



Economic viability of community-based forest management for certified timber production in southeastern Tanzania

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ABSTRACT

Community-based forest management has become increasingly widespread in Africa since the 1990s as an approach to conserving local forests while contributing social and economic benefits to local communities. Community forests (CFs) can sell forest goods and services to generate revenue for community benefit. Increased understanding of whether and how CFs can be economically viable is important for assessing their potential to alleviate rural poverty and deliver benefits to local communities. Questions of viability of commercial timber-producing CFs largely have not been addressed to date in the African context, and have important ramifications for community members, government decision-makers, and external donors. We conducted an economic and financial evaluation of a group of CFs in southeastern Tanzania that sell high-value tropical timber from Forest Stewardship Council-certified community forests. We found that this group of CFs currently is not economically viable, with forest management costs 2.6 times forest revenues over the five-year study period. However, revenues appeared to be increasing and costs decreasing over the period, and in the final two years costs were about 1.5 times revenues. The largest forest management costs were related to CF establishment and maintenance, which may be driven by the cost of relying on external experts; still, these costs decreased over time. Community transfer payments – used to support local development projects or community members – were the second largest cost category, but are unrelated to forest management. Based on current prices and rates of fixed and variable costs, timber sales would have to increase almost tenfold for these communities to be economically viable independent of external donations; however, some combination of increased timber sales, increased training and capacity, capped community payments, and added timber value could be successful in achieving economic viability. Increased sales seem to be the most direct approach, but is constrained by lack of demand at present, so marketing is needed.

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1. Introduction

Deforestation and forest degradation in the tropics are major environmental concerns because of impacts on carbon, biodiversity, water, and other factors (Miles et al., 2009). Deforestation and forest degradation can be caused by population pressures in rural communities with few livelihood alternatives (Fisher et al., 2011) or by outsiders motivated by profit (Ahrends et al., 2010), leading to agricultural expansion, unsustainable logging, mining, or other extractive activities. Nationalized management of forest resources in the past has tended to exacerbate this problem, giving

local communities little incentive to protect, maintain, or manage forests (Porter-Bolland et al., 2012). Thus, in recent decades, there has been global movement towards allowing local communities more authority over and opportunities to receive revenue from forest management (Charnley & Poe, 2007).

Community-based forest management (CBFM) is a term used to describe a variety of approaches from around the world that involve local community members in governance and management of local forests, and grant them certain rights to access and receive benefits from those forests (Charnley & Poe, 2007; Molnar et al., 2011). For CBFM to be sustainable over the long term, it must meet environmental, social, and economic objectives (Burivalova et al., 2017). One common approach for implementing CBFM is to generate forest goods and services from designated community forests (CFs) for sale, thereby offsetting costs and gen-

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erating revenue for the benefit of the community, among other objectives (Antinori & Bray, 2005). This manuscript deals with the economic sustainability of this approach.

Although CFs may have economic objectives beyond strict profitability, such as providing jobs or amenities to the local population (Antinori & Bray, 2005), viability or profitability remains an important component of economic sustainability (Frey et al., 2019). That is, if CFs consistently lose money, they eventually may be forced out of business, despite other positive environmental, social, and economic outcomes. Government or private-sector loans or financing generally are not available. Often, financial losses can be withstood for a period of time with support from international non-governmental organizations (NGOs) and donor agencies (Burivalova et al., 2017; De Pourcq, Thomas, & Van Damme, 2009; Taylor, 2010). However, international development projects only have an average duration of less than two years for NGOs (Golini et al., 2015) and five years for multilateral development banks (Ahsan & Gunawan, 2010). Opportunities for long-term international support, such as payments for reducing greenhouse gas emissions from deforestation and forest degradation (and other actions) (REDD +), are not viable for CFs at the present due to low prices and demand (Blomley et al., 2017). Therefore, dependence on continuous, long-term subsidization by external entities is a risky business model. If CFs cannot achieve viability in the medium term and external financial support dries up, communities will be forced either to revoke CF status, or to allow CFs to exist “on paper” only, with no regard for compliance with conservation goals, forest management plans, or harvest regulations.

This manuscript addresses questions related to the economic viability of a group of CFs in southeastern Tanzania that generate revenue from sale of high-value tropical timber from Forest Stewardship Council (FSC)-certified CFs. Increased understanding of whether and how CFs can be viable is important for assessing their potential to help alleviate rural poverty and deliver benefits to local communities. Questions of viability of commercial timber-oriented CFs largely have not been addressed to date in the African context, particularly for certified timber, and have important ramifications nationally, regionally, and globally for community members, government decision-makers, and external donors that seek to promote CFs. Our research questions are: 1) Are CFs based on high-value timber production economically viable in southeastern Tanzania at present? 2) Has the model progressed towards greater viability over time? 3) How could viability be increased by reducing costs or increasing revenues?

2. Background

2.1. Economic and financial viability of commercial timber-oriented community forests: International perspective

Research on the economic viability of tropical and subtropical, commercial timber-oriented CFs, most of which has been conducted in Latin America, has found mixed results. Many timber-oriented CFs may have a negative financial cost-benefit balance, at least at the beginning (Burivalova et al., 2017; De Pourcq et al., 2009). Timber-oriented CFs in natural forests often have high transaction, administration, and management costs (Cubbage et al., 2015c; Humphries et al., 2012; Piketty et al., 2015). In addition, timber sales may be lower than expected due to overestimates of inventory or demand (Piketty et al., 2015; Sungusia & Lund, 2016). Many CFs remain dependent on external financial support (Burivalova et al., 2017; De Pourcq et al., 2009; McDaniel, 2003; Scheba & Mustalahti, 2015). One of the flaws of many past financial analyses of CBFM is that the true costs of labor, supplies, services, and equipment funded by external donors are

not included in the analyzed costs of forest management, thus providing a skewed view of the CFs' true financial viability (Humphries & Holmes, 2015).

On the other hand, support provided by national governments and external donors to improve capacity and productivity can be effective (Frey et al., 2019), and after a few years of external support, some CFs in Latin America have been able to achieve gross revenues that exceed their costs (Cubbage et al., 2015c; Humphries et al., 2012, 2020; Piketty et al., 2015). Unlike plantation forests, these tropical and subtropical CFs, like those in southeastern Tanzania, are based on natural forests with standing, mature timber. As long as sales of revenue from standing or processed timber can meet the ongoing costs associated with forest management, it is possible for CFs to become profitable within a short timeframe after an initial period to establish governing bodies, conduct inventories, and build capacity. Those CFs with lower average costs and higher financial viability often are the ones with higher timber volume produced per area, larger scale of operation, and greater ability to share fixed costs among multiple communities; whereas CFs with poorly stocked, degraded, or small forests may never reach viability (Cubbage et al., 2015b; Humphries et al., 2012).

2.2. Community-based forest management in Tanzania

In 2002, Tanzania's Forest Act for the first time codified CBFM into law, under which communities are allowed to establish, manage, and directly benefit from Village Land Forest Reserves (hereafter referred to as CFs) that they delineate on community lands (Blomley & Ramadhani, 2006; Scheba & Mustalahti, 2015). Day-to-day management of a CF is conducted by the Village Natural Resource Committee, which is overseen by the local Village Council, with the goal of production and/or protection based on sustainable management objectives and written forest management plans (Scheba & Mustalahti, 2015). A key feature of the Forest Act is that it allows villages to retain revenues generated from their formally-established CFs.

CBFM in Tanzania has had somewhat mixed results. Devolution of authority over CFs to the village level generally has led to increased transparency and improved governance (Kalonga & Kulindwa, 2017; Khatun et al., 2015; Lund, 2007; Mwamfupe et al., 2019). Evidence suggests that lands managed directly by local villagers demonstrate decreased forest degradation and illegal activity, and increased cover density (Lupala et al., 2015; Persha & Blomley, 2010); however, deforestation and degradation may simply be pushed to other, unprotected lands, causing leakage (Sungusia & Lund, 2016).

CFs in Tanzania generate income from sale of a mix of forest goods and services, including charcoal, firewood, grazing rights, and fees from tourism and research, while sale of commercial timber and non-timber forest products is relatively rare (Green & Lund, 2015; Lund, 2007; Lund & Treue, 2008; Vyamana, 2009). From a strictly financial perspective, revenues can apparently be higher than operating expenses; this net income is frequently used for investment in public infrastructure and services, or other community development projects (Green & Lund, 2015; Khatun et al., 2015; Lund, 2007; Lund & Treue, 2008). These investments seem to improve general living conditions in the community, but generate only limited livelihood and income benefits, which tend to be distributed mostly among the relatively wealthy households, with the poorest and most marginalized households frequently missing out (Gross-Camp, 2017; Meshack et al., 2006; Mwamfupe et al., 2019; Pailler et al., 2015; Vyamana, 2009), although forest certification may generate more equitable results (Kalonga et al., 2015; Kalonga & Kulindwa, 2017).

