crops (e.g. coffee) with higher value in the market, as well as fruit or multipurpose trees (*Makerere Okullo*), subsequently give farmers more revenue and access to new markets (*INBAR*). A mix of benefits and added returns also reduces the risks of relying on short-term incomes from crop production and promotes a more sustainable and environmentally engaged approach (*NGO 1 and NGO 2*). Ultimately, this mechanism creates climate and livelihood resilience for the future (*NGO 3and Farmer 25*).

> Even after the project is completed (five years), farmers are going to be paid for the next 20 years with the contract for carbon credits. (NGO 1)

In contrast, large-scale carbon mechanisms reveal centralized governance and management structure because national or sub-national governments usually control project activities and benefit sharing. Farmers remain the most disadvantaged and marginalized stakeholders and are excluded from the benefits of the large projects, although they are the major actors to implement the projects (*MoW*). The main challenge is that it is technically difficult to measure the carbon sequestration performance for each individual level. Therefore, large-scale projects generally have social, non-monetary payback to

the community (i.e. infrastructure) rather than direct financial rewards. In Ugandan REDD+ programmes, for instance, governments provided roads and health facilities as compensation to communities in the project areas (*MoW*).

> It's hard. It's hard. That is why financial monetary benefits cannot be achieved. Rather we provide social services benefits and non-monetary benefits, depending on who has made which contribution or which region has been. If it is road construction, more. If it is hospitals, then more. (MoW)

3.3. Local autonomy in VCM governance

Bottom-up initiatives empower farmers to make decisions on land use and activities. Ugandan farmers have typically had abundant land or free access to community commons under customary tenures. Male-headed households have land tenure rights and decide to allocate areas of land for carbon activities. As part of this process, family members and community groups engage in discussions on whether to join carbon projects (*NGO 2 and ICRAF*). Moreover, NGOs provide farmers with different options (boundary planting, woodlots and agroforestry) for carbon activities and let them choose the option that works best for their existing land and conditions (*NGO 1*, *ICRAF*). This collective action streamlines transparency, accountability and internal governance (*NGO 2*).

> It's the father, so he is in charge of the land yeah, so what he does with the land is yeah, it is upon him at times maybe in consultation with his family … Yeah, then you can say household has consented yeah, groups of households or several households like in a locality village, make a group, so this there's also going to be um so group approach to this. (ICRAF)

In contrast, in large-scale carbon projects, it is challenging for farmers to achieve autonomy over their land, activities and decision-making because governments and donors at high levels make decisions on project activities. Moreover, REDD + and other large-scale afforestation initiatives mobilize large amounts of land in both community and protected areas where local people have traditionally relied on forest resources and cultural practices. Large-scale projects frequently result in land resource conflicts and generate tensions between conservation goals and local livelihoods. For example, forest conservation initiatives near Murchison Falls National Park have restricted indigenous peoples' access to the forest and evicted entire villages for environmental protection (*Total Energies)*. Therefore, this top-down approach creates perceived injustice when local contributors cannot gain direct returns from their efforts (*MoW*). The exclusion of these communities from decision-making and the restricted access to forest resources have raised serious concerns about environmental injustice. The fundamental disparity between large-scale and small-scale carbon projects underscores the need to reconsider governance structure and enhance local autonomy in carbon projects.

> We had to remove the communities from these wetland areas to allow regeneration or restoration of these wetlands. (Total Energies)

> But if we are to sell carbon as a country, then very likely the benefit sharing will be in terms of social services delivery to the areas that have delivered more, of the credits, for example, that they get a little bit more. If it's a road construction, more. If it's hospitals, more than an area which doesn't have much. So we look at what you've got, we look at who has contributed what in terms of the block part of the country. (MoW)

3.4. Ecosystem service benefits from VCM

Agroforestry provides synergistic benefits for both farming and the environment through ecosystem services: provisioning, regulating, supporting and cultural services (Shin et al., 2020). By practising agroforestry, farmers maximize their benefits from VCM. In Uganda, NGOs developed carbon projects based on traditional agroforestry (coffee or shea agroforestry). Annually harvested agricultural products such as coffee, bananas and root crops are the main sources of income for the farmers, while carbon credit becomes an added source of income (*Mekerere Okullu and ICRAF*).

> We are interested because this project when you benefit, the money will also help us as a farmer. I may even add more trees, plant more trees, maintain your banana plantation, maintain coffee, perform breeding and weeding, and add manure. (Farmer 15)

Planted trees offer essential provisioning services such as firewood and construction materials. Local people traditionally cut trees for firewood from community forests, but farmers now obtain tree debris by pruning branches from their own trees planted for agroforestry systems (*Farmer 6 and Farmer 26*). Multipurpose tree species also help enhance food security and reduce malnutrition with fodder for livestock, medicinal materials, fruits and nuts (*ICRAF*).

> I also get firewood from these trees from the branches when they are dry. I do not need to go to the firewood in the forests. (Farmer 6)

Agroforestry systems also regulate ecosystems, such as climate change mitigation, air filtration and soil erosion prevention. Farmers recognize the impact of planted trees in agricultural lands to alleviate soil erosion and extreme weather events like droughts and flooding (*ICRAF and Farmer 24*). Trees as natural air purifiers cool temperatures and generate oxygen, which contribute to a better quality of life (*Farmer 2 and Farmer 25*).

