Sowing the seeds of sustainable rural livelihoods?

An assessment of Participatory Forest Management through REDD+ in Tanzania

Esteve Corbera[1*], Adrian Martin[2], Oliver Springate-Baginski[2] and Adrián Villaseñor[3]

1. Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona
2. School of International Development, University of East Anglia
3. Centre for the Socioeconomic Impact of Environmental Policies (CESIEP), Pontificia Universidad Católica de Chile

* Corresponding author. Email addresses: esteve.corbera@uab.cat, adrian.martin@uea.ac.uk, o.springate-baginski@uea.ac.uk, luvillasenor@uc.cl

An article submitted for consideration under the special issue "Forests and Livelihoods Governance" in Land Use Policy, edited by Arun Agrawal (University of Michigan) Laura Rasmussen (University of Michigan); Cristy Watkins (University of Michigan) and Reem Hajjar (University of Michigan).

Highlights

- Participatory forest management through REDD+ incentives can potentially support rural livelihoods and local forest governance
- Assessment of a local project in Tanzania shows mixed results
- Forest management institutions and related knowledge improve unevenly across villages and social groups, respectively
- Material impacts on livelihoods are less evident and driven by agricultural activities
- Impact assessment of PFM and REDD+ projects require longer timeframes and context-sensitive methods

Acknowledgements

All authors gratefully acknowledge Norwegian funding of MCDI's REDD+ pilot project that paid for much of this research. We also thank MCDI staff for their committed support to this research exercise, and particularly to Steve Ball, Jasper Makala, Glory Massao and Frederick Mwendo. We acknowledge the support of Marta Borrós at ICTA-UAB in the production of the case study map. EC acknowledges the financial support of the UAB-Banco de Santander Talent Retention programme and notes that this work contributes to ICTA-UAB "María de Maeztu Unit of Excellence" (MDM-2015-0552). We thank Reem Hajjar, Jordi Honey-Rosés, Daniel Brockington and two anonymous reviewers for constructive comments to an earlier version of this manuscript.

Sowing the seeds of sustainable rural livelihoods? An assessment of Participatory Forest Management through REDD+ in Tanzania

Abstract

Participatory forest management (PFM) initiatives have emerged worldwide for a range of aims including to improve forest governance, enhance resource conservation and to increase rural people's access to and benefits from forest resources. Some of these initiatives have also received climate finance support to enhance their impact on mitigation. However, their effects on forest governance and livelihoods are complex and remain poorly studied. In this article, we address this gap by analysing governance and livelihood changes in a PFM initiative in Tanzania that has received funding as a REDD+ pilot site. Based on qualitative governance analysis and quantitative livelihood panel data (2011-2014) that compares villages and households within and outside the project, we find that improvements to forest governance are substantial in project villages compared to control villages, while changes in income have been important but statistically insignificant, and driven by a regional sesame cash crop boom unrelated to enhanced forestry revenues. Focusing on whether PFM had enhanced other wealth indicators including household conditions and durable assets, our analysis shows again no significant differences between participant and control villages, although the participant villages do have, on average, a greater level of durable assets. Overall, our findings are positive regarding forest governance improvements but inconclusive regarding livelihood effects, which at least in the short term seem to benefit more from agricultural intensification than forestry activities, whose benefits might become more apparent over a longer time period. In conclusion we emphasize the need for moving towards longer term monitoring efforts, improving understandings of local dynamics of change, particularly at a regional rather than community level, and defining the most appropriate outcome variables and cost-effective systems of data collection or optimization of existing datasets if we are to better capture the complex impacts of PFM initiatives worldwide.

Keywords

Participatory forest management; REDD+; governance; livelihoods; sesame; carbon; Tanzania

1. Introduction

Participatory Forest Management (PFM) emerged in the late 1970s in response to the degradation of government owned forests, partly explained by inadequate financial and human resources, and in order to grant or devolve formal management rights to local communities (Arnold 2001). PFM has been commonly built upon legal reforms establishing the foundations for forest rights devolution and benefit sharing, and it has been implemented by governments or non-governmental organisations, sometimes partnering with local communities. PFM has been considered critical to shift from top-down, government-based initiatives to community-led participatory forest management, with the aim to protect and improve forest quality and people's livelihoods.

In Tanzania, where this study is located, the Forest Act of 2002 allows two types of PFM. The first type is Joint Forest Management (JFM), which usually takes place within government-owned forests and where management responsibilities are shared between government and communities. JFM has proved problematic due to the slow progress in agreeing benefit sharing terms between the government and collaborating communities. The second type is Participatory Forest Management (PFM), which takes place on village lands and where communities have the right to 100% of PFM benefits and are not obliged to share management responsibilities or returns with external actors such as local or national government. Community-based PFM covered 23.3% of Tanzania's forestland in 2012, involved 2285 villages (MNRT 2012) and it is the focus of this article.

Environmental measures of PFM success, such as basal area and timber volume, have been found to increase in Tanzanian PFM forests, whereas those under open access and state management experienced declines in both (Blomley et al. 2008). It has also been found that community-based PFM can reduce illegal logging more significantly than JFM or government-centralised forest management, although its effectiveness in halting subsistence tree cutting can be equally limited (Persha and Blomley 2009). A more recent impact evaluation of JFM across the country also suggests that JFM has not been effective in halting forest degradation and deforestation, but has slowed forest degradation when compared with forests without a management regime. The analysis reveals that the strongest positive impact of JFM has been on the creation of local governance institutions (Persha and Meshack 2016).

Evidence of the social benefits of PFM in Tanzania, including JFM and community-based PFM, is somewhat less positive. Despite improvements in forest management institutions,

there is typically low income from forest management due to lack of high value products, and even these small benefits are often captured disproportionately by elites (Meshack et al. 2006; Vyamana 2009), albeit exceptions have been documented (McDermott and Schreckenberg 2009). PFM schemes have involved opportunities and costs for communities, in terms of foregone forest use, transaction costs of deliberations, and institutional time commitments for forest management operations (Merger et al. 2012). For the average villager, PFM might mean unwelcome additional work in return for often minimal benefits, at worst a situation that might only be sustained because it remains in the interest of the elite minority whose will prevails (Blomley and Ramadhani 2006). Additionally, PFM has sometimes become the means through which local elites have reinforced their privileges and acquired (more) power, specifically through the administration of their participation in and the knowledge of PFM governance institutions for their own economic and political advantage (Green and Lund 2015). This relative paucity of tangible livelihood benefits, coupled with the weak governance of what benefits there might be and who might reap those, poses a critical problem for the expansion and sustainability of PFM (Burgess et al. 2010; Mustalahti and Lund 2010; Gross-Camp 2017).

Understanding the impacts of PFM programs and projects has become even more critical with the advent of the international framework for Reducing Emissions from Deforestation and forest Degradation, and for the enhancement, sustainable management and conservation of forest stocks (REDD+), established under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC). REDD+ encourages countries in the global South to re-organise their land-use and forest governance in order to reduce the sector's greenhouse gas emissions contributions. Until now, REDD+ has mobilized millions from donor countries through World Bank and UN dedicated platforms (e.g. the Forest Carbon Partnership Facility and the UN-REDD programme), as well as through bilateral agreements (e.g. Norway's International Climate and Forest Initiative (NICFI)) to support policies and implementation efforts in developing countries.

Tanzania started to prepare for REDD+, including the development of its national REDD+ strategy, in 2008, and it has since hosted eight pilot projects (Campese 2012). Independent research in these projects points at shared concerns and challenges. Vatn et al. (2017), for example, examine one pilot in the country's Morogoro region and highlight that building institutions to trade carbon is time-consuming and can only be inclusive and legitimate if properly designed. They argue that the latter was challenging because some resource users,

particularly charcoal makers, considered the project detrimental to their interests and internal conflicts ensued as a result. Scheba and Rakotonarivo (2016) examine another project in the Lindi region and they also find that, despite well-intentioned NGO efforts for including all villagers in project development, conflicts emerged over the demarcation of village forest reserves, which changed existing resource access relations, and over the distribution of project economic revenues, which were perceived as unfair by some households. Khatun et al. (2015b) identify similar procedural and distributional concerns in four of the villages included in this article, and indicate the challenges that villagers face when trying to protect forests and secure "carbon stocks" against external actors and threats (Khatun, Corbera, and Ball 2016). The existence of such operational flaws, and the juxtaposition of REDD+ efforts with the formerly existing community-based PFM model, has led some critics to argue that PFM and REDD+ in Tanzania follow "the logic of the development and conservation industry more generally, which continuously produces and feeds off the development and testing of new policy models" (Lund et al. 2017, 133). These models generate expectations about income gains and development that are almost never met.

This article contributes to these debates about the social impacts of PFM and the risks of using PFM as a platform for REDD+ implementation (Robinson et al. 2013) by analysing the impacts of a PFM/REDD+ pilot project on community-based forest governance and households' livelihoods, including households' income, assets, and their participation in and knowledge of project activities. The studied project combines PFM efforts with REDD+ preparedness finance in the district of Kilwa, south-eastern Tanzania. Our analysis encompasses four villages where PFM has been fully established, timber sold, and additional REDD+ activities have been conducted, and another five villages where PFM has not been established but REDD+ activities have started. We examine the project's impacts through an analysis of forest governance institutions and household conditions *before-and-after* project implementation, using nearby non-MCDI villages that have no PFM or REDD+ activities in place as a control group.

The remainder of this paper is organised as follows. Section two introduces the case study in greater detail and develops the methods and data analysis techniques used to evaluate the impact of the studied project on local forest governance and livelihoods. Section three presents the results organised around three main sections: the project's effects on forest governance at village level; on households' wealth indicators, particularly income and material assets, and on households' perceptions of project fairness, including participation in

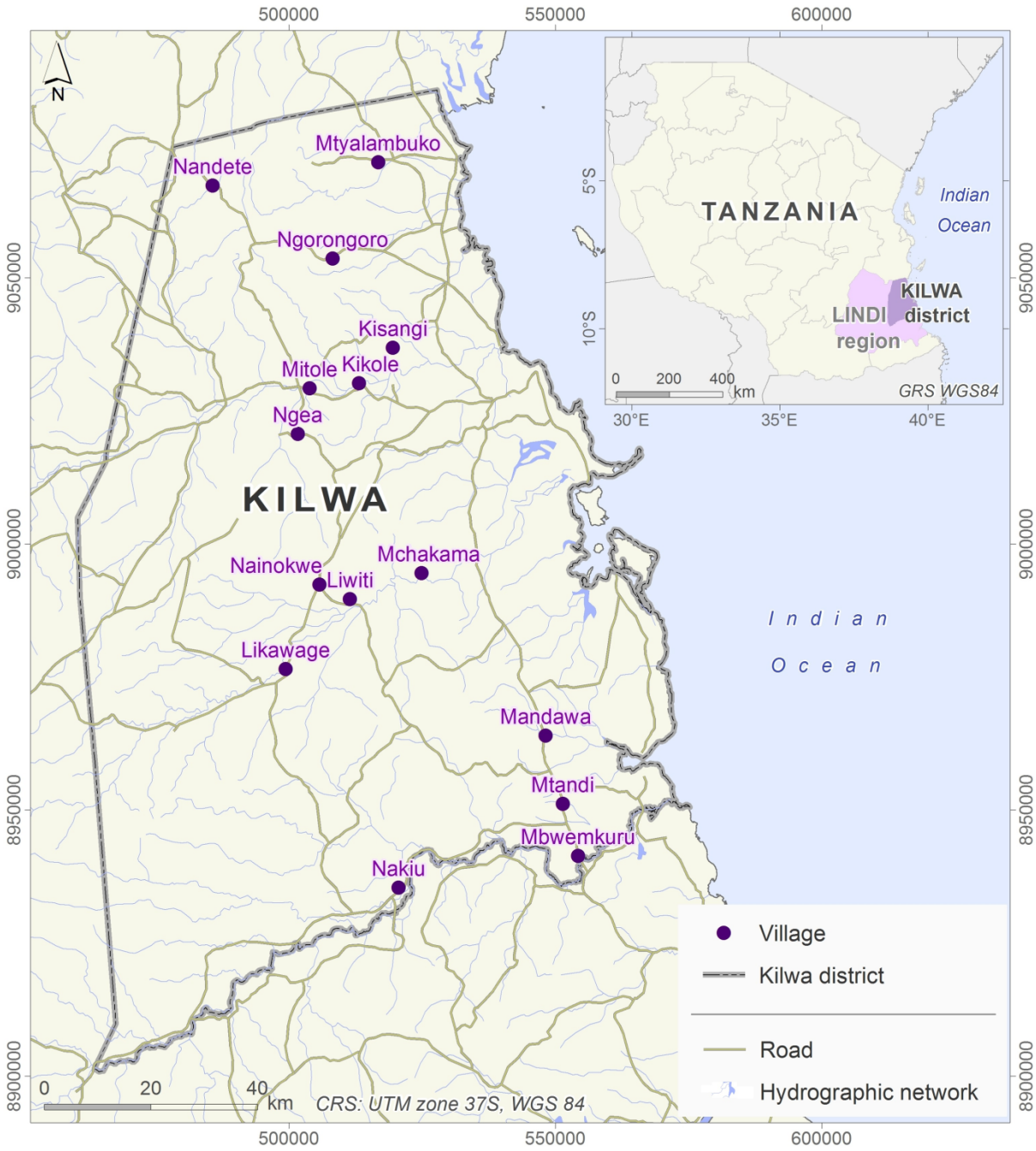
project activities, and distribution of project fees and related knowledge. Section four discusses the results, and section five concludes the article.