Past research has indicated that greater profitability and improvements in livelihoods are limited by an emphasis on outside

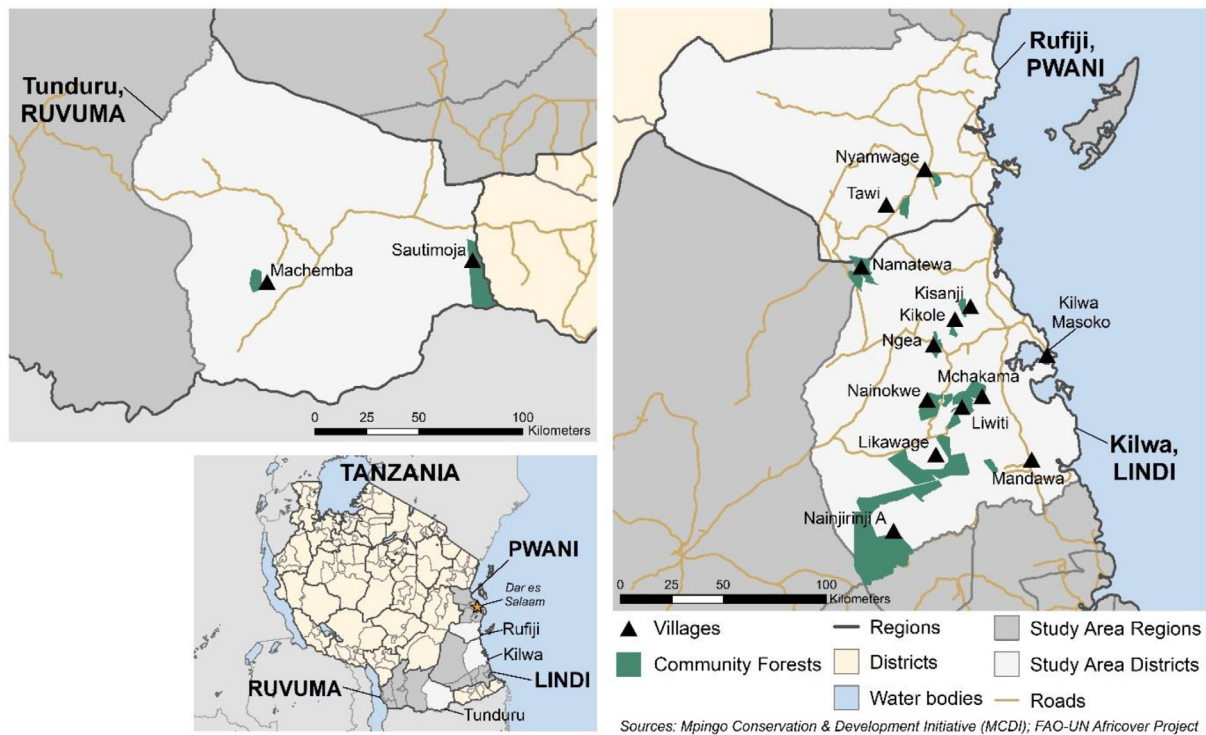


Fig. 1. MCDI project area.

expertise and bureaucratic rules, which can increase costs and undermine village autonomy (Green & Lund, 2015; Scheba & Mustalahti, 2015; Sungusia & Lund, 2016). Further, it is clear that external donors have been crucial in financing at least the establishment phase of many CFs (Green & Lund, 2015; Lund & Treue, 2008), and it is unclear to what extent outside financing continues to support ongoing management of Tanzanian CBFM in general and individual CFs in particular.

2.3. Commercial timber-oriented community forests in southeastern Tanzania

Completion of the Mkapa Bridge over the Rufiji River in 2003 and subsequent paving of the main highway has facilitated access to southeastern Tanzania and reduced transportation costs to markets in regional cities and the seaport in Dar es Salaam, the country's largest city. This improved access is simultaneously an opportunity and a threat, as it makes both sustainable and illegal

timber harvest more profitable (Ahrends et al., 2010; Milledge, Ahrends, & Gelvas, 2007). The area affected is located primarily within the Miombo woodland and East African coastal forest ecoregions, which are home to highly diverse flora and fauna (WWF, 2019a, 2019b). The area is characterized by strong rainy/dry seasons, frequent fires, charismatic wildlife, and several high-value tropical hardwood species, including East African blackwood (*Dalbergia melanoxylon*, “mpingo” in Swahili), bloodwood (*Pterocarpus* spp., “mninga”), pod mahogany (*Azela quanzensis*, “mkongo”), and a few other commercial species. Mpingo, in particular, is one of the highest-value timbers per cubic meter (m^3) in the world, and is prized for its black heartwood that is used for woodwind instruments (e.g., clarinets, oboes, and bagpipes), fine arts, and other specialized purposes (MCDI, 2013b). Mpingo and other high-value hardwood species are typically deciduous or semi-deciduous, have slow growth, and are mixed in the landscape with numerous other non-commercial species.

Table 1
Community forests (CFs) included in the FSC group certificate under MCDI, which are the subject of this study.

Village	District	Village population (2017)	Year CF created	Year certified	Area of CF (ha)
Kikole	Kilwa	1,547	2006	2009	916
Kisangi	Kilwa	1,025	2007	2009	1,900
Likawage	Kilwa	6,649	2013	2013	31,055
Liwiti	Kilwa	277	2010	2010	9,306
Machemba	Tunduru	2,560	2015	2015	4,612
Mandawa	Kilwa	2,062	2014	2014	1,994
Mchakama	Kilwa	1,592	2014	2014	5,639
Nainokwe	Kilwa	465	2010	2010	10,131
Namatewa	Kilwa	396	2017	2017	10,015
Nanjirinj A	Kilwa	5,691	2012	2012	83,538
Ngea	Kilwa	469	2014	2014	3,330
Nyamwage	Rufiji	3,993	2006	2010	1,644
Sautimoja	Tunduru	640	2015	2015	21,966
Tawi	Rufiji	1,220	2006	2010	2,787

In 2004, the local NGO Mpingo Conservation and Development Initiative (MCDI) was established to promote and facilitate sustainable forest use through CBFM in southeastern Tanzania. The aim of MCDI has been to utilize hardwood timber as an “economic tool to advance conservation” (MCDI, 2013a). MCDI has facilitated the establishment of CFs encompassing 408,500 ha in 41 villages in southeastern Tanzania since 2004, which sell timber to finance community development projects and partially offset the costs of forest management.

Fourteen of the CFs facilitated by MCDI, totaling 188,833 ha as of 2018, are certified by FSC for sustainable forest management (Fig. 1, Table 1). Certification of sustainable forest management is a tool used to communicate to buyers that timber was produced from forests following positive social, economic, and environmental principles and practices. FSC principles can be applied in many circumstances, from industrial plantations to small-scale natural forests. MCDI manages a group certificate for the 14 CFs, which allows sharing of auditing and other costs.

3. Data and methods

In order to understand economic viability and trends, we sought comprehensive revenue and cost data related to the 14 CFs involved in the MCDI FSC group certificate for fiscal years 2013–14 to 2017–18. Data before 2013–14 were not available in most CFs. Up through 2017–18, the CFs sold standing timber to third parties as their primary source of income.

We examined financial data regarding revenues received by CFs from timber harvests and other sources (revenue); costs incurred by the CF for the creation and ongoing management of CFs (CF internal forest management costs); costs incurred by outside donors (MCDI in particular) in support of creation and ongoing management of CFs (externally-funded forest management costs); and payments from the CF for projects or payments to benefit the community (community transfer payments). Although exact proportions varied by CF and year, most CFs followed a typical pattern for allocation of their revenue (Fig. 2): around 50% of their annual revenue for community transfer payments, 40% for internal CF forest management costs, 5% for transfer to the District Council,¹ and 5% for transfer to MCDI from 2014 onwards.²

3.1. Internal CF financial data

All CFs record their costs and revenues in ledgers maintained on site in village offices, in Swahili. Costs included both CF forest management costs and community transfer payments, as well as the District Council and MCDI transfer payments described above. For auditing purposes, MCDI annually compiles these cost and revenue data from each CF by activity type, and translates them to English. A few years were missing information or had questionable data; in these cases MCDI staff returned to the villages to compare the compilations to the original ledgers for verification and to fill in data gaps. Three of the CFs were not in the FSC group for the entire five-year period; these CFs were excluded from the analysis in those years.

