UNDERSTANDING THE ENTANGLEMENTS BETWEEN WEALTH STATUS AND EQUITABLE FOREST BASED LIVELIHOOD OUTCOMES UNDER DIFFERENT DECENTRALIZED CONTEXTS IN TANZANIA; DOES COMMUNITY BASED FOREST MANAGEMENT HAVE AN EQUALIZING EFFECT?

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ABSTRACT

Hillary Smith: Understanding the entanglements between wealth status and equitable forest based livelihood outcomes under different decentralized contexts in Tanzania; Does community based forest management have an equalizing effect?
(Under the direction of Dr. Lauren Persha)

Decentralized natural resource management is now widely implemented across the developing world, however much uncertainty remains over whether such programs really achieve their mulit-faceted aims, and how they should be structured at local levels to be equitable and effective. In the forest sector this increasingly popular paradigm is intended to improve forest conservation, governance and local livelihoods in parallel. While forest outcomes have received greater attention in existing literature there is less empirical support or clarity around how forest sector decentralization effects the equity of governance and livelihood outcomes. This study seeks to understand how greater levels of decentralized community rights and responsibilities under a "pro poor" Community Based Forest Management (CBFM) regime functions to attenuate elite capture, or instead reproduce existing marginalities within communities. To do so I exploit the co-occurrence of CBFM regimes alongside of state forests and state-community co-managed forests. Where these regimes are adjacent provides the opportunity to better understand how a household's access to CBFM might alter their participation in forest institutions and access to resources shifting the trajectory of outcomes. To do so extensive quantitative and qualitative household survey data are analyzed from 349 households drawn from 12 communities with state or co-managed forests where half of the sample additionally have CBFM processes. Particular attention is paid to whether there is any evidence of positive spillover effects, interactions or trade-offs across governance or livelihood objectives attributable to the presence of CBFM. To connect these separate policy objectives this study draws conclusions as to whether

institutions for forest governance may serve as a pathway to changing livelihood benefits, and ways in which pre-existing household wealth status mediate access to both.

To my co-workers, colleagues, friends and family who have supported me along this path.

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LIST OF ABBREVIATIONS

AME	Average Marginal Effect
ANOVA	Analysis of Variance
CBFM	Community Based Forest Management
CBNRM	Community Based Natural Resource Management
CIFOR	Center for International Forestry Research
CPR	Common Pool Resource
ES	Environmental service
IE	Impact Evaluation
IFRI	International Forestry and Institutions Research
JFM	Joint Forest Management
JMA	Joint management agreement
NGO	Non-governmental organization
NTFP	Non-timber forest product
OLS	Ordinary Least Squares
PEN	Poverty Environment Network
PFM	Participatory Forest Management
TANAPA	Tanzania National Parks
TSH	Tanzania Shilling
VEC	Village Environmental Council
VFR	Village Forest reserv

CHAPTER 1: LINKS BETWEEN POVERTY AND FOREST SECTOR DECENTRALIZATION IN CONTEXT

Introduction

The spatial overlap between severe poverty and remaining forest cover globally points to critical entanglements between linked human and natural systems which require further exploration (Sunderlin et al. 2008). Globally, forests play a critical role supporting human wellbeing indirectly through their myriad ecosystem services. However for millions of people forests are directly relied upon as a vital component of subsistence life (Sunderlin et al. 2005, Vedeld et al. 2007). Direct reliance on forests is mostly confined to poorer, rural areas within developing countries and is often less visible to those outside these spaces (Sunderlin et al. 2008). Therefore the diversity of resources and true significance of forests to rural livelihoods have often remained obscured as a "hidden harvest" overlooked or misunderstood among scientific and development communities (Angelsen 2003, Cavendish 2000, Campbell and Luckert 2002, Campbell 2002).

Accounting for the existence of informal economies, fluid livelihood strategies, and subsistence offsetting make estimating the local value of forests especially difficult. Due to these characteristics traditional approaches to studying rural socioeconomic systems critically underestimated income derived from natural resources such as forests. This repeated oversight ultimately undervalued the importance of forests to local livelihoods (Angelsen 2003, Vedeld et al. 2007, Jagger 2012). Theories around the development of sustainable livelihoods now conceptualize rural household strategies as a dynamic and diverse portfolio of activities (Ellis 2000). Within the realm of diversification forests may serve as an important source of natural capital feeding into a variety of livelihood activities (Ellis 2000). Three distinct functions forests fulfill in supporting livelihoods are now recognized including forests as a

a safety net in times of shortfall, as support for current consumption, and as a means of capital accumulation to achieve a path out of poverty (Cavendish 2003, Angelsen 2003). These functions are believed to be particularly important for the severely poor (Sunderlin et al. 2005).

Theoretical advances and the growing body of literature linking poverty, forests and livelihoods have drawn attention to forests' potential to alleviate rural poverty (Sunderlin et al. 2005, Vedeld et al. 2007). However, others are less certain that forests are affecting global poverty in any meaningful way (Sunderlin et al. 2005). While some are critical that forests as a "path out of poverty" is simply too optimistic (Sunderlin et al. 2005), others point out that the common modes of forest management have long prevented adequate forest access (Angelsen 2003, Vedeld 2004). In order to obtain forest benefits and affect a household's relative poverty forest resources must first be accessible. A broad set of social factors differentiate the relationships between individuals and their relative access to resources (Ribot and Peluso 2003). Forest access depends on multiple formal and informal processes including both *de jure* property rights and *de facto* institutional processes that shape them (Ostrom 1990). These processes can overlap unevenly creating disparities in households' relative power to derive forest benefits despite the same legal claim to resources (Ribot and Peluso 2003). Attention has been drawn in the last two decades to how institutions of governance can shape human-environment relationships and mediate access to natural resources particularly among poor, resource-dependent people. A better understanding of how these processes regulate household access to forests is especially important given recent global changes in forest conservation policy.

Amidst the larger paradigm shift towards community based natural resource management forest sector decentralization is increasingly popular for its potential to improve upon relevant social and ecological outcomes. These outcomes are consistently theorized to include improved forest conservation, functioning of local governance and livelihoods. Decentralization entails the downward transfer of autonomous rights over a domain such as forests to lower tiers of the political administrative

hierarchy (Agrawal and Ribot 1999). In the context of the rapid shift towards forest sector decentralization management rights are typically devolved from centralized forest departments to village government bodies. By transferring management rights and responsibilities to communities decentralization is posited to jointly improve the equity and efficiency of forest conservation, governance and local livelihoods (Ribot 2004). These improvements are anticipated from the "democratic dividend" effect whereby greater efficiency and equity emerge as positive externalities by the presence of more democratic processes of governance (Ribot 2002). Local institutions of government are believed to be more responsive and accountable to their constituents enabling greater transparency, information, and popular participation around the processes and therefore thought to be both more responsive and representative of local needs than a centralized body (Ribot 2002).

However, understanding of how changes in forest management policies affect outcomes is not clear nor is any unanimous picture of improvement based on the sparse empirical evidence (Treisman 2007, Ribot 2004). Empirical evaluation of decentralization and livelihood outcomes are relatively scarce compared to assessments of forest level outcomes (Jagger 2012, Angelsen et al. 2014, Jagger et al. 2014). Most existing work on livelihoods focus on community level outcomes. This aggregate level may not detect heterogeneous effects within communities and how forest access and outcomes may differ across marginalized sub-groups within communities. This research aims to address how the institutional arrangements under different decentralized forest management contexts shape households access to forest livelihoods in Tanzania. Focusing on Tanzania provides an opportunity to evaluate a decentralized forest sector with both a relatively long history and reputation as a model for policy implementation on the continent yet lacks robust empirical evaluation to bolster such claims. Drawing on data from 349 households across different combinations of participatory and centralized forest management arrangements enables exploration of the effects of decentralization on interrelated governance and livelihood outcomes. By exploring the links between wealth status, governance and forest livelihoods

this research aims to unpack the processes by which households gain access to forest benefits and whether "pro poor" decentralized management regimes enable more equitable outcomes in practice.

History of Managing Forests as Common Pool Resources

Forests' potential to contribute to rural livelihoods and poverty reduction has been restricted by the global ascendency of western forest conservation ideology (Hurst 2003, Neumann 1997, Weddell 2002, Kalamandeen and Gillson 2007). Scientific forestry developed in European schools educated a cadre of foresters trained to manage forests for timber production while conserving others to secure sufficient ecosystem services (Hurst 2003). Forested landscapes were separated under this approach into exploitable stands for timber production and reserves chosen for preservation; both designed to accrue particular benefits for the state with disproportionate costs borne by forest adjacent communities (Schwartzman, Moreira and Nepstad 2000, Hurst 2003). This focus on designating large swaths of pristine forest as strict protected areas is commonly referred to as fortress conservation (Schwartzman et al. 2000). This exclusionary agenda hinged on the belief that human presence and the persistence of biodiverse forests were inherently at odds (Redford 1992, Redford and Stearman 1993, Brandon, Redford and Sanderson 1998). These practices were motivated by simplistic assumptions that human access caused unchecked resource degradation driven by the livelihood practices and inevitable resource overuse by the rural poor (Reardon and Vosti 1995). These assumptions continued to permeate both conservation policy and academic writing for much of the 20th century with a focus on prescriptive tenure solutions particularly in the case of common pool resources.

Forests are common pool resource (CPR) systems which are characterized by particular features and related management challenges. CPRs are defined by two overarching characteristics; the difficulty of exclusion from the resource system and the subtractability of resource units (Ostrom 1990; 30). The nature of CPR systems makes excluding outside beneficiaries challenging. Exclusion is considered pivotal

to internalize costs and benefits associated with making long term investments in management and future resource provisioning (Ostrom 1990; 30, Dietz, Ostrom and Stern 2003). CPR systems are likely to suffer from compounding over exploitation if free riders who do not contribute to the costs of resource maintenance cannot be excluded from obtaining the benefits (Hardin 1968). The problem of exclusion from the resource system is exasperated by the subtractability of the resource units. While the resource system as a whole may be jointly owned, individual resource units (such as trees) cannot be concurrently consumed (Ostrom 1990; 31). Therefore any one user's consumption subtracts from all others future use.

Garett Hardin's (1968) infamous essay coined the term the "tragedy of the commons" to describe the cycle of resource over use and subsequent demise observed in some CPR systems. In Hardin's description users are entrenched in an inevitable trap of unsustainable exploitation bound by the attributes of CPR systems and his assumptions about human behavior. The tragedy of the commons is useful as an abstract metaphor but is often misconstrued as unassailable truth; that all CPRs are destined for system collapse under communal ownership because of innately individualistic human behavior (Hardin 1968, Ostrom 1990; 22). Hardin implored for private or state ownership of CPR systems as the only viable tenure solutions to the commons dilemma. Uncritical acceptance of Hardin's model ignored a 4th possibility; that individual's could act collectively to use and maintain a resource system sustainably by devising and enforcing a set of rules (Ostrom 1990). Hardin failed to distinguish between the spectrum of outcomes including at one end an unmanaged open access commons and at the other a group of organized users who follow a set of rules to manage their resource system.

Hardin's work provided scientific support and naturalized logic for centralized management already institutionalized in much of the world's forests by colonialism. Colonial administrations established organized forest departments throughout much of the world's tropical forests staffed and

trained in the doctrine of European scientific forestry (Neumann 1997). Centralized management remained imbedded in forest department practice post-independence in most former colonies largely unchallenged up to present; subsequent generations of foresters continued to receive training in European universities and replicate the same practices (Hurst 2003).

Despite lingering colonial influence and fear of the tragedy of the commons the mounting evidence of centralized forestry's multiple failures opened space for alternative forest management paradigms. In recent decades alternatives to traditional forest management have become increasingly popular which encourage community involvement in aspects of forest use and decision-making. Many of these alternatives fall under the umbrella of participatory forest management (PFM). PFM encompasses various approaches to community involvement in forest management ranging from token participation to full decentralization (Wily 2000b). Decentralization is the most democratic form of PFM where forest tenure and management rights are transferred to community institutions. As opposed to other less democratic or compulsory forms of community engagement popularized in various community based natural resource management schemes decentralization marks a shift towards truly democratic processes. Distinct from other ad hoc forms of engagement decentralization strengthens local institutions by transferring legitimate power from center to periphery (Wily 2001). Community Based Forest Management (CBFM) is a common, highly decentralized form of PFM currently implemented and expanding in many countries. Another popular approach is Joint Forest Management (JFM), a partially decentralized regime where forest management rights are jointly shared between communities and the state. There is no consensus on whether partially decentralized programs such as JFM provide sufficient incentives and supporting institutional structure to improve governance and livelihood outcomes in practice. Some critics believe JFM is an insufficient transfer of powers too weak to deliver on the benefits of the democratic dividend (Ribot, Lund and Treue 2010).

Notwithstanding disagreement about the appropriate level of decentralized rights best suited to deliver on improved outcomes both CBFM and JFM have become increasingly popular; it is estimated that at least 10-12% of the world's forests are under some form of decentralized management (Sunderlin et al. 2008, Ribot et al. 2010). Advocacy for forest sector decentralization is bolstered by its potential to deliver on a range of policy-relevant outcomes. The flow of enthusiasm and investment dollars into forest decentralization is fueled by the belief that community inclusion in democratic forms of management will improve forest conservation, local livelihoods and governance outcomes over the status quo state management (Larson, Barry and Ram Dahal 2010, Ribot 2002). Ensuring both secure and sufficient forest rights to communities is thought to structure the appropriate incentives for sustainable forest use while enabling good governance and improved access to needed forest resources supporting livelihoods (Ostrom 1990, Ribot 2004). By leveraging local institutions and internalizing the costs and benefits of management decentralization should improve the efficiency of forest management and distribute the benefits more equitably (Ribot 2002).

Despite its rapid spread decentralization has failed to live up to unrealistic "panacea" expectations at solving CPR dilemmas (Ostrom 2007). In light of decentralizations imperfect empirical record questions are emerging as to whether it delivers on improved equity and efficiency outcomes in practice (Ostrom 2007). Many scholars critique the likelihood of parallel success across forest conservation, governance and livelihood outcomes (Persha, Agrawal and Chhatre 2011), while others raise concerns that decentralization may actually increase elite capture of resources exasperating existing inequalities rather than improving equity (Persha and Andersson 2014, Lund and Saito-Jensen 2013). To evaluate these claims scholars have pursued a combination of in depth case studies and larger multi country analyses of PFM performance. Existing studies generally support a positive effect of decentralization on forest conservation outcomes (Pagdee et al. 2006, Hayes 2006) but there is less clarity around governance and livelihood outcomes (Jagger et al. 2014). It's difficult to evaluate how

decentralization alters the equity of governance and livelihood outcomes when only community level averages are considered as is the case in most existing quantitative studies. Therefore there is relative a gap in understanding how decentralization affects livelihoods and access to participation in governance institutions at the household level.

Decentralization in Tanzania

This study explores decentralized outcomes in the context of Tanzania's rapidly decentralizing forest sector. Like many other countries, Tanzania adopted decentralization as a strategy to attain sustainable forest use, improve livelihoods and local governance for rural populations (Wily 2000a, Wily 2002). Despite Tanzania's relatively long history of forest sector decentralization it still lacks robust comparative studies of PFM performance (Wily 2002). Most existing studies consist of single or comparative case studies based on a handful of purposely selected sites which limits their external validity and ability to make causal claims. Therefore while sentiments abound that Tanzania is a "model for equitable forestry" (Wily 2001) this supposition is supported mostly by qualitative findings and very small sample sizes. Specifically there are no robust studies of governance and livelihood outcomes that dissect the distribution of benefits within communities focusing on issues of access and evaluating the equity of decentralized outcomes.

Tanzania provides a useful context to further explore the effects of decentralization because of the co-occurrence of expanding CBFM processes alongside of existing state managed and JFM forests. The spatial co-occurrence of CBFM forests alongside JFM and state forests enables insight into how a highly decentralized forest management process may alter household level access to and participation in forest governance institutions and forest livelihood benefits. Forest patches or even continuous landscapes are often divided in a matrix of different tenure arrangements. Communities increasingly have access to more than one forest patch under different management regimes yet few existing studies

consider how this might shape forest related governance and livelihood outcomes at the household level. Several studies point to the potential for decentralized management to impart positive spillover effects (Vyamana 2009), but these cases are drawing from individual sites or very small sample sizes limiting the generalizability of their findings. Therefore the potential for democratic processes of forest management under CBFM to positively influence forest use and democratic participation beyond merely CBFM forests and institutions is a further unsubstantiated benefit attributed to decentralization. Yet the possibility of this positive interaction is important to understand as decentralization becomes increasingly popular. As the global shift away from exclusive state ownership of forests continues a better understanding of the substitution, interaction and spillover effects across different forest tenure arrangements is important for creating complimentary forest policies well positioned to achieve their supposed benefits (Jagger et al. 2014).

Research Questions

Using a mixed methods research design this study compares household level governance and livelihood outcomes under different decentralized arrangements in Tanzania. To do so households with access to forest reserves under centralized/state and JFM regimes are studied in comparison to those that additionally have CBFM processes underway in their villages. As a baseline I first examine the basic relationships between households' wealth status and different measures of access and participation in forest livelihoods and governance. These measures include the estimated market value of two different fuel types harvested, the variety of forest products gathered, and the frequency of participation in forest harvesting, forest rule making and monitoring. Expanding on the initial relationships between wealth status and participation in each forest livelihood and governance construct I explore whether the additional presence of CBFM processes in a village changes household level outcomes. Specifically I ask;

1. How does household level wealth shape (1) access to and participation in forest governance institutions, and (2) access to forest resources?
2. How does the co-occurrence of CBFM processes alongside centralized or JFM regimes within a village alter household access to institutions of forest governance and forest resources?
3. Is there any relationship between governance and livelihood outcomes and presence of CBFM processes?

Rather than searching for dichotomous outcomes of failure or success across decentralized programs this research aims to understand how access and related outcomes may differ for households within the same community. This research will address how wealth status influences access to forest governance, resources and related livelihoods and how these outcomes change under different forest tenure arrangements. Unpacking the pathways between wealth status and access to forest livelihoods provides a useful lens to understand the role that more democratic forms of forest management and governance institutions can play in shaping outcomes in decentralized forest management. By focusing on how a household's wealth status affects access to forest benefits and participation in governance institutions this research will help address whether these "pro-poor" forest policies are improving equitable access and outcomes around forest governance and livelihoods.

This thesis is organized as follows; chapter two covers relevant theory and existing empirical literature on forest decentralization and access theory. Chapter three addresses the study area and context of decentralization in Tanzania. Chapter four discusses the data used for this study and chapter 5 describes the analysis strategy and methods employed. Chapter six presents the results which are further discussed in chapter 7 and concluded in chapter 8 with discussion of the implications and limitations of this research.

CHAPTER 2. THEORY AND EXISTING LITERATURE

Theoretical Frameworks

A combination of formal property rights and informal processes shape access and determine the distribution of forest benefits within communities. To understand these processes this research draws upon existing theoretical work around the anticipated benefits of decentralization (Agrawal and Ribot 1999, Ribot 2004) and the theory of access (Ribot and Peluso 2003) to consider the equity of governance and livelihood outcomes, their interrelationships and how they might be shaped under different forest management contexts. While the theory of access has been frequently employed under a political ecology framework and critique of environmental governance it has seldom been applied to rigorous empirical studies of decentralized forest outcomes. The intersection of these bodies of theoretical work help structure the hypothesized outcomes and subsequent interpretations of relationships between wealth and access to forest governance and livelihoods in this study. Drawing on these theories will help disentangle the processes and outcomes around forest governance and livelihoods under different forest management contexts.

