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Elizabeth J.Z. Robinson and Razack B. Lokina

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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

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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

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Abstract

This paper explores the impact of participatory forest management (PFM) initiatives in Tanzania that have excluded villagers from forests to which they have traditionally, albeit illegally, had access to collect non-timber forest products (NTFPs). Motivated by our fieldwork and using a spatial-temporal model, we focused on the paths of forest degradation and regeneration and villagers' utility before and after PFM has been introduced. Our paper illustrates a number of key points for policymakers. First, the benefits of PFM tend to be greatest in the first few periods after it is introduced, after which the overall forest quality often declines. Second, villagers may displace their NTFP collection into more distant forests that may have been completely protected by distance alone before PFM was introduced. Third, permitting villagers to collect limited amounts of NTFPs for a fee, or alternatively fining villagers caught collecting illegally from the PFM forest, and returning the fee or fine revenue to the villagers, can improve both forest quality and villagers' livelihoods.

Key Words: participatory forest management, non-timber forest products, spatial-temporal modeling, Tanzania

JEL Classification: C15, Q23

Contents

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Introduction

Rural villagers in Tanzania, as in many other economically poor countries, are often highly dependent on nearby forests. Non-timber forest products (NTFPs), including fuelwood, forest fruits and vegetables, and forest medicinal plants, play a considerable role in livelihoods, consumption, and income generation, particularly for the rural poor. (Examples of the literature that address these issues include Poulson 1990; Reddy and Chakravarty 1999; Cavendish 2000; Mahapatra et al. 2005; and Narain et al. 2005.) This contribution of NTFPs to the well-being of the rural poor is increasingly being recognized by researchers, non-governmental organizations, and policy makers.

Recently, participatory forest management (PFM) has been introduced in Tanzania. Following the 1998 National Forest Policy and the Forest Act of 2002, PFM has been proposed as a way of both protecting Tanzania's forests and reducing rural poverty (MNRT 1998, 2002a, 2002b). Depending on the particular designation of a forest, villagers' access to the PFM forest may be curtailed, either in the short run—to let the forest regenerate before villagers resume managed and restricted resource collection (community-based forest management, or CBFM)—or permanently, in the case of protected preservation government forests (joint forest management, or JFM). In the short term therefore (and for some forests, even in the long term), villagers are losing access to forest resources that they have traditionally, albeit often illegally, had access to. In the long run, if villagers do not lose permanent access to the forests, they may be better off. But, in the short run, it would appear that most villagers living near PFM forests are likely to be worse off in terms of access to forest resources.

In this paper, we look in more detail at the likely impact of protecting a particular area of forest on other forested areas and on villagers' access to forest resources and thus on their

* Elizabeth J.Z. Robinson, Department of Economics, University of Dar-es-Salaam, Tanzania, (tel) +233 (0) 277 355700, (email) ejzrobinson@hotmail.com, (postal address) PO Box 768, Accra, Ghana; Razack B. Lokina, Department of Economics, Box 35045, University of Dar-es-Salaam, Tanzania, (tel) +255 22 2410252, +255 (0) 784574369, (email) rlokina@udsm.ac.tz,.

livelihoods. The paper is motivated by our research in Tanzania in Tanga and Morogoro regions in 2007, and adds to the literature that addresses the impact of PFM on forest resources and livelihoods. Examples of this literature include Kajembe, Nduwamungu, and Luoga (2005), who used secondary data, gathered from various studies conducted in two forest reserves under PFM, to assess PFM impact on the resource base and people's livelihoods. Their findings were mixed: in one, forest resource quality and livelihoods both had improved; in the second, forest exploitation had actually increased rather than decreased. Kumar (2002) found that JFM had, in general, succeeded in halting forest degradation in India. Although JFM's poverty reduction objective has not fully been evaluated, Kumar found that the poor have been net losers over a 40-year time horizon. Gosalamang and Gombya-Ssembajjwe (2004) authored one of the few papers that address the impact of changes in the legal status, and therefore protection, of a forest reserve in Africa, although their paper lacks sufficient data to draw any generalized conclusions.

Our paper also joins a small but growing body of literature on spatial-temporal aspects of resource extraction and the impact of changing resource regulations (for example, Clarke et al. 1993; Bluffstone 1995; Sanchirico and Wilen 1999 and 2005; Heltberg 2001; Köhlin and Parks 2001; Vance and Geoghegan 2002). Our model complements Robinson, Albers, and Williams (2008), who looked at how degradation affects spatial-temporal patterns of extraction; and their 2005 study, which looked at the impact of excluding villagers from a particular area of forest.

