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A triple win?

The impact of Tanzania's Joint Forest Management programme on livelihoods, governance and forests

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A triple win? The impact of Tanzania's Joint Forest Management programme on livelihoods, governance and forests

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Summary

Estimated government and donor funding to support Joint Forest Management (JFM) in Tanzania since the early-1990s exceeds US$30 million. While there are many small-scale and site-specific studies on JFM in Tanzania, no large-scale, independent and rigorous studies have to date sought to examine the program's impact. In the absence of strong evidence, implementers and policymakers have come to their own conclusions about whether JFM delivers on its core objectives of (1) restoring forests, (2) improving livelihoods, and (3) strengthening local governance.

JFM in Tanzania reflects the increasing emphasis across developing countries on the use of collaborative management approaches between governments and local communities to conserve natural resources and improve the livelihoods of impoverished local communities, which bear the opportunity costs of resource conservation. Decentralization is hypothesized to conserve resources as well or better than centralized management by government agencies, while also strengthening the governance and livelihoods of local populations. Decentralization has been viewed as one of few potential tools to address conservation goals as well as the underlying social, economic, and governance challenges that drive unsustainable resource use and habitat loss. At the same time, its effectiveness as a conservation tool remains poorly understood.

This study aims to contribute towards filling these knowledge gaps by assessing the impact of JFM in Tanzania on each of the three sets of outcomes. The study was supported by 3ie and implemented by researchers at the University of North Carolina at Chapel Hill, USA, in collaboration with the Tanzania Forest Conservation Group. The study was undertaken across 110 sites and 3,363 households in 7 regions of Tanzania. This included 42 control sites (forest reserves and villages not under JFM) and 68 JFM sites. Primary data was collected over a 16-month period between 2012 and 2014, using household surveys, focus group discussions with members of village institutions, key informant interviews with local government staff and data collection in forest plots.

The study used rigorous impact evaluation methods to determine JFM impacts. Initial research was conducted to characterize how villages and forest reserves selected for JFM by government, donors and projects differ from those not selected for JFM, prior to implementation, across key factors that can confound outcomes under JFM. To overcome the effect of these administrative selection biases, a random pool of JFM and non-JFM forest reserves and villages was drawn up, such that the JFM sites were very similar to the non-JFM sites across these key confounders. The total number of sites was determined through a power analysis targeted at the detection of fairly fine-scale impacts from JFM, if they were present. Statistical analyses followed best-practices for quasi-experimental matching processes, including careful construction of the control group and matched sample, use of a difference-in-difference estimator where possible, which draws on baseline data prior to JFM implementation, and running sensitivity analyses and other robustness checks to assess confidence in the results.

Key findings

1. JFM has a strong positive impact on local-level governance, particularly on the good governance functions of village natural resource committees and, to a smaller extent, on village governance overall. JFM has a positive impact on governance even in poorer villages and households, though the impact is not as great as in less poor villages and households.

2. There is no evidence of an impact (positive or negative) of JFM on livelihoods, but there are weak indications of improvements in subsistence forest product harvesting. We could not detect any impacts of JFM on overall household income, forest-derived income, or an asset-based measure of wellbeing. We also found that JFM slightly increases the number of forest products that households harvest from forest reserves, which may benefit household subsistence needs.

3. There is no evidence of impact of JFM on extreme forest degradation and deforestation, although there is weak evidence of JFM slowing forest degradation. We found no significant difference in deforestation rates between JFM and non-JFM forest reserves during 2000–2012. We found weak evidence that households in JFM villages viewed JFM reserves as improving over the same period. This may be linked to declines in household harvesting and improved protection in JFM reserves.

4. There is wide variation in the extent to which the actual implementation of JFM conforms to the program's formal design as set out in Tanzanian policy, particularly around revenue-generation opportunities and revenue-sharing arrangements with villages, and full legal processing of JFM agreements with villages. The strong impact observed on governance, even in the absence of full legal implementation, could suggest that more positive impacts on forest conservation or livelihoods follow under a supportive legal environment (as provided under the Forest Act), though robust assessment of this requires further study.

5. The positive changes in governance resulting from JFM are encouraging, but the lack of improvement in the livelihoods of villagers engaging in JFM call into question its long-term sustainability at the local level, and suggest a need for a more careful consideration of the contexts in which JFM should be targeted.

Thus, our study finds positive impacts for the first step in a hypothesized causal pathway from decentralization via JFM to improved forest governance outcomes at the village level. We do not find evidence that JFM improves household livelihoods, on average, but our study also demonstrates that JFM is predominantly implemented in contexts where there are no obvious livelihood opportunities for villages which participate in managing government forest reserves. In terms of forest conditions, we find that JFM does not lead to a change in deforestation rate compared to that of the

centrally-managed forest reservation system in Tanzania during the period 2000–2012, but we do find weak evidence that households may be changing their harvesting behavior in JFM forest reserves due to stricter protection and more effective patrols. These effects may eventually lead to improved forest conditions over a longer period of time.

Key recommendations for policy and practice

Overall, the study findings point to the net positive impact of JFM in comparison to the traditional state-managed approach in Tanzanian forest reserves. This positive outcome is encouraging, especially considering that JFM has not been formally implemented in accordance with its design in policy and legal reforms mandated by the Tanzanian Forest Act and Forest Policy. Despite this, our study finds evidence that improved village-level governance, the first step towards intended overall impacts, appears to be taking hold.

JFM could be further strengthened by:

1. Speeding up the approval and formalization process, with respect to by-laws at the local government level, and the signing of Joint Management Agreements between government and villages participating in JFM at the national level;

2. Reviewing how benefits for communities can be generated from protection forest reserves in Tanzania: Measures are needed to capture the significant contributions made by protection (catchment) forests to power generation and water supply and ensure that communities living around these forests are compensated for the environmental services they provide to the country as a whole; and

3. Improving targeting at the local level, with implementers ensuring that the poorest households amongst targeted communities, which depend most heavily on forest resources for their livelihoods, also benefit from JFM.

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Abbreviations and acronyms

ATT	average treatment effect on the treated
CBFM	Community Based Forest Management
CIFOR	Center for International Forestry Research
DEM	Digital Elevation Model
DID	difference-in-difference
FBD	Forest and Beekeeping Division
FR	forest reserve
GIS	Geographic Information System
GoT	Government of Tanzania
HBS	household budget survey
ICC	intraclass correlation coefficient
IE	impact evaluation
IFRI	International Forestry Resources and Institutions
JFM	Joint Forest Management
JMA	Joint Management Agreement
MDES	minimum detectable effect size
MNRT	Ministry of Natural Resources and Tourism
NBS	National Bureau of Statistics
NGO	non-governmental organization
NTFP	non-timber forest product
PCA	principal component analysis
PEN	Poverty Environment Network
PFM	Participatory Forest Management
TASAF	Tanzania Social Action Fund
TFCG	Tanzania Forest Conservation Group
TFS	Tanzanian Forest Service
URT	United Republic of Tanzania
VCF	vegetation continuous fields
VEC	village environment committee
VFMA	Village Forest Management Area
VNRC	Village Natural Resource Committee
WDPA	World Database of Protected Areas

1. Introduction

The move by country governments to decentralize their natural resource sectors (most commonly wildlife, forests and water resources) is one of the most significant and widespread environmental policy trends in recent decades. The shift towards decentralization has now been adopted by nearly all nations around the world (Faguet 2013). Over the last 30 years, nearly all developing countries have passed legislation to decentralize at least some portion of the rights, responsibilities and public resources associated with natural resource governance to local administrative bodies, local community groups (communal management), or some combination of these agents (co-management) (Agrawal and Ostrom 2001; Larson and Soto 2008; Phelps *et al.* 2010). A large body of literature which scrutinizes the impacts of natural resource sector decentralization has emerged as a result, seeking to compare these different modes of decentralization as well as assess their outcomes relative to centralized approaches.

Decentralized natural resource management is now widely ensconced in conservation practice, implemented in accordance with government policy in the forest, water, wildlife or fisheries sectors of nearly all countries in Latin America, Sub-Saharan Africa, and Asia. Decentralization is hypothesized to conserve resources as well or better than centralized management by government agencies, while also strengthening the governance and livelihoods of local populations (Larson and Soto 2008; Tacconi 2007). It has been viewed as one of few potential tools to address the goals of conservation as well as the underlying social, economic and governance challenges that drive unsustainable resource use and habitat loss (Adams *et al.* 2004). At the same time, the effectiveness of decentralization as a conservation tool remains poorly understood, partly because there is little conclusive work on the potential for livelihoods and conservation goals to be jointly met through decentralization, and even less understanding of the mechanisms by which such approaches might better conserve forests or improve livelihoods (Barrett *et al*. 2011).

Few existing studies in the forest sector use rigorous counterfactual approaches to determine decentralization outcomes (Samii *et al*. 2014), although these methods have been used to assess other forest-based interventions such as strict protected areas and payments for environmental services. Notable decentralization studies that do employ a counterfactual approach include Jumbe and Angelsen (2006) and Ameha *et al.* (2014). Jumbe and Angelsen (2006) used propensity score matching to examine the impacts of forest decentralization in Malawi on forest income, and find opposing directions of outcomes across the two forests included in their study. Ameha *et al*. (2014) used a matching approach to examine the impacts of participatory forest management on total income, forest income and other livelihoods measures across households that participate in a forest user group and those that do not. They find contradicting directions of livelihoods impacts across the two sites they study, suggesting that localized context around different harvesting permissions and subsistence versus commercial harvesting influences the efficacy of Participatory Forest Management (PFM) on livelihoods.

Recent non-counterfactual studies point to broad improvements from decentralization in terms of local governance (Andersson *et al*. 2009; Grindle 2007) and resource conservation as a whole (Phelps *et al*. 2010; Porter-Bolland *et al.* 2012; Somanathan *et al*. 2009), when substantive authority is sufficiently transferred to local institutions (Larson and Soto 2008; Persha *et al*. 2011). However, findings around livelihoods outcomes for community members highlight a range of issues, with some studies pointing to generally positive outcomes, but several others drawing attention, for instance, to widening wealth gaps across households, improvements to subsistence but not income-based components of livelihoods, ineffective pro-poor targeting, or substantial scale differences between household- and community-level benefits under decentralization (Maharjan *et al*. 2009; Schreckenberg and Luttrell 2009; Sikor and Nguyen 2007; Thoms 2008).

As in many developing countries aiming to achieve a balance of biodiversity conservation and livelihoods improvements for poor rural populations, Tanzania has sought to use governance changes via decentralization to alter the incentive structure for use and management in ways that are perceived to engender more sustainable trajectories of forest stewardship in coming decades. Decentralization theory suggests that local decision-makers will make more informed and efficient management decisions than central governments, due to their site-specific forest knowledge and lower cost of engaging in management activities. Additionally, the transfer of management powers is seen to incentivize local villagers to manage forests sustainably, due to their own dependency on forest resources (Agrawal and Chhatre 2007; Ribot *et al*. 2006). However, the evidence base for forest sector decentralization impacts, and the mechanisms that underlie any effects, remain notably limited.

Here, we use a quasi-experimental matching approach to determine the average impacts of Tanzania's decentralized forest policy across its three objectives of improved local governance of forests, household livelihoods and forest conditions. To do so, we draw on data collected across 110 villages and 3,363 surveyed households. Secondly, given abundant literature which suggests barriers to access or benefits from decentralized forest management for less empowered groups or households, we assess how governance and livelihoods outcomes vary for poorer villages and poorest households relative to others in the sample. We additionally draw on rich qualitative and contextual data collected from each of the study sites, to gain insights into how JFM can be better targeted towards village and forest reserve contexts where it is likely to have positive impacts.

2. Description of intervention and theory of change

2.1 Forest sector decentralization in Tanzania

Tanzania's PFM program aims to achieve three objectives through decentralized forest management: better resource governance, improved local livelihoods, and enhanced forest conditions. PFM was introduced in 1998 and strengthened through the government's 2001 National Forest Programme. As of the last comprehensive assessment conducted by the Government of Tanzania (GoT) in 2008, implementation covered more than 60 districts in the country, affecting nearly 20 percent of villages (more than 2,300), and 12 percent of Tanzania's forests by area (MNRT 2008).

PFM in Tanzania encompasses two approaches. The first is Joint Forest Management (JFM), where the forest department and a community institution jointly manage a government forest reserve and formally share revenues. JFM is largely implemented in existing Forest Reserves (FR) that were previously under centralized management by government, with no formal role or scope for participation by nearby communities, which typically consist of households that are to varying extents dependent on forest resources for subsistence and/or cash-income inputs to their livelihoods. Under JFM, the government and a village institution jointly manage a government forest reserve via a formal co-management agreement and decentralized process. JFM creates forest management institutions in villages, with a formal decision-making role for villagers around the conservation and management of government forest reserves. It specifies a set of management activities that communities should engage in as part of JFM, implements a legal agreement on the allocation of rights and responsibilities around forest use and management on the part of the government and community signatories, and provides for revenue-sharing from forest management activities between government and communities.

The second is Community-Based Forest Management (CBFM), where a community institution gains collective ownership and sole management authority over a village forest. Key differences between JFM and CBFM concern the extent of participation by villagers, provisions for revenue-generation and sharing, distribution of tenure rights over forests, and allowable harvesting activities. This study focuses on JFM. Tanzania's PFM is cited as a model strategy for developing countries to better protect forests and alleviate rural poverty. However, clear evidence and drivers of impacts across either JFM or CBFM, and the mechanisms through which positive outcomes might be generated across the program's three distinct objectives, are not well-understood.

Tanzania's JFM program aims to achieve its policy objectives through decentralization of forest management authority to local government or community-based institutions. However, 15 years after its introduction, there is still little empirical understanding of its impacts. Recent studies have made useful contributions (Friis and Treue 2008; Meshack *et al.* 2006; Persha and Blomley 2009; Vyamana 2009), but the ability to draw robust conclusions across them is limited by small case numbers, insufficient controls for confounding variables, incompatible methodologies, and a selective emphasis on JFM or CBFM, a single forest type, or a sub-set of objectives rather than forest conditions, governance and livelihoods together.

To date, all empirical understanding of JFM impacts in Tanzania rests on comparative studies rather than counterfactual analyses, and no existing study that we are aware of factors potential selection biases around JFM implementation into the research design. Furthermore, the largest existing comparative study of JFM in Tanzania to date consists of just 12 forest reserves and villages, but these cases are allocated across JFM, CBFM and centralized sites (see Treue *et al.* 2014). Prior research efforts in Tanzania have typically compared all three of these management approaches within the same analytic frame and assumed that each management approach serves as an appropriate control case for the other two. However, this is methodologically problematic because JFM and CBFM are generally implemented in mutually exclusive contexts, and through different processes. CBFM takes place on village lands, which were often severely degraded or with little forest cover prior to CBFM, whereas JFM is implemented in existing government forest reserves. Furthermore, CBFM is implemented through a different set of extension actors than JFM, and also transfers a much more comprehensive set of forest and land tenure rights to villages than JFM.

These limitations on sample size, comparison cases and analytic framings have made it difficult to draw firm conclusions about general and specific impacts attributable to JFM in Tanzania. Nevertheless, broad trends from the existing literature on JFM that is based on individual cases or small-n comparisons suggest improvements to forest conservation but not to livelihoods, while there has been a suggestion that governance issues remain problematic (Nielsen 2011; Nielsen and Treue 2012). Other studies have suggested small improvements to livelihoods but also increased capture of benefits by village elites (Lund and Saito-Jensen 2013; Vyamana 2009). All of the existing studies also point to a range of different outcomes across different sites, likely mediated by a host of contextual factors (Schreckenberg and Luttrell 2009). Heterogeneous outcomes are expected under JFM, given the wide range of village and forest contexts in which the program is administered, which reflects the difficulties of extracting average program effects from small numbers of comparative case studies.

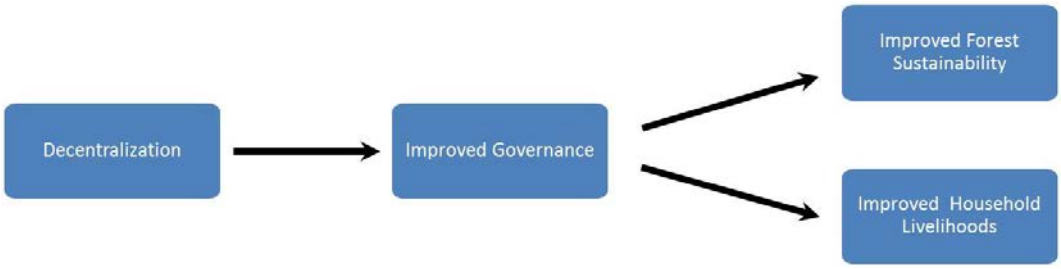
2.2 Intended impacts and pathways to impact

Forests provide important ecosystem services and sustain overwhelming numbers of the rural poor (Sunderlin *et al*. 2005). As forests continue to decline globally, decentralization reforms underway in more than 60 countries aim to improve rural livelihoods and conserve forests in tandem, by transferring management powers to local communities and governments. However, decentralization theory also holds that implementing agents are likely to choose to implement JFM in forest reserve and village contexts where the costs of undertaking the administrative transactions required under a program such as JFM are lower (Treisman 2007). This calls for careful attention to program administrators' explicit and implicit selection biases in terms of where they choose to implement JFM.

We represent the basic pathway to impact for JFM in Figure 1. However, we note that – as we suspect is the case for many decentralization policies under implementation across a range of countries and sectors – policy implementers for JFM in Tanzania do

not specify the processes by which they expect impacts to be generated. In fact, even the representation of improved governance as a mechanism for improved forest sustainability and household livelihoods is assumed rather than clearly stated. In our experience, we find little explicit articulation of the hypothesized mechanisms by which any step in this chain is expected to lead to the next one. The JFM policy and guidelines for Tanzania are opaque on this issue, and this reflects the state of JFM and forest sector decentralization policy implementation globally as well.

Figure 1: Basic conceptual framework for pathways to impact for JFM



Our analyses in this study focus primarily on estimating the average effects of the JFM program. However – as the program evaluation literature increasingly highlights (Ravallion 2009) – we do not expect JFM to impact each village uniformly. We expect instead that particular characteristics of villages, forest reserves, broader landscape and socio-political context, and households within villages, could potentially act as moderators of JFM impacts, leading to heterogeneous impacts across key factors. Understanding the drivers of this potential heterogeneity is useful for generating knowledge on where the program might be targeted for more effective results, or identifying more challenging contexts where the existing program design may need to be strengthened or explicitly modified to generate more desirable outcomes. In this report we focus on estimating the heterogeneity of JFM impacts by wealth subgroups, both in terms of poorer villages relative to wealthier villages, and within-village wealth variation. We particularly note that there are several household-level factors that could play a role in the extent to which households within JFM villages choose – or are able to exercise their right – to participate in the JFM process. These could include, for example, the nature and extent of household use of forest products (which often aligns with overall household wealth status), or the extent of household connectedness to existing village governance institutions and village elites (which may shape a household's ability to participate in governance aspects of JFM within the village).

There are also a number of theories related to why richer and poorer households within the same village might be affected differently by JFM. These include the processes of exclusion by wealthy village elites which might work to shut poorer households out of JFM benefits (Persha and Andersson 2014), or higher barriers of access to tools, capital or markets for poorer households, which might preclude them from taking advantage of higher-return forest-based livelihoods opportunities under JFM. It is also possible that poorer households might see more improvements to their livelihoods relative to wealthier households under forest sector decentralization, for instance due

to pro-poor positive governance changes which reduce access inequities and open up new forest-based livelihoods opportunities to such households, or as a result of expanded subsistence harvest allocations under JFM.

2.3 Program implementation

In Tanzania, forest agency staff decide where to implement JFM in roughly a two-stage process that is also influenced by the priorities of the different donor agencies that funded the process in different parts of the country. Forest reserves are selected for JFM on the basis of set agency priorities, followed by a selection of villages adjacent to each selected reserve in which to begin the sensitization and formal agreement process for co-management. The process is also influenced by donor agencies funding JFM, and non-governmental organizations (NGOs) partnering in implementation, and to date has tended to be oriented around biodiversity conservation objectives in many regions. All of the villages surrounding a selected reserve are intended to be involved in JFM, but in practice government authorities typically begin with a small number of villages surrounding each reserve, and may eventually expand to the remaining villages, contingent on funding and other resources. In that sense, there is an implicit village-level selection that occurs after reserve selection. We examined and accounted for both levels of potential selection bias in our study, incorporating pretreatment covariates related to the selection of forest reserves into JFM, and those associated with the selection of villages in which JFM has occurred to date.

A broad description of the basic process of engaging in JFM is described in Figure 2 below, as set out for local government staff and forest officers working on PFM implementation at local levels, in the most recent version of GoT's JFM guidelines (URT 2013).

Figure 2: Broad process steps for JFM implementation (URT 2013)

PART III

The JFM Process

Overview of the six basic stages in planning for JFM

Stage One: Getting Started

This takes place at the district or forest level, with the selection of forest area and the surrounding villages, together with briefing of district staff and the formation of a team of staff with different skills to do the work. At the village level, you meet with Village Council and Assembly and facilitate the establishment and orientation of the Village Natural Resource Management Committee.

Stage Two: Assessment and Management Planning

This is where together with members of the VNRC you confirm, agree and mark the boundaries of the forest as well as the internal Village Forest Management Areas, (if the forest is to be managed on a village-by-village basis). The forest is then "assessed", and if it is to be utilised for timber or other forms of harvesting, the trees measured to calculate sustainable harvesting levels. Based on this, a management plan is developed for the VFMA.

Stage Three: Formalising and legalising

This is where you provide communities with the legal basis for management. A Joint Management Agreement is prepared that defines how management costs, benefits and responsibilities are to be shared. The JMA is negotiated based on the broad management objectives set out in the forest management plan for the VFMA and where it exists, the Forest Reserve itself. The draft JMA is discussed by the Village Assembly and forwarded to FBD (or the District Council) for comments. Based on comments received, the JMA is finalised and signed by FBD/District Council and the Village Council. Bylaws are developed to support the enforcement of the JMA. Once the JMA has been signed, the villagers can now start implementing their management plan.

Stage Four: Implementing

This is where you help the community put the systems needed to manage the forest in place: appoint and train the Patrol team, start records, make sure the rules are known, and so on. You need to visit frequently, keep an eye on progress and help out with problem-solving. After a few years of implementation it may be necessary to make some changes in the plan or the bylaws.

Stage Five: Revising

After three years, or so, the management plan can be reviewed to see if any changes need to be made, such as harvesting levels, rules, fines and so on.

Stage Six: Expanding to new areas

It is likely that other villages will start requesting JFM in their villages. It is during this stage you plan and budget for expanding into new areas.

Figures 3 and 4 list the expected responsibilities and benefits for villages engaging in JFM, as outlined in the GoT JFM Guidelines (URT 2013). These include forest management tasks that communities are asked to perform, such as: patrol and monitor the forest for illegal activities, fight forest fires, hold monthly meetings in the village, report on monitoring, revenues and expenditures, and oversee planting and harvesting operations where they are allowed. The responsibilities and benefits are slightly different for forest reserves under more restrictive protection, such as catchment forest reserves and nature reserves. Here, the main difference is that no harvesting activities are allowed in such reserves beyond dead fuelwood collection, and communities are asked to participate in developing tourism and research activities that the Tanzanian government implements in these higher protection status reserves. Benefits as stated by government range from community right of access to enter the reserve and harvest a range of products, to the right to claim varying percentages of cash revenues generated from the forest reserves that might accumulate across activities such as commercial harvesting, timber royalties, carbon sales, fines from illegal activities, and research and ecotourism opportunities.