Decentralization is thought to improve forest conservation, governance and livelihoods by providing a better institutional fit over a centralized regime (Ribot 2002). Top down forms of management typically apply a one-size fits all approach insensitive to local context which can create inefficiencies in management and inequitable outcomes (Ostrom 1990). Operating through local institutions decentralization should engender efficiency and equity advantages over detached centralized management. Local governance can lower the operational costs of forest management and

incorporate finer scale environmental and social information increasing efficiency and encourage equitable benefit sharing facilitated by good governance (Ribot 2004). Local users may be more efficient resource managers because of their localized time and place specific knowledge of the resource system and community of forest users (Ostrom 1990). By operating closer to the constituency of users' local institutions of governance are presumed to exhibit tenants of "good governance" and be more accountable, transparent and responsive to local needs which is presumed to include more equitable distribution of benefits (Ribot 2002). These advantages are thought to emerge as positive externalities from democratic decision making processes (Agrawal and Ribot 1999, Ribot 2002). Two main requirements are recognized for decentralization to deliver on these improvements; powers transferred must be both sufficient and downwardly accountable (Ribot 2002). When both of these conditions are met more equitable and efficient outcomes are expected under decentralization (Smoke 2003). Therefore the functioning of local institutions of governance play a key role as linchpins in the expected chain of benefits and anticipated equity and efficiency dividends from decentralization. Important decisions about forest access and use are made in these spaces and knowledge generated which shape the distribution of forest benefits, ideally equitably, among households.

By devolving rights to local communities decentralization is expected to improve forest governance making the resulting process more malleable and responsive to collective needs. Local institutions of government are more tangible and are therefore thought to be more transparent and accessible to the constituency of forest users (Van Laerhoven and Andersson 2013). Users can hold their locally elected officials more accountable through their vote and voice than they could a more powerful and removed forest department bureaucrat. With sufficient rights communities have the agency to create rules that permit appropriate access to immediate forest derived livelihood benefits that reflect the community's equilibrium resource needs. When elected official are downwardly accountable to the

community and community members have access to participate in their local institutions of forest governance then more equitable outcomes should emerge (Ribot 2002).

Evidence from the commons literature suggests that security of property rights over forest resources incentivizes sustainable management and decisions imparting coupled livelihood improvements and forest conservation (Ostrom 1990). Challenging the myth of spiraling overuse and inevitable tragedy of the commons secure property rights can create incentives to forego immediate resource consumption when users feel confident about the return of future benefits (Ostrom 1990). Therefor decentralization is hypothesized to engender good governance, access to livelihood benefits and create incentives for sustainable resource management through secure tenure (Ribot 2002). These outcomes are thought to be achieved in part by a more parsimonious management chain operating closer to actual forest resource and therefore with greater access to sensitive local and temporal information (van Laerhoven 2014).

Moving from theory to implementation, the outcomes of decentralization depend in part on what rights are devolved to communities. Critical and comparative work evaluating the outcomes of community centered forestry initiatives have often failed to distinguish between the extensive range of CBNRM approaches and full decentralization (Ribot et al. 2010, Wily 2002). The former may engage any range of local actors in fleeting or even token participatory processes. By contrast decentralization permanently vests authority in local, downwardly accountable institutions (Ribot et al. 2010). Blurring tenuous CBRM participatory processes and full political decentralization has led to analytic imprecision in some existing work (Tacconi 2007, Ribot et al. 2010).

Beyond this distinction it is further important to compare decentralized regimes by which types of rights are conferred to communities. While it's commonly accepted that no one arrangement of rights is inherently sufficient for success in CPR management (Ostrom 1990), it's important to unpack which

types of rights are transferred and their subsequent authority over resources prior to analysis of outcomes or judgements of relative success of any decentralized programs. Schlager and Ostrom (1992) provide a framework (see table 1) to disaggregate rights into mutually exclusive types. They distinguish between users' rights of resource access, withdrawal, management, exclusion and alienation in relation to the resource system. Under different decentralized contexts communities can hold different individual rights which collectively form an aggregate "bundle of rights" (Schlager and Ostrom 1992). Positions of authority are labeled corresponding to the different bundles of rights a community holds in Schlager and Ostrom's typology which represent the different tiers of sovereignty communities' wield. This framework allows for more careful evaluation of decentralization by disaggregating the diverse spectrum of resource related rights potentially transferred to communities. Further, how the individual bundles of rights array across different forest regime types hold implications around community power and outcomes. These differences in rights are used to generate hypothesis around how the presence of a more decentralized regime might shape outcomes.

Bundles of Rights Associated with Users' Positions of Authority

Rights	Full Owner	Proprietor	Authorized Claimant	Authorized User	Authorized Entrant
Access	X	X	X	X	X
Withdrawal	X	X	X	X	
Management	X	X	X		
Exclusion	X	X			
Alienation	X				

Table 1 Rights Framework. Source: Ostrom and Schlager (1996:133)

Applying the typology of rights to decentralized forest management in Tanzania the differences between CBFM, JFM and state management in relation to community power become apparent (see table 2). Legally the president owns all non-private land in Tanzania preventing any community from holding rights of alienation, or right to sell their resource rights, over forests (Wily 2002). Despite this technical limitation communities hold rights of access, withdrawal, management and exclusion under

CBFM conferring sole forest proprietorship to the community. Under JFM the same set of rights are conferred but are jointly shared between the community and a state actor. Therefor the authority the community is granted under JFM is not autonomous as it is under CBFM but requires co-determination and collaboration with the state. Under centralized/state management communities may have restricted rights of access or withdrawal depending on forest designation and the specific management plan devised. Often the forest rules are defined by the state actor and enforced by village government bodies (VEC/VNRC) (Treue et al. 2014).

Forest Management Regimes and Rights Held by the Community in Tanzania

Rights	State	JFM	CBFM
Access	X (depends)	X (co determined with state)	X
Withdrawal	X (depends)	X (co determined with state)	X
Management		X (co managed with state)	X
Exclusion		X (co determined with state)	X
Alienation			

Table 2 Regimes and Rights in Tanzania

The typology provided by Schlager and Ostrom is a useful starting point to compare forest management regimes by the types of rights devolved to communities. However focusing solely on *de jure* property misses how rights might be coopted differently among users reproducing or extending existing intracommunity power disparities. Ribot and Peluso (2003) explore these processes further by extending the rights framework to explicitly include these informal processes that transform rights into powers. They draw the distinction between the Schlager and Ostrom's concept of bundles of rights from their subsequent bundles of power; if rights are a result of rules then powers are the result of how rights and rules are employed (Ribot and Peluso 2003). Ribot and Peluso emphasize that despite equal legal claim to rights a combination of social and institutional processes mean these rights are often not equally accessible or applied in practice. Disentangling how rights are transformed into powers highlights the important concept of *access.* They contrast the definitions of property, the *right to benefit* from things, with access, the *ability to derive benefits* from things (Ribot and Peluso 2003). While these terms are often conflated and assumed to be equivalent Ribot and Peluso highlight that despite the

same property rights not all users have equal access i.e. opportunity to mobilize their rights to capture the full range of possible resource benefits from forests (Leach, Mearns and Scoones 1999). Therefor going beyond merely the legal property rights granted considering how preexisting social differences and institutions create or hinder access to forests differently among users is essential to evaluate the equity of forest management outcomes.

Institutions of governance are one arena in which powers are derived from rights (Ribot and Peluso 2003). Processes of forest governance can reproduce existing power dynamics and further marginalize less powerful subgroups or serve as spaces for equitable distribution. If access to participation in institutions of forest governance is inequitable with disproportionate influence by the already powerful, then elites will disproportionately benefit from the powers created in forest management institutions. Elite domination can result in institutions which reflect elite preferences and serve elite interests. Command over the powers created in forest management institutions can be leveraged to increase capture of resource benefits (Van Laerhoven and Andersson 2013). Conversely, equitable institutions can provide opportunities for non-elites to articulate their unique resource preferences and influence outcomes (Van Laerhoven and Andersson 2013). While decentralization should create better fitting rules representative of local users' equilibrium preferences it depends on each user's ability to participate and influence the outcomes. If access is skewed then resulting rules will be tilted in favor of those participating in the process resulting in elite control of governance (Lund and Saito-Jensen 2013, Van Laerhoven and Andersson 2013). Wealth status can serve as an important indicator of elite status at the node of several overlapping strands of power derived from educational, cultural, and capital advantages (Ribot and Peluso 2003). Wealth status can therefor serve as a social leverage point creating differences in relative ability to access forest resources and participation in institutions of resource governance. The functioning and accessibility of institutions of governance are

important to consider when comparing decentralized outcomes because institutions can mediate the relationship between preexisting wealth status and access to needed forest resources.

The existing literature presents a tension between decentralization theory which supports that good governance will improve livelihood outcomes and be more equitable than centralized regimes, and the possibility that decentralization increases opportunities to exasperate existing inequalities. How decentralization influences elite control of governance and elite capture of forest benefits is contested. While theory supports that decentralization creates more equitable governance and livelihood outcomes decentralization may also create access to new resources for elites to control. Elite capture of forests may merely be transferred downwards under decentralization from the forest department to local elites. Therefore, instead of creating more equitable outcomes decentralization could accelerate existing inequalities within communities by providing access to new opportunities to intensify existing power disparities (Persha and Andersson 2014). Lund and Saito-Jensen (2013) point out that processes of elite control over resource governance are often conflated with elite capture of resource benefits. Following on their work I look separately for evidence of elite control of governance, elite capture of forest resources and whether elite control is linked to elite capture and how the presence of CBFM processes might alter these pathways.

Drawing on decentralization theory I predict that the presence of more democratic forest governance processes under CBFM will impart more equitable governance and livelihood outcomes for forest users. I predict CBFM will enable greater opportunities to participate in institutions of forest governance and harvest forest resources than more centralized state or JFM regimes. Further I anticipate these benefits to be more equitably distributed -- i.e., participation in forest governance processes and resources accessible even to poorer households. While I predict that wealth status will be positively related to forest use and participation in institutions of forest governance I believe this effect will be moderated by the presence of CBFM as its more democratic processes will enable equitable

access less dependent on preexisting wealth status. Therefor in sites with CBFM processes underway in addition to JFM or state forests I anticipate more equitable outcomes than sites with only JFM or state-managed forests. The greater degree and autonomy of rights under CBFM should create more equitable access to participate in institutions of forest governance and improved access to livelihood benefits regardless of wealth status. As less democratic processes, institutions of forest governance under JFM and state regimes are anticipated to be less accessible to poorer households and elite wealth status more influential. Under the status quo state regime and JFM, which is jointly managed with state actors, I anticipate a stronger effect of wealth on participation in governance and capture of forest benefits. Further I predict that the influence of more democratic processes introduced through CBFM will have positive spillover effects onto household participation in JFM and state forest governance activities.

Existing Literature

The complex suite of factors that potentially influence forest management outcomes makes empirical evaluation of decentralization inherently challenging. However, a growing body of literature studying outcomes in different contexts has corroborated a set of influential factors related to success (Baland and Platteau 1996, Agrawal and Gibson 1999, Gibson, Williams and Ostrom 2005, Ostrom 1990, Agrawal 2001). These studies are contributing increasing clarity towards collective understanding of the mechanisms and outcomes emerging from decentralization. Within existing work there is growing consensus that decentralization is linked to improved forest conservation (Porter-Bolland et al. 2012, Pagdee et al. 2006) and governance outcomes (Andersson and van Laerhoven 2007, Bartley et al. 2008, Grindle 2004, Persha and Andersson 2014, Persha and Meshack 2015) but there is less clarity on livelihood outcomes (Jagger et al. 2014)

Of the three policy objectives, forest conservation outcomes have received the most attention in forest decentralization literature. In a meta-analyses of existing case studies of community forestry

Pagdee et al. (2006) found that decentralized management improved forest conservation outcomes over state management. Common indicators linked to success included secure forest tenure, clear ownership, sanctioning and enforcement, and tangible livelihood benefits. While concrete livelihood benefits are emerging as a common indicator and important element of successful forest conservation (Pagdee et al. 2006), they are less studied and understood by comparison. One reason for the relative dearth of information on livelihood outcomes is they are inherently challenging to measure (Jagger 2012, Angelsen et al. 2014). Studies of forest livelihood outcomes are particularly challenging to orchestrate data collection with large, random samples. Due in part to these challenges many existing studies typically draw on a handful of purposefully selected sites limiting the external validity of their findings and interpretation of results to descriptive statistics and qualitative analyses. While these studies have aided in enriching the body of knowledge on key variables linked to processes and outcomes of forest sector decentralization they are limited in generalizability. There are an increasing number of quantitative studies of forest conservation, governance and livelihood outcomes moving towards empirical testing of key relationships identified by more qualitative work. However, most are still limited by problems of method and relatively small sample sizes (Agrawal 2001). Quantitative studies encompassing large sample sizes with multiple countries are less common with some notable exceptions (Agrawal and Chhatre 2006, Jagger et al. 2014, Persha et al. 2011).

Within the existing body of work on the outcomes of forest sector decentralization in Tanzania much of the trends and limitations of empirical work on decentralization in general also hold true. Only a handful of empirical studies exist which evaluate the outcomes of forest sector decentralization in Tanzania (Blomley et al. 2008, Lund and Treue 2008, Persha and Blomley 2009, Schreckenberger and Lutrell 2009, Vyamana 2009, Rantala and German 2013, Rantala et al. 2012, Treue et al. 2014). These studies address the impacts and outcomes of forest decentralization from different lenses contributing to the body of knowledge around forest decentralization outcomes in Tanzania. However all of these

studies are based on small numbers of purposely selected sites and small sample sizes for their various units of analysis (households, villages and forests). Many of these studies focus on performance of CBFM and or JFM on forest conservation outcomes (Persha and Blomley 2009, Blomley et al. 2008, Treue et al. 2014). Persha and Blomley (2009) found a positive effect of CBFM on forest conservation attributed to stronger more effective institutions. Strong forest tenure and decision making autonomy ensured under CBFM proved important for forest conservation improvements which JFM lacked by comparison. However, the authors were not overly optimistic about the longevity of these programs without greater livelihood benefits. These findings point towards the need for further understanding of the outcomes and limitations of livelihoods access within different approaches to forest sector decentralization.

Studies have also found differences in JFM performance and benefit distribution compared to CBFM. The costs of JFM implementation and enforcement borne by communities can be high relative to the benefits leading to lower levels of buy in and satisfaction (Ribot 2004). Individuals are believed to be more likely to create, monitor and enforce rules when they are engaged in the process and feel that the potential benefits of their effort outweigh the costs (Ostrom 1990). Persha and Blomley (2009) found tenuously successful CBFM sites in the Eastern Arc Mountains of Tanzania. The improved tenure and rights of management under CBFM seemed to provide sufficient incentives to improve forests and governance outcomes despite an unreliable flow of livelihood benefits. They found that JFM faced challenges emerging from power imbalances between community institutions and government forest officials. One serious challenge to the process in their study was forest officials tasked to implement JFM in collaboration with communities may harbor a conflict of interest where they benefited from involvement in illegal logging prior to JFM. Therefor JFM may not only face inherent power imbalances in community-forest department partnerships but also be battling against the more powerful partners' self-interest (Persha and Blomley 2009). Others criticize that JFM transfers the costs of management to communities without sufficient benefits (Vyamana 2009). Forest departments shed some of the costs of

monitoring and enforcing rules in JFM forests by passing them to community institutions. Yet community institutions are often not permitted to enact rules that would increase livelihood benefits commensurate with management costs. Similar mistrust and power disparities in the co-management dynamic have also been observed outside Tanzania (Agrawal and Chhatre 2006). Therefore existing work generally supports that livelihood benefits are often negligible under JFM and that the power "sharing" dynamic is prone to issues including inequity, lack of autonomy for communities and corruption.

Existing work generally casts CBFM as outperforming JFM in Tanzania. Several case studies in Tanzania suggest that CBFM improves livelihood benefits over state managed forests, with less optimistic assessments of JFM (Lund and Treue 2008). Lund and Treue (2008) assess outcomes across all three objectives and find positive evidence of CBFM performance reducing logging but more ambiguous results across livelihood and governance outcomes. They found a mix of livelihood improvements when considering village level outcomes but also harmful restrictions borne particularly on the poorest, forest dependent households. The authors suggest that negative livelihood outcomes could be mediated through more accountable and equitable institutions of governance. The findings from this study would benefit from further empirical testing and a larger sample size; their study considered only one CBFM village and therefor the generalizability of their results is limited. In the largest existing comparative study considering livelihood outcomes from nine villages across all regime types Vyamana (2009) found slight livelihood improvements under CBFM and JFM but indication of elite capture of forest benefits. Despite being one of the largest existing household level studies in Tanzania their study design restricted their analyses to descriptive comparisons limiting the interpretation of their results. These study design issues limit their ability to justify the underlying comparability of chosen study sites or their representativeness of their respective management regimes in general. Therefore the general optimism

around CBFM performance in Tanzania is built upon tenuous evidence in need if further empirical corroboration.

Despite relatively positive tentative conclusions about the outcomes of CBFM relative to JFM and state forest management not all findings around CBFM are optimistic. Several case studies exist which compare livelihood and governance outcomes from CBFM across a few communities (Rantala et al. 2012, Rantala and German 2013, Lund and Treue 2008). Rantala and German (2013) and Rantala et al. (2012) studied livelihood and governance outcomes from CBFM in Tanzania and found issues of elite capture, corruption and insufficient livelihood benefits. Benefits from CBFM were marginal and unevenly distributed within communities. Limitations to CBFM were attributed to elite control of institutions of governance and corruption as processes shaping irregular benefit flow. These studies yield interesting insight into interrelated governance and livelihood outcomes but rely exclusively on descriptive, comparative analyses. Together these studies uncover important potential caveats of CBFM functioning in Tanzania that indicate CBFM may not be creating "pro-poor" equitable outcomes as policy intends and theory has predicted. The authors highlight the important limitations of linked elite control of governance and elite capture of resources, which can constrain access to the potential benefits of decentralization for the poor and other marginalized groups within communities. Further studies of issues of elite control and elite capture linked to decentralized outcomes are needed to further test the possible relationships and outcomes identified in these qualitative studies. Understanding of these processes and defensible determination of their outcomes in the context of Tanzania requires further exploration using rigorous statistical methods.

Very few existing studies measure livelihood outcomes for JFM and state forests both with and without CBFM for comparison, and none that consider a relatively large, random sample of households distributed across forest management types. A few cases have witnessed that managing forest

commons at the village level revitalized existing institutions spreading to improvements across village level governance and management of surrounding forests (Alden Wily and Dewees 2001, Vyamana 2009). Vyamana's (2009) study found widespread improvements in governance that transcended merely the institutions of forest governance. Is appears possible then that the benefits of forest decentralization under CBFM could improve the governance and livelihood outcomes for households beyond the boundaries of the village forest reserve impacting how surrounding forests are managed. Vyamana's findings are compelling but again rely on observations and descriptive statistics to support his conclusions. Few existing studies have explored the potential for interaction or spillover effects across different forest management types and none using robust statistical inference.

Brockington (2007) points out that if decentralization's success has not been well demonstrated then neither has its failure. Ultimately opinions abound ranging from decentralization as an utter success improving livelihoods and lessening inequalities to casting it as a complete failure riddled by poor implementation and elite capture. These propositions remain in the realm of conjecture or potentially isolated cases without sufficient supporting data. To deal with the complexity of possible variables this study benefits from the existing case study literature that identifies issues of equity and resource access which require further exploration. However, case studies lack the ability to link outcomes to explanatory variables (Agrawal 2001). Existing work largely consists of case studies rich in detail but limited in generalizability and multi country studies with large sample sizes able to make stronger causal claims but lacking supporting qualitative detail. This study leverages the accumulated knowledge provided by descriptive case studies and larger multi country studies but aims to bridge this gap combining the strength of quantitative and qualitative methods applied to the representative context of decentralized forest outcomes in Tanzania.