> Now we understand that trees give us oxygen and that trees are life. (Farmer 2)

Farmers observed the benefits from agroforestry as a soil management system. Trees with their leaf litter enrich soil fertility and boost water-retention capacity by reducing surface runoff and improving water infiltration (*Farmer 11 and Farmer 25*). Native nitrogen-fixing species as shade trees like *Albizia* and *Cordia* also improve natural fertilization (*Farmer 1*). These supporting services further stabilize crop yields and reduce fertilizer use dependency.

> The litter from the trees improves soil fertility. (Farmer 11)

> The trees are helping us reduce the speed of fast-running water … before the project people didn't care so much about soil management but people have now learned. (Farmer 25)

Trees also have cultural and spiritual roles. Among many rural Ugandan communities, trees are sacred and part of the identity and heritage of the communities. Trees are perceived as divine gifts of nature, so community members keep long-standing trees as part of a legacy to pass on to their next generation (*Mekerere Okullu*).

> Local people still think that these natural sources are God given … those trees were planted by God. (Mekerere Okullu)

Trees in agroecosystems improve the quality and quantity of crops. In fact, coffee under shade trees has shown better growth, less stress and pest resistance than open-field and monoculture coffee (*Farmer 1 and Farmer 23*). Farmers also observed that coffee beans grown under the shade are denser and more aromatic. Shade and vegetation structure also build natural weed and pest barriers and further decrease chemical inputs such as herbicides and pesticides (*Farmer 1*). Moreover, farmers are aware that planting trees expands habitats to host a wide range of birds and insects (*ICRAF and Farmer 10*). In turn, agroforestry systems increase the market value of crops, reduce production costs with less use of chemical inputs and conserve biodiversity by offering natural habitats for species.

> Coffee under shade is great because coffee grown under shade doesn't suffer as much from stress, pests, or diseases. (Farmer 1)

3.5. Cross-scale governance: structural and operational constraints

3.5.1. Weak legal framework and conflict with NDCs

During COP29 in Baku in November 2024, countries agreed on the detailed rules of Article 6 of the Paris Agreement (UNFCCC, 2024). This agreement triggered countries to meet their NDCs and exchange carbon credits officially through the UNFCCC system according to Articles 6.2 and 6.4 (CFP Energy, 2024). However, this progress exacerbates the potential tensions between government-led carbon projects and smaller NGO-led projects, especially because Article 6.2 bilateral trading grants host countries substantial authority over the generation and management of carbon credits at the national level. The Uganda government may possibly prioritize larger and more 'efficient' carbon projects over smaller and local projects to reach their NDCs. NGOs and farmers express concerns about the potential of government consolidation of carbon resources to achieve its NDC goal and local communities end up losing their ownership of carbon credits (*MoW*).

> Uganda is also trying to put a lot of effort into the NDC to meet the level of emissions. What is happening with these kinds of NGOs or other carbon projects in terms of the ownership of carbon credits? I mean, that the government has its own arrangements with farmers. (MoW)

This tension further intensifies the risk of double-counting, as the buyer and host country may count the same emission reduction (*Mekerere Michael*). As of June 2024, the Ugandan government was in the process of developing carbon market regulations and establishing a national carbon registry to avoid such overlaps (*FAO*). However, a lack of a sound legal regime and inadequate technical expertise delayed legal advancement and posed serious hurdles to small carbon projects in Uganda. At the local level, by-laws have limited powers to control carbon activities, while the slowdown in the actualization of the 2021 Climate Change Act has weakened investor confidence in funding (*NGO 3and MoW*). Another challenge is the shortage of cost-effective and manageable MRV methods that are consistent with the international requirements. Such MRV protocols from large registries like Verra and Gold Standard are too complicated and costly for small projects to tap into the carbon market (*FAO and Mekerere Okullu*). These transaction costs represent financial and economic barriers in carbon trade and put NGOs under financial insecurity.

> Probably 30% of it has already been taken by the verification process and everything. (NFA)

Despite some buyers who pledge to support small-scale projects and community-friendly approaches (*FAO*), the absence of national regulations and guidelines fosters unfair benefit-sharing and speculation, especially in savannah and woodland agroecological systems, where resource-poor farmers find it difficult to meet the strict verification requirements (*Mekerere Okullu*). Small-scale carbon projects are likely to encounter difficulties competing within the dynamic market change, and will face risks for loss of financing, low farmer participation and weakened social capital initiatives.