In this paper, we present a spatially explicit model of forest management and NTFP extraction that explores how the location of different forest patches around a village, and the relative protection of each, interacts with villagers' collection of NTFPs. Tropical forests that are subject to NTFP collection tend to degrade slowly and, once protected, tend to regenerate slowly. We therefore focus on the path of NTFP extraction and forest quality, before and after PFM access restrictions are introduced, rather than simply looking at the equilibria.

Our paper reveals a number of significant findings. First, villagers may displace their NTFP collection to more distant forests that may have been completely protected by distance alone before PFM was introduced. Second, the benefits of PFM tend to be greatest in the first few periods after it is introduced, after which the overall forest quality often declines. Third, permitting villagers to collect limited amounts of NTFPs for a fee or alternatively fining villagers caught collecting illegally, and returning the fee or fine revenue to the villagers can improve forest quality and villagers' livelihoods, relative to the situation without PFM.

In the next section of this paper, we present some of our empirical data that we collected from Morogoro and Tanga regions in Tanzania. Because no baseline data were collected concerning the state of Tanzania's forests before PFM was introduced, we relied on villagers' perceptions of how the forest quality and their own access to forest resources had changed as a result of PFM initiatives. In section 2, we develop a theoretical model to explore in more detail the implications of differentially protected forest patches with respect to villagers' livelihoods and forest resources. Finally, in section 3, we address some of the policy issues revealed through our model and empirical findings, and section 4 concludes.

1. Empirical Observations

Currently, there is insufficient understanding of how villagers in Tanzania are affected by PFM. Villagers have been encouraged to understand the importance of PFM to the environment, including ecosystem provisioning. And, indeed, we found a lot of support for PFM in the villages that we visited. But, we also found that most villagers perceived themselves to be worse off after the introduction of PFM because of temporary or permanent moratoria on the collection of non-timber forest products. The extent to which villagers were worse off as a consequence of a nearby PFM initiative naturally was influenced by the importance of the forest to their livelihoods. But, it also became clear from informal discussions in the villages, that villagers were less likely to be negatively affected by PFM if there were alternative, less protected forests nearby to which they could switch their extraction activities. Such a finding may seem intuitive, but forest policy in Tanzania, as in many countries, does not taking a landscape approach and ignores the possibility that villagers "displace" their extraction activities from more to less protected forests, and thus is likely to overstate the ecological benefits of forest protection (Lewis 2002; Robinson, Albers, and Williams 2005).

Our theoretical model was motivated by our fieldwork, which explored villagers' perceptions of the success of PFM. So, in this section, we summarize the evidence concerning how participatory forest management has affected villagers and the surrounding forests in Tanzania. In theory, joint forest management and community-based forest management differ considerably in that villagers often have few, if any, rights to collect resources from JFM forests, whereas villagers own and manage CBFM forests and can determine rules over the collection of forest resources. However, we found that the CBFM initiatives in Tanga and Morogoro regions, where we undertook our fieldwork, had been introduced relatively recently and that most still had moratoria against collecting from the forest until it had regenerated significantly. Therefore, when we undertook our fieldwork, CBFM and JFM were relatively similar, in as much as their introduction had resulted in villagers losing access to forests from which they had traditionally collected resources.

Villagers' perceptions about the impact of the introduction of PFM in their village appeared to confirm concerns that protecting one forest may simply displace degradation to other forests. For example, we asked village-level focus groups how they felt different forested areas around the village had been affected by the introduction of CBFM and PFM (table 1).[1]

Table 1. Focus Group Perceptions of the Impact of PFM on Forests around the Village and Individual Livelihoods

Forest type	Number of village focus groups which answered question about forests				
	Much less degraded	*Somewhat less degraded*	*About the same*	*Somewhat more degraded*	*Much more degraded*
Impact on CBFM forest	9	2	0	0	0
Impact on JBM forest	15	3	0	0	0
Impact on unprotected forests	0	1	1	6	4