CHAPTER 3. STUDY AREA

To explore these relationships Tanzania provides an excellent context because of its relatively long history of forest decentralization, representative forms of PFM and the relative dearth of empirical evaluation of decentralized outcomes (as discussed above). While decentralized forest management was underway in Nepal and India in the late 70's and early 80's, forest decentralization only gained popularity in Africa in the 1990's (Wily 2001). Tanzania has one of the longest histories of decentralization on the continent and widest spread with at least 11% of the country's forest area under some form of PFM (Blomley et al. 2008). It is estimated that PFM is now underway in 3.6 million ha of forest engaging over 1,800 villages (Blomley et al. 2008). A focus on Tanzania allows for comparison of two common forms of PFM; both JFM and CBFM in Tanzania are representative of approaches to decentralized forest management currently in place and expanding in many less developed countries (Jagger et al. 2014).

Tanzania introduced PFM through a series of forest policy reforms and larger processes of democratic decentralization beginning in the late 1990's. The National Forest Policy of 1998, Village Land Act of 1999 and the Forest Act of 2002 combined provide the vision and supporting legislation for decentralized forest management in Tanzania. Tanzania's forest policy outlines three motivations for PFM: i.) Improved forest quality from sustainable management; ii.) Improved livelihoods through access to needed forest products; and iii.) Improved governance through engagement with local institutions (United Republic of Tanzania 2003). Democratically elected village councils constitute the lowest tier of the governmental hierarchy to which forest management responsibilities are devolved. Leveraging

existing community institutions management decisions are entrusted to the Village Environmental Council (VEC), which is an existing committee in local government elected by the village general assembly.

Under JFM's co-management arrangement the community and forest department collaborate to manage an existing forest reserve. This process is not self-selecting by the villages themselves but top down driven by the government (Persha and Meshack 2015). JFM covers mostly montane forests at higher altitudes valued for their particularly high rates of biodiversity and crucial role in water catchment (Persha and Blomley 2009). Management responsibilities are shared between the community and the district forest office. Responsibilities include participating in and reporting on forest monitoring activities, meetings, and accounting. Management powers are vested with the Village Environmental Council (VEC) on behalf of and accountable to the community. JFM by decree includes greater restrictions on forest use, typically only granting rights to collect dead fuel wood and select non-timber forest products as well as rights to benefit from tourism and research activities (URT 2013). Therefore the role of the community and VEC in management under JFM falls on monitoring and enforcement rather than devising harvest rules. Any profits accrued through non-extractive activities such as research or ecotourism are typically split between the village and the forest department. The specifications and restrictions of JFM are laid out in the contractual joint management agreement (JMA) sign by the community and forest department (Blomley and Ramadhani 2006). Many JFM forests are gazetted but still in process towards gaining full legal recognition (Persha and Blomley 2009).

Under CBFM the community demarcates a village forest reserve (VFR) from forest on village land. The rights of access, use and exclusion are determined, monitored and enforced by the village through their elected VEC (Wily 2003). Therefor CBFM is a more decentralized form of PFM in Tanzania where the forest department only plays a supporting, advisory role (Wily 2000). Official establishment of

CBFM is typically facilitated with the help of local forest department or NGO's to navigate the bureaucratic process (Rantala et al. 2012). Vested with management rights villages may decide to permit timber extraction and collect royalties along with enforce sanctions for rule violations and collect fines paid to the village council. To gain official recognition a VFR requires establishment of bylaws and a management plan for approval by the village general assembly and district council (URT 2007). However, most CBFM forests do not go through the full process of legal recognition but their *de facto* communal rights to forest use and management are supported by the Village Land Act of 1999 (Wily 2002). The remainder of forests considered here fall under centralized state management by the Tanzania Forest Service (formerly the Forestry and Beekeeping Division).

CHAPTER 4. DATA

Study Design

This MA thesis study utilizes a subset of data from a larger impact evaluation (IE) of JFM performance in Tanzania conducted during 2011-2015 by researchers at University of North Carolina Chapel Hill together with the Tanzania Forest Conservation Group (Persha and Meshack 2015). The impact evaluation covered 3,363 households from 110 villages and adjacent forest reserves under different forest management regimes in Tanzania. The full impact evaluation study of JFM's outcomes across governance, livelihoods and forest conditions was structured as a quasi-experiment, in which sites with JFM management were randomly selected and then matched to comparable sites under centralized management, which serve as approximate control sites which are similar on relevant characteristics to JFM sites. Please refer to Persha and Meshack 2015 for full details of the broader JFM impact evaluation design, sampling and empirical strategies, and results of JFM impacts in Tanzania.

Through the data collection process for the broader IE, a number of JFM and centralized sites sampled also had CBFM processes underway in the study villages, and for which the full set of household, village and forest data was also collected by the IE team. This study draws on a subset of data from Persha and Meshack 2015 to explore how the addition of CBFM in a village affects household level access to forest resources and participation in institutions of forest governance. To so do, data is drawn from a sub-set of sites from the larger IE study, representing all four forest management combinations that are currently possible in Tanzanian villages (see table 3). To generate a random sample of 12 cases for this thesis study, the full study site pool was first restricted to a band of similar

sites on the basis of the site's propensity to be under JFM implementation (Persha and Meshack015), and then three cases per regime type were randomly selected. Persha and Meshack (2015) calculated the propensity scores from a set of village and forest level characteristics that were determined through their analyses to be determinants of where JFM is implemented in Tanzania relative to sites that remain centralized[1]. In all the cases used for this MA thesis study, the CBFM process at each site was initiated after JFM. The twelve communities yield a sample of 349 surveyed households.

Sample Size for Household Surveys by Forest Management Type

Forest Regime Type	Household N	Village N
State	85	3
JFM	90	3
State + CBFM	86	3
JFM + CBFM	88	3
	349	**12**

Table 3 Study Sample

Data collection for the full IE study focused on evaluating the performance of JFM across ecological, social and institutional arenas. The study consisted of a set of research tools including household surveys, semi structured interviews with key members of forest governance institutions, focus groups with forest users, and randomized vegetation plots. The household level study drew on well-tested research protocols developed by the International Forestry and Institutions Research (IFRI) research program (www.ifriresearch.net) and CIFOR's Poverty Environment Network (PEN). These longstanding research programs informed the development of a unique set of survey questionnaires specifically designed for the aims of the IE study. Questionaries' focused on household forest livelihood activities and participation in governance in addition to basic socioeconomic and demographic information (Persha and Meshack 2015). Approximately 30 randomly selected households were sampled roughly evenly distributed across low, average and wealthy strata determined by a participatory exercise at each site (Persha and Meshack 2015). Interviews were conducted by 10 trained

[1] For further detail on the larger study design and data please see the full report by Persha and Meshack 2015.

enumerators in Kiswahili with the household head covering a range of demographic and socioeconomic household level characteristics as well as information on household participation in aspects of forest governance and harvest.

Data

For this MA thesis study a subset of the larger IE household questionnaire data set were utilized primarily focusing on questions related to household income, demographics, and participation in forest harvesting and governance. Additionally households' open ended, categorical and ranking responses were included to better understand perceptions of the functioning and benefits attributed to each forest management type. Data were analyzed using the statistical software package STATA version 13.1. Descriptions of each variable from the questionnaire and how certain variables were constructed from the existing data proceeds organized by their function in the modeled relationships[2].

Independent Variables

Two focal independent variables were used to approximate households' wealth status; the natural log of per capita income (*loginc*) and an asset based wealth indicator (*lowestquintile*). Income is a ratio level variable constructed from the household survey; household's self-reported annual income was divided by the number of household members yielding an annual per capita income in local currency (Tanzanian shillings) which was transformed to the natural log. This transformation makes a skewed distribution more compact and roughly normally distributed to enable statistical analyses. To address potential issues with endogeneity in statistical modeling an asset-based measure of household wealth status was also used as a construct of wealth status[3]. Using a measure of physical assets to capture wealth status is preferable to monetary income in models that include a measure of forest

[2] For a full table of variable names and descriptions see appendix
[3] For further detail on how the asset based measure was constructed see Persha and Meshack 2015

income as the dependent variable to avoid correlation among variables within the model. The principal component scores from households' assets were divided into quintiles and a dummy variable was created to capture the membership in the two poorest quintiles of households. The resulting dichotomous variable indicates the poorest households based on assets (0 nonmember or 1 member) as a construct of wealth status, which includes 44% of households in this sample (see table 4).

The presence of community based forest management was included in all models. Presence of CBFM was applied site wide (all households in the same site have the same status) and coded as a dummy variable (0= JFM or state-managed forests only or 1= CBFM also present).

Dependent Variables

Dependent variables in this study include several different measures of households' forest use and participation in institutions of forest governance. Forest use measures covered the variety of forest products a household gathers (*prod2cats*) and value of fuel wood (*fuelwoodvalue*) and charcoal harvested (*charcoalvalue*). The variety of forest products was measured as a recall of each distinct forest product gathered (as opposed to purchased) from the last month and ranged from 0 to 4 products in the data set. This was summed per household to capture a measure of the variety of forest products harvested per household, not a measure of volume or intensity of harvest. The variety of forest products were recoded into a dummy variable with those harvesting zero or just one forest product (equal to 0) and those harvesting greater than one product (equal to 1). The vast majority of households (75%) reported harvesting just one product, so this recode enabled testing for determinants of households which harvest a greater than average range of different forest products. As fuel wood was the most common forest resource collected it was isolated for further analyses. For comparison charcoal was also analyzed as a corollary to compare a low and high value fuel type. Households reported value of fuel wood and charcoal harvested from the last month's activities were recorded in Tanzanian shillings. The

household surveys collected each individual's estimated quantity harvested, their chosen unit of measurement, and estimated local market price per unit for both fuelwood and charcoal. The final variables were constructed by multiplying the quantity harvested, unit and price per unit to yield an estimated market value (in Tanzania shillings) harvested for fuelwood and charcoal per household. Average prices for each product were compared within each village to household's responses and any responses missing prices were imputed using the village mean price per unit for each product. Each measure was transformed to the natural log as the distributions were highly skewed.

Different household measures of participation in forest activities were also modeled as outcome variables. Household heads recorded their participation in forest harvest, monitoring and rule creation for their activities in their state or JFM forests. Households' responses were recorded on a likert scale (never, rarely, sometimes, and often) in response to the question, "How often do you participate in each activity (harvest, monitoring, and rule creation)?" Their responses were recoded into dummy variables for those harvesting never/rarely (equal to 0) and sometimes/often (equal to 1). The resulting variables (*harvestOther, monitorOther, createOther)* have responses from the full set of 349 households.

Variable Name	Mean	Std. err	Min	Max	N
loginc	11.65	0.08	2.34	15.61	349
lowestquintiles	0.44	0.03	0	1	349
anyCBFM	0.50	0.03	0	1	349
prod2cats	0.25	0.02	0	1	349
fuelwoodvalue	7.58	0.18	0	12.25	349
charcoalvalue	1.00	0.16	0	13.86	349
monitoringOther	0.09	0.02	0	1	349
harvestOther	0.11	0.02	0	1	349
createOther	0.04	0.01	0	1	349
age	48.23	0.87	18	92	349
education	5.00	0.18	0	13	349
femaleheaded	0.15	0.02	0	1	349

Table 4 Descriptive Statistics Summary of Variables

Control Variables

Other important household level characteristics measured include age and education of the household head (*age*, *education*) and if a household is headed by a single female (*female headed*). Household head's age and years of education are self-reported in years. Whether or not a single female headed each household is coded as a dummy variable (0= male headed 1= female headed). Other controls considered including land and livestock owned shared a high degree of correlation with the different independent variables measuring wealth status so were left out of the models to avoid issues with collinearity among predictors.

Qualitative Data

Qualitative data came from answers to open ended question in the household level survey. Short responses from each survey were coded for common themes including perceptions of forest benefits, functioning of local governance, and issues of equity and access to forest resources. Households' open-ended responses to questions included; 1) Explanation of forest benefits to the household 2). Explanation of perceptions of which group is most active in forest decision-making 3). Explanation of perceptions of which group benefits most from forest decision-making. Reponses were coded and for similar themes and are reported as categorical outcomes rather than the full open ended responses.

CHAPTER 5. METHODS

This study employs a sequential mixed methods research design using statistical modeling and supporting qualitative analysis to explore possible pathways underlying quantitative relationships. First descriptive statistics and distributions for the different measures of households' forest use and participation forest governance activities are compared organized by forest regime types and different measures of household wealth status. One-way ANOVA tests are used to compare means of two or more groups to see if they differ significantly from one another. The resulting F-test and statistics reveal whether the assumption that the groups share a common mean should be rejected at the chosen alpha level. This method is used to compare the averages for each independent variable across different categorical groupings including wealth status and forest regime type. ANOVA test results are reported including the F statistic, and p value[4]. Expanding upon these initial ANOVA tests the analysis proceeds utilizing a combination of ordinary least squares regression and logistic regression models.

Models are used to better understand to what extent household wealth is associated with varying access to participation in 1). Institutions of forest governance and 2). Forest livelihood benefits and 3). Whether these relationships differ when CBFM is additionally present. Participation in forest rule making, monitoring and harvesting activities were studied to understand whether increasing wealth is associated with greater access to these forest institutions and benefits and if CBFM creates more equitable outcomes i.e. access less dependent on wealth. If poorer households have less access relative

[4] Results of ANOVA tests are reported in the format of; between group degrees of freedom, within group degrees of freedom, F statistic, and p value.

to wealthier households holding other factors fixed this is treated as an indicator of inequitable access.

Multivariate regression models expand upon the focal relationships to explore the partial effects of other relevant variables on each dependent variable and permit testing for interactions. In this study household wealth status is interacted with the presence of CBFM. Interaction models are used to interpret whether CBFM has any equalizing effect -- i.e., whether CBFM affects the direction or the magnitude of any relationship between wealth status and participation in each forest activity. The extent to which CBFM alters any relationship between wealth status and participation is used to infer whether CBFM enables more equitable access. Further, the modeling approach also aims to illuminate potential spillover effects that CBFM has on non-CBFM forest activities. The effect of wealth and the presence of CBFM are modeled as predictors of governance participation and harvesting behavior in JFM or state-managed forests. This additional analysis is used to infer whether the presence of supposedly more democratic CBFM processes has any spillover effects on participation in institutions of governance and forest use in non-CBFM forests within the same village.

All models are estimated with cluster robust standard errors clustered to account for the nested structure of the data (households sampled within villages). The assumption can be made that households within the same village will be more alike and potentially exhibit correlation in unobserved ways. Any correlation in unobserved variables among households within the same village violates the regression assumption that errors are independent and identically distributed. Without accounting for correlation of the errors OLS regression will typically underestimate standard errors and overestimate test statistics (Wooldridge 2012). One means of accounting for nested data is to cluster the standard errors at the highest level where there may be correlation (Pepper 2002). Using robust errors clustered at the village level adjusts the standard errors making them robust to unobserved correlation among individuals within the same village. This approach yields more reliable estimates of the standard errors,

which reflect the nested structure of the data. Future work could incorporate a multi-level modelling approach as another method for dealing with the nested structure of the data to account for both household level and village level effects. The OLS regression approach employed here is limited by problems of unobserved heterogeneity in the models errors, which could be correlated with household wealth status. Therefore differences in household wealth status may both be associated with changes in each outcome measure capturing forest use and also be associated with indirect changes in forest use through the errors. In future work a two stage least squares regression with instrumental variables is a potential approach to better address issues of endogeneity. This approach could test for an instrumental variable capturing wealth status which is correlated with direct household income but not correlated among the errors. Given that all observational data are subject to unobserved heterogeneity, OLS is assumed to be a sufficient modeling approach despite potential unobserved or omitted variable bias. However, the results are interpreted cautiously and limitations discussed further in the results chapter.

Qualitative analysis is employed to aid interpretation of observed relationships among key variables derived from each model. Exploring the range and frequency of responses in sites with and without CBFM will provide further insight into any differences in the functioning of forest governance institutions and accessibility of forest benefits by regime. These data will be compared to the modeled outcomes to provide reinforcement or points of contrast with output results. The qualitative analysis provides additional information on how households perceive the functioning of their forest governance institutions and access to livelihood benefits and whether these outcomes are shaped by CBFM.

Section 5.1

Ordinary Least Squares Regression

OLS regression models are used to test the effect of household's wealth status on their harvest of two different fuel sources; fuelwood and charcoal. This approach allows for decomposition of how

household wealth status might impact the environmental income households' harvest for fuel types with different relative values. The separate OLS models (see table 5) will tease out any effect of households' wealth status on harvest of a low value fuel product (fuel wood) and a high value product (charcoal) and how each modeled focal relationship (regression of wealth status on fuelwood and charcoal) changes with the presence of CBFM in a village. Results are reported as marginally significant for test statistics between alpha .10 and .05, significant at $p<.05$, and highly significant $p<.01$.

Ordinary Least Squares Models and Hypothesis

Of the two fuel types I anticipate the market value of fuelwood households harvested to be less dependent on wealth status and the presence of CBFM. In the regression of low wealth status on the value of fuelwood harvested (OLS model1) I anticipate a positive effect of low household wealth status on fuel wood harvested. I anticipate poorer households to have a greater reliance on fuel wood, which is a lower value product than charcoal. I do not anticipate any significant effect of CBFM on fuel wood harvest or any significant interaction between CBFM and poverty on harvest (OLS model 2). This low value and abundant fuel source is typically accessible in all forests regardless of management type therefor I do not expect the presence of CBFM to impact the relationship. As a lower value product I do not expect fuel wood to be subject to significant issues of access and elite capture. By contrast charcoal is a more valuable product, which requires greater inputs for extraction and potential barriers (both social and punitive) to access. As a valuable forest product I anticipate poverty to be negatively related to the value of charcoal a household harvested. Charcoaling is typically a restricted activity in government and JFM forests yet wealthier households may be able to leverage their elite status or engage in rule breaking and gain access to this valuable product. CBFM permits villages to set their own guidelines around charcoaling and as a more democratic form of management should enable more equitable access to charcoaling for poorer households. Therefor in the model of poverty on charcoal

harvest (OLS model 3) I anticipate a negative focal relationship, CBFM to have a positive effect on charcoal harvest and a positive moderating effect (OLS model 4).

Variables	**OLS Model 1**	**OLS Model 2**	**OLS Model 3**	**OLS Model 4**
Independent variable	*lowestquintiles*	*lowestquintiles*	*lowestquintiles*	*lowestquintiles*
Dependent variable	*fuelvalue*	*fuelvalue*	*charcoalvalue*	*charcoalvalue*
Regime type	*anyCBFM*	*anyCBFM*	*anyCBFM*	*anyCBFM*
Moderator	---	*lowestquant*anyCBFM*	---	*lowestquant*anyCBFM*
Controls	*age*	*age*	*age*	*age*
	education	*education*	*education*	*education*
	femaleheaded	*femaleheaded*	*femaleheaded*	*femaleheaded*

Table 5 OLS Models 1-4

Ordinary Least Squares Dependent Variables

The dependent variables modeled with OLS regression were total value estimates for two forest products harvested; fuel wood and charcoal. Separate OLS bivariate models are used to capture the effect of wealth status on households' estimated market value of fuel wood harvested (*fuelwoodvalue*), and the estimated market value of charcoal harvested (*charcoalvalue*). These variables were each transformed to the natural log which is a common and useful transformation for skewed variables[5].

OLS Independent Variable

The dummy variable for membership in the lowest asset based wealth quintiles (*lowestquintiles)* is used as the independent variable in all OLS models to capture household wealth status. This approach compares differences in the value harvested for each forest product across the poorest and wealthiest households. To deal with potential endogeneity in these models the wealth quintiles derived from households' assets are used as a proxy for wealth status instead of the log of income to avoid using a measure of monetary income for both independent and dependent variables.

