Tanzanian Journal of Population Studies and Development, Vol. 32 No. 1, 2025: 1–18

Exploring the Effects of Carbon Trading on Local Communities in Mbulu District, Tanzania

Gideon Joseph Matekele[*] *& Digna Wolfram Mlengule*[‡]

Abstract

Carbon trading projects are widely promoted as effective climate mitigation tools, and are often lauded for their potential to alleviate poverty and improve livelihoods. They are intended to significantly reduce deforestation and forest degradation, and improve livelihoods for rural forest-dependent communities. This article explores the socio-economic effects of a carbon trading project on the local community in two villages—Mongo wa Mono and Yaeda Chini—in Mbulu District, Tanzania. The study was guided by the theory of change, which suggests that a project involves processes and outcomes for a local community throughout its lifecycle. The study employed a descriptive design, using both qualitative and quantitative methods. Data was collected through semi-structured interviews (n=91), in-depth interviews (12 participants), 2 focus group discussions, documentary reviews, and field observation. The findings revealed several positive outcomes of the project, including financial benefits to local communities through cash payments that are used to improve the education infrastructure and healthcare facilities. The youth have also been employed as game scouts. As well, the project has improved natural resource conservation and environmental restoration. The article emphasizes the importance of collaborative environmental conservation in carbon trading initiatives to ensure sustainable and equitable benefits for local communities. It highlights multiple benefits of carbon trading projects, which are crucial for policymakers, environmental organizations, and future projects to achieve sustainable climate solutions.

Keywords: *climate change, carbon trading, socio-economic effect, local community*

1. Introduction

Global focus on climate change has intensified since the release of the first assessment report, in 1990, of the Intergovernmental Panel on Climate Change (IPCC), which highlighted the anthropogenic causes of climate change, particularly the emission of greenhouse gases (GHGs) (Refseth, 2010). Globally, human activities—such as burning fossil fuels and deforestation—are key contributors to the increase in GHGs, with deforestation alone accounting for approximately 20% of the global carbon dioxide (CO_2) emissions (Merger et al., 2012). These activities have been most prevalent in industrialized nations—including the United States, Europe, and China—whose rapid development has relied heavily on fossil fuels (Höök et al., 2010; IPCC, 2014).

[*]Teofilo Kisanji University Mbeya: gideonjosephm@gmail.com
[‡]University of Dar es Salaam: mlenguled@gmail.com

 ▪ *https://doi.org/10.56279/tjpsd.v32i1.301*

Among the most promising approaches to mitigate climate change is the conservation of forests, which plays a critical role in absorbing CO_2 from the atmosphere. Efforts to reduce tropical deforestation and degradation, and to enhance forest cover, have been identified as essential strategies for mitigating climate change (Vilà-Cabrera et al., 2018). The effectiveness of these strategies depends largely on the implementation of appropriate policies and institutional frameworks (Gizachew et al., 2017). The United Nations Framework Convention on Climate Change (UNFCCC) has progressively recognized mechanisms such as *Reducing Emissions from Deforestation and Forest Degradation Plus* (REDD+) as viable options for early and low-cost climate change mitigation in developing countries (UNFCCC, 2015). REDD+ creates performance-based incentives that reward local communities for conserving forests and enhancing forest carbon stocks, thus reducing GHG emissions (Kajembe et al., 2016). This is done through carbon trading projects (CTPs), which operate under the REDD+ framework.

The concept of carbon trading projects has grown significantly in the last decade, with high-polluting sectors required to offset their GHG emissions through the compliance carbon market since 2005 (Ratnatunga & Balachandran, 2009). CTPs compensate for the emission of CO_2 into the atmosphere as a result of industrial or other human activities, especially when quantified and traded as a part of a commercial scheme (Yanai et al., 2020). In addition, individuals and organizations can voluntarily offset their carbon footprint through the voluntary carbon market, which is primarily composed of projects that prevent the release of carbon into the atmosphere (Kiffner et al., 2019).

These global efforts have aimed to improve community well-being and development opportunities by investing in natural resource management, with REDD+ projects in countries like Brazil, Nepal, and Uganda showing the potential to reduce climate change impacts while supporting local economies (Raybould et al., 2013; Xin & Cuifeng, 2021). In Peru, the CTP was perceived as one of the best interventions to ensure sustainable forest management aimed at providing benefits to local communities (Atmadja et al., 2022). Local people were supposed to get incentives such as direct financial payment and subsidies to ensure the projects did not harm the previous forest dependants. Carbon trading project payments, to some extent, helped reduce income inequality among households (Holland et al., 2016).

In Africa, carbon offset projects have been implemented in Kenya, Uganda, Malawi, Mozambique, and Tanzania (Fassbender, 2016; Khatun, 2017; Van Kooten et al., 2016). Their sources of funds are mainly donors who purchase an amount of carbon absorbed in the forest, and pay money to the local people who run the project (Van Kooten & Johnston, 2016). For example, in Uganda, projects like the Eco Trust's Trees for Global Benefits (TFGB) have contributed to income stability, food security, and energy security among rural farmers (Xin & Cuifeng, 2021). Also, in Kenya, citizens have established one of the great

solutions, which is to sequester and sell CO_2 from mangroves through the Vanga Blue Forest project that is partially funded by the United Nations Environmental Organization (Nelson, 2014).