2. Case study and methods

2.1. Combining PFM and REDD+ in Kilwa, Tanzania

MCDI is a Tanzanian NGO that promotes the sustainable management of high-value timber trees, including the flagship East African Blackwood (*Dalbergia melanoxylon*, locally known as Mpingo), through community-based PFM village schemes across the Kilwa district, in the Lindi region (Map 1). Kilwa is one of the most densely forested districts in Tanzania, with forests and woodlands covering around 70% of the land. The forests are a complex mosaic of miombo woodlands and patches of East African Coastal Forests. MCDI started working in the district in 2004, laying the groundwork for PFM in four villages that gained group certification from the Forest Stewardship Council (FSC) in 2009 and 2010 (Khatun et al. 2015a). In 2009, MCDI also started activities linked to a pilot REDD+ intervention, building on PFM institutions to generate carbon offsets through fire management (Khatun, Corbera, and Ball 2016). MCDI is now active in ten villages and its objectives are to expand and improve PFM for sustainable forest management, generate new sources of income for communities and support villagers' development aspirations.

Map 1. Case study villages



Source: elaborated with cartographic data from GDAM and Digital Chart of the World repositories and geo-referenced information provided by MCDI.

The MCDI project is built around three components. The first focuses on PFM development, which encompasses i) village meetings for the preparation of the PFM plan, which involves the approval of local forest management by-laws and defining boundaries of a Village Land Forest Reserve (VLFR), from which timber can be sustainably extracted, and ii) the setup of a Village Natural Resource Committee (VNRC), which complements the existing Village Council (VC) and acts as the overseeing authority of forest management rules and the

conservation of the VLFR. The second component involves activities to obtain FSC certification and facilitation of logging and timber sales, with MCDI providing advice to village institutions on how to manage timber revenues fairly. As highlighted in Table 1 (column 7), only four villages have sold timber to date and the revenues generated were invested and distributed differently in each village. Some money was invested collectively on public health infrastructure, and the rest split across community and VNRC households for different purposes as decided by the –see (Khatun et al. 2015a) for details on this issue-. Finally, the third component, funded by NICFI between 2010 and 2015 as a REDD+ pilot scheme, has consisted of meetings and activities to request Free, Prior and Informed Consent (FPIC) and develop controlled early burning trials as activities to generate marketable carbon offsets certified through a Voluntary Carbon Standard methodology, and not yet sold. In the future, a share of the revenues generated by verified carbon offsets will be distributed to villages through their formal institutions, the VC and the VNRC. MCDI has rewarded households economically for their participation in each activity related to this component[1].

The research presented in this article was developed across nine project and six control villages, respectively (Table 1). Four of the nine project villages (hereafter referred as early entry villages) had benefited from timber sales in the years prior to the introduction of REDD+ activities (i.e. before 2010), and they had signed a REDD+ agreement with MCDI and piloted controlled early burning activities. The other five (hereafter referred as late entry villages) had signed the REDD+ agreement and developed controlled early burning activities but had not yet fully developed their PFM/FSC processes. Given these differences, it is important to understand, first, that early entry villages and their households have economically benefitted from MCDI activities more than late entry villages due to their access to both timber and REDD+ related project revenues and, second, that the relative impact of MCDI activities on households' income can vary significantly, since the flow of timber and (future) carbon revenue to the households is influenced by decisions made by village institutions, while flows derived from project activities depend on the household's effective access to the latter.

The six control villages were selected for the livelihood analysis, since they had no PFM or other REDD+ related efforts in place and they had no contact with MCDI or other forest

[1] Households receive different levels of fees, depending on the type of meeting attended or project activity conducted: a) attending MCDI meetings 3000 TSh/day; b) Marking VLFR boundaries 7000 Tsh/day; c) Patrolling VLFR boundaries 7000 Tsh/day; d) Clearing VLFR boundaries 7000 Tsh/day; e) Harvesting FSC timber & REDD+ early burning trials 10000 Tsh/day.

management and conservation projects alike. Following consultation with MCDI staff with extensive local experience, the two most important criteria for selecting village controls were population size and proximity to the main highway to Dar es Salaam. Population size effects the demand pressure on forests as well as the dynamics of local self-organisation. Proximity to the highway also determines pressure on forests (via transport costs to market) and remoteness can be a determinant of poverty.

Table 1. Characterisation of case study villages

Village	Name	MCDI association	Population (2008)	Participants in governance focus group (N>202 * 2)	Households sample (N=452)	Timber sales	REDD+ preparation
Early entry villages, i.e. PFM/FSC activities + preparing for REDD+ (N=113)	Kikole	PFM 2004; FSC 2009	1,271	14	30	2009. 41.9% share of timber proceeds invested in the midwife's house; remaining invested in forest patrolling activities of the VNRC and other household members.	Conducted early burning in the VLFR in 2014
	Kisangi	PFM 2005; FSC 2009	847	17	28	2011. 34.8% share of timber proceeds invested in the medic's house; remaining proceeds spent on VNRC patrolling and boundary clearing activities.	Conducted early burning in the VLFR in 2014
	Liwiti	PFM 2009; FSC 2010	238	14	25	2011. 54.9% share of timber proceeds invested in school building; remaining proceeds spent on VNRC patrolling and boundary clearing activities.	Conducted early burning in the VLFR in 2014
	Nainokwe	PFM 2009; FSC 2010	386	14	30	2011. 61.5% of timber proceeds invested in the new house for the Village Executive Officer; remaining share allocated to cover the medical insurance or school meals of specific households, and the rest transferred to all households to cover the costs of accessing bank account in nearby town.	Conducted early burning in the VLFR in 2013 and 2014
Late entry villages, i.e. only preparing for REDD+ and not yet any timber sales or FSC certified (N=166)	Likawage	REDD+ preparation since 2010	2,638	13	30	None	Conducted early burning trial in 2013, and conducted early burning in the VLFR in 2014
	Mandawa	REDD+ preparation since 2010	4,132	15	29	None	Project meetings held but no early burning trial

Village	Name	MCDI association	Population (2008)	Participants in governance focus group (N>202 * 2)	Households sample (N=452)	Timber sales	REDD+ preparation
							conducted at the time of research
	Mchakama	REDD+ preparation since 2010	1,313	15	29	None	Project meetings held but no early burning trial conducted at the time of research
	Mitole	REDD+ planned	2,730	15	28	None	Project meetings held but no early burning trial conducted at the time of research
	Ngea	REDD+ preparation since 2010	Not available	13	20	None	Conducted early burning trial in 2013
Control villages (only used for household survey) (N=173)	Mtyalambuko	None	1,923	N/A	29	N/A	N/A
	Ngorongoro	None	Not available	N/A	30	N/A	N/A
	Nakiu	None	1703	N/A	30	N/A	N/A
	Mtandi	None	719	N/A	30	N/A	N/A
	Nandete	None	3395	N/A	28	N/A	N/A
	Mbwemkuru	None	1243	N/A	26	N/A	N/A

2.2. Analysing MCDI outcomes

To analyse the project's expected changes in village forest governance, we drafted a set of governance criteria and questions with associated thresholds for scoring, and then validated them with a sample of elected authorities in both project and control villages in November 2010 (Table A in Supplementary Information). We held a focus group in each village to agree on a scoring for each governance criteria between November 2011 and February 2012. We repeated such exercise with the same participants in January-February 2014 (Table 1). Before the first round, we invited village households to attend the focus group in advance, but only an average of 15 people showed up in the project villages. Among the participants, there were usually more men than women, and a few were always formal members of village institutions, such as the VNRC or the VC.

We acknowledge that the social composition of the focus groups can be seen as a caveat and as a limitation of our research, and we are thus aware that our governance-related findings should be treated with caution and better explored in the future. Given limited time and resources, we did not pursue the development of other focus groups, stratified according to gender, resource user groups, or involvement in village institutions, for example. However, as our results below will demonstrate, the possible bias of our focus groups towards elites and people who were genuinely interested in the issues to be discussed during the focus group has not precluded us from collecting negative performance scores and critical reflections by participants about what works and what does not at village level.

During the focus groups, the governance criteria were introduced one at a time by the authors and by MCDI staff who were fluent in English and Swahili, and they were subsequently discussed at length. Participants were asked to reflect on performance in relation to each criterion and question, and a grade (+/~/**-**) was agreed according to indicated judgements and thresholds for each of these grades (Table A in Supplementary Information). Deliberations were rich and the process worked reasonably well, with little apparent problem of elite domination or misrepresentation. Overall, the process generated a simple qualitative grade for each question, which were then combined into an overall grade for the correspondent governance criteria (Table 2).

To investigate the direct effects on households' income, the indirect effects on other wealth indicators and the level of knowledge about PFM and other project activities we used a household questionnaire. The household was the unit of study and we required two respondents for each questionnaire, a man and a woman. In most cases, this was husband and wife. The questionnaire was piloted first and deployed in November 2011 and February 2012, while the second round of data collection took place during the first half of 2014. Data were collected by a team of MCDI staff, who were trained by UEA staff before each round of data collection, and enumerators were fluent in both English and Swahili.

Before deploying the questionnaire, we classified all existing households in each village across three classes of wealth (ie. rich, medium, low wealth), according to their existing household assets and based on information provided by village authorities. We then randomly selected from each class of households in proportions that represented the profile for the village as a whole. We aimed for at least a 20% sample of households in each village, but given budget constraints we introduced a maximum limit of 30 households for each village. We surveyed a total of 452 households twice and findings should thus be treated with caution since our sample represents approximately only 10% of the possible sample.

The questionnaire collected data on the demographic and education profile of household members; housing conditions and durable assets; agricultural cultivation area and crop types; livestock assets; PFM and project activities' knowledge levels; and expenditure and income activities and amounts over the previous year, including agricultural and livestock sales and average forest product sales. Reported income and expenditure data were recorded in Tanzanian shillings and we adjusted 2014 data for inflation. We did so using Tanzania's Consumer Price Index for July 2011 (CPI index = 112.7) and March 2014 (CPI index = 149.49), a roughly 33% increase in prices in less than two years that is likely to have affected households in a range of ways. These dates were chosen because they were approximately in the middle of each data collection period. To adjust for inflation, we then multiplied 2014 income data by 112.7/149.49, i.e. 0.753.