[5] The interpretation of log-level regression coefficients for each x_i is interpreted as $\%\Delta y = 100 \cdot \beta 1 \cdot \Delta x_i$

This measure was considered more robust to endogeneity because physical assets are not as directly related to forest derived income as a direct liquid asset measure such as reported income. Therefore the asset-based measure of wealth status is less prone to problems with reverse causality brought about by using two income-based measures.

Ordinary Least Squares Moderator

Each bivariate model is elaborated upon to include a dummy variable for presence of CBFM and for any moderating effect of CBFM. The dummy variable for presence of CBFM (*anyCBFM*) is included to reveal the partial effect of CBFM on the value harvested for each product net of other predictors. Adding forest regime to the models as a dummy regressor illustrates any differences in intercepts for each regression line (outcomes for JFM and centralized management with and without CBFM). The coefficient for the regime dummy reveals if households in CBFM sites are associated with distinct levels of harvest (for each fuel product) holding wealth status and other controls fixed. Any difference in the intercepts is the mean difference in value harvested with the addition of CBFM holding other covariates constant. To test for moderation an interaction term between membership in the lowest wealth quintiles and presence of CBFM (*lowestquintiles*anyCBFM*) is added to each model. Moderation reveals whether the effect of wealth status (IV) on the different measures of fuel products harvested (each DV) depends on the value of a third variable (Z), in this case the presence of CBFM.

Ordinary Least Squares Controls

In order to elucidate the effect of wealth net of potential confounding covariates certain household level characteristics were controlled for including age, years of education, and whether or not the household is female headed (*age, education, femaleheaded*). These characteristics are controlled for because they are related to both the independent and dependent variables; they are causally prior to wealth status and known to influence aspects of forest harvest. Households that are

older, less educated or female headed are anticipated to participate less in forest governance institutions and harvest activities. Other household level controls were considered including land holding, large livestock and small livestock owned but were not included due to issues with multicollinearity introduced into the models due to overlap in these measure and the different measures of household wealth status. The larger IE study accounted for different forest and community level factors related to the administrative selection bias for JFM in the study design using a principal component analysis to compare sites with similar scores or propensity for JFM implementation. The subset of sites for this thesis study were drawn randomly within each forest regime after first restricting the sample to those with similar principal component scores (as described in the study design section). Therefore the villages from which this study is drawn are alike on average across the range of covariates known to bias JFM site selection such as forest size and type, community population, and distance to markets, among others[6].

Section 5.2

Logistic Regression

Logistic regression models were used to determine the influence of wealth status and regime type on binary measures capturing household participation in different aspects of forest harvest and institutions of governance. Following on the analysis of market value harvested for two specific forest products (fuelwood and charcoal) logistic regression is used to further explore how wealth and regime are related to participation in different aspects of forest harvesting and institutions of governance. The variety of forest products a household gathered (binary capturing those harvesting greater than one product) is modeled to explore whether wealth status and the presence of CBFM are associated with a greater likelihood of harvesting more than one forest product. Additionally an interaction model is used

[6] All processes motivating the selection of control variables described here apply to all subsequent models.

to test whether CBFM has any moderating effect on the relationship between wealth and likelihood of harvesting a greater variety of forest products. Further logistic modeling is also used to identify any spillover effects related to the presence of CBFM. To do so the dummy variable for presence of CBFM is added as a predictor of household participation in forest harvest, monitoring and rule creation in JFM and state-managed forests and institutions. This will reveal whether the presence of CBFM processes in a village is related to any differences in a household's participation in aspects of their JFM and state-managed forests and institutions of governance. In logistic regression the interpretation of coefficients becomes the effect of each predictor on the log odds of the outcome modeled as a linear combination of the predictor variables. Log odds are reported as odds ratios and predicted probabilities to aid interpretation of key relationships. Results are reported as marginally significant for test statistics between alpha .10 and .05, significant at p<.05, and highly significant p<.01.

Logistic Regression Models and Hypothesis

I anticipate a greater diversity of forest products to typically incorporate higher value forest products and therefor expect a positive relationship between income and the likelihood of harvesting greater than one forest product (see Table 6 for logistic regression model 5 and 6). I anticipate CBFM to have a positive marginal effect on the variety of products gathered and mitigate the positive affect of income on the likelihood of harvesting greater than one product.

Variety of Forest Products **Variables**	**Model 5**	**Model 6**
Independent variable	*loginc*	*loginc*
Dependent variable	*prod2cats*	*prod2cats*
Regime type	*anyCBFM*	*anyCBFM*
Moderator	---	*loginc*anyCBFM*
Controls	*age*	*age*
	education	*education*
	femaleheaded	*femaleheaded*

Table 6 Logistic Regression Variety of Forest Products Harvested

To understand how wealth and CBFM affects participation in monitoring, rule creation and frequency of harvest in state and JFM forests logistic regression models were run (see table 7). I hypothesize that wealth will have a positive effect on each measure of forest use and participation in institutions of forest governance under state and JFM regimes. I anticipate CBFM to have a positive spillover effect increasing the likelihood that a household participates in each activity.

Models of participation in JFM and state forests

Variables	**Model 7**	**Model 8**	**Model 9**
Independent variable	*loginc*	*loginc*	*loginc*
Dependent variable	*createOther*	*monitorOther*	*harvestOther*
Regime type	*anyCBFM*	*anyCBFM*	*anyCBFM*
Controls	*age*	*age*	*age*
	education	*education*	*education*
	femaleheaded	*femaleheaded*	*femaleheaded*

Table 7 Logistic Regression Models of Participation in Forest Rule Creation, Monitoring and Harvest

Logistic Regression Dependent Variables

Four aspects of forest participation were modeled with logistic regression; the variety of forest products gathered, participation in rule creation, monitoring, and frequency of forest harvesting.

The variety of forest products a household gathered was grouped into those harvesting zero or just one forest product (equal to 0) and those harvesting greater than one product (equal to 1). Since the majority of households reported gathering just one product (and that product was almost always firewood) this recode enabled testing of whether wealth and presence of CBFM increase the likelihood of gathering a greater variety of forest products, which are also typically higher value forest products.

Households' responses to their participation in JFM and state forest governance institutions and forest use were categorized into dichotomous average and above average participation for each outcome. This categorization enabled closer attention to what factors distinguish households which are

unique in their involvement in forest governance and use, particularly whether wealth and CBFM are influential. Responses across these ordinal scale variables were disproportionately clustered on lower ends of participation (never/rarely participating). These variables were regrouped into binary variables capturing those who never/rarely participate (equal to 0) and sometimes/often participate (equal to 1) for each activity (rule creation, monitoring, and forest harvest) and parsed into activities reported in state/JFM forests and CBFM forests.

The dummy variable for presence of CBFM (anyCBFM=0 or 1) and an interaction term between CBFM and income are also included (*inc*CBFM*).

Logistic Regression Independent Variables

The log of income (l*oginc*) is the predictor representing household wealth status in all logistic regression models.

Logistic Regression Controls

Household level characteristics controlled for included age, years of education, and whether or not the household is female headed (*age, education, femaleheaded*) in all models. Similar to the elaboration of the OLS models adding these controls to the model holds their effect on the outcomes constant to isolate the effect of wealth and regime on participation in forest use and governance regime net of these potential confounders. Future extensions of this work will include further controls capturing the importance of forest income to the household and satisfaction with VEC/VNRC as additional controls related to household participation.

Section 5.3

Qualitative Analysis

Qualitative analysis of open ended survey questions is guided by a set of codes. The codes are designed to group information from the supporting text and provide theoretical basis for further interpretation of the focal and elaborated relationships in this study. Specifically the qualitative analysis is employed to understand the means by which key predictors are influencing household participation in forest governance and forest use under different forest regime types and specifically how the additional presence of CFM affects; activities within CBFM forests and institutions of governance and if there are any spillover effects to activities into state or JFM activities. Codes grouped responses that signified issues around access and perceived barriers to participation in governance and access to forest resources. The qualitative analysis is designed to provide a better understanding of whether CBFM appears to be more equitable than state or JFM arrangements and whether more democratic governance might be linked to any improved outcomes. Further the qualitative data is coded for any indication of spillover effects i.e. positive outcomes around equity and access in JFM or state activities linked to presence of CBFM. Households' description of forest benefits derived from each forest regime were condensed and coded from open ended responses to like categories. For example common benefits such as "rain, shade, clean water, protection of soil," were coded as environmental services.

CHAPTER 6. RESULTS

Section 6.1

Forest Livelihood Outcomes; Relationships between Wealth Status and Decentralized Management on Household Harvest of Fuelwood and Charcoal

Comparing the mean values harvested for both fuelwood and charcoal by household wealth status (see fig. 1) there appear to be wealth based differences in access to forest derived fuel sources[7]. While the average value harvested for both fuel types are greater for wealthier households this gap is steeper for charcoal (a difference of TSH 10,645 or about USD 5.30). Charcoal is typically considered a more desirable, value added product compared to fuelwood with a greater average market value. Wealthier households in this study harvested a greater average value of charcoal (the higher value fuel product) relative to fuelwood. A one-way ANOVA test confirmed the averages for fuelwood and charcoal for the wealthiest households were statistically different ($F(14,180)=7.9$ p=.0). By contrast poorer households reported harvesting a greater average value of fuelwood than charcoal (difference of TSH 4,895 or USD 2.63). However for the poorest households the difference between average charcoal and fuelwood harvest were not statistically significant ($F(7,146)=.40$ p=0.90). The difference in mean fuelwood harvest by wealth status was marginally significant ($F(1, 347)=3.66$ p=.06) with wealthier households reporting a greater average harvest of fuelwood. However the apparent difference in charcoal harvest by wealth status was not statistically significant ($F(1, 347)=1.88$ p=.17). Therefore wealthier households attained greater environmental income from charcoal, the higher value fuel

[7] This comparison is made using the asset based measure of household wealth described in the data section to mitigate issues with endogeneity in concept and subsequent modelling. Poorest households represents those in the bottom two quintiles of assets.

source, relative to fuelwood. Wealthier households also reported a greater average value of fuelwood harvested compared to poorer households.

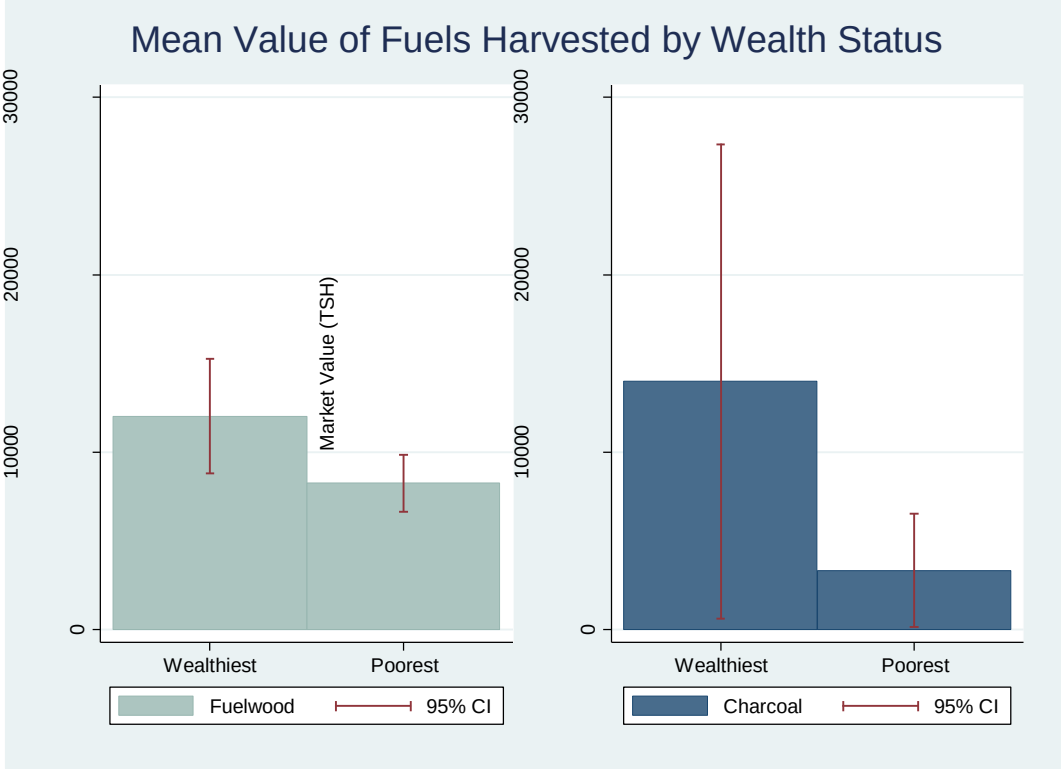


Figure 1 Fuel Types and Wealth Status

Disaggregating these relationships further differences in average fuelwood and charcoal harvest are compared by forest management type (see fig. 2). Comparing the average harvest for each fuel type by regime reveals some potential differences in harvesting opportunities related to forest management context. The mean value of fuelwood harvested across all possible regime combinations did not display much variation ranging from a low of TSH 9,640 under JFM to TSH 11,445 in sites with state forest management and CBFM processes underway. Further, the slight differences across group means were not statistically significant as determined by the one-way ANOVA test ($F(3, 345)=0.15$ $p=.93$). As a lower value product and one that is largely unregulated regardless of regime type this relatively consistent average was expected. By contrast the mean value of charcoal harvested by regime shows greater

variation. The average value of charcoal harvested was very low in sites with only state or JFM forest management (TSH 558 and TSH 561 respectively). Average charcoal harvest was greater in sites where CBFM was additionally present; households in sites with state and CBFM forests reported an average of TSH 13,366 charcoal harvested and TSH 22,676 in JFM sites with CBFM. However the one-way ANOVA test indicated these differences were just outside the bounds of statistical significance at the alpha .1 level ($F(3,345)=1.98$ $p=.12$).

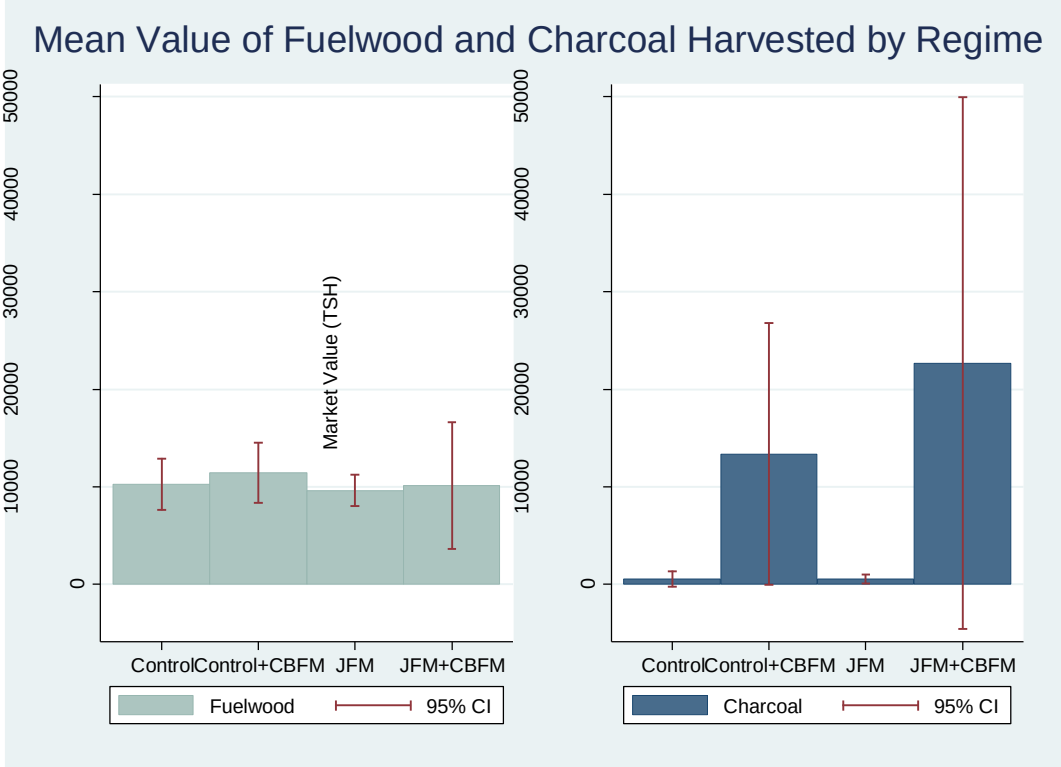


Figure 2 Fuel Types Harvested by Management Regime

The initial relationships between household wealth status and fuel harvest (fig. 1), and management regimes and harvest (fig. 2) are further explored to see whether the intersection of wealth status and forest management regime are related to differences in harvest of fuelwood or charcoal (see fig.3). This comparison investigates the potential for an interactive effect of wealth status and presence of CBFM processes on each measure. To do so average harvest for both fuelwood and charcoal are compared for the poorest and wealthiest households in sites with only state and JFM management to those which additionally have CBFM processes underway. The average value of fuelwood that a household harvests appears largely unaffected by household wealth status in sites with only state or JFM forests; the one-way ANOVA test confirmed that the difference in average fuelwood harvest for the poorest and wealthiest households was not statistically significant ($F(1,173)=0.02$ $p=.88$). However, the difference in average fuelwood harvest by household wealth status was significant where CBFM was additionally present; the wealthiest households reported a greater average value of fuelwood collected in sites with CBFM underway ($F(1,172)=4.05$ $p=.05$). Comparing the value of charcoal harvested in sites with only state or JFM forests there is no apparent difference across wealth groups ($F(1,173)=.85$ $p=.36$). Overall the average charcoal harvested is very low in sites without CBFM regardless of household wealth status. Where CBFM was also present the difference in the average value of charcoal harvested by wealth status appears large (TSH 19,283 or about USD 9.65) with wealthier households harvesting more. However, the one-way ANOVA test revealed this difference was not statistically significant ($F(1,172)=1.53$ $p=.21$). While descriptive comparison points to a potential interaction effect between wealth status and presence of CBFM processes on charcoal harvest (with a substantial gain in charcoal harvest under CBFM especially for the wealthiest households), these differences were not statistically significant at even the $p<.1$ level.

