

Spatial aspects of forest management and NTFP extraction in Tanzania

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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). Using a spatial-temporal model the paper demonstrates that, for example, whether or not there is an alternative source of NTFPs, and villagers' opportunity costs of labour, has a large impact on both villagers' wellbeing after PFM is introduced and on the forest stocks. The paper then illustrates some of the theoretical findings with data collected from Tanga region where PFM has recently been introduced.

1. 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 addressing these issues include Poulson, 1990; Reddy and Chakravarty, 1999; Cavendish, 2000; Mahapatra et al, 2005; Narain et al, 2005). This contribution of NTFPs is increasingly being recognised by researchers, NGOs, 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, or permanently in the case of protected preservation government forests. In the short run therefore, and for some forests even in the long run, villagers are losing access to forest resources that they have traditionally, albeit often illegally, had access to. In the long run, if they do not lose permanent access to the forests, villagers may be better off. But in the short term it would appear that most villagers living near to 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' livelihoods. The paper is motivated by our research in Tanzania in Tanga region in 2007. We undertook a 578-household survey at the individual household level and also collected village level data from 30 villages. We were particularly interested on the spatial layout of forests around the villages, the extent to which these forests are protected, and villagers' perceptions on how and why both their livelihoods and forest quality had been affected by the introduction of participatory forest management.

A number of papers have addressed the impact of PFM on forest resources and livelihoods. Using secondary data gathered from various studies conducted in two

forest reserves under participatory forest management, Luoga et al (2005) assess the impact of PFM on the resource base and people's livelihoods. The findings were mixed, in one forest resource quality and livelihoods had improved, in the second forest exploitation had actually increased rather than decreased. Kumar (2002) found that Joint Forest Management (JFM) has in general succeeded in halting forest degradation in India. Though JFM's poverty reduction objective has not fully been evaluated, Kumar did find that the poor have been net losers over a 40-year time horizon. Gosalamang and Gombya-Ssembajjwe (2004) is one of the few papers to address the impact of changes in the legal status and therefore protection of a forest reserve in Africa though their paper lacks sufficient data to draw any strong conclusions.

Our paper joins a small but growing body of literature that addresses spatial-temporal aspects of resource extraction and the impact of changing resource regulations (for example, Clarke et al, 2003; Bluffstone, 1995; Sanchirico and Wilen, 1999 and 2005; Heltberg, 2001; Kohlin and Parks, 2001; Vance and Geoghegan, 2002). Our model builds on work by Robinson et al (2006) that looks at how degradation affects spatial-temporal patterns of extraction and Robinson et al (2005) that looks at the impact of excluding villagers from a particular area of forest. In this paper we develop 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. We assume that there are either one or two forest patches at different distances from the village and with different levels of protection.

Our paper reveals a number of key findings. First, we find that when there are fixed distance costs to access a particular forest patch, the long-run equilibrium may well be cyclical, that is, comprising more than one period, in which villagers collect from none, one, or both of the forest patches each period of the equilibrium. This multi-period equilibrium that we find is a feature of Robinson et al (2005) and is also similar to "pulse fishing", found by, for example, Hannesson (1975) and Nostbakken (2006), and is driven in part by the fixed distance cost imposed on villagers when they visit a particular patch. Second, we find that the rate of regeneration of the resource

strongly influences the equilibrium resource density in the different forest patches and the impact on forest-dependent villagers.

Currently there is insufficient understanding of how villagers in Tanzania are affected by PFM. Villagers have been encouraged to understand the importance of PFM for 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 (NTFPs). 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, by not taking a landscape approach, and ignoring the possibility that villagers “displace” their extraction activities from more to less protected forests, is likely to overstate the ecological benefits of forest protection (Lewis, 2002; Robinson et al, 2005).

In the next section of this paper, 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. In Section 3 we present some of our empirical findings based on our newly collected data. Finally in Section 4 we address some of the policy issues revealed through our model and empirical findings.

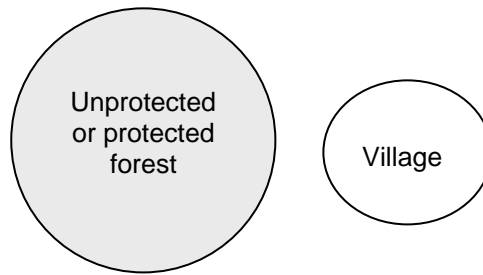
2. The model

In our model we consider from where and in what quantities villagers collect resources from the nearby forests before and after PFM is introduced to the forest. Although in some types of PFM, such as community-based forest management (CBFM), villagers have rights to manage the forest and collect forest resources, we found that in almost all the villages that we visited there was a complete or virtually complete moratorium on collecting from the PFM forest until the resource had regenerated, and in joint forest management (JFM) forests that are designated

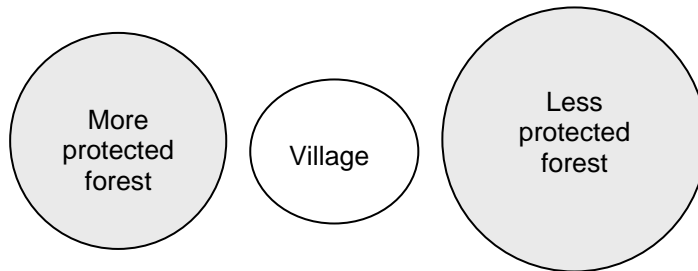
“preservation forests” there was a permanent ban on collecting from the PFM forest. Therefore we model the introduction of PFM as an access restriction in which villagers are not permitted to collect from the PFM forest though the enforcement of this access restriction may be incomplete.¹

Based on our fieldwork we consider 3 stylised “types” of spatial forest arrangement. The first spatial arrangement is where there is only one forest that may or may not be a protected PFM forest. In the second type, there are two forests either side of the village, one of which is the more protected JfM forest and one less protected. In the third the village is adjacent to the less or unprotected forest which in turn is adjacent to the more protected JFM forest. Although a simplification, for example, several villages that we surveyed are surrounded by more than two forest patches, these spatial arrangements encompass the key elements of the spatial patterns of forests that we find.