¹ The District Council is the level of government above the Village. The 5% payment to the District Council was technically voluntary, but seen as a necessary “cost of doing business,” to recognize and acknowledge the District’s provision of technical and political support.

² The 5% payment to MCDI was considered partial compensation for its technical support; however, when considering the internal and externally-funded forest management costs, this 5% transfer payment was not included, as it is simply a transfer between the two entities under consideration and inclusion would double-count costs.

3.2. MCDI financial data

MCDI expends resources in support of creation and ongoing management of CFs (externally-funded forest management costs), so any understanding of the true costs of CBFM must include these costs. Support activities include training villagers, guiding forest inventories and the creation of management plans, overseeing controlled burns and timber harvests, and auditing records. Associated costs include vehicle depreciation, maintenance, and fuel; staff field allowances; villager allowances for labor; villager allowances for meetings; and supplies. Upon request, MCDI provided information on their costs directly attributable to each of the 14 CFs, or to the 14 CFs as a group, for the period indicated. MCDI also provided a list of equipment that had been given to each CF.

3.3. Economic and financial analysis

Our analytical approach was a hybrid that included elements of both economic and financial analysis. Our primary analytical aim was to include the fullest accounting possible of the costs and benefits of the CF initiative, consistent with an economic analysis (Cubbage et al., 2015a).³ Secondly, we also sought to understand how community transfer payments impact viability, consistent with a financial analysis. An “economic” understanding of the viability of the CFs thus includes the internal and externally-funded forest management costs. A “financial” accounting of the CFs’ costs and returns would include only the internal forest management costs (not external costs) and community transfer payments, as well as the 5% that is transferred to MCDI. Therefore, we clearly delineated financial community transfer payments and separated them from the economic forest management costs.

Economic and financial analysis of CBFM projects can be used to estimate profits, and to analyze the cost and revenue structure (Cubbage et al., 2015a). In general, profits equal to or greater than 0 indicate viability. Profits (π) are defined as the difference between revenues (R) and costs (C), and can be given by

$$R = p \cdot q \quad (1)$$

$$C = vc \cdot q + fc \quad (2)$$

$$\pi = R - C = (p - vc) \cdot q - fc \quad (3)$$

where p is price per unit produced, q is quantity of units produced, vc are variable costs per unit produced, and fc are the total fixed costs of the operation.

We conducted the economic/financial analysis using the Green Value Tool,⁴ which “provides a simplified method for evaluating the financial viability of forest-based initiatives” (Humphries & Holmes, 2014). The Green Value Tool has been used for research into economic/financial viability of CFs in the past (e.g., Humphries et al., 2012, 2020; Humphries & Holmes, 2015). Compilation and analysis with the Green Value Tool was done for each year using the original revenue and expense data from CFs and MCDI in nominal Tanzanian Shillings. Analysis results and summaries for each fiscal year were then converted to United States Dollars (\$) using the exchange rate for December 31 of the relevant year (the approximate midpoint of the fiscal year).

³ An economic analysis is undertaken from a broader, societal standpoint, accounting for all relevant income and costs for a project, from multiple stakeholders, ignoring transfers between those stakeholders, and can use other shadow prices to account for nonmarket goods and services, whereas a financial analysis is undertaken from the perspective of a single individual or entity, such as the CF, and uses market prices only (Cubbage et al., 2015a). Although our analysis is consistent with an economic perspective, estimation of the value of non-market ecosystem services was beyond the scope of this work, as discussed in the section on Limitations.

⁴ www.green-value.org

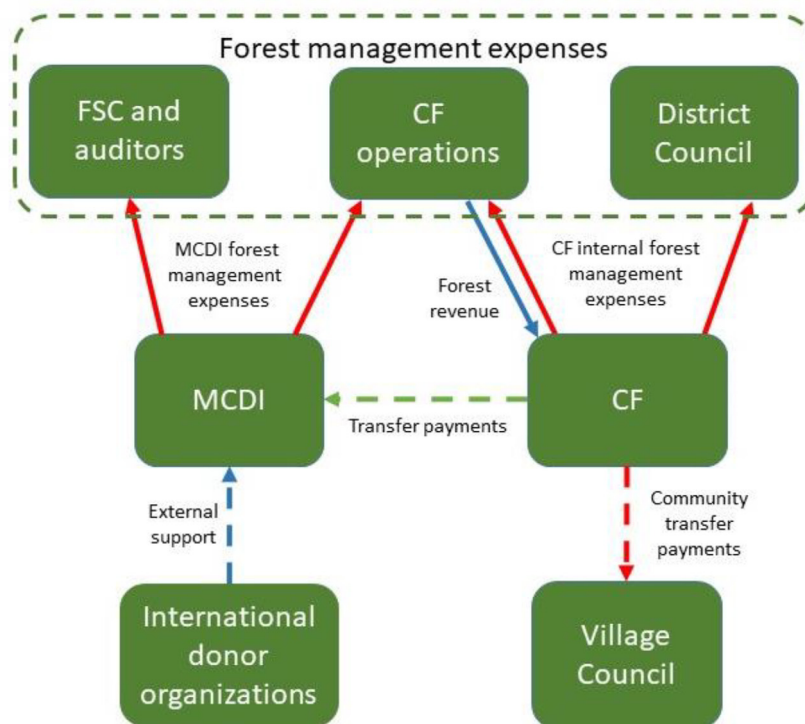


Fig. 2. Income (blue arrow), cost (red), and within-system transfers (green) in CF and MCDI financial data. Dashed arrows are not directly accounted in forest management expense and revenue categories. Community transfer payments (dashed red) are included in the text where noted. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

We defined revenue and cost categories, which are presented along with subcategories and examples in Table 2. Costs are also broken down based on pre-defined input types: labor, materials and services, and equipment and machinery.⁵ Generally categorization was straightforward, although some costs could potentially have been placed under two or more of the categories, so we reviewed post-categorization and followed up with MCDI to ensure consistency and accuracy. The cost of the international third-party FSC audit (included in certification cost category), and some administrative overhead costs were the lone costs not attributable to individual CFs. We divided these annual costs among the CFs proportionally based on certified forest area in a given year. Timber sales and community transfer payments are variable costs (vc in equation (3)), whereas the other items are fixed costs (fc). The Green Value Tool assumes straight-line depreciation of machinery and equipment based on its useful life; Appendix Table 1 gives the useful lifetimes we assumed for the most common types of equipment.

Inclusion of all relevant CF costs paid for by all parties is recommended to get a full sense of how self-sustainable a CF is (Humphries & Holmes 2014). In our case, this includes the internal and externally-funded forest management costs. Community transfer payments from CFs to Village Councils for community development projects are a use of revenue rather than a cost necessary for the creation and ongoing management of the CF.

We estimated a break-even timber sales volume for the MCDI group of 14 CFs for each year. Break-even timber sales volumes are the amount of timber required to be sold in order to exactly

compensate costs, i.e., to have zero profit. The break-even volume (q_0) can thus be found by setting π to 0 and solving equation (3) for q :

$$q_0 = \frac{fc}{p - vc} \quad (4)$$

A timber sales volume below the break-even volume implies a loss (negative profit), and a timber sales volume above the break-even volume implies a positive profit. This break-even volume is based on the assumption that variable costs increase proportionally as sales increase, but fixed costs remain constant. For break-even estimation purposes, we assume a single price (p) for all timber produced.

3.4. Limitations

There were some potential weaknesses of the data and limitations of the analysis. In terms of data, first, some CFs had no accounted forest management costs or revenues for entire years. MCDI staff indicated that the CFs most likely had no revenues in these years, and no costs directly accounted in their ledger. However, the CFs may have conducted forest management activities that were not recorded in the ledgers. For example, forest patrols may have been carried out by volunteers or with payment by the Village Council from other village funds. If so, the true (internal) costs would have been underestimated in those CFs in those years.⁶ Even in these cases, however, MCDI did report (external) costs in those villages and years, and these are included in our analysis (e.g., if MCDI paid the costs of forest patrols). Second, the CFs may have utilized services or equipment that was informally loaned

⁵ Labor costs are paid to local people based on time worked or based on units of production; materials and services costs are paid to third party contractors or for purchasing items with a useful life of less than one year; and equipment and machinery costs are paid for items with a useful life greater than one year.