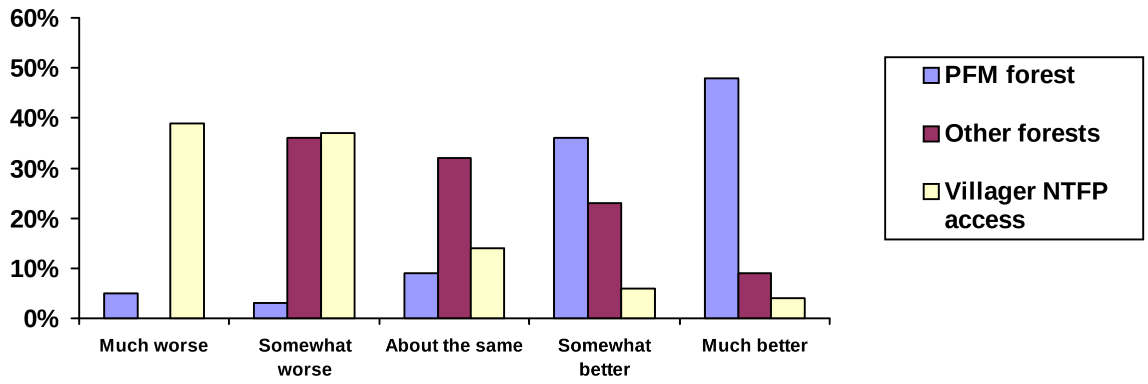
Note: Sample size: 41 village focus groups. *Source*: Authors' data collection, 2007.

Even with this relatively small village-level data set, we found that the members of the focus group perceived PFM to have benefited the specific forest that was protected by the initiative, whether a CBFM or JFM forest, but they felt other forests around the village had been harmed. Naturally these data do not prove that the increased degradation was caused by the introduction of PFM, but there is a pattern. We posed similar questions at the household level to those villagers who knew that PFM had been introduced and got similar results (figure 1).[2]

[1] Because baseline data were not available, we had to rely on villagers' perceptions of forest quality and their own access to forest resources before and after PFM was introduced.

[2] We made sure that we talked in general terms about the introduction of a new way of protecting the forests, so we could include respondents who, although they had not heard the terms PFM, CBFM, and JFM (and their Kiswahili equivalent terms), did know that access restrictions had been reimposed.

Figure 1. Villagers' Perceptions of Impact of PFM on the PFM Forest, Other Forests, and Livelihoods



Note: Sample size: 265 households. *Source*: Authors' data collection, 2007.

Again, we can see from figure 1 above that although villagers typically perceived PFM as successful in terms of improving the quality of the actual PFM forest, it was often at the expense of villagers' access to forest resources and other less protected forests. Many villagers felt that their own livelihoods had been negatively affected by the PFM forest, and the data and responses to our open-ended questions suggested that this was nearly always because they had lost access to forest resources that they traditionally collected.

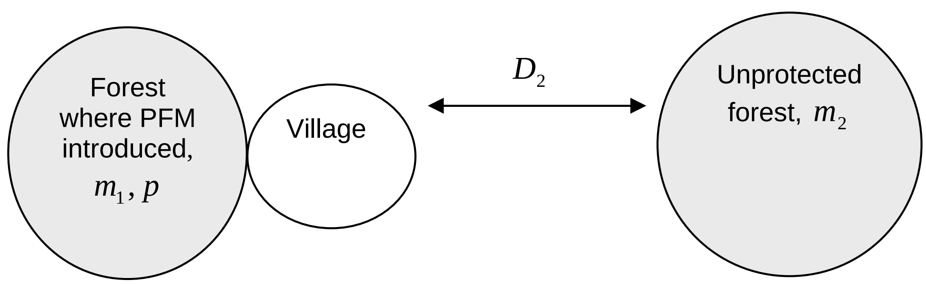
During our focus group discussions, we found that a number of factors appeared to influence the extent to which villagers' access to NTFPs, the PFM forest, and other forested areas were affected by PFM initiatives. One is the extent to which the NTFPs collected are essential, whether they can only be found in the forests, or whether close substitutes can be purchased from markets. Another factor was whether villagers had alternative opportunities, whether wage labor or on-farm, and the level of their opportunity cost of labor. Men and women within a particular household typically collect different NTFPs and are likely to have different opportunity costs of labor (Robinson and Kajembe 2008). Finally, in some villages, villagers told us directly that when PFM access restrictions were introduced, they simply "displaced" their extraction to other more distant, but less protected, forests.

2. The Model

We developed our model based on key, stylized facts from our fieldwork. The model allowed us to explore how villagers' access to NTFPs, the impact on their livelihoods, and the extent to which villagers displace their NTFP collection to other more distant forests—once PFM is introduced—are influenced by a number of specific parameters, particularly the distance to alternative, less-protected forest patches; the extent to which the PFM forest is successfully protected; whether villagers are compensated; and villagers' opportunity costs of labor.