¹ We do recognise 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. The aim of our paper is to explore the impact of strict access restrictions that have been imposed in many of the villages that we visited. Some of these are temporary but some are permanent.



1a: Villager has only one forest patch from which to collect resources



1b: Village is between protected and unprotected forest patches



1c: Unprotected forest patch acts as buffer zone for protected forest patch

Figure 1: Stylised spatial patterns of forest patches

Such spatial patterns of the forest patches highlight a number of key stylised facts. In the first spatial arrangement (Figure 1a) where there is only one forest patch, there can be no displacement of villagers' extraction activities into an alternative forest. Efforts to protect that forest patch are therefore likely to result either in villagers ignoring the ban, possibly resulting in increased conflict, or in villagers simply reducing the quantity of NTFPs that they collect, with a consequent negative effect on their livelihoods.² In the second spatial arrangement (Figure 1b), protecting one forest patch may simply displace villagers' extraction activities into the less protected forest. The impact on villagers' livelihoods will be affected by how far from the village and

² In the longer run one might expect villagers to start planting trees on their own land, as has been observed by other authors.

how degraded the less-protected forest is. Finally, in the third spatial arrangement (Figure 1c), the less protected forest can be considered to act as a buffer zone, reducing the likelihood of villagers going into the protected forest whilst providing villagers with a source of NTFPs. Displacement effects may also occur in this case as villagers extract more from the less-protected forest, but it is possible that the PFM forest was relatively protected by the forest patch closer to the village even before PFM was introduced.

2.1 Villager extraction

Consider first a general model of villager NTFP extraction in which villagers allocate their labour to a number of activities that could variously include on-farm activities, off-farm labour, and collecting NTFPs from a number of different areas of forest around the village. We recognise that our model's findings are likely to be strongly influenced by how we specify the villagers' optimisation. For example, demand for fuelwood, the most important NTFP, is relatively inelastic and most households collect their full requirement even if the introduction of PFM means that they must spend over twice the amount of time searching for and collecting the fuelwood (authors' fieldwork findings). In contrast, demand for forest fruits and vegetables appears to be much more elastic with respect to forest access. Collection of NTFPs such as fuelwood and fruits and vegetables is undertaken predominantly by women, whose labour supply curves may well be independent of those of their husbands. Villagers with a higher opportunity cost of labour are more likely to use the market, where one is available, than those with a lower opportunity cost of labour.

Although we recognise the complexity of villagers' decisions over collecting NTFPs, we want to keep our model simple enough to provide useful insights. We consider for the moment the following model specification. Villagers allocate a fixed amount of labour, \bar{L} , to collecting NTFPs from the different forest patches or to wage labour (alternatively this could be on farm work, it does not change the spirit of the paper). Labour for collecting NTFPs comprises the time take to reach forest patch i , T_i , and the time spent collecting L_i , $i=1,2$. The quantity collected is a function of the resource density in the forest patch i , m_i , and the time spent collecting – the greater the time

and the greater the resource density, the more is collected. We assume diminishing returns to time spent harvesting NTFPs and constant returns to wage labour. We set the price of a unit of NTFP to be the numeraire, and returns to a unit of villagers' wage labour L_w to be w . When PFM is introduced to a forest patch there is some probability p that villagers who choose to collect from the PFM forest illegally are caught. p is not proportional to the time spent collecting and the only punishment is confiscation of the collected NTFPs.³ These assumptions do not change the key insights of the model and its findings. Villagers allocate their labour to collecting from the two forests, 1 and 2, and to wage labour, so as to maximise V :

$$\max_{L_1, L_2} [V] = \max_{L_1, L_2} \{w(\bar{L} - L_1 - L_2 - \delta_1 T_1 - \delta_2 T_2) + (1-p)h_1(m_1, L_1) + h_2(m_2, L_2)\} \quad [1]$$

$$\text{s.t. } \bar{L} = L_1 + L_2 + L_w + \delta_1 T_1 + \delta_2 T_2$$

$$L_i \geq 0 \text{ and } \delta_i = 1 \text{ if } L_i > 0 \text{ else } \delta_i = 0$$

$$h_i = m_i L_i^\gamma \leq M, \text{ the total available resource}$$

At the optimum villagers could allocate their labour to both forest patches and to wage labour, allocate their labour only to collecting from one or both forest patches, allocate their labour to one forest patch and wage labour, or only undertake wage labour. Naturally the optimum will depend on the wage rate (the villager's opportunity cost of time), and the relative distance, protection, and resource density in each forest patch.