Tanzania is also actively involved in REDD+ initiatives in various districts, including those in the Katavi and Manyara regions, benefiting from carbon offset projects to conserve forests and reduce emissions (Burgess et al., 2010). A total of TZS380m has been directly paid to forest communities through Carbon Tanzania (CT) under a project called Ntakata Mountains REDD+ Project (*Carbon Tanzania Annual Report*, 2021). This amount of money has helped local communities to improve their wellbeing. However, the implementation of these projects has not been without challenges. In some areas, issues that have been surrounding land tenure security include inadequate community involvement in decision-making, and the unequal distribution of carbon revenues, leading to tensions over land ownership and resource access (Sass et al., 2022).

In Mbulu District, Manyara Region, the Yaeda Valley CTP uses the REDD+ mechanism to generate carbon credits through the protection and management of forests (Nelson, 2014). This initiative aims to reduce greenhouse gas emissions and improve local livelihoods, support biodiversity conservation, and conserve/respect traditional cultural practices (Thompson et al., 2013). The marginalized Maasai communities in the district have benefited from compensation for their role in forest conservation, which has enabled them to maintain their traditional lifestyles while enhancing their economic conditions (*Carbon Tanzania Annual Report*, 2022).

The REDD+ projects have been initiated to reduce CO_2 emissions from deforestation and degradation by involving local communities in improving forest management and livelihoods (Lawlor et al., 2013). Several studies—like those by Tapping (2020), Hwargard (2020), and Pan et al. (2022)—have focused more on measuring the preparedness, readiness, and perspectives of local communities on REDD+ projects and CTPs. with less concern on changes in livelihoods associated with CTPs. Therefore, this article focuses on assessing the socio-economic implications of the Yaeda Valley CTP on the livelihoods of the bush societies in the Mbulu District, which seem to be marginalized. The interest is to get a clear picture of the extent to which the communities have benefited from the carbon trading project.

To map out the causal pathways towards improving community livelihoods, lowering deforestation, mitigating forest degradation, and improving carbon sequestration, this article is informed by the theory of change, which is concerned with processes and outcomes (Taplin et al., 2013). The theory helps in clearly reflecting the outcomes and pathways associated with an intervention project. Outcomes comprise changes such as behaviours, attitudes, and knowledge resulting from an intervention. The theory describes several events that are expected to influence a particular intended outcome (Richards & Panfil, 2011). In this case, it is useful in assessing the socioeconomic impact of the project on the communities.

The following sections focus on the context and methods used in this study. The results are divided into three parts. The first part deals with the respondents' social and economic characteristics, while the second part looks at the implications of the CTP on community livelihoods. Such implications include financial benefits, employment opportunities, improvement in agricultural productivity, and conservation and restoration of natural resources. The last section concludes the article.

2. Context and Methods

As mentioned earlier, this article is based on a study conducted in two villages—Yaeda Chini and Mongo wa Mono—which are located in Mbulu District, Manyara Region, in Tanzania. Mbulu District is one of the six administrative districts of Manyara Region, situated in the north-eastern part of Tanzania. The district is bordered by Arusha Region to the north, Babati District to the east, Hanang District to the south, and Singida Region to the west. Covering an area of 4,350km², it constitutes approximately 8.5% of the total area of Manyara Region, which spans 50,921km². Geographically, the district is located between latitudes 3.8560°S and 35.5466° E (URT, 2018).

The vegetation in Mbulu District consists of both natural and planted forests. The region is predominantly covered by woodlands characterized by medium-height trees; and a relatively dense mixture of Acacia woodland, commiphora-combretum woodland, seasonally flooded grasslands, and baobab trees. These vegetation types are significant for carbon sequestration, making the area suitable for CTPs. The presence of these forest types supports the ongoing CTP in the study area.

A descriptive research design was employed in this study, enabling the collection of both qualitative and quantitative data, to achieve the objectives of the study. Simple random sampling was used to select household respondents, while purposive sampling was employed to select participants for focus group discussions (FGDs) and key informant interviews (KIIs). The study surveyed a sample of 91 households, with the heads of household serving as respondents. To determine the sample size, Yamane's (1967) formula was used, which is recommended for finite populations where the size is known (Israel, 1992). A 90% confidence level was chosen to ensure the data accurately reflected the target population. Among the 91 households, 56 were selected from Yaeda Chini village (among 650 households), and 35 households were selected from Mongo wa Mono village (within 400 households).

Both primary and secondary data was collected for the study. The primary data was gathered through household surveys, FGDs, KIIs, field observation and document reviews. The survey included both open- and closed-ended questions administered to 91 household heads in the selected villages (56 questionnaires in Yaeda Chini village, and 35 questionnaires in Mongo wa Mono village). The data

collected through this method was on the socioeconomic characteristics of the respondents; and how the CTP affected their livelihoods, including agricultural activities, livestock keeping, hunting, beekeeping, and infrastructure development. The household survey made it easy to reach many respondents within a short time, and enabled the comparison of household information.

Two FGDs were conducted with 12 participants from the selected villages. Participants were selected based on age, gender, and experience; ensuring a diverse representation of community members. The discussions were guided by open-ended questions related to the study's objectives. The method helped to reveal the attitudes of villagers on the CTP and its effect on their livelihoods. The information collected was then linked with data obtained through structured interviews. In-depth interviews were conducted with 12 key informants (3 CTP officials, 5 village leaders, 1 ward executive officer, and 4 village leaders), 4 village game scouts, and 4 local carbon money account leaders. These informants were purposively selected due to their involvement in coordinating and implementing the CTP in the area.