Collected data were compiled in an Excel database and each household was coded to identify the village, the number and the wealth category it originally belonged to. In this way, we facilitated the pairing of households in the analysis of change between 2011 and 2014. The database was cleaned and analysed using STATA 12.1 to have a consistent account of the data management performed and use 95% confidence intervals throughout the analysis.

Following Hadi (1992, 1994)[2], variable outliers were identified and not accounted for when distilling 'average' results for key variables. For example, the value of 'average total income' per village does not necessarily result from the sum of discrete income categories, such as 'subsistence crops income', 'cash crops income', 'forest products' income, since the outliers identified for each of these categories result in a different sample size to calculate sub- and total income averages.

When collecting data, we confronted a set of challenges and also made some adjustments. First, we had several missing data for children and adults' age in both survey rounds which meant we could not calculate the household's dependency ratio, critical to assess if most dependent households were benefitting more or less than others from project activities. However, we developed a 'modified dependency ratio' based on the number of adults fit to work and total number of members in the household, expressed as percentage. This provided us with key information on the pressure experienced by households to maintain their livelihoods, with lower ratios (e.g. <25%) reflecting a higher livelihood burden on adults fit to work than higher ones (e.g. >75%).

The 'housing quality index' was developed using a simple weighting scheme based on previous fieldwork knowledge. Therefore, 'grass walls' (1 point) were weighted lower than 'mud walls' (2 points) and this lower than 'brick walls' (3 point) and rendered 'cement walls' (4 points). The same logic was applied to floors, doors and roofs and their different possible configurations. The minimum index value was four points, and the maximum 11. The amount of durable assets in each household was a simple count variable, summing up the amount of observed assets present in each household. These included solar panels, cars, motorbikes, bicycles, televisions, radios, mobile phones or other goods worth more than a phone.

Collecting data on cultivated land proved challenging in the case of cashew-cultivating farmers because some would provide us with the number of cultivated trees and were unable to translate this into land area. Therefore, we applied a conversion factor from trees to acreage size based on recommended planting densities for southern Tanzania of 69 trees/ha, i.e. approx. 28 trees/acre (Martin *et al.*, 1997, p. 12). We thus multiplied the number of trees noted by farmers by a factor of 0.0358.

[2] Hadi proposes a series of steps to find outliers by calculating the Mahalanobis distance with respect to the mean or to a chosen "center" point. These distances follow a chi-square distribution which is used to test the hypothesis that certain observations might constitute outliers.

To discern the project's direct effect on income or durable assets, we estimated poisson (for durable goods) and OLS (for income and expenditure) 'difference-in-difference' models comparing households in project villages with controls. Difference in difference models allow to 'average out' time constant unobservable characteristics that might be influencing both the participation in the program or project and the outcome of interest (Donald and Lang 2007). Three dependent variables were used to investigate the possible effect of the MCDI project: 'total income'; 'total monthly expenditure' and 'total amount of durable assets'. For each dependent variable three different types of comparisons were made. In the first one, early entry and late entry villages were grouped together and compared against control villages. In the second analysis, control villages were dropped to compare early entry against late entry villages. Finally, in the third analysis, all villages were grouped together and compared.

We also added relevant control variables that we thought to be related to changes in our dependent variables and which would allow us to reduce potential biases in our 'difference-in-difference' estimator. In this way, we hoped to get cleaner estimates of the changes in our dependent variables resulting from the MCDI project. These independent variables included: 'household size', 'modified dependency ratio', 'highest education level reported', 'total land acreage', 'number of fruit trees', 'number of livestock' and 'percentage of land used for sesame production', 'income from crops' and 'income from forest products'. We decided to report our results using bootstrapped standard errors (Efron and Tibshirani 1986) and to evaluate those based on the distribution of our empirical data –the results did not change using robust standard errors.

We found significant positive correlations at 95% confidence level between total land acreage and income, durable assets, the housing quality index and household size for 2011 and 2014 in both early and late entry villages, as well as for controls, except for the relationship between land acreage and household size in controls for 2011, which proved non-significant. This demonstrates data consistency and suggests that improvements in these variables are related to each other with more or less intensity.

3. Results

3.1. Changes in forest governance at village level

Evidence gathered through the focus groups indicated that the project had an overall positive effect on forest governance during the study period (Table 2), including social cohesion and

organisation, decision-making quality and knowledge about PFM and project activities more generally, and this was particularly significant in early entry villages where MCDI had been working longer. Three of these four villages showed very significant improvements across just about all criteria and indicators discussed in the focus group. The exception was Liwiti, which was initially the strongest but was at the time of our second focus group facing a conflict that reduced what was previously the best performance (see Khatun et al. 2015, pp. 2103).

As regards organisation and level of social cohesion, early entry villages maintained a good standard between 2011 and 2014, but performed relatively poorly regarding communication and awareness criteria due to their limited understanding of REDD+ during the second focus group. These villages also showed improved performance regarding decision-making, reflecting the effect of project management activities on improved deliberation procedures. Seemingly, they improved their already relatively good performance on forest management indicators, which resulted from demarcating VLFR boundaries and effective forest protection. They also scored well for fund development reflecting good village dynamism around revenue generation and allocation.

Of the late entry villages involved in REDD+ preparedness, but which had not yet sold any FSC certified timber, four improved their overall performance over time but such improvement was low. None was facing fundamental conflicts, with the exception of Mchakama, where practical forest management was problematic. As regards communication and social cohesion, their performance improved over the study period but villagers complained about certain constraints to full participation, including limitations on awareness and understanding of project activities, particularly for households outside the main village. Their knowledge about the PFM project and the REDD+ component was poor, and remained so over the years. As a result, in late entry villages, focus group participants complained about poor recording of decisions and limited follow-up of adopted decisions. These villages were all suffering relatively poor forest management, which significantly reduced people's perceived access to forest products. There was little use of revenues for local development activities in late entry villages, which we argued earlier is logical since they had not seen any substantial timber or carbon offset revenues arriving.

Table 2. Forest governance criteria scores in project villages

	PFM/FSC villages								REDD villages									
Criteria	**Kikole**		**Kisangi**		**Liwiti**		**Nainokwe**		**Likawage**		**Mandawa**		**Mchakama**		**Mitole**		**Ngea**	
Year	11	**14**	11	**14**	11	**14**	11	**14**	11	**14**	11	**14**	11	**14**	11	**14**	11	**14**
1. User organization & Cohesion	+/~	+	+	+	+	+/~	+	+	+	~	+/~	+	~	+/~	~/-	~	~	+
2. Communication & Awareness	+	~	~	~	+/~	-	~	~	~	~	+	~/-	-	~/-	-	~/-	-	~/-
3. Decision-making & Implementation	~	+/~	~	~	~	~	+/~	+/~	~	+/~	~	+/~	-	~	~	~	-	~
4. Forest Management	+/~	+	~	+	+	+	~	+	-	+	~/-	~	-	-	-	~	~/-	~
5. Forest product access & distribution	~	+	~	+	+/~	+/~	+	+	~	+	+/~	+/~	+	+	+	+/~	+	+
6. Gender and Equity Considerations	~	~	~	~	~	~	~	~	~	~	~	~	~	~	+	~	+	~
7. Economic / Fund development	+/~	+	+	+	+/~	+	~	+	-	-	+	na	+	-	~	-	-	-
8. Conflict management	~/-	+	~/-	+	+	~	-	+	~	+	+/~	+	+/~	+	+	+	+	+
9. Linkage and network development	~	~	-	~	~	+	+/~	+/~	~	~	~	~	-	~/-	-	~	-	~
Overall score (∑scores)	**2**	**<u>5.5</u>**	**0.5**	**<u>5.0</u>**	**4.5**	**3.0**	**2.0**	**<u>6.0</u>**	**-1.0**	**<u>2.5</u>**	**3**	**2.5**	**-1.5**	**<u>-0.5</u>**	**-0.5**	**<u>0.0</u>**	**-1.5**	**<u>1.5</u>**

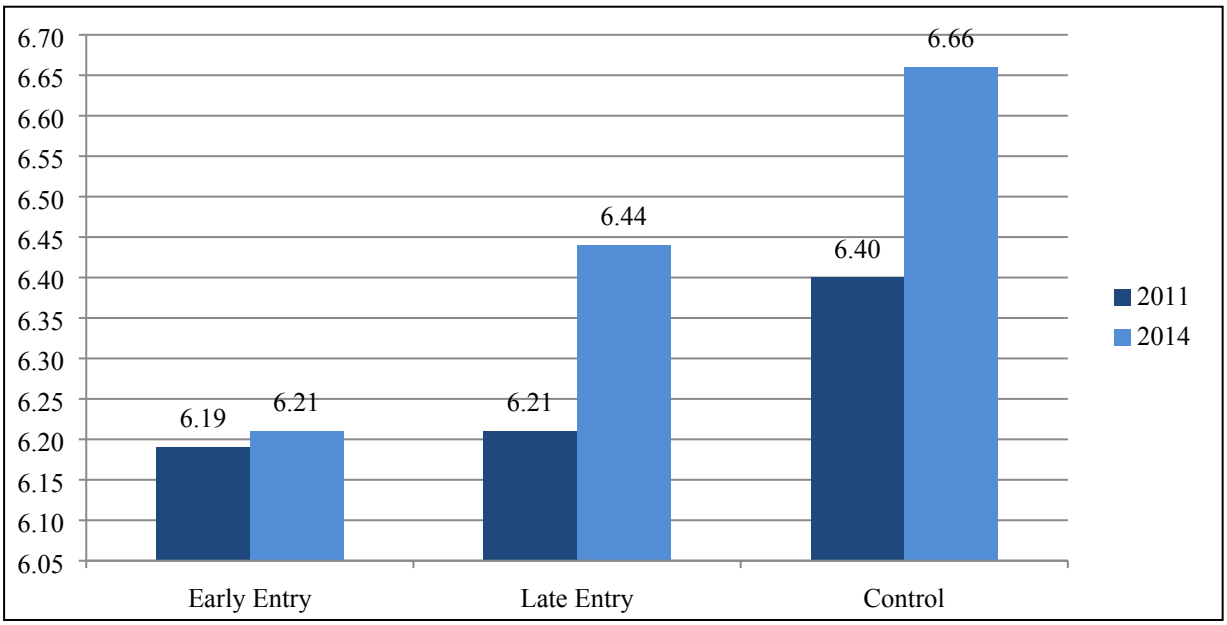
Legend: + good; +/~ moderately good; ~ moderate; ~/- moderately poor; - poor. Overall score is added on the basis of + = 1 point; +/~ = 0.5; ~ = 0; ~/- = -0.5; - = -1 point. Underlined scores for 2014 indicate improvement.

None of the nine villages performed well on gender and equity considerations (see 3.3. for more detail on these issues at household level), although they did not score very negatively either: in general, the decision-making deliberations around forest management issues were observed to be primarily male dominated and women were very sparsely included. By inference their views were not incorporated directly.

3.2. Changes in housing conditions, durable assets and income

Figure 1 shows that all surveyed villages had similar average housing quality index values, with standard deviations of around 0.9 points in 2011 and of around 1.3 points in 2014. We did not find any striking differences in housing conditions across our sampled households. This index slightly increased in value across villages between 2011 and 2014, except for one early entry village (Kisangi), one late entry (Mchakama) and two controls (Mtyalambuko and Nandete), which experienced minimal decreases that might be explained by data collection inconsistencies. The small overall increase coupled with relatively higher standard deviations found in 2014 compared to 2011 suggests that some households improved their housing conditions while others had mostly continued with the same conditions. On average, housing conditions had not improved more in MCDI-supported villages than in controls.