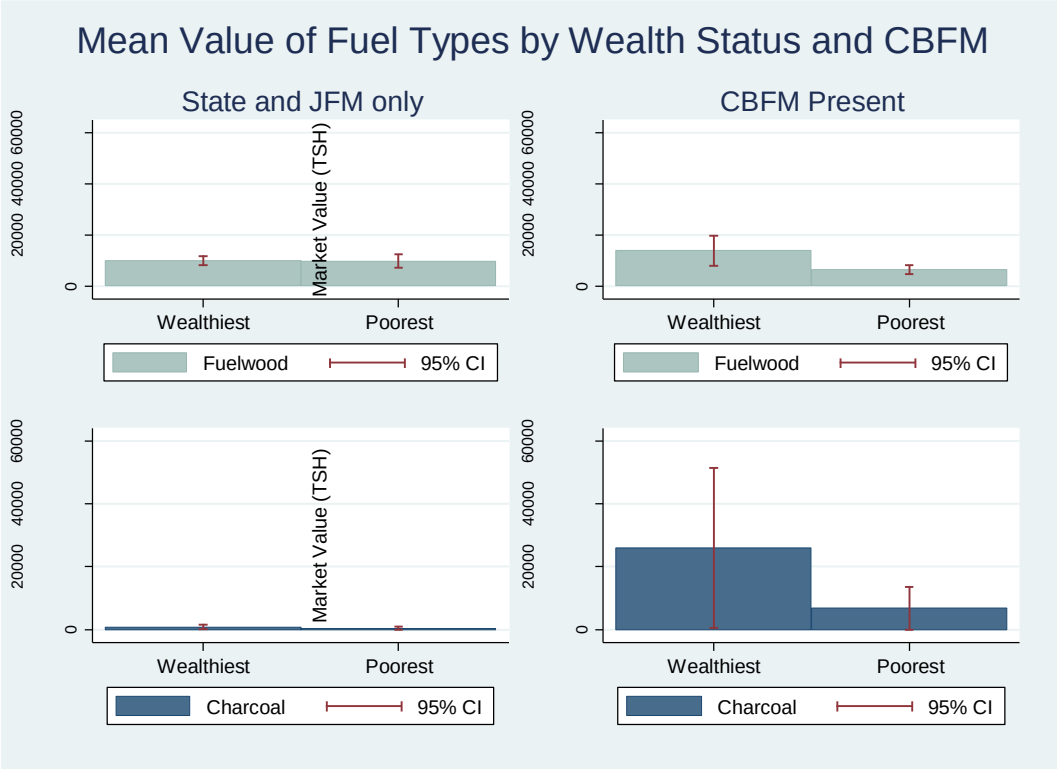


Figure 3 Fuel Types, Household Wealth Status and Presence of CBFM

Forest Livelihood Outcomes; Exploring Determinants of Households' Fuelwood and Charcoal Harvest with Ordinary Least Squares Regression

Expanding beyond the descriptive comparisons of fuel wood and charcoal harvest OLS regression was used to test for any significant effects of wealth status and CBFM on the market value of each fuel type harvested and for any moderating effect of CBFM on the focal relationship (see table 8). The regression results for the models of fuel wood harvest (models 1 and 2) revealed no significant relationships with wealth status, presence of CBFM or any interaction between wealth status and CBFM on households' harvest. The only regression model that revealed any significant result is the negative effect of being in the poorest asset based wealth group on the harvest of charcoal. The effect of being among the poorest households (lowestquintiles=1) is associated with a 47.6% decrease in the value of charcoal harvested which is statistically significant at the $p<.01$ level. While the descriptive comparisons indicated differences across theses fuel types by wealth status and regime type these relationships did

not prove to be statistically different from zero at even the p<.1 significance level. This indicates that household wealth status (based on household assets) is not significantly related to any difference in the average value of fuel wood harvested. By comparison being among the poorest households reduces the expected market value of charcoal harvested by about half. There is no significant effect of the presence of CBFM in a village on the value of either fuel type harvested nor any conditional effect of CBFM. The model fit for all regression models were low. In the model of charcoal harvest with the significant effect of wealth status (model 3) the predictors explained 7.2% of the variation in the value of charcoal harvested. The model was post checked for heteroskedasticity and multicollinearity and neither test revealed violation of regression assumptions[8].

OLS Regression Outputs	Fuel wood		Charcoal	
Fuel types	m1	m2	m3	m4
	b/se	b/se	b/se	b/se
lowestquintiles	-0.559	-0.666	-0.646**	-0.315
	(0.385)	(0.49)	(0.206)	(0.245)
anyCBFM	-0.515	-0.614	0.951	1.253
	(0.603)	(0.388)	(0.645)	(0.759)
Female headed	0.355	0.352	0.058	0.066
	(0.546)	(0.544)	(0.433)	(0.409)
Education	0.031	0.032	0.107	0.104
	(0.052)	(0.051)	(0.056)	(0.058)
Age	-0.002	-0.002	-0.014	-0.015
	(0.012)	(0.015)	(0.011)	(0.011)
*lowestquintiles*anyCBFM*	---	0.222	---	-0.682
	---	(.812)	---	(0.41)
Constant	7.966**	7.995**	0.940**	0.85**
	(0.768)	(0.698)	(0.675)	(0.626)
R^2	0.01	0.01	.072	.075
+ p<0.10, * p<0.05, **p<.01				

Table 8 OLS Fuel Type Outputs

[8] After running cluster robust standard errors the residuals were examined and plotted against the dependent variable for constant variance. Variance inflation scores were checked for all regressors and all VIF< 1.3.

The combined results of the fuel type harvest analysis indicate that fuel type harvest is not significantly affected by the presence of CBFM on household level outcomes and that any wealth effect is not conditional on CBFM for either fuelwood or charcoal. The average value of charcoal harvested is about 47% greater for wealthier households but is not significantly affected by the presence of CBFM in a village. Overall the fit of these models was very low indicating that the explained variance in the value of each fuel harvested was largely unexplained by the modeled predictors. These results are limited by the relatively large standard errors for both measures. The instability of these estimates make conclusive and statistically significant model results unlikely.

Section 6.2

Forest Livelihood Outcomes; Relationships between Household Wealth Status, Forest Management and Variety of Forest Products Harvested

Expanding from the comparison of two specific forest products (fuelwood and charcoal) I further explore potential differences in household forest livelihood outcomes using a measure of the variety of forest products a household harvested. Comparing fuelwood and charcoal enabled insight into potential the effects of wealth status and management regime on households' access to both a low and high value forest derived fuel source. Utilizing the variety of forest products gathered as an independent variable captures a range of other potential forest resources (not just fuels) households might harvest and whether wealth status and forest management type shape access to these resources.

Comparing the mean variety of forest products gathered by household income (quartiles of logged per capita income) and presence of CBFM some potential differences in household access to forest products become apparent (see figure 4). Where CBFM is present the data point to a steady increase in the average variety of forest products households gathered by income. The poorest households appear to gather a similar variety of products regardless of CBFM, but the patterns across regime types diverge at higher levels of income. Households in the highest income quartile in sites

without the additional CBFM processes (i.e. villages that only have either JFM or centralized management) gathered a greater variety of products on average compared to sites that do have CBFM underway. Differences in the average variety of products gathered by income quartiles were significant for households with only JFM or state forests ($F(3,171)=8.49$, p=.00) and differences by income were also significant where CBFM was additionally present $F(3,170)=2.61$ p=.05). A further one-way ANOVA test confirmed that the difference in between the average variety of forest products gathered for the wealthiest quartile in centralized/JFM compared to sites which also have CBFM was significant ($F(1,87)=5.24$, p=.02) with the wealthiest households gathering a greater variety in sites without CBFM underway.

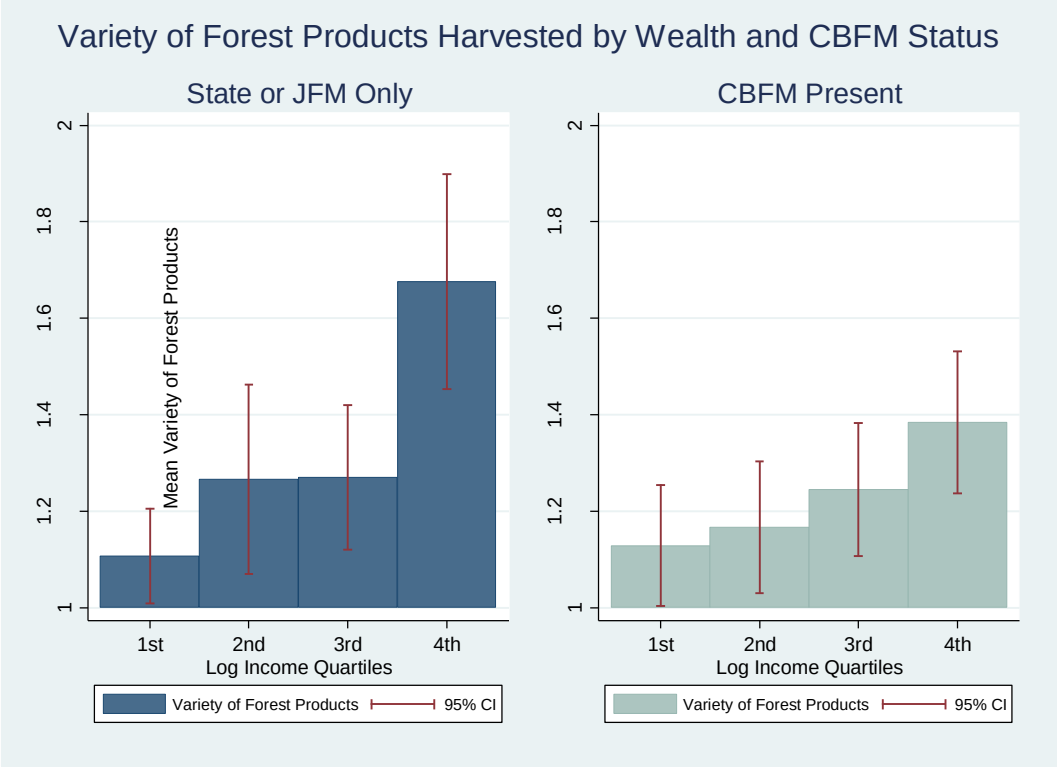


Figure 4 Variety of Forest Products Gathered by Income Quartiles and CBFM

Comparing the proportion of households gathering greater than one forest product by income quartiles and forest management regime the apparent difference for the wealthiest households persists (see fig. 5). Differences in the average proportion of households gathering greater than one forest

product by income are statistically significant for sites with only JFM or state-managed forests (F(3,171)=10.32, p=.00) as well as those which additionally have CBFM processes underway (F(3,170)=2.44 p=.07). In sites with only JFM state managed-forests 56% of households in the highest income quartile harvest more than one forest product compared to only 36.5% where CBFM is also present. While there is still a relationship between increasing wealth and the proportion of households gathering a greater variety of forest products regardless of forest management type, the gap for the wealthiest households in sites with only JFM or state-managed forests appears greater. The difference in the proportion of the wealthiest households gathering more forest products in JFM or state-managed forests compared to those where CBFM was present proved to be statistically significant in a one-way ANOVA test (F(1,87)=3.64, p=.06). Across lower and moderate levels of income there appear to be no differences in the proportion of households harvesting a greater variety of forest products regardless of the presence of CBFM in a village. One-way ANOVA tests for all other income quartiles were not significant[9]. Therefore access to a greater variety of forest products was related to income but the presence of CBFM processes was not significantly related to differences in access except potentially for

[9] ANOVA results log income=1 (F(1,86)=.33, p=.56), ANOVA results log income=2 (F(1,85)=.13, p=.72), ANOVA results log income=3 (F(1,84)=.23, p=.63)

the wealthiest households. presence of CBFM processes was not significantly related to differences in access except potentially for the wealthiest households.

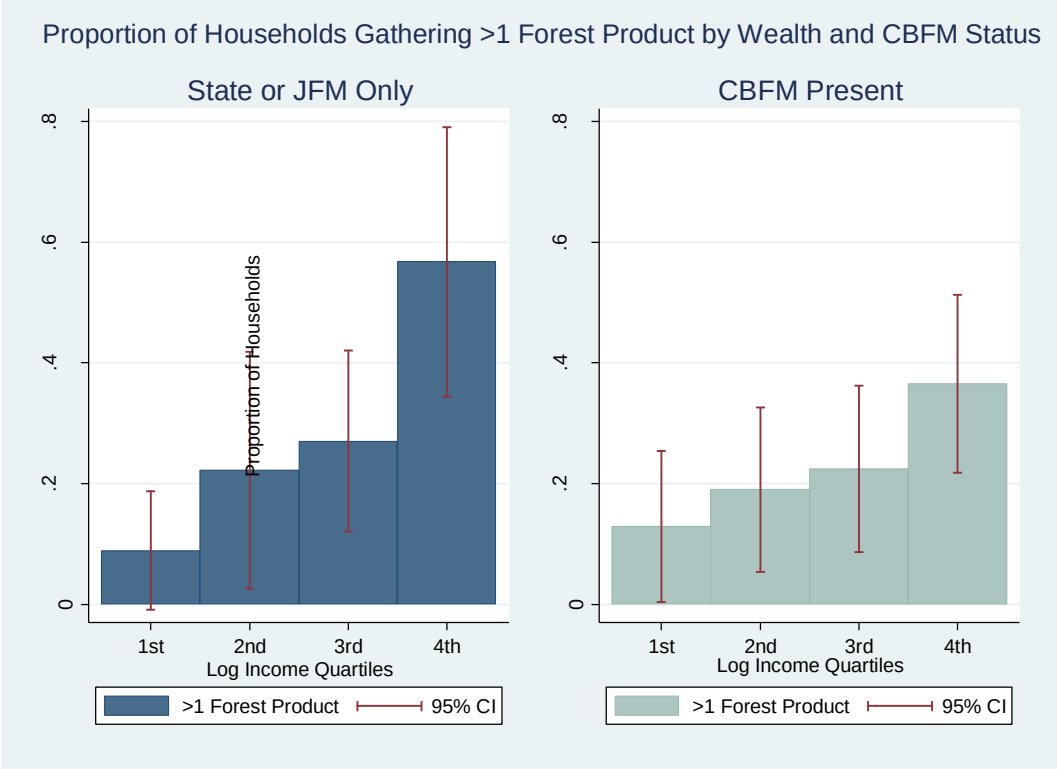


Figure 5 Proportion of Households Gathering >1 Forest Products by Logged Income Quartiles and CBFM

Forest Livelihood Outcomes; Exploring Determinants of Household Access to a Variety of Forest Products with Logistic Regression

The relationships between wealth status and forest regime were investigated further through logistic regression to better understand what factors influence the likelihood a household harvests a greater variety of forest products. The results from model 5 indicate that the likelihood a household harvests greater than one forest product is influenced by income and age of the household head (see table 9). As predicted there is a positive effect of income on the odds of harvesting greater than one forest product. For every one unit increase in the log of income there is an 56% increase in the odds of harvesting greater than one forest product (odds ratio of 1.563) which is statistically significant at the p<.01 level. Age has a small negative effect on the odds of harvesting greater than one product. For

every additional year in age of the household head the households odds of harvesting greater than one product decrease by 1.5% (odds ratio of .985) which is significant at the p<.05 level. The partial effect of CBFM on the likelihood of harvesting greater than one product was just outside of the statistical significance bounds set (p<.104) and is therefore not interpreted as statistically different from 0. The constant represents the odds ratio for a household with a log income of 0 holding the other predictors constant (state or JFM forest, not female headed, 0 education 0 age).

Logit Models	Model 5		Model 6	
>1 Variety of Forest Products	b/se	Odds ratio	b/se	Odds ratio
Log income	0.447**	1.563**	0.601**	1.825**
	(0.088)	(0.138)	(0.091)	(0.167)
anyCBFM	-0.399	0.671	3.347	28.424
	(0.492)	(0.33)	(2.062)	(58.604)
Female headed	-0.429	0.651	-0.385	0.681
	(0.384)	(0.25)	(0.387)	(0.263)
Education	0.068	1.07	0.065	1.067
	(0.056)	(0.06)	(0.056)	(0.06)
Age	-0.015*	0.985*	-0.014*	0.986*
	(0.006)	(0.006)	(0.006)	(0.006)
*Log income*anyCBFM*	---	---	-0.311*	0.733*
	---	---	(0.147)	(0.108)
Constant	5.815**	0.003**	7.654**	0.000**
	(1.295)	(0.004)	(1.492)	(0.001)
+ p<0.10, * p<0.05, **p<.01				

Table 9 Logistic Regression Results on Harvesting >1 Forest Product

Elaborating upon this relationship model 6 includes the marginal effect of having an additional CBFM process in the village on the odds of a household harvesting greater than one forest product. The odds ratio coefficient for income indicates that for a one unit increase in the log of income there is a 82.5% increase in the odds of harvesting greater than 1 forest product (odds ratio of 1.825) for households with only state or JFM management processes (significant at the p<.01 level). Comparatively the effect of a one unit increase in the log of income in CBFM increases the odds of harvesting greater than one product by only 33% (odds ratio of 1.33). There is a 50% reduction in the effect of income on

the odds of harvesting greater than one product for households in villages with CBFM compared to those with only state or JFM forests. The marginal effect of CBFM on the likelihood of harvesting greater than one product at different levels of predicted income can be seen in the marginal effects table and plot (see table 10 and fig.6). The marginal effects of CBFM on the likelihood of harvesting a greater variety of products at different levels of income reveals that this interaction is only statistically significant at higher levels of income. As the marginal effect of CBFM scales with income it becomes statistically different from 0 as income is greater than or equal to 14 on the log scale. While this effect is statistically significant, only 7.25% of households (n=25) in the sample had logged per capita incomes greater than or equal to 14. Therefor this effect is interpreted cautiously. Age also has a significant effect in model 6 slightly reducing the odds of harvesting more forest products. For every additional year in age for a household in state or JFM forests there is a .986 change in the odds ratio, or about a 1.4% reduction in the odds of harvesting greater than one product. The constant indicates the odds ratio of harvesting greater than one product for a hypothetical household with an income of 0 in state or JFM forests holding all other controls at 0.

AME **Model 6**			
Log Income	dy/dx	SE	P
8	.0484	.0612	0.429
9	.0443	.0694	0.523
10	.0267	.0785	0.734
11	-.0112	.0883	0.899
12	-.0731	.0973	0.452
13	-.1536	.1028	0.135
14	-.2362	.1028	0.022*
15	-.3011	.0983	0.002**
+ p<0.10 *p<0.05 **p<.01			

Table 10 Average Marginal Effect of CBFM on Harvesting Greater than 1 Forest Product at Different Levels of Income

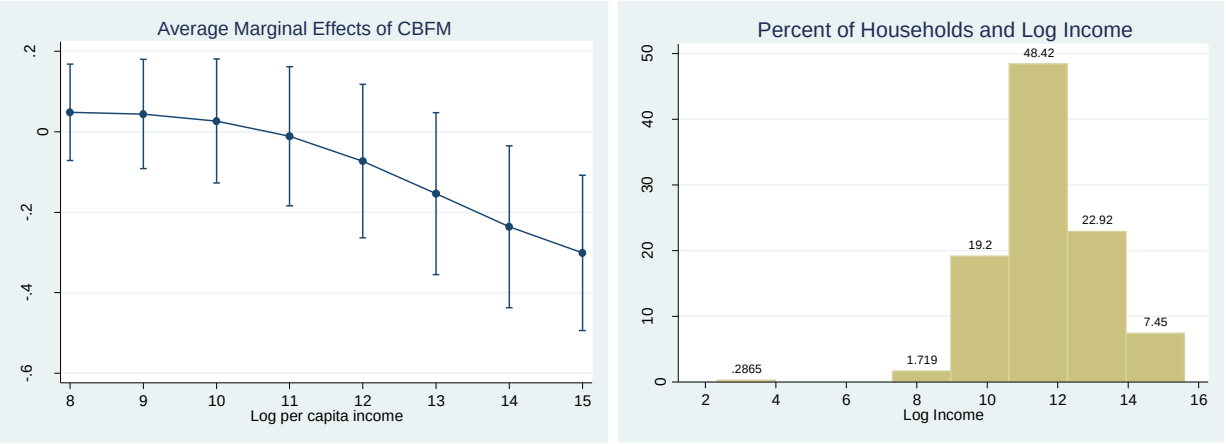


Figure 6 Average Marginal Effect of CBFM

This relationship is plotted at predicted margins for households in state and JFM forests compared to those with CBFM present in figure 7. Again, the predicted probability of harvesting greater than one forest product does not vary with CBFM at most levels of income. However, the predicted probability of harvest diverges at the highest levels of income between households with only state or JFM managed forests and those where CBFM is also present. Overall this indicates that there is no statistically significant marginal effect of CBFM on the likelihood of harvesting more forest products at most levels of income. However, the divergence for the wealthiest households indicates that the presence of CBFM processes may affect the probability of accessing a greater variety of forest products for elites. The reduction in the effect of income on the odds of harvest for the wealthiest households under CBFM is tentative indication of an equalizing effect of CBFM; access to a greater variety of products may be more equitable i.e. less dependent on wealth status when CBFM processes are present in a village. However given the relatively small proportion of households with log income >14 this effect is interpreted cautiously.