Figure 3: Table of community responsibilities and benefits under JFM, in productive government forest reserves (URT 2013)

Productive Forests (Terrestrial and Mangrove)		
Community Responsibilities (Conditional on receipt of benefits)		**Community Benefits (Conditional on fulfilment of responsibilities)**
Partipate in preparation and implementation of the JMA		41% of profit gain from carbon is paid to the communities, the remaining part to go to the owner of the forest
Patrolling and enforcing laws stipulated in the management plan of the forest		32% of fines retained in the village from offences committed in the VFMA, the remaining part to go to the owner of the forest
Enrichment planting of apropriate and favoured timber species		19% of timber royalty fee is paid directly to village government and the remaining is paid to the owner of the forest
Conduct village meetings to discuss general forestry issues quartary and monthly VNRC meetings.	▶	46% of the net revenue from confiscated forest products goes to Village Government and the other 54% goes to TaFF/District Council. The confiscated equipment and tools are remitted to relevant forest authorities
Submit quarterly implementation and monitoring report to the owner of the forest		Employment opportunities in various forest activities
Prevention, controlling and fighting fire in VFMA		Access to forest for beekeeping activities using appropriate technology
Supervising harvesting operations including identification of harvesting areas and resource assessment	◀	Access to forest for collection of vegetables, mushrooms, medicinal plants (without dameging the plant), fibres, thatching and fodder grass collection, dead fuel wood and fruits. Also right of way, attending ritual areas, bamboo wine taping and water access for irrigation and domestic use basing on regulations governing the forest use
Manage tree nurseries and plant trees in their farm lands		Access to fishing and hunting will be done in accordance with relevant laws and regulations and any benefits accrued from these activities
Report on revenue collection and expenditure to the village assembly quartarly		35% of research, entry, camping, instalation of tansimission towers and filming (permits) fee goes to the Village Government and the remaining part to go to the owner of the forest
Prepare and keep proper forest management records		
Participate in protecting and controlling ellegal activities along water sources and environment inside and outside the forest		
Participate in all meeting related to the management of the forest		
Ensure forest boundary becons and signs are not removed or destroyed		

Note: These images are less than optimal and have been reproduced from the original source.

Figure 4: Table of community responsibilities and benefits under JFM, in more strictly protected government forest reserves (Catchment Reserves or Nature Reserves) (URT 2013)

Protective Forests (Nature Reserves)	
Community Responsibilities (Conditional on receipt of benefits)	**Community Benefits (Conditional on fulfilment of responsibilities)**
Partipate in preparation and implementation of the JMA	46% of profit gain from carbon is paid to the communities, the remaining part to go to the owner of the forest
Patrolling and enforcing laws stipulated in the management plan of the forest	32% of fines retained in the village from offences committed in the VFMA, the remaining part to go to the owner of the forest
Prevention, controlling and fighting fire in VFMA	36% of research, entry, camping, instalation of tansimission towers and filming (permits) fee goes to the Village Government and the remaining part to go to the owner of the forest
Conduct village meetings to discuss general forestry issues quartary and monthly VNRC meetings.	26% of revenue generated from ecotourism is paid to the communities, the remaining part to go to the owner of the forest
Controlling and timely reporting acurately on illegal activities to the relevant forest authorities ▶	49% of the net revenue from confiscated forest products goes to Village Government and the other 51% goes to TaFF/District Council. The confiscated equipment and tools are surendered to relevant forest authorities
Vermin control and loss of crops, property and human life in colaboration with the owner of the forest	Employment opportunities in various forest activities
Develop tourism areas and ensure security of tourists, students and researchers in VFMA	
Removal of invasive exotics, (based on supportive research and on managed basis) boundary planting and gap management using right species and allowing natural regenaration to take place to ensure recovery of biodiversity	Access to forest for collection of vegetables, mushrooms, medicinal plants (without dameging the plant), fibres, thatching and fodder grass collection, dead fuel wood and fruits. Also right of way, attending ritual areas, bamboo wine taping and water access for irrigation and domestic use basing on regulations governing the forest use
Submit quarterly implementation and monitoring report to the owner of the forest	Access to forest for beekeeping activities using appropriate technology
Prepare and keep proper forest management records ◀	
Participate in protecting and controlling ellegal activities along water sources and environment inside and outside the forest	
Report on revenue collection and expenditure to the village assembly quartarly	
Participate in all meeting related to the management of the forest	
Ensure forest boundary becons and signs are not removed or destroyed	

3. Impact evaluation objectives and evaluation questions

The overarching goals of this impact evaluation of Tanzania's JFM are to: (1) determine JFM's average impacts on its stated goals of improved village governance, household livelihoods, and forest conditions; (2) understand if and how JFM impacts poorer villages and the poorest households within villages differently from other villages and households; and (3) draw on our study findings to generate policy-relevant recommendations for how JFM might be modified or better targeted to meet its goals more effectively. Our study uses a quasi-experimental research design across 110 decentralized and matched control sites in eastern Tanzania, collecting data from some 3,360 households, 110 villages and all adjacent forests, and implementing agency staff from 22 districts, to evaluate decentralization impacts across forest conservation, household livelihoods, and local governance outcomes. Tanzania's decentralization policy, introduced nearly 15 years ago, has served as a model for countries throughout Sub-Saharan Africa, but a nuanced understanding of the policy's impacts on any of its three major goals is lacking.

Three primary research questions guide this impact evaluation:

1. What is the average treatment effect on the treated (ATT) of JFM on each of the three families of outcomes that the program aims to impact—forest governance within villages, household livelihoods, and forest conditions in Tanzanian forest reserves?
2. How do JFM impacts vary across key subgroups of interest, particularly for the poorest villages and households relative to other villages and households?
3. Drawing additionally on rich qualitative and contextual data collection from each of the sites in our study, in what ways can JFM be better targeted towards village and forest reserve contexts where it is likely to have positive impacts?

4. Evaluation design

Tanzania's JFM program has been under implementation since 1998; thus we use a quasi-experimental design and a potential outcomes framework to determine the program's impacts on village-level forest governance, household-level livelihoods, and forest conditions in Tanzanian forest reserves. The quasi-experimental design relies on constructing the JFM treatment and control samples such that the control pool has a similar distribution to the treated pool across all pretreatment covariates, which relate to systematic bias in where JFM is implemented and also affect outcomes. For each family of outcomes, we test for the null hypothesis that JFM has no effect on outcomes (two-sided tests for significance). Assuming the null hypothesis is rejected, Section 4.1 describes expectations around the direction of effect, as suggested by the program's intended outcomes and potential pathways to impact. Additional design details related to constructing the counterfactual pool, power calculations, sampling details and data collection, and our analytic approach, are also elaborated in this section.

4.1 Hypotheses

H1. Villages under JFM implementation have more positive forest governance outcomes, as indicated by village-level means for household satisfaction with village government overall, with the Village Natural Resource Committee (VNRC) tasked with forest management issues, and by a comprehensive forest governance index which characterizes core aspects of good governance within villages.

- JFM villages have higher rates of household participation in VNRC and/or Village Environment Committee (VEC) elections;
- JFM villages have higher household participation rates in substantive forest management activities, such as drawing up or modifying rules about forest use or management, forest monitoring and sanctioning processes, and forest-related dispute resolution;
- JFM villages have a higher level of household knowledge over forest management information for the neighboring forest reserve;
- VNRC and VEC institutions in JFM villages are involved in a more diverse and substantive range of forest management activities;
- VNRC and VEC institutions in JFM villages are perceived by households to be more transparent, accountable and legitimate.

H2. Households in villages under JFM experience a positive change in overall livelihoods, as indicated by higher village-level mean per capita annual household income overall, higher mean per capita annual household income from forest products, an asset-based measurement of household wellbeing, and the mean number of forest products harvested from the forest reserve.

- Households in JFM villages harvest a greater number of forest products from the adjacent forest reserve;
- Households in JFM villages are able to take advantage of a greater number of income-based opportunities around forest products, as indicated by mean per capita annual household income from forest products;
- Households in JFM villages are able to benefit from the forest reserve and capitalize on their involvement in forest management in a number of diverse ways that can contribute to their improved livelihoods overall, as measured by higher mean per capita overall income and an asset-based measurement of overall household wellbeing.

H3. Forest reserves under JFM are better conserved relative to non-JFM forest reserves, as indicated by mean rate of deforestation over 2000–2012, household ranking of forest condition trajectory since the year 2000, and village-level means for the household change in quantity of forest products harvested from the forest reserve since the year 2000.

- Increased perceived legitimacy of forest rules, overall forest governance improvements within JFM villages, and more effective forest monitoring in JFM reserves will result in lower outright deforestation;

- Households in JFM villages will respond to forest management and governance changes under JFM by altering their harvesting behavior in line with more sustainable forest use;
- Households in JFM villages will perceive improved forest conditions over the period since JFM implementation.

H4. Poorer villages will experience no difference in JFM impacts relative to wealthier villages.

H5. The poorest households within JFM villages will experience more positive governance and livelihoods outcomes relative to wealthier households and/or villages.

- JFM opens opportunities for a wide range of villagers to participate in forest governance processes, which we expect could create space for more marginalized community members (such as the poorest households) to experience more equitable processes around forest resource access and governance in ways that they tend traditionally to be shut out of. (For example, being allowed to participate in management decisions, or reduced inequitable targeting of fines and punishments of forest rule-breakers to marginalized individuals who are less able to contest such decisions.)
- Poorer households in rural Tanzania tend to rely on forest resources for livelihoods inputs to a greater extent than wealthier households, because wealthier households have more resources to take advantage of non-forest alternatives. JFM is supposed to expand forest access and livelihoods opportunities for all villagers, so we hypothesize that all villagers will have greater opportunity to participate in forest management, to access forest-based livelihoods opportunities, and to otherwise benefit from forest governance processes.

4.2 Constructing the counterfactual

Since its introduction, JFM roll-out has occurred in waves across districts in the country, often coincident with new donor support and as new projects are established with NGOs to support district-level processes. Within each district, JFM typically has been established in a small number of forests and villages initially, slowly spreading to new locations as resources become available. In many districts or regions, several government FRs still remain under the pre-JFM centralized management approach, or the status quo forest management approach in Tanzanian forest reserves prior to the introduction of the JFM program. We use a selection of these non-JFM forest reserves and adjacent village pairs as the control group to establish JFM's impact on livelihoods, governance and forest conditions. That is, our control group consists of Tanzanian government FRs and adjacent villages that are currently still under the pre-JFM forest management system, because they have not been selected by government for JFM implementation. Control sites are matched with corresponding JFM sites on the basis of appropriate pretreatment covariates across both forest reserve and village characteristics, as listed in Table 1.

We also highlight that JFM is implemented in Tanzania through a top-down government-driven process. Government (often with donor and NGO inputs) selects forest reserves and villages to be involved in JFM. Villages cannot request JFM implementation in their village or the forest reserve they live near, nor can they effectively decline involvement if government decides to implement JFM in their village, other than by failing to carry out their duties as JFM participants.

4.3 Administrative selection bias in JFM implementation

In order to understand underlying administrative selection processes that may have been at work for JFM, we undertook extensive analyses of a set of factors characterizing different aspects of forest reserve and village context, which we expected could be associated with systematic administrative preferences for the locations of JFM implementation in Tanzania. This was particularly necessary because the Tanzanian government does not enforce a set of fixed criteria at the national level to decide which forest reserves and villages should be under JFM. Much of the decision-making around which forest reserves will go under JFM occurred through regional meetings of associated regional and district forest agency staff, together with NGO and donor representatives involved in funding and implementing JFM.

To ensure that our matching design accounted for all the important administrative selection biases that may be at work around JFM program implementation, we undertook extensive analyses of factors that might (1) be related to the non-random distribution of JFM and (2) also impact JFM outcomes across all government forest reserves and adjacent villages or sub-villages within the seven study regions. We examined 10 factors characterizing different aspects of forest reserve and village context, which we expect could be systematically associated with JFM implementation while also influencing outcomes. This is technically referred to as selection bias in quasi-experimental literature, and we highlight that its usage does not have a negative connotation.

We used administrative and spatial data from Tanzania's JFM program to characterize administrative selection bias for the program overall, and spatial, temporal and context heterogeneity. In undertaking this work, we used the full universe of government FRs and adjacent villages across the seven regions in our study, which resulted in a sample of 300 forest reserves and roughly 1,600 forest reserve-adjacent villages or sub-villages. We found that JFM is non-randomly implemented with respect to several key characteristics of the FRs selected for decentralization and villages targeted for participation, which we used to guide our propensity score modeling and key pretreatment covariates to include in our genetic matching model.

At the reserve selection stage, we found six clear sources of administrative selection bias related to the implementation of JFM. On average, JFM is more likely to be implemented in forest reserves that are larger, in middle and higher elevation montane

forest types[1], in better overall condition, with a higher number of surrounding villages, yet with lower population pressure and higher availability of off-reserve forest resources on adjacent village lands. At the village selection stage, we also found highly significant support that once a reserve has been selected for JFM, the surrounding villages in which the decentralization process is initially targeted on average have higher existing institutional capacity at the start of the process (Persha *et al*. in prep). That is, once a forest reserve has been selected for JFM, our analysis suggests that program administrators tend to begin the process of working with surrounding villages by starting with villages that already have at baseline (in other words, prior to the start of the process) a greater institutional capacity to implement the village-level management responsibilities that are required under JFM[2]. We used this information to ensure that we included all relevant pretreatment covariates in our matching models, and to guide prioritization of bias reduction across different covariates when assessing covariate balance results prior to running outcomes.

4.4 Sampling details

Our study is focused on seven regions of eastern Tanzania (Figure 5), comprising 54 per cent of mainland Tanzania's forest reserves (IUCN and UNEP 2014) and the bulk of JFM activity in the country (73 per cent of forest reserves and 74 per cent of villages involved in JFM during the first 10 years of implementation). These regions also contain nearly all of Tanzania's conservation priority reserves, comprised of Eastern Arc Afromontane or coastal forest types which are of global conservation interest due to their high levels of biodiversity, endemism[3] and threat (Burgess *et al*. 2007; Myers *et al.* 2000). Furthermore, these seven regions of Tanzania all had a reasonable number of forest reserves that had been under JFM implementation for several years (we focused on sites under JFM for at least five years of implementation, in order to work with sites representative of the JFM experience rather than sites potentially confounded by long start-up periods and transition dynamics during the first few years of

[1] Montane areas of Tanzania generally consist of middle and higher elevation areas ranging from 800 to more than 3,000 meters above sea level. They contain unique forest types, habitats and species that are not found in lower elevations. Please see Burgess *et al.* (2007) for a comprehensive characterization.

[2] We emphasize that this does not reflect negatively on program administrators. Indeed, targeting program implementation to villages which are more likely to have high levels of collective action and the institutional capacity to implement JFM is likely to be an efficient decision for achieving program outcomes. We simply highlight that our analyses point to this as a confounding influence for evaluating JFM impacts via observational studies. Because it is a source of selection bias in determining which villages receive JFM relative to those that do not, it needs to be taken into account to obtain accurate estimates of JFM impacts.

[3] Endemism refers to a particular characteristic of species, in which they uniquely occur only in restricted geographic or biophysical locales. For example, a species of plant or animal that is endemic to Eastern Arc montane forests in Tanzania is a species which only occurs in those particular forest habitats, and not anywhere else on earth. Montane and coastal forests in Tanzania have many such unique species, and are therefore highly valued from a conservation perspective, from the perspective of maintaining high levels of biodiversity, and also driven by concerns over species extinctions if such forests are lost or become sufficiently degraded such that they can no longer support viable populations of these unique species.

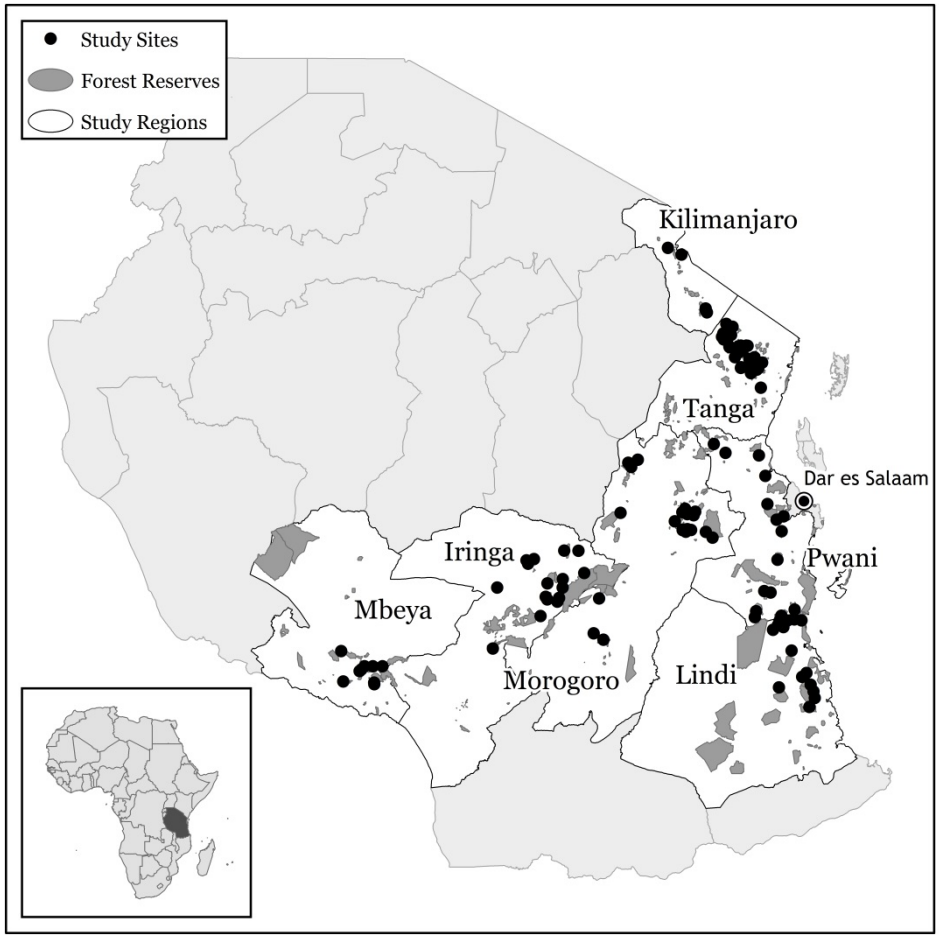
implementation). These seven regions also had a relatively large pool of non-JFM forest reserves to draw from, and substantial coverage of lowland as well as montane forest reserves (which are primarily located in the eastern, south-eastern and far-western regions of Tanzania). Although there is some JFM implementation in western Tanzania, it is generally more recent and sites are widely dispersed across remote areas that are difficult to reach by vehicle. In general, we considered sampling in far-western Tanzania for this study to be unfeasible due to much higher field and travel costs and related logistical and time constraints.

The impact evaluation findings are drawn from mixed quantitative and qualitative data collection across each of the three families of JFM outcomes, potential causal mechanisms and a host of relevant contextual variables that were collected from a set of JFM sites (where a site consists of a forest reserve and adjacent village under JFM) and matched control sites which are similar to JFM sites across important contextual factors that also affect governance, forest conditions and livelihoods outcomes, but are not under JFM. Given non-random selection biases that skew *where* JFM is implemented, the pools of JFM treatment and control sites for this evaluation were constructed such that they were similar across these key pretreatment covariates which, based on our knowledge of forest sector decentralization in Tanzania, factor into whether a forest reserve and village comes under JFM, and also affect JFM's stated objectives around governance, forest conditions, and livelihoods improvements. The pretreatment covariates are listed in Table 1. Treatment and control sites were then matched on the basis of these pretreatment covariates, in order to arrive at a non-biased estimate of average governance, forest conditions and livelihoods impacts that are attributable to the decentralization policy and not to other confounding factors.

Our initial power calculations prior to the selection of sites for data collection indicated that a balanced design of 65 JFM sites and 65 control sites would be sufficient to detect effect sizes of interest. Details of the power calculations are described in the ensuing section. The initial pool of potential treated and control sites available to us consisted of all 300 GoT FRs that are located within the seven study regions that we focused on, and the approximately 1,600 villages which border these reserves. We further restricted the pool to forest reserve + adjacent village pairs in which the village was also part of a cluster sampled for the 2001 Household Budget Survey (HBS), because our study aimed to use household income data from the 2001 GoT HBS as a baseline benchmark for livelihoods outcomes. The pool of preferred sites for our study was therefore drawn from the overlap of villages that were: (a) adjacent to either PFM forests or government FRs; and (b) in an enumeration area that was sampled for the 2001 GoT HBS. Of the 300 forest reserves across the seven regions in the study, 105 are under JFM. We randomly drew 65 JFM treatment and 65 control sites (a site = a village-forest reserve combination) from this pool, with the aim of accommodating three goals: (1) generating a set of sites that showed balanced distribution across key covariates for the treated and control sets, based on the treatment and covariate information that we had prior to sampling; (2) including relatively even numbers of treated and control sites within regions, and (3) taking into account field logistics associated with sampling in highly dispersed and remote sites, which would greatly increase the time and cost of the fieldwork.

Prior to fieldwork, we ran the selected site pool through a genetic matching process across the pretreatment covariates that we expected to be relevant for our analyses, to check for balance on key covariates across the JFM and control sites selected for data collection. Roughly halfway through the fieldwork, we added six additional sites to the control site pool in order to maintain the likelihood of well-matched samples. This was necessary because we discovered early in the fieldwork that the JFM status information we received from administrators in the Tanzanian Forest and Beekeeping Division (FBD), which we used to construct our initial list of treatment and control sites, was sometimes incorrect or outdated for particular sites, as FBD had not updated this information since 2008. Most of these situations were encountered in districts visited during the early months of the fieldwork, but we worried about potential implications for covariate balance and optimal matching if we continued to experience uncertainty and unexpected changes to treatment status of sites as the data collection continued. We obtained updated administrative information from FBD in 2013 as part of FBD efforts to update their monitoring of JFM, which provided us with reliable information on all JFM forest reserves and villages in the seven study regions. We re-ran our selection bias analyses and re-assessed the covariate balance of our study sample with the updated treatment information, to ensure that our sample would still provide a well-matched sample for analyses.

Figure 5: Map of sampling locations in the seven study regions



4.5 Sample size and power calculations

We conducted *a priori* power calculations to guide the determination of overall sample size for the study, using a two-level cluster randomized design with person-level outcomes and treatment at level two (the village), and the Optimal Design software package (Raudenbush 2011). Our calculations suggested that a balanced sample of 105 villages (clusters) would be sufficient for a .15 minimum detectable effect size (MDES) of JFM on household annual income (Figure 6), and a conservative upper limit of 130 clusters would be needed to detect a similar MDES if using the more conservation upper limit of the 95 percent CI on the Intraclass Correlation Coefficient (ICC). The MDES is the magnitude of impact that can be detected for a given sample size, reported in standard deviations from the mean. It provides a benchmark for the magnitude of real effects that the JFM program would need to generate in order to be detectable and statistically significant under the sample size parameters in our study design.

For our study, we aimed to be able to detect an effect size in the small to medium range (standardized MDES of 0.2 to 0.45) for person-level outcomes, meaning that our study aimed to be powered to detect relatively fine-scale impacts, which represent meaningful changes due to the JFM program. Finer-scale impacts, such as MDES

values < .10, are interesting from a research perspective, but from a policy standpoint, given the substantial increase in sampling effort necessary to detect such small impacts, we did not consider them worthwhile for this study. In acknowledging this trade-off, we make the assumption that policymakers are unlikely to see the estimated at least US$30 million in PFM investment in Tanzania to date (Treue *et al*. 2014) as a good investment, if the program yields only very marginal improvements in governance, livelihoods or forest conditions outcomes relative to the pre-JFM centralized forest management system.

Model parameters for our power calculations followed standard assumptions, and were informed by baseline data where it was available. We drew on conservative estimates where assumptions needed to be made without the benefit of reliable baseline information. For all of our power calculations, we assumed an $\alpha = 0.05$, $\beta = 0.20$ (meaning that power is set to 0.80), and a standard cluster level reliability value of 0.70. We included a pretreatment village-level covariate which explains 25 percent of the variation in household income, and an ICC of 0.05 that we calculated from household income data from a sub-sample of the 2001 GoT HBS data from the 230 rural primary sampling units (5,525 households) that were sampled in the seven regions of Tanzania covered in our project. In our power calculations, we varied both of these parameters across a range of reasonable assumptions, from 0 to 25 percent for the village-level covariate and 0.05 to 0.20 for the ICC, to demonstrate that our target MDES is still attainable under reasonable departures from our already conservative assumptions.