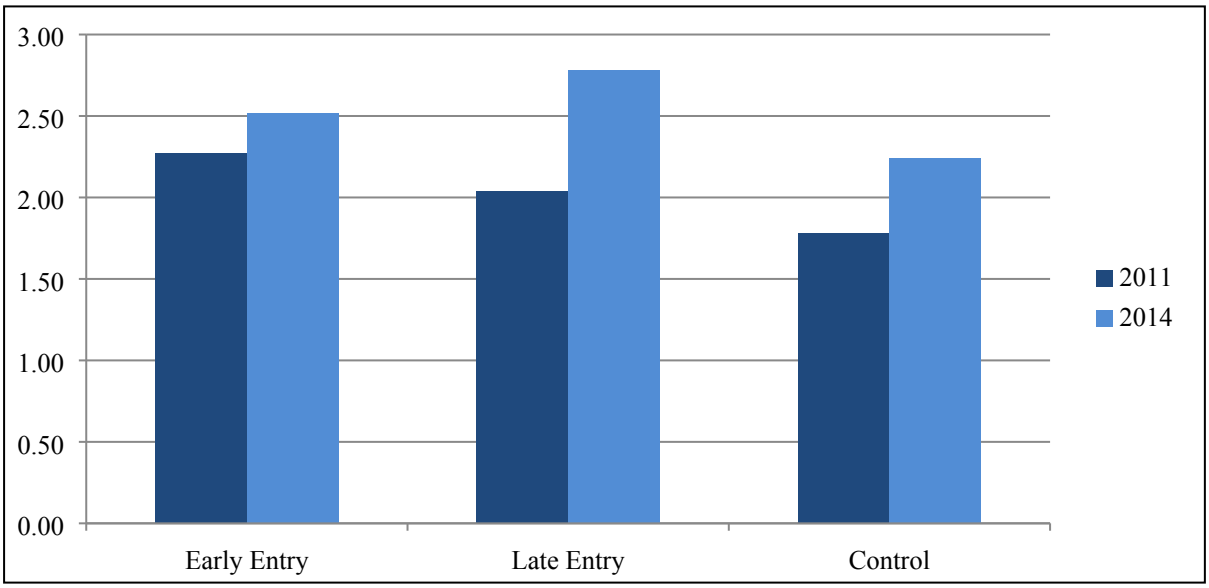
Figure 1. Housing quality index by village groups and year



Again, we did not observe significant differences in the average number of goods held by households across surveyed villages, and neither across participant and controls. Nonetheless,

we found a trend towards an increased number of assets (Figure 2). Higher standard deviations found in data from 2014 also suggest that intra-village inequality in the number of durable assets between those with more and fewer goods had increased. In all but one of the control villages the share of households with 5 or more durable assets increased between 2011 and 2014 at the expense of the category with two to four durable assets, which should be regarded as a positive trend from a material poverty reduction perspective. However, in some early entry (Kikole, Nainokwe) and control villages (Mbwemkuro, Mtyalambuko and Ngorongoro), the average number of households in the zero to one goods category increased. This suggests that the poorest households, across all village types, had found it difficult to increase their assets, irrespectively of PFM and REDD+ activities.

Figure 2. Average durable assets by village groups and year



Reported average income levels from selling subsistence crops, i.e. maize, millet and rice, by village groups in 2011 were lower in early entry and control than in late entry villages. However, there were very high standard deviations, which indicated a high disparity in income derived from these crops. By 2014, most households across all villages –except for Mtyalambuko- reported that they had not gained any income from sales. This was due to the fact that most villages in 2014 obtained their agricultural income exclusively from cash crops. Additionally, the overall production of subsistence crops in 2013 was poorer than in 2010 due to meteorological conditions, which also explained why there was a higher shortage of subsistence crops available for sale in 2014 (Table B in Supplementary Information).

In contrast, average income derived from cash crops, including sesame and cashew, increased across early entry and late entry village groups during the study period, and it diminished slightly in controls. Total cash income became dominated by sales of sesame (and cashew to a lesser extent). Early and late entry villages showed higher cash crop income averages, but standard deviations were very high and above the mean. On average, MCDI-supported villages derived more income from cash crops over the study period. It is also worth noting that, after accounting for inflation, cash crop income levels for 2014 decreased slightly in Nainokwe and in all control villages except Mbwemkuru (Table C in Supplementary Information).

In 2011, we found a positive and statistically significant correlation between the proportion of acres dedicated to sesame and cashew cultivation and total household income for many early and late entry villages (Kisangi, Likawage, Mandawa, Mitole, Ngea), as well as controls (Mbwemkuru, Mtandi and Ngorongoro). In 2014, it was only found positive for an early entry village (Kikole) and three controls (Mtyalambuko, Nandete and Ngorongoro). We also found a positive correlation between the proportion of land under sesame and cashew and total agricultural income that was statistically significant for 2011 across five project villages and two controls, which in 2014 was significant only for Kikole, Likawage, Nandete and Ngorongoro. It is likely that such relationships were not significant in other villages due to three possible reasons: the fact that 2013 was a drought year with poor harvest might have considerably reduced the reported income from cash crops in these other villages, falling sharply in comparison to the amount of land dedicated to their cultivation; possible flaws in income data; and the reduced number of observations in our sample (Table D in Supplementary Information).

Reported income for forest products, including ropes, grass, honey, wildmeat, logs and charcoal, was low but increased considerably between years (Table E in Supplementary Information). This runs against our expectation that forest products extraction and related income would get reduced over time as a result of VLFRs establishment. However, this was not the case for at least two reasons: 1) the VLFRs encompassed a rather small proportion of total village lands and forests, which means that their demarcation has not constrained access to the forests –at least from surveyed households-; and 2) we were able to collect better data on the second round –with fewer missing values as a result of increasing confidence with MCDI staff and enumerators, which translated in higher income levels being reported.

Table 3 summarises the levels of average annual income both across years and across villages. early entry villages' average annual income in 2011 was approximately 373,500 Tsh, increasing up to approximately 492,400 Tsh in 2014. For both years, standard deviations were close to or greater than the mean, which reflects a large variation in reported incomes. A similar growth in average income can be observed in late entry villages, increasing from 353,800 Tsh in 2011 to 477,000 Tsh in 2014, with standard deviations exceeding the correspondent means. Annual average household income in control villages was similar to participant villages in 2011, i.e. 317,021 Tsh, and it had not increased much in 2014, i.e. 318,308 Tsh. Standard deviations in control villages were also above the mean. Table 3 also shows consistency in the data for individual villages across time, with most villages' relative average income position -except for Nandete- not changing much in the two surveyed years.

Average income inequality by village group and year revealed an increase in early entry villages (acutely if we accounted for outliers) during the study period, while it remained very similar in late entry and control villages (Table 4). Among project villages, the Gini coefficient only diminished in Kisangi and in Mandawa for 2014, while in control villages such coefficient diminished for Mtyalambuko, Nandete and Ngorongoro (Figure F in Supplementary Information). Such increasing income inequality echoes the widening gap observed in durable asset counts within some villages, and irrespective of MCDI presence.

Figure 3 shows that most villages present very similar expenditure averages for 2011 and 2014, oscillating between 30,000 and 50,000 Tsh. However, reported monthly expenditure levels in control villages were somewhat higher for both years across the six villages. Most money was spent on clothes, labour, education, medicines, trips to town and food related items, including mostly maize, millet and rice, followed by sugar and cooking oil (Figure 4). This indicates that most households are not food secure from a subsistence cropping perspective and that they rely on local markets to meet their food annual requirements. Importantly, the rise in expenditure of basic staples in 2014 also meshes with the change in income data for staple crops reported above, confirming that harvests in 2013 were poor and that many households moved from a surplus of subsistence crops to a deficit. Unfortunately, the households who reported accessing MCDI project monies over the study period (see section 3.3) were unable to indicate how they had used such revenues, and they noted that PFM revenues were spent it in whatever was needed at the time they became available.

Figure 3. Mean reported monthly expenditure by village and year

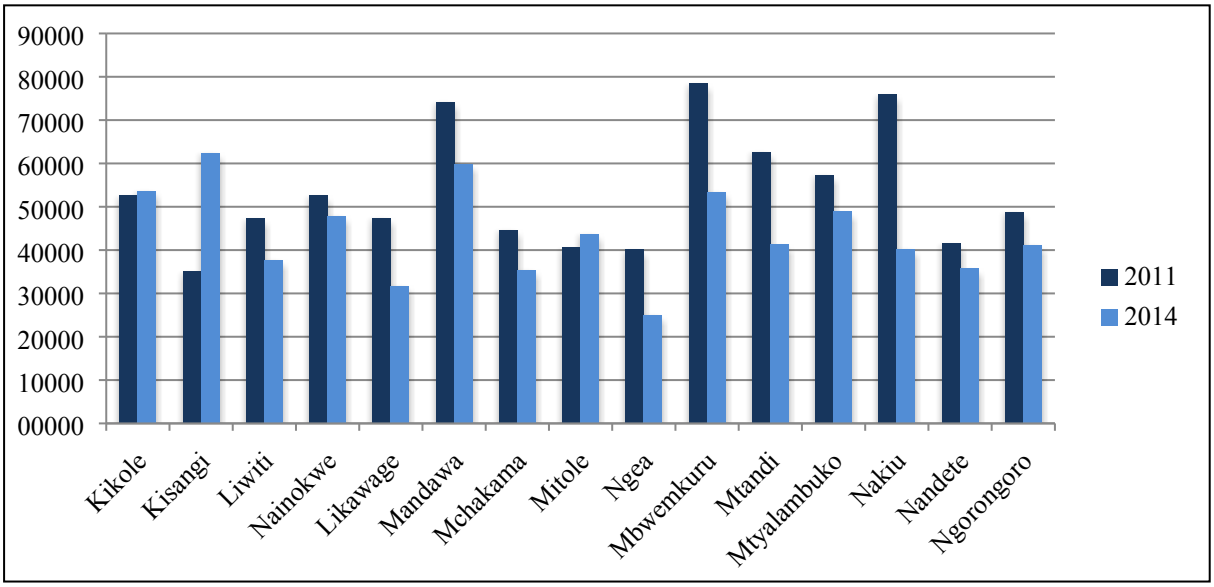
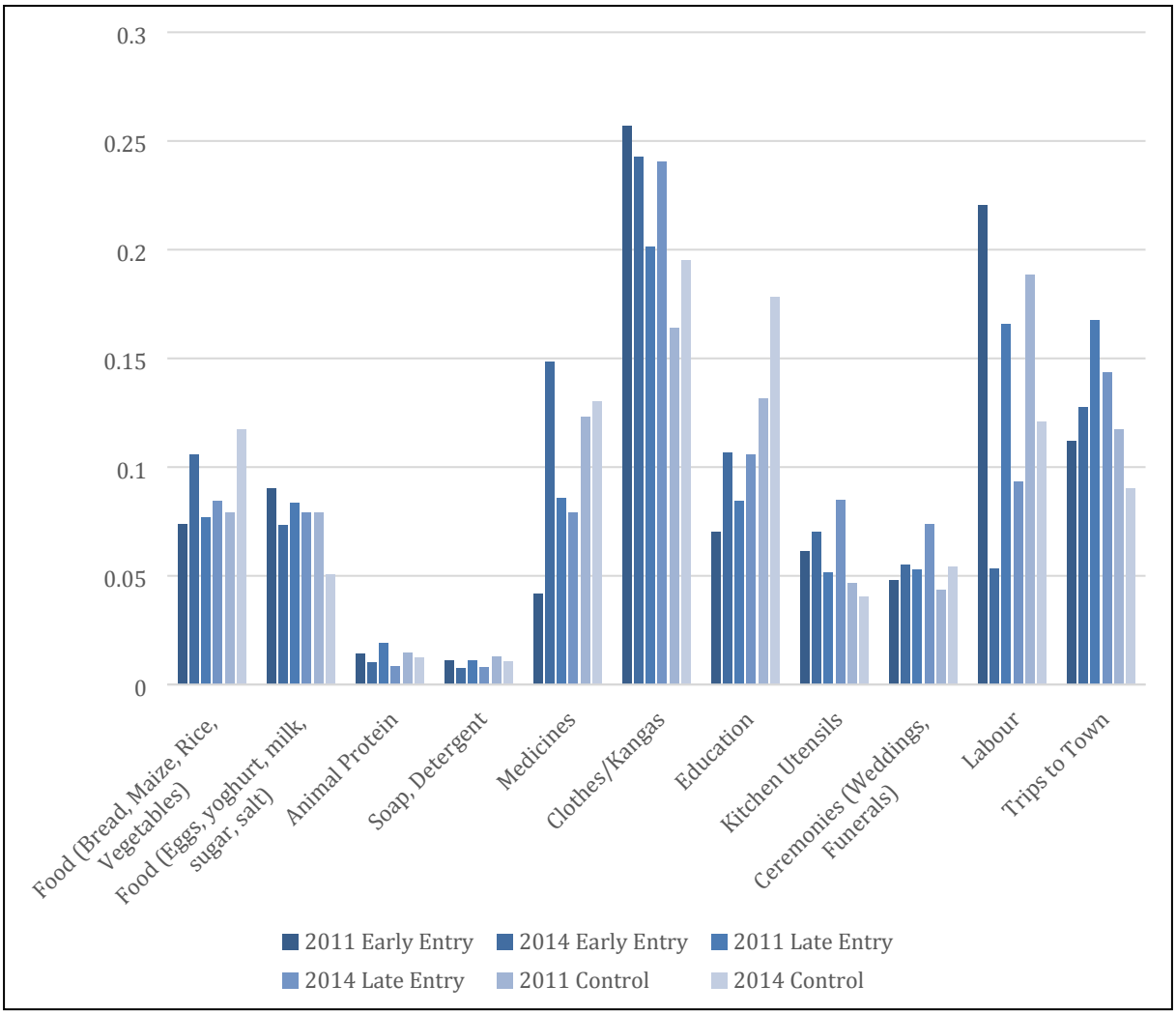