⁶ These accounted for a total of 16 village-years.

Table 2
Revenue and cost categories, subcategories, and examples.

Categories (and typical frequency)	Subcategories	Examples
Revenue		
1. Timber sales (varies)		Sale of standing timber
2. Other sources of revenue (varies)	a. Fines b. Fees c. Other sales	Fine for illegal logging Fine for illegal grazing Fee for visiting CF Sale of non-timber forest products Sale of confiscated equipment or timber
Costs		
1. Establishment and maintenance (most activities every 3–5 years)	a. Resource assessments b. Maintenance c. Related training	Land survey and demarcation Forest inventory Forest management planning Repainting boundary markers Road work
2. Security and monitoring (most activities monthly to quarterly)	a. Security b. Monitoring c. Related training	Patrols Biodiversity monitoring Seedling survival assessment Post-burn transects
3. Silviculture (annually)	a. Silviculture b. Related training	Enrichment planting Prescribed burns
4. Timber sales (varies)	a. Harvests b. Related training	Tree selection and marking Supervision of loggers
5. Certification (annually)	a. External audits b. Internal audits and assessments c. Related training	FSC third-party audits
6. Administration (most activities monthly to quarterly)		Village General Assemblies and Village Council meetings Committee meetings Bank fees Transportation to meetings, bank, etc. Local development projects Payments to local community members
7. Community transfer payments (with each revenue-generating sale, fine, or fee)		

or donated (e.g., office space, personal transportation, village-owned or personal tractors, shovels, etc.) and therefore not recorded in the ledgers or other documentation, also generating underestimates of the true costs. However, equipment and supplies donated by MCDI through formal channels were accounted in the externally-funded costs. Third, by only accounting for costs directly attributable to supporting the 14 CFs, some overhead costs such as rental and utilities for the main MCDI office and office personnel salaries are not included. These three limitations mean our cost estimates are likely to be underestimates.

In terms of the analysis, first, because of selection bias, there was no way to conduct a fully comparable analysis between this group of FSC-certified villages and non-certified villages. That is, the CFs selected to be included in the FSC group are likely to be those with better governance and administration, and no underlying issues like land disputes. Therefore, we focus exclusively on the FSC-certified group. Last, we were unable to quantify and estimate the value of non-market ecosystem services in monetary terms. A full economic analysis would include these non-market values; however, non-market valuation was beyond the scope of this work.

4. Results

4.1. Timber sales

Each CF's current forest management plan stipulates a total annual allowable cut by species that is believed to be sustainably produced over the long term, based on current stocking rates and estimates of timber growth (see "Increasing sales" section in Discussion below). The allowable harvest and actual timber sales for each commercial species from the CF data, summed over all 14 CFs, is given in Table 3. The allowable harvest is 22,562 m³/yr; however, the CFs are only harvesting about 1,065 m³/yr on average, less than 5% of the allowable amount.

4.2. Revenue and cost averages by CF

Our initial analysis of viability entailed comparing the total revenue from 14 FSC-certified CFs combined and averaged annually for the five-year period (2013–14 through 2017–18), with the total

Table 3

Total volume of timber sold from 13 FSC-certified community forests^b for the five-year period, 2013–14 to 2017–18, and allowable harvest volume over a five-year period.

Swahili common name	Scientific name	Allowable harvest (m ³) [*]	Actual timber sold (m ³)
Mpingo	<i>Dalbergia melanoxylon</i>	9,310	1,456
Mninga ^a	<i>Pterocarpus</i> spp. ^a	25,076	1,383
Mkongo	<i>Afzelia quanzensis</i>	6,366	1,151
Mtondoro	<i>Julbernardia globiflora</i>	30,921	745
Msufi pori	<i>Bombax rhodognaphalon</i>	8,625	212
Msekeseke	<i>Bobgunnia madagascariensis</i>	165	147
Mpangapanga	<i>Milletia stuhlmannii</i>	16,463	41
Mkarati	<i>Burkea africana</i>	156	10
Msenjele	<i>Acacia nigrescens</i>	15,730	0
Unspecified/Other			179
Annual average		22,562	1,065
5-year total		112,812	5,323

^{*} These numbers represent the sum total allowable cut from the villages' most recent five-year management plans. Data source = MCDI.

^a "Mninga" refers to two species of the same genus, which are sometimes, but not always, differentiated in timber sales: mninga jangwa (*P. angolensis*) and mninga bondi (*P. tinctorius*).

^b Namatewa is not included because the community forest was established in 2017 and the forest inventory had not yet been completed at the time of our fieldwork.

Table 4

Average annual forest revenue and costs* for 14 FSC-certified community forests for the five-year period from 2013–14 to 2017–18 (US\$).

	Annual Forest Revenue *			Annual Costs *				
	Timber	Other	Total	Internal Forest Mgt	External Forest Mgt	Total Forest Mgt	Comm. Payments	Total
Village values								
Mean	8,859	415	9,275	2,724	20,802	23,526	4,615	28,141
Median	3,475	0	3,676	1,358	17,663	19,867	1,736	21,290
Standard dev.	18,834	1,245	19,413	13,394	16,805	19,179	9,626	26,169
Minimum	0	0	0	0	264	264	0	264
Maximum	92,030	9,123	92,030	27,143	61,563	83,731	51,318	121,779
Group total	115,169	5,401	120,570	35,410	270,427	305,836	59,998	365,834

* Forest revenue includes revenue from sale of timber and other sources associated with the community forest. Forest costs include all costs related to the creation and ongoing management of the community forest, but exclude community transfer payments.

combined average annual costs for all 14 CFs (Table 4). Average annual revenue was approximately \$9,300 per CF (standard deviation \$3,700), whereas average annual total forest management costs were about 2.5 times that, \$23,500 per CF (st. dev. \$19,900). Of the forest revenues, about 96% were from sale of standing timber, with additional small amounts from fines, fees, and sales of other products or goods confiscated from illegal loggers. Of the annual forest management costs, about \$2,700 per CF were paid by the CFs (st. dev. \$1,400) and \$20,800 per CF by MCDI (st. dev. \$17,700). This means that, over this five year period, CFs spent about 29% of the revenue on internal forest management costs. However, CFs only paid about 12% of the total forest management costs; MCDI paid the rest, implying that CBFM is not currently economically self-sustaining in these CFs.

Community payments, which are not considered part of the “economic” forest management costs because they do not contribute directly to creation and ongoing management of the CF, added an annual average of approximately \$4,600 per CF to the total costs (st. dev. \$1,700). When considering these total costs, the annual average was about \$28,100 per CF (st. dev. \$21,300). Total costs were 3.0 times the total forest revenues.

There was wide variation among the 14 CFs in the level of costs relative to revenue. The CF with the highest revenue (\$72,400 per year) and highest forest management costs (\$68,300), in absolute terms, was Nanjirinji A, which also is the village with the largest CF area. This allows Nanjirinji A to take advantage of economies of scale, demonstrated by the fact that fixed costs are the smallest percentage of costs out of the 14 CFs, at 56% for Nanjirinji A compared to 69% for the average for all 14. Further, the large forest area seems to attract greater attention among buyers. Despite having the highest total costs, Nanjirinji A is the only CF whose revenue exceeded the total forest management costs on average for the entire five-year period. Thus, this is the only CF that could be considered potentially viable at present, in the sense that the revenue could cover their full “economic” forest management costs, with some funds left over for community transfer payments (6% of the revenue). This CF is recognized as a “success story” in the region and the country, and has conditions (large forest area, large volume of high-value timber species) that are not replicable in most other villages (Charnley et al., in review). Nevertheless, the current financial model in the CFs is based on MCDI still bearing the majority of forest management costs, which allows the CFs to continue making community transfer payments of about 50% of revenues; in this sense, even Nanjirinji A is not self-sustaining, because they do not generate enough revenue for the CFs to pay all the forest management costs and community transfer payments at current levels. The next closest CF to economic sustainability was Liwiti, with forest management costs exceeding revenue by about 46% over the full five-year period. Three CFs (Namatewa, Nyamwage, and Tawi), had no or only very nominal timber sales over the five years, and two other CFs (Mchakama and Sautimoja) had relatively limited revenue of less than \$2,000 /yr, while numerous forest manage-

ment costs were still incurred, so costs were quite high compared to revenue – forest management costs were 19 times the revenue or higher for all five of these villages.