We let there be two forest patches, 1 and 2; the first is adjacent to the village and the second is a distance D_2 from the village. In a particular period, a representative villager has a fixed amount of labor $\bar{L}$ that she can allocate to collecting non-timber forest products (NTFPs) from one or both of the forest patches, or to alternative activities L_w (which could be on-farm work or off-farm labor). Labor for collecting NTFPs comprises the time spent collecting in each patch i, L_i, $i = 1,2$ —plus, if she collects from forest patch 2, the time it takes go to and from that forest patch T_2. Recognizing that the greater the load to be carried home, the longer it takes (Robinson, Albers, and Williams 2008), we let T_2 be a function of both D_2 (the distance of the forest patch from the village) and h_2 (the harvest from that forest patch). $h_i = h_i(L_i, m_i)$, where m_i is the resource density in forest patch i, and $h_L > 0$, $h_{LL} < 0$, $h_m > 0$, and $h_{mm} \leq 0$ (see figure 1).[3]

Figure 2. Spatial Patterns of the Village and Nearby Forest Patches



We modeled the introduction of PFM as an access restriction introduced in some period S and for all future periods in which villagers are not permitted to collect legally any resources from the PFM forest. This is a realistic representation of JFM in government preservation forests, and typical of JFM in government production forests and CBFM in the early years of the

[3] If distance to the second forest patch were simply a fixed cost, then, if the villagers chose to go to both forest patches, the optimal harvest decision would be such that the remaining resource in each forest patch would be the same at the end of each period. But, this is not what we saw in our research for this paper, and our model fits with villagers' reports.

initiatives when moratoria are often imposed (authors' fieldwork).[4] However, we recognized that PFM is rarely fully enforced, and so we assumed that, if PFM is introduced to a forest patch i, there is some probability p that the extracting villager will be caught and punished with confiscation of the collected forest resources and possibly a fine proportionate to the value of the NTFP collected.[5] Villagers maximize a quasi-linear utility function U period by period:[6]

$$\max_{L_1,L_2,L_{we}} [U] = \max_{L_1,L_2,L_{we}} \left[wL_w + \left((1-p)h_1 + h_2\right)^{\alpha}\right], \qquad [1]$$

where $p = 0$ in periods before PFM is introduced, and $0 < p \leq 1$ in periods after PFM is introduced.

s.t. $\bar{L} = L_1 + L_2 + L_w + \delta T_2(D_2, h_2)$;

$L_i \geq 0$ and $\delta = 1$, if $L_2 > 0$, else $\delta = 0$; and

$h_{i,s} = h_{i,s}(m_{i,s}, L_{i,s}) \leq m_{i,s}$;

where $m_{i,s}$ is the total available resource at the beginning of the period.

Periods are linked through the NTFP growth function, and both forest patches have the same natural growth rate r:

$$m_{i,s+1} = (m_{i,s} - h_{i,s}) + r(m_{i,s} - h_{i,s})\left(1 - \frac{(m_{i,s} - h_{i,s})}{M}\right). \qquad [2]$$

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4 We do recognize that there are a number of very successful PFM initiatives in Tanzania, particularly CBFM, that have increased villagers' access to non-timber forest products through effective management of the forest resources. However, for many of these initiatives—when CBFM is first introduced—there is a moratorium on collecting NTFPs because the forests are so degraded. Moreover, the aim of our paper is to explore the impact of strict access restrictions that have been imposed on many of the villages that we visited. Some of these are temporary, but some are permanent.

5 We assumed that p is not proportional to the time spent collecting. This is reasonable if, for example, patrols are located at the edge of the forest, as we found in many of the villages where we undertook our fieldwork. If patrols are distributed throughout the forest, then the probability of being caught could be proportional to the time spent collecting.

6 Because there are fixed costs to accessing the more distant forest patch, it is natural to use a discrete time model rather than a continuous time model.

Period-by-period optimization is a reasonable assumption for the situation we found in many of the villages we surveyed, where extraction was not coordinated or restricted, other than through enforcement activities in the protected forest.[7] For such a period-by-period myopic model, we solved forwards. In period s, depending on the resource density in each forest patch, a representative villager chooses her optimal labor allocation. At the end of each period, the resource regenerates in each patch, resulting in new $m_{i,t+1}$; and, given this new level of resource density, the villager chooses a new pattern of extraction in the two patches. In each period, the villager can extract in neither, one, or both patches, and can use all or part of her labor for non-NTFP activities. A long-term equilibrium is reached when the regeneration exactly equals the extraction each period for each forest patch.