Figure 4. Percentage of expenditure per items by village group and year



In our attempt to discern the MCDI project's effects on income and assets, respectively, Table 5 presents the results for our three 'difference-in-difference' models controlling for relevant variables. The row 'Wave' indicates the change between years for each of the three dependent variables across all surveyed households. In other words, it is the coefficient indicating the average change from 2011 to 2014 without taking into account participation in MCDI activities. The row 'Treatment' indicates the difference between households surveyed in MCDI villages and households from control villages, irrespective of the year surveyed. The row 'Difference-in-Difference estimator' is the value of interest because it tells us how different the households in MCDI villages are in 2014 in comparison to the households in control villages, as well as how they had changed across surveyed years.

The coefficient for 'Wave' indicates the average change from 2011 to 2014 without taking into account participation in MCDI activities. The coefficient for 'Treatment' indicates the difference between households surveyed in MCDI villages and households from control villages, irrespective of the year surveyed. The coefficient for the 'Difference-in-Difference estimator' is the value of interest because it tells us how different the households in MCDI villages are in 2014 in comparison to the households in control villages, as well as how they had changed across surveyed years. In other words, this coefficient reflects if the change in our dependent variables can be attributed to the MCDI project.

Table 3. Mean household income (Tsh) by village group, village and year (mean, standard deviation and sample size, respectively. 2014 data deflated using Consumer Price Index changes

Group	Summary Results (Tsh)			Village Mean (Tsh)	
	2011	2014	Village	2011	2014
Early Entry	**373,504** *(± 369,240, n=113)*	**492,432** *(± 591,496, n=101)*	Kikole	478,225	596,757
			Kisangi	284,443	520,385
			Liwiti	395,348	601,447
			Nainokwe	275,540	248,496
Late Entry	**353,825** *(± 465,294, n=136)*	**477,049** *(± 566,345, n=124)*	Likawage	553,950	585,675
			Mandawa	401,663	610,617
			Mchakama	231,838	393,649
			Mitole	323,365	499,938
			Ngea	181,300	245,953
Control	**317,021** *(± 422,854, n=130)*	**318,308** *(± 435,128, n=166)*	Mbwemkuru	342,500	522,256
			Mtandi	359,350	271,584
			Mtyalambuko	227,345	246,217
			Nakiu	525,020	590,929
			Nandete	179,643	128,950
			Ngorongoro	161,517	153,230

Table 4. Gini coefficient by village group and year

	2011	2014	2011	2014
Early Entry	0.52	0.61	0,59	0,87
Late Entry	0.58	0.61	0,63	0,64
Control	0.62	0.65	0,67	0,67
	Outliers (N=40) discarded		Outliers (N=40) included	

Note: coefficients have been calculated discarding all outliers found across all income categories (agriculture, livestock, forest, and other income sources).

Table 5. “Difference in difference” analysis for MCDI activities' impact on livelihoods

	Model 1: Early+Late Entry versus Control villages			Model 2: Early versus Late Entry villages			Model 3: Early / Late versus Control villages		
	(1) Durables Poisson	(2) Expenditure OLS	(3) Total Income OLS	(4) Durables Poison	(5) Expenditure OLS	(6) Total Income OLS	(7) Durables Poisson	(8) Expenditure OLS	(9) Total Income OLS
Wave	0,064	-6,921	97,208**	0,003	-4,164	106,073	0,063	-6,9	95,976**
Treatment	0,163*	1,022	66,716**						
Difference-in-Difference estimator (Early+Late Entry versus Control villages)	-0,174	7,078	-30,854						
Early versus Late Entry villages				0,069	-4,901	17,563			
Difference-in-Difference estimator (Early versus Late Entry villages)				-0,143	12,243	-41,673			
Early							0,21**	-2,23	76,425**
Late							0,122	4,178	57,78*
Difference-in-Difference estimator (Early Entry versus Control villages)							-0,273**	12,78	-50,584
Difference in Difference estimator (Late Entry versus Control villages)							-0,063	1,086	-6,492
Household Size	0,018	0,783	-8,95	0,046***	1,477	-3,968	0,018	0,773	-8,89
Dependency Ratio	0,098	-3,17	-12,715	-0,154*	-4,504	-15,113	0,098	-3,205	-12,919
Max. Educ. Level	0,067***	2,605***	21,092***	0,06***	2,517***	20,877**	0,067***	2,621***	21,034***
Total Crops Acres	0,028**	3,346***	48,358***	0,025*	4,23***	63,351***	0,027**	3,382***	48,331***
Number of Trees	0,001**	0,046	0,375	0,001	0,095	0,5	0,001**	0,042	0,389
Number of Livestock	0,008***	0,582**	8,411**	0,002	0,134	5,981*	0,008***	0,572**	8,437**
Proportion of Land for Sesame	-0,006	8,95	122,652	0,023	1,214	136,843	0,101	5,098	143,395
Income from Cash Crops	0***			0***			0**		
Income from Forest Products	0,001**			0			0,001**		
Mean Durables in Village	0,409**	-3,416		0,39**	-5,582		0,404**	-2,811	
Mean Income in Village	-0,001**		0,799***	-0,001**		0,608*	-0,001**		0,785***
Mean Expenditure in Village		1,013***			0,815			1,044**	
N	693	728	733	397	421	424	693	728	733
R^2 Adjusted		0,142	0,261		0,154	0,236		0,141	0,259
Pseudo R^2	0,126			0,127			0,127		
* p<0.10, ** p<0.05, *** p<0.001									

We only found a significant (at 95% confidence level) but negative 'difference-in-difference' estimator for durable assets on column 7 of Table 5, for the comparison between early entry villages and control villages. This means that durable assets in early entry villages were apparently reduced as a consequence of project activities as compared to those villages that did not participate in the project. However, given that all remaining 'difference-in-difference' coefficients (regardless of whether we compare early and late villages *versus* control villages, and early or late entry villages with control villages) are not statistically significant, we can conclude that there is not any robust evidence to attribute significant changes on our independent variables to MCDI activities.

3.3. Participation and knowledge effects in project villages

This section turns now to analyse the participation in project activities, and the distribution of project monies and related knowledge in project villages. Figure 5 shows how many of the household heads surveyed, either men or women, confirmed participation in MCDI activities. It is interesting to note that surveyed women participated more often than surveyed men in MCDI meetings. We did not find striking gender differences in participation in other activities, except for marking boundaries and harvesting timber, which are more physically demanding. Again, it was surprising that the frequency of women surveyed in early entry villages reporting involvement in early burning activities was higher than men, despite being a risky and more labour intense activity. Figure 5 also reflects that people's engagement in MCDI's most demanding activities is lower than attending meetings, which is logical. It also reflects that more time-consuming activities that require training involve fewer people to reduce management costs and create specific capacities among certain individuals.

Figure 6 identifies the percentage of surveyed households acknowledging to have benefitted from direct MCDI payments related to project activities, regardless of activity type and the gender of the household participant. Average percentages of benefited households are higher in early entry villages, which was expected given that MCDI has been operating in these villages for longer and have thus conducted a wider variety and number of activities. In late entry villages, the percentage of households that have received MCDI-related fees diminishes, with Likawage and Mitole showing the lowest percentages. As regards average fees received, we observed logical differences in the average value of such fees in early entry villages compared to late entry ones, given that the former have participated in more activities on average and have been involved in MCDI activities longer. Ngea is an exception to this but we cannot explain confidently why, since both Likawage and Ngea have engaged in REDD+

early burning trials in 2011 and 2013, respectively, and have had, at least in theory, the same potential access to MCDI-related fees (Figure G in Supplementary Information).

Figure 5. Participation in MCDI activities by household heads, 2011-2014

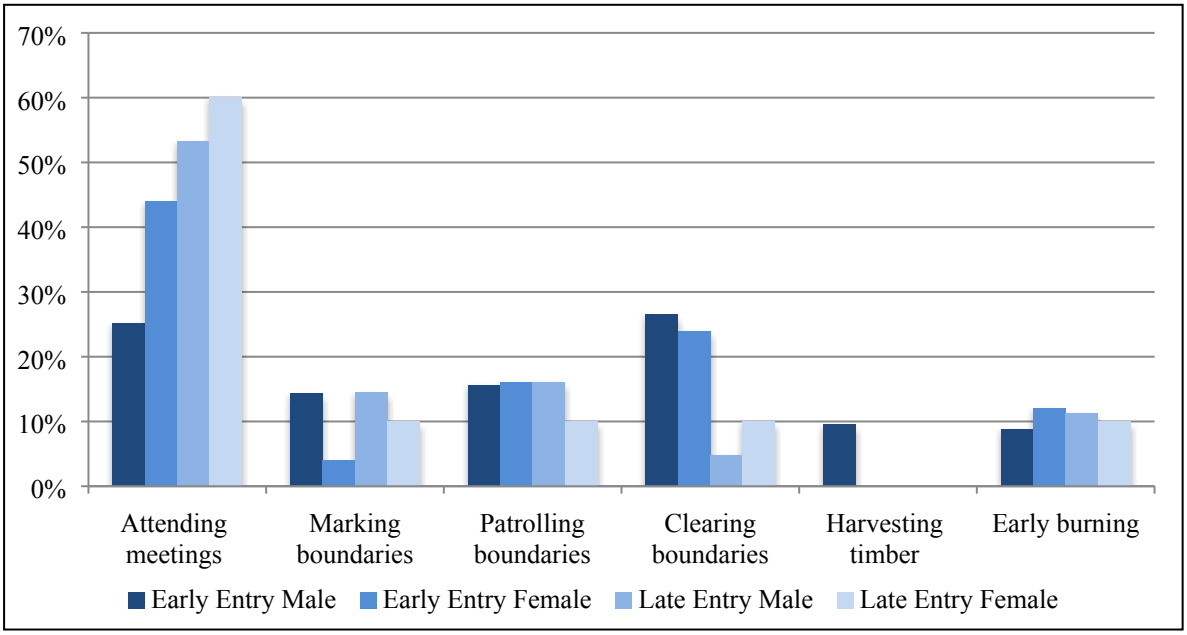
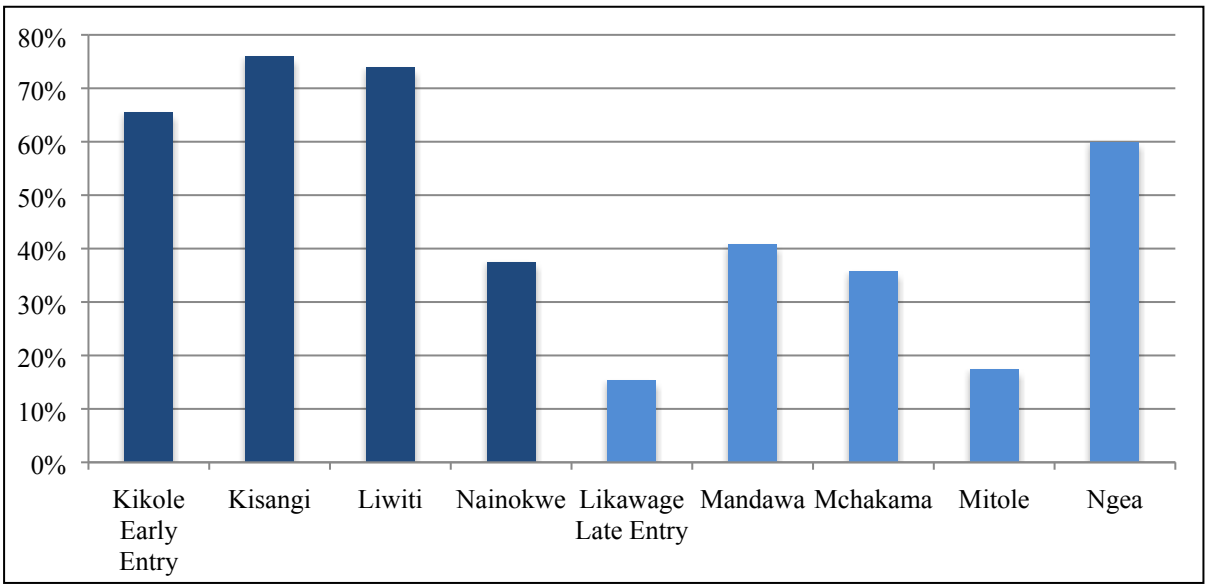


