Environment for Development

Discussion Paper Series

June 2012 ■ EfD DP 12-07

Insiders, Outsiders, and the Role of Local Enforcement in Forest Management

An Example from Tanzania

Elizabeth J.Z. Robinson, Heidi J. Albers, Razack Lokina, and Guyslain Ngeleza

RESOURCES FOR THE FUTURE

School of Business, Economics and Law
UNIVERSITY OF GOTHENBURG

Sida

Environment for Development

The **Environment for Development** (EfD) initiative is an environmental economics program focused on international research collaboration, policy advice, and academic training. It supports centers in Central America, China, Ethiopia, Kenya, South Africa, and Tanzania, in partnership with the Environmental Economics Unit at the University of Gothenburg in Sweden and Resources for the Future in Washington, DC. Financial support for the program is provided by the Swedish International Development Cooperation Agency (Sida). Read more about the program at www.efdinitiative.org or contact info@efdinitiative.org.

Central America
Environment for Development Program for Central America
Centro Agronómico Tropical de Investigacíon y Ensenanza (CATIE)
Email: centralamerica@efdinitiative.org

China
Environmental Economics Program in China (EEPC)
Peking University
Email: EEPC@pku.edu.cn

Ethiopia
Environmental Economics Policy Forum for Ethiopia (EEPFE)
Ethiopian Development Research Institute (EDRI/AAU)
Email: ethiopia@efdinitiative.org

Kenya
Environment for Development Kenya
Kenya Institute for Public Policy Research and Analysis (KIPPRA)
Nairobi University
Email: kenya@efdinitiative.org

South Africa
Environmental Policy Research Unit (EPRU)
University of Cape Town
Email: southafrica@efdinitiative.org

Tanzania
Environment for Development Tanzania
University of Dar es Salaam
Email: tanzania@efdinitiative.org

Insiders, Outsiders, and the Role of Local Enforcement in Forest Management: An Example from Tanzania

Elizabeth J.Z. Robinson, Heidi J. Albers, Razack Lokina, and Guyslain Ngeleza

Abstract

Typically both local villagers (“insiders”) and non-locals (“outsiders”) extract products from protected forests even though the activities are illegal. Our paper suggests that, depending on the relative ecological damage caused by each group, budget-constrained forest managers may be able to reduce total forest degradation by legalizing “insider” extraction in return for local villagers involvement in enforcement activities. We illustrate this through the development of a game-theoretic model that considers explicitly the interaction between the forest manager who can combine a limited enforcement budget with legalization of insider resource extraction and livelihood projects such as bee keeping, insider villagers, and outsider charcoal producers.

Key Words: participatory forest management, local enforcement, Tanzania, charcoal production, non-timber forest products, bee keeping

Contents

Insiders, Outsiders, and the Role of Local Enforcement in Forest Management: An Example from Tanzania

Elizabeth J.Z. Robinson, Heidi J. Albers, Razack Lokina, and Guyslain Ngeleza*

1. Introduction

During the last 30 years, the number of protected areas worldwide established to protect natural systems has grown dramatically. Coinciding with that expansion, many government agencies and conservation NGOs are advocating for combinations of development/livelihood policies and conservation policies that attempt to address rural poverty and welfare while conserving forests (Naughton-Treves, et al., 2005). For example, WWF's policy on forest and poverty states that "national and international forest policies and the conservation movement should address both the sustainable management of natural forests and rural poverty alleviation; one should never be addressed at the other's expense" (Gutman, 2001; p.9, para 1). The economics literature discussing policies aimed at conservation and poverty, such as Community-based Forest Management (CBFM), Joint Forest Management (JFM), and their predecessor Integrated Conservation-Development Projects (ICDPs), emphasizes their failure to create incentives for conservation by rural people (see Hughes and Flintan, 2001, for a literature review; Behera and Engel, 2006; Ghimire, 1994; Johannesen, and Skonhoft, 2005; Ligon and Narain, 1999; Muller and Albers, 2004; and Shyamsundar, 1996).

Yet a number of key positive lessons have been learned. Particularly pertinent to our paper, a relatively recent and expanding literature finds that the involvement of local communities in monitoring and enforcing access and extraction rules tends to result in more favorable outcomes in terms of forest quality and reduced conflict. Early contributions to this literature include Balland and Platteau (1996) and Gibson et al (2005). More recently Chhatre and Agrawal (2008) provide one of the first multi-country studies of the importance of local

* (Corresponding author) Elizabeth J Z Robinson, Reader in Environmental Economics, University of Reading, UK; non-resident Associate Professor, University of Gothenburg; Research Associate, Environment for Development Tanzania; e.j.robinson@reading.ac.uk. Heidi J. Albers, Professor, Applied Economics at Oregon State University, USA; Research Associate, Environment for Development Tanazania, jo.albers@oregonstate.edu. Guyslain Ngeleza, Agricultural Economist, Fintrac, USA, gngeleza@fintrac.com. Razack B. Lokina, Director, Environment for Development Tanzania, and Department of Economics, University of Dar es Salaam, Tanzania, rlokina@udsm.ac.tz.
The authors gratefully appreciate funding for the fieldwork provided by the Sida-funded Environment for Development initiative, and additional funding from Formas COMMONS.

enforcement. The authors explore the relationship between forest regeneration and the extent of local enforcement using data that spans nine countries and find that the relationship between local enforcement and forest regeneration is complex but positive. That complexity depends in part on the extraction pressures on the particular forest, including whether people collect primarily for subsistence or commercial motives. Porter-Bolland et al (2012) highlight the reality of many low-income countries: that most forests, even those under strict protection designations, are traditionally inhabited and managed by local people who extract various forest products; and in these situations forest cover is often better maintained than when there is solely a protection objective.