We did not have pretreatment baseline data to draw on for the governance family of outcomes, but we make the assumption that the power analyses for the livelihoods outcome is a reasonable approximation for the governance outcome as well. For the forest-level outcomes, we drew on the lead author's plot data from Tanzanian forest reserves collected as part of earlier research efforts (Persha and Blomley 2009), and determined that a cluster N of 105 would be sufficient to detect an MDES of .20, well within an effect size that we consider to be of policy relevance.

Figure 6: Relationship between MDES and total number of villages sampled, under a range of reasonable parameter assumptions for our study

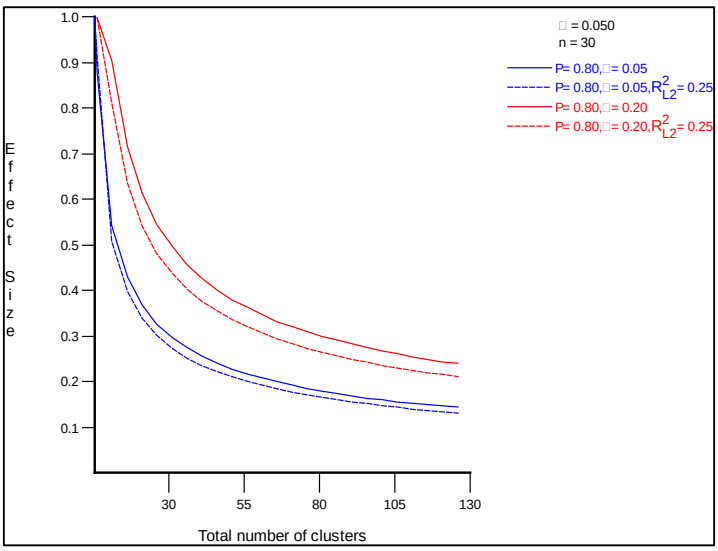


Figure 6 shows that even under highly conservative assumptions about ICC and proportion of variance explained by village-level covariates, our study is likely to be able to detect a fairly small MDES (in other words, MDES < .25) with a total number of 105 village clusters.

Based on our power calculations, we aimed to conservatively sample closer to the upper limit of 130 sites, and we drew up a pool of 65 JFM treatment and 65 control sites to sample. Given that our study regions consisted of a large area covering virtually all of the eastern half of Tanzania, with a relatively small team of enumerators, we also needed to factor in transport costs, time constraints and related field logistical considerations. From the initial list of 130 sites that we intended to sample for this evaluation, we were unable to sample 12 sites due to field logistical constraints associated with field sampling in remote areas of Tanzania, such as a lack of road access after the onset of the rainy season which made sites inaccessible. In addition, eight sites were sampled but not usable in the analysis because (1) the forest reserve had been degazetted[4] many years prior to JFM program implementation, or (2) the forest reserve intended for sampling did not exist and the field team chose a replacement site in the vicinity which had no associated spatial data, or (3) the reserve was (atypically) under CBFM management instead of JFM or the centralized system. These challenges are reflective of the difficulties in prospective sampling in remote developing country field contexts, and where the available administrative data is less than perfect but inconsistencies are difficult to verify except by visiting the location itself. In order to remain on budget and avoid further delays to our project timeframe, we chose to move forward with the evaluation using the 110 sites that were suitable for

[4] In this context degazettement refers to the removal of the official legal status of forest reserve, by government authorities. A forest reserve which has been degazetted is no longer a forest reserve, nor does it continue to be managed by FBD or the TFS; the land reverts to general use or it is re-allocated by government for other purposes.

analyses, and felt confident in doing so because this site N still exceeds that which was determined sufficient through our power calculations. Our final sample for analysis consisted of 110 sites (68 JFM treatment sites and 42 control sites), each consisting of a forest and selected forest-adjacent communities. The total number of households sampled was 3,363 households.

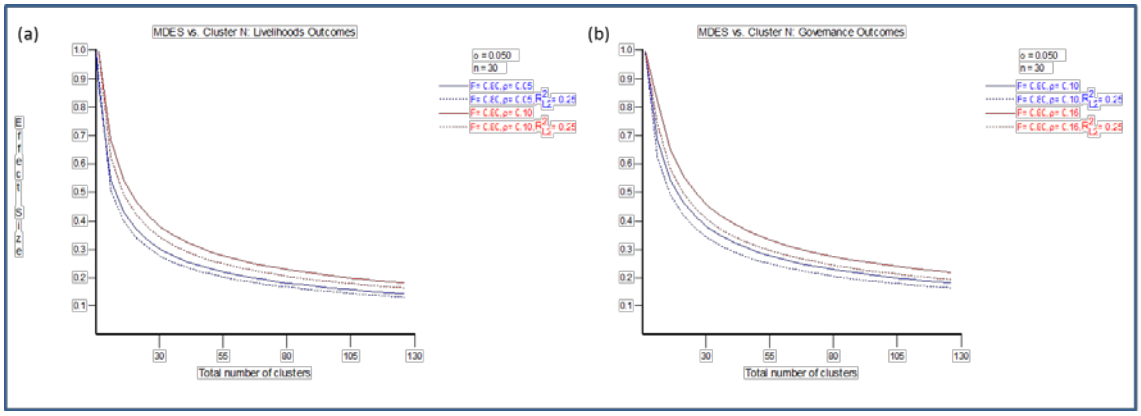
4.5.1 Additional notes on control pool construction and study power

We drew up our list of sites to sample and checked for covariate balance across treatment and control groups across key potential confounders in early2012, prior to the onset of field sampling. Over the course of the initial field sampling, we discovered that the information we received from the Tanzanian Forest Service[5] (TFS) about JFM treatment status for forests and villages was sometimes incorrect or outdated, which was not surprising given that TFS had not conducted a comprehensive update of JFM administrative data from districts since 2008. As a result, the actual treatment status for some of our sites was the opposite of what we expected prior to arrival at the site. Most of these situations were encountered during the early months of the fieldwork. We obtained updated JFM administrative data from TFS in 2013, and re-ran our balance assessments across key pretreatment covariates at that time, to ensure that we remained on track for achieving covariate balance across our treatment and control pools.

Given that we ended up with a smaller site N than we initially aimed to sample, we double-checked that our study remained powered to detect effect sizes of interest to us prior to moving forward with the analyses. After data collection, we re-ran our power calculations using actual ICC values obtained from the full dataset, for each outcome, as an additional check on the study's power. This confirmed that our final sample was sufficiently powered to detect a standardized effect size < 0.20 standard deviation units for livelihoods outcomes, in the range of .20 to .30 for governance outcomes (Figure 7). Thus, our final village N of 110 remains powered to detect even fairly small differences due to JFM impacts, across each of the outcome families that we set out to assess.

[5] Please note that the Tanzanian FBD implemented PFM in Tanzania from its emergence in the mid-1990s until PFM oversight responsibilities were subsumed into the newly created Tanzanian Forest Service (TFS) agency, during a multi-year transition period that began in 2011 as part of broader public sector restructuring in Tanzania. TFS is an executive agency under the Ministry of Natural Resources and Tourism (MNRT). We use TFS throughout this report to refer to the agency currently charged with implementation oversight of PFM in Tanzania.

Figure 7: Minimum detectable effect size to number of village clusters, using actual ICC values obtained from study data for (a) livelihoods and (b) governance outcomes



4.6 Impact indicators

A. Governance outcomes (village-level means across all households surveyed):

1. Mean household satisfaction with village government overall;
2. Mean household satisfaction with village natural resource committee (VEC or VNRC);
3. A comprehensive forest governance index which characterizes six core governance aspects: leadership, transparency, accountability, compliance and consistency of rule of law, citizen participation, and rulemaking process and coherence.

B. Livelihoods outcomes (village-level means across all households surveyed):

1. Mean per capita annual household income (and a Difference-in-Difference [DID] estimate of change in this from 2001–2013);
2. Mean per capita annual household income from forest products;
3. Mean number of products harvested from the forest reserve per household;
4. Mean asset-based poverty index score (and a DID estimate of change in this from 2001–2013).

C. Forest conditions outcomes (forest-level means across all pixels surveyed, or means as above)

1. Mean area of forest reserve deforested between 2000–2012;
2. Mean household ranking of forest condition trajectory since year 2000; and
3. Mean change in household harvesting quantity from the forest reserve since year 2000.

4.7 Quantitative and qualitative primary data collection

PFM's objectives encompass the social, institutional and ecological arenas, hence our data collection employed three sets of integrated research tools structured around JFM's objectives on livelihoods, governance, and forest conditions: (1) A household survey to collect livelihoods data; (2) Semi-structured interviews with key members of forest governance institutions in villages and related administrative levels; and (3)

Randomized vegetation plots in forests for quantitative assessment of forest structure, disturbance and related conditions. We additionally drew on 30-m Landsat calibrated Vegetation Continuous Field (VCF) data to measure extreme degradation and deforestation rates in each forest reserve, and drew on village- and district-level social, demographic and public administration data available through GoT and other secondary sources, as well as extensive Geographic Information System (GIS) and spatial data analyses.

Data collection materials were developed at the onset of the study in early-2012, and drew from the well-tested research protocols of the International Forestry Resources and Institutions (IFRI) research program (www.ifriresearch.net), Center for International Forestry Research's (CIFOR) Poverty Environment Network study household questionnaire around forest contributions to household livelihoods (www.cifor.org/pen), and income, assets and livelihoods questions from the GoT's HBS (www.nbs.go.tz). Local enumerators received 10 days of training on household survey, key informant and focus group discussion data collection in 2012, by the principal investigator on the study Lauren Persha, and prior to the onset of fieldwork in Tanzanian villages. During this time, the household survey was also translated into Kiswahili and pre-tested in a village setting by local enumerators, and under supervision by the study lead investigators Persha and Meshack. Data collection was conducted by 10 enumerators from July 2012 through February 2014, with periodic breaks for data entry and to avoid enumerator fatigue. Data for this study was collected over a 16-month period during 2012–2014, through household surveys, focus group discussions with members of village institutions, forest plots, and key informant interviews with local government staff. We briefly describe each below.

Household survey

The household survey was administered to 30 randomly selected households per village, stratified across households in poor, average and well-off wealth classes as determined through a participatory exercise on the first day of sampling in each site. The household survey covered basic demographic information for households, including: age, occupation, gender, ethnicity, education and migration information; land, livestock and other assets; income and livelihood strategies; shocks to household welfare and coping strategies employed; household interactions with forests in the area and management activities across any of four management categories (centralized government, JFM, community-based management and private forests) including information on how households use the forest, perceptions on forest rules, equity issues, distribution of benefits, satisfaction with village-level institutions for forest management, meeting attendance and household participation in a range of management activities; a forest harvesting module quantifying detailed information around household harvesting for each of six different product categories – fuelwood, charcoal, leaf or grass fodder, timber, non-timber forest products (NTFP), and any other important product as specified by the household.

Some of the key JFM-related issues that were covered on the household questionnaire included: quantifying household livelihoods contributions of PFM; equity of benefits and

other issues pertaining to forest use and management; institutional capacity for forest governance; forms and extent of participation in various forest management activities; perceptions of forest conditions; and key indicators of forest use and sustainability at the household level. The survey also included targeted recall questions on forest harvesting by the household and overall forest conditions from prior to PFM implementation, or over the same time period for the control sites. Lastly, it included relevant questions on leakage, to determine whether JFM communities might displace illegal or more intense forest harvesting activities to other forests in the area.

Focus group discussions and key informant interviews

Forest governance encompasses the actors, institutional arrangements, and mechanisms of regulation by which either state or non-state actors undertake forest management decision-making and shape forest use outcomes (Lemos and Agrawal 2006). Institutional arrangements are the formal and informal rules and norms that define who has decision-making authority over a forest, and the specific use, management, monitoring and enforcement decisions that are produced (Ostrom 2005). Much of our primary governance data for this study was collected through semi-structured interviews and focus group discussions held with key actors involved in forest management, including members of local forest management committees, and village and district government. Questions focused on characterizing actors and processes related to, among others: history of forest use and management in the village and neighboring forest reserve; the history and process by which current village-level institutions for forest management were formed and currently function; obtaining management resources; distribution of property rights regarding forest resources; formal and informal processes for forest rule-making and other management decisions; levels of rule violations, efficiency in monitoring rules and rule enforcement; issues of forest-based revenue generation, collection and distribution; any challenges, conflicts and resolution processes related to forest use and management in the village.

Plot sampling in forests

Primary data on forest conditions was collected from each forest reserve via plot-based vegetation sampling. All stems > 2.5 cm Diameter at Breast Height (DBH) were measured within 20 x 20 meter plots, and identified to genus, and species level where possible. Indicators of broad forest disturbance and overall forest condition were also recorded within each plot, as well as key physiographic variables. In addition, the kinds and intensities of eight extractive forest uses were assessed within each plot in order to quantify the intensity of different kinds of forest uses. These data were used to complement the rich qualitative data obtained on forest conditions, use and trajectories of change obtained from FBD and VEC and VNRC key informant interviews and group discussions, as well as household-level survey data on forest condition trajectory and threats and opportunities.

Qualitative data

We additionally collected extensive qualitative and supplemental quantitative data to interpret outcomes and qualitatively explore a series of hypothesized mechanisms by which each outcome family effect is produced. This was done primarily via focus group discussion, key informant interviews, and through several short answer open-ended text variables on the household survey. Separate focus group discussions were conducted in each village with members of the VNRC or VEC, and with members of any formalized or informal group of forest users that was present in each sampled village. Key informant interviews were conducted with district forest officers, and with village leaders such as the village chairman or village executive officer.

Secondary spatial and administrative data

To facilitate our understanding of selection factors that play a role in where JFM is implemented, and to facilitate site selection in order to generate a balanced pool of JFM treatment and control sites (in terms of their distributions across key confounding characteristics), we also worked with several secondary administrative and spatial data sources, covering all forest reserves and forest reserve-adjacent villages in the seven regions covered by our study. These included GoT census data for years 2000 and 2012, including: population, demographic and population density information; spatial forest reserve boundaries and associated administrative information from the World Database of Protected Areas (WDPA); 30-m Landsat-calibrated VCF data for forest cover and deforestation from 2000 through 2012 for all FRs and adjacent villages in the study regions; spatially linked FBD administrative data around JFM administration for JFM forest reserves and associated villages; biophysical data derived from a 20-m digital elevation model (DEM) for Tanzania, including elevation and derived forest type; and travel time and village and forest reserve distance to administrative towns.

4.8 Analyses

4.8.1 Average treatment effects on the treated (ATT) for governance, livelihoods and forest conditions outcomes

Our impact evaluation focuses on estimating the average impacts of JFM on JFM-treated villages and forest reserves, or the ATT (Imbens 2004) on the three families of outcomes targeted by the program's objectives: forest governance, household livelihoods within villages, and forest conditions within neighboring forest reserves. As is typical for quasi-experimental studies in which treatment predates the study and has not been randomly assigned, an overarching concern is that the impact estimate can be improperly quantified due to confounding which results from systematic biases in treatment assignment (Stuart 2010). Thus, correct attribution of observed impacts to the program intervention can only occur if potential confounders are identified and factored into the analytic approach. Although a range of methods are available to do so, matching approaches have gained traction as a particularly viable strategy for causal inference around program effects for assessments in which program implementation predates the study, for which program administrative data is available

and there is fairly strong knowledge of how treatment assignment was carried out, as well as relatively good availability of data to measure or proxy pretreatment confounding variables.

We use a matching estimator obtained via a genetic matching algorithm to estimate causal impacts of JFM on each family of outcomes listed in Section 4.6. We estimate the ATT for each outcome family using one-to-one matching with replacement (Abadie and Imbens 2006). We use genetic matching in R to obtain balance between JFM treatment and control groups across eight pretreatment covariates and an estimated propensity score (Sekhon 2011). Genetic matching uses a non-parametric approach to find the optimal covariate balance across groups (Diamond and Sekhon 2013), and allows researchers to assess covariate balance prior to estimating treatment effects. Genetic matching has been found in several empirical studies to obtain superior balance across pretreatment covariates than other matching approaches, and to produce less biased impact estimates than propensity score or other more traditional matching approaches (for example see Diamond and Sekhon 2013; Kreif *et al*. 2013; Sekhon and Grieve 2012). Given the range of matching methods that are available for quasi-experimental studies, the literature guides researchers to use the matching approach that results in the best balance across pretreatment covariates, and to focus on improving balance across covariates that are most related to determining treatment and affecting outcomes (Ho *et al*. 2007; Stuart 2010). For our analyses, we selected genetic matching over other matching approaches because it yielded substantially better balance across key pretreatment covariates than other approaches that we tried, such as matching solely on propensity score. We conduct 1:1 nearest neighbor matching, and we match with replacement given the relatively small number of units in our sample and that we have fewer control observations than treatment observations (Dehejia and Wahba 1999).
The ATT is formally defined as (Imbens and Wooldridge 2009):

$$T_{ATT} \,|(T = 1) = E(Y_{i1} - Y_{i0} \,|\, T_i = 1) = \; E(Y_{i1}|T_i = 1) - E(Y_{i0}|T_i = 1) \qquad (1)$$

in which τ is the outcome of interest; T is an indicator for the treatment status which has a value of 1 for units in the treatment group, and a value of 0 for units in the control group; Y_{i1} is the outcome for each case *i* in the treated group given that it has been treated; and Y_{i0} is the counterfactual outcome for each case *i* in the treated group had it *not* been treated. The problem, however, is that Y_{i0} is not possible to observe, because a given unit receiving an intervention cannot both be treated and not treated at the same time (Imbens and Wooldridge 2009; Rubin 1974).

Under a potential outcomes framing, the ATT estimate is derived by constructing a suitable comparison or control group which represents the counterfactual outcome, or what would have been the outcome for treated units, had they not been subjected to the treatment. In non-experimental studies, in which units which receive the treatment are not randomly determined, the ATT estimate is subject to bias stemming from systematic differences between the treatment and comparison groups, but can still be accurately obtained by conditioning on a vector of pretreatment covariates that determine non-random treatment assignment (Dehejia and Wahba 2002). That is,

conditional on the pretreatment covariates which determine selection into treatment or not, the outcome of the control group ($Y_{i0} \mid T_i = 0$) can be substituted for the potential outcome of the treated group had it not received treatment ($Y_{i0} \mid T_i = 1$). In our study, assuming we have included all relevant and observable pretreatment confounders, we expect that once JFM treatment assignment has been conditioned on the vector of pretreatment covariates, then the difference in outcomes across the JFM treatment and control groups can be taken as an unbiased estimate of JFM program impact. The ATT is therefore obtained as:

$$T_{ATT} = E\ [(E(Y_{i1}|X_i\ ,\ T_i = 1) - E(Y_{i0}|X_i\ ,\ T_i = 0)|T_i = 1] \qquad (2)$$

in which *X* represents the vector pretreatment covariates that affect selection of units into JFM treatment or control status and also shape outcomes under JFM treatment.

4.8.2 Difference-in-difference (DID) approach

The above matching approach on post-treatment outcomes for observational studies is well-accepted as a more rigorous approach to estimating program impact than naïve comparisons of outcomes across sets of JFM treated and control sites (Stuart 2010). To build additional robustness into our evaluation, we also use a difference-in-difference model for the two families of outcomes (livelihoods and forest conditions) where baseline data from prior to program implementation are available. The DID approach assumes that the change in mean outcomes across the JFM treated and control villages would have followed a similar trend if JFM had not been introduced in the JFM treated villages. To implement the DID, we draw on baseline household livelihoods data from the 2001 GoT HBS, and forest conditions data from year 2000. Baseline data were unavailable for village-level governance indicators, and for household livelihoods indicators they were only available for 78 of the 110 sites that we sampled.

The difference-in-difference approach assesses the change in mean per capita household income, an asset-based poverty index[6] and area deforested across 2000–2012. DID approaches are generally considered more robust than matching solely on endline outcomes, as we do in the genetic matching approach outlined above, because the DID approach also controls for time invariant differences between treatment and control groups for baseline characteristics which are less easily observed or not taken into account in the covariate matching. In our study, we obtain the DID outcome estimate by subtracting the village mean per capita household income that we obtained from our field sampling, from the mean per capita household income obtained in 2001

[6] We construct static indices for each time period of data (2001 assets from HBS data; 2013 asset data from our household survey), using the same asset list. We make the assumption that these assets remain stable indicators of household welfare, and that there is no major change in the relative importance of the different components across the two time periods (Cavatassi, Davis, Lipper 2004). Poverty analyses by the Tanzania government over the most recent period available (2001–2007) supports these assumptions as well (URT 2009).

from the GoT HBS, drawing on the data from the nearest sampled cluster in the same ward as each of our study villages. Thus, it is important to note that the DID values for this study are not based on true panel data, and this can introduce variation. We also note that baseline livelihoods data were not available for 32 sites in our sample, because one of the regions in our study had very little congruence between 2001 HBS surveyed wards and forest reserve-adjacent villages. We therefore place more confidence in our matching results based on end line outcomes in 2013 (Section 5, Table 2), although we also present the DID livelihoods results on the sub-sample of cases with baseline livelihoods data (see Appendix G).

Given the constraints on conducting a difference-in-difference analysis, and to further bolster our end line analyses, we also examined the distribution of several baseline demographic and landscape characteristics of villages across our treatment and control group. We demonstrate they are largely similar in terms of their broader baseline contexts. Thus, although we are not able to use the DID approach for all of our outcomes, we think it is unlikely that there are hidden processes or altered trajectories at work in our sample which strongly correlate with and systematically affect only one of these groups over the time period since JFM came under implementation.

4.8.3 Covariate balance checks

We aim via the matching approach to reduce bias in the obtained estimates of JFM program impact, which would arise from administrative selection biases that render control group forest reserves and villages to be, on average, systematically different from JFM forest reserves and villages across factors that also influence forest governance, livelihoods and forest condition outcomes. We match JFM treated sites with control sites on the basis of eight pretreatment covariates determined by our earlier analyses to be key factors associated with administrative selection bias on where JFM is implemented in Tanzania (Persha *et al*. in prep), and the propensity score calculated for each site. The eight pretreatment covariates include four confounding attributes of the forest reserves, and four attributes of the adjacent villages. At the forest reserve level they include: (1) forest reserve size; (2) the number of adjacent villages surrounding the forest reserve; (3) the mean elevation of the reserve; and (4) baseline mean percent tree cover in year 2000. At the village level they include: (1) the minimum travel time from the reserve to the nearest administrative town; (2) forest pressure (proxied by the year 2000 village population per hectare of forest reserve); (3) village institutional capacity in the early-2000s, proxied by whether the village received funding under the Tanzania Social Action Fund (TASAF) II community-driven development program[7]; and (4) baseline mean per- cent tree cover on village lands within 5 kilometers of the forest reserve in year 2000, as an indicator of off-reserve forest resource availability in the village. The propensity score specification is described in Appendix A.

[7] For additional support of this measure as an indicator of village collective action and institutional capacity see (Baird *et al.* 2011).

Following Austin, who notes that there is currently no consistent standard for assessing covariate balance (Austin 2009), we assess balance using several alternative measures, but focus on the mean eQQ[8] and the standardized mean difference across our JFM treatment and control samples. Table 1 shows the balance results, and demonstrates that the genetic matching approach yielded good balance across all key pretreatment confounders, meaning there are no significant differences in the distribution of each covariate, across treatment and control groups. As an additional check, Figure 8 demonstrates dramatic improvement in the distribution of the propensity score across the JFM treatment and control observations in the matched dataset relative to the full sample prior to matching. We used genetic matching (Sekhon 2011) to obtain optimal weights across the full sample for each of the individual covariates listed above, and the propensity score (model specifications described in Appendix A).