Figure 6. Percentage of households who had received direct fees from MCDI activities



As regards the spread of PFM and project knowledge, we expected that early entry households would be more knowledgeable about MCDI project activities, and would also perceive these activities more positively in terms of expected benefits. Our findings confirm

this, showing that early entry village respondents are more likely have heard about activities and more likely to also be aware of what these activities involve (the measure of awareness was based on questions that tested whether key features of activities were understood). Knowledge of project activities improved between 2011 and 2014, both for men and women, with the exception of Kikole that showed a different direction of change, with a small drop in awareness of project activities for men and a larger drop for women. Overall, we also observed a gender difference in knowledge and awareness of project activities, with women less likely to know about MCDI activities than men for both study years even if they apparently participated more often in project meetings (Figure H in Supplementary Information).

Finally, we also found that the percentage of late entry village respondents with awareness of MCDI activities was lower than for early entry villages. The knowledge of MCDI activities had increased between 2011 and 2014, to the point where very few respondents had not heard of project activities. This was equally true for female respondents and there was indeed less gender difference observed in late entry villages compared to early entry ones. This may be attributable to MCDI having placed greater emphasis on gender equality as their working practices developed over time (Figure I in Supplementary Information).

4. Discussion

We started this article arguing that there was a research need for more impact assessment of PFM programs and projects, particularly now that these initiatives are likely to be increasingly promoted in the context of REDD+ policies and incentives. Evidence in this regard is still scarce, with few analyses grounded on panel data and placing emphasis on governance and socio-economic issues. Grounded on the experience of the MCDI project in Tanzania, we have investigated the project's effects on village forest governance and local livelihoods connecting project activities with their hypothetical outcomes through a set of evaluation criteria and indicators. Overall, our results align with those who had previously suggested that PFM can transform village-level resource management institutions but deliver limited benefits to local households (Gross-Camp 2017; Persha and Meshack 2016).

Our qualitative governance analysis at village level, corroborated with insights from the household survey, demonstrates that villages working with MCDI for longer had experienced improvements in forest governance, driven in turn by a longer period of support to build their

forest governance capacities and by the fact that they had already benefited from timber revenues that had contributed to mobilise interest and attention of the community at large towards forest management. Notwithstanding, the results also demonstrate that the project activities as such have been insufficient to address socially entrenched gender inequities and to address very uneven and insufficient access to project information and forest management rules and responsibilities across all project villages.

These findings corroborate earlier studies focused on what it takes to develop well-functioning PFM and REDD+ projects (Merger et al. 2012; Vatn et al. 2017; Robinson et al. 2013). It takes considerable time, resources and awareness that when such institutions are in place they can still be slow in recognizing fund-management grievances and in making decision-making more transparent, gender sensitive and inclusive. Our findings also partly align with evidence suggesting that longer-term external support can mitigate the risk of elite capture in forest communities (Persha and Andersson 2014), but also suggest the potential existence of critical socio-cultural barriers that might require longer timespans to be overcome.

Findings related to changes in households' material wellbeing yield some interesting but inconclusive results. MCDI participating villages had, on average, more durable assets than control villages but the effect of project activities on these assets was negative (i.e. we found a decrease in assets relative to control villages over the study period). As regards income, and looking at simple descriptive statistics, it appears that MCDI project villages have done much better than control villages, with comparatively substantial gains between 2011 and 2014, even when adjusted for inflation. These recorded income gains are also supported by our respondents' more subjective assessment of changes in their household economy across years, with MCDI village respondents much more likely to report improvements in their household situation than control villages.

However, whilst our descriptive statistics have shown that income has increased in MCDI villages relative to control villages, the difference-in-difference analysis finds that this is not statistically significant. We think that this result arises, first and foremost, from the fact that village economies are much larger than just forestry, and market-based income is dominated by sales of sesame and other cash crops such as cashew, as reported for other parts of Tanzania (Brockington 2016). It is hard to isolate the effect of increasing forest incomes given that these changes are dwarfed by wider economic transitions occurring across all villages. In fact, this leads us to underscore the importance of analysing PFM and REDD+

outcomes beyond project boundaries and focusing instead on the broader forest-agriculture landscapes where these activities are often located and where environmental and economic conditions might change significantly from year to year. In our particular case, we have presented evidence that a boom in sesame farming has been driving village economies in the region, thus overshadowing the effects of any possible income-related effects of MCDI activities in early entry villages. Under such circumstances, PFM may promote new and more equitable income streams, particularly for those who cannot mobilize the capital or labor to participate in cash cropping, but it is unlikely to be a driver of livelihood transformation.

Secondly, we think that many of the pathways to household economic benefits in project villages are indirect, through investment in public goods such as improved water provision, healthcare and schooling. These are long-term investments geared towards building important and flexible assets related to human capital. It is quite expected that it would take a longer period of time to see these effects materialise. Third, we must also acknowledge that there are significant challenges to collecting very accurate data with consistency across years. This was perhaps most evident in the highly surprising data on income from harvested forest goods. We found a massive increase in use of forest resources for income generation and we could seek to explain this as a use of forests as a safety net given the collapse of sales of maize, millet and rice due largely to drought, as well as an increase in villagers' reporting confidence.

As regards the project's equity effects, including the fair distribution of project benefits and costs across households, our analysis of changes to income distribution within villages using a Gini coefficient reveals small rises in inequality across both MCDI villages and control villages. We speculate that this concentration of income, such that a higher proportion of total village income is concentrated in the wealthier households, is again explained by boom in the sesame cash crop economy. As hinted above, the income that can be gained from sesame presents a significant opportunity to those households who command the labour and working capital to invest in expanded production, which widens the income gap with those who do not control the assets to expand sesame production. This explanation would fit the pattern we have seen with asset counts, in which those with few assets to begin with have failed to improve their position. This explanation would also be somewhat supported by the observation that early entry villages are the ones who have most expanded their cash crop income and have also most increased their inequality, although we recognise that this would need further research to confirm it. Regarding knowledge of forest management operations,

we find that the MCDI project has had a positive impact, which has been captured by the household survey but not so much through the focus group activities.

5. Conclusions

This article aimed to investigate the effects of a project that combines PFM efforts with REDD+ finance on forest governance and rural livelihoods. We have demonstrated that MCDI activities have led to improvements in forest governance and related knowledge within project villages, although there is room for improvement in several of the governance criteria and indicators explored, as well as in the way forest management and project knowledge is disseminated, which should ideally avoid relying only on the new established institutions for its dissemination. In this regard, we have argued that the continuous and sustained involvement of MCDI at village level is key, as demonstrated by the fact that institutions were more robust and knowledge more fairly distributed within those villages where the project had been operating for longer. Furthermore, such long-term commitment to the project villages is the only possible pathway to deliver on its promises about sustainable income gains, through timber and carbon offsets, and rural development more generally. It is either this or becoming indeed another "conservation fad" (Lund et al. 2017).

With regards the project's effects on local livelihoods, our results are inconclusive. We cannot suggest with confidence that the project has been the main driver of positive changes in household income, assets and expenditure levels. Neither we can say that observed increases in inequality in some villages and the material impoverishment of some households have been caused by the project. To move towards a more conclusive understanding of change, MCDI and/with independent researchers would need to monitor change over a longer period, continue to improve the quality of data collection, and in an ideal world, enhance sample sizes and spatial reach.

In this regard, we recognize that collecting detailed household livelihood and income panel data is costly and time consuming, and that neither ourselves nor MCDI might be able in the future to continue such recurrent data collection process. In this case, the main way of developing a long-term impact evaluation strategy might be to rely on existing government or international datasets if existent or developed, or to concentrate on identifying relatively simply but locally appropriate livelihood indicators that might be impacted directly or indirectly by project activities, such as (weighted) indices of durable assets, and innovative

measures that capture the pathways by which public goods spending benefits individual household economies. Any survey-based approach will have to be accompanied by improved understandings of project and non-project villages realities, for example through ethnographic work, to develop a more robust understanding of the project's impact pathways at collective and household levels, and to be able to interpret panel data analysis in further detail.

References

Arnold, J.E.M. 2001. "Forests and People: 25 Years of Community Forestry." Rome: FAO.

Blomley, Tom, Kerstin Pfliegner, Jaconia Isango, Eliakimu Zahabu, Antje Ahrends, and Neil Burgess. 2008. "Seeing the Wood for the Trees: An Assessment of the Impact of Participatory Forest Management on Forest Condition in Tanzania." *Oryx* 42 (3): 380–91. doi:10.1017/S0030605308071433.

Blomley, Tom, and H Ramadhani. 2006. "Going to Scale with Participatory Forest Management: Early Lessons from Tanzania." *International Forestry Review* 8 (1): 93–100. doi:10.1505/ifor.8.1.93.

Brockington, Daniel. 2016. "The Sesame Seed Cash Injection. Asset Investment and Economic Change in Mtowisa Village, Rukwa Region, 2000-2016." SAFI Project. https://www.dropbox.com/sh/dggrv1gpbzihy9o/AAAuKbh6D1bj_QOjc_AQ0gOaa?dl=0&preview=The+Sesame+Cash+Injection+III.docx.

Burgess, N.D., B. Bahane, T. Clairs, F. Danielsen, S. Dalsgaard, M. Funder, N. Hagelberg, et al. 2010. "Getting Ready for REDD+ in Tanzania: A Case Study of Progress and Challenges." *ORYX* 44 (3): 339–51. doi:10.1017/S0030605310000554.

Campese, Jessica. 2012. "Equitable Benefit Sharing: Exploring Experiences and Lessons for REDD+ in Tanzania." http://www.tfcg.org/pdf/TZ%20REDD%20Equitable%20Benefit%20Sharing%20Experiences%202012.pdf.