The data gathered from this method focused on various aspects, including household socio-economic characteristics, income sources, carbon trading implications on community livelihoods, and the challenges associated with the CTP. In addition to primary data, secondary data was collected through document reviews. Information on how the project was operating and affecting community livelihoods from 2011 to 2023 was also collected through document review. In addition, the data on the number of employees and agricultural productivity before and after the establishment of the CTP was also collected. The reviewed documents included the Tanzania National Carbon Trading Guideline of 2022, Tanzania Forest Act of 2002, Tanzania National Forest Policy of 1998, Yaeda Chini Carbon Trading Reports of 2012–2023, and the village government reports concerning the project. Observation took place throughout the study to triangulate and verify the collected data. Moreover, such observation enabled the researchers to compare the data obtained through other methods.

The quantitative data collected through the household surveys was analysed using the IBM SPSS (version 23) and Microsoft Excel softwares. The analysis followed several key steps. The data was first edited to correct errors and ensure consistency within each questionnaire. It was then coded and entered into IBM SPSS (version 23) and Microsoft Excel softwares for analysis. Descriptive statistics (frequencies and percentages) were used to summarize how local respondents answered the study's questions. Cross-tabulation was employed to identify relationships between the variables; and particularly to explore the effects of CTPs on local community livelihoods. In addition, secondary data on the number of employees and agricultural productivity before and after the establishment of the CTP was analysed using Microsoft Excel to evaluate the impact of the carbon trading initiative on the livelihoods of the local community.

The qualitative data obtained through FGDs, KIIs, and document reviews was analysed using content analysis. This involved identifying key themes and patterns within the qualitative data, which helped to answer the research questions. The data was presented in a descriptive form, where actual statements from the key informants and discussants were presented in quotations.

3. Results and Discussion

Carbon trading projects (CTPs) are initiatives to reduce greenhouse gas emissions through market-based mechanisms. The projects typically involve trading carbon credits, which represent the reduction or removal of carbon dioxide or other greenhouse gases from the atmosphere. While the primary goal of carbon trading is environmental, the project also has significant social and economic impacts on local communities. This section examines the socioeconomic characteristics of the respondents and the implications of the CTP on the livelihoods of the local communities in Yaeda Chini and Mongo wa Mono villages.

3.1 Social-economic Characteristics of the Respondents

The respondents were composed of 73.6% males and 26.4% females. While this suggests a gender imbalance, it is important to note that the higher proportion of male respondents reflects the fact that men head many households in the study villages. Gender was a crucial factor in assessing the livelihood impacts facilitated by the project, as men and women experienced these impacts differently based on their roles and interactions with the environment. Regarding income, 48.4% of the respondents reported earning more than TZS300,000 annually, followed by 40.7% who earned between TZS200,000 and 300,000. Those with an annual income exceeding TZS300,000 were more likely to have diversified sources of income.

The study found that 50.5% of the respondents had never attended formal education, 22.0% had completed primary school education, 16.5% had attended secondary school, and only 11.0% had reached higher education levels. The community in the study area is predominantly made up of hunters, gatherers, pastoralists, and smallholder farmers who traditionally are subsistence farmers. This implies a high dependency on environmental resources such as land and the forest. Limited formal education implies little access to alternative livelihoods. The interest of the CTPs is the conservation of forests, which implies a change to access to forest resources for community livelihoods. The following section examines the implication of the project on community livelihoods.

3.2 Implication of the Carbon Trading Project on Community Livelihoods

The CTP is key in enhancing various forms of capital (social, economic, human, and environmental) within the Mongo wa Mono and Yaeda Chini villages in Yaeda Chini ward. These improvements resulted in significant changes to the livelihoods of the local community. Beyond the financial benefits, the project provided a range of positive impacts that contributed to the community's overall well-being. These impacts are elaborated in the sub-sections that follow.

3.2.1 Financial Benefits to Local Communities through the Carbon Trading Project

(a) Financing Health Services

The Yaeda Valley project has directly impacted the livelihoods of the local community, particularly in improving health services and facilities. In-depth interviews with community leaders from the Mongo wa Mono hunters-gatherers revealed significant changes in healthcare access since the initiation of the project. Before the coming of the project, the Hadza community rarely sought medical care from the hospital; instead they relied on traditional plant-based medicines; and in severe cases, individuals who could not recover were often abandoned by the community, and left to die. The introduction of the CTP has greatly improved the community's access to healthcare. A percentage of the carbon revenue is allocated to medical care, with the funds transferred to the Haydom Hospital. Every Hadza member receives a special identity card that grants him/her free access to medical services at the hospital, with the costs being covered by the community funds. One Hadza respondent made the following admission:

> *"The Hadza community did not have the habit of going to a hospital to seek healthcare services. People who got sick used to be treated with local medicines from plants, and if they became overwhelmed, they were abandoned in a camp. Establishing the carbon project has become a saviour to our livelihoods because we have dedicated some of our carbon funds to medical care. These funds are sent to the Haydom Hospital account. Every Hadza has been given a special identity card. When one needs health services, s/he goes to the Haydom Hospital and gets treatment without having to pay for the service. The cost of treatment is deducted from the community funds paid to the hospital account."* ***(In-depth Interview with the Hunter-gatherer Community Chairperson in Mongo wa Mono Village, 12 June 2023).***

Similarly, the CTP in the Yaeda Chini ward has significantly boosted the local health sector. Carbon funds are used to build essential infrastructure such as toilets at the Yaeda Chini Health Centre, and to purchase necessary items like the national flag and the president's portrait. Additionally, impoverished individuals in Yaeda Chini Village receive support for transportation to the Haydom Hospital for more sophisticated healthcare services. At the Mongo wa Mono Health Centre, TZS4m from the Hadza community's carbon account, and another TZS4m from the pastoralists' account, were used for infrastructure development. A solar power system, including solar panels and wiring, was installed to improve the efficiency of health services. These investments have led to a shift in community's attitude towards healthcare, with more people now seeking treatment at the hospital rather than solely relying on traditional cures.

