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The Impact of Participatory Forest Management on Tree Species Abundance and Diversity in Selected Village Forest Areas in Kasungu, Malawi

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Research Article

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ABSTRACT

Since the influential article "*The Tragedy of the* Commons" in 1968, management approaches to share on natural resources has been widely discussed. In the context of forest resources management, people-centered participatory approach has been given more attention. A study was conducted to determine the impact of participatory forest management (PFM) on tree species abundance and diversity in selected village forest areas (VFA) in Kasungu, Malawi. A total of eight VFA's (four under PFM approach and the other four outside PFM) were identified. An inventory was carried out using systematic line transect sampling design. The data obtained was analysed using Rényi diversity profile in Biodiversity R. The results show that VFA's under PFM had higher abundance Hα (3.22 to 3.61) at 0-Alpha than Hα (2.89 to 3.14) for VFA's without PFM. This indicates that VFA's under PFM had higher tree species abundance or richness than those without PFM. Furthermore, VFA's under PFM were more diverse than non-PFM VFA's. VFA's under PFM had higher profiles, 3.45 to 1.83 from 0-Alpha to infinity, than non-PFM VFA's, 3.03 to 1.15 from 0-Alpha to infinity on average. The differences appear to have been achieved due to regulated access and the forest development work communities exercised in the VFA's under PFM. Therefore, it is recommended that the government mainstream PFM as one possible scheme in managing the country's dwindling forest and woodland resources. However, further studies are needed in the study area to assess the impact of PFM on livelihoods of the communities.

INTRODUCTION

Participatory Forest Management (PFM) refers to processes and mechanisms that enable those people who have a direct stake in forest resources to be part of decision-making in all aspects of forest management, from managing resources to formulating and implementing institutional frameworks [1]. Since the persuasive article "*The Tragedy of the Commons*" [2] was published in 1968, management approaches on shared natural resources has been widely discussed. In the context of forest resources management, people-centered participatory approach has been given more attention in developing countries [3-10]. Numerous studies have shown that PFM is instrumental in the recovery and the maintenance of forest conditions [5-9]. The approach is also central to organize people, make a community based institution, and implement the forest management activities based on the collective interest at community level [3,11,12]. Above all the approach is a key role for livelihood improvement of communities living near the forests [3,13-15].

Malawi, with forest cover of about 20% land surface area in 2010 [16], has experienced severe degradation of its forest resources and a considerable change in its land cover which was 47% land surface area in 1975 [17]. It was recognized in Malawi that social factors affect forest degradation, and combating poverty is a prerequisite for forest resource management. Therefore,

the government of Malawi set utmost priority on people-oriented forest management approaches since 1990s. PFM is stipulated in the National Forest Policy of 1996 [18] and operationalized by the National Forest Act of 1997 [19]. The law recognizes two main types of PFM, namely: Co-management and Community Based Forest Management (CBFM). Co-management is based on a management agreement between local communities and government authorities regarding the management of state government forest reserves or plantations. With Co-management, land ownership remains with the government while local communities are duty bearers and in turn get user rights and access to some forest products and services [20]. CBFM takes place in forest on village lands and villagers take full ownership of village forest areas (VFA) [20,21].

In Malawi, a few PFM pilot programmes were initiated with support from different donor agencies. Most notably, the Improved Forest and Management for Sustainable Livelihood Programme (IFMSLP) with support from European Union. The programme was implemented in two phases, Phase I (2005-2010) and Phase II (2011-2014) and was implemented in twelve districts out of the total twenty-eight districts in Malawi. The main aim of the programme was to improve the livelihoods of forest dependent communities through a combination of three strategies: (1) PFM in forest reserves, (2) PFM in village forest areas and (3) Forest Based Enterprises [22]. The introduction of PFM in the programme sites was expected to improve forest conditions, socio-economic status of the local community and sustainable management of the forest resources. However, systematic studies are lacking that assess whether the PFM initiatives in Malawi have achieved their objectives as expected, and to draw lessons that can be used in the future in applying the experiences to other sites. In view of this, a study was conducted to determine the tree species abundance and diversity by comparing village forest areas under and outside PFM.

MATERIAL AND METHODS

Study Area

The study was conducted in Malawi located in Southern Africa in the tropical savanna region at Mkanakhoti Extension Planning Area in Kasungu district. Mkanakhoti is located 12°35'S, 33°31'E, and about 1100 m above sea level. It receives 800 mm to 1200 mm rainfall per annum, with annual temperature ranging from 12ºC to 32ºC. The soils are lateritic and it is situated about 130 km north of Lilongwe the capital [23].

Study Design and Data Collection

A total of eight village forest areas (VFA) (four under PFM approach and the other four outside PFM) were identified for the study. Details of the studied VFA's are provided in Table 1. An inventory was carried out using systematic line transect sampling design. The line transects were laid out at the regular interval of 50 m. Plots were then laid along the transects at the interval of 40m in order to allow adequate coverage of the forests [24]. Furthermore, the starting plots from each transect were placed at 50 m from the edge of the forest in order to minimize edge effects [24]. According to Mahan et al. [25] the recommended number of sample plots for an ecosystem profile assessment of biodiversity is determined by: (1) the level of structural heterogeneity of a targeted ecosystem, (2) the defined goal of the project, and (3) the level of funding and other necessary resources. However, the recommended minimum number of sample plots for a 5 ha forest stand is 20 for a 0.04 ha square plots [25,26]. Therefore, in this study square plots of 400 m^2 (20m x 20m) were used and a total of 160 plots (20 plots from each VFA) were taken. Tree species stocking, for all woody species of all stages, were enumerated and their species name were also recorded. The study was conducted from August to October 2013 (Table 1).