> Now, many of these methodologies when you look at them, for them to work for a country like Uganda, might need to make some adjustments to put in the local context. But it is not cheap. It's not easy. (FAO)

3.5.2. Accessibility and information gaps

One of the biggest hurdles for small-scale farmers is the lack of accessibility and information gaps. In this study, we conceptualize accessibility as the extent to which farmers can gain clear and timely information as well as practical guidance to sign up to carbon programmes regardless of their remote location, social status or size of landholding. NGOs and cooperatives usually deliver projects within communities either through personal outreach by enumerators or by restructuring traditional community workshops. Successful outreach combines multiple approaches. Participation is largely communicated through word of mouth and peer influence, as farmers observe neighbouring farmers being successful and willing to participate (*NGO 1, NGO 2, Farmer 12, Farmer 14*). Other forms of outreach include radio campaigns and faith-based networks to create awareness (*ICRAF*). However, a significant number of potential participants remain excluded from the projects because of a lack of accessibility.

> I did not join because I did not have access. It is just that maybe I did not get the information. Otherwise, I am always very positive. (Farmer 7)

Another farmer highlighted the importance of clear and easily accessible communication, in that the project promotor did not provide explicit information on either how to register or on specific requirements (*Farmer 25*).

> The people who came to promote the project didn't provide us with clear details about registration or the specific requirements. (Farmer 25)

Farm size and land fragmentation also constrain farmers' ability to access carbon projects, though many would like to participate. When it came to selecting households to participate in pilot projects, enumerators focused only on households with more than one hectare.

> Now, when we did the enumeration, when we went to farmers, we could go and first talk to the farmer. But by that specific time, they wanted a farmer whose land was beyond one hectare. So we could go and talk to farmers. (Local coordinator)

Moreover, some cooperatives favour existing members when they choose their participants due to familiarity. But this mechanism compromises inclusivity and the opportunities for non-members of cooperatives and carbon projects (*Farmer 4*). As pointed out by local coordinator 1, projects of carbon should enhance their social network, cooperation, and community development to promote accessibility.

> The cooperative called its members. After calling the members, they were given more information about the project. The husband kept sharing what he had heard, and the wife started building her understanding based on what he mentioned. After that, the cooperative sent a team to visit at home and assess the garden. (Farmer 4)

3.5.3. Other barriers and challenges

Economic insecurity is the one of the greatest challenges for small-scale carbon projects, given that most of the rural farmers are under the extreme poverty line (*NGO 3*). Smallholder households struggle to prioritize long-term conservation activities to meet their short-term financial requirements for school fees, medical expenses, and food (*NFA and ICRAF*). Underdeveloped social safety nets in Uganda leave farmers with little financial flexibility to invest in carbon projects (*Mekerere Okullu*). Especially, rural farmers suffer from dry seasons and chop down trees to produce and sell charcoal for food and school fees for their children. The project implementation also requires financial capital for seedlings, fertilizers and other inputs. Farmers can borrow from SACCOs and NGOs, but they still have trouble covering the costs of inputs (*NGO 2 and Farmer 25*). Planting, nurturing and monitoring trees require both human and technical capability, but farmers cannot afford to hire additional labour (*Farmer 11 and Farmer 12*).

Another obstacle is that there is a pervasive mistrust of farmers towards carbon project developers. In the past, farmers have found that previous government programmes coupled with external NGO involvement have led them to move from their inherited land in return for monetary compensation (*Farmer 4*). This trauma has caused them to be reluctant to participate with less confidence. Farmers fear the geo-mapping implementation for MRV since this is expected to result in land grabbing and losing control over their lands (*NGO 1 and Farmer 9*). Farmers suspect that outside organizations, especially international organizations, utilize them and their knowledge without any legitimate return (*Farmer 25*).

> I am worried that they may be selling my land. Yeah, that's right. This was one of the worries I had, that people were moving with GPS, and maybe they wished to sell my land. (Farmer 9)

> Previous NGO and government organization asked, "If we give you money, can you shift to a safer place?" Farmers agreed in principle, but many just wanted to receive the money without actually moving. they expected people to move. Farmers then resisted and said, "This is my area, I don't want to shift." (Farmer 4)

When payment is delayed, farmers lose interest in the project activities and become disillusioned (*NGO 2, Farmer 5, Farmer 14*). Project developers reported that complex and time-consuming MRV processes often negatively impact the payment timeline because farmers' contributions must be verified before issuing any payments. When farmers did not receive promised payments on time, they started to question the value of the effort and resources they had committed to the project (*Farmer 5, Farmer 9, Farmer 21*).

> From the farmers it's things like sometimes they delays in payments because at the end of the day when you have so many farmers, you have to pass money to them and of course evaluate the results to be verified before you can pay them, so sometimes they are delays in payments. (NGO 2)

In addition, natural disasters threaten farmer participation in tree planting activities. Farmers are concerned that their trees may not survive, particularly at the onset of the programme, because young trees are vulnerable to pest infestations and natural disasters such as floods and landslides (*Farmer 18 and Farmer 24*). Such losses surpass the financial capabilities of farmers alone, and the emergency funds are not enough to bring confidence and hope back to the community, and they are left to rely on the limited resources from NGOs (*NGO 1*). Greater technical assistance, more robust payment mechanisms, and better disaster response plans are also crucial to ensuring the long-term viability of small-scale carbon projects.