4.3. Revenue and cost trends over time

We calculated total revenue and costs for all 14 CFs⁷ for each fiscal year from 2013–14 to 2017–18 in order to examine trends over time, and whether they were increasing as the CFs became more established. Over the five-year period, and including community transfer payments, the cost breakdown by cost category was as follows: establishment and maintenance equaled 21% of total costs; security and monitoring, 10%; silviculture, 10%; timber sales, 13%; certification, 18%; administration, 12%; and community transfer payments, 16%. This means that fixed costs equal about 69% of total costs, and variable costs (community transfer payments and timber sales) about 31%.

Fig. 3 presents the total revenue and “economic” forest management costs (internal plus externally-funded forest management costs, not including community transfer payments) by year, summing the CFs together. We found that there were yearly variations in revenue, and a potential trend towards increasing overall revenue, although the trend is far from clear. Fiscal year 2016–17 was a particularly good year for the group in terms of revenue, although this uptick was mostly driven by one especially large timber sale in Likawage village. This large sale was paid for in 2016–17, but some of the timber harvest (and associated costs) occurred through 2017–18. If the revenue from the sale had been spread over the two years, then an upward trend over the final three years of the period would be more apparent.

Aside from upticks in 2014–15 and 2017–18, there is apparently a trend towards decreasing costs. These apparent decreases occurred during a period that revenue was increasing and the certified forest land base was increasing, as new CFs joined the group and CFs already in the group expanded their certified forest area. The high costs in 2014–15 were driven by large increases in timber sales, certification, and administration costs. In particular, the raw data showed large costs for prescribed burning in a few communities that year, and high costs for training and auditing.

Upticks in annual costs do coincide with the creation of new CFs and their addition to the group certificate. As shown in Table 1, new CFs were created in 2013–14 (3), 2014–15 (2), and 2017–18 (1). Creation of new CFs incurs substantial costs in terms of planning, training, conducting inventory, and boundary demarcation, which are included in the establishment and management category (Table 2). Furthermore, new CFs in the group certificate can have higher certification training, monitoring, and auditing costs relative to existing members of the certificate. We compared costs

⁷ Excluding villages in years when they were not part of the FSC-certified group.

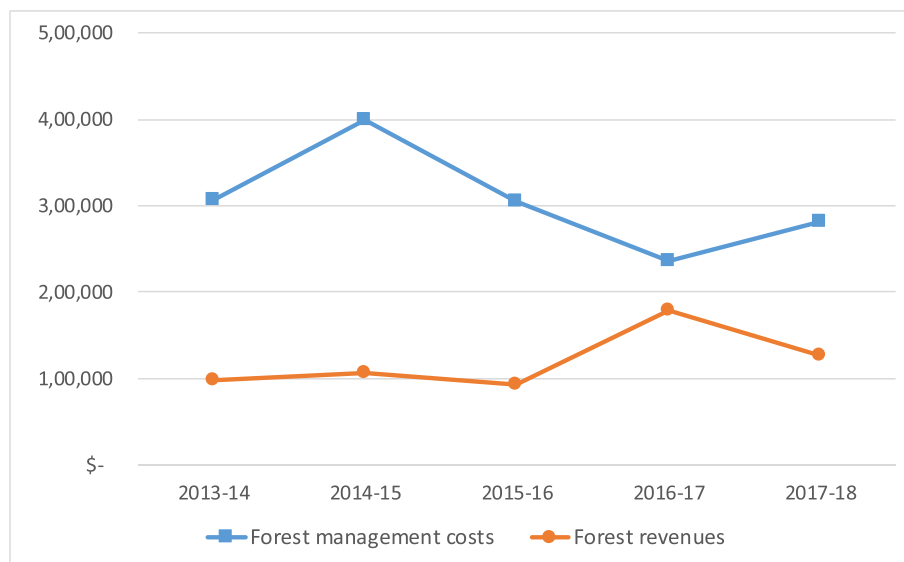


Fig. 3. Total forest management costs (internal + external) and forest revenues by year (USD), for the group of FSC-certified community forests.

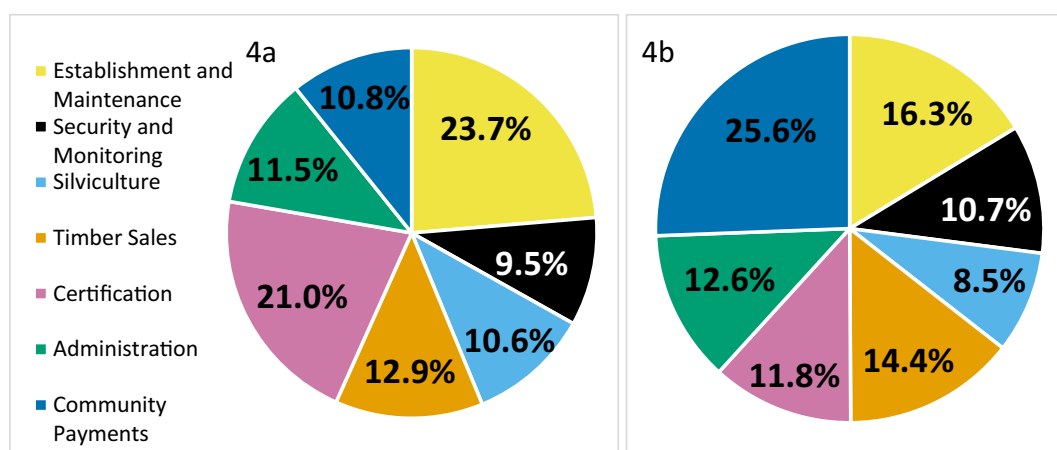


Fig. 4. Percent of total costs (internal and external forest management costs, plus community payments) by activity. 4a: 2013–14 through 2015–16. 4b: 2016–17 through 2017–18.

for the first year after CF creation/certification to subsequent years, for the five CFs established 2013–14 and 2014–15. In the first year of creation/certification, establishment and maintenance costs averaged \$14,400 per CF, whereas that cost averaged \$5,800 per CF in years 2–4 after creation. In the first year, certification costs averaged \$10,100 per CF, whereas that cost averaged \$6,200 per CF in years 2–4.

For the group overall, our analysis showed that revenues were higher and costs lower for the final two years of this five-year period. Costs were lower because of decreases in costs of establishment and maintenance, as well as silviculture. The costs for establishment and maintenance have declined dramatically over time, from about \$140,000 /yr for the entire group for each of the first three years, to about \$85,000 /yr for the final two years of the five-year period. Silviculture costs have also dropped from about \$52,000 /yr to about \$21,000 /yr over the same timeframe. This may be due to a greater emphasis in earlier years on prescribed burning to achieve REDD+ credits, but this has been scaled back since REDD+ has been deemed relatively infeasible by MCDI. Fig. 4 shows the cost breakdown over the first three years (4a) and the final two years (4b), including community transfer payments.

Comparing the final two years to the first three, we find that establishment and maintenance and certification costs decreased substantially as a percent of total costs, whereas community payments increased. Over the final two years, establishment and maintenance equaled 16% of total costs; security and monitoring 11%; silviculture 9%; timber sales 14%; certification 12%; administration 13%; and community transfer payments 26%. In other words, during this two-year period, fixed costs were down to 60% of total costs, and variable costs were up to 40%.

The overall average shows that establishment and maintenance was the highest forest management cost, and security and monitoring and silviculture were the lowest. However, these proportions are highly variable by CF and by year. There is no single category that is the largest or the smallest cost in all the CFs. CFs on average were much closer to economic sustainability in the more recent years, moving from total forest management costs that were about 3.4 times forest revenue in the earlier three years to costs 1.7 times revenue in the more recent two years. In the more recent two years, three of the fourteen CFs (Kikole, Liwiti, and Nanjirinji A) had revenue greater than total forest management costs.