Funds from the CTP are also used to assist pastoralists in Mongo wa Mono village who require medical treatment beyond cases that cannot be handled by the local health centre at the Haydom Hospital. Since the establishment of the livestock account in 2022, approximately TZS1,756,180 has been used to cover medical expenses for community members with serious health conditions. This came out during one of the interviews:

> *"We use the carbon money to pay for patients sent to referral hospitals. Since the opening of the livestock account in 2022, we have spent approximately TZS1,756,180 to pay for medical services for three people from the livestock community who suffered from serious health problems."* ***(In-depth Interview with the Pastoralist Community Secretary in Mongo wa Mono Village, 12 June 2023).***

It was found through FGDs that the improved healthcare services have contributed to a decline in mortality rates among the elderly and children, and timely access to healthcare, including maternal services. People no longer incur exorbitant costs to undergo treatment. Prior to the carbon project, many community members could not afford the TZS30,000 round-trip costs to access healthcare. Hence, the project has made medical services more accessible to a larger population. This is a good move to ensure health services are accessible to the marginalized community, hence the decline in mortality. A healthy community is vital for it permits community members to continue performing their social and economic activities efficiently. However, improving health services should not mean totally replacing traditional healing. Instead, there should be a way to conserve community traditions, such as conserving herbs that are used for healing, while at the same time they are serving as carbon sequesters.

(b) Financing Education Sector Services

In addition to health improvements, the carbon funds have been used to build infrastructure in the education sector. At the Yaeda Chini Primary School, two classrooms and a teacher's house were constructed using the carbon funds. Furthermore, one teacher's office and a three-room laboratory were built, partly funded through a partnership between the government and the local community.

Since the inception of the carbon trading project, the education sector in Yaeda Chini has undergone a significant transformation. The increased availability of educational services has contributed to a rise in student enrolment. Also, the project has provided full and partial sponsorship for students, with 47 students from Mongo wa Mono and Yaeda Chini villages receiving full support for their education from secondary school to college or university. The gender disparity in sponsorship shows preference for girls, with 29 girls and 18 boys supported. This prioritization is in response to challenges such as early forced marriages that often hinder girls' education.

Among the sponsored students, three were at university, two were at college, two were taking A-level studies, and the remaining 40 were attending secondary schools. Additionally, over 30 male students who were living off-campus received financial support for accommodation; while the school's dormitory fees for girls were also covered. Carbon funds were further used to provide for the educational needs of students from disadvantaged families. This is in line with the findings of other studies: that carbon trading projects in developing countries have improved the education sector through financial and material

support (Lawlor, 2023; Richards et al., 2011; Zahabu et al., 2012). Hence, the CTP offers a variety of advantages, such as creating jobs, supporting educational opportunities, and increasing income, which endure even after the projects have been completed (Tapping, 2020).

(c) Improving Income

The introduction of the CTP had a significant impact on the financial status of local people in the study villages, as indicated by the results from the household survey. Of the 91 respondents, 48.3% saved TZS300,000 or more annually; 40.7% saved between TZS200,000 and 299,999; and 11.0% saved between TZS100,000 and 199,999 per year. Notably, no respondent saved less than TZS100,000 annually. One of the key effects of the project was that it encouraged people to save more from their income each year. Before the project was established, individuals were responsible for individually covering the costs of social services; including healthcare, water, security, and village development contributions. However, with the implementation of the CTP, there was a notable shift: carbon credits were now used to pay for these social services, significantly reducing the financial burden on individuals. As a result, the money that citizens had previously used for these services was now available for personal development and savings. This is supported by the quotation below, given during one group discussion:

> *"Before the project, we were responsible for paying for social services such as health, water, and security; and contributing to community development efforts. Each person had to cover these expenses out of one's pocket. If someone could not afford the contribution, s/he would offer livestock or crops instead. However, with the introduction of the carbon project, we now receive funds for community development, which cover these social services. As a result, we have saved significant amounts of money, helping to strengthen our economic wellbeing."* ***(Participant in a FGD with Pastoralists in Mongo wa Mono village, 12 June 2023).***

The CTP has also brought about a shift in financial behaviour across different communities. For instance, most Yaeda Chini community members (58.9%) saved over TZS300,000 annually; while in Mongo of Mono, 45.7% of respondents saved between TZS200,000 and 299,999. The amount of savings varied depending on the number of services an individual needed. Ultimately, the CTP facilitated a shift in the financial dynamics of the community. While the carbon money was used for community development and paying for social services, the money that individuals would have spent on these services was redirected towards personal savings and improvements in their well-being. This shift contributed to overall income development, as the savings enabled individuals to enhance their economic standings and meet their families' needs.

The selling of emission reductions in carbon markets generates additional income for local communities (Rimhanen, 2009). The Hadza had made more than $350,000, which allowed them to save their income and pay for local wildlife

scouts' salaries, healthcare services, and community development projects (Bumpus, 2011). Carbon trading payments, to some extent, helped to reduce income inequality among households (Holland et al., 2016; Van Kooten, 2017). Local communities can also gain economically from carbon credits in cases where financial compensation is received by those reducing carbon emissions (Tapping, 2020). Overall, the CTP has played a crucial role in enhancing the local community's access to healthcare and education, showing the broader impact of carbon financing on social services in Yaeda Chini and Mongo wa Mono villages. The World Bank (2020) argues that carbon offset projects contribute to livelihoods in different parts of the world. This is supported by Van Kooten and Johnston (2016), who confirm that revenues from carbon projects are used to fund essential services such as healthcare, education, food security; and also the provision of employment opportunities. These statements support what is done at Yaeda Chini and Mongo wa Mono villages.