If the villager allocates at least some of her time to wage labour, then we get the following first order conditions (assuming an interior solution):

$$\left[-w + (1-p)h_1'(m_1, L_1) \right] L_1 = 0 \text{ and } \left[-w + h_2'(m_2, L_2) \right] L_2 = 0 \quad [2]$$

From which we have:

3 The assumption that p is not proportional to the time spent collecting 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 would be proportional to the time spent collecting. We could also include a fine that is proportional to the amount confiscated.

$$L_1 = \min \left[0, \left(\frac{w}{(1-p)\gamma m_1} \right)^{\frac{1}{\gamma-1}} \right] \text{ and } L_2 = \min \left[0, \left(\frac{w}{\gamma m_2} \right)^{\frac{1}{\gamma-1}} \right] \quad [3]$$

$$L_w = \bar{L} - L_1 - L_2 - \delta_1 T_1 - \delta_2 T_2; \delta_i = 1 \text{ if } L_i > 0 \text{ else } = 0$$

There are no surprises in these equations. If, in a particular forest patch, degradation is higher (smaller m) or the probability of being caught higher, then the villager collects less from the particular patch and spends more time on wage labour.

These equations confirm that if the villager extracts from at least one forest and allocates at least some of her time to wage labour, then we simply get a solution in which the time spent harvesting in a particular forest patch depends only on the wage and conditions in that particular patch and not on the conditions in the other forest patch. So long as villagers allocate some of their labour to wage labour, marginal changes in the extent to which a forest patch is protected or the extent to which it is degraded do not change the amount of labour allocated to collecting from the other forest patch and so do not affect degradation of the other forest patch. That is, the model cannot accommodate “displacement” effects from one forest patch to another when there is a marginal change in the condition of one of the patches. However, the model could demonstrate displacement if the changes are sufficiently large such that villagers switch from collecting from one forest either to both forests or to the other forest, as could be the result of a sudden change in the status of one forest due to the introduction of PFM that restricts access to the designated forest.

If villagers allocate all their labour to extracting from the forest patches then

$\bar{L} = L_1 + L_2 + \delta_1 T_1 + \delta_2 T_2$ and the extraction decisions from each of the patches are not separable.⁴ We let \bar{L}_E equal the effective labour available for extraction, taking into account costs of reaching the forests, T_i . If the villager chooses to collect from both forests then $\bar{L}_E = \bar{L} - T_1 - T_2$ and in equilibrium:

⁴ We could also get such a non-separable equilibrium if, for example, there is some fixed or minimum amount that villagers must collect, or if villagers’ extraction decisions are separate from their wage labour supply decision.

$$L_1^* = \frac{L_F}{\left(1 + \left((1-p)\frac{m_1}{m_2}\right)^{\frac{1}{\gamma-1}}\right)} \text{ and } L_2^* = L_F - L_1^* \quad [4]$$

The above calculations simply confirm that the extraction decisions are no longer separable when the villagers allocate all their labour to forest resource extraction. Villagers take into account relative degradation and relative probability of being caught (in this case the probability of being caught in the non-protected forest is zero) in each of the forests when they make their decision over how much labour to allocate to each patch.

From the above we can get an explicit value for the profitability, Π , of collecting from both forest patches.

$$\begin{aligned} \Pi &= (1-p)m_1 L_1^{*\gamma} + m_2 (L_F - L_1^*)^\gamma && \text{if } L_1^* > 0, L_2^* > 0, L_w^* = 0 && [5] \\ \Pi &= (1-p)m_1 L_1^{*\gamma} + w(\bar{L} - \delta_1 T_1 - L_1) && \text{if } L_2^* = 0, L_1^* \geq 0 \\ \Pi &= m_2 L_2^{*\gamma} + w(\bar{L} - \delta_2 T_2 - L_2) && \text{if } L_1^* = 0, L_2^* \geq 0 \\ \Pi &= w\bar{L} && \text{if } L_1^* = 0, L_2^* = 0 \end{aligned}$$

2.2 Long-run multi-period equilibrium

This single-period model illustrates that distance to the resource, degradation, and enforcement, can all contribute to protecting a particular forest patch and can each substitute for the other. It also allows us to explore the impact of changing, for example, the relative probability of detection in each patch or the relative degradation. However, to determine the long-run equilibrium levels of forest quality, we need a multi-period model that takes into account the rate of regeneration of each forest patch and how this regeneration interacts with villagers' extraction decisions.

While developing this long-run model we soon realised that the equilibrium may be more than one period long when there is more than one forest patch. That is, we get cycles of extraction behaviour in the equilibrium. With hindsight this finding should not be surprising. When we include a growth function for the resource and allow

multiple extraction periods and forest patches, if villagers extract from only one forest patch in a particular period, then the relative degradation between the two patches increases – one patch has a chance to regenerate further whilst the other patch is further degraded through extraction, and so it becomes more likely in the next period that villagers will extract from the patch in which there was no extraction in the previous period. However, it is also possible that in equilibrium villagers do not enter the protected forest patch, or that each period they extract from just one or from both patches.

Without using simulation data, there is therefore little more that we can say about the long-run equilibrium. Villagers can collect from either, both, or none of the forest patches, and their decision each period will be determined by the relative resource quality in each of the patches, the extent to which the forest patches are protected, and the distance of each forest patch from the village.

To consider the long-run equilibrium pattern of extraction and how a sudden change such as the introduction of a protected area influences this equilibrium, we introduce a growth function for each of the forest patches. We assume that the two forests have the same natural growth rate r , in which case we write the growth function for forest patch i and time period s as:

$$g_{i,s} = m_{i,s+1} - (m_{i,s} - h_{i,s}) = r(m_{i,s} - h_{i,s}) \left(1 - \frac{(m_{i,s} - h_{i,s})}{M} \right) \quad [6]$$

We assume that villagers optimise period by period. This assumption is appropriate for the situation we found throughout many of the villages we surveyed where extraction was not coordinated or restricted other than through enforcement activities in the protected forest.⁵ For such a period-by-period myopic model we solve forwards. In period t , a representative villager chooses her optimal extraction pattern. After her extraction activities the resource regenerates resulting in a new $m_{i,t+1}$, and,

⁵ Modelling a situation in which villagers together optimise 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 on-going research is exploring the forward-looking model and how the myopic and forward-looking equilibria differ (see also Robinson et al, 2005).

given the new level of resource density in each period, the villagers choose a new pattern of extraction in the two patches in the next period. Each period the villager can extract in patch one only, patch two only, or both patches. In a particular period t the resource quality depends on the resource quality in period $t-1$, how much was collected in period $t-1$, and the intrinsic growth rate r , in addition to the other model parameters.