The single period optimization is simple to solve. Dropping the s subscript for clarity, we get the following first order conditions, assuming that the villager allocates some of her labor to non-NTFP activities:

$$\text{(i)} \quad w = \alpha\left[(1-p)h_1(L_1)\right]^{\alpha-1}\frac{\partial h_1}{\partial L_1} \ .$$

$$\text{(ii)} \quad w + D_2\frac{\partial T_2}{\partial h_2}\frac{\partial h_2}{\partial L_2} = \alpha\left[h_2(L_2)\right]^{\alpha-1}\frac{\partial h_2}{\partial L_2} \ . \qquad [3]$$

$$\text{(iii)} \quad w = \alpha\left[(1-p)h_1(L_1)+h_2(L_2)\right]^{\alpha-1}\frac{\partial h_1}{\partial L_1}$$

$$w + D_2\frac{\partial T_2}{\partial h_2}\frac{\partial h_2}{\partial L_2} = \alpha\left[(1-p)h_1(L_1)+h_2(L_2)\right]^{\alpha-1}\frac{\partial h_2}{\partial L_2} \ .$$

Condition (i) holds if the villager collects only from forest patch 1; condition (ii) holds if the villager collects only from forest patch 2; and condition (iii) holds if the villager collects from both patches. We can see from these equations that, because the distance cost is a function of the amount collected in forest patch 2, when the villager collects from both forest patches, the

[7] Modeling a situation in which villagers together optimize the net discounted returns to collecting NTFPs over an infinite time horizon also adds considerably to the complexity of the model solution algorithm. Our myopic/non-cooperative model itself provides a number of interesting insights. However, our ongoing research is exploring the forward-looking model and how the myopic and forward-looking equilibria differ (see also Robinson, Albers, and Williams 2005).

amount collected in one forest patch is influenced by the extent of degradation in the other. This is what we observed in practice, and so it is important to incorporate it into the model.[8]

To determine the long-term equilibrium for the period-by-period optimizing villager, conceptually we could simply determine the resource densities for each of the forests for which the growth rate equals the harvest rate. However, for this paper, we did not focus on the long-term equilibrium, but rather on the paths of resource extraction in the 10 periods before and after PFM is introduced. We did this for a number of reasons. First, most forests in Tanzania are not in an extraction-regrowth equilibrium. The forests degrade gradually over many years and, after PFM is introduced, they regenerate slowly. These transition phases are lengthy and more relevant to households' livelihoods than the long-term equilibrium that might not be reached for several decades. There is another reason that we looked at the path, rather than looking for a steady-state single-period equilibrium. When there is a fixed cost to access a renewable resource, it is quite possible that the long-term equilibrium is cyclical, that is, it comprises more than one period, in which villagers collect from none, one, or both of the forest patches each period of the equilibrium cycle.

This multi-period equilibrium is a feature of Robinson, Albers, and Williams (2008) and is also similar to the "pulse fishing" found by Hannesson (1975) and Nostbakken (2006). Other particularly interesting aspects of the transition phase have been identified in other research. For example, a more distant forest may initially be protected when villagers choose to collect from a nearby forest, but as the nearby forest becomes more degraded, villagers also begin to collect from the more distant forest (Robinson, Albers, and Williams 2008).

In the next section, we show a number of paths of forest degradation and regeneration for both the PFM forest and the more distant forest patch and the resulting impact on villagers' utility. These paths vary according to our choice of model parameterization. We did not calibrate the model to the particular villages that we visited. Rather, we chose simulation data that illustrated particular situations that we observed or points that villagers made during our focus group discussions.

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[8] There are other ways that we could incorporate this feature into the model, such as imposing a fixed quantity of NTFPs that had to be collected.