Donald, Stephen G, and Kevin Lang. 2007. "Inference with Difference-in-Differences and Other Panel Data." *Review of Economics and Statistics* 89 (2). The MIT Press : 221–33. doi:10.1162/rest.89.2.221.

Efron, B., and R. Tibshirani. 1986. "Bootstrap Methods for Standard Errors." *Statistical Science* 1 (1): 54–77.

Green, K.E., and J.F. Lund. 2015. "The Politics of Expertise in Participatory Forestry: A Case from Tanzania." *Forest Policy and Economics* 60: 27–34. doi:10.1016/j.forpol.2014.11.012.

Gross-Camp, Nicole D. 2017. "Tanzania's Community Forests: Their Impact on Human Well-Being and Persistence in Spite of the Lack of Benefit." *Ecology and Society* 22 (1).

Khatun, Kaysara, E. Corbera, and S. Ball. 2016. "Fire Is REDD+: Offsetting Carbon through Early Burning Activities in South-Eastern Tanzania." Article in Press. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84973917383&partnerID=40&md5=1a9af6307cfc484ca40e785ade53b150.

Khatun, Kaysara, N. Gross-Camp, E. Corbera, A. Martin, S. Ball, and G. Massao. 2015a. "When Participatory Forest Management Makes Money: Insights from Tanzania on Governance, Benefit Sharing, and Implications for REDD+." *Environment and Planning A* 47 (10): 2097–2112. doi:10.1177/0308518X15595899.

Khatun, Kaysara, N. Gross-Camp, Esteve Corbera, Adrian Martin, Steve Ball, and Glory Massao. 2015b. "When Participatory Forest Management Makes Money: Insights from Tanzania on Governance, Benefit Sharing and Implications for REDD+." *Environment and Planning A* 48 (this issue).

Lund, J.F., E. Sungusia, M.B. Mabele, and A. Scheba. 2017. “Promising Change, Delivering Continuity: REDD+ as Conservation Fad.” *World Development* 89: 124–39. doi:10.1016/j.worlddev.2016.08.005.

McDermott, M.H., and K. Schreckenberg. 2009. “Equity in Community Forestry: Insights from North and South.” *International Forestry Review* 11 (2): 157–70. doi:10.1505/ifor.11.2.157.

Merger, Eduard, Christian Held, Timm Tennigkeit, and Tom Blomley. 2012. “A Bottom-up Approach to Estimating Cost Elements of REDD+ Pilot Projects in Tanzania.” *Carbon Balance and Management* 7 (1): 9. doi:10.1186/1750-0680-7-9.

Meshack, Charles K., Bhim Ahdikari, Nike Doggart, and Jon C. Lovett. 2006. “Transaction Costs of Community-Based Forest Management: Empirical Evidence from Tanzania.” *African Journal of Ecology* 44 (4): 468–477. doi:10.1111/j.1365-2028.2006.00659.x.

MNRT. 2012. “Participatory Forest Management. Facts and Figures.” Dar Es Salaam, Tanzania: Ministry of Natural Resources and Tourism, The United Republic of Tanzania. http://www.tfs.go.tz/index.php/resources/view/participatory-forest-management-facts-and-figures.

Mustalahti, Irmeli, and Jens Friis Lund. 2010. “Where and How Can Participatory Forest Management Succeed? Learning From Tanzania, Mozambique, and Laos.” *Society & Natural Resources* 23 (1): 31–44. doi:10.1080/08941920802213433.

Persha, Lauren, and Krister Andersson. 2014. “Elite Capture Risk and Mitigation in Decentralized Forest Governance Regimes.” *Global Environmental Change* 24 (January): 265–76. doi:10.1016/j.gloenvcha.2013.12.005.

Persha, Lauren, and Tom Blomley. 2009. “Management Decentralization and Montane Forest Conditions in Tanzania.” *Conservation Biology* 23 (6): 1485–96. doi:10.1111/j.1523-1739.2009.01276.x.

Persha, Lauren, and Charles K. Meshack. 2016. “A Triple Win? The Impact of Tanzania’s Joint Forest Management Programme on Livelihoods, Governance and Forests, 3ie Impact Evaluation Report 34.” New Delhi, India: International Initiative for Impact Evaluation.

Robinson, E.J.Z., H.J. Albers, C. Meshack, and R.B. Lokina. 2013. “Implementing REDD through Community-Based Forest Management: Lessons from Tanzania.” *Natural Resources Forum* 37 (3): 141–52. doi:10.1111/1477-8947.12018.

Scheba, A., and O.S. Rakotonarivo. 2016. “Territorialising REDD+: Conflicts over Market-Based Forest Conservation in Lindi, Tanzania.” *Land Use Policy* 57: 625–37. doi:10.1016/j.landusepol.2016.06.028.

Vatn, A., G. Kajembe, E. Mosi, M. Nantongo, and D.S. Silayo. 2017. “What Does It Take to Institute REDD +? An Analysis of the Kilosa REDD + Pilot, Tanzania.” *Forest Policy and Economics* 83: 1–9. doi:10.1016/j.forpol.2017.05.004.

Vyamana, V. G. 2009. “Participatory Forest Management in the Eastern Arc Mountains of Tanzania: Who Benefits?” *International Forestry Review* 11 (2): 239–53.

Supplementary Information

Table A. Village governance criteria, questions and scoring thresholds

Criteria and Indicators	Scoring thresholds		
	+	~	-
1. User Organisation & Cohesion			
A. Is there a PFM group in the village and, if so, is everyone involved?	All included	Almost all	Exclusions or no group
B. Does everyone in the village participate in the VNRC activities (including meetings)? [for villages where this applies] Are all the legitimate forest users included in the PFM Group, and does the Council take into account the needs of all legitimate forest users?	Yes	Mixed	No
C. Does the Village Council take into account the needs of all legitimate forest users?	Yes	Mixed	No
D. Whose forest is it? Is there a sense of ownership of forest amongst villagers?	Strong	Moderate	Weak
E. What do you do when outsiders enter your forests illegally? Do you assert control (i.e. obstruct / apprehend / punish?)	Challenge & exclude	Moderate efforts	Open access
F. Do all the villagers who use the forest cooperate in looking after the forest?	Most-all (>2/3) united	Many (1/3-2/3)	Few (<1/3)
2. Communication & Awareness			
A. Are all forest users fully aware what PFM is about and who is or should be involved? [for villages where this applies]	Most-all (>2/3)	Many (1/3-2/3)	Few (<1/3): -
B. Are users aware of roles & responsibilities regarding the use and conservation of the village forest?	Fully	Somewhat	Not
C. Does the community know what REDD+ is? [new question in 2014 when REDD+ had already been introduced] [for villages where this applies]	Fully	Somewhat	Not
D. Did all villagers understand the Mpingo REDD project contract and agree to it? [for villages where this applies]	Most-all	Some / majority	None-few
3. Decision-making & Implementation*			
A. Is there regular committee & assembly interaction? Eg. How many village general assembly meetings were held last year?	Very good 4	Medium-good 2-3	Poor 0-1
B. Do ordinary villagers attend general assembly discussions?	Most: >⅔	Moderate: ⅓ to ⅔,	Few: <⅓

C. Is the decision making inclusive of whole village community? Eg Number of people not in leadership positions recorded as speaking in general assembly?	Good > 10	Medium 5-10	Poor 0- 4
D. Does each sub-village have discussions contributing to the Village Council and/or General Assembly?	Yes	Somewhat	No
E. Are the specific concerns of the different sub-villages considered in general village meetings?	Yes	Somewhat:	No
F. Are the agreed decisions at the Village Council, the General Assembly (and/or the VNRC meetings) actually implemented? [Check last year's record book]	Most: >⅔	Moderate: ⅓ to ⅔,	Few: <⅓
G. Is there any political interference / factionalism affecting forest management?	No	Somewhat	Yes
H. Communication – are decisions taken in the Village Council, the General Assembly (and/or the VNRC meetings) clearly communicated – eg through a notice-board? [New question in 2014]	No	Somewhat	Yes
4. Forest Management			
A. What percentage of the village forest reserve boundary is marked? [for villages where this applies]	>95%	25-95%	0-25%
B. How has the village forest reserve changed over the last 5 years? [for villages where this applies]	Improving	Stable unchanging	Deteriorating
C. How have the other village forests changed in the last 5 years? [for villages where this applies]	Improving	Stable unchanging	Deteriorating
D. Is the forest protection effective? Eg. Enforcement of management plan measures; protection against outsiders extracting, timber felling, grazing, fire etc.	Fully effective	Moderately	No
E. Do you have a forest management plan? If so to what extent implemented?	Fully implemented	Partly implemented	Not implemented
5. Forest Product Access & Distribution			
A. Are villagers' household forest product needs met? Eg. fuelwood, fodder, any other basic needs	Easily fulfilled	Hard but possible	Difficult or not possible
B. Can villagers still easily collect/harvest forest products for sale/business?**	Easily	Moderate	Difficult
C. Can villagers' use the forest equally? Or do some villagers or outsiders have preferential access for some reason? (may include bushmeat)	Fair / pro-local	Moderately fair	Unfairly pro-outside
D. Are forest products used sustainably or are they declining? (ie. all forest products from surrounding forests)	Stocks secure	Moderate stocks / at risk	Stocks declining
6. Gender and Equity Considerations			
A. Do women actively participate in village meetings? What is the % of comments coming from women in the Village Council and the Village General Assembly (and/or the VNRC)?	>33%	10% < 33%	<10%
B. Are the rights, duties, punishments the same for everyone?	Yes always	Mostly	No, unfair
C. Are the needs of the families that depend more on the forest, either formally or informally (eg. charcoal makers, timber harvesters, honey producers, etc.) specifically considered in forest management and use?	Favourable consideration	Somewhat	No

7. Economic / Fund development			
A. Is the use of the forest generating cash for the village? If so, what are the sources of this cash?	Significant	Modest	No
B. Is the money obtained from the village forests for the benefit of the community managed transparently by village authorities (and the VNRC)?	Full transparency & general knowledge	Some understanding	Unclear
C. Is the use of money coming from forest use agreed openly by everyone in the Village Council or the Village General Assembly?	Very democratic	Moderate	Unclear
D. What % of forest management incomes / profits are used for community development?	Significant (45% or more)	Modest (<45%)	None
8. Conflict Management			
A. Are there any disputes among community members and/or between community members and the government regarding forest management?	No	Moderate	Significant
B. Are the conflicts discussed above managed and resolved effectively?	Effectively managed	Moderately	Poorly
9. Linkage and Network development			
A. Are the regional or national forestry departments supportive and helpful? Eg. Have they offered training for sustainable forest management/backup for enforcing rules?	Helpful	Neutral	Cause problems
B. Does your village work with other organisations related to forest management? Eg. Non-governmental organisations, logging companies, etc.	Good links	Moderate	None-Poor
C. How beneficial is the relationship of the village with these other stakeholders for the management of your forest?	Very satisfactory	Satisfactory	Not very
D. How is the VNRC's relationship with the Village Executive Officer? [for villages where this applies]	Friendly and cooperative: proactive support given	Moderate: basic cooperation with no significant disputes	Poor: non-cooperative and/or significant disputes

* In future assessments this could be usefully split into 3 sub-criteria for VNRC, VC and VGA, which may show varying results, and which would be interesting to track separately. Some institutions might be more dysfunctional than others.
** Note the answer may properly be 'difficult', since commercial use of the forest is regulated.