If we were considering only one forest patch then to determine the long-run equilibrium with no fixed distance cost to reach the forest we would have the condition that the growth each period is equal to the harvest. But with fixed costs to reach the resource or multiple forest patches the equilibrium is not so simple to determine.

3. Exploring long-run patterns of resource extraction

We explore the equilibrium pattern of resource extraction for a number of different parameterisations of the model and then undertake a comparative dynamics exercise. In each of these simulations we run the model for 40 periods to allow us to find the long-run equilibrium before and after PFM is introduced. Before PFM is introduced we assume that neither of the forest patches are protected, that is, they are *de facto* open access, reflecting the situation of most of the government forests in Tanzania before the introduction of PFM. After PFM is introduced we assume that there is a moratorium on extraction. However, enforcement in the protected PFM forest need not be perfect (forest patch 1), that is, the probability of being caught could be less than 1.

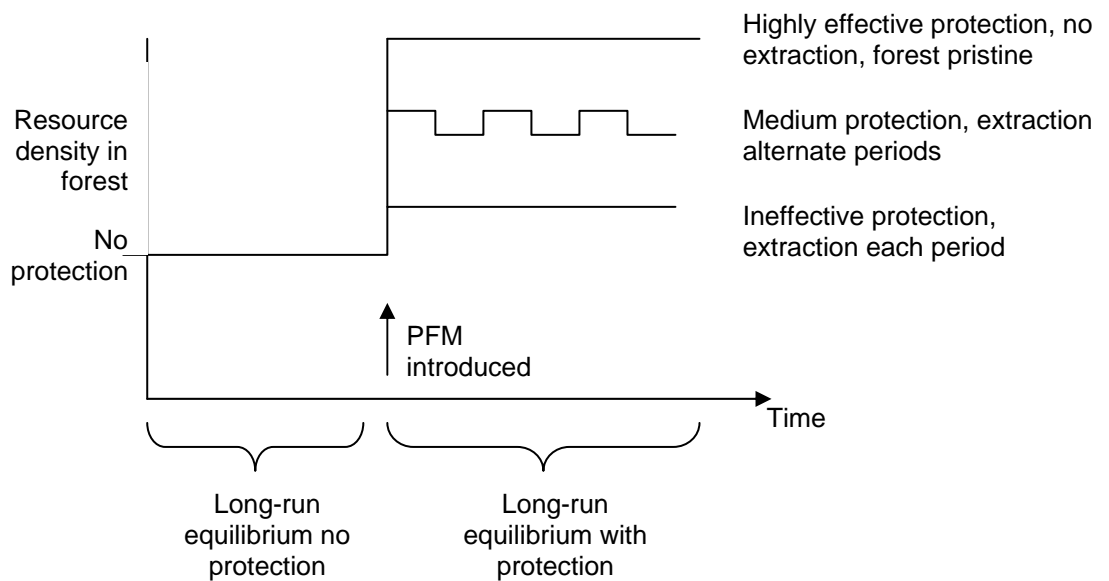


Figure 2: Schematic of resource density in the protected forest when the level of protection is low, medium, and high, assuming only one forest patch

Even with just one forest patch, the fact that there is a fixed cost to access the resource results in cycles at intermediate levels of protection even in this most simple of examples. If protection of the newly introduced PFM initiative is sufficiently high, villagers can be induced not to collect at all from the forest which over time becomes pristine. When protection of the forest is relatively ineffective, the villagers continue to collect each period from the forest and so the period-by-period harvest equals the period-by-period growth, though the overall resource density is better than before the introduction of PFM access restrictions. It is at intermediate levels of protection that villagers alternate collecting with not collecting and the equilibrium exhibits cycles.

We now consider the impact of taking into account a second forest patch. We assume that this second forest patch is further from the village than the protected forest and in a different direction (Figure 1b). The typical situation we found in a number of villages with this spatial arrangements of forests was that the introduction of PFM in the nearer more degraded forest often displaced extraction activities into the more distant unprotected forest. Without PFM the more distant forest was protected by

distance alone. But once PFM is introduced, villagers could find that the distance cost of the forest further from the village no longer stops villagers from entering.

Figure 3 illustrates the impact of protecting the PFM forest on the resource density in each forest patch. In this example we assume that the probability of being caught once the forest is protected is 0.5 and the opportunity cost of labour is low. PFM is introduced at period 23. On average the protected forest becomes rapidly less degraded and the more distant unprotected forest gradually more degraded. We would get similar findings if we imposed some resource requirement. The pattern of resource density after the forest is protected is not smooth due to the cyclical nature of collection from the different forests. For this simulation the equilibrium is four periods: in two periods the villagers collect only from the more distant less protected forest; in one period they collect from the protected forest; and in one period they work off farm. Villagers still go to the protected forest but not as often as to the unprotected forest.