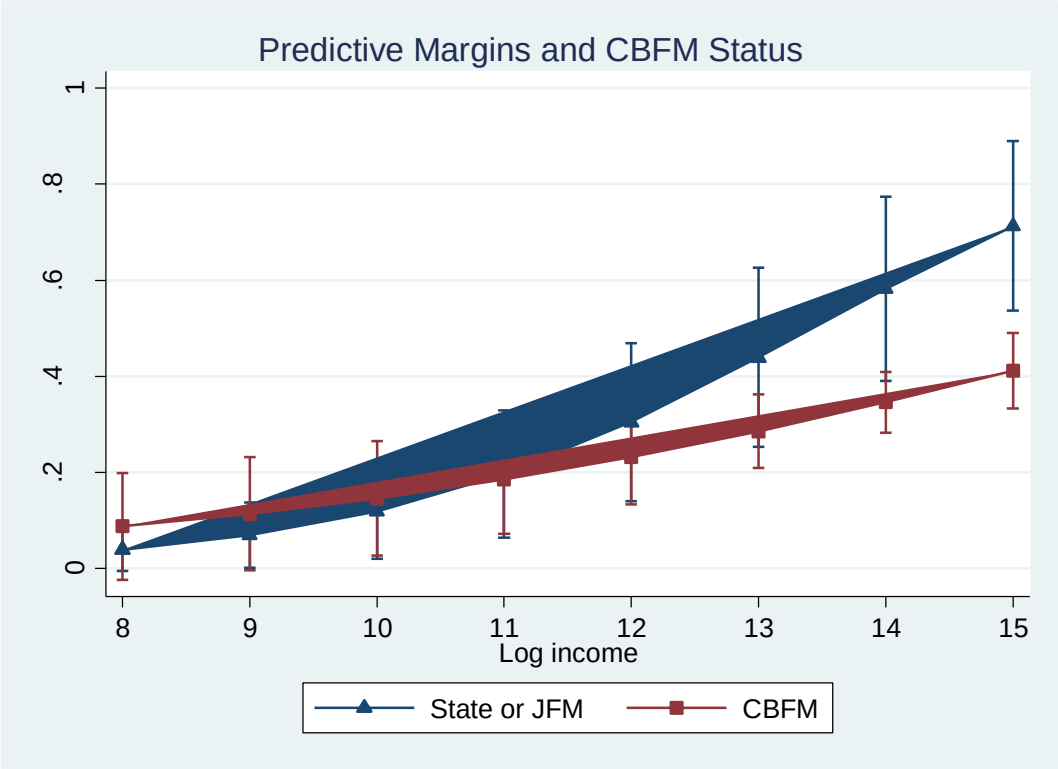


Figure 7 Predicted Margins Probability of Harvesting

Section 6.3

Forest Governance and Forest Harvest Outcomes; Exploring Determinants of Household Participation in Different Institutions of Forest Governance through Logistic Regression

Logistic regression was used to model the effect of wealth status and CBFM on participation in different institutions of forest governance and forest harvesting in state and JFM forests (see table 11). Wealth status had a significant effect on the likelihood of participating in forest monitoring and harvest. In the model of income on the likelihood of participating in forest monitoring (model 7) there was a positive and significant effect. For every one unit increase in log income the odds of participating in forest monitoring increased by 45% (odds ratio of 1.45) which was significant at the p<.01 level. The age of the household head also affected the likelihood of participation; for every year in age the odds of participating increase by 4.7% which was significant at the p<.05 level. There was no significant effect of having an additional CBFM process in the village on a household participation in forest monitoring activities in state or JFM forests. This indicates that household wealth is related to higher participation in

forest monitoring in state and JFM forests, and that there is no significant change in that relationship when CBFM is additionally present at any level of income.

Logit Model	m7	
Monitoring	b/se	Odds Ratio
loginc	0.371**	1.450**
	(0.140)	(0.203)
anyCBFM	-0.022	0.979
	(0.385)	(0.376)
Female headed	-0.186	0.83
	(0.773)	(0.641)
age	0.024**	1.025**
	(0.009)	(0.009)
education	0.038	1.039
	(0.074)	(0.077)
constant	-8.099**	0.000**
	(1.75)	(0.001)
+ p<0.10, * p<0.05, **p<.01		

Table 11 Logit Results for Participation in Monitoring

The logistic regression of income on participation in state and JFM forest harvesting revealed a positive effect of income (model 8 see table 12). For every one unit increase in the log of income the odds a household had greater than average participation in forest harvesting increased by 44.4% (odds ratio 1.44) which was significant at the p<.01 level. Female headed households had significantly lower odds of participation in forest harvesting relative to other households with a decrease of 87.9% (odds ratio 0.12). There was no significant effect of CBFM on the likelihood of participating in forest harvesting in JFM or state forests.

Logit Model *Harvest*	m8 b/se	Odds Ratio
loginc	0.368**	1.444**
	(0.139)	(0.201)
anyCBFM	-0.629	0.533
	(0.579)	(0.309)
Female headed	-2.113*	0.121*
	(0.997)	(0.12)
age	-0.008	0.992
	(0.009)	(0.009)
education	-0.05	0.951
	(0.049)	(0.046)
constant	-5.341**	0.005**
	(1.896)	(0.009)
+ p<0.10, * p<0.05, **p<.01		

Table 12 Logit Results Participation in Harvesting

The models of participation in rule creation revealed no statistically significant relationships with income or presence of CBFM (model 9 see table 13). The only significant predictor was household age. In agreement with the previous models of participation age slightly increased the odds of participation in rule creation by 4.7% (odds ratio of 1.047) for every additional year in age of the household head.

Logit Model *Create Rules*	m9 b/se	Odds ratio
loginc	0.171	1.186
	(0.148)	(0.175)
anyCBFM	0.063	1.065
	(0.636)	(0.678)
Female headed	-0.015	0.985
	(0.575)	(0.566)
age	0.046*	1.047*
	(0.018)	(0.019)
education	0.1	1.105
	(0.115)	(0.127)
constant	-8.085**	0.000**
	(2.747)	(0.001)
+ p<0.10, * p<0.05, **p<.01		

Table 13 Logit Model of Participation in Rule Creation

The outcome of the logistic regression models of household participation indicate that wealth status increases the likelihood a household participates in monitoring or harvesting of their JFMN or state forests. Presence of CBFM has no apparent effect on the likelihood a household participates in these institutions of forest management and use in reserve forests. The relationship between wealth status and predicted participation is potential indication that monitoring and forest harvesting are dominated by wealthy elites and may not be equally accessible to poorer households. Wealthy elites may be benefitting from the knowledge and influence gained by participating in forest monitoring activities which may feed into their greater participation in forest harvesting. Conversely wealthier households may harvest more forest resources and therefor have a higher stake in forest monitoring to help ensure rule compliance and enforcement. There does not appear to be any positive spillover effects introduced by the presence of more democratic forms of forest management through CBFM on participation or access to institutions of JFM and state forest governance and use.

Section 6.4

Forest Governance Outcomes; Perceptions of Management Functioning and Benefits

Following on the descriptive and quantitative analysis of factors related to households' engagement in various aspects of forest livelihoods and governance qualitative data on households' perceptions of forest benefits and governance functioning are explored. Household's responses to categorical and open-ended questions describe household perceptions of how forest management functions and who benefits. These responses are compared across different management types to further explore whether the additional presence of CBFM processes are potentially related to any marked improvements in outcomes. This exploration aims to further reveal whether the presence of democratic CBFM processes creates better access to forest benefits and local level engagement in forest management.

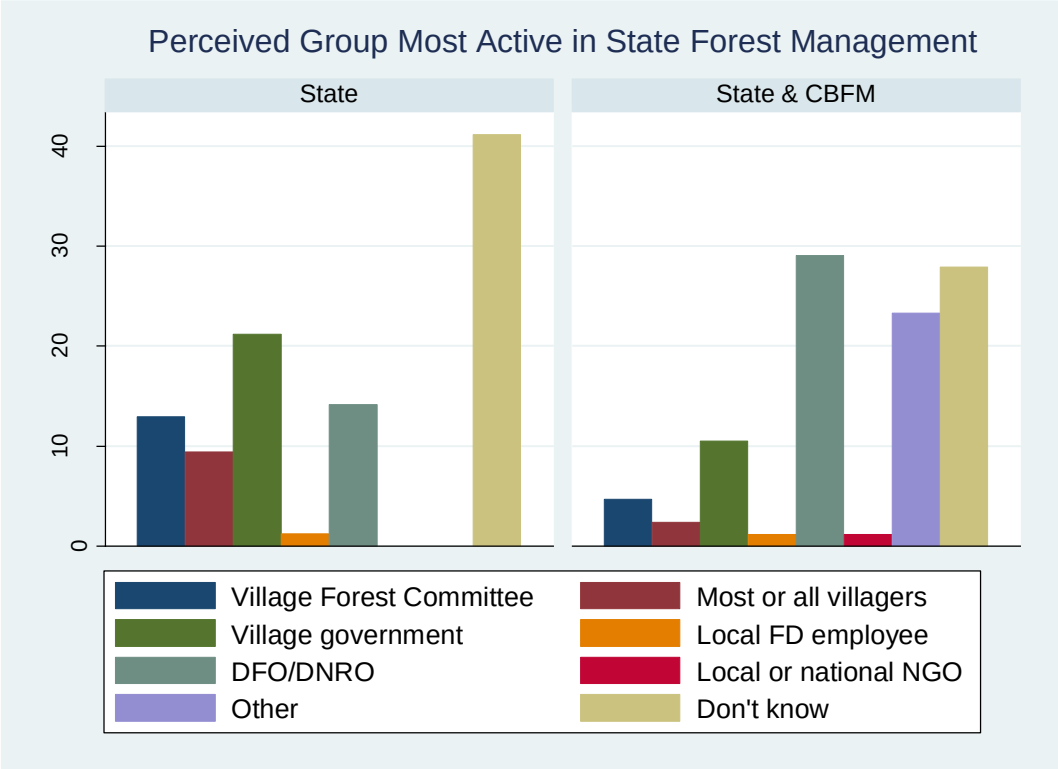
To do so households' perceptions of which group 1). Is most active and 2). Benefitting from forest management. Households answered these questions in regards to their state, JFM or CBFM forest management regimes separately. Further, household responses pertaining to JFM and state management are compared where they are the sole forest management type and where CBFM co-occurs. Additionally the outcomes for the same questions in regards to CBFM processes are also provided for comparison.

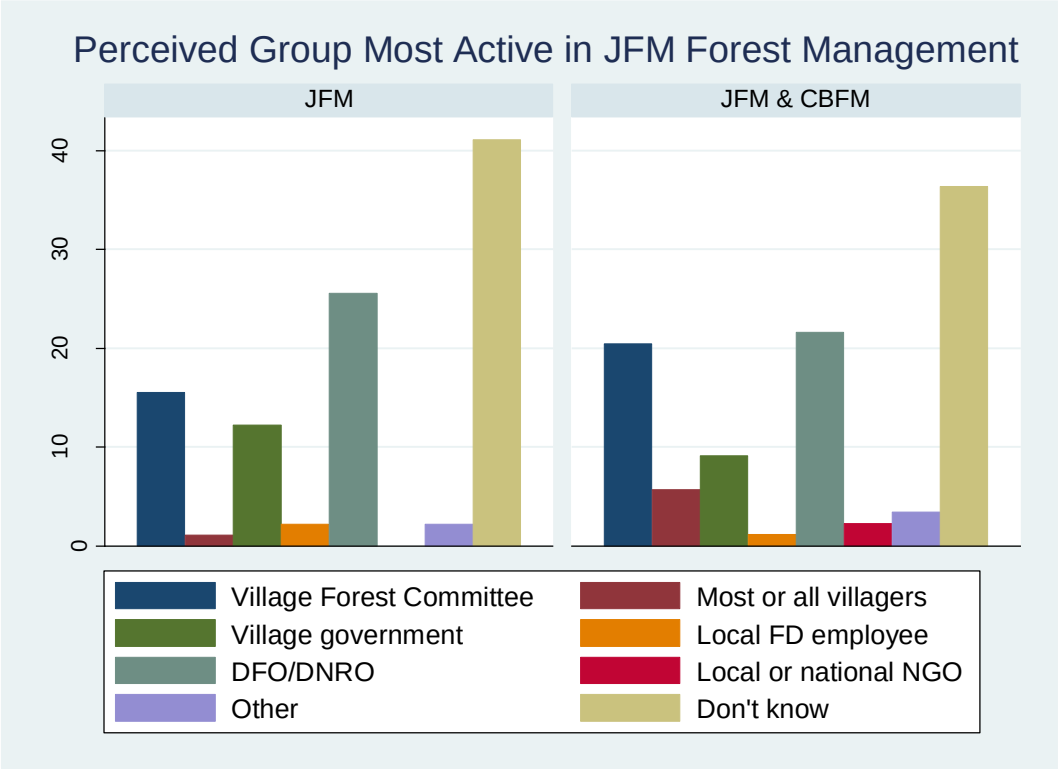
Households responses to which group is most active in forest management are indicative of potential differences in how forest governance operates and whom it engages. In state forest management a greater proportion of households' perceive that the district forest officer or "other" are most active in management when CBFM is additionally present (see fig.10). The presence of CBFM processes in villages with state forest management would likely involve new outside actors including the DFO, whereas in communities with only state forest management outside actors such as a DFO may be less involved. However there is no indication of greater community or local government activity in state forest management compared to sites that also have CBFM processes. However the additional presence of CBFM with state forest management is associated with a decrease in households responding, "don't know" to which group is most active in management. This could indicate increased awareness around forest management in general when CBFM is present. However there does not appear to be any clear improvements, such as greater perceived involvement of community level institutions or the community at large in management, when CBFM processes occur alongside of state forest management.

Households' perceptions of the most active group in management of JFM forests show little variation when CBFM is additionally present. Given that both JFM and CBFM operate through the same existing local government institutions this result is not unsurprising. Again uncertainty about who is most active is slightly less common among households in JFM sites that also have CBFM underway. The DFO/DNRO was the second most common response for all JFM respondents followed by members of

the village forest committee and village government. Slightly more households responded that most or all villagers were the most active group when CBFM processes were present. This is a potentially positive indication, however the difference is not drastic. Overall, perceptions of which group is most active in forest management were similar in regards to JFM forest management regardless of whether CBFM was also present in a village.

Households' perceptions of who was most active in CBFM forest management revealed similar patterns to perceptions of JFM and state forest management. The only notable difference was that the majority of households responded that their village government was the most active group. Whereas for JFM and state management the most common response was, "don't know" followed by the DFO in regards to CBFM processes there appears to be greater clarity and engagement of a local government body in forest management. As the most decentralized form of management this is a positive, although not entirely surprising result as this is how CBFM is designed to function. There is only a very small percentage of households that believe most or all villagers are the most active in forest management, which is proportionally less than this group received in regards to JFM or state forest management. As the most democratic form of forest management I anticipated CBFM to be associated with greater involvement of the community at large and community institutions. While local government is perceived to be more active under CBFM, most or all villagers were not commonly perceived as the most active group. Overall the results showed no strong differences in perceptions of which group are most active in forest management for CBFM. Further, there is no indication of positive spillover effects from CBFM on the impressions of community involvement in JFM or state forest management.


Perceived Group Most Active in State Forest Management
State
State & CBFM
0
10
20
30
40
Village Forest Committee
Most or all villagers
Village government
Local FD employee
DFO/DNRO
Local or national NGO
Other
Don't know



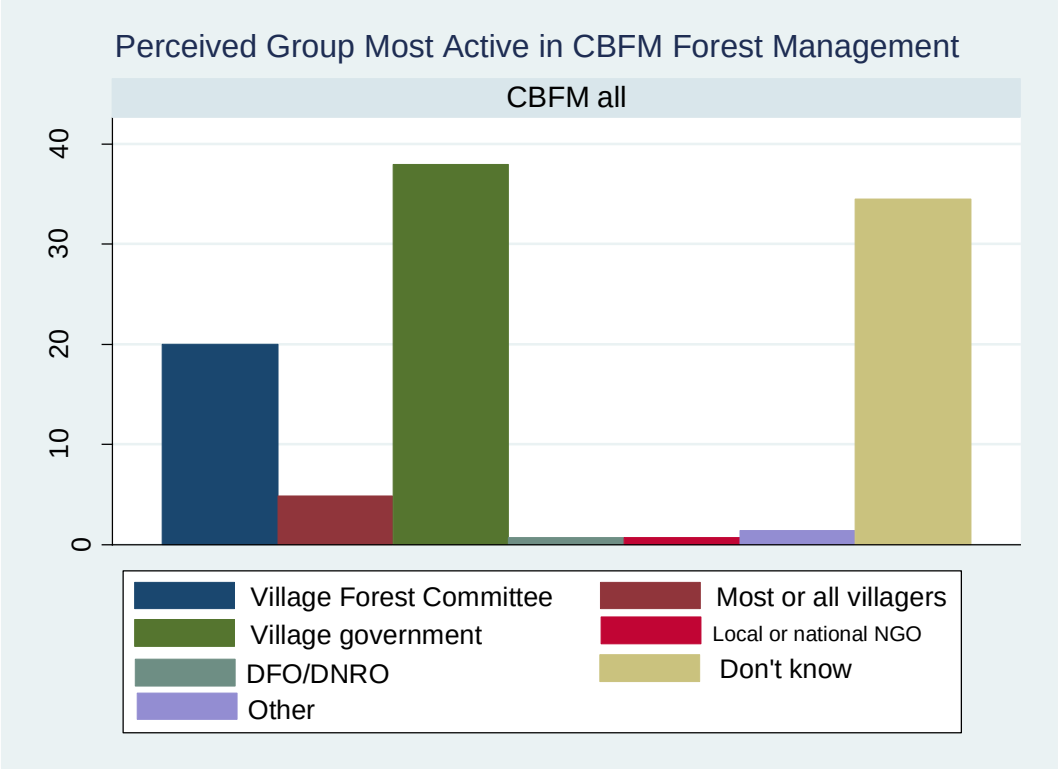


Figure 8 Forest Management Outcomes by Regime

Perceptions of who benefits the most from forest management were also compared for any spillover effects or differences in outcomes by regime type (see fig. 9-11). Uncertainty about the distribution of management benefits was the most common response regardless of forest management type. In state forest management uncertainty about who benefits was less frequent when CBFM was also present. However more households responding their DFO or "other" benefit the most account for this trade off in uncertainty. Fewer households responded that the majority of villagers benefited the most from management when CBFM was present alongside state management. In regards to JFM forest management there is very little variation in the perceptions of who benefits from management when CBFM is present. These results do not lend any support to the notion that CBFM is having any positive spillover effects on forest management outcomes in state or JFM forest governance. However, responses to CBFM management processes show some potentially positive shifts in who directly benefits the most from CBFM management. Although don't know is still the most common response, there is a greater number of households responding that local institutions of governance or most villagers are benefitting from forest management.