3. Paths of Forest Degradation, Regeneration, and Villagers' Utility

The following simulations illustrate how the paths of NTFP extraction, forest degradation, and forest regeneration depend on villagers' opportunities for their labor, their opportunity cost of labor, the distance to the second forest patch from the village, and the extent to which the PFM forest is protected after PFM is introduced. We introduce an explicit harvest function and an explicit distance cost: [9]

$$h_{i,s} = m_{i,s}\left(1-\frac{1}{1+\phi\frac{m_{i,s}}{M}L_{i,s}}\right) \text{ and } T_2\left(D_2, h_2\right) = D_2\left(1+\theta h_2\right)^{\gamma} \quad . \qquad [4]$$

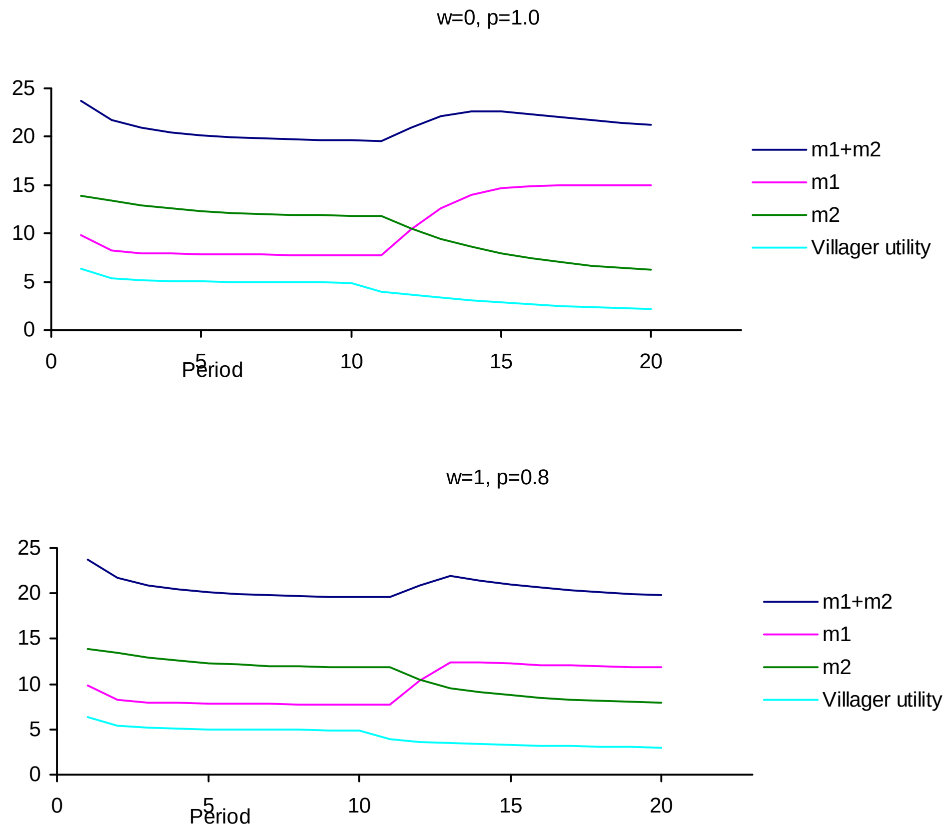
Policy implication 1

> **The first few periods after PFM is introduced typically overstate the long-term benefits of PFM, particularly when the opportunity cost of labor is low.**

For the particular calibration chosen (baseline calibration and w =0, p =1), in the 10 years before PFM is introduced, the forest quality gradually declines in the more distant forest patch 2, but reaches an equilibrium in the nearby forest patch 1. Naturally, the path of degradation for each of these forest patches depends on the choice of $m_{1,0}$ and $m_{2,0}$. At first, after PFM is introduced at the end of period 10—although the forest quality in forest patch 2 starts to decline more steeply—overall, the total forest biomass initially increases rapidly as villagers stop collecting NTFPs from forest patch 1 (figure 2). However, after period 14, the total biomass then decreases once more. We find similar results when we set w =1, p =0.8 (also shown in figure 2). Our representative villager's utility shows a rapid decline in the first few periods after PFM is introduced, reflecting the fact that she stops collecting any NTFPs from the PFM forest, even when the PFM forest is not perfectly protected. Moreover, for this calibration, her utility, along with total forest biomass, continues to decline for the ten periods of the simulation after PFM is introduced, although at a slower rate, because the PFM forest is not in equilibrium even 10 periods after the introduction of PFM.

[9] In the baseline simulation, the parameterisation is as follows: M =15; ϕ =1.1; r =0.3; $\bar{L}$ =1.9; D =0.2; θ = 0.4; γ = 2; α = 0.55.