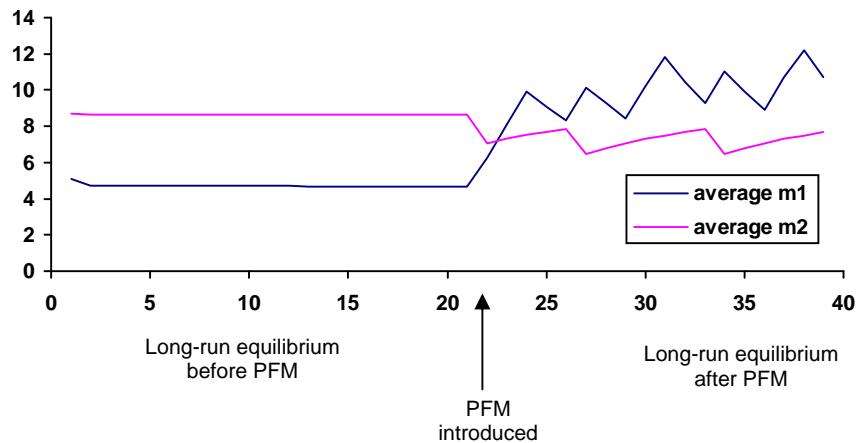
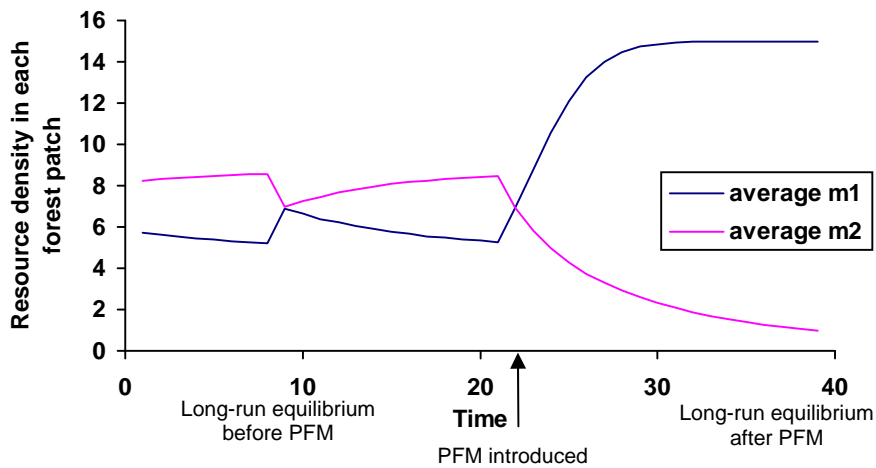
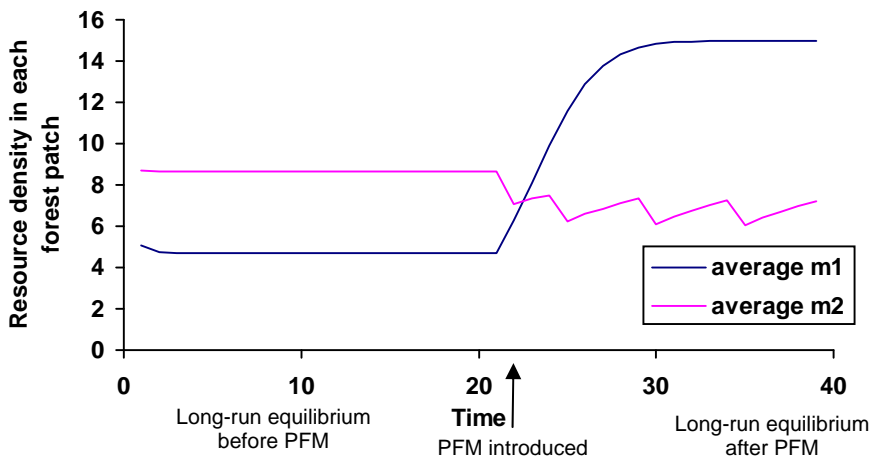


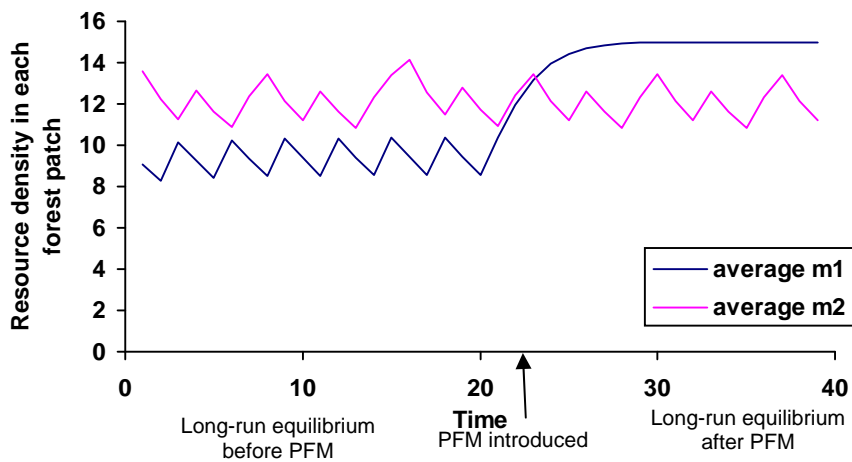
Figure 3: Example of pattern of resource extraction in two forest patches when the probability of being caught in PFM forest = 0.5, and the wage = 5