> I planted trees along the riverbanks, but the floods removed them. (Farmer 18)

4. Discussion

This research highlights both the potential and limitations of NGO-led participatory carbon initiatives as a transformative alternative for large-scale projects. By exploring how small-scale carbon projects in Uganda contribute to inclusivity, equity, and sustainability through the lens of environmental governance, this study reveals the role of decentralized governance, MAFIs, and cross-scale governance strategies in shaping transformative outcomes.

Decentralized governance in small-scale carbon projects ensures equitable benefit sharing among a wide range of actors and contributes to broader climate and development outcomes (Paavola & Adger, 2005). This research presents a collective governance model and participatory mechanisms where farmers and local communities actively get involved in carbon markets. Such participatory governance structures led by NGOs and embedded in the society strengthen local autonomy and inclusion (Lee et al., 2016). However, these grass-roots initiatives face their own criticism, such as the potential to overlook vulnerable social groups. For example, project enumerators are likely to turn away new or non-cooperative members who wish to join. It is also challenging to reach out to rural residents staying in a remote area. Farmers with limited land size will not be able to participate, despite being the ones who could benefit significantly from the project. A similar case was

found in a carbon project that exacerbated the exclusion of the poorest and most vulnerable (Lee, 2017). Furthermore, early integration of farmers into a complex market system without sharing sufficient knowledge is likely to establish an asymmetric power relationship between project authorities and local communities (Cash et al., 2006; Lee et al., 2016). In such cases, large-scale projects work with more hierarchical, centralized structures and focuses on credit generation, rather than benefit sharing. This opens up questions of 'carbon colonialism' (Lyons & Westoby, 2014) and 'green extractivism' (Bruna, 2022) whereby carbon credits become profitable for foreign and powerful actors at the cost of local people (doing and supporting climate action in practice). In other words, while the farmers supply labour and costs for the projects originating the carbon market mechanism, they are not the ultimate beneficiaries due to externalities (Pigou, 1920). Green Resources Plantation in Uganda, for instance, focused on carbon sequestration but led to the eviction of the local population and diminution of their control over their land (Lyons & Westoby, 2014). The Indian government acquired land from tribal communities under the excuse of trees through the Compensatory Afforestation Fund Act (CAFA) (Saxena, 2019).

Carbon credits in the carbon market, as MAFIs are a direct and strong driver for environment-friendly actions. Our findings suggest that Ugandan NGOs are striving to ensure equitable benefit sharing, where 60–80% of the credit revenues are distributed to the farmers. While small-scale projects make tangible progress towards more inclusive and just approaches, small-scale projects also have the potential to reproduce extractive practice at a smaller scale as capitalistic market systems commodify land and nature (Heynen & Robbins, 2005). Market-solutions approach often underestimates specific socio-environmental dynamics in rural contexts where farmers struggle in their long-term persistence (Gómez-Baggethun et al., 2010). This market-oriented VCM theoretically prioritizes climate and economic interests over socio-economic realities in developing countries (Matheus, 2018; Muniz & Cruz, 2015). For example, in many cases, large-scale afforestation projects have led to deforestation, conversion of natural forests to plantations, displacement of forest-dependent local population and disturbance to the traditional agriculture practices (Pasaribu et al., 2020; Scheidel & Work, 2016). Profit-oriented practices like monoculture plantations also tend to compromise ecosystem services (Botene et al., 2023; Pasaribu et al., 2020). In these cases, carbon projects often offer fewer benefits to local communities than designed, but rather bring burdens on them (Mathur et al., 2014). Moreover, due to existing social inequalities and disparities among farmers, carbon projects are likely to leave out the most vulnerable, such as women, sharecroppers and marginalized remote households who have limited access and capacity to participate in projects (*NGO 2, Farmer 7 and Farmer 17*). While we acknowledge that the market-oriented character and neoliberal nature deepens inequality in theory (Heynen & Robbins, 2005), this research suggests that small-scale projects are practical means to mobilize bottom-up actions through polycentric governance, equitable benefit sharing, and participation.

Cross-scale environmental governance links local initiatives to higher-level policy and global climate goals (Lemos & Agrawal, 2006). A bottom-up approach strengthens participatory structures throughout the project cycle, where the NGOs and cooperatives are directly engaged in the project from its onset to implementation, MRV, benefit sharing, and beyond. These local and NGO-led initiatives produce hybrid and polycentric systems in which various actors collectively share authority in decision-making rather than the top-down model observed in large-scale projects (Harvey, 2003; Lee et al., 2016). For example, local farmers hardly have a voice in large-scale programmes where bigger and powerful stakeholders determine the project details (Paavola & Adger, 2005). In small-scale programmes; however, local communities and leaders have the power to approve project contracts and make deals with project developers (*NGO 2*). Small-scale activities should be directly related to forest regulations and national strategies. Government institutions emphasized that project developers must align their interventions to the 2021 Uganda Climate Change Act in order to get legal recognition (*MoF, MoW and FAO*). Cross-scale environmental governance, bridging from local-level practices to national-level policies, can scale up a successful carbon model in Uganda, together with good governance as well as climate justice. This synergy also gives the local NGOS a chance to access the international market by meeting international standards. Beyond that, new investors and buyers will demand more ethical and credible offsets from small-scale projects. Such multi-stakeholder collaboration can lead to improved availability and transparency that, in turn, generates trust and support (Gupta, 2008), but it needs to be carefully managed and designed to avoid overburdening local communities (Weil et al., 2006). In this regard, well-organized small-scale carbon projects promote good governance, conflict resolution, and community-based decision-making (Ostrom, 1990), while bridging the gap between local needs and national strategies.