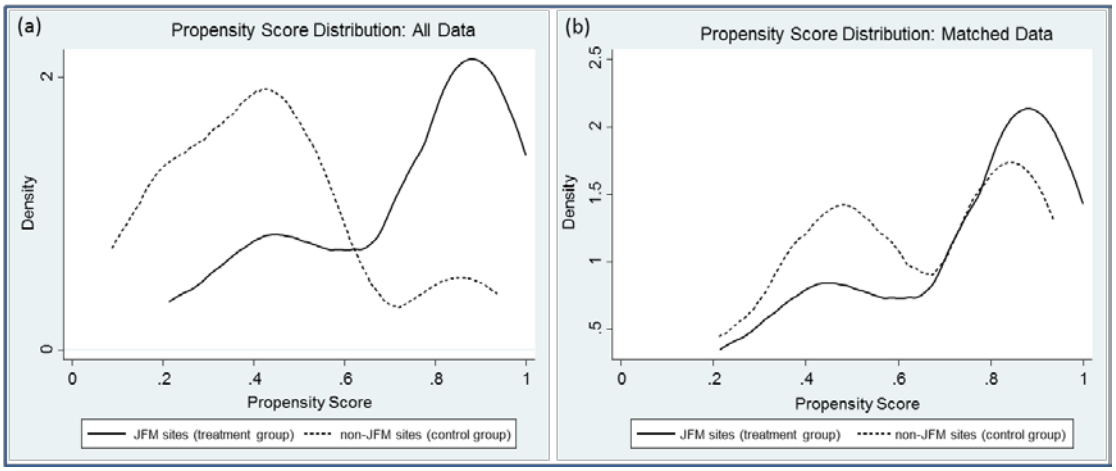
Table 1: Summary of balance statistics across all data, and the matched sample[9]

	All data (before matching)				**Matched data (after matching)**			
Pre-Treatment Covariates	Mean Treated	Mean Control	Mean Diff.	eQQ Mean	Mean Treated	Mean control	Mean Diff	eQQ Mean
[Forest Reserve Characteristics]								
Log of forest size (ha)	8.24	8.66	-0.42	0.55	8.24	8.47	-0.22	0.91
Number of surrounding villages	9.94	9.02	0.92	1.64	9.94	10.29	-0.35	1.11
Year 2000 forest condition (% tree cover)	60.23	55.31	4.93	5.48	60.23	59.32	0.92	5.89
Mean elevation of forest (masl)	1329.1	820.7	508.4	495.0	1329.1	1287.7	41.4	325.4
[Village Characteristics]								
Year 2002 forest pressure (popn / hectares of forest)	15.80	1.33	14.47	16.91	15.80	2.28	13.52	34.39
Distant to administrative town (travel time in hours)	5.34	5.61	-0.27	1.01	5.34	4.84	0.50	0.97
Village institutional capacity (high collective action, Y/N)	0.22	0.26	-0.04	0.05	0.22	0.16	0.06	0.00
Year 2000 village forest resources (% tree cover on village land w/in 5km of forest reserve boundary)	39.79	41.97	-2.18	3.89	39.79	38.21	1.58	3.04
Propensity score for JFM selection	0.73	0.43	0.31	0.30	0.73	0.71	0.02	0.17

[8] A measure of balance based on the mean standardized difference in the empirical quantile-quantile (eQQ) plot, for each covariate.

[9] Note the matched data retains all 68 JFM treated sites and 22 control sites (20 control sites are dropped).

Figure 8: Distribution of propensity scores across JFM treatment and control sites in our sample, across (a) all data and (b) the matched sample



4.8.4 Sensitivity analyses and other robustness checks

Matching approaches can be vulnerable to introduced bias from unobserved confounding factors. Although we endeavored to identify and account for all possible direct confounders on treatment assignment in our analyses, we also use three strategies to assess the robustness of our impact estimates: (1) we examine how the estimates change with the addition of calipers (Austin 2014), and by using a 2:1 matching approach (Rosenbaum 2013); (2) we employ a bias-correction via a post-matching regression adjustment (Abadie and Imbens 2011); (3) we use Rosenbaum bounds to test how strong an effect there would need to be from a hypothetical pretreatment confounder which we failed to include in our analyses, in order for the impact estimates that we obtained to change significantly (Becker and Caliendo 2007; DiPrete and Gangl 2004).

4.8.5 Subgroup analyses

We undertake post-hoc subgroup analyses to test for heterogeneous impacts of JFM on (1) poorer villages relative to wealthier villages and (2) poorest households relative to other households within each village. Understanding whether poorer villages and households are affected differently by JFM is a key policy concern for forest sector decentralization in Tanzania and elsewhere. We focus on the governance and livelihoods families of outcomes for these subgroup analyses. Because the forest outcomes in our study were primarily measured at the village level rather than the household level, it is not practical to test for wealth-based heterogeneous impacts of JFM on forest conditions. We focus instead on testing for different impacts of JFM on wealth subgroups across the household level forest use, forest and overall income, forest management participation and governance measures that are indicated by our household-level governance and livelihoods outcome variables. Although we planned to examine impact heterogeneity across wealth groups from the start of the project, our subgroup analysis can be considered posthoc because we did not explicitly design the selection of JFM treatment and control sites, or the household sampling, around detecting differences in JFM impacts by wealth group. However, our household

sampling was stratified across poor, average and wealthy households in all villages in our sample, thus the wealth range present in each village is represented in our sample.

The wealth subgroup analyses assesses the ATT separately for: (1) poorer villages and wealthier villages and (2) the poorest quintile of households, and remaining households in the upper wealth quintiles, drawing on the village-level mean outcomes for each of these subgroups. We note that JFM treatment is assigned only at the village level (and not at the level of individual households within villages), and JFM rules and management processes apply to all villagers in a JFM village. Because JFM assignment is at the village level, all households in a village have the same likelihood of treatment assignment. Thus, there is no explicit administrative targeting of particular households or individuals within villages to participate in JFM. Because JFM treatment is assigned at the village level, the village level covariates we used to specify JFM treatment assignment for the overall ATTs also apply to the wealth subgroup analyses.

Poorer villages versus wealthier villages

Our first subgroup analysis examines whether there are differences in JFM impacts for poorer villages relative to wealthier villages. This analysis is fairly straightforward. We categorized villages in the sample into poorer or wealthier groups using the median value of the end line mean village score for the asset-based wealth index that we calculated for each surveyed household. We regressed each of the governance and livelihoods outcomes on treatment, the binary wealth category indicator and the vector of pretreatment covariates using the pre-processed matched sample obtained from genetic matching, and tested for a significant interaction across treatment and village wealth group indicator for each outcome, as well as the linear combinations of the null hypothesis that the JFM impact in poorer villages is equal to the JFM impact in wealthier villages, for these outcomes.

Poorest households versus not-poorest

We also examined whether there are heterogeneous impacts of JFM across the poorest households and the rest of the households within villages. This is a key question of interest to JFM policy and implementation stakeholders, but the analysis strategy is more complicated due to limitations on data availability and our study design. There are a number of theories related to why richer and poorer households within the same village might be affected differently by JFM, including processes of exclusion by wealthy village elites which might work to shut poorer households out of JFM benefits (Persha and Andersson 2014), or higher barriers of access to tools, capital or markets for poorer households which might preclude them from taking advantage of higher-return forest-based livelihoods opportunities under JFM. It is also possible that poorer households might see more improvements to their livelihoods relative to wealthier households under forest sector decentralization, for instance due to pro-poor positive governance changes which reduce access inequities and open up new forest-based livelihoods opportunities to such households, or as a result of expanded subsistence harvest allocations under JFM.

Although there is no explicit administrative targeting of particular households or individuals within villages to participate in JFM, household-level factors can play a role in determining the extent to which households decide or are able to participate in JFM activities in their villages (such as choosing to volunteer to serve on a forest monitoring committee, or seeking election to the village forest management institution), and more active participators might be able to use their participation in JFM activities to their own advantage. Although JFM operates at the village level, with JFM forest rules and management processes designed to apply to everyone in the village, a rich set of forest sector decentralization literature exists which suggests that in many co-management situations such as that of JFM, village elites often find ways to co-opt the process and any benefits for themselves. To better account for such potential confounders for our wealth subgroup analyses based on poorest households, we therefore pre-process the dataset by matching, and add an additional set of household-level covariates in the ensuing regression, which account for the extent to which households choose or are able to participate in JFM activities in their village, and also affect their governance and livelihoods outcomes. We include four household-level factors determined prior to JFM assignment at the village level: household head age, head years of education, residency time in the village, and head gender. In doing so, we aim to ensure that outcome differences across JFM and control sites for the poorest households subgroup analyses are drawn from treated and control cases that are well-matched in terms of the administrative selection factors that cause bias in where JFM is implemented, as well as the wealth subgroup level mean household characteristics that shape access to JFM and its outcomes, for each of the two wealth subgroups. We explain this further in the section below.

We grouped each household surveyed into poorest or non-poorest wealth groups using a standard asset-based definition of poverty. Following convention, we derived the poverty index for each household from a principal components analysis (PCA) run on a set of 11 durable household assets, total landholding, and housing roof and wall construction material (Michelson *et al*. 2013). The durable assets which we included in the PCA focus on a set of assets aimed to show variation in wealth status across households (thus we exclude assets which were owned by < 1% or > 95% of households surveyed, or those owned by nearly all or nearly no households; for our sample this excluded refrigerators, landline telephones, electric or gas stoves, cars, handcarts, wheelbarrows, threshing machines, dish, and power tillers at the low end; and mosquito nets and hoes at the high end), and are also consistent with a set of assets that was included in the 2001 HBS survey. They are: radio, cell phone, sewing machine, television, radio cassette player, motorbike, bicycle, wick lantern, iron, plow, generator and solar panel. We additionally include two binary indicator variables for housing conditions, indicating that the house walls were not constructed of materials most associated with poorer conditions (mud or wattle), and that the house roof was not constructed of materials most associated with poorer conditions (thatch). Asset-based poverty indices often include landholdings in the PCA model, but we did not include this in our final model, in order to be able to retain all households in our data. This was because 57 households (or 1.6 percent of our total sample) declined to answer this question. Households which declined to answer this question include both

very poor households and households that are wealthy, thus we cannot assume that all households that declined to answer did so because they were landless, as one might expect. We ran the PCA excluding (retains all households) and including landholdings (drops 57 households), but we used the poverty index constructed without landholdings because excluding this variable resulted in few substantive changes to the PCA score for the first factor for most households, while allowing us to retain our full sample.

We then categorized households into wealth quintiles on the basis of the first component of the PCA-derived poverty index. We note that this identifies the poorest quintile of households across our dataset, which can be considered similarly poor regardless of the overall wealth status or range of wealth present in any individual village in the study. This method yields somewhat varying numbers of households in the poorest quintile within each village, and a mean household N of six households in the subgroup for our data. We account for different household N across the villages by weighting the subgroup means for each village by the inverse of the variance of the mean (we also ran the analysis without weighting, and found little material difference in results).

To undertake this subgroup analyses, we first use demographic, education, assets, other socio-economic and shock data that we collected via our households survey to test and demonstrate similarities in distributions across these household-level factors for (1) village-level means for households in the poorest subgroup, across JFM treatment and control villages; and (2) village-level means for households in the non-poorest subgroup, across JFM treatment and control villages (Table F.2 in Appendix F). We use the same genetic matching approach as for the ATT analysis to draw a balanced matched sample for each subgroup, to ensure that distributions are similar across the JFM treatment and control groups. We then regress each outcome on this vector of covariates using the pre-processed matched sample, and additionally include as covariates in the regression the four household-level characteristics that we hypothesize relate to a household's likelihood and ability to participate in and benefit from JFM within JFM villages (these are: highest education level obtained by any household member, head age, residency time in village, and female-headedness). We include in the regression an interaction term between treatment and wealth subgroup, and run a post-regression analysis to test for significance of the linear combination of coefficients.

Qualifications and constraints

We note that our strategy to assess impacts for poorest households is necessarily limited, particularly because we do not have a true panel of household baseline data prior to JFM. The key issue is that we identify poorest households in villages on the basis of their current asset-based wellbeing rather than their pretreatment wealth status. This means that we assume that there has not been major movement of households in and out of poverty groups within the same village over the last decade or so, and particularly as a result of JFM. We note that our assumption of no major movement of households in rural Tanzanian villages in and out of poverty groups is strongly bolstered by the Tanzanian government's findings of stagnant poverty and

inequality rates in rural Tanzania over the last two decades. Independent analyses of HBS data over 2001–2007 (the last period assessed) shows there has been virtually no change in household poverty status over this period – and particularly in rural Tanzania where our study sampled – across any measure of household wellbeing, including consumption, assets, or income (URT 2009). Similarly, there has been no change in inequality over the same period, and a non-statistically significant reduction in the poverty headcount in rural Tanzania of less than 1 percentage point (REPOA 2009). Thus, our assumption that on average households that were poor in the early-2000s (prior to JFM implementation) are likely still poor today, is, unfortunately, likely to be valid. Our additional assumption of no change in household poverty status as a result of JFM is strongly supported by our own findings from this impact evaluation (IE) around no significant livelihoods impacts resulting from JFM (see Section 5).

Despite the design limitations that we acknowledge above, we move forward with this subgroup analysis because our discussions with TFS and JFM implementers in Tanzania strongly emphasize that understanding whether poorest households are differently impacted by JFM is a key policy concern. This question is also likely to be of the greatest interest to a wider range of stakeholders. Given the importance of the issue, we proceed with the analysis, being careful to state our assumptions upfront and to note that our findings may be taken more as suggestive rather than definitive since our dataset to explore these issues is not 100 percent ideal.

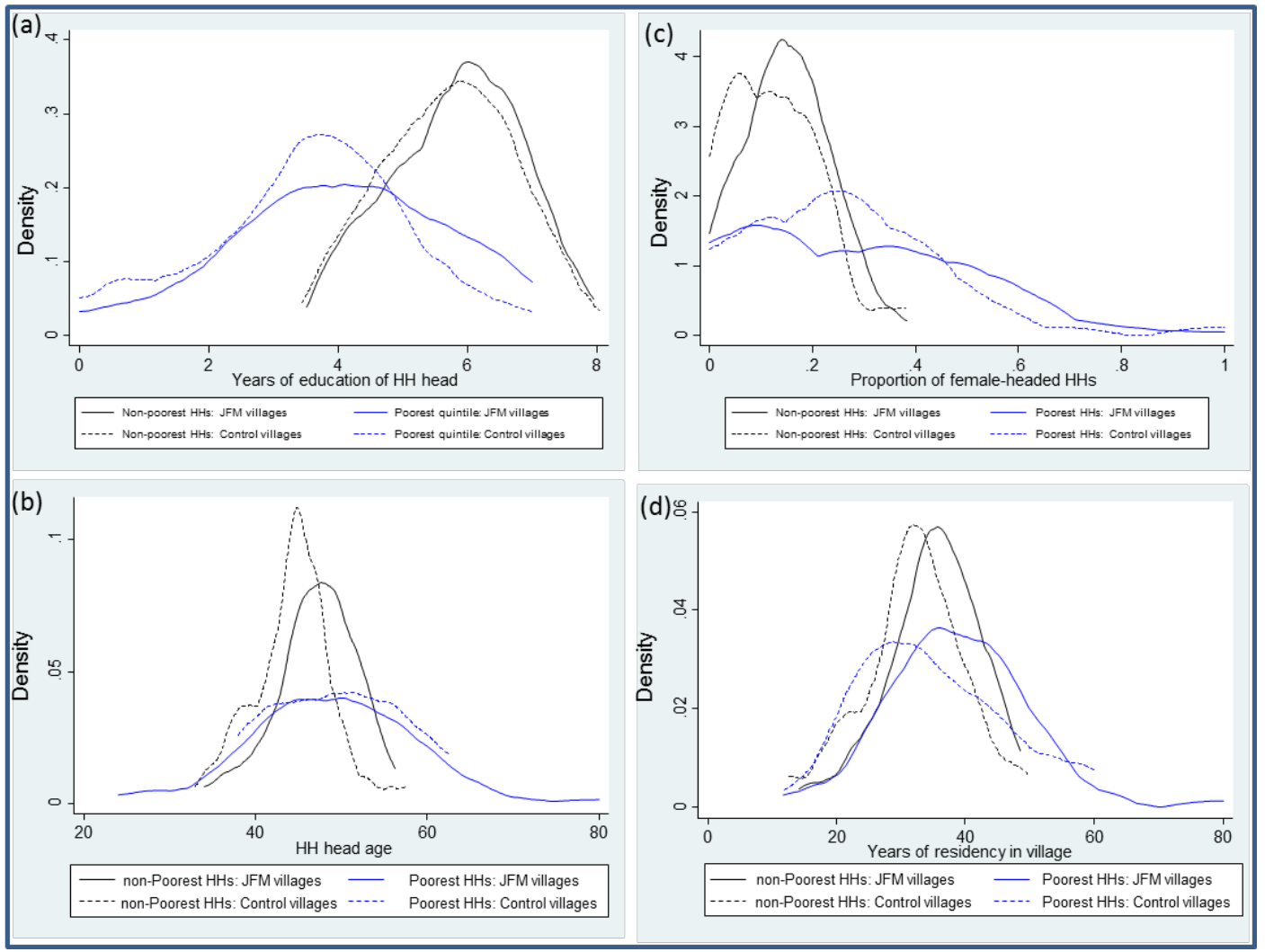
Balance check on covariates and other demographic characteristics of households across wealth subgroups

As we expect, there are some key demographic and socio-economic characteristics that tend to distinguish poorest households from non-poorest households. These characteristics are also established for a household prior to the onset of JFM. In line with much poverty literature from Tanzania, we see that the poorest quintile of households are especially different from non-poorest households in terms of the highest level of education attained by any member of the household, and whether the household is female-headed or not, and less so on household head age and years of residency in the village. Still, household heads that are younger or very old tend to be somewhat more likely to be in the poorest quintile. Households that have longer residency in a village are likely to be more connected to networks within the village. These factors reflect characteristics of marginalization within a village in the Tanzanian setting. In this sense, these factors can be considered as household-level pretreatment characteristics that relate to household barriers to access and self-selection into higher or lower levels of participation in JFM or forest management activities and benefits processes within the village.

We examine these characteristics of our two wealth subgroups within villages carefully, because we want to ensure that distributions across these key characteristics, which can also shape a household's ability to participate in JFM and benefit from it, are similar across the JFM treatment and control groups for each wealth subgroup. Figure 9 demonstrates that there were no major differences in the distribution of these characteristics across the JFM and control groups, for each of the two wealth

subgroups (that is, distributions are similar for the poorest quintile of households within each village across JFM and control sites; and the same holds true for the distributions of the non-poorest households within each village across JFM and control sites). Table F.2 in Appendix F provides additional information. To determine JFM impacts on poorest households relative to other households, we classify each household surveyed into poorest quintile or not, and then generate disaggregated mean measures across this classification for the household-level governance and livelihoods outcome indicators.

Figure 9: Density distributions of four key household characteristics by wealth subgroup within village

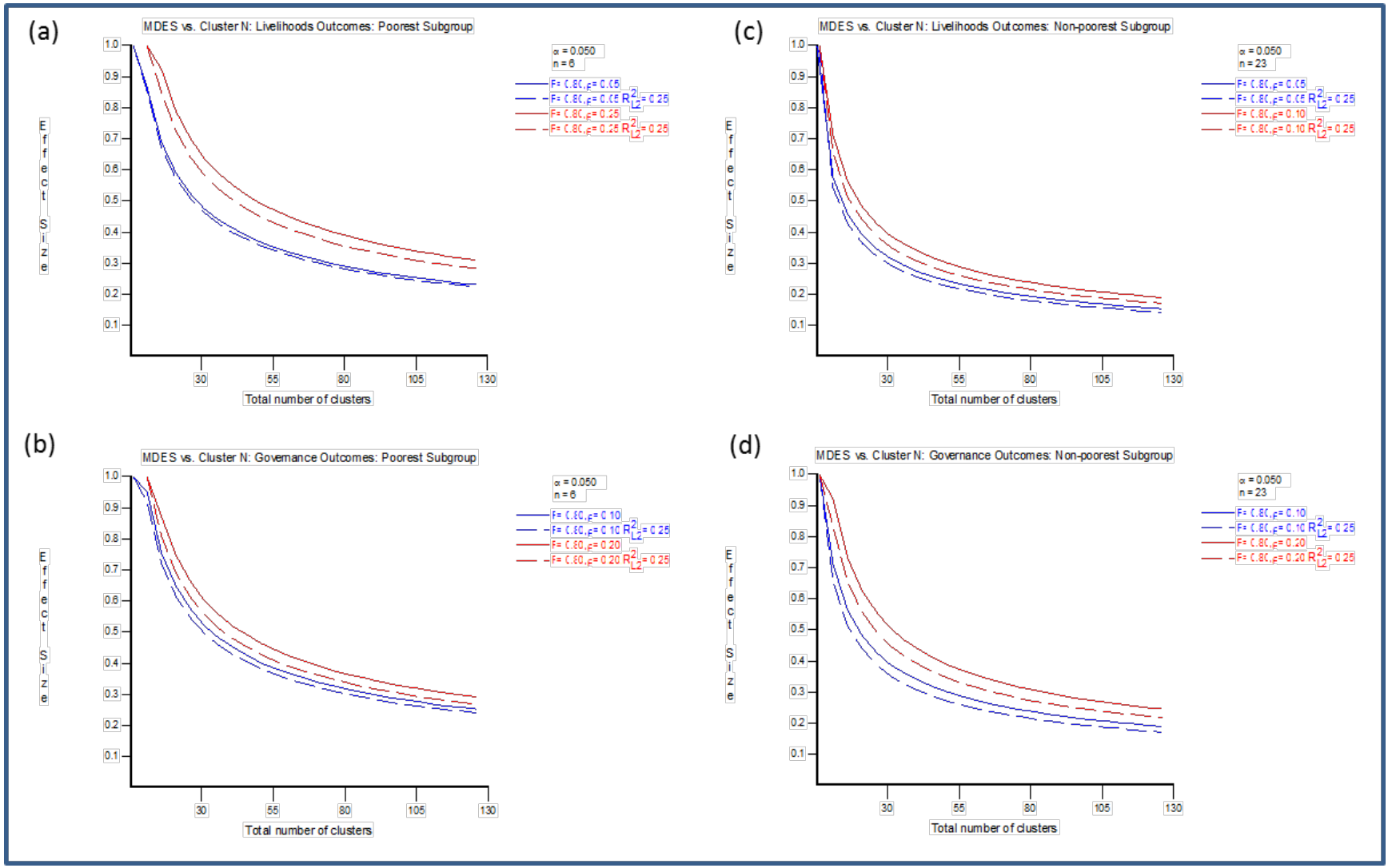


Power calculations supporting the subgroup analyses

As an additional check on the power of our subgroup analysis of poorest households relative to the rest of households, we re-ran power calculations to determine the MDES likely to result from a household sample size that was in line with the mean household N that we obtained for each of the two wealth subgroups within villages (poorest households and rest of households per village). The mean household N was six households for the poorest households within villages, and 24 for the non-poorest households group. We recalculated ICC values for each outcome within each of these two wealth groups across our data, and generated power curves based on the actual ICCs and household N per cluster that we obtained for these subgroups. Figure 10 demonstrates that even with the smaller household N and higher ICC that we obtained (particularly for governance outcomes), the study is still powered to detect effect sizes under .30 standard deviation units for this subgroup analysis.

For the wealth group analyses by poorest villages versus wealthier villages, we note that the power curves in Section 4.5 above, for the study as a whole, suggest that even with a cluster or village N of 34 villages per wealth group, our study is powered to detect an actual effect size that is below 0.3–0.4 standard deviations of the observed outcome (that is, this analysis is still powered to detect fairly small effects, if they are truly present).