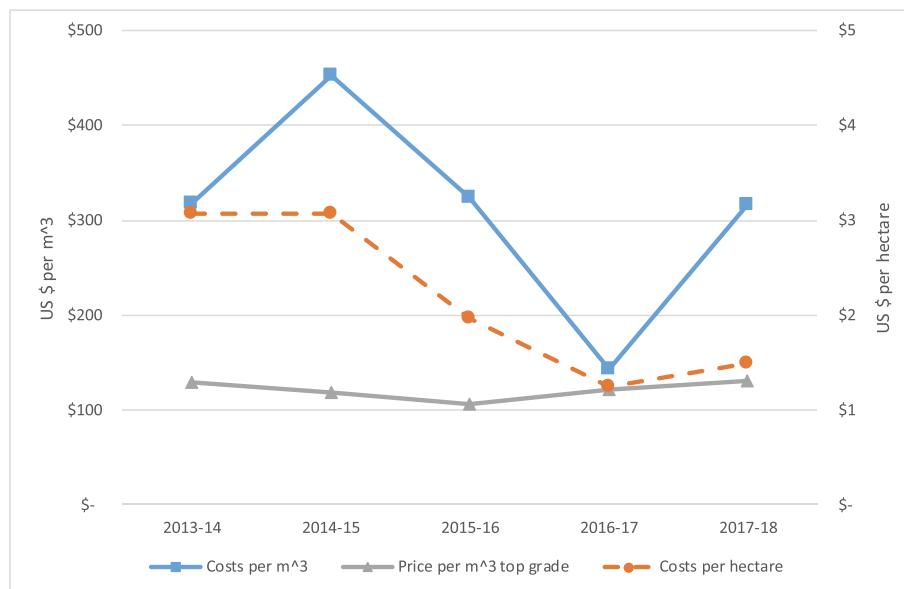


Fig. 5. Total forest management costs (internal plus external) and timber price (top grade timber) per unit timber sold (left axis), and total forest management costs per hectare (right axis).

Table 5

“Break-even” timber sales volume estimate for the group of 14 FSC-certified community forests. Break-even values based on “forest management costs” include costs related to the creation and ongoing management paid by both CFs and MCDI, but not the community transfer payments. Total costs include forest management costs and community transfer payments.

	2013–14		2014–15		2015–16		2016–17		2017–18	
	Forest mgt	Total	Forest mgt	Total	Forest mgt	Total	Forest mgt	Total	Forest mgt	Total
Costs (\$)	306,219	353,528	399,464	424,160	305,516	355,344	235,821	346,612	282,162	349,525
Variable costs (\$)	27,023	74,333	52,453	77,150	66,783	116,612	51,191	161,982	48,828	116,191
Costs per unit (\$/m³)	317	366	452	480	324	377	144	212	316	391
Variable costs per unit (\$/m³)	28	77	59	87	71	124	31	99	55	130
Actual price (\$/m³)	129		118		107		122		130	
Actual timber sold (m³)	965		883		944		1,638		894	
Break-even volume (m³)	2,759	5,349	5,912	11,296	6,643	NA	2,037	8,027	3,084	806,511

4.4. Forest management costs per unit of area and output

Since costs were changing while CF land area and timber output were both increasing, it is valuable to normalize costs by dividing them by those factors to examine relative improvements in costs per unit land area and costs per unit of timber output (Fig. 5). Forest management costs decreased from \$3.08 /ha /yr in 2013–14 to \$1.49 /ha /yr in 2017–18. Although there potentially is a trend towards decreasing costs per ha, there is also substantial year-to-year variability.

Costs per m³ appeared to decline from a high of \$452 /m³ in 2014–15 to a low of \$144 /m³ in 2016–17; however, they rebounded substantially in 2017–18 to \$316 /m³ (Fig. 5). Achieving costs of \$144 /m³ in 2016–17 is significant, as that cost approaches the price of the most valuable species of timber, which ranged from \$107 to \$130 /m³ during the five-year time period. That is, if costs per m³ could be reduced slightly compared to their 2016–17 level, the 14-CF group would be close to the break-even level in terms of overall forest management costs (not including community transfer payments), which we explore in more detail below.

4.5. Break-even timber sales

Another way of looking at the question of economic viability is to ask, how much timber would the CFs need to sell at a given price to break even? Table 5 demonstrates that in most years, with the

exception of 2016–17, the CFs would have needed to sell many times as much timber as they actually did to break even. The estimate in Table 5 assumes the only variable costs are the timber sales and community transfer payments, which would increase proportionally as timber sales increase, and all other costs remain fixed. In 2016–17, as noted previously, the CFs came reasonably close to breaking even strictly in terms of forest management costs; however, the CFs would have had to produce five times as much timber to compensate all forest management costs and also contribute community transfer payments in the same proportion (generally 50% of revenue) (Table 5).

5. Discussion

5.1. Economic and financial viability of community forests

A relatively well-developed literature has emerged over the past three decades that outlines factors that are linked to sustainable governance of common-pool natural resources (e.g., Agrawal, 2001; Pagdee, Kim, & Daugherty, 2006), but forest enterprises additionally require factors that can lead to economic success (Sanchez Badini, Hajjar, & Kozak, 2018), which not all CFs achieve (Piketty et al., 2015). The continued existence of CFs depends on either internal financial viability or support from external donors. Relatively little literature has comprehensively detailed the economic performance of CFs or compared them to other forest gover-

Table 6

Forest management costs per unit of land (\$/ha/yr) and per unit of production (\$/m³), compared to other cases of CFs managing subtropical and tropical natural timber stands worldwide. For comparison purposes, forest management costs for benchmark references are calculated excluding community payments and any type of harvesting, skidding, loading, transportation, or processing costs. Costs are averages over each study period, and over multiple CFs where indicated.

Source	Location	Forest type	Area (ha)	Study period	Certified?	Costs	
						(\$/ha/yr)	(\$/m ³)
This study	Tanzania, 14 CFs in southeast	Tropical hardwoods	Up to 188,833	2013–18	Y	Average: 2.01	Average: 287
Cubbage et al. (2015c)	Mexico, 30 CFs in 12 states	Softwoods (27), tropical hardwoods (3)	Average: 12,269	2011	Y/N	Average: 51	Average: 20
Humphries et al. (2012)	Brazil, 3 CFs in Amazon	Tropical hardwoods	9,000	2006–07	N	31	76
			450		N	13	19
			2,000		Y	6	220
Humphries et al. (2020)	Brazil, 1 CF in Pará State	Tropical hardwoods	33,691	2007–13	Y	10	31

nance options (Burivalova et al., 2017). This research has explored economic results, trends, and levels of production that would be needed to achieve profitability.

It remains to be seen whether or not the CFs working with MCDI can achieve economic/financial viability. During the study period from 2013–14 to 2017–18, none of the 14 CFs were totally self-sustaining when community transfer payments were added to the forest management costs. Overall, external funds paid 83% of forest management costs, though some CFs were closer to viability than others. Nevertheless, there were indicators of progress made at the group level; in particular, total costs appeared to decrease over the period, and revenues increase. Additionally, over the final two years, three of the 14 CFs achieved a minimal level of economic viability in the sense that their revenues were greater than the forest management costs – although even in these cases revenues were still less than the total costs.

If the group can replicate and build on the relative success from 2016–17 in terms of increasing timber sold and limiting forest management costs, and perhaps also cap community transfer payments as revenue rises, there is some hope of eventually reaching economic viability. However, if timber revenue is not increased, forest management costs are not held in check, or community transfer payments are kept at 50% of revenue, economic viability is not likely in the short to medium term. In particular, we note that in 2015–16, variable costs alone were higher than the price of timber sold,⁸ meaning that no level of timber sales could reach economic viability.

There is little information in the literature detailing costs of comparable natural forest management with slow-growing high-value timber, for CFs or otherwise.⁹ Compared to international benchmarks for industrial timber plantations (Cubbage et al., 2020),¹⁰ forest management costs per ha for these 14 CFs in Tanzania are quite low. More appropriate comparisons are to other tropical and subtropical naturally-regenerated community forests (Table 6). Costs per ha for this group in Tanzania are low even compared to CFs in Mexico and Brazil. However, average annual forest management costs (i.e., excluding community transfer payments and any harvest or post-harvest costs) per m³ of timber were significantly higher than for CFs in Mexico and Brazil. The combination of high costs per unit of timber volume, but low costs per ha is indicative of a very extensive operation (low relative input and output per ha).

⁸ Additionally, in 2017–18, variable costs were essentially equal to the price of timber.

⁹ There is a relatively larger literature on tropical timber logging costs (in particular, comparisons between traditional and reduced-impact logging), but that was outside the scope of the work of these CFs, which sold standing timber to third-party loggers.

¹⁰ Industrial timber plantations of commodity softwood are not a particularly apt comparison for community-based natural forest management for high-value tropical hardwoods, but it is one of the few data points on forest management costs per ha available for comparison.