4a. Probability of being caught in PFM forest = 1.0, wage = 0.5



4b. Probability of being caught in PFM forest = 1.0, wage = 5.0



4c. Probability of being caught in PFM forest = 1.0, wage = 10.0

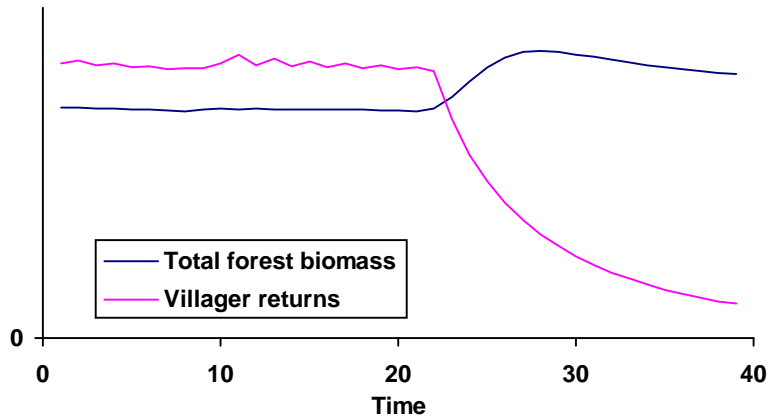
Figure 4: Impact of varying wage rate on patterns of resource extraction

In Figure 4 we see that the pattern of resource extraction is influenced considerably by the prevailing wage rate. For our chosen calibration, for all the wage rates the PFM forest is successfully protected. However, when wages are very low, the introduction of PFM progressively but pervasively degrades the more distant forest (Figure 4a). In contrast, when the wage rate is high, there is very little “displacement” and there is relatively little degradation in either forest.

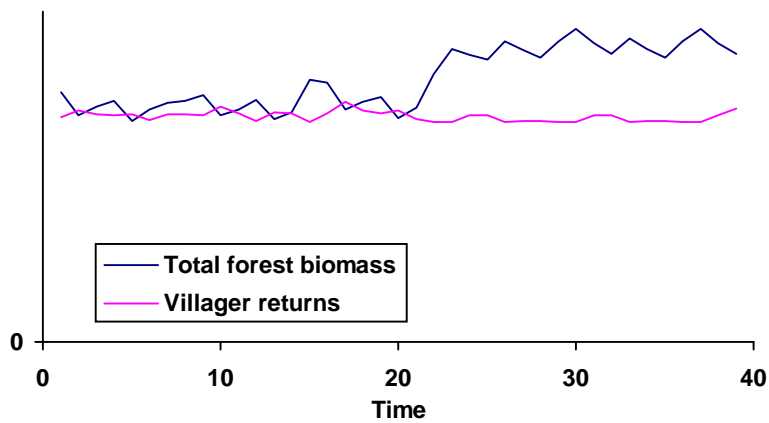
	Wage=0.5	Wage = 5.0	Wage = 10.0
Returns to villager before PFM introduced	3.3	3.3	5.3
Returns to villager after PFM introduced	1.2	2.7	5.0
Resource density in PFM forest before PFM introduced	5.7	5.0	9.3
Resource density in PFM forest after PFM introduced	14.0	13.8	14.4
Resource density in unprotected forest before PFM introduced	8.1	8.5	12.4
Resource density in unprotected forest after PFM introduced	2.5	6.8	11.9

Table 1: Comparison of average returns to villagers and average resource density before and after PFM is introduced for different wage rates

Table 1 shows a summary of the average returns to villagers before and after PFM is introduced and the average resource density in each of the forest patches. Some results stand out. First, PFM most harms villagers who are located in an area with a low opportunity cost of labour, that is, with a low off-farm wage w , who we can consider to be poorer villagers. Second, PFM has a similar impact on the protected forests whether the prevailing wage is 5 or 10. However, PFM has a very negative impact on the unprotected forest where the prevailing wage is 0.5. These results are shown in more detail in Figure 5 below.