Figure 10: Effect size curves for poorest and non-poorest wealth subgroups within villages



5. Impact results

Our impact evaluation results point to several key findings, which we briefly summarize here before discussing each one in further detail below. We find that under the current implementation of JFM in Tanzania (noting that actual implementation often varies fairly substantially from JFM program design), on average:

1. JFM has a strong, positive, and statistically significant impact on local-level governance, particularly on good governance functions of village natural resource committees (VECs or VNRCs) and to a smaller extent for village governance overall.
2. Positive and statistically significant governance impacts from JFM are present even in poorer villages and households, but impacts are not as high compared with less-poor villages and households.
3. There is no evidence that JFM results in a significant difference in overall household income, forest-derived income, or asset-based measures of wellbeing. JFM does result in a small but statistically significant increase in the number of forest products households harvest from forest reserves, which may benefit household subsistence needs.
4. There is no statistically significant difference in deforestation rates between JFM and non-JFM forest reserves during 2000–2012.
5. There is some evidence that households in JFM villages view JFM reserves to be improving over the same period. This may be linked to declines in household harvesting and improved protection in JFM reserves.

Positive governance changes as a result of JFM are encouraging, but the lack of livelihoods improvements for villagers engaging in JFM calls into question its long-term sustainability at the local level. Importantly, we also find that in a majority of sites, JFM is not being formally implemented according to policy design. We find that most steps in the legal chain of JFM implementation do occur, including the creation and signing of formal village-level bylaws around forest use and management between a village and the District Council. However, we found that perhaps the most important legal step in the process generally does not occur: the signing of a Joint Management Agreement (JMA) contract between government and the community involved in JFM. This step is the legal underpinning for a village's rights and responsibilities under JFM, including its claim to revenues that government states it will share with them. However, in practice GoT has not proceeded to sign these contracts in the vast majority of randomly selected sites we sampled in our study. We discuss implications in Section 5.2.

The JMA is a contract between the village and the Tanzania Forest Service (TFS) which, in addition to describing the forest rules and management responsibilities that are undertaken by each party in the agreement (usually TFS, local government and the

village), also states for each village: (1) the benefits that will be provided to communities, (2) how these benefits will be administered, and (3) how funds that are received by the village will be managed (URT 2013). Thus, in the absence of government signing these JMA agreements, a village engaging in JFM has no formal legal claim to revenue-sharing, or any legal standing around their right to a share of any funds received from the government FR, even if these activities are currently proceeding on an informal basis. This is a tenuous situation that certainly places communities in the position of trusting that government will implement a benefit-sharing plan as agreed, but with little legal recourse if this does not happen. In our study, we found that only 8 percent of JFM sites had signed JMAs, while 45 percent of JFM sites did at least have a formal set of village bylaws passed by the District Council. Another 47 percent of sites were still waiting for District Council bylaw approval, and in those cases the average time they had been waiting for approval was 55 months, or nearly 4.5 years.

Thus, in the absence of the completion of the last legal step in the JFM process, most villages in Tanzania are implementing JFM under a set of informal arrangements in which their claims to revenue or other benefit-sharing from engaging in the management of government FRs as set out by the JFM program are not formally supported. Despite this situation, we still found that many JFM villages in our study continued to be interested and enthusiastic about engaging in JFM despite recognizing that they were receiving few tangible livelihoods benefits (while other JFM villages in our study were fairly disillusioned with the process), and we still found net positive governance impacts of JFM.

Based on expectations around how JFM could impact livelihoods, and the rich qualitative data we collected from household respondents and focus groups in the 110 villages in the study, we think that the lack of formalization of benefits-sharing on the part of the Tanzanian government could be one important reason undermining the potential for livelihoods opportunities as a result of JFM. However, we suggest that a stronger undermining factor is likely to be that in Tanzania, JFM is more likely to be implemented in higher-elevation montane forest reserves, where there are very few potential livelihoods opportunities for villagers to engage with, because GoT views these forests as important catchment reserves and therefore allows virtually no extractive activities, regardless of whether they are under JFM or not. In such reserves, the available set of forest-based revenue-generating activities for villagers is necessarily more limited

Table 2: ATT impact estimates on forest governance, livelihoods and forest conditions outcomes

	Genetic Matching[a]				2:1 Matching				3:1 Matching				PSM - 1:1 NN[d]				PSM - with caliper[b]			
Impacts	*N*	estimate	SE	*P*	*N*	estimate	SE	*P*	*N*	estimate	SE	*P*	*N*	estimate	SE	*P*	*N*	estimate	SE	*P*
Governance Outcomes																				
Village Government Satisfaction	110	0.21*	0.109	0.057	136	0.2*	0.103	0.058	204	0.23**	0.095	0.018	110	0.26**	0.257	0.049	110	0.21*	0.130	0.1
VEC or VNRC satisfaction	110	0.65***	0.212	0.002	136	0.73***	0.192	0.000	204	0.77***	0.173	0.000	110	0.63***	0.248	0.006	110	0.63***	0.210	0.003
Forest governance index	110	0.06**	0.025	0.025	136	0.06***	0.023	0.007	204	0.07***	0.021	0.001	110	0.06***	0.217	0.005	110	0.05**	0.020	0.018
Livelihoods Outcomes																				
Per capita annual household income ('000 Tsh)	110	30.27	37.814	0.423	136	8.39	39.70	0.83	204	-11.60	47.80	0.800	110	-0.250	0.210	0.115	110	-0.253	0.175	0.148
Per capita annual household income from forest products ('000 Tsh)	110	-15.56	10.464	0.137	136	-11.76	9.56	0.219	204	-10.10	8.90	0.260	110	-0.580	0.599	0.168	110	-0.489	0.487	0.315
Number of forest products harvested from the forest reserve per household	110	0.26***	0.090	0.003	136	0.23***	0.087	0.008	204	0.23***	0.083	0.006	110	0.21***	0.086	0.008	110	0.183*	0.102	0.072
Forest Condition Outcomes																				
Area of forest reserve deforested between 2000-2012	110	0.02	0.026	0.409	136	0.03	0.030	0.300	204	0.02	0.027	0.550	110	-0.013	0.033	0.352	110	-0.010	0.029	0.7
Household ranking of trajectory of forest reserve condition since year 2000	110	0.13	0.107	0.222	136	0.2**	0.100	0.050	204	0.23**	0.097	0.018	110	0.094	0.161	0.282	110	0.093	0.129	0.47
Change in household harvesting trajectory from the forest reserve since year 2000	110	-0.11	0.096	0.258	136	-0.05	0.100	0.609	204	-0.05	0.092	0.581	110	-0.162	0.145	0.133	110	-0.164*	0.096	0.088

* $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$

Matched Treated Units: [a]68; [b]65; [c]68; [d]68.

Abadie-Imbens standard errors are reported.

5.1 Overall JFM program effects: village governance

JFM involves the establishment of local committees and the identification and election of local representatives who are responsible for coordinating local management. Hence, there is great interest in understanding whether the JFM process results in improved local-level governance around forest issues. Our study finds a positive and highly significant effect of JFM on local-level village governance around forests, which was supported across all three of the indicators we focused on for governance outcomes. According to our data, households in JFM villages are not only more satisfied with the performance of their local VNRC relative to VECs in non-JFM villages, they are also more satisfied with the performance of their village government overall.

We note that we have high confidence that households used the VEC and/or VNRC and overall village government rankings in our household survey as a reflection of good governance attributes, because of the reasons that households provided as a short-answer follow-up question in the survey which asked respondents to explain their ranking. When asked to explain the reasons for their level of satisfaction with these village institutions, households across the study indicated that their ranking reflected common elements of good governance – such as a lack of corruption, or effective management – such that higher overall rankings indicate households perceived the institution to have fewer issues with poor governance. JFM villages also score higher on a comprehensive governance index, which reflects a range of good governance attributes, including, among others, higher household participation rates in JFM villages in forest monitoring and rule-making, in electing members of the VEC or VNRC, and in perceptions of fairness and clarity over forest rules and penalties by households in JFM villages.

Sensitivity analyses

Sensitivity analyses via Rosenbaum bounds (Rosenbaum 2004; Keele 2010) indicate that the impact estimates for all three of our governance indicators are robust to fairly wide departures from our underlying model assumptions. All our estimates maintain statistical significance even assuming the influence of an additional and fairly strong unobserved confounder. For example, we found an estimate of a 0.65 point increase in mean village satisfaction with the VEC or VNRC as a result of JFM. The log odds of a site receiving JFM would need to be 2.4 times higher as a result of a hypothetical unobserved pre-treatment covariate in order to materially change this finding of a strong causal effect of JFM on mean village satisfaction with the VEC or VNRC.

We found an estimate of a 0.21 point increase in mean village satisfaction with village government overall as a result of JFM. The log odds of a site receiving JFM would need to be 1.5 times higher as a result of this hypothetical unobserved pre-treatment covariate in order to materially change this finding of a strong causal effect of JFM on mean village satisfaction with village government as a whole. And, we found an estimate of a 0.06 point

increase in a village's overall governance index as a result of JFM. The log odds of a site receiving JFM would need to be 1.7 times higher as a result of this hypothetical unobserved pre-treatment covariate in order to materially change this finding of a strong causal effect of JFM on this overall governance index at the village level.

Given the results of our sensitivity analyses, we place a high level of confidence in our finding of a causal effect of JFM on each of the governance indicators that we assessed. The size of effect varies across indicators, with a fairly large effect of JFM on VEC satisfaction, and somewhat smaller impacts on village governance as a whole. Lastly, we emphasize that the sensitivity analyses reinforce our governance results by suggesting that our finding of a positive impact of JFM on each of the governance indicators that we assessed holds up to a fairly wide departure from our assumptions around the true sources of bias in how JFM is assigned. Even if we unintentionally failed to include a strong source of bias (that is, we've left out a pre-treatment covariate in our matching that is indeed a relevant confounder), the extent to which this confounder changes JFM assignment from how we've modelled it would need to be quite strong for this to materially change our results for any of the three governance indicators. Given our extensive analyses of treatment assignment as part of this study, we think it unlikely that there exists a strongly influential additional pre-treatment covariate which we somehow overlooked.

Supporting qualitative data interpretation

JFM involves the transfer of limited forest management responsibilities to VNRCs or VECs, and the election of village representatives to serve on the committee. The committees become responsible for local coordination of forest management issues under the guidance of government forest officers. The expanded forest rights and incentives for villager participation in forest management under JFM are thought to lead to improved local-level forest governance.

This study found a strong positive effect of JFM on local-level village governance around forest issues. On average, we found that JFM leads to an 18 percentage-point increase in household satisfaction with the performance of their VECs or VNRCs in JFM villages. JFM also positively impacts village governance overall, although the impact is smaller. The reasons households gave for higher satisfaction with these village institutions reflect common elements of good governance, such as a lack of corruption, more transparency or more effective management. Reasons for villager dissatisfaction with the VNRC or VEC reflected governance problems such as committee involvement in illegal harvesting, lack of transparency, not undertaking their responsibilities, or failure to conserve the forest.

We include below selected direct quotes from household respondents that exemplify this, in terms of representative explanations that respondents commonly gave for a high (satisfied) or low (dissatisfied) ranking of their satisfaction with a VEC or VNRC or village government overall:

VEC/VNRC satisfaction

'they are implementing the forest rules well'
'they are representing villagers in forest management'
'they are patrolling the forest regularly'
'they help in forest conservation'
'they are helping to protect the forest'
'they are managing the forest properly'
'they are supervising our forest well, including punishing the ones who break the rules'.

Village government satisfaction

'they are doing good things'
'they are fair'
'they treat everybody fairly'
'there is good cooperation with villagers'
'they are open to us'
'they are responsible'
'we chose them ourselves'
'they are trying to provide services in the village'
'they hold meetings and read the income and expenditures'.

Examples of respondent quotes which reflect common reasons households gave for their dissatisfaction with the forest management institution within the village, or with village government, include:

VEC/VNRC dissatisfaction

'they are the reason for forest destruction'
'they are taking bribes in forest management'
'when they catch [forest] offenders they use the fine money themselves'
'they engage in harvesting timber illegally'
'they sell timber for their own benefit'
'they do not conserve the forest'
'they participate in forest degradation'.

Village government dissatisfaction

'the leaders are not cooperating with the villagers'
'there is no transparency on revenue in this village'
'they are not honest'
'they are not implementing their responsibilities'
'they are not solving our problems'
'they collect money from villagers but there is no development'
'they don't involve us in decision making and they mistreat us'.

JFM villages also scored higher on a comprehensive forest governance index, which takes into account several good governance attributes. This included higher household participation rates in VEC or VNRC elections, forest monitoring and involvement in forest decisions, and perceived fairness of forest rules and penalties. On average, 26 percent of households in JFM villages participated in the last VEC or VNRC election held in their village, compared to 19 percent of households in non-JFM villages. More encouragingly, several JFM villages in the study had VEC or VNRC election participation rates above 50 percent, which was not the case for any non-JFM villages sampled.

VNRCs in JFM villages are also substantially more active than in non-JFM villages. This includes the types of activities these village institutions undertake about forest management, and how often they undertake them. For example, 9 percent of JFM village VNRCs in the sample had coordinated the sale of forest products, and 15 percent of them distributed forest revenue in the year prior to the study, compared to 0 percent on either activity for VECs or VNRCs in non-JFM villages. Ninety-five percent of JFM VNRCs in the sample had been involved in forest monitoring and enforcement activities during the past year, compared to 54 percent of non-JFM VECs or VNRCs.

Results suggest that VNRCs in JFM villages are exercising many of the institutional responsibilities around forest management that are provided for under the law. However, few VNRCs in JFM villages had undertaken some of the more substantive responsibilities that they are allowed under JFM, such as revenue generation and distribution, or making decisions about who is authorized to harvest forest products and in what quantities.

Study results also highlighted few sources of financial support for VNRCs involved in JFM. Forty-five percent of VNRCs in JFM villages reported no source of financial support, and 28 percent depended primarily on revenue from fines. External income flows from activities such as tourism, sale of forest products, or research fees comprised the main source of financial support for only 8 percent of VNRCs in JFM villages, although it was 0 percent for non-JFM village VNRCs.

Our results also suggest that JFM appears to be meeting some of its objectives around widening the scope of forest management and benefits participation for different groups in JFM villages (Figures 11 and 12). Our data point to a greater diversity of interest groups and local actors involved in management of forests under JFM than in control sites, and demonstrate that households appear to see a clear role for VNRCs in forest management in JFM villages. A much greater proportion of households in JFM villages indicated that the group receiving the most benefits from forest management is villagers in general (Figure 12). In JFM villages, VECs and VNRCs were seen as the most important actors in day-to-day forest management within JFM forest reserves, while central government was seen as the most important actor in control sites. Our study also suggests that in both JFM and non-JFM villages alike, many villagers have rather limited awareness of forest management (including who in their village is responsible for or involved in forest management, and who benefits most from forest management). However, these figures are much lower for JFM villages than control sites.

Figure 11: Diversity of groups participating in decisions around forest management

(Data from CBFM forests where they were present at study sites is included for comparison)

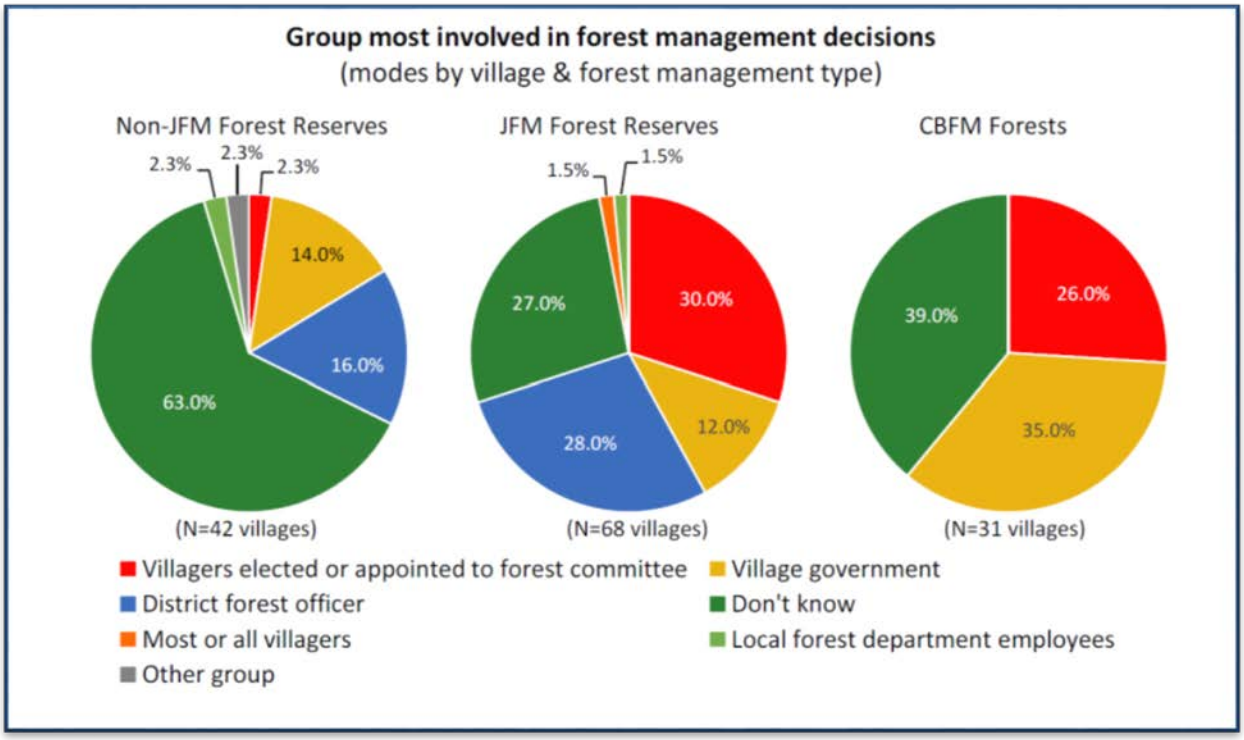
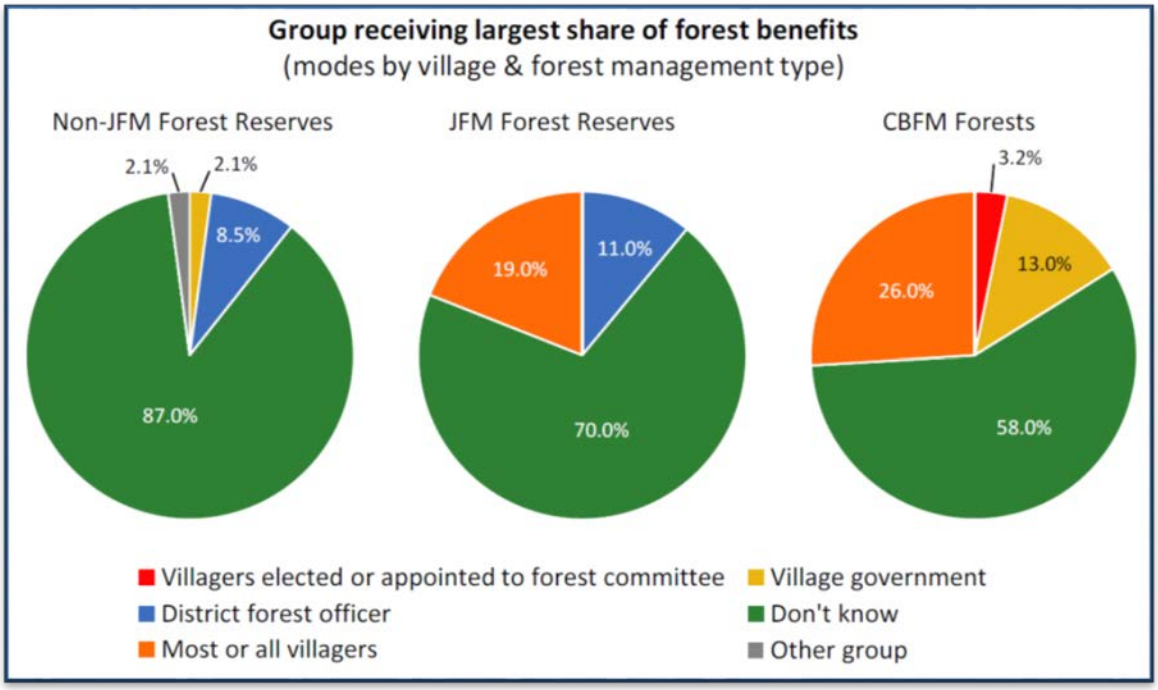


Figure 12: Household perception that villagers benefit more from JFM sites than control sites

(Data from CBFM forests where they were present at study sites is included for comparison)



5.2 Overall JFM program effects: household livelihoods

Many studies over the past decade have highlighted that communities engaging in JFM in Tanzania receive few material benefits. Concerns have been raised that the costs of forest management by villagers (such as patrolling, enforcement, meetings) outweigh any benefits received, bringing into question the long-term viability of JFM as it is currently implemented. Our study suggests that these concerns are justified. Our results provide strong evidence that on average, JFM is currently not impacting household livelihoods. We found no evidence of an impact from JFM on annual household income, on forest-derived income, or on an asset-based measure of household wellbeing (Table 2). In JFM villages, there is also no significant difference in the change in either income or asset-based measures of household wellbeing over 2001–2013 as a result of JFM (Appendix G).

However, we also found that on average JFM leads to a small increase in the number of different forest products harvested from the forest reserve by households in JFM villages. We interpret this as an indication of a small but clear impact of JFM on household subsistence use of forest reserves. Our results suggest that households in JFM villages are using a wider diversity of products from forest reserves than households in non-JFM villages, although we find no evidence that such use is currently resulting in higher household income.

Sensitivity analyses

Sensitivity analyses via Rosenbaum bounds (Rosenbaum 2004; Keele 2010) indicate that the livelihoods impact estimate of a 0.26 increase in the number of different forest products harvested from the forest reserve per household due to JFM maintains statistical significance even in the presence of a strong but unobserved confounder. The log odds of a site receiving JFM would need to be 2.5 times higher as a result of this hypothetical unobserved pre-treatment covariate in order to materially change the findings for this livelihoods outcome indicator. Given this high level of T we obtain, we can place a high level of confidence in our finding of a causal effect of JFM on the number of forest products harvested from the forest reserve by households, despite the fact that the point estimate we obtain is relatively small. In other words, the impact on this subsistence livelihoods indicator due to JFM is small, but we have high confidence in the finding. The sensitivity analyses reinforce our results by suggesting that our finding of a positive impact of JFM on the number of different forest products harvested by a household holds up to a fairly wide departure from our assumptions around the true sources of bias in how JFM is assigned.

Supporting qualitative data interpretation

Open-ended short answer text variables in our household survey, and additional qualitative data obtained via focus group discussions, suggested that in general villagers clearly recognize that they are not receiving tangible livelihoods benefits from JFM, and

point to a number of reasons why. However, these responses still tended to be more positive than those from control sites, where communities tend to be even further disenfranchised from forest use.

For example, these constraints are visible in several of the open-ended short text questions in our household survey, which asked households to describe the subsistence and commercial benefits they received from the forest reserve. In the majority of control sites, household responses gave the impression that households appreciate the ecosystem services that the forest reserve generates, such as good weather conditions and forests as a source of water and rainfall, but perceive few tangible income benefits from the reserve. Households commonly responded that they receive no benefits from the reserve. Representative explanations that households gave to support their statement that they receive no income-based forest benefits are as follows:

'we are not benefitting from this forest'
'we are not allowed to harvest anything from the forest'
'government is the one who benefits from this forest'
'we are getting rainfall but we are not allowed to harvest anything'.

In some of the few JFM cases in our sample where there was a formalized system for income-generation from the forest reserve, and a functional revenue-sharing scheme in place, we did see some indication that households could be seeing livelihoods improvements directly, or broader community benefits that indirectly benefit their livelihoods. For instance, in such sites households frequently made comments such as:

'we are getting employment from tourists'
'we get foreign currency'
'the forest brings income from tourism, water, attractive animals, tourism activities and good relations'
'we get tourists, water, a dispensary, police station and classrooms'.