Table B. Average subsistence crops income (Tsh) by village group, village and year (mean, standard deviation and sample size, respectively). 2014 data deflated using Consumer Price Index changes

Group	Summary Results (Tsh)			Village Mean (Tsh)	
	2011	2014	**Village**	2011	2014
Early Entry	**8,861** *(± 36,068, n=111)*	**0** *(± 0, n=101)*	Kikole	11,422	0
			Kisangi	13,051	0
			Liwiti	12,000	0
			Nainokwe	0	0
Late Entry	**9,505** *(± 34,873, n=136)*	**0** *(± 0, n=123)*	Likawage	15,200	0
			Mandawa	0	0
			Mchakama	14,482	0
			Mitole	11,309	0
			Ngea	5,000	0
Control	**8,140** *(± 34,468, n=171)*	**460** *(± 3.37, n=164)*	Mbwemkuru	0	0
			Mtandi	2,000	0
			Mtyalambuko	14,896	2,694
			Nakiu	11,000	0
			Nandete	21,923	0
			Ngorongoro	0	0

Table C. Average cash crop income (Tsh) by village group, village and year (mean, standard deviation and N, respectively). 2014 data deflated using Consumer Price Index changes

Group	Summary Results (Tsh)			Village Mean (Tsh)	
	2011	2014	**Village**	2011	2014
Early Entry	**317,645** *(± 351,585 n=111)*	**484,033** *(± 582,845, n=93)*	Kikole Kisangi Liwiti Nainokwe	454,250 223,071 370,920 234,020	565,800 543,168 671,416 190,234
Late Entry	**316,995** *(± 450,568, n=135)*	**454,039** *(± 551,029, n=120)*	Likawage Mandawa Mchakama Mitole Ngea	526,052 380,370 175,710 291,948 161,900	641,240 565,800 369,656 475,272 188,600
Control	**286,204** *(± 413,774, n=170)*	**271,837** *(± 412,089, n=161)*	Mbwemkuru Mtandi Mtyalambuko Nakiu Nandete Ngorongoro	318,846 385,779 201,862 518,952 124,071 165,500	445,096 226,320 181,056 505,448 90,528 105,616

Table D. Correlations between proportion of cultivated sesame and cashew, and household total income and total agricultural income

		Total income		Total agricultural income	
		2011	2014	2011	2014
	Village	Correlation	Correlation	Correlation	Correlation
Early Entry	Kikole	Non Sig.	0,50	0,37	0,65
	Kisangi	0,47	Non Sig.	0,48	Non Sig.
	Liwiti	Non Sig.	Non Sig.	Non Sig.	Non Sig.
	Nainokwe	Non Sig.	Non Sig.	Non Sig.	Non Sig.
Late Entry	Likawage	0,44	Non Sig.	0,51	0,44
	Mandawa	0,32	Non Sig.	Non Sig.	Non Sig.
	Mchakama	Non Sig.	Non Sig.	Non Sig.	Non Sig.
	Mitole	0,43	Non Sig.	0,42	Non Sig.
	Ngea	0,51	Non Sig.	0,49	Non Sig.
Controls	Mbwemkuru	0,42	Non Sig.	0,44	Non Sig.
	Mtandi	0,37	Non Sig.	0,42	Non Sig.
	Mtyalambuko	Non Sig.	0,37	Non Sig.	Non Sig.
	Nakiu	Non Sig.	Non Sig.	Non Sig.	Non Sig.
	Nandete	Non Sig.	0,61	Non Sig.	0,57
	Ngorongoro	0,45	0,67	Non Sig.	0,68

Table E. Average forest products cash income (Tsh) by village group, village and year (mean, standard deviation and N, respectively). 2014 data deflated using Consumer Price Index changes

Group	Summary Results (Tsh)			Village Mean (Tsh)	
	2011	2014	**Village**	2011	2014
Early Entry	**2,072** *(± 7,810, n=113)*	**33,291** *(± 90,528, n=91)*	Kikole	2,167	75,440
			Kisangi	2,393	3,018
			Liwiti	1,200	24,168
			Nainokwe	2,403	36,117
Late Entry	**2,375** *(± 15,042, n=136)*	**26,564** *(± 65,212, n=123)*	Likawage	10,500	32,410
			Mandawa	0	34,325
			Mchakama	0	16,341
			Mitole	0	7,183
			Ngea	400	45,471
Control	**925** *(± 9,327, n=173)*	**37,925** *(± 75,440, n=159)*	Mbwemkuru	4,615	67,173
			Mtandi	333	50,935
			Mtyalambuko	1,034	37,427
			Nakiu	0	29,292
			Nandete	0	13,611
			Ngorongoro	0	31,114

Figure F. Gini coefficient (without outliers) by village and year

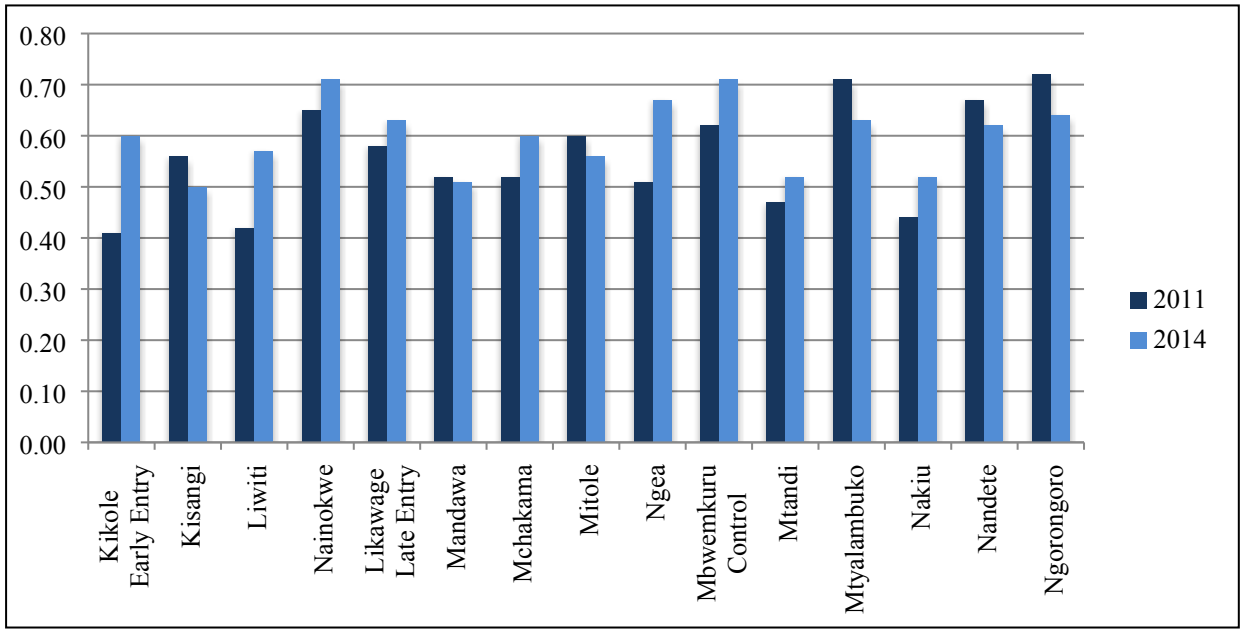


Figure G. Average MCDI-related fees (in Tsh) by participant village

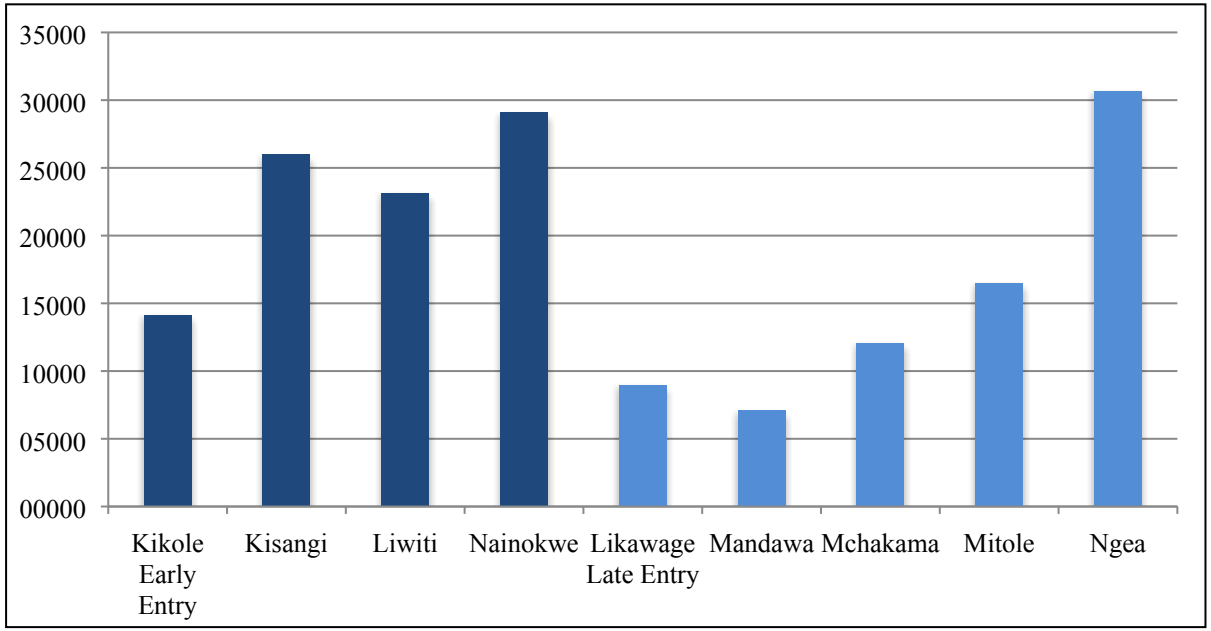


Figure H. Household head members' knowledge of MCDI activities in early entry villages, by gender

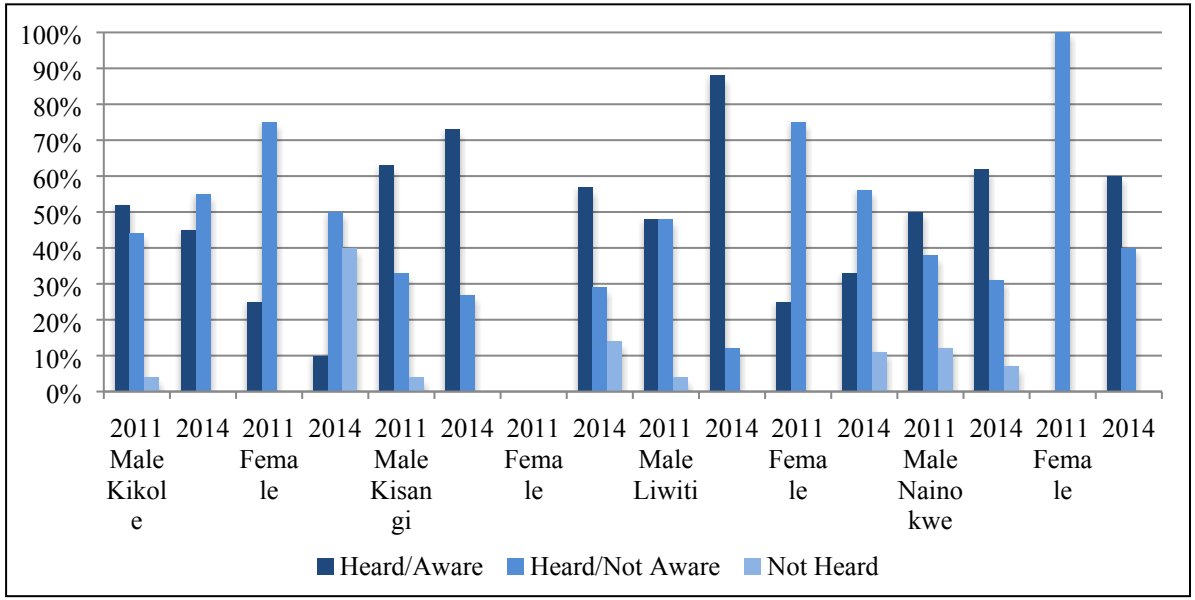


Figure I. Household head members' knowledge of MCDI activities in late entry villages, by gender