5a. Probability of being caught in PFM forest = 1.0, wage = 0.5

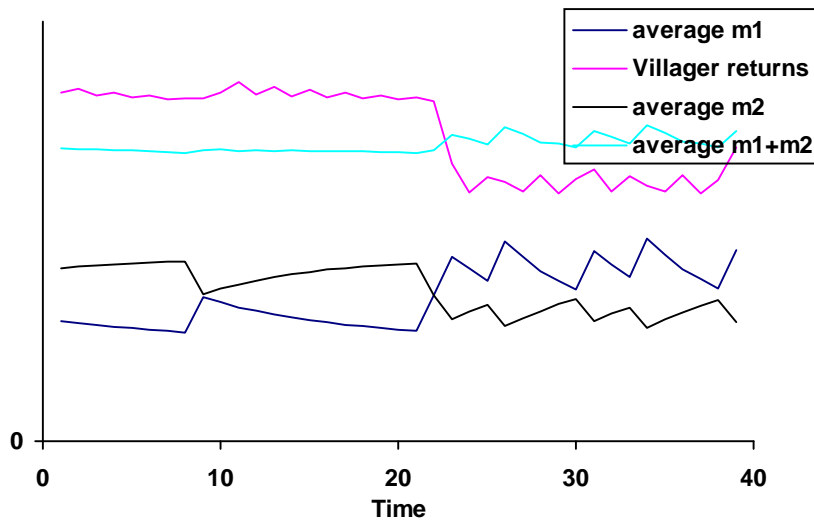


5a. Probability of being caught in PFM forest = 1.0, wage = 10.0

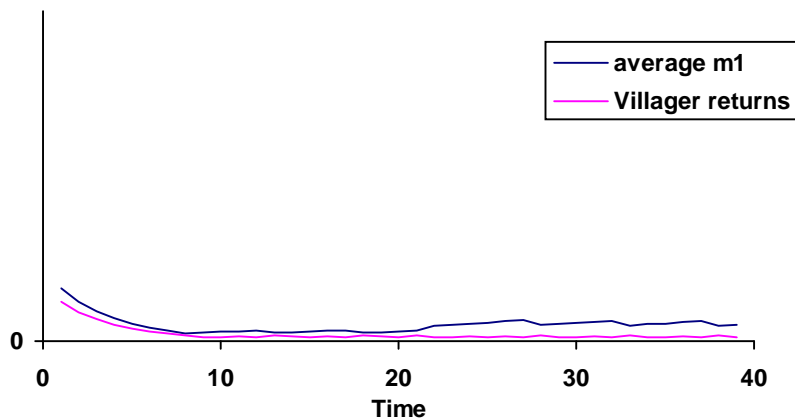
Figure 5: Impact of varying wage rate on total forest biomass and on returns to villagers

We can see from Figure 5a that although the total forest biomass increases considerably immediately after the introduction of perfectly-enforced PFM, the unprotected forest is progressively degraded over time and so the total biomass falls a few periods after PFM is introduced.

We provide one more comparison, the impact of PFM in situations in which there is an alternate forest for villagers to collect from, and a situation in which there is not. We compare both for a low-wage village and a high-wage village.



6a. Wage =0.5, p=0.5, two forest patches, one protected after PFM introduced



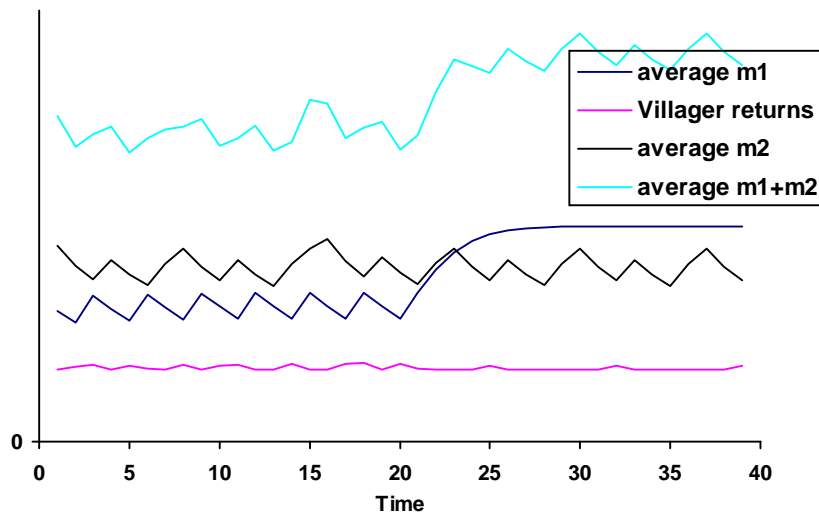
6b. Wage =0.5, p=0.5, one forest patch, protected after PFM introduced

Figure 6: Impact on forest resources and villager welfare from having one or two forest patches available: low opportunity cost of labour

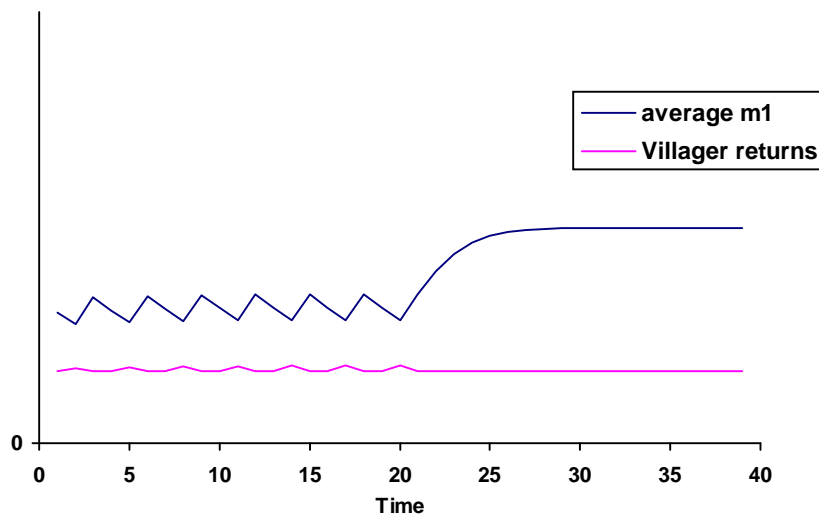
In Figure 6a we see that when villagers' opportunity cost of labour is low, their returns to labour activities (collecting from the forest and off-farm work) fall considerably after PFM is introduced, but there is little impact on the total biomass in the two forests. We get this result because villagers have few opportunities to undertake wage labour and so, even though there is a 50% chance that they are caught undertaking the illegal activity in the protected forest, they continue to allocate most

of their labour to collecting from the forests rather than to off-farm work. The key difference is that after PFM is introduced villagers collect more from the more distant unprotected forest and so spend more time travelling to the forest and less time collecting. The returns to their labour fall because there is a high probability that they are caught and the forest products confiscated.

In 6b where there is only one forest, villagers degrade the forest heavily before PFM is introduced. After PFM is introduced the villagers have no alternative so they continue to heavily degrade the only forest in the village, switching to the low wage labour only when the forest is almost fully degraded. We have used the same scale on both graphs to demonstrate clearly the comparison. With few opportunities and only one forest, the forest is heavily degraded whether or not PFM is introduced, assuming that perfect enforcement is not feasible, a reasonable assumption, and villagers' livelihoods are hardly affected. This comparison makes clear the importance of providing alternative sources of forest resources for villagers, particularly when there are few employment (or, for example, farming) opportunities.