These sites are indicative of some of the benefits that JFM was intended to provide, but our study shows that in practice such processes rarely occur. We should also note that in our sample nearly all of the JFM cases with community-wide revenue-generation came from forest reserves that had been marketed for tourism, or a targeted and externally-introduced forest product-based income-generating scheme introduced by an NGO or external organization had facilitated access to a market and helped guide the implementation of a harvesting system. An example is Msambu seed collection in Amani Nature Reserve. On the whole, however, we encountered few examples of self-generated revenue processes within JFM villages.

Lack of formalization of Joint Management Agreements

Another potential reason contributing to the lack of livelihoods improvements relates to the gap in formalized JFM implementation that we observed through this study. We found that a majority of JFM sites are operating in the absence of approved bylaws or signed JMAs, as explained earlier in this section. Given how few sites in our study actually had these signed contracts, it is difficult to know with certainty how JFM would function differently for household livelihoods had these agreements been signed in the typical JFM implementation context of highly protected forest reserves where there are ostensibly few livelihoods opportunities from the forest reserve to begin with, and forest extraction is prohibited. But, in the absence of extractive-based revenue opportunities, there are two possibilities. Firstly, communities could enforce forest rules more strongly and become more aggressive over pursuing fines against rule-breakers for commercial activities such as illegal logging and charcoaling (where established government fines are steep) when they have the incentive of a stronger legal assurance that they will be allowed to keep a significant portion of the fine revenue. Secondly, communities could become more proactive about starting or helping to sustain or improve, or more actively engaging in, creative non-extractive income-generating activities (including eco-tourism, but perhaps other innovations would also emerge) when they have the JMA-based legal assurance that government will allow them to keep the ~30-50 percent of revenues that JFM guidelines say they are entitled to.

5.3 Overall JFM program effects: forest conditions

We note that a naive comparison of forest conditions in JFM forest reserves compared to control sites across our data indicates that JFM reserves are significantly better protected from forest degradation and outright deforestation. However, our quasi-experimental analyses, which take into account that JFM is implemented in forest reserves that on average were already in better condition than non-JFM reserves, find no significant difference in the overall deforestation rate in JFM forest reserves as a result of JFM. Although it is widely believed that JFM is associated with improved forest conditions in Tanzania, this study finds no evidence for a difference in deforestation rates in JFM forest reserves relative to non-JFM reserves between 2000–2012 (measured as loss of tree canopy cover), that can be attributed to the JFM management approach.

Overall, we also found that households in both JFM and non-JFM villages reported a net decline in their own harvesting from the forest reserve over the past 10 years (prior to the start of JFM for JFM villages), across each of six common forest products that we assessed. Our results suggest weak evidence that households in JFM villages report a somewhat greater reduction in harvesting (statistically significant for results based on propensity score matching but not for the impact estimate obtained via genetic matching). Of greater interest is the difference in reasons given for why households are harvesting less. Across JFM villages, households were much more likely to say that they were

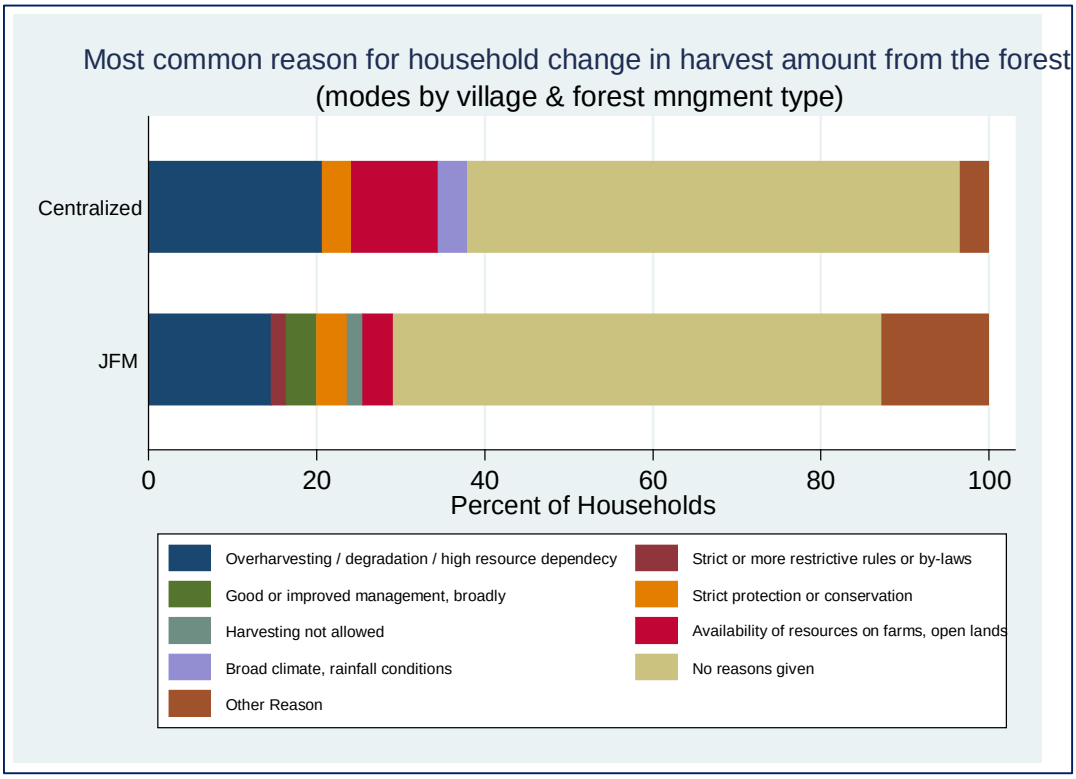
harvesting less from the forest reserve now compared to 10 years (prior to JFM) because of management-related reasons such as stricter rules, more effective patrols, the passing of their own bylaws around forest use, and so on. In contrast, households in control villages were much more likely to cite forest degradation factors, and declining resource availability, as the reasons why they harvest less from the forest reserve now compared to 10 years ago.

Supporting qualitative data interpretation

Although we find no difference in extreme forest degradation and tree canopy loss as a result of JFM, measures related to household harvesting and the legitimacy of forest conservation processes may suggest a slowed trajectory of forest degradation in JFM forest reserves. We find weak evidence that households in JFM villages view the condition of JFM reserves as improving over the past 10 years, linked to changes in household harvesting and improved protection. It is possible that such processes reflect slowly improving conditions in JFM reserves that may become apparent over a longer timeframe than our study (since JFM has only been implemented since the late-1990s, this was the timeframe available for study, but it may be that positive JFM impacts on forest conditions accrue more slowly than this).

In 21 percent of JFM villages (and only 4 percent of non-JFM villages), the majority of households said that improved forest management, the presence of stricter forest bylaws, or harvest bans had resulted in them harvesting less from the forest reserve compared to 10 years ago, across five common forest products (charcoal, timber, fuelwood, fodder, other NTFPs). In contrast, 46 percent of non-JFM villages cited overharvesting and forest degradation as the main reason why households harvest less from the forest reserve now compared to 10 years ago, compared to 30 percent of JFM villages.

Figure 13: Reasons households gave for their own reduced harvesting from the forest reserve



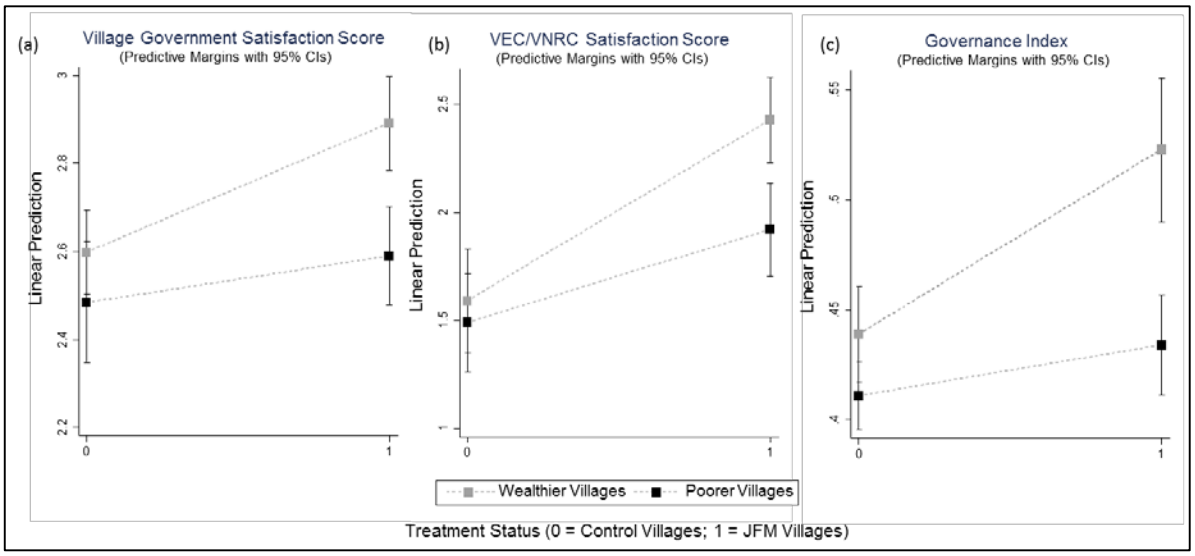
5.4 Heterogeneous impacts: wealth subgroups

A number of reviews of JFM have highlighted that village elites often tend to benefit most. These elites can include those with higher incomes, higher education levels or those in positions of responsibility (such as members of the VNRC or village council). Whether and how JFM impacts poorest groups differently is a key policy concern. Our study examined whether JFM impacts differ across poorer and less poor villages. We also looked at whether JFM impacts are different for the poorest households relative to the rest of households within a village.

Poorer villages in our study score lower than less poor villages on all governance indicators, regardless of whether they are JFM villages. This is demonstrated graphically for each governance outcome, across poorer and wealthier villages, in Figure 14. For two of the three governance outcomes – VEC or VNRC satisfaction and village governance satisfaction – we do not find a statistically significant impact due to JFM across poorer and wealthier villages. This means that for these outcomes, although the trend suggests smaller governance impacts from JFM for poorer villages, on average this difference relative to wealthier villages is not statistically significant. In contrast, we do find a positive and significant interaction between JFM treatment and village wealth status for the overall governance index outcome. Here, we find that JFM leads to a positive and statistically

significant increase in the governance index score in poorer villages, but the magnitude of improvement due to JFM is significantly lower in poorer villages under JFM than the increase which occurs for less poor villages as a result of JFM (Figure 14 c). We find that the overall governance index score is 0.06 lower (95% CI: -0.11, -0.01) in poorer JFM villages relative to wealthier JFM villages (t = -2.37; P = 0.02). Thus, a positive impact from JFM is also present in poorer villages, but this effect is not as high in poorer villages as in less poor villages. For livelihoods outcomes and household ranking of forest condition trajectory, the impacts from JFM are not significantly different across poorer and less poor villages.

Figure 14: Role of village wealth status on governance impacts of JFM



We find a somewhat similar trend for differences in impacts across poorest households compared with the rest of households within villages. For the poorest quintile of households in the study, we find that JFM still has a significant and positive impact on household-level governance indicators (Figure 15). However, the magnitude of impact due to JFM is smaller for poorest households in JFM villages than the rest of households for some outcomes (Table 3). Differences in JFM impacts for poorest households are greatest for household satisfaction with the VNRC. We also note that our analysis by household wealth groups suggests that non-poorest households, which generally exploit forests for cash income to a greater extent than poorest households, may experience a negative impact on forest-based livelihoods as a result of JFM. This finding requires further study.

Table 3: Estimated impacts of JFM on forest governance and livelihoods outcomes across household wealth subgroups

JFM Impact Estimates by Household Wealth Subgroups (independent regressions, pre-processed via matching)	Village Government Satisfaction	VEC or VNRC satisfaction	per capita annual household income ('000 Tsh)	per capita annual household income from forest products ('000 Tsh)
Poorest quintile of households	0.131	0.636***	9.05	2.7
	(0.123)	(0.171)	(25.76)	(12.15)
Non-poorest households	0.156**	0.78***	31.1	-17.50***
	(0.070)	(0.117)	(20.21)	(6.56)
Difference	-	-0.144	-	-
		[0.48]		

* $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$

(Robust standard errors are reported).

[P value, Welch's t-test]

In terms of the main message for the wealth-based subgroup analyses, our results suggest that there are likely to be wealth-based differences in JFM participation and how JFM is experienced by households, within JFM villages (Appendix H). We find the strongest evidence for this in terms of household-level indicators for JFM impacts on forest governance outcomes. The poorest households in JFM villages also experience a positive governance impact from JFM, but the magnitude is not as great as for the non-poorest households. Our data also suggest that poorest households benefit very little from forest reserves in terms of cash income, regardless of whether the reserve is JFM or not (Figure 16).

We also reiterate that our wealth-based subgroup analysis for poorest households relative to other households suffers from design constraints as outlined in Section 4.8.5, which means that these results should be used with caution and viewed as suggestive rather than definitive. However, particularly given the key policy concern around this issue and the dearth of other rigorous, large-scale work around the question of if and how JFM impacts poorest households differently, we see this as a useful step. Our data suggest that, at least on governance outcomes, it appears that JFM does alter governance processes within JFM villages in ways that positively impact poorest households' experience with village governance, even if these impacts may not be as great as for other households. This may still be taken as a positive outcome of JFM in the sense that although JFM in theory could open up benefits that improve the wellbeing of poorest households, in practice there is very little about how JFM is implemented which can explicitly be considered a 'pro-poor' activity. That is, JFM implementation in Tanzania does not require any explicit attention to pro-poor issues in villages, such as ensuring that the poorest or marginalized groups of people within the village are represented on the VEC or VNRC. Despite this, we find that the poorest households on average do experience

positive governance impacts as a result of JFM, suggesting at a minimum that JFM does not work strongly against pro-poor objectives. However, our findings also suggest that there is scope for improvement in this respect.

Figure 15: Boxplot distribution of mean satisfaction with VEC/VNRC by village and wealth subgroup (matched sample)

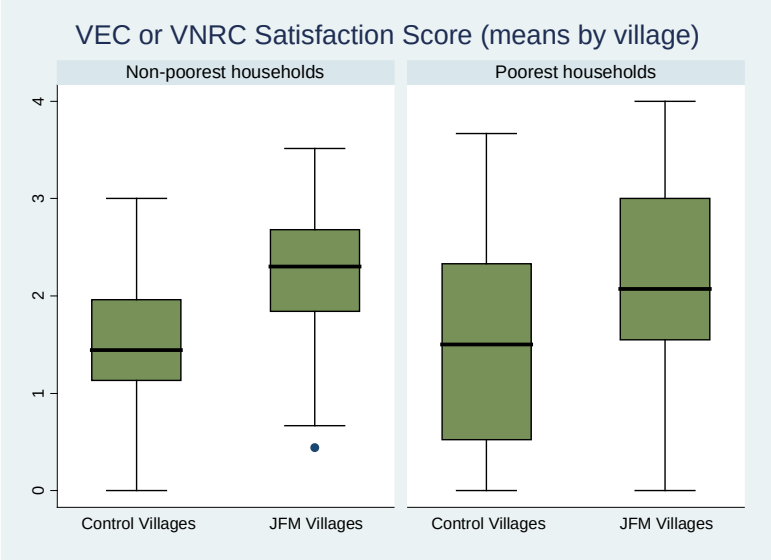
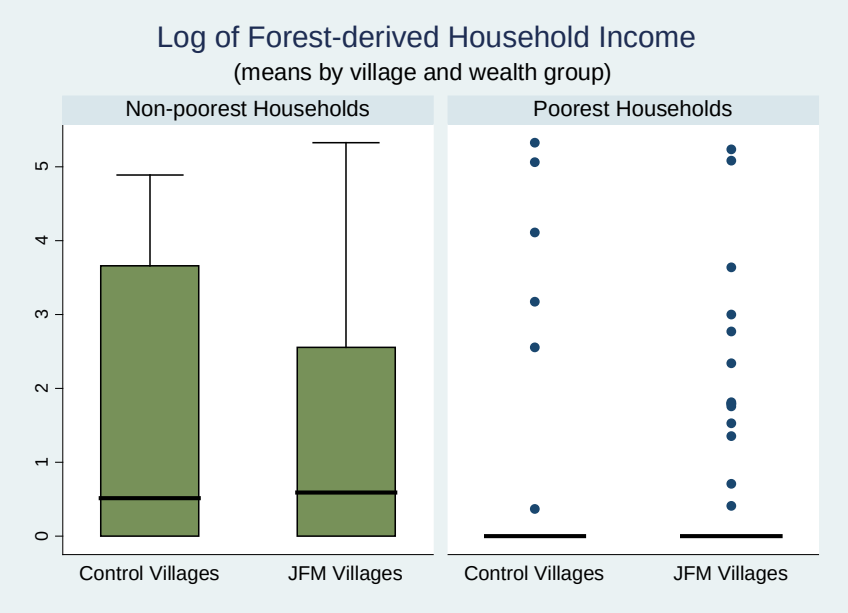


Figure 16: Boxplot distribution of mean forest-derived household income by village and wealth subgroup (matched sample)



5.5 VEC and VNRC composition and functioning

VECs or VNRCs are now established in many villages in Tanzania, and JFM works through these existing village-level institutions to implement the co-management process related to government forest reserves. However, many villages which surround government forest reserves have been informally involved in monitoring and patrolling government forest reserves on behalf of local forest staff for many years, irrespective of whether the village is involved in JFM. JFM formalizes this co-management, and expands the authorities and kinds of decisions that these institutions can be involved in, as well as – at least according to design – making it possible for villages to benefit from the arrangement via revenue-sharing from forest activities. In this section, we briefly summarize key comparisons of the composition and functioning of VECs and VNRCs across the JFM and control villages in the study.

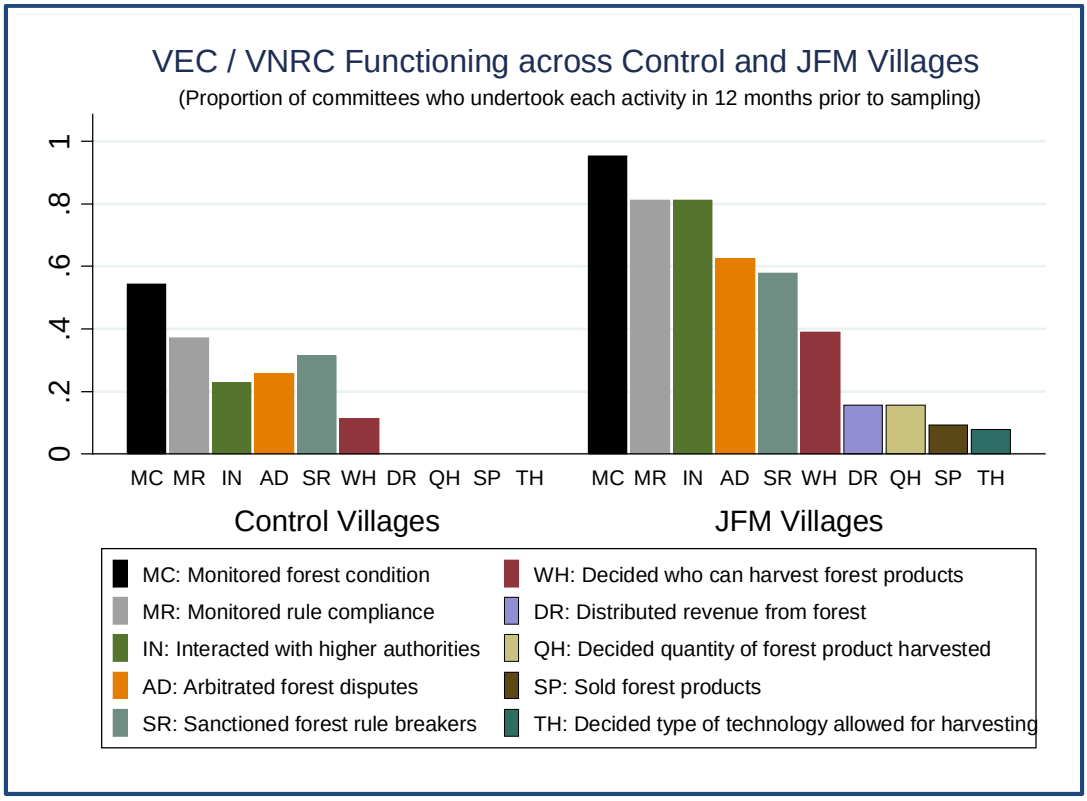
VEC and VNRC committee composition appears to be fairly similar across the JFM and control villages in our sample. The average number of committee members is 11 for control villages (ranging from 2 to 18 members total), and 12 for JFM villages (ranging from 6 to 28 members total). Women comprise anywhere from 25 to 55 percent of committee members for the majority of both control and JFM village committees, suggesting that female representation tends to be considered in committee construction across both pools. The committee is elected in 76 percent and 77 percent, respectively, of the control and JFM villages in our sample. Members are appointed rather than elected in the remaining cases.

In terms of committee functioning, we assessed information such as the frequency and attendance at meetings, kinds and extent of record-keeping, sources of financial support, and more detailed information about 10 types of forest management activities, in order to gain an understanding of the types of activities that the different committees undertake, with what frequency, and the extent of their engagement in each. For each activity that we assessed, we found that a greater proportion of committees in JFM villages had undertaken or made decisions about that activity during the 12 months prior to our study, relative to the proportion of committees in control villages who did the same (Figure 17).

On the whole, Figure 17 illustrates the extent to which VNRCs in JFM villages tend to be more active across a range of different forest management processes and decision-making. However, it also shows that while many committees in JFM villages are very active in forest monitoring and enforcement activities, they tend to be less active on substantive decisions around the kinds of forest products that can be harvested, by whom and in what quantities. In general, there is little activity related to collecting and distributing revenues from forest-based activities, despite the fact that these are likely to be some of the key routes by which improved livelihoods benefits might be realized for villages under JFM. We also note that several of these activities are ones in which villages that are adjacent to government FRs are often informally expected to participate, together with

local forest agency staff. These activities include monitoring the forest, or participating in dispute resolution around forest activities, even when a village is not involved in JFM. Others are activities for which JFM specifically expands this responsibility to village VNRCs, such as decisions around the sale of forest products, or revenue distribution from the forest reserve. For such activities (particularly the last four listed in Figure 17), we are therefore not surprised to see that a greater proportion of JFM committees have been involved in these management processes relative to control villages. This attests to some degree of change in the substance of forest management that occurs at village level in at least some villages under JFM, although on the whole the number of JFM committees that do engage in some of these more substantive management activities appears to be fairly low.