3.2.2 Provision of Employment Opportunities

In-depth interviews with Yaeda Chini ward leaders revealed that the carbon trading project had created various employment opportunities for the local residents, as shown in Table 1.

Table 1: Workers Employed Through CTP

Village	VGSs	Watchmen	Total
Mongo wa Mono	22	2	24
Yaeda Chini	17	3	20
Total	**39**	**5**	**44**

Source: Yaeda Chini Ward Office (2023)

The findings show that the Yaeda Chini CTP played a significant role in providing employment opportunities and helping local people sustain their livelihoods. Specifically, 39 village game scouts (VGSs) were employed; with 22 working in Mongo wa Mono village, and 17 in Yaeda Chini village. These were hired also to ensure the safety of both village offices, ward offices, and health centres. Moreover, the project employed two project managers in the Yaeda and Eyasi valleys, who worked as official CTP salaried staff. These employees also benefited from monthly allowances, thereby improving their economic wellbeing. Through in-depth interviews, the following was reported:

> *"There is an increase in carbon revenue, and the communities involved in the Yaeda-Eyasi Landscape project can hire additional staff to effectively protect their endangered forests, which now include nine additional villages. A total of 75 village game scouts have been recruited across these villages, along with two financial officers and an additional community coordinator. These newly created roles are crucial in ensuring the protection of community-owned forests, and guaranteeing that the benefits are shared among all community members."* ***(In-depth Interview with CTP Director of Operations, 19 June 2023).***

Moreover, the CTP provides several benefits to biodiversity conservation, including the retention of biodiversity, the prevention of forest conversion to agriculture, and employment opportunities for poor local communities (Edwards et al., 2010). Providing such employment opportunities aligns with the broader goals of biodiversity conservation. Carbon projects, including REDD+, often support local communities by preventing the conversion of forest reserves to agricultural land, and providing jobs that strengthen economic stability. For example, a survey of 21 REDD+ projects in Africa found that 14 projects generated jobs, creating employment opportunities for 1 to 15 people per 1,000 individuals living near the projects (Lawlor et al., 2013). This highlights the potential of carbon trading projects to contribute to environmental sustainability, while at the same time providing vital economic benefits to local communities. This directly aligns with the Sustainable Development Goal 8, which emphasizes promoting sustainable economic growth and decent work for all.

3.2.3 Increase in Agricultural Productivity and Food Security

The findings of this study indicate a significant improvement in agricultural productivity and food security since the establishment of the CTP. Notably, the number of cattle in the region has more than doubled, as shown in Table 2. According to the Yaeda Chini Ward report, the cattle numbers grew from 4,600 in 2017 to 11,520 in 2023, demonstrating a clear increase in livestock productivity.

Table 2: Average Number of Livestock from 2017 to 2023

	2013–2017				**2022–2023**			
Village	***Cows***	***Goats***	***Sheep***	***Total***	***Cows***	***Goats***	***Sheep***	***Total***
Mongo wa Mono	980	450	120	**1550**	3500	900	220	**4620**
Yaeda Chini	1800	1000	250	**3050**	4000	2300	600	**6900**
Total	**2780**	**1450**	**370**	**4600**	**4350**	**3200**	**820**	**11520**

Source: Yaeda Chini Ward Office (June, 2023).

During FGDs in Yaeda Chini village, farmers and pastoralists noted that the increase of livestock was linked to the availability of pasture, which was influenced by the presence of the CTP. This was through an agreement that prohibited cattle grazing in the forest during winter to allow pasture to regenerate for the summer. One participant highlighted the impact of the land planning and conservation restrictions:

> *"Pastoralists no longer graze on farms due to land planning, which separate areas, especially for grazing and those for cultivation; thereon influencing increase in crop production. Further, restrictions on grazing in conserved areas during the winter season have led to maximum livestock production because it enables pasture availability, which is used in the summer season."* ***(FGD with Farmers and Pastoralists in Yaeda Chini Village, 1 June 2023).***

The study also found a notable increase in the production of both cash and food crops in Yaeda Chini village. Sunflower cultivation, which was primarily grown as a cash crop, saw a rise alongside the continued cultivation of millet and maize for food. Farmers attributed this increase in production to several factors, including a reduction in crop theft, which was facilitated by constructing a police station that was funded through carbon revenues. Additionally, soil fertility improved due to land-use planning that separated settlement, grazing, and cultivation areas.

In Mongo wa Mono village, the CTP also contributed to food security for pastoralists and the Hadza community, who traditionally rely on hunting and gathering. The carbon funds are primarily used to purchase food, particularly maize, which become crucial during the summer when natural food sources in the forest are scarce. One participant explained this thus:

> *"Before 2017, pastoralists used to harvest 2–5 sacks of maize per hectare, but now they get 8–10 sacks. The Hadza community uses carbon money to buy maize, especially during summer when fruits are rare, roots dry up, and animals are fewer. This helps us cope with food shortages; enabling us continue living comfortably despite the food crisis."* ***(In-depth Interview with the Mongo wa Mono Village Executive Officer, 12 June 2023).***

This study finding contrasts with those of Baykar and Marafa (2016), who reported that REDD+ projects sometimes disrupt local livelihoods, strategies, and socio-cultural systems by causing issues such as unequal benefit-sharing and food insecurity. However, in our case the carbon project contributed positively to agricultural productivity. Too, the construction of a police station using CTP funds helped reduce livestock and crop thefts, which had previously hindered productivity. As a result of this move, among others, farmers could now retain their cattle for longer, leading to increased production and better food security.