Our paper contributes to this expanding literature, whilst providing a new perspective on local level community enforcement. The paper is motivated by a situation that we find in Kibaha's forests in Tanzania, where forests are under pressure both from nearby villagers, "insiders", who rely on the forests for fuelwood and other non-timber forest products; and from "outsiders" who illegally extract timber and produce charcoal typically for sale in nearby Dar es Salaam; and where forest managers struggle with limited budgets to protect the forests. In the following Section 2 we set the scene, describing the particular situation in Kibaha district, Pwani Region. Following a series of interviews with forest managers and patrollers in Kibaha Forest Reserve, and interviews with rural villagers, in Section 3 we develop a modeling framework that incorporates the goals and tools of the forest reserve manager and the decisions of the two groups of resource extractors—insider village NTFP extractors and outsider charcoal producers—from those reserves. Although meant to inform Kibaha's management directly, the model is sufficiently general to address a wide range of forest reserve settings with goals of forest protection and rural poverty alleviation. Section 4 concludes the paper with a discussion of the implications of our findings for including local people in forest management.

2. An Example from Tanzania: Kibaha's forests

Despite the lack of well-established and documented mechanisms to induce conservation through poverty alleviation projects in and around parks, many parks still expect managers or NGOs to generate goodwill and achieve compliance with park regulations through a combination of enforcement activities and compensation for lost access to resources through poverty alleviation projects. Indeed, in Kibaha we have observed just such a combination of patrols and projects intended to provide the sticks and carrots needed to protect the nearby forests. Nearby villagers were pleased with the reserve management's tree planting, efficient stoves, and beekeeping projects, but frustrated particularly with charcoal producers who often do not belong to their communities. But they also reported that they themselves did not try to prevent outsider charcoal production nor contact forest guards about that production. After many discussions to understand why villagers do not report charcoal production, a group of women villagers described candidly their own extraction behavior as it relates to the beekeeping projects. They told us that when they are going to check on their beehives in the reserve forest, it is natural for them to collect forest resources at the same time. They also reported that they often see outsiders making charcoal but they do not report them to the forest managers because the villagers themselves are collecting illegally, albeit whilst on their way to check on their legally located beehives in the protected forest. The villagers told us that if their collection of forest resources was not illegal, then they would have an unofficial mandate to report the charcoal producers to the forest manager, thereby improving the forest manager's ability to detect and punish charcoal production, given the constraints of a small enforcement budget.

As in many settings, the protected forests near to these villagers' homes have traditionally provided important non-timber forest products (NTFPs) to rural people, albeit illegally. In addition, illegal extraction of logs and the in-reserve production of charcoal, often by non-local "outsiders," for sale in nearby Dar es Salaam causes serious forest degradation in addition to conflict with local people and forest guards. Urban populations rely on charcoal for much of their energy needs and Kibaha's proximity to Dar es Salaam's large charcoal market makes illegal charcoal production a significant cause of degradation in Kibaha Forest Reserve (NBS, 2007; interviews and personal communication, 2009 and 2010). Indeed, we saw abandoned charcoal pits and young men leaving the reserve on bicycles laden with charcoal during all of our visits to the reserve and surrounding villages. This charcoal extraction by and for outsiders leaves less forest biomass for NTFP collection by local people and reduces ecosystem services. Many forests face these two types of illegal extraction: for home use typically by locals; and for sale in towns, often by outsiders. The forest manager's tools to influence this resource collection by locals and outsiders include enforcement, income-generating activities, and access rights for locals. Enforcement can be used to deter both types of illegal activities, but livelihood projects only provide incentives for households that live within "project" areas. Moreover if local villagers collecting NTFPs face the same enforcement as outsiders producing charcoal, any goodwill generated through livelihood projects may well be lost. Forest managers told us that they hoped that local villagers would be sufficiently invested in the forest reserve to enforce access restrictions against outsider charcoal producers, yet express dismay at the lack of such cooperation.