5. Conclusion

Focusing on small-scale carbon projects with traditional agroforestry practices in Uganda, this research examines whether and how bottom-up projects replicate extractive patterns found in top-down initiatives. The findings from 54 interviews and three FGDs with diverse stakeholders show that small-scale projects show decentralized and polycentric governance in VCM as stakeholders share power and benefits. Especially, farmers directly get 60–80% of carbon credits for their contribution and have autonomy over their land and project activities. Although the main income resource comes from crops (i.e. coffee), additional benefits from agroforestry and carbon credits significantly improve farmer well-being. Farmers have shared power and/or autonomy to choose project activities based on their local knowledge and experiences (i.e. what species to plant, where to plant, and how to plant) in small-scale initiatives where farmers are directly a part of contracts with NGOs. Therefore, community-centred climate policies should be adapted to local circumstances instead of top-down universal solutions, as decentralized governance is not feasible in all circumstances, but depends on sociopolitical contexts.

However, there are still structural and operational challenges that hinder the full potential of projects. In particular,

effective cross-scale governance is challenging due to conflicts of interest between national governments and local NGOs. For example, state governments strive to meet NDC and trade carbon credits under the Paris Agreement Article 6, but local NGOs try to expand small-scale carbon projects. This potentially leads to double-counting issues between local and national projects and the extraction of credit ownership from local projects. The findings suggest that governments should reform carbon policies and regulations to clarify credit ownership and ensure benefit sharing for individual farmers.

It is also essential to adopt new MRV methods, such as Satellite imagery and Light Detection and Ranging (LiDAR) (Johnson et al., 2022). These innovations can reduce the MRV costs from the traditional ground-truth verification while improving the credibility and feasibility at the individual farm level. Our results highlight that small-scale carbon projects can provide a promising opportunity for bridging between global-scale mitigation targets and the local, inclusive and equitable approaches to VCM. Effective governance is essential to ensure equitable access and benefit sharing in the carbon markets.

Although this research offers a detailed picture of small-scale carbon projects in Uganda, further research should explore additional cases with different agroecosystems, landscapes, and social structures in the long term to examine their scalability and feasibility. Given that this research generally represents local actors (farmers, NGOs and cooperatives), future research can expand into the perspective of other actors (buyers, third parties, governments, etc.) to deal with ethical concerns, including greenwashing in small-scale projects. Quantitative approaches (i.e. survey and modelling) will help figure out socio-economic factors and perceptions of stakeholders to understand the market structure better.

Author contributions

Seongmin Shin conducted research design, fieldwork, analysis, manuscript drafting and revision. Yurim Nam helped write the manuscript for the introduction and method. Steven Wolf contributed to the theoretical framework, reviewed and revised the manuscript. Mi Sun Park supported figure creation, manuscript draft and revision. Ojok Okello joined fieldwork, site visits, interviews and manuscript writing. Edward Mabaya funded the fieldwork through a grant from the Polson Institute for Global Development and reviewed the manuscript. Chuan Liao supervised the whole process of writing and fieldwork. All authors approved the final version for publication and agreed to be accountable for all aspects of the work following the journal's authorship policy.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work benefited from the support of the Cornell Institute for Digital Agriculture (CIDA), Polson Institute for Global Development, and NASA-Acres.

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References

ACMI. (2022). *Africa carbon markets initiative: Roadmap report*. Africa Carbon Markets Initiative. https://www.seforall.org/publications/africa-carbon-markets-initiative-roadmap-report

Ahonen, H.-M., Kessler, J., Michaelowa, A., Espelage, A., & Hoch, S. (2022). Governance of fragmented compliance and voluntary carbon markets under the Paris Agreement. *Politics and Governance*, *10*(1), 4759.

Bellassen, V., Stephan, N., Afriat, M., Alberola, E., Barker, A., Chang, J.-P., Chiquet, C., Cochran, I., Deheza, M., Dimopoulos, C., Foucherot, C., Jacquier, G., Morel, R., Robinson, R., & Shishlov, I. (2015). Monitoring, reporting and verifying emissions in the climate economy. *Nature Climate Change*, *5*(4), 319–328. https://doi.org/10.1038/nclimate2544

Blaufelder, C., Levy, C., Mannion, P., & Pinner, D. (2021). *A blueprint for scaling voluntary carbon markets to meet the climate challenge*. McKinsey Sustainability. https://www.mckinsey.com/capabilities/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

BloombergNEF. (2023). *Long-term carbon offsets outlook 2023 | Insights*. https://www.bloomberg.com/professional/blog/long-term-carbon-offsets-outlook-2023/

Boffa, J.-M. (2015). Opportunities and challenges in the improvement of the shea (Vitellaria paradoxa) resource and its management. *Occasional Paper*, *24*, 54.