3.2.4 Improved Conservation of Natural Resources

During an in-depth interview with the chairperson of Mongo wa Mono village, it was revealed that before introducing the CTP, the local forest faced significant deforestation and land degradation. Human activities—such as settlement expansion, crop cultivation, and livestock grazing—mainly contributed to this environmental degradation. There were no restrictions on forest resource use, thus pastoralist communities used to cut trees for building temporary shelters (*bomas*), and farmers cleared forest land for cultivation. As a result, the deforestation rate was high. The village chairperson explained:

> *"Pastoralist societies used to cut trees to construct seasonal houses (*bomas*). Farmers also cleared trees to establish farms. With many pastoralists and farmers, deforestation and land degradation were rampant. However, once the project started, forest restrictions were enforced. Old* bomas *were reused when moving to new pastures, and farmers were no longer allowed to expand their farms, which helped protect the forest from further deforestation, and enhance conservation efforts."* ***(In-depth Interview with Mongo wa Mono Village Chairperson, 12 June 2023).***

The carbon offset project has played a pivotal role in conservation efforts throughout the Yaeda Valley, leading to improved forest cover and biodiversity. According to the 2022 Yaeda Valley project report, the project had prevented the cutting of approximately 171,700 trees annually. Likewise, the 2020 report on the Yaeda Valley project highlighted the conservation of both forest ecosystems and biodiversity, which included 37 species of large mammals (such as elephants, wild dogs, kudu, and lions), 495 bird species (including two endemics: Fischer's lovebird and ashy starling), and 57 tree species (including baobab and umbrella thorn acacia). Additionally, during a household survey in Yaeda Chini village, one respondent shared her newfound awareness and commitment to forest conservation:

> *"I did not know how to preserve my surroundings before the carbon-based projects. But since it started, I have taken it upon myself to protect the forest and ensure no one is cutting down trees."* ***(Female Respondent, Household Survey in Yaeda Chini Village, 14 June 2023)***

Photos 1 and 2 showcase some of the conserved natural forests in Mongo wa Mono and Yaeda Chini villages.

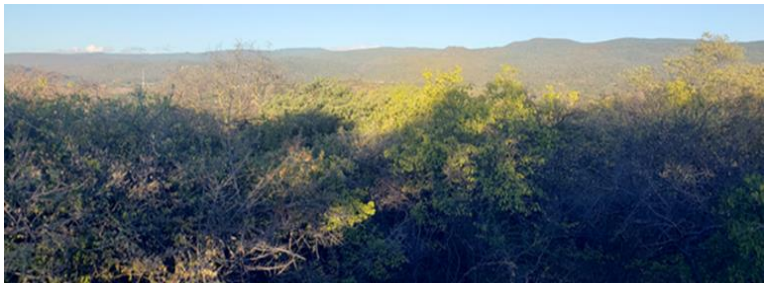

Photo 1: Yaeda Valley Forest in Yaeda Chini Village
Source: Field data (2023)

Photo 2: Part of Yaeda Valley Forest View in Mongo wa Mono Village
Source: Field data (2023).

Photos 1 and 2 show the conserved forest in Yaeda Valley, special for the CTP. These forests trap CO_2 in the atmosphere, and project officials measure carbon absorbed in that forest twice a year (May and November) in cooperation with the villagers and village government authorities. After measurement, they pay villagers a compensation fee for conserving those forests. Payments are made by considering carbon tones absorbed in the forests, and the carbon price in the world carbon market.

Hence, forest preservation in Yaeda Chini and Mongo wa Mono villages, in Yaeda Chini Ward, generates multiple benefits, which are both monetary (through carbon money provided); and non-monetary, like biodiversity protection. Forests are home to about 60,000 tree species, 80% of animal species reliant on forests and wetlands, 75% of bird species, and 68% of mammal species: all vital for maintaining biodiversity (UNDP, 2021).

In recognition of these efforts, the Yaeda Valley CTP received a prestigious UNDP Equator Prize in 2019, honouring outstanding community efforts to reduce poverty through conservation and sustainable biodiversity use. The award included a cash prize of US$10,000, which was reinvested into enhancing natural resource protection, as well as a visit from a UN film crew and a trip for a community representative to receive the award in New York during the 2019 UN General Assembly and Climate Week (UNDP, 2021). CTPs can mitigate climate change by preserving carbon stocks, enhancing biodiversity, and providing benefits to the local communities undertaking sustainable forest management (Atmajda et al., 2012; Shrestha & Shrethsa, 2017). For instance, in the Amazon, more than 8 billion trees are being conserved as part of special efforts to restore the planet's forest resources to their neutral, carbon-capturing state (Poudyal et al., 2020).

The success of the Yaeda Valley CTP exemplifies how carbon offset initiatives can facilitate powerful conservation strategies that benefit both the people and biodiversity. In the Yaeda Valley, communities did not engage in tree planting for conservation purposes, but instead relied on the natural forest; something that changed with the onset of the CTP. Forest conservation, in turn, has supported basic needs such as food, shelter, and clothing, thereby strengthening the community's commitment to preserve the environment. The Yaeda Chini Ward CTP provided livelihoods and played a crucial role in reinforcing the value of protecting natural ecosystems for both the local population and global biodiversity.