Figure 3. Quantity of Biomass and Villager Utility over Time, before and after PFM Is Introduced, When the Opportunity Cost of Labor *W* Is Low



These simulation data also illustrate that comparisons of cross-sectional data (where they are available) of forest quality and village well-being—before and after PFM is introduced—may not be representative of what is actually happening. If the data are collected too soon after PFM is introduced, the benefits of PFM may be overstated and the costs to villagers understated. Our data asked villagers for perceptions of changes before and after, but did not stipulate a timeframe for these changes. Although we do not have any precise measures of the impact of PFM, by asking for perceptions of change, we were able to identify a sense of trends in the impact on forest quality and access to NTFPs, before and after the introduction of PFM.

Policy implication 2

> **More distant forests that are protected by distance alone, before PFM is introduced, may no longer be protected after PFM is introduced.**

If the displacement effect is not anticipated, then even stakeholders, who are aware of other nearby forests that are not involved in PFM, may not realize that if PFM is introduced into a particular forest, other more distant forest patches that were fully protected by distance alone may be vulnerable to degradation due to the displaced NTFP extraction. In figure 3, we can see that, for the particular calibration chosen (baseline calibration and $w = 2$, $p = 0.8$), both forest patches are in equilibrium before PFM is introduced. Forest patch 1 is heavily degraded, whereas no NTFPs are collected from forest patch 2, which is fully protected by distance alone. After PFM is introduced, villagers start to collect some NTFPs from forest patch 2, and so it starts to degrade. Forest patch 1 recovers considerably, though it remains more degraded than forest patch 2. In this example, the impact on the representative villager's utility is relatively small, in part because of the relatively high opportunity cost of labor.

Figure 4. Quantity of Biomass and Villager Utility over Time, before and after PFM Is Introduced, When Forest Patch 2 Is Initially Protected by Distance Alone

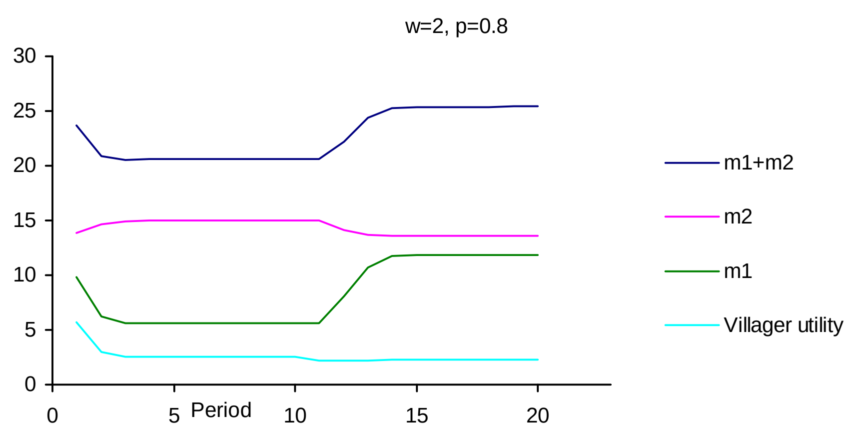
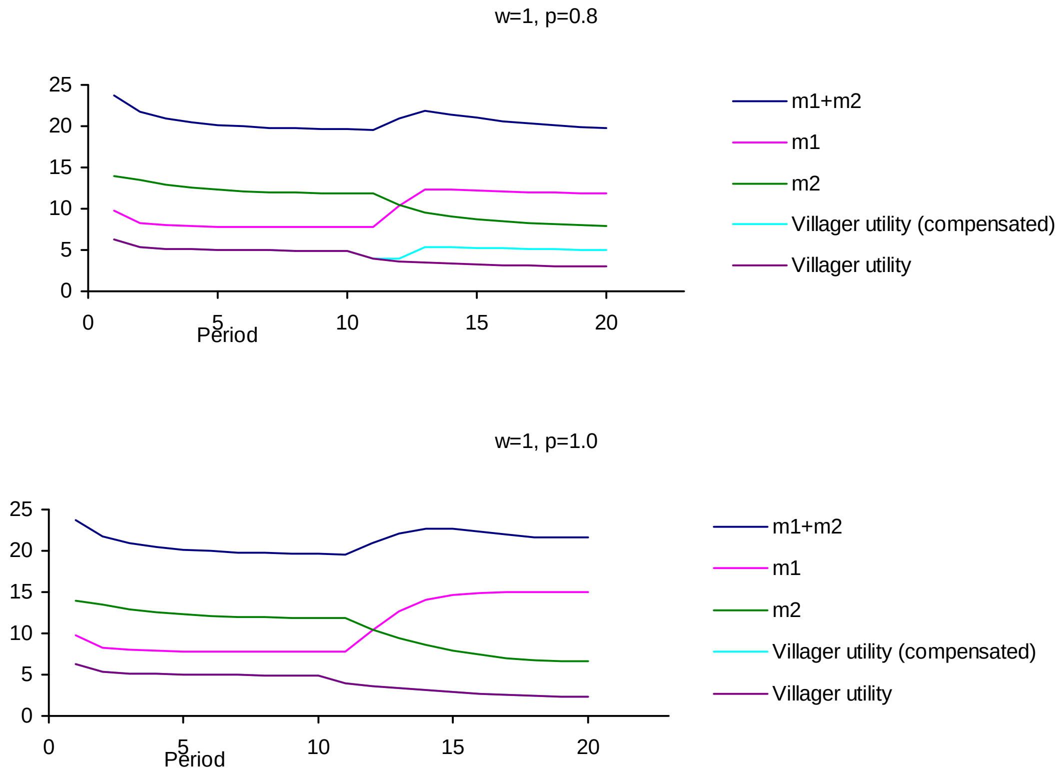