3. The Model

We develop a model to explore some of the key issues raised by our observations in Kibaha. Our modeling structure considers explicitly the interaction between three actor groups: the forest manager who has a mandate to protect the forest and to consider rural livelihoods; the "outsider" extractors (here, charcoal producers who typically sell to the urban markets); and the rural "insider" extractors or local villagers. We include in our model the option of granting "access rights for locals" as a forest manager's tool that encourages local people to help enforce access restrictions against more damaging activities. The access rights decision is akin to making a choice of the IUCN classification of a protected forest.[1]

We build our model off of a series of spatially explicit resource extraction and enforcement models (Robinson, et al., 2002; Albers, 2010; Robinson, et al., 2011; and Albers and Robinson, 2011). In this paper we model explicitly the impact of enforcement levels, livelihood projects (here, beekeeping), and the rules or access rights for resource extraction on villager and outsider extraction decisions, including the interaction between the extractor groups, on resulting levels of forest resource protection and on rural livelihoods. As in Albers and Robinson (2011), we use beekeeping as our livelihood project because it is non-extractive and is a popular alternative income-generating project worldwide and specifically in Kibaha Forest Reserve (see, for example, www.beesfordevelopment.org; Lietar, 2009; Bradbear, 2004, 2009).[2] Indeed, Tanzania's Ministry of Natural Resources and Tourism (MNRT) manages forests through its Forestry and Beekeeping Division (MNRT, 1998; 2002a; 2002b; 2005). Through this framework we can consider the tradeoffs between less restrictive protected area designations (access rights), levels of enforcement, and the introduction of livelihood projects.

---

[1] In this paper our focus is a non-spatial model that enables us to explore the interactions analytically. We do recognise that distance, enforcement, and resource collection interact in real situations. For example, villagers may prefer to collect forest resources from near to their village because that reduces the distance costs associated with collecting from the forest. Charcoal producers may prefer to make charcoal deep in the forest because they know that the costs of patrollers going to these patches is high and so patrollers rarely go that far. Such a spatially multi-dimensional model would be relevant to the situations that we find in Kibaha and elsewhere. But such a model also soon loses analytical tractability and so requires simulation modeling. Because this paper introduces new modeling approaches to the analysis of managing protected areas, we leave such a model to on-going research in which we bring in a spatial dimension and identify the optimal allocation of enforcement, projects, and rights over space to achieve different management goals.

[2] The projects discussed here do not include bark beekeeping but instead relate to creating beehives in a manner that does not degrade the forest as occurs with using locally lopped limbs or bark for the hives.

We set up the game-theoretic model of forest use and protection in this paper in the following way. The landscape for the model is a forest that we envisage as comprising one homogeneous forest patch. We identify three distinct sets of players. First are a number of villagers living adjacent to the forest who value the non-timber forest products (NTFPs) found in the forest because they can sell them in a nearby market. Second are charcoal producers who come from outside the nearby villages and produce charcoal illegally in the forest. Third is the forest manager (FM) who has overall responsibility for the forest, but a limited enforcement budget. The forest manager can determine whether or not NTFP collection by villagers is legal (charcoal production is always illegal); and whether to allow and provide beehives in the forest for villagers to benefit from.

3.1 Equilibrium with no Livelihood Projects

If there is no option of beehives in the forest, the forest manager chooses whether to allow villagers to collect NTFPs or to make the collection of NTFPs illegal, given a fixed enforcement budget. If NTFP collection is legal, then villager enforcement supplements FM enforcement (imagine that villagers let the FM know if they have seen illegal charcoal production and thus supplement the FM's detection efforts). If NTFP collection is not legal then villagers do not contribute to enforcement against the charcoal producers, in keeping with our discussions with villagers in Kibaha.

The optimization is formulated as follows. A representative villager maximizes her expected returns to labor, subject to a total labor allocation L. She can allocate her labor to NTFP collection and to "work" that could be wage labor or farming. Any NTFPs collected are sold in a nearby market.[3] Charcoal producers maximize their expected returns to labor spent producing charcoal in the forest. The presence of charcoal production reduces the returns to villagers' NTFP collection effort. The forest manager chooses whether NTFP collection is legal or illegal (charcoal production is always illegal). If NTFP collection is illegal then the FM's enforcement efforts reduce the expected returns to both NTFP collection and charcoal production. If NTFP collection is legal, then villagers engage in enforcement which supplements the FM's

[3] We are therefore not considering NTFPs where there is some own consumption resource requirement, as is often the case for fuelwood, but rather the model assumes that there is a functioning and efficient market for NTFPs and villagers sell anything that they collect (in keeping with such papers as Lopez-Feldman and Wilen, 2008).

enforcement. In this case there is a strategic interaction between the three sets of players. We model that interaction as a Nash equilibrium in which the players move simultaneously.

More specifically, suppose there are n identical villagers. A representative villager allocates her total labor L to the collection of forest products, l_F, and/or work, l_W such that $l_F + l_W = L$. With neither charcoal producers in the forest nor enforcement we write the total NTFP harvest by the n villagers as:

$$H_F = R\alpha(nl_F)^{\beta} \quad [1]$$

R is the resource density in the forest before any extraction; α is a scaling parameter; and $\beta<1$ such that there are diminishing returns to effort in the forest. With charcoal harvest H_C the total villager NTFP harvest becomes:

$$H_F = R\alpha(nl_F)^{\beta}\left(1 - \frac{\gamma H_c}{R}\right) \quad [2]$$

γ is a scaling parameter, and $H_F + H_C \leq R$. This function is simply a modified Schaefer function in which there is "congestion" due to both multiple villagers and a coordinated group of charcoal producers. The harvest of the individual villager can therefore be written:

$$h_F = \frac{H_F}{n} = \frac{R\alpha(nl_F)^{\beta}}{n}\left(1 - \frac{\gamma H_c}{R}\right) \quad [3]$$

With no enforcement we write the charcoal harvest as $H_c = R\theta l_c^{\phi}$. Again, this is a modified Schaefer function that recognizes diminishing returns to charcoal production. However, NTFP collection does not degrade charcoal production effort.