5.2. Options to increase economic viability

In this section, we review some options the CFs may have to increase economic viability. Simply put, this involves increasing revenue, decreasing costs, or both. Revenue is increased by increasing price or volume sold. Costs are decreased by reducing fixed costs or variable costs. Humphries et al. (2020) document an example of a CF in Brazil that achieved profitability over a six-year period by increasing timber sales nearly sixfold, while total costs only increased about threefold, leading to a 50% reduction in costs per unit of timber. Such dramatic changes can occur when CFs have relatively low initial capacity and are able to learn and invest in training and equipment, and also when they have high initial fixed costs of operation.

MCDI and CFs continue to look for options to increase economic viability so that the CFs can be economically viable and self-sustaining. However, there are constraints on how revenues can be increased or costs decreased under the existing business model of selling standing timber. Increases in timber price are limited by competition with timber from government forest reserves, unreserved forests, and other legal or illegal sources (Sungusia & Lund, 2016). Furthermore, price cannot be reduced to drive higher sales volume, because this would be seen as undercutting the government reserves, and would be politically untenable. During the period of our study, the CFs were selling standing timber to buyers, who would subsequently conduct their own harvesting operation. Therefore, despite the inventory and capacity to sell more timber, volume sold has been limited to date due to low domestic demand at the fixed price.

5.2.1. Reducing costs

Reductions in fixed costs (which are assumed to be constant in a given year regardless of the amount of output produced) would reduce average forest management costs per unit of timber. Most forest management activities, such as forest inventory, forest patrols, prescribed burning, and audits, are fixed. Over the study period, fixed costs related to establishment and maintenance, and certification were high, but decreased significantly. This reflects a combination of higher costs related to earlier stages in the process of establishing a CF, cyclical costs, or increased capacity. Investment in organizational and human capacity of CFs by government or external organizations has been shown to be effective at lowering costs per unit of output in other parts of the world (Frey et al., 2019), and MCDI has been investing heavily in training and capacity-building among the CFs in this group. Ideally, the reduced level of cost in this area will be maintained or further reduced.

The largest single cost category was the establishment and maintenance of the CF, which is a fixed cost. Importantly, this category includes sub-categories such as demarcating boundaries, management planning, writing bylaws, and conducting

inventories. Scheba & Mustalahti (2015); Green & Lund (2015), and Sungusia et al. (2020) document how national policies and regulations concerning CBFM in Tanzania, in part due to the influence of external conservation interests, frequently require the use of “professional” and “expert” consultants in these types of processes and documents, artificially driving up costs. Therefore, to a certain degree, high costs may be “baked into” the CBFM policy in Tanzania, and lowering costs to some extent would require policy revision, which is outside the scope of these 14 villages. Further, this external guidance often does not consider local conditions or costs of implementation; or produces contradictory, misleading, or incorrect guidance (Green & Lund, 2015; Sungusia & Lund, 2016; Sungusia et al., 2020). For example, installation of an externally-recommended firebreak in one village cost many times the revenue derived from the CF (Sungusia et al., 2020). To date, MCDI seems to have been able to balance provision of sound external and scientific guidance with local participation and knowledge in most of the villages, most of the time; however, it does come at a cost and with occasional lessons learned.

Certification can compound the dependence on costly external experts in the form of international consultants and auditors to create and verify plans (Dahal & Cao 2017). MCDI stakeholders have discussed that certification could be dropped if it proves too costly (Frey et al., in review). To date, most timber from the CFs, although certified, has been sold at the same price as uncertified timber harvested from Tanzania's government forest reserves, because domestic demand for FSC-certified wood is low and buyers willing to pay a price premium for it are rare. Direct FSC certification costs are about 18% of the total costs, so dropping certification alone would not make the CFs economically viable, and CF managers perceive numerous indirect and non-monetary benefits of certification (Frey et al., in review).

The true variable costs (those that change in proportion to the amount of production) include harvest supervision, as well as transfer payments to the District Council and Village Council. The community transfer payments to Village Councils equaling (usually about) 50% of revenue are an important strategy for generating benefits from CF that can be enjoyed by villagers, and incentivize support for sustainable forest management. These payments have been sustained by using external support from donors via MCDI to subsidize the costs of forest management. If these costs were not subsidized, then maintaining a community transfer payment at 50% would necessitate a 100% return on investment every year (revenues would have to be double the forest management costs). However, if timber sales increased, the community transfer payments could potentially be maintained in absolute terms but decreased in percentage terms.

5.2.2. Increasing sales

Given high fixed costs relative to variable costs other than community transfer payments, increasing timber sales offers the clearest opportunity to improve viability. CFs are harvesting less than 5% of the allowable amount (Table 3). Increasing timber sales from the current average of about 1,000 m³/yr up to 8,000–10,000 m³/yr would get the group close to economic self-sustainability given the typical levels of fixed versus variable costs (Table 5), including community transfer payments, and would still be within the currently prescribed harvest limits of 22,562 m³/yr, or 0.12 m³/ha/yr total from a range of commercial species (Table 3). This ignores any potential increases in human capacity or technology, which might make the operation more profitable. The range of financially viable harvest is just an approximation; the exact value would depend on precisely which species would be harvested since some species command higher prices than others. It is important to note that allowable harvest limits are set by species (Table 3), and

potential eight- or ten-fold increases in total commercial harvest volume would hit the allowable harvest limit of specific species,¹¹ so the CFs would have to do a better job marketing and spreading harvests over all the various commercial species.

If community transfer payments were eliminated, the break-even volume is much lower, ranging from 2,000–7,000 m³/yr (Table 5), which seems more realistic given current demand and past sales levels. Under this scenario, the 50% community transfer payments could be a barrier to viability in the future if external donor support is not maintained. However, if timber sales increased, the community transfer payment might be capped at some level, which would provide the same absolute level of funding support to Village Councils but reduce it as a percentage.

A sales level of 2,000–7,000 m³/yr or more has not been achieved to date, and has not even been approached with consistency. There may not be sufficient demand for this level of sales from CFs on the domestic market, given competition with the government forest reserves, unreserved forests, and other sources, which have looser rules and regulations (Sungusia & Lund, 2016) or may be subject to illegal logging. International markets in Europe, North America, and East Asia offer promise for sale of certified tropical timber (De Pourcq et al., 2009). A second opportunity is to find uses and markets for lesser-known species. MCDI has explored both options – international markets and uses of lesser-known species – with limited success to date. Accessing and taking advantage of those markets and opportunities can be challenging and require dedicated staff. CFs in Latin America and Asia have relied on marketing expertise from external NGOs at first, then later shifted to a cooperative arrangement where a group of CFs jointly hire one or more marketers (Harada & Wiyono, 2014; Humphries & Kainer, 2006; Humphries et al., 2020).

For increased harvests to be an economic solution over the long term, harvest must be ecologically sustainable, that is, harvest rates for each species lower than its aggregate rate of growth over the entire forest area. This depends on four main factors: current stocking rates of each species (inventory), rate of growth of individual trees, mortality rates, and recruitment rates of young trees. There is very little peer-reviewed literature or other science on growth and yield of tropical dry forest species in general, and miombo woodland species in particular. Thus, although annual allowable cut rates are determined using conservative approximations of growth and mortality rates (MCDI, 2010), there is a chance that these harvest rates could still be too high. The process of inventory and calculating allowable harvest is repeated every five years, giving an opportunity to learn and readjust future harvest rates (up or down).

Stocking rates are determined through a Participatory Forest Resources Assessment as described in MCDI (2010; n.d.). In this process, villagers themselves conduct the inventory under the guidance and supervision of MCDI foresters. MCDI foresters divide the CF into forest units based on reasonably homogeneous forest types. Foresters and villagers follow transect routes through each of the forest units and classify trees within 5 m of the transect center into species and size classes. Three size classes are used: “not yet harvestable” (diameter greater than half the legal minimum diameter for harvest [LMDH] but less than LMDH), “harvestable” (diameter greater than LMDH but less than twice LMDH), and “seed trees” (diameter greater than twice LMDH). Initial transects are supplemented with additional transects until a statistically sound number of trees of each species is reached. The estimate of harvestable trees in the CF uses the lower 75% confidence limit,

¹¹ As Table 3 indicates, harvest of some primary commercial species (notably mpingo and mkongo) could only be increase by a factor of about six, whereas others (e.g., mninga, mtondoro, mpangapanga) could be increased by a factor of eighteen or more.

rather than the mean, to be conservative. LMDH is set by species and the CFs conservatively assume 100 years to be the age for trees to grow to “harvestable” size for each species (MCDI, 2010). It is furthermore assumed that one-third of the “not yet harvestable” trees will die before reaching “harvestable” size. After taking these considerations into account, the resulting allowable harvest equates to approximately 1.5% of the total harvestable and seed tree volume of commercial species annually. This percentage is reduced in cases where the “not yet harvestable” trees are insufficient in quantity to replace the harvestable trees (MCDI, 2010).