4. Conclusion

This article concludes that the introduction of the CTP has significantly contributed to the improved livelihoods of local communities in the Yaeda Chini Ward by providing financial and non-financial benefits. Financially, the CTP has played a crucial role in supporting key social services such as education,

healthcare, and administrative functions. The funds generated by the project have enabled farmers, pastoralists, and hunter-gatherers to improve their wellbeing, thereby enhancing their overall quality of life. Non-financially, the project has been instrumental in promoting successful conservation efforts, which have helped forest communities meet their basic needs, including food, clothing, and shelter. Based on the theory of change, the project has brought positive effect to the community and to the environment.

Furthermore, conservation activities have supported agricultural productivity, hence fostering long-term sustainability for these communities. The article recommends that the government—through the Ministry of State, Vice President's Office, and CTP implementers (Carbon Tanzania)—should ensure that the project is well-protected and made sustainable. This can be achieved by formulating policies based on the current global market to guide the project; regularly engaging, with and listening to, local communities; ensuring a robust supervision of carbon revenues and expenditures; and making follow-ups on the project to ensure that all the rules and regulations guiding its operationalisation are followed. Additionally, it should be ensured that community members adhere to all project guidelines to help scale up the initiative and enhance its positive impacts on their livelihoods.

References

Atmadja, S. S., Duchelle, A. E., De Sy, V., Selviana, V., Komalasari, M., Sills, E. O. & Angelsen, A. (2022). How do REDD+ projects contribute to the goals of the Paris Agreement? *Environmental Research Letters*, 17(4): 044038.

Bayrak, M. M. & Marafa, L. M. (2016). Ten years of REDD+: A critical review of the impact of REDD+ on forest-dependent communities. *Sustainability*, 8(7): 620.

Bumpus, A. G. (2011). *The matter of carbon: Understanding the materiality of CO_2 in carbon offsets,* 43(3): 612–638. http//doi.org/10.

Burgess, N. D., Bahane, B., Clairs, T., Danielsen, F., Dalsgaard, S., Funder, M. & Zahabu, E. (2010). Getting ready for REDD+ in Tanzania: A case study of progress and challenges. *Oryx*, 44(3): 339–351.

Carbon Tanzania (2022). Annual report; reducing emissions from deforestation and forest degradation in the Yaeda-Eyasi Landscape, Tanzania. Plan Vivo.

Edwards, D. P., Fisher, B. & Boyd, E. (2010). Protecting degraded rainforests: Enhancement of forest carbon stocks under REDD+. *Conservation Letters*, 3(5): 313–316.

Fassbender, S. (2016). Forest conservation and the Hadzabe. An integrated approach in protecting biodiversity and cultural diversity case study: Carbon Tanzania. Master Thesis in Sustainable Development at Uppsala University, Department of Earth Sciences, Uppsala University.

Gizachew, B., Astrup, R., Vedeld, P., Zahabu, E. M. & Duguma, L. A. (2017). REDD+ in Africa: Contexts and challenges. *Natural Resources Forum,* 41(2): 92–104). Oxford, UK: Blackwell Publishing Ltd.

Holland, T. G., Coomes, O. T. & Robinson, B. E. (2016). Evolving frontier land markets and the opportunity cost of sparing forests in Western Amazonia. *Land Use Policy*, 58: 456–471.

Höök, M., Sivertsson, A. & Aleklett, K. (2010). Validity of the fossil fuel production outlooks in the IPCC emission scenarios. *Natural Resources Research*, 19: 63–81.

Hwargård, L. (2020). Swedish companies' current use of carbon offsetting – underlying ethical view and preparedness for post-2020 carbon market conditions. Master's thesis, Department of Earth Sciences, Uppsala University. https://www.diva-portal.org/ smash/ get/diva2:1441234/FULLTEXT02.pdf

IPCC (2014). *Mitigation of climate change: IPCC Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Institute for Global Environmental Strategies, Tokyo.

Israel, G. D. (1992). *Determining sample size*. University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, EDIS: 1–5.

Kajembe, G. C., Silayo, D. A., Mutabazi, K. J., Massawe, F., Nantongo, M. & Vatn, A. (2016). Lessons learned from REDD+ pilot projects in Kondoa and Rungwe Districts, Tanzania. *Climate Change Impacts and Adaptation and Mitigation Project* (CCIAM)-Sokoine University of Agriculture (SUA).

Khatun, K., Corbera, E. & Ball, S. (2017). Fire is REDD+: Offsetting carbon through early burning activities in South-eastern Tanzania. *Oryx*, 51(1): 43–52.

Kiffner, C., Arndt, Z., Foky, T., Gaeth, M., Gannett, A., Jackson, M., ... & Kissui, B. (2019). Land use, REDD+ and the status of wildlife populations in Yaeda Valley, Northern Tanzania. *PLoS One*, 14(4): e0214823.

Lawlor, K., Myers Madeira, E., Blockhus, J. & Ganz, D. J. (2013). Community participation and benefits in REDD+: A review of initial outcomes and lessons. *Forests*, 4(2): 296–318.

Merger, E., Held, C., Tennigkeit, T. & Blomley, T. (2012). A bottom-up approach to estimating cost elements of REDD+ pilot projects in Tanzania. *Carbon Balance and Management*, 7: 1–14.

Nelson, F. (2014). Laws and carbon offset give new start to lost Tanzanian tribe. *Conservation Letters, 7*(2): 131–142. https://doi.org/10.1111/conl.12021

Pan, C., Shrestha, A., Innes, J. L., Zhou, G., Li, N., Li, J….. & Wang, G. (2022). Key challenges and approaches to addressing barriers in forest carbon offset projects. *Journal of Forestry Research*, 33(4): 1109–1122).