Botene, T. S., Spanevello, R. M., & Andreatta, T. (2023). Estrangeirização de terras: A destinação produtiva nas diferentes regiões brasileiras. *Revista Brasileira de Gestão e Desenvolvimento Regional*, *19*(3), 735–753. https://www.rbgdr.com.br/revista/index.php/rbgdr/article/view/7070

Boyd, E., Gutierrez, M., & Chang, M. (2007). Small-scale forest carbon projects: Adapting CDM to low-income communities. *Global Environmental Change*, *17*(2), 250–259. https://doi.org/10.1016/j.gloenvcha.2006.10.001

Brancalion, P. H. S., & Holl, K. D. (2020). Guidance for successful tree planting initiatives. *Journal of Applied Ecology*, *57*(12), 2349–2361. https://doi.org/10.1111/1365-2664.13725

Bruna, N. (2022). A climate-smart world and the rise of Green Extractivism. *The Journal of Peasant Studies*, *49*(4), 839–864. https://doi.org/10.1080/03066150.2022.2070482

Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L., & Young, O. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society*, *11*(2), art8. https://doi.org/10.5751/ES-01759-110208

CFP Energy. (2024, December). *COP29: Article 6 approved – paving the way for a new era in global carbon markets*. CFP Energy. https://www.cfp.energy/en/insight/cop29-article-6-approved

Cormier-Salem, M., & Panfili, J. (2016). Mangrove reforestation: Greening or grabbing coastal zones and deltas? Case studies in Senegal. *African Journal of Aquatic Science*, *41*(1), 89–98. https://doi.org/10.2989/16085914.2016.1146122

Davis, A. P., Kiwuka, C., Faruk, A., Walubiri, M. J., Lumu, M., Mulumba, J. W., Heusinkveld, G. J., & Kalema, J. (2023). *The wild coffee resources of Uganda: A precious heritage*

Delacote, P., L'Horty, T., Kontoleon, A., West, T. A. P., Creti, A., Filewod, B., LeVelly, G., Guizar-Coutiño, A., Groom, B., & Elias, M. (2024). Strong transparency required for carbon credit mechanisms. *Nature Sustainability*, *7*(6), 706–713. https://doi.org/10.1038/s41893-024-01310-0

Ecosystem Marketplace. (2025). 2025 *state of the voluntary carbon market*. https://www.ecosystemmarketplace.com/publications/2025-state-of-the-voluntary-carbon-market-sovcm/

Edstedt, K. (2017). *Can the clean development mechanism bring community co-benefits? A case study of the Kachung Forest Project, Uganda*. http://lup.lub.lu.se/student-papers/record/8924441

Ellis, P. W., Page, A. M., Wood, S., Fargione, J., Masuda, Y. J., Carrasco Denney, V., Moore, C., Kroeger, T., Griscom, B., & Sanderman, J. (2024). The principles of natural climate solutions. *Nature Communications*, *15*(1), 547. https://doi.org/10.1038/s41467-023-44425-2

Fairhead, J., Leach, M., & Scoones, I. (2014). *Green Grabbing: A new appropriation of nature* (pp. 11–36). Routledge. https://www.taylorfrancis.com/chapters/edit/10.43249781315829654-6/green-grabbing-new-appropriation-nature-james-fairhead-melissa-leach-ian-scoones

FAO. (2018). *Small family farms country factsheet*. FAO. https://openknowledge.fao.org/server/api/core/bitstreams/cb10cbd0-a04f-4f18-8bd1-e9dbdd38361f/content#:~:text=Economic%20situation%20and%20diversification,54%20percent)%20next%20to%20livestock

Fleischman, F., Basant, S., Chhatre, A., Coleman, E. A., Fischer, H. W., Gupta, D., Güneralp, B., Kashwan, P., Khatri, D., & Muscarella, R. (2020). Pitfalls of tree planting show why we need people-centered natural climate solutions. *BioScience*, *70*(11), 947–950.

Gómez-Baggethun, E., De Groot, R., Lomas, P. L., & Montes, C. (2010). The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics*, *69*(6), 1209–1218. https://doi.org/10.1016/j.ecolecon.2009.11.007

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., … Fargione, J. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, *114*(44), 11645–11650. https://doi.org/10.1073/pnas.1710465114

Gupta, A. (2008). Transparency under scrutiny: Information disclosure in global environmental governance. *Global Environmental Politics*, *8*(2), 1–7. https://doi.org/10.1162/glep.2008.8.2.1

Harvey, D. (2003). *2003: The new imperialism*. Oxford University Press.