Figure 5. Compensating Villagers with Fine Revenue



Policy implication 3

> **Returning fine revenue to villagers after PFM is introduced can improve their livelihoods and forest quality, relative to the situation before PFM is introduced**.

If the fine is sufficiently high, villagers may stop collecting altogether from the PFM forest. However, under most parameters, villagers are likely to collect some resources from the PFM forest, even when there is some probability of being caught and fined. Thus, the fine acts as a tax on their activities. The tax can be thought of as somewhat akin to a Pigouvian tax, taxing the externality of villagers collecting from an open access resource. The tax reduces the amount collected from the forest and allows the forest to regenerate, so that villagers' extraction costs are lower. The total forest biomass increases, and returning the fine revenue to the villagers can actually improve both villagers' returns to their labor and the total forest biomass, as we illustrate in figure 4 (baseline calibration and w =1, p = 0.8 and 1). Naturally, with perfect enforcement p = 1, no villagers enter the PFM forest and no fine revenue is collected, so there are no internally generated funds to provide compensation for the villagers. Similarly, if enforcement is completely ineffective, $p = 0$, there is no fine revenue collected because no one is caught and the situation is no different from that in which PFM is not introduced. The maximum fine revenue generated, therefore, occurs for some $0<p<1$. Because villagers naturally restrict their collection of NTFPs in the few periods after PFM is introduced, villagers are considerably worse off in these periods because there is no fine revenue to compensate them, emphasizing the need for transition strategies.

4. Concluding Thoughts and Policy Implications

Participatory forest management has been introduced in Tanzania, ostensibly both to protect forest resources and to improve rural communities' livelihoods. However, our theoretical model and empirical findings suggest that, when PFM involves a moratorium on NTFP collection—to allow what are often highly degraded forests to regenerate—there are a number of negative consequences that have not been thought through sufficiently by practitioners. Villagers may displace their activities to more distant but less protected forests; villagers may ignore the moratorium and continue to collect, albeit illegally; or villagers are simply worse off with no access to fuelwood and other important forest resources that they are unlikely to purchase from the market. That is, the PFM forest may improve considerably, but villagers' livelihoods and more distant forests often suffer.

In some villages where there are no alternative forest resources, we found that forest managers have recognized some of these problems and permitted villagers to collect from the periphery of the protected forest—thereby introducing a *de facto* buffer zone. But, we found little systematic evidence of, for example, such buffer zones, preparation of woodlots to reduce the pressure on the forests by providing villagers with an alternative source of fuelwood, or explicit transition strategies to ease the impact on nearby villagers.

A general finding from our research is that the implementation of PFM needs to be specific to the particular situation of the nearby villages, and take into account, for example, the extent to which villagers rely on the forest resource; alternative opportunities for villagers' labor, recognizing that men and women typically collect different NTFPs and have different opportunity costs of labor; and alternative sources of NTFPs. Furthermore, when a moratorium on collection is imposed on a specific PFM forest, other forests that were protected by distance alone become particularly vulnerable. This is of particular concern if villagers displace most of their extraction activity to the alternate forest, rather than reduce their extraction and rely more on the market and nearby substitutes. It is also of considerable concern if these alternate forests are, for example, homes to endangered species that are particularly vulnerable to human interference, as is the case for many of Tanzania's forests that are themselves biodiversity hotspots. A landscape approach would be more likely to protect the overall forest resources, rather than focusing on individual PFM forests at the expense of less protected forests.

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