7a. Wage =10.0, $p=0.5$, two forest patches, one protected after PFM introduced



7b. Wage =10.0, $p=0.5$, one forest patch, protected after PFM introduced

Figure 7: Impact on forest resources and villager welfare from having one or two forest patches available: high opportunity cost of labour

Comparing Figure 6 with Figure 7 we can see that when the wages are high, whether or not there is an alternate forest available, PFM has a significant positive impact on the PFM forest with little negative impact on villagers' livelihoods.

4. Some empirical observations

In this section we look briefly at empirical evidence concerning how participatory forest management has affected villagers and the surrounding forests in Tanzania. In theory, Joint forest management (JFM) and community based forest management (CBFM) differ considerably in that villagers 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 region where we undertook our fieldwork have been introduced relatively recently and that most still have moratoria against collecting from the forest until it has 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 on the impact of the introduction of PFM in their village appears to confirm concerns that protecting one forest may simply displace degradation into 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.

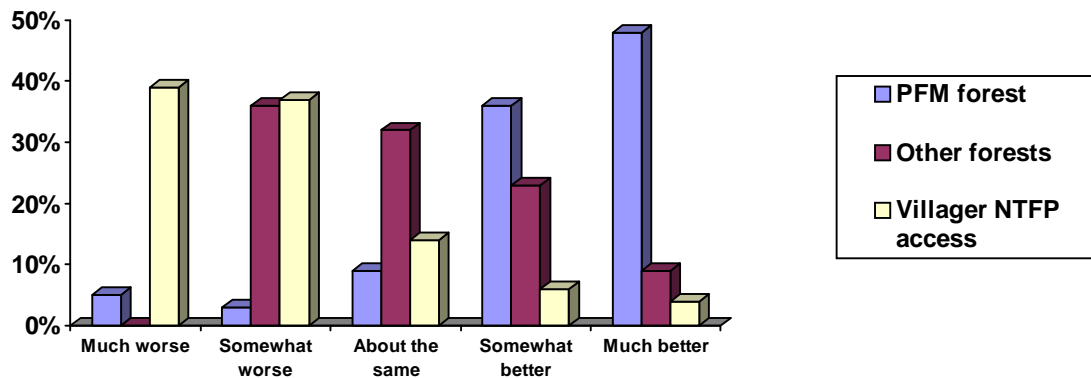
Table 1: Perceptions of impact of PFM on forests around the village

	Number of village focus groups that answered ...				
	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 JFM forest	15	3	0	0	0
Impact on unprotected forests	0	1	1	6	4

Sample size: 41; authors' data collection 2007

Even with this relatively small village-level data set we can see that the members of the focus group perceive PFM to have benefits for the specific forest that is protected through the initiative, whether a CBFM or JFM forest, but other forests around the village have been harmed. Naturally these data do not prove that the increased degradation is caused by the introduction of PFM but there is a correlation.

We asked similar questions at the household level to those villagers who knew that PFM had been introduced.⁶



Sample size: 265; authors' data collection 2007

Figure 8: Villagers' perceptions of impact of PFM on the PFM forest, other forests, and livelihoods

Again we can see from the above figure that although villagers typically perceive PFM as being successful in terms of improving the quality of the actual PFM forest, it has been at the expense of villagers' access to forest resources, and other less protected forests. Many villagers feel that their own livelihoods have been negatively affected by the PFM forest, and the data suggest that this is nearly always because they have lost access to forest resources that they have traditionally collected.

We wondered whether the spatial pattern of forests around the village influenced the extent to which PFM affected different forested areas around the village and villagers' livelihoods, as is predicted by our theoretical model. A number of villagers who we interviewed in more detail did suggest to us that this was indeed the case, and pointed out to us more distant forests that they had not previously collected from but that were now their primary source of NTFPs after PFM was introduced. Econometric regressions revealed that whether or not there are other forested areas near the village was highly significant in terms of whether individual villagers perceived PFM to have been a success or not and the impact of PFM on their own access to forest resources

⁶ 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, though they had not heard the terms PFM, CBFM, and JFM (and their kiswahili equivalent terms) did know that access restrictions had been reimposed.

and therefore their livelihoods. This finding confirms our concerns that the success of a particular PFM initiative may in part be driven simply by the displacement of NTFP collection into other less protected and possibly more vulnerable forests.

5. 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 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; or villagers are simply worse off without access to fuelwood and other important forest resources. That is, the PFM forest may improve considerably, but villagers' livelihoods and more distant forests suffer. In some villages where there are no alternative forest resources, we found that forest managers have recognised 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 very little systematic evidence of, for example, introducing such buffer zones or encouraging the preparation of woodlots to reduce the pressure on the forests by providing villagers with an alternative source of fuelwood.

A general finding from our research is that the implementation of PFM needs to be very specific to the particular situation of the nearby villages, taking into account, for example, the extent to which villagers rely on the forest resource, their opportunity cost of time, and alternative sources of NTFPs. In particular, 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 into the alternate forest rather than reduce their extraction and rely more on the market and near 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.

PFM typically has been implemented on a forest-by-forest or village-by-village basis, rather than using a landscape approach. A consequence is that a PFM policy that appears rational from an individual forest or village perspective could actually cause more damage to those unprotected forests that before PFM was introduced did not need protecting because they are relatively remote from village populations.

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