Heynen, N., & Robbins, P. (2005). The neoliberalization of nature: Governance, privatization, enclosure and valuation. *Capitalism Nature Socialism*, *16*(1), 5–8. https://doi.org/10.1080/1045575052000335339

International Trade Administration. (2023, October 13). *Uganda – agricultural sector*. https://www.trade.gov/country-commercial-guides/uganda-agricultural-sector

Johnson, L. K., Mahoney, M. J., Bevilacqua, E., Stehman, S. V., Domke, G. M., & Beier, C. M. (2022). Fine-resolution landscape-scale biomass mapping using a spatiotemporal patchwork of LiDAR coverages. *International Journal of Applied Earth Observation and Geoinformation*, *114*, 103059. https://doi.org/10.1016/j.jag.2022.103059

Knox-Hayes, J., Hayes, J., & Hughes, E.-L. (2020). Carbon markets, values, and modes of governance. *Knowledge for Governance*, *15*, 193–224. https://doi.org/10.1007/978-3-030-47150-7_9

Lee, J. (2017). Farmer participation in a climate-smart future: Evidence from the Kenya Agricultural Carbon Project. *Land Use Policy*, *68*, 72–79. https://doi.org/10.1016/j.landusepol.2017.07.020

Lee, J., Ingalls, M., Erickson, J. D., & Wollenberg, E. (2016). Bridging organizations in agricultural carbon markets and poverty alleviation: An analysis of pro-poor carbon market projects in East Africa. *Global Environmental Change*, *39*, 98–107. https://doi.org/10.1016/j.gloenvcha.2016.04.015

Lemos, M. C., & Agrawal, A. (2006). Environmental governance. *Annual Review of Environment and Resources*, *31*(1), 297–325. https://doi.org/10.1146/annurev.energy.31.042605.135621

Lin, B. B., Macfadyen, S., Renwick, A. R., Cunningham, S. A., & Schellhorn, N. A. (2013). Maximizing the environmental benefits of carbon farming through ecosystem service delivery. *Bioscience*, *63*(10), 793–803. https://doi.org/10.1525/bio.2013.63.10.6

Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New Directions for Program Evaluation*, *1986*(30), 73–84. https://doi.org/10.1002/ev.1427

Lyons, K., & Westoby, P. (2014). Carbon colonialism and the new land grab: Plantation forestry in Uganda and its livelihood impacts. *Journal of Rural Studies*, *36*, 13–21. https://doi.org/10.1016/j.jrurstud.2014.06.002

Matheus, F. S. (2018). The role of forests and protected areas in climate change mitigation: A review and critique of the ecosystem services and REDD+ approaches. *Desenvolvimento e Meio Ambiente*, *46*, 23–36. https://doi.org/10.5380/dma.v46i0.54187

Mathur, V. N., Afionis, S., Paavola, J., Dougill, A. J., & Stringer, L. C. (2014). Experiences of host communities with carbon market projects: Towards multi-level climate justice. *Climate Policy*, *14*(1), 42–62. https://doi.org/10.1080/14693062.2013.861728

Ministry of Water and Environment. (2022). *Updated nationally determined contribution (NDC)*. Republic of Uganda.

Muniz, R., & Cruz, M. J. (2015). Making nature valuable, not profitable: Are payments for ecosystem services suitable for degrowth? *Sustainability*, *7*(8), 10895–10921. https://doi.org/10.3390/su70810895

Namaalwa, J., & Byakagaba, P. (2019). Analysis of Uganda's policy and legal framework for the implementation of REDD+. *Environmental*

Science & Policy, *95*, 38–45. https://doi.org/10.1016/j.envsci.2019.02.003

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press. https://books.google.co.kr/books?hl=en&lr=&id=4xg6oUobMz4C&oi=fnd&pg=PR11&dq=Ostrom,+E.,+1990.+Governing+the+Commons:+The+Evolution+of++Institutions+for+Collective+Action.+Cambridge+University+Press,++Cambridge.&ots=aQ6ryFoEVi&sig=2RnG_6kcDPaN82JBhRnAT13hklw

Paavola, J., & Adger, W. N. (2005). Institutional ecological economics. *Ecological Economics*, *53*(3), 353–368. https://doi.org/10.1016/j.ecolecon.2004.09.017

Pagiola, S. (2007). *Guidelines for "pro-poor" payments for environmental services*. World Bank.

Pasaribu, S. I., Vanclay, F., & Zhao, Y. (2020). Challenges to implementing socially-sustainable community development in oil palm and forestry operations in Indonesia. *Land*, *9*(3), 61. https://doi.org/10.3390/land9030061

Paustian, K., Larson, E., Kent, J., Marx, E., & Swan, A. (2019). Soil C sequestration as a biological negative emission strategy. *Frontiers in Climate*, *1*, 1–11. https://doi.org/10.3389/fclim.2019.00008

Pigou, A. (1920). *The economics of welfare*. Routledge. https://doi.org/10.4324/9781351304368

Saxena, K. B. (2019). Compensatory afforestation fund act and rules: Deforestation, tribal displacement and an Alibi for Legalised Land Grabbing. *Social Change*, *49*(1), 23–40. https://doi.org/10.1177/0049085718821766

Scheidel, A., & Work, C. (2016). Large-scale forest plantations for climate change mitigation? New frontiers of deforestation and land grabbing in Cambodia. *Global Governance/Politics, Climate Justice and Agrarian/Social Justice: Linkages and Challenges*, *11*, 1–13. https://www.tni.org/files/publication-downloads/11-icas_cp_scheidel_and_work.pdf