5.2.3. Adding value

Another option to increase economic viability is to add value to the timber harvested. In 2018, MCDI and the CFs began piloting the use of a portable sawmill to convert logs into rough-sawn lumber, and one international company established a small sawmill in Nanjirinji A, the CF with the highest sales to date. In 2018, MCDI also constructed a kiln for drying lumber. However, literature on the use of portable sawmills in tropical forestry suggests that caution should be taken before investing heavily in this approach. Scudder, Herbohn, and Baynes (2018) and Scudder et al. (2019b) found in Papua New Guinea that portable sawmill operations used to produce rough-sawn lumber from tropical forests often prove unprofitable, and are not likely to ever become profitable unless only the highest-value trees (best species and optimal form) are selected, which could result in high-grading. Profitability is highly sensitive to efficiency of operation and wood recovery rates (Smorfit, Harrison, & Herbohn, 2006), so operators must be highly trained and sawmills well-maintained. On the other hand, if additional value-adding can be undertaken beyond the rough-sawing of lumber with a portable sawmill, profits are potentially available for delivery of semi-finished or finished products such as flooring, molding, or structural lumber (Scudder et al., 2019a).

5.2.4. Selling multiple outputs

Tourism could be a source of revenue for some CFs. Although there is relatively little local tourism infrastructure such as hotels, there is a small subset of tourists who might appreciate an “off-the-beaten-track” alternative (or in addition) to the large-scale nature tourism that takes place in other parts of the country, including the nearby Selous Game Reserve – Tanzania’s largest. So far, the financial records indicate relatively little true tourism, although certainly the CFs occasionally charge nominal access fees for interested researchers/scientists and others potentially interested in visiting. Research on Tanzania’s tourism-oriented community-based natural resource management initiatives, Wildlife Management Areas, has shown disappointing results in terms of generating economic benefits (Noe & Kangalawe, 2015; Keane et al., 2020). Therefore, it seems that at best, tourism may provide a marginal supplement to CF revenues and a small stimulus to the local economy, but is not likely to be a game-changer.

Other revenue-generating alternatives might also be found to supplement sale of timber. MCDI has explored the sale of carbon credits by promoting prescribed burning as a mechanism for REDD+. So far this has not been viable due to low carbon prices and high transaction costs (Blomley et al., 2017; Kweka, 2014). Another possibility would be to develop markets for non-timber forest products. We did not investigate the topic of non-timber forest products production in depth during this study, although some of the financial records did indicate a limited number of sales of products including bamboo, and some CFs are exploring the potential for beekeeping. There may also be opportunities to utilize wood that currently is not being utilized, whether from tops and limbs of harvested trees or from underutilized species, for production of charcoal or for artisanal products.

5.3. The role of external support

Since 2004, MCDI has been the driving force behind CBFM in southeastern Tanzania. One of its goals is for CFs to eventually become economically self-sustainable. Furthermore, dependence on external support creates a great deal of uncertainty about the future as international NGO and donor agency projects operate on short time scales of typically 2–5 years (Ahsan & Gunawan, 2010; Golini et al., 2015); thus our research focused on how to increase economic/financial viability. Another component of economic sustainability is managing the business aspect of the CF by marketing wood products and working with buyers. The FSC-certified CFs in our study were established between 2006 and 2017, with more continuing to be added to the group certificate.

These findings underscore the importance not only for CFs to be self-sustaining, but also of investment in training and capacity building among villagers to develop the skills needed for effective forest management, governance, and marketing of forest products. These findings also highlight the need for long-term partnership between external organizations that offer financial and technical assistance, local organizations like MCDI, and villages for developing sustainable CBFM and CFs.

The CFs in this study generate global and local ecosystem services, including carbon storage and sequestration, wildlife habitat, water quality, and cultural sites (e.g., burial and prayer sites). It is clear that international organizations value these services (in particular the first two), and therefore have provided financial support. However, as long as markets for these services are non-existent or underdeveloped, depending on these short-term donations can be risky. Long-term commitments to financial support and technical assistance could overcome these risks.

6. Conclusions

To our knowledge, this research is the first to comprehensively document economic returns of CFs in Africa focused primarily on sale of certified, commercial timber. Although it was not a direct focus of this research, and there is variability among the villages in the study, the community governance and external factors seem to be conducive to potential CF success (Pagdee et al., 2006): tenure over forests is clear and relatively secure, there is relatively effective monitoring and enforcement of rules, local support for and common interest in the potential benefits, and external support from higher levels of government (Gross-Camp, 2017; Charnley et al., in review). In particular, the Tanzania Forest Act recognizes villages’ tenure and allows them to retain forest revenues (Frey et al., in review). Economic viability, therefore, may be the final “piece of the puzzle” to ensure sustainability.

We found that a group of 14 FSC-certified CFs in southeastern Tanzania, which sells standing high-value timber, is not currently economically independent, but has made progress towards that goal and still has a few opportunities potentially to improve economic outcomes. Such opportunities include increasing timber sales by marketing to international buyers, capping community transfer payments, adding value to timber, and selling multiple outputs. Additional training of and on-the-job learning by community members may increase capacity and further drive down costs, which are relatively high when compared to the few other cases in the literature that have documented costs per unit of timber sold. Part of the reason costs are high may be the emphasis on outside, expert judgments created by government policy (Scheba & Mustalahti, 2015) and forest certification.

The role of FSC certification in making CFs more or less successful or profitable was not a major focus of this manuscript. This research did show that a group of FSC-certified CFs in Tanzania

could be viable if timber or other product sales could be increased, value added to timber, or costs decreased substantially. Direct costs of third-party audits for certification, and other related fees and training were about 18% of the total costs. Comparing those costs to the benefits of FSC certification was beyond the scope of this manuscript, but will be a major focus of a future manuscript (Frey et al., in review).

The current level of community transfer payments, which are used for local development projects and support of local villagers, may be too high to sustain independent of external support for the CFs. However, these payments, at some level, are viewed as important benefits of the CFs, and likely are key to the continued support of CBFM by local people. A difficult trade-off between community payments or economic viability might be forced in the future, but could be avoided if substantial external support can be maintained, or if timber sales can be increased.

The simplest approach to greater viability seems to be to increase timber sales, but this is limited by demand from the current timber buyers. National and regional buyers have purchased most of the wood to date, but there is competition from government forests and illegally-logged timber, and relatively little additional demand for timber from sustainably-managed CFs. In order to increase timber sales, CFs need access to new markets. International markets may be receptive to the FSC-certified high-value tropical timber that these CFs produce, but finding the right buyers is a challenge.

This research also documents an approach that can be used for economic/financial evaluation of CFs elsewhere in Africa and other parts of the developing world. Continued monitoring will be necessary to track improvement and learn from future experiences and opportunities. The Green Value Tool (Humphries & Holmes, 2014) has been used to a moderate extent in parts of Latin America, but this is its first documented use in Africa. We found that the tool worked well with researchers and technical service providers involved in the process in Tanzania, but at present many of the CFs in this group would need additional technology and training to fully adopt and independently use the Green Value Tool. In addition, our analysis included the external financial support of MCDI, which is a critical factor for understanding holistic economic viability, but is outside of the financial data typically managed by CFs themselves.

CBFM has become increasingly widespread in Africa since the 1990s as an approach to conserving local forests while contributing social and economic benefits to local communities. One model for achieving these goals is to develop CFs based on marketing timber or other forest products to generate revenue for community members. For this model of CBFM to be successful, CFs must be economically sustainable. This paper highlights a robust methodology for assessing economic and financial viability of CFs, applied to 14 CFs in southeastern Tanzania. It conveys insights gained from this analysis about strategies for increasing the viability of timber-based CFs that aim to minimize tradeoffs for the community benefits derived from CFs. These insights may be useful for promoting economic viability of CFs elsewhere in Africa and the developing world.

CRediT authorship contribution statement

Gregory E. Frey: Conceptualization, Investigation, Methodology, Formal analysis, Data curation, Writing - original draft, Visualization, Project administration. **Susan Charnley:** Conceptualization, Investigation, Validation, Writing - review & editing, Funding acquisition, Project administration. **Jasper Makala:** Conceptualization, Supervision, Resources, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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