We introduce a simple enforcement regime (following a Becker, 1968, framework) in which there is some exogenous enforcement budget that translates into a probability of detection for villagers (if NTFP collection is illegal) and charcoal producers of q. Punishment is simply confiscation of the illegal NTFP/charcoal. If villager collection of NTFPs is legal, village enforcement supplements FM enforcement and is proportionate to the time villagers spend in the forest collecting NTFPs. We write the probability of the charcoal producers being caught when villager enforcement supplements FM enforcement as:

$$q_F = q + ml_F,\ q_F \leq 1, \text{ and } m>0 \quad [4]$$

Where $m\, m$ is simply a scaling parameter.

Villager enforcement acts very much like congestion—the more time villagers spend in the forest, the more likely that they will see and report illegal charcoal production. Writing the opportunity cost of labor for villagers as k_F and charcoal producers as k_C we can write a set of equations that we solve simultaneously to determine the Nash equilibrium. Our optimization functions take account of both enforcement and congestion. If NTFP collection is illegal (local villagers are not involved in enforcement) we write the optimization as follows:

For the representative villager: $\max_{l_F}\left[W_F\right] = \frac{R}{n}\alpha\left(n\, l_F\right)^{\beta}\left(1-\gamma\theta l_C{}^{\phi}\right)\left(1-q\right) + k_F\left(L - l_F\right)$

For the charcoal producers: $\max_{l_C}\left[W_C\right] = \left(1-q\right)R\theta l_C{}^{\phi} - k_C l_C$ [5]

In this situation where NTFP collection is illegal the villagers' actions do not affect the charcoal producers' optimal labor allocation and so the first order condition for the charcoal producers can be written:

$$W_C{}' = \left(1-q\right)\phi R\theta l_C{}^{\phi-1} - k_C$$

And so for an interior solution $l_C = \left[\frac{k_C}{\left(1-q\right)\phi R\theta}\right]^{\frac{1}{\phi-1}}$ [6]

For the representative villager:

$$W_F{}' = \frac{R}{n}\alpha\beta n^{\beta} l_F{}^{\beta-1}\left(1-\gamma\theta l_C{}^{\phi}\right)\left(1-q\right) - k_F \qquad [7]$$

For an interior solution:

$$l_F = \left[\frac{k_F}{R\alpha\beta\left(1-\gamma\theta l_C{}^{\phi}\right)\left(1-q\right)n^{\beta-1}}\right]^{\frac{1}{\beta-1}} \text{ where } l_C = \left[\frac{k_C}{\left(1-q\right)\phi R\theta}\right]^{\frac{1}{\phi-1}} \qquad [8]$$

If NTFP collection is legal the optimization equations become:

For the representative villager: $\max_{l_F}\left[W_F\right] = \frac{R}{n}\alpha\left(n\, l_F\right)^{\beta}\left(1-\gamma\theta l_C{}^{\phi}\right) + k_F\left(L - l_F\right)$ [9]

For the charcoal producers: $$\max_{l_C}[W_C] = (1-(q+ml_F))R\theta l_C^{\phi} - k_C l_C \qquad [10]$$

In this case there is a strategic interaction and we find the Nash equilibrium for an interior solution by solving the first order equations simultaneously to obtain the following reaction functions:

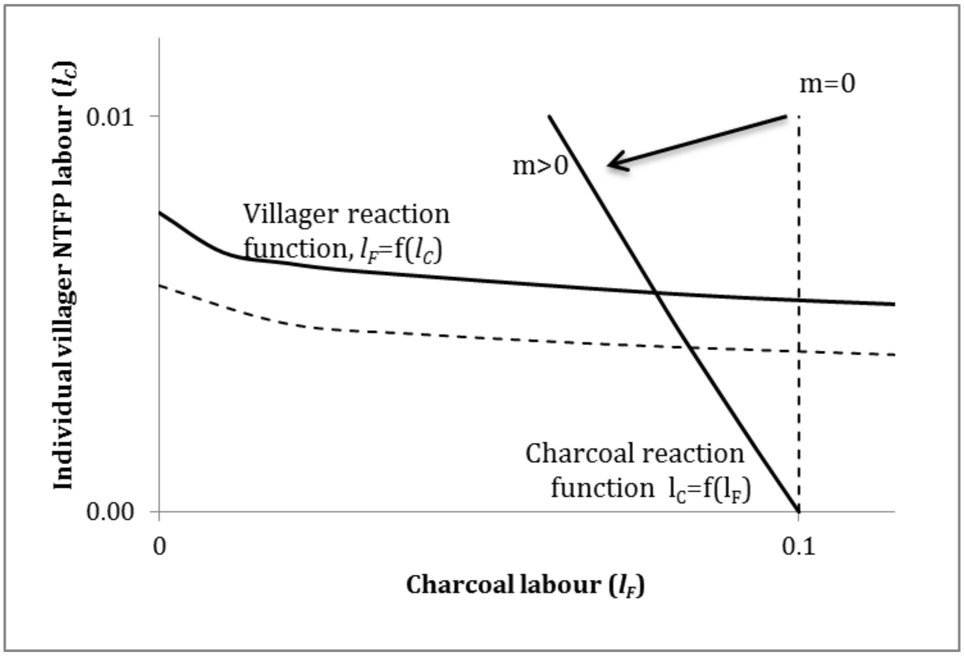
$$l_F = \left[\frac{k_F}{R\alpha\beta n^{\beta-1}(1-\gamma\theta l_C^{\phi})}\right]^{\frac{1}{\beta-1}} \text{ and } l_C = \left[\frac{k_C}{(1-(q+ml_F))\phi R\theta}\right]^{\frac{1}{\phi-1}} \qquad [11]$$