Poudyal, B. H., Maraseni, T., Cockfield, G. & Bhattarai, B. (2020). Recognition of the historical contribution of indigenous peoples and local communities through benefit-sharing plans (BSPs) in REDD+. *Environmental Science & Policy*, 106: 111–114.

Ratnatunga, J. T. D. & Balachandran, K. R. (2009). Carbon business accounting: The impact of global warming on the cost and management accounting profession. *Journal of Accounting, Auditing and Finance*, 24(2): 333–355. https://doi.org/10.1177/0148558X0902400208.

Raybould, A., Borem, A., Fox, T., Handley, L., Hertzberg, M. & Lu, M. (2013). *Genetically engineered trees for plantation forests: Key considerations for environmental risk assessment.* 785–798. https://doi.org/10.1111/ Pbi.12100.

Refseth, T. H. D. (2010). *Norwegian carbon plantations in Tanzania: Towards sustainable development?* Norwegian University of Life Sciences.

Richards, M. & Panfil, S. N. (2011). Towards cost-effective social impact assessment of REDD+ projects: Meeting the challenge of multiple benefit standards. *International Forestry Review*, 13(1): 1–12.

Rimhanen, K., Kahiluoto, H., Tseganneh, B. & Rötter, R. (2009). *Exploring potential of carbon trading to enhance food security in Sub-Saharan Africa*. Conference on International Research on Food Security, Natural Resource Management and Rural Development: Tropentag 2009, University of Hamburg.

Sass, E. M., Caputo, J. & Butler, B. J. (2022). United States family forest owners' awareness of and participation in carbon sequestration programmes: Initial findings from the USDA forest service national woodland owner survey. *Forest Science,* 68(5–6): 447–451. https://doi.org/10.1093.

Shrestha, S. & Shrestha, U. B. (2017). Beyond money: Does REDD+ payment enhance household's participation in forest governance and management in Nepal's community forests? *Forest Policy And Economics*, 80: 63–70. https://doi.org/ 10.1016/ j.forpol.2017.03.005.

Taplin, D. H., Clark, H., Collins, E. & Colby, D. C. (2023). Theory of change: Technical papers. *Acknowledge,* 4: 23. http://www. *Theory of Change*. ord/wp-content/ uploads/ toco_libtatry/pdf/toc-tech papers.

Tapping, L. (2020). REDD+ projects providing sustainable livelihoods for rural communities? An assessment of voluntary carbon offsetting projects in Peru and Tanzania. Master's thesis, Department of Earth Sciences, Uppsala University. https://www.diva-portal.org/smash/get/diva2:1475396/FULLTEXT02.pdf.

Thompson, O. R. R., Paavola, J., Healey, J. R., Jones, J. P., Baker, T. R. & Torres, J. (2013). Reducing emissions from deforestation and forest degradation (REDD+) transaction costs of six Peruvian projects. *Ecology and Society*, 18(1).

UNDP. (2021). United Republic of Tanzania Yaeda Valley Project. *Local Sustainable Development Solutions for People, Nature, and Resilient Communities*.

United Nations Framework Convention on Climate Change. (2015). Adoption of the Paris Agreement: Draft decision CP.21. Conference of the Parties, Twenty-first session, Paris, 30 November–11December 2015. https://unfccc.int/resource/ docs/ 2015/cop21/eng/10a01.pdf.

United Republic of Tanzania (URT). (2018). *Manyara Region Investment Guide 2018*. The President's Office Regional Administration and Local Government.

URT. (2021). *National climate change strategy*. Vice Presidents Office, Division of Environment, Dar es Salaam.

Van Kooten, G. C. (2017). Forest carbon offsets and carbon emissions trading: Problems of contracting. *Forest Policy and Economics*, 75: 83–88.

Van Kooten, G. C. & Johnston, C. M. (2016). The economics of forest carbon offsets. *Annual Review of Resource Economics*, 8(1): 227–246.

Vilà-Cabrera, A., Coll, L., Martínez-Vilalta, J. & Retana, J. (2018). Forest management for adaptation to climate change in the Mediterranean Basin: A synthesis of evidence. *Forest Ecology and Management*, 407(August 2017): 16–22. https://doi.org/ 10.1016/ j.foreco.2017.10.021.

World Bank. (2020). *Making benefit sharing arrangements work for forest dependent communities: Insights for REDD+ initiatives*. Retrieved from: https://openknowledge. worldbank.org/handle/10986/12616.

Xin, W. & Cuifeng, M. (2021). Brief introduction of carbon neutral international organizations. *E3S Web of Conferences,* 290: 03012. EDP Sciences.

Yamane, T. (1967). *Statistics: An introductory analysis*. New York: Harper and Row.

Yanai, R. D., Wayson, C., Lee, D., Espejo, A. B., Campbell, J. L., Green, M. B., Zukswert, J. M., Yoffe, S. B., Aukema, J. E., Lister, A. J.. Kirchner, J. W. & Gamarra, J. G. P. (2020). Improving uncertainty in forest carbon accounting for REDD+ mitigation efforts. *Environmental Research Letters,* 15(12). http://doi.org/10.1088.

Zahabu, E. & Malimbwi, R. E. (2012). The potential of community forest management under REDD+ for achieving MDG goals in Tanzania. *Community Forest Monitoring for the Carbon Market,* 154–167. Routledge.