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

Shin, S., Soe, K. T., Lee, H., Kim, T. H., Lee, S., & Park, M. S. (2020). A systematic map of agroforestry research focusing on ecosystem services in the Asia-Pacific Region. *Forests*, *11*(4), 368. https://doi.org/10.3390/f11040368

Siedenburg, J., Brown, S., & Hoch, S. (2016). Voices from the field – Carbon markets and rural poverty as seen from Madagascar and Mali. *Climate and Development*, *8*(1), 10–25. https://doi.org/10.1080/17565529.2014.998602

UNDP. (2023, March). *Uganda raises ambition to deal with greenhouse gas emissions in new climate change plan*. https://www.undp.org/uganda/news/uganda-raises-ambition-deal-greenhouse-gas-emissions-new-climate-change-plan

UNFCCC. (2024, November). *COP29 agrees international carbon market standards*. https://unfccc.int/news/cop29-agrees-international-carbon-market-standards

Ventura, A. C., Farias, L. D. G. Q. D., Paiva, D. S., Gomes, G. A. M. D. M., & Andrade, J. C. S. (2015). Carbon market and global climate governance: Limitations and challenges. *International Journal of Innovation and Sustainable Development*, *9*(1), 28. https://doi.org/10.1504/ijisd.2015.067347

Weil, D., Fung, A., Graham, M., & Fagotto, E. (2006). The effectiveness of regulatory disclosure policies. *Journal of Policy Analysis and Management*, *25*(1), 155–181. https://doi.org/10.1002/pam.20160

White, A. E., Lutz, D. A., Howarth, R. B., & Soto, J. R. (2018). Small-scale forestry and carbon offset markets: An empirical study of Vermont Current Use forest landowner willingness to accept carbon credit programs. *PLoS ONE*, *13*(8), e0201967. https://doi.org/10.1371/journal.pone.0201967

Wunder, S. (2008). Payments for environmental services and the poor: Concepts and preliminary evidence. *Environment and Development Economics*, *13*(3), 279–297. https://doi.org/10.1017/S1355770X08004282

Appendix 1. Interview questions.

Questions for farmers (participants)

(1) Could you explain climate change in Uganda?
(2) Could you explain what the carbon project that you participate in is about?
(3) Could you share your experiences and stories while participating in the project?
(4) How did you get to know about the opportunity to get involved in the carbon project at the beginning?
(5) Could you explain the contract-making process at the beginning?
(6) Can you describe why some farmers choose to participate in carbon projects while others do not?
(7) What kind of practices do you implement to receive the carbon credit?
(8) Could you compare the changes before and after your engagement in the carbon project (i.e. which crops do you produce, changes in land use, how long did/do you worked, any extra labour)?
(9) What benefits do you [or did you] see from participating in a carbon project? (monetary and non-monetary benefits)?
(10) What are the difficulties you [or others] have faced in participating in carbon markets?
(11) Would you be willing to continue joining the carbon project after finishing your current contract?
(12) How do other farmers in your community view your participation in the carbon project?
(13) What do you think would happen if the organization left?
(14) Is there anything to add more?

Questions for farmers (non-participants)

(1) Could you explain climate change in Uganda?
(2) Have you heard about carbon markets or carbon projects in your area?
(3) If yes, what is your understanding of how these projects work?
(4) Why haven't you chosen to participate in a carbon project so far?
(5) What potential benefits do you see in carbon markets for smallholder farmers like yourself?
(6) Are there any aspects of carbon projects that you find appealing or discouraging?

Questions for project operators, NGOs,

(1) What is your understanding of climate change in Uganda to you?
(2) What is your understanding of the carbon project is about?
(3) Could you share your experiences and stories while implementing the project?
(4) How did you choose or find communities or regions to implement in the carbon project in the beginning?
(5) Could you explain the contract-making process at the beginning?
(6) Could you explain the benefit-sharing process of carbon credits?
(7) Can you describe why some farmers choose to participate in carbon projects while others do not?
(8) What kind of practices do you encourage farmers to receive the carbon credit?
(9) Could you compare the changes in farmers before and after the carbon project (i.e. which crops do you produce, changes in land use, how long did/do you work, any extra labour)?
(10) What benefits do you [or did you] see for farmers and NGOs to join a carbon project? (monetary and non-monetary benefits)?
(11) What are the difficulties you [or others] have faced in implementing carbon projects?
(12) Did you face any conflict with local communities or other organizations?
(13) How do you find the future of the carbon market?
(14) What kinds of policy changes would help make carbon market participation more inclusive?

(15) What do you think would happen if you could not keep carbon projects due to no funding available?
(16) Is there anything to add more?

Questions for international organization and government representatives

(1) What is your understanding of climate change in Uganda?
(2) Does your organization have any projects/efforts to combat climate change in Uganda?
(3) Could you explain your understanding of the carbon market and the carbon project?
(4) How do you find the carbon market and project?
(5) What could be some of the difficulties in implementing carbon projects?
(6) Could you explain how your organization communicates with local communities about climate change issues?
(7) Did you face any conflict with local communities or other organizations about climate change?
(8) How do you find the future of the carbon market?
(9) What kinds of policy changes would help make carbon market participation more inclusive?
(10) Is there anything to add more?