We graph the reaction functions for legal and illegal NTFP collection showing the Nash equilibrium levels of labor allocated to charcoal and NTFPs under the different regimes in Figure 1.[4] The figure can be read in the following way. When NTFP collection is illegal and so villagers are not involved in enforcement, the charcoal producer's reaction function is vertical because the villagers' actions do not affect the charcoal producers' production decision (dashed lines). In this case m=0 and the equilibrium levels of labour allocated to NTFP and charcoal collection are given by (l_C^*,l_F^*). When NTFP collection is legal the charcoal producers' reaction function rotates anti-clockwise and there is a strategic interaction. The equilibrium levels of labour allocated to NTFP and charcoal collection are now (l_C^{**},l_F^{**}). The greater the effectiveness of villager enforcement (proxied by m), the greater the rotation.

We can see from Figure 1 that the forest manager faces a trade-off when deciding whether or not to allow legal NTFP collection in exchange for villagers contributing to enforcement against charcoal producers. When NTFP collection is legal charcoal production decreases but NTFP collection increases (as represented by the time each player spends undertaking the forest-based activity). Which regime is preferred by the FM depends on his objective function that might incorporate the supply of ecosystem services and villager welfare, the impact on total biomass, and how charcoal production and NTFP extraction affect the ecosystem services provided by the forest.

[4] To draw the graphs we use the following parameter values: R=20; α=0.6; β=0.2; γ=0.9; n=100; k_F=3; p_F=1; θ=0.6; ϕ=0.35; φ=0.6; k_C=15; q=0.2; m=22.

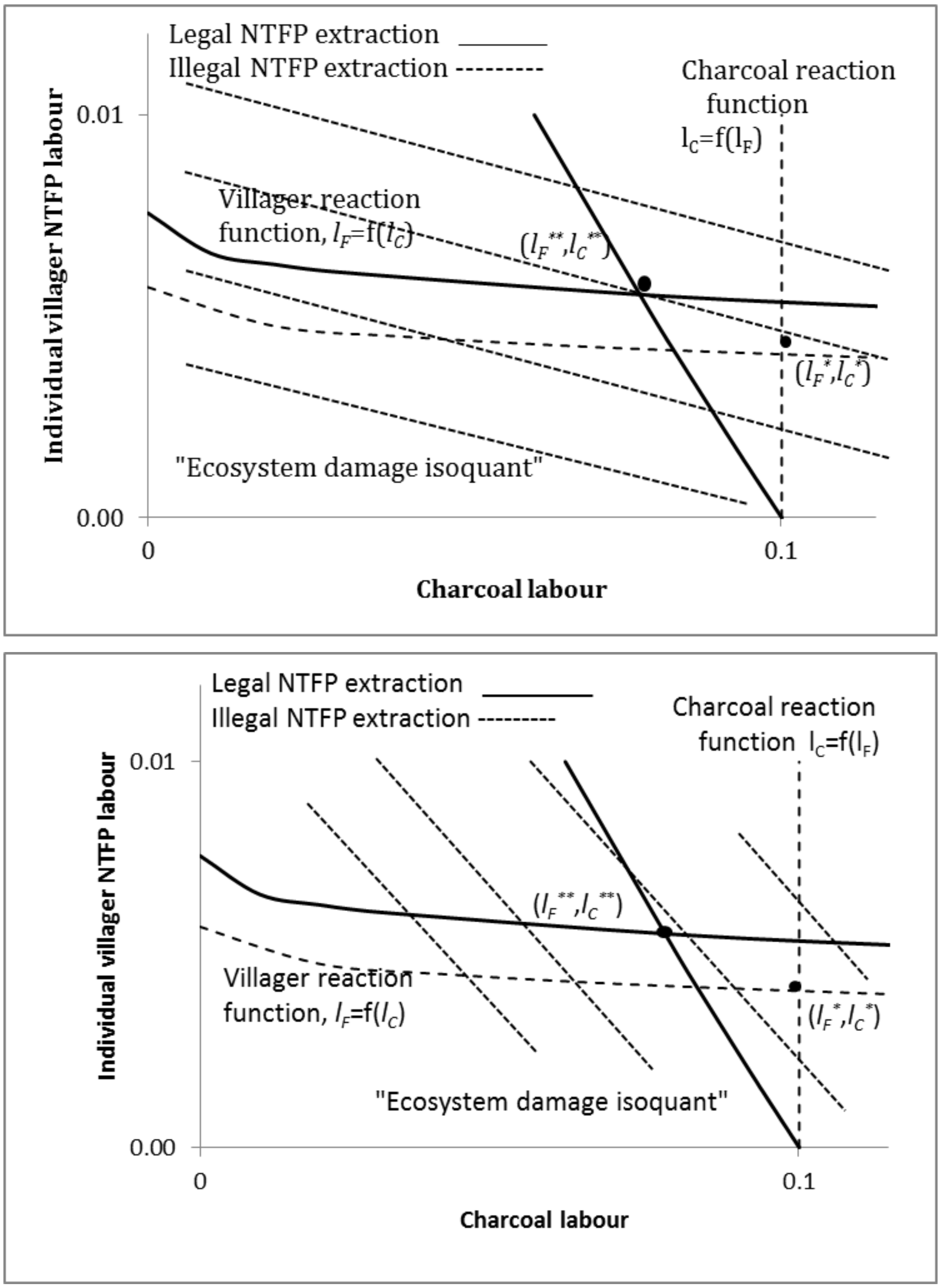
Figure 1. Villager and Charcoal Producer Reaction Functions and Equilibria as a Function of Villager Access Rules