Figure 17: Forest management activities undertaken by VECs and VNRCs

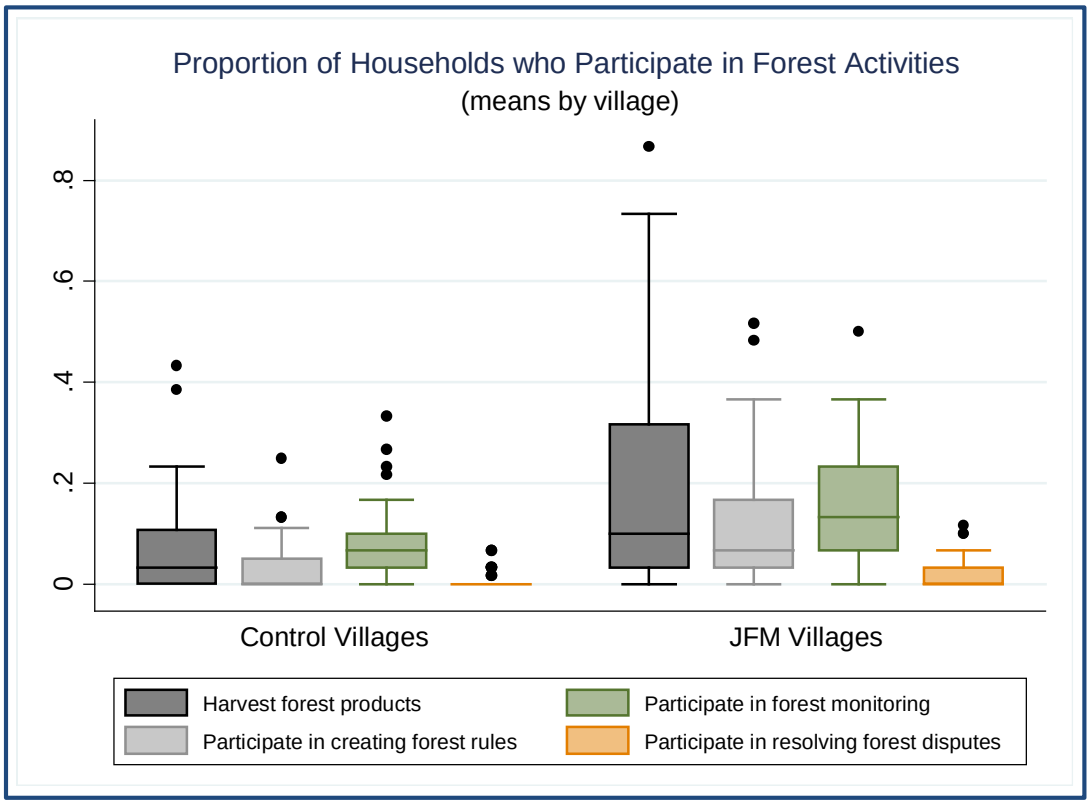


5.6 Household participation in forest management activities

We also comment briefly here on trends in household-level participation in forest harvesting and management activities across the JFM and control villages in the study. Household survey respondents were asked about their level of participation in four key activities: harvesting forest products from the reserve, creating rules related to forest use, harvesting or management, forest monitoring or enforcement, and resolving conflicts or disputes related to the forest reserve. Both pools of sites have a fairly wide distribution of

participation levels – meaning that villages with widespread participation across households, and those where very few households participate in any of the four activities, are found in both the JFM and the control sets of villages (Figure 18). However, our data suggest that on average, a significantly higher proportion of households participate in each of these activities in JFM villages compared with control villages. For example, a mean of 8 percent of households in control villages participate in forest monitoring activities, compared with 15 per cent of households in JFM villages ($t = -4.02$; $p = 0.0001$). We also note that while several JFM villages have quite high participation levels ($\geq$ 30 percent of households) for most of the activities we assessed, there are also many villages where participation is low, and the overall means across the JFM pool as a whole are relatively low (18 per cent, 11 percent, 15 per cent and 2 percent of households participating in harvesting, rule creation, monitoring and dispute resolution, respectively; the means are 7 percent, 3 percent, 8 percent and < 1 percent of households participating in the same activities across the control villages). Participation in dispute resolution activities was very uncommon for households across all villages in the study, regardless of whether they were involved in JFM. Although it is outside the scope of analysis for this report, one goal of future work is to undertake more targeted analysis to understand determinants of heterogeneous household-level participation in forest activities under JFM, and how the varying levels of household participation that we observed in these different activities across villages may influence outcomes under JFM.

Figure 18: Boxplot distribution of mean household participation in forest management activities (means by village)



5.7 Results fit with existing quasi-experimental studies of decentralized forest management impacts

Our study focused on assessing the impacts of Tanzania's JFM policy on governance, livelihoods and forest condition outcomes, and providing information that may be useful for program administrators seeking to improve or better target the program in the Tanzanian context. To our knowledge, this research represents the first counterfactual study of forest sector decentralization impacts in Tanzania, and draws on a sample size that is considerably larger than most existing work on this issue throughout Sub-Saharan Africa. Here we also briefly contextualize our findings within the broader quasi-experimental literature to assess similar decentralized forest management programs in developing countries. However, we caution that there are very few such existing studies to draw on, which have also used robust counterfactual approaches to establish the causal effects of forest sector decentralization (Miteva, Pattanayak *et al.* 2012). In fact, a recent systematic review funded by 3ie could find only 12 such studies globally (Samii *et al.* 2014), even though decentralized approaches have a history of implementation spanning more than three decades.

Similarly, it must be noted that decentralized forest programs across different countries may not share the same policy construction or implementation process (although they are often relatively similar), and the outcomes assessed and ways that they are measured differ widely across existing quasi-experimental studies of decentralized forest management. Thus, the extent to which our findings agree or not with existing impact evaluations from other country contexts must be qualified with the observation that the existing body of work on this issue, which also takes a rigorous counterfactual approach, is currently very small and methodologically diverse. If we were to break down these existing studies by co-managed approaches, such as we assess here, and more fully devolved communal forest management (which we do not assess here), we find that the body of co-managed work that is available to draw on is even further reduced. In this sense, the need for more studies within the forest sector which adopt this kind of approach is clear.

Despite these limitations, we briefly note that our result of no significant effect on broad deforestation rate appears to agree with the two existing studies (from India and Bolivia) that have also measured this outcome, where effects have ranged from negligible to small but significant (Samii *et al.* 2014). However, given the small number of cases and widely variable country contexts, we do not suggest this constitutes a trend.

There is a slightly higher number of studies which assess livelihoods outcomes from decentralized forest management, based on studies in Uganda, Malawi and Ethiopia. Here, our results are again fairly consistent with this small set of work, which finds highly variable livelihoods impacts and also calls attention to equity issues across wealth groups. For example, in a study of two villages in Malawi, Jumbe and Angelsen (2006) find a net improvement on forest income as a result of decentralized co-management, but dramatically opposing directions of income impacts across participants in the two villages in their study. Their results also suggest positive livelihoods impacts for poorest households under some circumstances, but not when households are highly dependent on forest resources and the program restricts their cash-based forest activities (a situation which is arguably similar to the Tanzanian context). A quasi-experimental study from Ethiopia also found contradicting directions of livelihoods impacts across the two villages in their sample, and more positive impacts for village elites. Together these results suggest that positive impacts on livelihoods are possible under decentralized management, but that localized context around harvesting permissions, revenue-sharing arrangements and subsistence versus commercial dependencies on forests among households, influence the extent to which decentralized management can positively impact livelihoods within villages (Ameha, Nielsen *et al*. 2014). Lastly, we find no comparable studies of forest sector decentralization impacts on village-level governance and thus we are unable to contextualize our findings on that set of outcomes.

6. Policy recommendations

Tanzania's PFM program is ensconced in both policy (1998 National Forest Policy) and law (2002 Forest Act). PFM remains a key strategy by which FBD aims to achieve its broader forest management and conservation objectives set out in its National Forest Programme. Benefits associated with the PFM program are intended to be long-lasting, and to grow as the program continues to expand. This is one of the reasons why a robust impact evaluation of the program at this stage could provide crucial information to strengthen future outcomes, such as enabling more targeted implementation that stems from a stronger understanding of the key factors and conditions which shape particular outcomes, and providing an empirical basis to address critical implementation challenges that the research might uncover.

This study assesses JFM impacts according to the way it is implemented in practice, following changes to the legal and policy framework in the late-1990s. Results show that JFM has been able to meet some, but not all, of its policy objectives. Our study finds positive impacts for the first step in a pathway from decentralization via JFM to improved forest governance outcomes at village level. We do not find evidence that JFM improves household livelihoods, but our study also demonstrates that (1) JFM is predominantly implemented in contexts where livelihoods opportunities from government FRs are not apparent; and (2) JFM as currently implemented does not follow the legal process through to signed contracts between government and communities, which would solidify the legal claim of communities to a portion of any revenues actually generated through forest management activities. These two shortcomings must be seen as substantive dampers on the incentives that communities have to fully engage with JFM. In terms of forest conditions, we find no evidence that JFM leads to a change in deforestation rates over the status quo, centrally-managed, forest reservation system in Tanzania during the period 2000–2012. However, we do find weak evidence that households may be changing their harvesting behavior in JFM forest reserves due to stricter protection and more effective patrols. These effects may eventually accrue to improved forest conditions over a longer period of time.

Overall, our study findings point to net positive impacts of JFM in comparison to the traditional state-managed approach in Tanzanian forest reserves. These impacts are encouraging, especially taking into account that JFM has not been formally implemented as it was designed in the policy and legal reforms created by the Forest Act and Forest Policy. Despite this, our study finds evidence that the first step in the intended pathway to impacts, around improving village-level governance, appears to be have been taken. The positive impacts of JFM could be further strengthened by:

1. Speeding up the approval and formalization process: This is needed both at the local government level with regard to bylaws, and at the national level with the signing of JMAs by government and villages which engage in JFM.

2. Reviewing how benefits for communities can be generated from protection forest reserves in Tanzania: Measures are needed to capture the significant contributions that are made by protection (catchment) forests to power generation and water supply, and to ensure that communities living around these forests are compensated for the environmental services they provide to the country as a whole through their forest management activities.

3. Improved targeting at the local level: Implementers of JFM should work to ensure that the poorest households within targeted communities (which depend most heavily on forest resources for their livelihoods) also benefit from JFM arrangements.

Some of the key policy messages that emerge are:

JFM is an important way in which village governance (around forests, and in general) can be strengthened. Despite widespread criticisms of village natural resource management committees, this study indicates that one of the most important outcomes of JFM is improved local-level governance. VNRCs are now established in many villages across Tanzania, irrespective of whether the village is involved in JFM, although in many cases they are not very active and have seemed to provide few benefits. Where JFM is implemented, on average, these committees are empowered and motivated to take on their responsibilities, and their work appears to promote elements of good governance in the local community.

Limited or negligible livelihood benefits are being generated from JFM. The study found no evidence of impact from JFM on household livelihoods. Furthermore, only 15 percent of JFM sites in the study were generating any forest-based revenue and only 20 percent had a functional and legally recognized benefits-sharing mechanism in place (regardless of whether it was being used). Although the Ministry of Natural Resources and Tourism (MNRT) recently issued JFM guidelines that specify how benefits will be shared under JFM, much work will be needed to update and formalize agreements. In catchment forests, where harvesting is not permitted, there are even greater challenges to generating forest-based benefits, and fewer incentives for villagers to engage in forest management.

Failure to legalize many JFM agreements may be undermining its potential impacts. Although the study indicates that forest protection is no worse in JFM forest reserves, few of the JFM sites in the study were implementing JFM as it is described in the 2002 Forest Act. For example, only 8 percent of the JFM sites in the study had a signed JMA, while 45 percent had their bylaws approved by local government but no signed JMA. Of the 47 percent of sites still awaiting this first step of bylaw approval by local government, the average time in pending status at the time of our study exceeded three years. Thus, many villagers are effectively implementing JFM through an informal set of management arrangements. Despite these obstacles, the study has shown positive impacts on

governance even when agreements and bylaws are not ratified by government. It is possible that impacts could be further magnified if government takes steps to speed up the approval and legalization process within JFM.

Appendix A: Propensity score modelling

The propensity score is a single metric which combines information from a range of pre-treatment covariates to predict the probability of receiving treatment, for each unit in the treatment and control groups (Stuart 2010). The propensity score is formally defined as: $e_i = Pr(Z_i = 1 \mid X_i)$, in which for each unit *I,* e is the estimated propensity score, and Z is the treatment status, conditioned on a vector of pretreatment covariates, X (Rosenbaum and Rubin 1983).

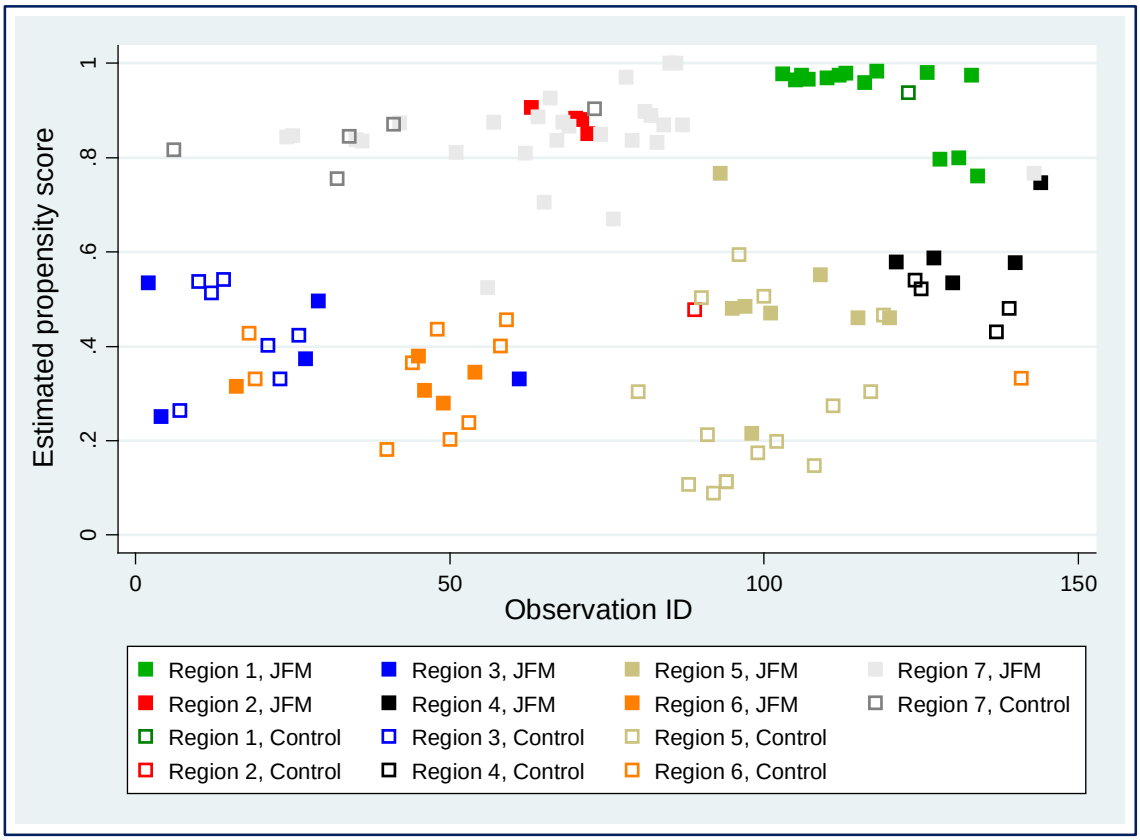
We modeled our propensity score by including eight observable pre-treatment covariates across a set of forest reserve and village characteristics that we expect to be associated with selection into JFM by program administrators, and to also affect JFM outcomes across any of the outcome family that we assess in our study, as well as a set of region dummies. The observable covariates are, at the forest reserve level: (1) reserve size, (2) number of surrounding villages, (3) mean tree cover in year 2000, (4) mean elevation, (5) village population density per hectare of forest; and at the village level: (1) minimum travel time to nearest government administrative town, (2) a binary indicator of high or low village-level collective action, and (3) mean tree cover on village land within 5 kilometers of the forest reserve boundary in year 2000. Our set of pre-treatment covariates includes variables for which we have strong evidence as true confounders, and others which theoretically influence JFM outcomes but for which we have either weak or no empirical evidence of their role in determining treatment in the Tanzanian JFM context (potential confounders) (Austin 2011). We arrived at our final set of variables to include in the propensity score model after substantial work to characterize administrative selection bias for JFM across the regions in our study (Persha *et al*. in prep). Persha *et al.* (in prep) further discusses pre-treatment covariates, and theoretical and empirical justifications for their inclusion.

Our selection bias analyses suggested the importance of key factors involved in JFM assignment potentially differed across different regions in our study, resulting in different selection bias profiles for different regions of Tanzania. This was not necessarily surprising since determinations on where to implement JFM in Tanzania were often made via regional meetings which brought together regional and district forest officers, donors and NGOs working in particular regions of the country and planning or coordinating their JFM implementation strategies together. We include region dummies in our propensity score model to account for this effect, which essentially generates different effective propensity scores for each region, and results in more similar propensity scores across regional clusters which followed a similar selection profile to each other (Figure A1). We note that another strategy for dealing with this could have been to block on Region in our matching analyses. However, this alternative turned out to be unfeasible because several of the regions in our study with high levels of donor focus currently have few forest reserves left that are not impacted by JFM, leaving few available control sites in these regions and

severely constraining the options for generating a balanced and sufficient N of JFM and matched control sites in each of the study regions.

Matching on the propensity score can work well, but only if the propensity score model is correctly specified, which is often not possible to determine in observational studies (Austin 2011). Following standard methods, we assess the specification of our propensity score model by determining how well the resulting score produces a balanced distribution of pre-treatment covariates across the JFM treatment and control groups.

Figure A1: Propensity score distribution by region



Appendix B: Distribution of outcome values across full sample of JFM and non-JFM sites (post-matched sample)

Figure B1: Governance family of outcomes

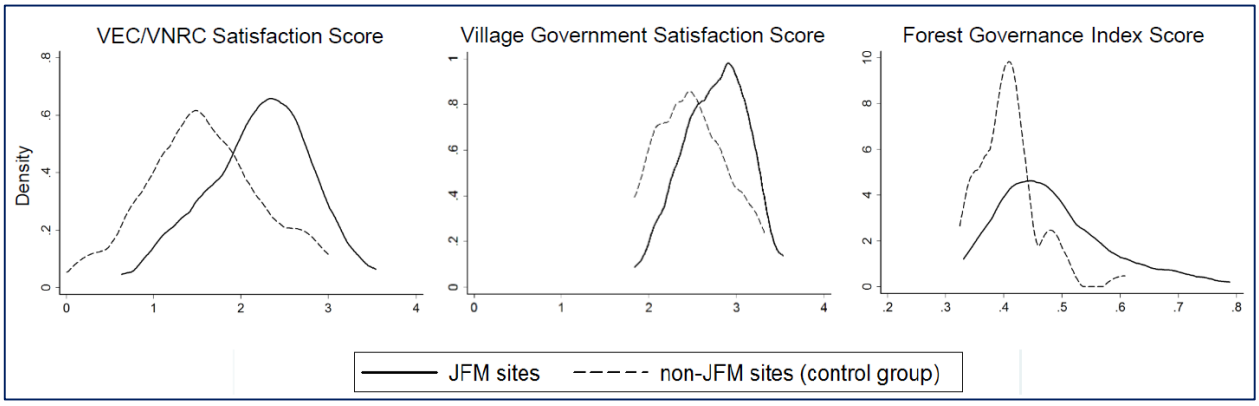


Figure B2: Livelihoods family of outcomes

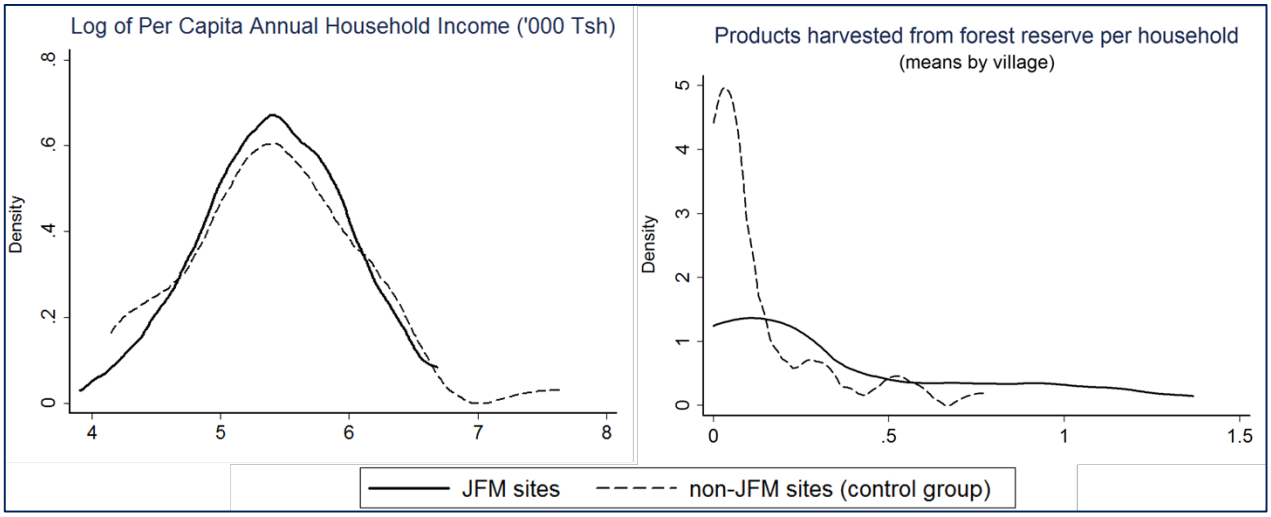
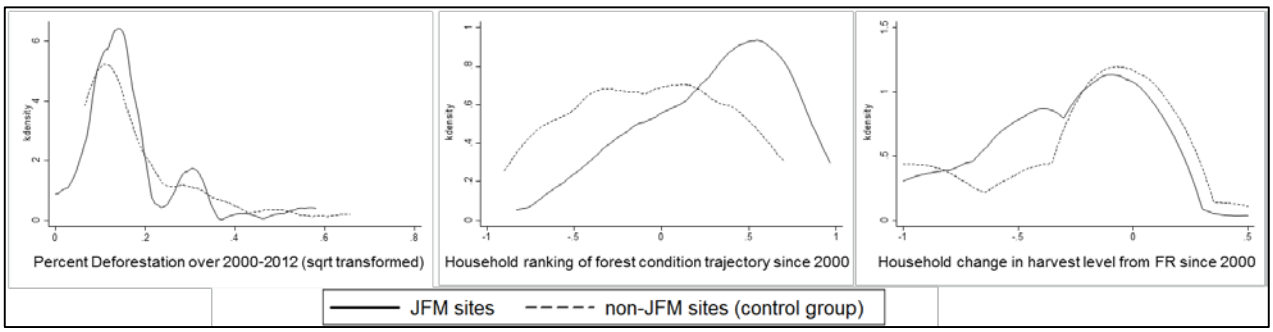


Figure B3: Forest conditions family of outcomes

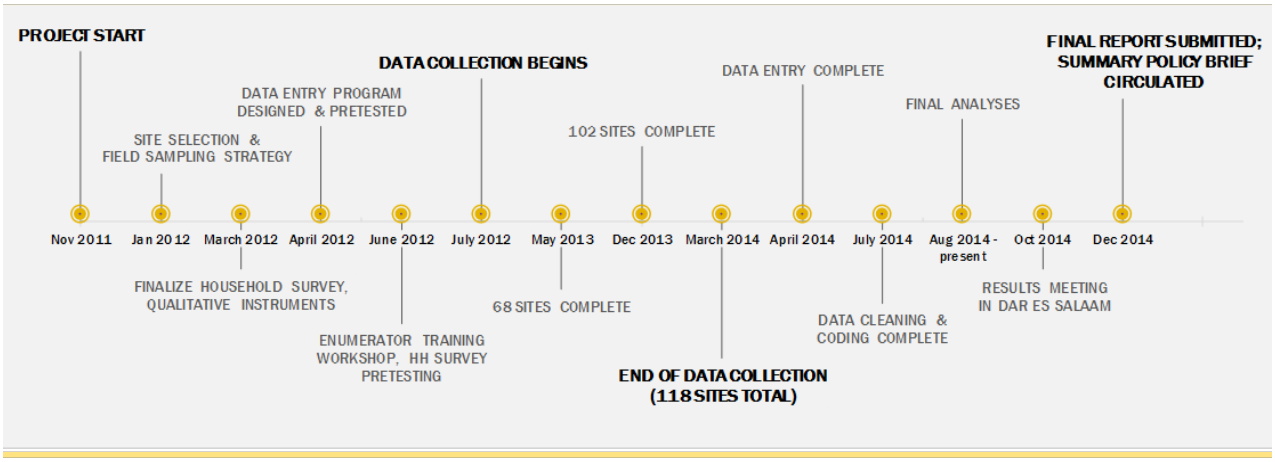


Appendix C: Survey instruments

Survey instruments are available at the following link: http://persha.web.unc.edu/tanzania-pfm-impact-evaluation-knowledge-products/

Appendix D: Project timeline

Tanzania JFM Impact Evaluation: PROJECT TIMELINE



Appendix E: Descriptive statistics for pre-treatment covariates, unweighted sample before matching

Pre-Treatment Covariate	JFM Forest Reserves			non-JFM Forest Reserves			T-test of differences in means		Normalized difference in means1
	Mean	SD	N	Mean	SD	N	*t*	*P*	
[Forest Reserve Characteristics]									
log of Forest size in hectares	8.24451	2.09156	68	8.661146	1.605	42	1.175	0.242	-0.22
High conservation value forest type (Y/N)	0.89706	0.30614	68	0.547619	0.5038	42	-4.056	0.0001***	0.85
Mean elevation of forest (masl)	1329.06	672.194	68	820.6857	750.26	42	-3.591	0.0006***	0.71
Number of surrounding villages	9.94118	7.38066	68	9.02381	8.2948	42	-0.587	0.559	0.12
Year 2000 forest condition (% tree cover)	60.2348	18.0316	68	55.30522	16.77	42	-1.455	0.149	0.28
[Village Characteristics]									
2002 Forest pressure (Popn / hectare of forest)	15.7993	81.9224	68	1.328887	3.9744	42	-1.453	0.151	0.25
Distance to administrative town (min travel time in hours)	5.33933	3.87813	68	5.60943	3.6086	42	0.371	0.712	-0.07
High collective action (Y/N)	0.22059	0.41773	68	0.261905	0.445	42	0.484	0.630	-0.10
Year 2000 village forest resources 2 (5km buffer; % tree cover)	39.7887	15.5072	68	41.97082	18.025	42	0.650	0.518	-0.13

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

[1] A value > .25 indicates a substantial difference (highlighted in gray).