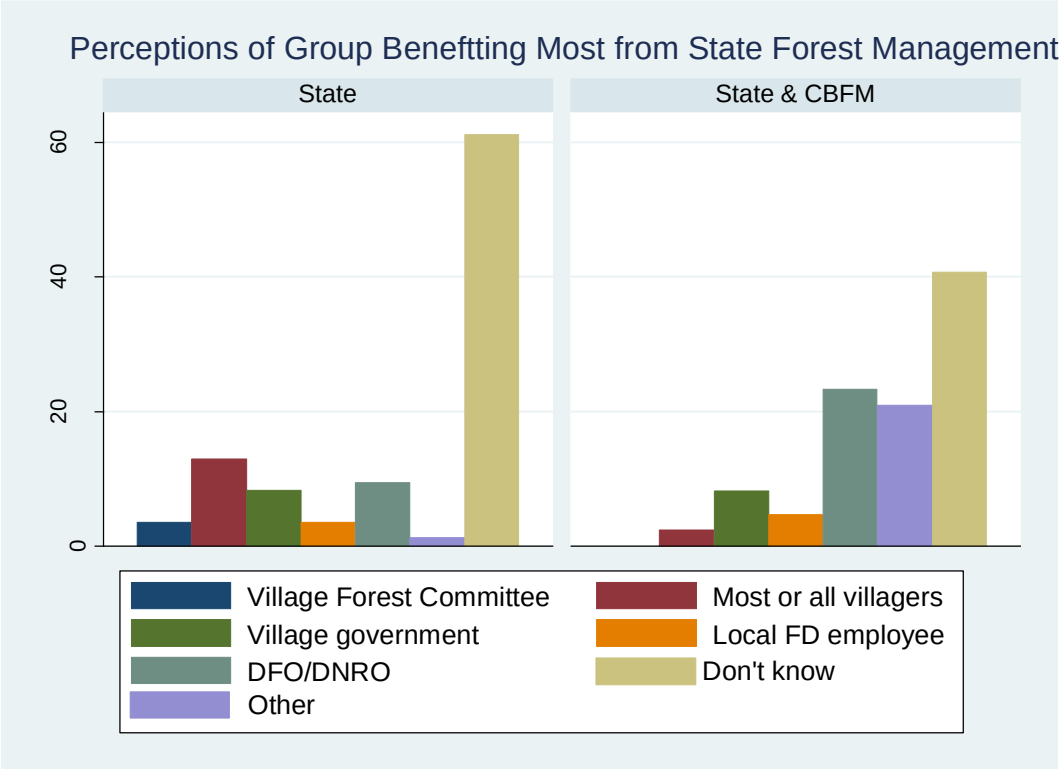


Figure 9 Perceptions of State Forest Management Benefits

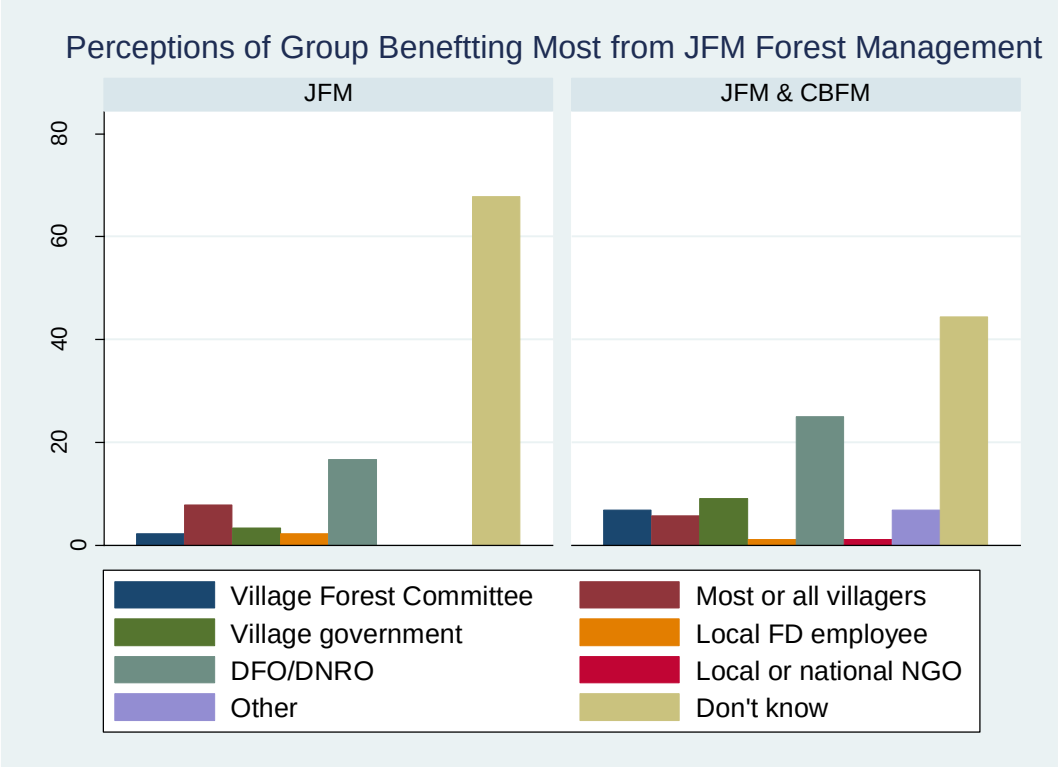


Figure 10 Perceptions of Forest Management Benefits JFM

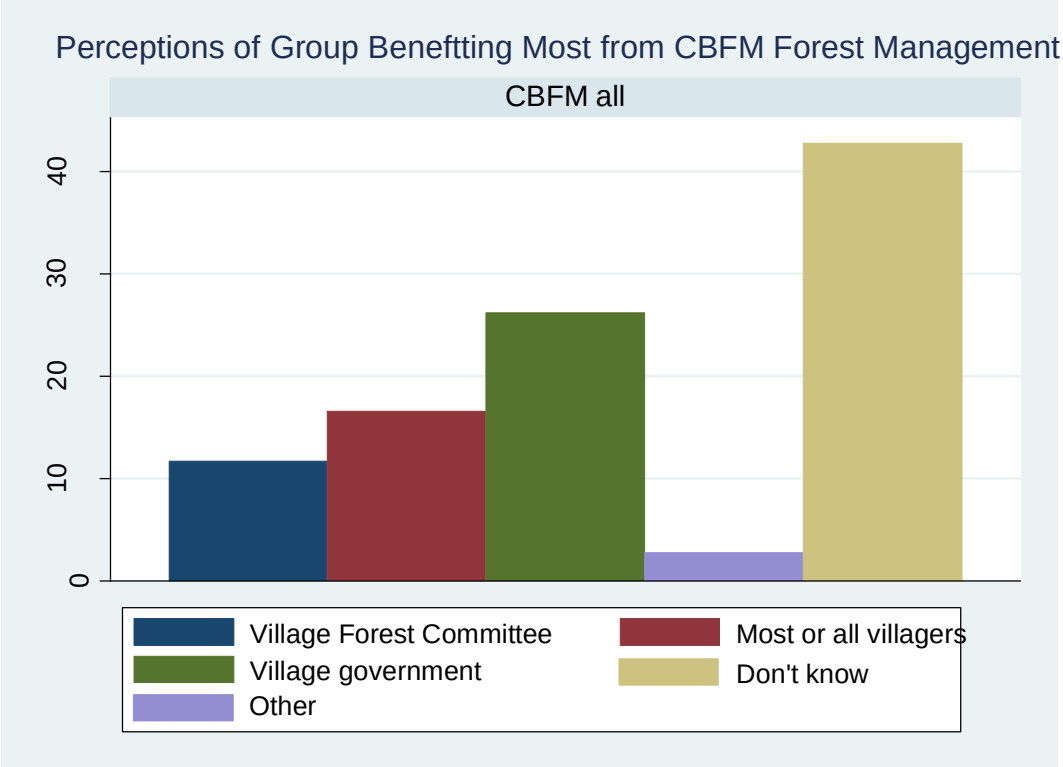


Figure 11 Perceptions of Forest Management Benefits CBFM

To better understand what types of benefits households receive from forests open-ended questions were grouped by common themes to compare the frequency of different kinds of responses by management type. While the previous quantitative analysis focused on relationships between wealth and management on different measures of direct forest use there are a range of other possible benefits forests might provide households. Therefor households own explanations and examples of forest benefits are compared to capture the range of potential direct and indirect benefits households acknowledge and receive from forests and whether these differ by forest management.

The range and frequency of forest benefits households derived from state forests are shown in fig. 12. Environmental services were the most frequently cited type of forest benefit (43%) obtained from state forests. Examples of services included rainfall, water catchment, clean air and water, shade, and biodiversity of plants and wildlife. Direct forest benefits were less frequently reported but included

non-timber forest products (16%), timber (6%) and direct forest income from the sale of products (1.5%). Forest products included firewood, poles, medicinal plants, grass, and timber. Over a third of respondents in state forests could not cite any forest benefits (39%). Of the third that did not report benefits most responded that there simply are none at present (16%) while others offered a variety of critical factors constraining forest benefits. The most frequent reason cited was strict protection preventing entry to the forest (13%). Respondents described that Tanzania National Parks (TANAPA) owns the forests and "will chase anyone off trespassing" (Respondent in state forest). A handful of households reported issues such as corruption, lack of community participation or lack of knowledge as reasons preventing households from obtaining forest benefits. Therefor overall in state forests households seems to acknowledge environmental services as an indirect benefit and less commonly describe any direct forest benefits. Many households report no forest benefits and acknowledge the forest reserve status as a limiting factor.

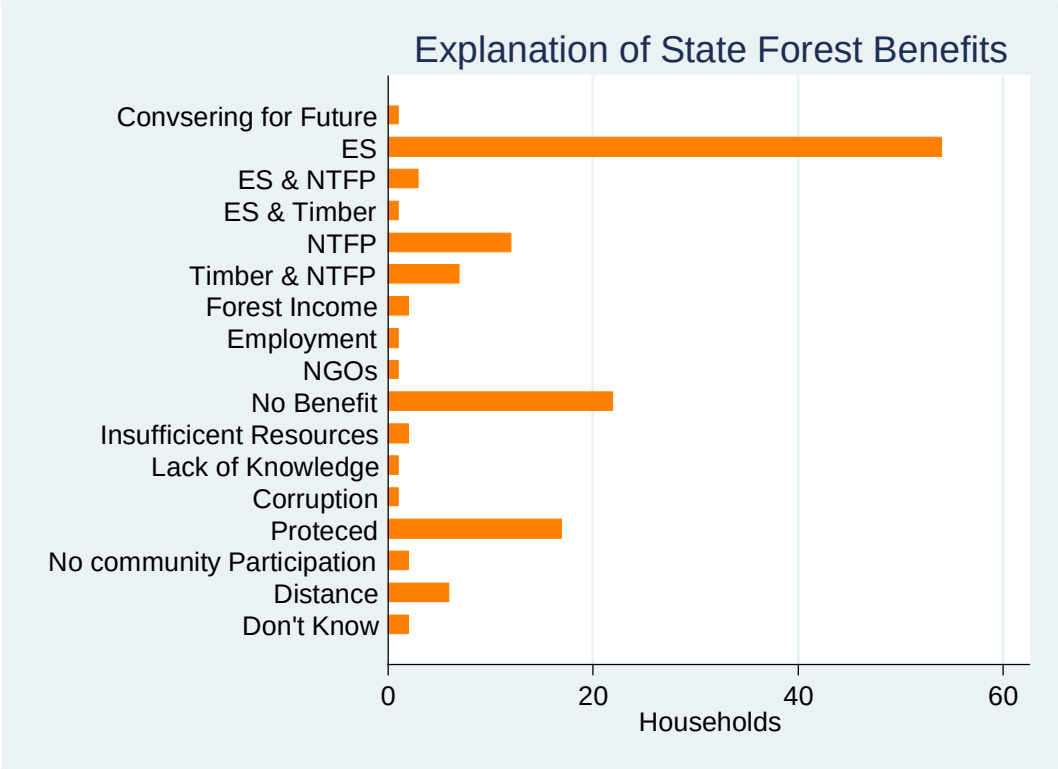


Figure 12 State Forest Benefits

In regards to JFM environmental services were also the most common forest benefit described (57.64%). Households described a similar range of environmental services again mostly pertaining to preservation of clean water, air and biodiversity (see fig. 13). Less households reported directly harvesting forest products compared to state forests, only 9% reported harvesting non-timber forest products and less than 1% reported timber as a forest benefit. Overall though less households in JFM reported no benefits or any mitigating reasons preventing benefits (23% in JFM compared to 39% in state forests). The most common factors described as preventing forest benefits in JFM included protection status (8%), distance to forest (7.5%), lack of knowledge (3%), and corruption (2%). It appears in JFM households are less likely to describe that they receive no benefits at all from forests and more likely to acknowledge environmental services as a direct benefit despite citing less direct forest use. Households are less likely to report specific forest products as a benefit from JFM indicating households

may not be obtaining sufficient resources to perceive NTFP or timber as direct household benefits under JFM.

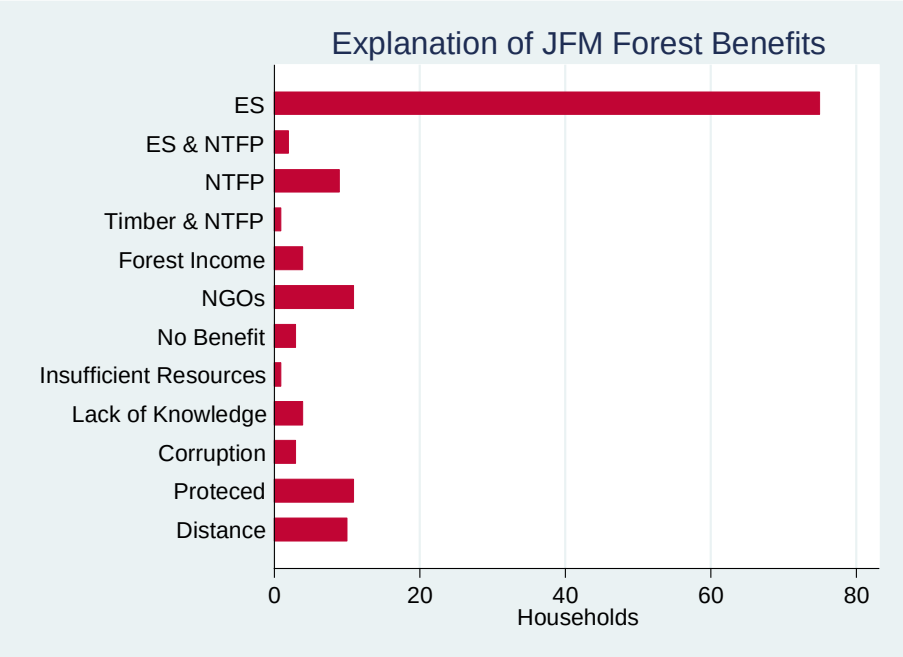


Figure 13 JFM Forest Benefits

Perceptions of forest benefits in CBFM sites show a greater diversity of responses (see fig. 14). The most common benefit reported was NTFP (33%) followed by environmental services (28%), timber (5%), tourism (5%) and conserving forests for the future (4%). Still 38% of households reported no benefit and or described an issue preventing forest benefits. Common reasons preventing households from obtaining benefits included distance to forest (6%) lack of knowledge (4.5%), insufficient forest resources (3.5%), they don't know (3.5%) and protection status (2.5%).

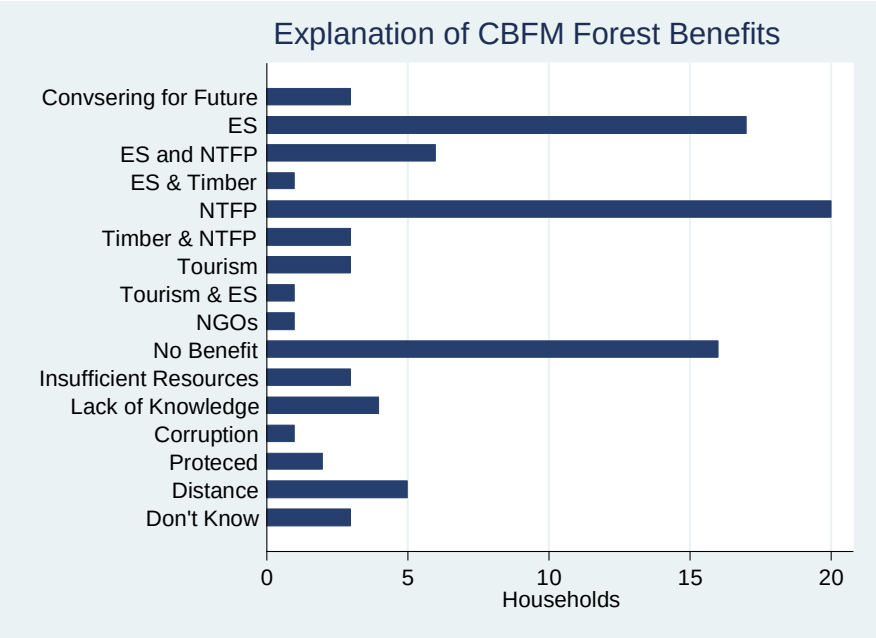


Figure 14 CBFM Forest Benefits

Overall households describe a greater variety of forest benefits in CBFM including greater direct forest use and income generating activities such as tourism. While households in CBFM still describe environmental services as a forest benefit, they are also able describe different means of direct forest use or income generating activities as tangible benefits. Households under JFM are the least likely to describe direct forest use (such as NTFP and timber) as a household benefit but do recognize environmental services provided by forests. Issues around mismanagement, corruption and elite capture are not frequently cited as preventing access to forest benefits across any management types.

CHAPTER. 7 DISCUSSION

Overall, the results of both the quantitative and qualitative analysis indicate that CBFM is not producing markedly different outcomes around forest governance or livelihoods outcomes at present for households within this study. While it was hypothesized that a more decentralized and democratic forest regime would increase equitable access to forest benefits and participation in forest governance institutions, the results from this study largely do not support these predictions. Specifically the hypothesis that CBFM would create more equitable results, where access to participation in forest activities would be less dependent on household wealth status did not find substantial support through analysis. The greatest determinant of participation and access to institutions of forest governance and forest livelihoods was household wealth status, which revealed significant results across nearly all measures in this study. Despite failing to confirm my hypothesis, these results fit with other existing work supporting a picture of insufficient and inequitable livelihood outcomes from decentralized forest management in practice in Tanzania (Rantala et al. 2012, Rantala and German 2013, Persha and Blomley 2009, Lund and Treue 2008).

In this study household participation in forest monitoring, frequency of forest harvesting, the value of charcoal and the variety of forest products a household harvested were all positively related to wealth status and not substantially affected by the presence of CBFM processes. The relative capital advantages a wealthier household has at its disposal seem to enable greater access to participation in both forest governance and harvesting activities regardless of forest management context. Despite policy hopes that CBFM will be more equitable and “pro-poor” it appears that there may not be a substantial shift in local power dynamics impacting the advantage that comes with greater wealth

status; despite the same *de jure* rights and promise of democratic redistribution resulting access (as defined by Ribot and Peluso) is still inequitable.

The presence of CBFM forest management processes did have a significant moderating effect on the likelihood of harvesting a greater variety of products for the wealthiest households. If this effect held with larger sample sizes or under multilevel modeling approaches in future studies this could indicate that the presence of democratic CBFM processes might be curtailing elite capture of certain forest resources for the wealthiest households. However, this moderating effect was not related to significantly different outcomes at most levels of income and had no positive affect on the poorest households as CBFM policy is intended to. While the quantitative analysis did not reveal substantial, positive outcomes attributed to CBFM on most forest use indicators the descriptive analysis provides some reasons for cautious optimism. Households recognized a greater variety of forest benefits from CBFM in comparison to centralized or co-managed regimes. Greater frequency and variety of direct forest use and income generating activities were reported as benefits of CBFM as opposed to predominantly indirect benefits (mainly ecosystem services) attributed to both JFM and state-managed forests. Better access to a greater variety of forest resources can support forest livelihood activities and household wellbeing. However any livelihood impacts from forest benefits were not captured by the quantitative analysis in this study and may not be substantial or consistent at present. Therefore despite some indication that decentralized forest management was related to improved access to direct forest use these benefits were not detected through the quantitative analysis to support a picture of significant livelihood improvements related to CBFM. Further there is no evidence in this study that the presence of CBFM is associated with improved access to any forest benefits for the poorest households as decentralized policy is intended.