If the forest manager does not take account of villager welfare, whether or not the forest manager chooses to make villager NTFP collection legal depends on the relative ecosystem costs imposed by the villagers' and charcoal producers' extraction. Conceptually we can overlay on Figure 1 what we call "eco-isoquants" that show combinations of charcoal production and NTFP extraction for which the FM is indifferent in terms of the resulting ecological damage. We provide examples of such eco-isoquants in Figure 2.

For example, in Figure 2a we show an example of relatively flat eco-isoquants (note that for these eco-isoquants, the FM prefers to be on an isoquant closer to (0,0) where the damage is least). A flat isoquant implies that the ecosystem damage caused by the collection of NTFPS is relatively high per unit of labour compared with the damage caused by charcoal production. Under such circumstances, as demonstrated in Figure 2a, the FM prefers to keep NTFP collection illegal and not to benefit from local villagers engaging in enforcement. In Figure 2b the isoquants are steeper implying that NTFP collection causes relatively little ecosystem damage compared with charcoal production. Here the FM prefers to allow NTFP collection to be legal, implying the that additional ecosystem damage caused by the legalised NTFP collection more than offsets the added enforcement effort provided by the local villagers. Intuitively we might think that this second scenario is the more likely scenario. But which scenario is appropriate is an empirical question that is likely to be situation specific.

Figure 2a and 2b. Reaction Functions and Two Possible Eco-Isoquants



To summarise the implications of our model: If the FM is concerned only with the ecological damage caused by NTFP extraction and charcoal production (and not villager welfare), then whether or not it is better to legalise NTFP collection in the forest depends on the effectiveness of villager enforcement effort (*m*) and the steepness of the isoquants. When NTFP collection is legal, villagers spend relatively more time in the forest. This increases the quantity of NTFPs collected for two reasons. First, more time is spent collecting. Second, that time spent collecting is more effective because there is less charcoal production due to the double deterrence of the FM and villagers being engaged in enforcement against charcoal producers, and so less charcoal congestion. Therefore not surprisingly villagers unambiguously collect more NTFPs and are better off when NTFP collection is legal. However, the FM faces a trade-off. Steeper eco-isoquants reflect situations where charcoal production is more damaging than NTFP extraction and so it is natural that in these situations we are more likely to find that the legalization of NTFP extraction reduces overall ecological damage to the forest.

3.2 Equilibrium with Bee Keeping Livelihood Project

We find in Kibaha, as in many such situations, that the forest manager has the option of offering villagers a livelihood project as a "carrot" to compensate for lost livelihood benefits from reduced access to forest resources. In Kibaha, the forest managers introduced beekeeping to the villagers. Beekeeping is a popular livelihood option from the forest manager's perspective because the returns to beekeeping are higher the less degraded the forest—thereby giving villagers an incentive not to undertake degrading forest-based activities; and because of "conservation by diversion" in which villagers allocate some of their labor to bees—the hope being that in exchange they allocate less to collecting forest resources. In most of the examples we found in Kibaha, the forest managers placed the beehives relatively deep in the forest rather than on the villagers' land or in the buffer zone.

We add beekeeping as an option in the model in the following way. Villagers involved in beekeeping allocate a fixed amount of labor, l_B to that activity. The returns to beekeeping depend on this labor and the extent of degradation in the forest caused by charcoal production. We write the returns to beekeeping as:

$$Bl_B\left(1-\mu\theta l_C^{\ \phi}\right) \qquad [12]$$

B is a constant that translates bee keeping effort into villager income. If NTFP collection is legal the optimization for the representative villager and charcoal producer are, respectively:

$$\max_{l_F}\left[W_F\right]=\frac{R}{n}\alpha\left(n\,l_F\right)^{\beta}\left(1-\gamma\theta l_F^{\ \phi}\right)+Bl_B\left(1-\mu\theta l_C^{\ \phi}\right)-k_F\left(l_F+l_B\right) \qquad [13]$$

$$\max_{l_C}[W_C] = \left(1 - \left(q + m(l_F + l_B)\right)\right)R\theta l_C^{\ \phi} - k_C l_C$$

We can solve these equations simultaneously as a Nash Equilibrium as before and get similar conditions, assuming an interior solution:

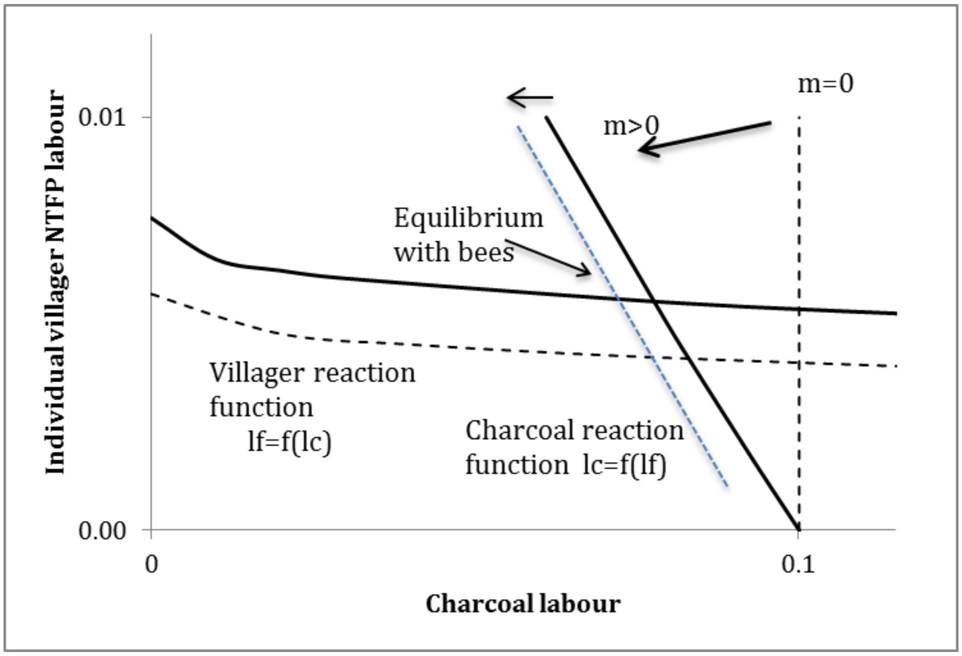
$$\frac{R}{n}\alpha\beta n^{\beta} l_F^{\ \beta-1}\left(1 - \gamma\theta l_C^{\ \phi}\right) - k_F = 0 \quad => \quad l_F = \left[\frac{k_F}{R\alpha\beta n^{\beta-1}\left(1 - \gamma\theta l_C^{\ \phi}\right)}\right]^{\frac{1}{\beta-1}} \qquad [14]$$

$$\left(1 - \left(q + m(l_F + l_B)\right)\right)R\phi\theta l_C^{\ \phi-1} - k_C = 0 \ => \ l_C = \left[\frac{k_C}{\left(1 - \left(q + m(l_F + l_B)\right)\right)R\phi\theta}\right]^{\frac{1}{\phi-1}}$$

The villager’s reaction function does not change. We can see from the villager’s optimization that if the villagers have a constant opportunity cost of labor (as is assumed in this model) then they will choose bee keeping if the returns to bee keeping are better than the returns to working and NTFP collection but the time spent on NTFP collection will only be reduced (all other things equal) if the villager has a labor constraint.

The charcoal producer’s reaction function does however change. If villagers keep bees and NTFP collection is legal, then the probability of being caught is now greater given that villagers spend longer in the forest because of the beehives. The charcoal producer’s response function therefore shifts if villagers do indeed take up the bee keeping projects and collect NTFPs legally, as we illustrate in Figure 3.

Figure 3. Equilibrium with Beekeeping as an Option and NTFP Collection Legal



4. Discussion

In this paper we have explored a situation that is common for forest managers in low income countries, but that is rarely addressed explicitly in either the literature or policy. In almost all participatory forest management initiatives such as community-based forest management or joint forest management, there are “insiders” and “outsiders”. “Insider” villagers typically traditionally use nearby forests for extractive purposes (albeit often illegally), live adjacent to or close to the forest, and are an integral part of new participatory forest management regimes. Outsiders have also traditionally used the forest, such as to collect charcoal or timber, do not live locally, and typically have no rights or responsibilities when a new forest management regime is introduced. Insiders may be given privileged rights to use the forest in some modified form after a change in the forest management regime, but whether this occurs is often a function of the official designation of the forest and does not take into account how these new rights might influence the effectiveness of the new regime. We found that in Kibaha’s reserve forests, officially no-one is allowed to collect resources from the forest. But when the reality is incomplete enforcement, allowing insider villagers to collect some forest resources might—as we have shown in this paper—reduce the total ecological damage because the insider villagers in turn have an incentive to engage in enforcement against the outsiders.

Our paper suggests that understanding the relationship between specific resource extraction and the impact on eco-system services—as represented in our paper by eco-isoquants—will be critical for determining appropriate enforcement policy, in particular whether to introduce differential enforcement by legalizing the collection/production of some forest resources but not others. Yet currently there is little information even of the total quantities of biomass taken from the forests as fuelwood (mainly used by local rural households) and charcoal (mainly for use in nearby urban Dar es Salaam), let alone the relative ecological impact of such activities.