Appendix F: Descriptive statistics for demographic and household characteristics of households sampled across treatment and control villages

Table F1 demonstrates that underlying demographic and household characteristics were similarly distributed across villages in the JFM treatment and control groups in our study. The only major difference was that a substantially greater proportion of households in control villages had thatched roofs. A thatched roof can be an indicator of higher levels of poverty, but this is not always the case. For our study we do not think this difference suggests that control villages in our study tended to be poorer. For example, there were no significant differences across more direct poverty indicators that we looked at, such as landholdings, livestock ownership, and land rental. We think the higher proportion of thatched roofs in control villages is more likely related to geography, materials availability and different cultural preferences around thatching in colder highland areas relative to much hotter lowland areas of Tanzania, and we do not think this difference reflects a substantial difference in poverty levels across the villages in the treatment and control groups in our sample. Table F2 demonstrates the same within wealth subgroups.

Table F1: Descriptive statistics for demographic and household characteristics of households sampled across treatment and control villages (reported values are means by villages)

Indicators	JFM Sites			non-JFM Sites			T-test of differences in means		Normalized difference in means[1]
	Mean	SD	N	Mean	SD	N	*t*	*P*	
Demographic Characteristics									
Household size	4.92	0.62	68	4.74	0.62	42	-1.426	0.157	0.28
Female-headed household	0.18	0.10	68	0.17	0.09	42	-0.956	0.340	0.05
Household residence time in village	35.99	6.81	68	32.46	8.74	42	-2.236	0.029*	0.45
Age of head	47.60	4.44	68	46.10	4.21	42	-1.880	0.063	0.35
Highest years of education by hh member	7.50	1.08	68	7.07	1.10	42	-1.990	0.05*	0.39
Household Characteristics									
Area of cropland farmed by household	3.34	1.58	68	3.67	1.65	42	1.048	0.298	-0.21
Total area of land owned by HH	3.96	1.96	68	4.13	2.16	42	0.399	0.691	-0.08
Household rents or borrows land for agricultural use	0.18	0.14	68	0.15	0.13	42	-1.001	0.315	0.07
Large livestock owned	2.09	1.64	68	1.59	2.26	42	-1.241	0.219	0.25
Small livestock pwned	6.89	3.88	68	7.26	4.55	42	0.440	0.661	-0.09
Thatch roof	0.23	0.29	68	0.46	0.31	42	3.730	0.0003***	-0.48
Mud or wattle walls	0.61	0.30	68	0.67	0.31	42	0.958	0.341	-0.12

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

[1] A value > .25 indicates a difference of note in some aspect of the distribution across the two groups; larger values indicate greater differences.

Table F2: Descriptive statistics for demographic and household characteristics of households sampled across treatment and control villages, disaggregated by wealth subgroups (reported values are means by wealth-group within villages)

Indicators	JFM Sites			non-JFM Sites			T-test of differences in means		Normalized difference in means[1]
	Mean	SD	N	Mean	SD	N	*t*	*P*	
NON-POOREST WEALTH SUB-GROUP									
Demographic Characteristics									
Household size	5.02	0.65	68	4.90	0.72	42	-0.887	0.378	0.18
Female-headed household	0.15	0.09	68	0.12	0.10	42	-1.356	0.178	0.07
Household residence time in village	35.34	7.29	68	31.91	8.18	42	-2.198	0.031*	0.44
Age of head	47.28	4.76	68	44.41	4.81	42	-3.010	0.003**	0.60
Highest years of education by hh member	7.66	1.11	68	7.47	1.12	42	-0.871	0.386	0.17
Household Characteristics									
Area of cropland farmed by household	3.52	1.79	68	4.05	1.85	42	1.462	0.147	-0.29
Total area of land owned by HH	4.21	2.17	68	4.62	2.58	42	0.834	0.407	-0.17
Household rents or borrows land for agricultural use	0.19	0.15	68	0.15	0.14	42	-1.295	0.199	0.10
Large livestock owned	2.21	1.75	68	1.86	2.48	42	-0.771	0.443	0.16
Small livestock pwned	7.62	4.85	68	8.70	5.97	42	0.975	0.333	-0.20
Thatch roof	0.18	0.27	68	0.35	0.30	42	2.864	0.005**	-0.38
Mud or wattle walls	0.56	0.33	68	0.59	0.35	42	0.501	0.617	-0.07
POOREST QUINTILE WEALTH SUB-GROUP									
Demographic Characteristics									
Household size	4.23	0.99	60	4.40	0.95	41	0.882	0.380	-0.18
Female-headed household	0.26	0.24	60	0.25	0.21	41	-0.133	0.894	0.01
Household residence time in village	38.86	11.20	60	35.20	11.79	41	-1.561	0.122	0.32
Age of head	49.08	9.80	60	49.59	7.42	41	0.299	0.765	-0.06
Highest years of education by hh member	6.11	1.56	60	6.05	1.42	41	-0.221	0.826	0.04
Household Characteristics									
Area of cropland farmed by household	2.66	1.31	60	2.63	1.21	41	-0.088	0.930	0.02
Total area of land owned by HH	2.78	1.36	60	2.75	1.23	41	-0.114	0.909	0.02
Household rents or borrows land for agricultural use	0.12	0.18	60	0.15	0.22	41	0.857	0.394	-0.10
Large livestock owned	1.06	1.98	60	0.81	1.67	41	-0.670	0.504	0.13
Small livestock pwned	3.76	3.50	60	4.59	4.37	41	1.009	0.316	-0.21
Thatch roof	0.62	0.40	60	0.78	0.30	41	2.360	0.020*	-0.37
Mud or wattle walls	0.97	0.15	60	0.94	0.19	41	-0.882	0.381	0.15

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

[1] A value > .25 indicates a difference of note in some aspect of the distribution across the two groups; larger values indicate greater differences.

Appendix G: Difference-in-difference analyses, additional charts and figures

Figure G1: Kernel density distributions of each of the DID outcomes, across treated and control groups (drawn from a sub-sample of N = 78 sites with baseline income data)

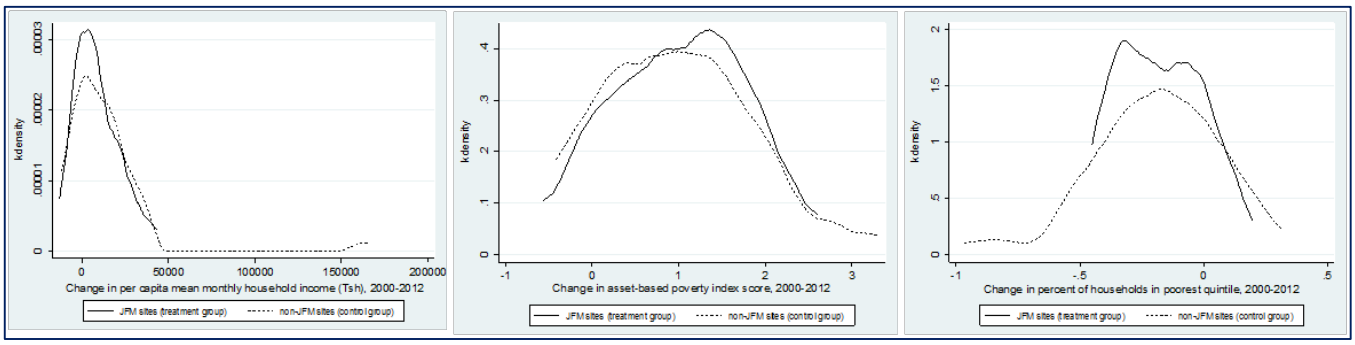


Table G1: ATT impact estimates for livelihoods impacts of JFM using a difference-in-difference approach (drawn from a sub-sample of 78 sites with baseline income data)

		Genetic Matching[a]		
DID-based Livelihoods Impacts	*N*	estimate	SE	*P*
Change in per capita annual household income over 2001-2012 (Tsh)	78	-2724.1	5487.1	0.619
Change in asset-based poverty index score over 2001-2012	78	-0.03	0.253	0.905

* $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$

[a]Matched Treated Units: 47; Potential controls: 31

Abadie-Imbens standard errors are reported.

Appendix H: Outcome means for poorest and non-poorest household wealth groups

Table H1: Mean outcome values by poorest and non-poorest household wealth groups within villages (matched sample; mean outcomes by household wealth subgroup are reported for household-level outcome indicators only)

JFM outcome indicator	Mean	SE	[95% CI]	
VEC or VNRC satisfaction				
Control Villages, Non-poorest Households	1.63	0.10	1.44	1.82
Control Villages, Poorest Households	1.48	0.13	1.23	1.73
JFM Villages, Non-poorest Households	2.25	0.08	2.10	2.40
JFM Villages, Poorest Households	2.15	0.13	1.90	2.40
Village Government Satisfaction				
Control Villages, Non-poorest Households	2.49	0.05	2.39	2.60
Control Villages, Poorest Households	2.62	0.09	2.45	2.79
JFM Villages, Non-poorest Households	2.72	0.05	2.62	2.82
JFM Villages, Poorest Households	2.76	0.08	2.61	2.92
Per capita annual household income ('000 Tsh)				
Control Villages, Non-poorest Households	244.87	18.28	208.86	280.88
Control Villages, Poorest Households	153.00	13.22	126.98	179.03
JFM Villages, Non-poorest Households	280.77	20.85	239.71	321.82
JFM Villages, Poorest Households	163.58	22.55	119.18	207.98
Per capita annual household income from forest products ('000 Tsh)				
Control Villages, Non-poorest Households	29.64	5.90	18.03	41.25
Control Villages, Poorest Households	20.67	6.50	7.86	33.48
JFM Villages, Non-poorest Households	13.17	4.00	5.29	21.05
JFM Villages, Poorest Households	21.45	14.22	-6.55	49.45
Household ranking of trajectory of forest reserve condition since year 2000				
Control Villages, Non-poorest Households	0.13	0.06	0.02	0.24
Control Villages, Poorest Households	0.30	0.07	0.17	0.44
JFM Villages, Non-poorest Households	0.27	0.05	0.17	0.38
JFM Villages, Poorest Households	0.29	0.07	0.16	0.42

References

Abadie, A, Imbens, GW, 2006. Large sample properties of matching estimators for average treatment effects. *Econometrica* 74, pp. 235–267.

Abadie, A, Imbens, GW, 2011. Bias-corrected matching estimators for average treatment effects. *Journal of Business and Economic Statistics* 29, pp. 1–11.

Adams, WM, Aveling, R, Brockington, D, Dickson, B, Elliott, J, Hutton, J, Roe, D, Vira, B, Wolmer, W, 2004. Biodiversity conservation and the eradication of poverty. *Science* 306, pp.1,146–1,149.

Agrawal, A, Chhatre, A, 2007. State involvement and forest co-governance: Evidence from the Indian Himalayas. *Studies in Comparative International Development* 42, pp. 67–86.

Agrawal, A, Ostrom, E, 2001. Collective action, property rights, and decentralization in resource use in India and Nepal. *Politics and Society* 29, pp. 485–515.

Ameha, A, Nielsen OJ, *et al.* 2014. Impacts of access and benefit sharing on livelihoods and forest: Case of participatory forest management in Ethiopia. *Ecological Economics* 97, pp. 162–171.

Andersson, K, Gordillo, G, van Laerhoven, F, 2009. *Local governments and rural development: Comparing lessons from Brazil, Chile, Mexico, and Peru.* University of Arizona Press, Tucson.

Austin, PC, 2009. Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. *Statistics in Medicine* 28, pp. 3,083–3,107.

Austin, PC, 2011. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research* 46, pp. 399–424.

Austin, PC, 2014. A comparison of 12 algorithms for matching on the propensity score. *Statistics in Medicine* 33, pp. 1,057–1,069.

Baird, S, McIntosh, C, Ozler, B, 2011. The regressive demands of demand-driven development. The World Bank. *Policy Research Working Paper* No. 5883.

Barrett, CB, Travis, AJ, Dasgupta, P, 2011. On biodiversity conservation and poverty traps. In *Proceedings of the National Academy of Sciences of the United States of America 108*, pp. 13,907–13,912.

Becker, S, Caliendo, M, 2007. Sensitivity analysis for average treatment effects. *Stata Journal* 7, pp. 71–83.

Burgess, N, Butynski, TM, Cordeiro, NJ, Doggart, N, Fjeldsa, J, Howell, KM, Kilahama, FB, Loader, SP, Lovett, JC, Mbilinyi, B, Menegon, M, Moyer, DC, Nashanda, E, Perkin, A, Rovero, F, Stanley, WT, Stuart, SN, 2007. The biological importance of the Eastern Arc Mountains of Tanzania and Kenya. *Biological Conservation* 134, pp. 209–231.

Cavatassi, R, Davis, B, Lipper, L, 2004. Estimating poverty over time and space: Construction of a time-variant poverty index for Costa Rica. *Working Papers* 04-21, Agricultural and Development Economics Division of the Food and Agriculture Organization of the United Nations (FAO--ESA).

Dehejia, RH, Wahba, S, 1999. Causal effects in nonexperimental studies: Reevaluating the evaluation of training programs. *Journal of the American Statistical Association* 94, pp. 1,053–1,062.

Dehejia, RH, Wahba, S, 2002. Propensity score-matching methods for nonexperimental causal studies. *Review of Economics and Statistics* 84, pp. 151–161.

Diamond, A, Sekhon, JS, 2013. Genetic matching for estimating causal effects: A general multivariate matching method for achieving balance in observational studies. *Review of Economics and Statistics* 95, pp. 932–945.

DiPrete, TA, Gangl, M, 2004. Assessing bias in the estimation of causal effects: Rosenbaum bounds on matching estimators and instrumental variables estimation with imperfect instruments. *Sociological Methodology* 34, pp. 271–310.

Faguet, JP, 2013. Decentralization and governance. *World Development* 53, pp. 2–13.

Friis, J, Treue, T, 2008. Are we getting there? Evidence of decentralized forest management from the Tanzanian Miombo woodlands. *World Development* 36, pp. 2,780–2,800.

Grindle, M, 2007. *Going local: Decentralization, democratization and the promise of good governance.* Princeton University Press, Princeton, NJ.

Ho, DE, K Imai, *et al.* 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis* 15(3): pp. 199–236.

Imbens, GW, 2004. Nonparametric estimation of average treatment effects under exogeneity: A review. *Review of Economics and Statistics* 86, pp. 4–29.

Imbens, GW, Wooldridge, JM, 2009. Recent developments in the econometrics of program evaluation. *Journal of Economic Literature* 47, pp. 5–86.

IUCN, UNEP, 2014. The World Database on Protected Areas (WDPA). UNEP-WCMC. www.protectedplanet.net, Cambridge, UK.

Jumbe, CBL, Angelsen, A, 2006. Do the poor benefit from devolution policies? Evidence from Malawi's forest co-management program. *Land Economics* 82(4): pp. 562–581.

Imai, K, Keele, L and Yamamoto, T, 2010. Identification, inference and sensitivity analysis for causal mediation effects. *Statistical Science*, pp.51-71.

Kreif, N, Grieve, R, Radice, R, Sekhon, JS, 2013. Regression-adjusted matching and double-robust methods for estimating average treatment effects in health economic evaluation. *Health Services and Outcomes Research Methodology* 13, pp. 174–202.

Larson, AM, Soto, F, 2008. Decentralization of natural resource governance regimes. *Annual Review of Environment and Resources* 33, pp. 213–239.

Lemos, MC, Agrawal, A, 2006. Environmental governance. *Annual Review of Environment and Resources* 31, pp. 297–325.

Lund, JF, Saito-Jensen, M, 2013. Revisiting the issue of elite capture of participatory initiatives. *World Development* 46, pp. 104–112.

Maharjan, MR, Dakal, TR, Thapa, SK, Schreckenberg, K, Luttrell, C, 2009. Improving the benefits to the poor from community forestry in the Churia region of Nepal. *International Forestry Review* 11, pp. 254–267.

Meshack, CK, Ahdikari, B, Doggart, N, Lovett, JC, 2006. Transaction costs of community-based forest management: Empirical evidence from Tanzania. *African Journal of Ecology* 44, pp. 468–477.

Michelson, H, Muñiz, M, DeRosa, K, 2013. Measuring socio-economic status in the millennium villages: The role of asset index choice. *Journal of Development Studies* 49, pp. 917–935.

Miteva, DA, Pattanayak, SK, *et al,* 2012. Evaluation of biodiversity policy instruments: What works and what doesn't? *Oxford Review of Economic Policy* 28(1): pp. 69–92.

MNRT 2008. Participatory Forest Management in Tanzania: Facts and figures. Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division, Dar es Salaam.

Myers, N, Mittermeler, RA, Mittermeler, CG, Da Fonseca, GAB, Kent, J, 2000. Biodiversity hotspots for conservation priorities. *Nature* 403, pp. 853–858.

Nielsen, MR, 2011. Improving the conservation status of the Udzungwa Mountains, Tanzania? The effect of joint forest management on bushmeat hunting in the Kilombero nature reserve. *Conservation and Society* 9, pp. 106–118.

Nielsen, MR, Treue, T, 2012. Hunting for the benefits of Joint Forest Management in the Eastern Afromontane biodiversity hotspot: Effects on bushmeat hunters and wildlife in the Udzungwa Mountains. *World Development* 40, pp. 1,224–1,239.

Ostrom, E, 2005. *Understanding institutional diversity*. Princeton University Press, Princeton, NJ.

Persha, L, Agrawal, A, Chhatre, A, 2011. Social and ecological synergy: Local rulemaking, forest livelihoods, and biodiversity conservation. *Science* 331, pp. 1,606–1,608.

Persha, L, Andersson, K, 2014. Elite capture risk and mitigation in decentralized forest governance regimes. *Global Environmental Change* 24, pp. 265–276.

Persha, L, Blomley, T, 2009. Management decentralization and montane forest conditions in Tanzania. *Conservation Biology* 23, pp. 1,485–1,496.

Persha, L, Blomley, T, Meshack, C, (in prep). Understanding administrative selection processes in forest sector decentralization: Evidence from Tanzania's Joint Forest Management program, (in preparation).

Phelps, J, Webb, EL, Agrawal, A, 2010. Does REDD plus threaten to recentralize forest governance? *Science* 328, pp. 312–313.

Porter-Bolland, L, Ellis, EA, Guariguata, MR, Ruiz-Mallen, I, Negrete-Yankelevich, S., Reyes-Garcia, V, 2012. Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics. *Forest Ecology and Management* 268, pp. 6–17.

Raudenbush, SW, 2011. Optimal design software for multi-level and longitudinal research (Version 3.01) [Software], Available from www.wtgrantfoundation.org.

REPOA, 2009. An analysis of household income and expenditure in Tanzania (Brief No 4). Research and Analysis Working Group of the Ministry of Finance and Economic Affairs, Dar es Salaam, Tanzania.

Ravallion, M, 2009. Evaluation in the practice of development. *World Bank Research Observer* 24(1): pp. 29–53.

Ribot, JC, Agrawal, A, Larson, AM, 2006. Recentralizing while decentralizing: How national governments reappropriate forest resources. *World Development* 34, pp. 1,864–1,886.

Rosenbaum, PR, 2004. Design sensitivity in observational studies. *Biometrika* 91, pp. 153–164.

Rosenbaum, PR, 2013. Impact of multiple matched controls on design sensitivity in observational studies. *Biometrics* 69, pp. 118–127.

Rosenbaum, PR, Rubin, DB, 1983. The central role of the propensity score in observational studies for causal effects. *Biometrika* 70, pp. 41–55.

Rubin, DB, 1974. Estimating causal effects of treatments in randomized and nonrandomized studies. *Journal of Educational Psychology* 66, pp. 688–701.

Samii, C, Lisiecki, M, Kulkarni, P, Paler, L, Chavis, L, 2014. Effects of Decentralized Forest Management (DFM) on deforestation and poverty in low and middle income countries: A systematic review. *Campbell Systematic Reviews* 2014:10. DOI: 10.4073/csr.2014.10

Schreckenberg, K, Luttrell, C, 2009. Participatory forest management: A route to poverty reduction? *International Forestry Review* 11, pp. 221–238.

Sekhon, JS, 2011. *Multivariate and propensity score matching software with automated balance optimization: The matching package for R. Journal of Statistical Software* 42, pp. 1–52.

Sekhon, JS, Grieve, RD, 2012. A matching method for improving covariate balance in cost-effectiveness analyses. *Health Economics* 21, pp. 695–714.

Sikor, T, Nguyen, TQ, 2007. Why may forest devolution not benefit the rural poor? Forest entitlements in Vietnam's Central Highlands. *World Development* 35, pp. 2,010–2,025.

Somanathan, E, Prabhakar, R, Mehta, BS, 2009. Decentralization for cost-effective conservation. *Proceedings of the National Academy of Sciences* 106, pp. 4,143–4,147.

Stuart, EA, 2010. Matching methods for causal inference: A review and a look forward. *Statistical Science* 25, pp. 1–21.

Sunderlin, WD, Angelsen, A, Belcher, B, Burgers, P, Nasi, R, Santoso, L, Wunder, S, 2005. Livelihoods, forests, and conservation in developing countries: An overview. *World Development* 33, pp. 1,383–1,402.

Tacconi, L, 2007. Decentralization, forests and livelihoods: Theory and narrative. *Global Environmental Change-Human and Policy Dimensions* 17, pp. 338–348.

Thoms, CA, 2008. Community control of resources and the challenge of improving local livelihoods: A critical examination of community forestry in Nepal. *Geoforum* 39, pp. 1,452–1,465.

Treisman, D, 2007. *The architecture of government: Rethinking political decentralization.* Cambridge University Press, New York.

Treue, T, Ngaga, YM, Meilby, H, Lund, JF, Kajembe, G, Iddi, S, Blomley, T, Theilade, I, Chamshama, SAO, Skeie, K, Njana, MA, Ngowi, SE, Isango, JAK, Burgess, ND, 2014. Does participatory forest management promote sustainable forest utilisation in Tanzania. *International Forestry Review* 16, pp. 23–38.

URT, 2009. *Poverty and Human Development Report 2009*. Research and Analysis Working Group, Ministry of Finance and Economic Affairs, Dar es Salaam, Tanzania.

URT, 2013. *Joint Forest Management Guidelines. December 2013*. Policy and Planning Division, Dar es Salaam, Tanzania.

Vyamana, VG, 2009. Participatory forest management in the Eastern Arc Mountains of Tanzania: Who benefits? *International Forestry Review* 11, pp. 239–253.

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