Further, CBFM forest governance does not appear to be functioning any differently than JFM or state forest governance across the chosen indicators nor have any substantial spillover effects. It was hypothesized that CBFM would both improve outcomes within its own institutions of governance and positively affect state and JFM processes and outcomes. As CBFM is designed to increase community participation in forest governance and actively engage local institutions it was predicted that CBFM would have greater and more equitable participation and additionally increase participation across JFM and state management processes. Participation in forest monitoring and rule formation can serve as an opportunity for individuals to gain knowledge about other users' behavior, the state of the resource system and shape the rules that govern them (Ostrom 1990). It was predicted that CBFM would create greater access to participation in these institutions, an indicator of "good governance". However, this was not supported through the analysis of household participation. Therefore despite granting greater and more autonomous rights over forest management CBFM may not be increasing local participation in these institutions at present.

The analysis revealed that perceptions of forest management functioning and benefit allocation do not substantially improve in response to state/JFM processes when CBFM was additionally present. Responses are still dominated by a lack of knowledge of who is in charge of and benefitting from forest management. Following "don't know" the most common perception was that centralized and external actors dominate management as opposed to any community level groups or the community at large. The logistic regression analysis of JFM and state participation scores indicated no statistically significant variation with presence of CBFM. The mere presence of democratic forest management processes in a village were not associated with increased household participation in institutions of forest governance in this study further providing no support for the positive spillover effects hypothesis proposed by Vyamana (2009). There is some positive indication that households perceive that village institutions are more active in CBFM forest management and that the community and community institutions receive a

greater proportion of management benefits compared to JFM or state-management processes. Despite these subtle differences, the overall picture is that forest governance processes are not substantively different within CBFM management and therefor are also not providing any positive impacts on JFM and state-managed institutions of forest governance as detected in this study.

Despite finding little support for the stated hypothesis these results are important in what they indicate CBFM is *not* currently doing; despite greater rights and autonomy granted to communities under CBFM the potential benefits of the democratic dividend are not substantial at present. However, most CBFM processes are young (less than 10 years old) and benefits may take time to accrue particularly if communities are foregoing harvest for the future. Caution has been raised that democratic decentralization is a process not an end point and takes time to transition and accrue benefits (Ribot et al. 2010).

Finally, this study and its results are limited by several factors. First despite being a large study of forest decentralization outcomes compared to existing work in Tanzania, the sample size was still small and potentially insufficient to detect outcomes and underlying processes. Specifically the instability of the estimates chosen in this study created wide confidence intervals around the estimated effects increasing the possibility of false negatives in hypothesis testing. Underlying relationships between wealth and regime status on forest governance and livelihood outcomes may well not have been captured. Further the methods chosen for this study have several limiting factors. While clustering the standard errors for the estimates of all variables at the village level accounts for heteroskedasticity introduced by autocorrelation it does not decompose the village level and universal effects within each model. In future analysis, the nested structure of the data could be accounted for using hierarchal linear modeling as a preferred tactic to address the nested structure of the data and better account for multi-level effects.

CHAPTER 8. CONCLUSION

Decentralized forest management continues to expand encompassing both a greater total area of remaining tropical forests and numbers of impoverished rural people it engages (Sunderlin et al. 2008, Jagger et al. 2014). Despite optimism that decentralized management will improve forest conservation, governance and livelihood outcomes existing empirical evaluations of these claims do not present any cohesive or clear picture. Mixed findings and uncertainty are particularly common across governance and livelihood outcomes (Jagger et al. 2014). Existing work highlights the apparent disconnect between the theoretical benefits of decentralization and it's less than stellar empirical record and tries to link causal processes and mechanisms related to failed or successful outcomes.

As a "pro poor" policy decentralized management such as CBFM is designed to increase equitable access to forest resources and engage democratic participation in local institutions of forest governance. Recent work has highlighted the importance of forest governance as a mediator for forest conservation and livelihood outcomes as well as the importance of substantial livelihood improvements as a slow feedback into the social ecological system (Persha et al. 2011, Dietz, Ostrom and Stern 2003). It's been demonstrated that tangible livelihood benefits may be necessary to ensure the sustainability of CPR management systems and can improve forest conservation outcomes (Pagdee et al. 2006). Therefore a better understanding of how decentralization is affecting interrelated governance and livelihood outcomes is important for the durability of these management systems as well as increasing the potential for forests to contribute to rural poverty alleviation (Sunderlin et al. 2005). This study aimed to address the dearth of understanding on household level livelihood and governance outcomes

under decentralized management in Tanzania. Among the existing evaluations of governance and livelihood outcomes the majority explore only qualitative data or limited statistical analysis that restrict the generalizability of their results. This study aimed to extend existing work on decentralized outcomes in Tanzania to better understand whether CBFM is creating more equitable access to participation in aspects of forest governance and livelihoods through a study design more robust to case based specific variation in local context. Overall, the findings from this study do not support that CBFM is likely creating more equitable access to forest resources or participation in forest governance institutions for the poorest households at present. CBFM was not associated with any substantial differences in the functioning and governance of forest management institutions. There was also no clear support for CBFM either creating more equitable access to forest resources or improving overall livelihood outcomes. While this study did not directly test for mediating pathways between forest governance and livelihood outcomes, the murky findings on governance outcomes may be related to lack luster livelihood benefits as both seem relatively inaccessible and unaffected by the presence of more "democratic" processes aa present. Often decentralization lacks sufficient transfer of power, autonomy or accountability to deliver the benefits of the democratic dividend (Ribot 2002). Further exploring the links between these outcomes is a direction for future research to better understand the links between the functioning of local governance institutions and access to forest livelihoods.

A final unique contribution of this study was further exploration of possible spillover effects related to the presence of CBFM processes in a village. While a recent study in Tanzania observed that the presence of CBFM created positive spillover effects, i.e. effects that transcended the boundaries of the specific CBFM reserve and influenced the management of surrounding JFM and state forests (Vyamana 2009), these findings have not been corroborated or investigated further to the knowledge of the author. However, these findings were based on small samples and descriptive comparisons alone. The potential for institutional spillover effects is currently not well understood, particularly in regards to

decentralized forest management outcomes despite the rapid expansion of CBFM alongside of existing, more centralized forest regimes (Jagger et al. 2014). This study provides a robust counter point to Vyamana's findings and revealed no statistically significant outcomes nor substantial qualitative support for positive spillover effects from CBFM. The presence of CBFM in a village did not appear to improve perceptions of how JFM or state forest management functioned, who benefitted and was not associated with statistically different outcomes for household participation in monitoring, rulemaking or forest harvesting. Future work would benefit from combining both multi-level, robust quantitative approaches and richer observational and qualitative data to better understand the effects CBFM is having, or importantly *not* having, on households' access to participation and resulting benefits from forest governance and resources within and beyond its own borders and institutions.

APPENDIX

Variable Name	***Description***
loginc	Natural log of per capita income
lowestquintiles	Dummy variable measuring household asset based wealth status using the lowest 2 quintiles derived from the PCA 0= not member of the poorest two quantiles 1= member of the poorest two quantiles
anyCBFM	Dummy variable for presence of CBFM 0= JFM or state without CBFM 1= JFM or state with CBFM
prod2cats	Binary measure of the variety of forest products harvested 0= none or 1 type of forest product 1= greater than one forest products
fuelwoodvalue	Natural log of the estimated value of fuel wood harvested in the past month
charcoalvalue	Natural log of the estimated value of charcoal harvested in the past month
subsistencefuel	Dummy variable for subsistence use for fuelwood harvested 0= not subsistence use 1= subsistence use
subsistencecharc	Dummy variable for subsistence use for charcoal harvested 0= not subsistence use 1= subsistence use
monitoringOther	Binary measure of households' participation in monitoring activities in state or JFM forests 0= never/rarely monitor 1= sometimes/often monitor
harvestOther	Binary measure of households' participation in forest harvesting in state or JFM forests 0= never/rarely harvest 1= sometimes/often harvest
createOther	Binary measure of households' participation in rule creation in state or JFM forests 0= never/rarely create 1= sometimes/often create
monitoringCBFM	Binary measure of households' participation in monitoring activities in CBFM 0= never/rarely monitor 1= sometimes/often monitor
harvestCBFM	Binary measure of households' participation in forest harvesting in CBFM 0= never/rarely harvest 1= sometimes/often harvest
createCBFM	Binary measure of households' participation in rule creation in CBFM 0= never/rarely create 1= sometimes/often create
age	Age of household head
education	Years of education household head
femaleheaded	Dummy variable 0= not female headed 1= female headed

REFERENCES

Agrawal, A. (2001) Common Property Institutions and Sustainable Governance of Resources. *World Development,* 29**,** 1649-1672.

Agrawal, A. & A. Chhatre (2006) Explaining success on the commons: Community forest governance in the Indian Himalaya. *World Development,* 34**,** 149-166.

Agrawal, A. & C. C. Gibson (1999) Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation. *World Development,* 27**,** 629-649.

Agrawal, A. & J. Ribot (1999) Accountability in decentralization: A framework with South Asian and West African cases. *Journal of Developing Areas,* 33**,** 473-502.

Alden Wily, L. & P. A. Dewees (2001) From users to custodians: changing relations between people and the state in forest management in Tanzania. *World Bank Policy Research Working Paper*.

Andersson, K. & F. van Laerhoven (2007) From Local Strongman to Facilitator: Institutional Incentives for Participatory Municipal Governance in Latin America. *Comparative Political Studies,* 40**,** 1085-1111.

Angelsen, A., P. Jagger, R. Babigumira, B. Belcher, N. J. Hogarth, S. Bauch, J. Börner, C. Smith-Hall & S. Wunder (2014) Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development*.

Angelsen, A., Wunder, S. (2003) Exploring the forest-poverty link: Key concepts, issues and research implications. *CIFOR Occasional Paper No. 40. Bogor, Indonesia: Center for International Forestry Research*.

Baland, J.-M. & J.-P. Platteau. 1996. *Halting degradation of natural resources: is there a role for rural communities?* : Food & Agriculture Org.

Bartley, T., K. Andersson, P. Jagger & F. Van Laerhoven (2008) The contribution of institutional theories to explaining decentralization of natural resource governance. *Society & Natural Resources,* 21**,** 160-174.

Blomley, T., K. Pfliegner, J. Isango, E. Zahabu, A. Ahrends & N. Burgess (2008) Seeing the wood for the trees: an assessment of the impact of participatory forest management on forest condition in Tanzania. *Oryx,* 42**,** 380-391.

Blomley, T. & H. Ramadhani (2006) Going to Scale with Participatory Forest Management: Early Lessons from Tanzania 1. *International Forestry Review,* 8**,** 93-100.

Brandon, K., K. H. Redford & S. Sanderson. 1998. *Parks in peril: people, politics, and protected areas*. Island Press.

Campbell, B. & M. Luckert (2002) Towards understanding the role of forests in rural livelihoods.

Campbell, B. M. 2002. *Household livelihoods in semi-arid regions: options and constraints*. CIFOR.

Cavendish, W. (2000) Empirical Regularities in the Poverty-Environment Relationship of Rural Households: Evidence from Zimbabwe. *World Development,* 28**,** 1979-2003.

Cavendish, W. (2003) How do forests support, insure and improve the livelihoods of the rural poor: a research note. *Center for International Forestry Research, Bogor, Indonesia*.

Dietz, T., E. Ostrom & P. C. Stern (2003) The Struggle to Govern the Commons. *Science,* 302**,** 1907-1912.

Gibson, C. C., J. T. Williams & E. Ostrom (2005) Local Enforcement and Better Forests. *World Development,* 33**,** 273-284.

Grindle, M. S. (2004) Good Enough Governance: Poverty Reduction and Reform in Developing Countries. *Governance (Oxford),* 17**,** 525-548.

Hardin, G. (1968) The tragedy of the commons. *science,* 162**,** 1243-1248.

Hayes, T. M. (2006) Parks, people, and forest protection: an institutional assessment of the effectiveness of protected areas. *World Development,* 34**,** 2064-2075.

Hurst, A. (2003) State Forestry and Spatial Scale in the Development Discourses of Post-Colonial Tanzania: 1961-1971. *The Geographical Journal,* 169**,** 358-369.

Jagger, P. (2012) Environmental income, rural livelihoods, and income inequality in western Uganda. *Forests, Trees and Livelihoods,* 21**,** 70-84.

Jagger, P., M. K. Luckert, A. E. Duchelle, J. F. Lund & W. D. Sunderlin (2014) Tenure and Forest Income: Observations from a Global Study on Forests and Poverty. *World Development*.

Kalamandeen, M. & L. Gillson (2007) Demything "wilderness": implications for protected area designation and management. *Biodiversity & Conservation,* 16**,** 165-182.

Larson, A. M., D. Barry & G. Ram Dahal (2010) New rights for forest-based communities? Understanding processes of forest tenure reform. *International Forestry Review,* 12**,** 78-96.

Leach, M., R. Mearns & I. Scoones (1999) Environmental Entitlements: Dynamics and Institutions in Community-Based Natural Resource Management. *World Development,* 27**,** 225-247.

Lund, J. F. & M. Saito-Jensen (2013) Revisiting the Issue of Elite Capture of Participatory Initiatives. *World Development,* 46**,** 104-112.

Lund, J. F. & T. Treue (2008) Are we getting there? Evidence of decentralized forest management from the Tanzanian Miombo woodlands. *World Development,* 36**,** 2780-2800.

Neumann, R. P. (1997) Forest rights, privileges and prohibitions: contextualising state forestry policy in colonial Tanganyika. *Environment and History***,** 45-68.

Ostrom, E. 1990. *Governing the commons: The evolution of institutions for collective action*. Cambridge university press.

--- (2007) A diagnostic approach for going beyond panaceas. *Proceedings of the national Academy of sciences,* 104**,** 15181-15187.

Pagdee, A., A. Pagdee, Y. S. Kim & P. J. Daugherty (2006) What makes community forest management successful: A meta-study from community forests throughout the world. *Society & natural resources,* 19**,** 33-52.

Pepper, J. V. (2002) Robust inferences from random clustered samples: an application using data from the panel study of income dynamics. *Economics Letters,* 75**,** 341-345.

Persha, L., A. Agrawal & A. Chhatre (2011) Social and Ecological Synergy: Local Rulemaking, Forest Livelihoods, and Biodiversity Conservation. *Science,* 331**,** 1606-1608.

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

Persha, L. & T. Blomley (2009) Management decentralization and montane forest conditions in Tanzania. *Conservation Biology,* 23**,** 1485-1496.

Persha, L. & C. Meshack (2015) Is Tanzania's Joint Forest Management Program a Triple Win? Understanding Causal Pathways for Livelihoods, Governance and Forest Condition Impacts.

Porter-Bolland, L., E. A. Ellis, M. R. Guariguata, I. Ruiz-Mallén, S. Negrete-Yankelevich & V. Reyes-García (2012) Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics. *Forest Ecology and Management,* 268**,** 6-17.

Rantala, S., R. Bullock, M. A. Mbegu & L. A. German (2012) Community-Based Forest Management: What Scope for Conservation and Livelihood Co-Benefits? Experience from the East Usambara Mountains, Tanzania. *Journal of Sustainable Forestry,* 31**,** 777-797.

Rantala, S. & L. German (2013) Exploring village governance processes behind community-based forest management: legitimacy and coercion in the Usambara Mountains of Tanzania. *International Forestry Review,* 15**,** 355-367.

Reardon, T. & S. A. Vosti (1995) Links between rural poverty and the environment in developing countries: asset categories and investment poverty. *World development,* 23**,** 1495-1506.

Redford, K. H. (1992) The Empty Forest. *BioScience,* 42**,** 412-422.

Redford, K. H. & A. M. Stearman (1993) Forest-Dwelling Native Amazonians and the Conservation of Biodiversity: Interests in Common or in Collision? *Conservation Biology,* 7**,** 248-255.

Ribot, J. C. (2002) African decentralization: local actors, powers and accountability. *United Nations Research Institute for Social Development, December 2002. ix 89 pp***,** ix 89-ix 89.

Ribot, J. C. (2004) Waiting for democracy: the politics of choice in natural resource decentralization.

Ribot, J. C., J. F. Lund & T. Treue (2010) Democratic decentralization in sub-Saharan Africa: its contribution to forest management, livelihoods, and enfranchisement. *Environmental Conservation,* 37**,** 35-44.

Ribot, J. C. & N. L. Peluso (2003) A Theory of Access*. *Rural sociology,* 68**,** 153-181.

Schlager, E. & E. Ostrom (1992) Property-Rights Regimes and Natural Resources: A Conceptual Analysis. *Land Economics,* 68**,** 249-262.

Schwartzman, S., A. Moreira & D. Nepstad (2000) Rethinking tropical forest conservation: perils in parks. *Conservation Biology,* 14**,** 1351-1357.

Smoke, P. (2003) Decentralisation in Africa: goals, dimensions, myths and challenges. *Public administration and development,* 23**,** 7-16.

Sunderlin, W. D., A. Angelsen, B. Belcher, P. Burgers, R. Nasi, L. Santoso & S. Wunder (2005) Livelihoods, forests, and conservation in developing countries: An Overview. *World Development,* 33**,** 1383-1402.

Sunderlin, W. D., S. Dewi, A. Puntodewo, D. Müller, A. Angelsen & M. Epprecht (2008) Why forests are important for global poverty alleviation: a spatial explanation. *Ecology and Society,* 13**,** 24.

Tacconi, L. (2007) Decentralization, forests and livelihoods: Theory and narrative. *Global Environmental Change,* 17**,** 338-348.

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

Treue, T., Y. M. Ngaga, H. Meilby, J. F. Lund, G. Kajembe, S. Iddi, T. Blomley, I. Theilade, S. A. O. Chamshama, K. Skeie, M. A. Njana, S. E. Ngowi, J. A. K. Isango & N. D. Burgess (2014) Does participatory forest management promote sustainable forest utilisation in Tanzania? *International Forestry Review,* 16**,** 23-38.

van Laerhoven, F. (2014) When is Participatory Local Environmental Governance Likely to Emerge? A study of collective action in participatory municipal environmental councils in Brazil. *Environmental Policy and Governance,* 24**,** 77-93.

Van Laerhoven, F. & K. P. Andersson (2013) The virtue of conflict: an institutional approach to the study of conflict in community forest governance. *International Forestry Review,* 15**,** 122-135.

Vedeld, P. 2004. *Counting on the environment: Forest incomes and the rural poor*. World Bank, Environment Dept.

Vedeld, P., A. Angelsen, J. Bojö, E. Sjaastad & G. Kobugabe Berg (2007) Forest environmental incomes and the rural poor. *Forest Policy and Economics,* 9**,** 869-879.

Vyamana, V. G. (2009) Participatory forest management in the Eastern Arc Mountains of Tanzania: who benefits? *International Forestry Review,* 11**,** 239-253.

Weddell, B. J. 2002. *Conserving living natural resources: in the context of a changing world*. Cambridge University Press.

Wily, L. A. 2000a. The evolution of community-based forest management in Tanzania. In *Proceedings of the international workshop on community forestry in Africa*.

---. 2000b. *Land tenure reform and the balance of power in Eastern and Southern Africa*. Overseas Development Institute.

--- (2001) Reconstructing the African commons. *Africa Today,* 48**,** 76-99.

---. 2002. Participatory forest management in Africa: an overview of progress and issues. In *Second international workshop on participatory forestry in Africa (ed) Defining the way forward: sustainable livelihoods and sustainable forest management through participatory forestry. Arusha, United Republic of Tanzania*, 18-22.

Wooldridge, J. 2012. *Introductory econometrics: A modern approach*. Cengage Learning.

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