Beehives projects initiated by forest managers bring local villagers into the protected forests where the hives are located. Such projects are meant to encourage these villagers to reduce extraction of NTFPs because such activities degrade the forest and so reduce the value of the bee products. Yet if the most ecologically damaging activities are undertaken by outsiders who have no stake in the forest, then allowing villagers to undertake less degrading extraction in exchange for their help in preventing the more degrading activities may make sense.

References

Albers, H. J. 2010. Spatial extraction and enforcement in developing country protected areas, *Resource and Energy Economics* 32(2):165-179, April.

Albers, H.J., and E.J.Z. Robinson. 2011. The trees and the bees: Using enforcement and income projects to protect forests and rural livelihoods through spatial joint production. Forthcoming in Agricultural and Resource Economics Review. December, 2011.

Baland J-M and Platteau J-P. 1996. Halting Degradation of Natural Resources: Is There a Role for Rural Communities? (Clarendon Press, Oxford).

Becker, G.S. 1968. "Crime and Punishment: An Economic Approach," *Journal of Political Economy* 76: 169–217.

Behera, B and S. Engel. 2006. Institutional analysis of evolution of joint forest management in India: A new institutional economics approach. Forest Policy and Economics, 8(4): 350-365.

Bradbear, Nicola. 2004. Beekeeping and sustainable livelihoods. FAO. Rome. ISBN 92-5-105074-0. 62 pp.

Bradbear, Nicola. 2009. Bees and their role in forest livelihoods: A guide to the services provided by bees and the sustainable harvesting, processing, and marketing of their products. FAO. Rome. ISBN 978-92-5-106181-7. 194 pp.

Chhatre, A. Agrawal, A. 2008. Forest commons and local enforcement, Proceedings of the National Academy of Sciences of the United States of America , 105(36): 13286-13291

Gibson C.; Ostrom E.; Williams J. T. 2005. Local enforcement and better forests. World Development 33(2):273-284.

Ghimire, K. 1994. Parks and people: Livelihood issues in national park management in Thailand and Madagascar. Development and Change 25 (1):195-229.

Gutman, P. 2001. Forest conservation and the rural poor: A call to broaden the conservation agenda. WWF Macroeconomics for Sustainable Development Program Office, Washington, D.C.

Hughes, R. and F. Flintan. 2001. Integrating conservation and development experience: A review and bibliography of the ICDP literature. London: International Institute for Environment and Development.

Johannesen, A. B. and A. Skonhoft. 2005. Tourism, poaching and wildlife conservation: what can integrated conservation and development projects accomplish? Resource and Energy Economics. 27(3).

Litaer, Charlotte. 2009. Impact of beekeeping on forest conservation, preservation of forest ecosystems and poverty reduction. XIII World Forestry Congress. Buenos Aires, Argentina. 18-23 October. 5 pp.

Ligon, E. and U. Narain, 1999. Government management of village commons: comparing two forest policies, Journal of Environmental Economics and Management 37: 272–289.

Lopez-Feldman, A. and J. E. Wilen. 2008. Poverty and spatial dimensions of non-timber forest extraction, *Environment and Development Economics,* 13(5): 621-642

MNRT (Tanzania Ministry of Natural Resources and Tourism). 1998. National Forest Policy (March).

———. 2002a. Beekeeping Act No 15 of 2002.

———. 2002b. Forest Act No 14 of 2002.

MNRT (Tanzania Ministry of Natural Resources and Tourism). 2005. Mnazi Bay Ruvuma Estuary Marine Park General Management Plan. 56 pp.

Muller, J. and H. J. Albers. 2004. Enforcement, payments, and development projects near protected areas: How the market setting determines what works where, Resource and Energy Economics 26: 185-204.

Naughton-Treves, Lisa, Margaret B. Holland, and Katrina Brandon. 2005. The Role of Protected Areas in Conserving Biodiversity and Sustaining Local Livelihoods. *Annual Review of Environmental Resources* 30: 219-252.

NBS. National Bureau of Statistics Tanzania. 2007. Household Budget Survey 2007; Chapter 7: Income and poverty inequality. Dar es Salaam, Tanzania.

Porter-Bolland, L.; E. Ellis; M. Guariguata; I. Ruiz-Mallen; S. Negrete-Yankelevic; and V. Reyes-Garcia. 2012. Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics," Forest Ecology and Management, 268: 6-17.

Robinson, E. J. Z.; Albers, H. J.; and J.C. Williams. 2008. Spatial and temporal modelling of community non-timber forest extraction, Journal of Environmental Economics and Management 56: 234-245.

Robinson, E. J. Z.; Albers, H. J.; and J.C. Williams. 2011. Sizing Protected Areas within a Landscape: The Roles of Villagers' Reaction and the Ecological-Socioeconomic Setting. Land Economics.

Robinson, E. J. Z., J.C. Williams, and H.J. Albers. 2002. "The Influence of Markets and Policy on Spatial Patterns of Non-Timber Forest Product Extraction" Land Economics 78 (2): 260-271.

Topp-Jorgensen, E; M. Poulsen; J. F. Lund; and J. Massao. 2005. Community-based monitoring of natural resource use and forest quality in montane forests and miombo woodlands of Tanzania, Biodiversity and Conservation, 14:2653–2677.