Table 1: Details of the Village Forest Areas Studied in Kasungu District, Malawi.

Category	Name of Village Forest Area	Total Area (ha)	Location
Under PFM	Chikondawanga	4.83	12°34'46"S, 33°30'55"E
	Deka-deka	5.10	12°36'05"S, 33°31'33"E
	Gondoli	5.03	12°36'12"S, 33°31'08"E
	Mona	6.21	12°36'32"S, 33°30'57"E
Outside PFM	Chaguma	4.72	12°36'52"S, 33°31'19"E
	Chileta	6.04	12°35'53"S, 33°31'39"E
	Jumbo	4.90	12°36'21"S, 33°31'32"E
	Perekamoyo	5.38	12°36'30"S, 33°31'45"E

Statistical Analysis

Data obtained on the inventory was tested for normality and homogeneity with Kolmogorov-Smirnov D and normal probability plot tests using Statistical Analysis of Systems software version 9.1.3 [27]. After the two criteria were met, tree species abundance and diversity was determined by using Rényi diversity profile in Biodiversity R. [28]. Biodiversity R. description has been well explained by Missanjo et al. [29].

RESULTS AND DISCUSSION

Tree Species Abundance

Rényi diversity profiles for the VFA's under and without PFM are presented in Figure 1. The results show that VFA's under PFM

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had higher abundance Hα (3.22 to 3.61) at 0-Alpha than Hα (2.89 to 3.14) for VFA's without PFM. This suggests that VFA's under PFM had higher tree species abundance or richness than those without PFM. A total of 44 woody species were recorded in both VFA's under PFM and non-PFM. Of the total wood species recorded, 43 were found in VFA under PFM, while 32 were found in non-PFM VFA's. Out of the 44 species, 6 were common to all the eight VFA's. Only one species encountered in the non-PFM VFA's was absent from the VFA's under PFM, while 12 species found in VFA's under PFM were not encountered in the non-PFM VFA's (Table 2).

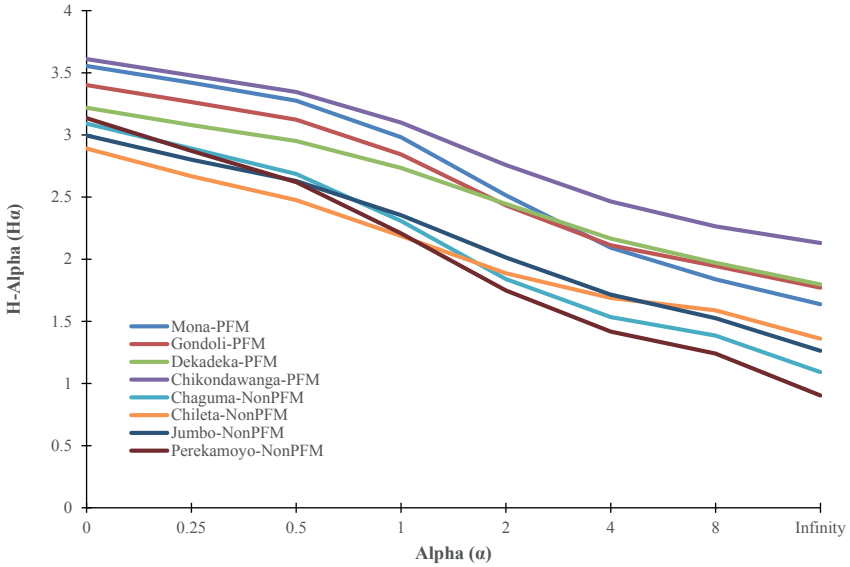

Figure 1: Rẻnyi diversity profiles for the eight village forest areas under and without PFM in Kasungu district, Malawi.

The present results are in agreement to those in literature [5,30-32]. Gobeze et al. [5] reported higher tree species abundance in forest under PFM than non-PFM forest. In the present study, the differences appear to have been achieved due to regulated access and the forest development works communities exercised in the VFA's. The results reported by Mgumia and Oba [33] that restriction imposed on the access of the forest products found in the VFA's under PFM results in higher tree species richness also support the findings of the present study.

Tree Species Diversity

Rẻnyi diversity profiles showing tree species diversity for the VFA's under and without PFM are given in Figure 1. The results indicate that VFA's under PFM had higher profiles, 3.45 to 1.83 from 0-Alpha to infinity, than non-PFM VFA's, 3.03 to 1.15 from 0-Alpha to infinity on average. This implies that VFA's under PFM were more diverse than non-PFM VFA's. The results further show that the profiles for non-PFM were crossing each other. This suggests that no VFA is more diverse than the other for the non-PFM VFA's. Similarly, three VFA's (Mona, Gondoli, Deka-deka) profiles under PFM criss-cross each other, indicating that there is no VFA more diverse than the other. However, the profile for Chikondawanga VFA under PFM is always higher than the other profiles, suggesting that it, Chikondawanga VFA, was more diverse that the other VFA's.

The results shows that the shape of the profiles for both VFA's under and without PFM were less horizontal. This suggests that the proportion of the individual species were not evenly distributed. This was attributed to dominance of certain species (Table 2). The dominance of one species in the ecosystem is an example of degraded or exploited community [34,35]. The results reported by Lameed and Ayodele [36] that there is a tendency of dominance of one species once the woodland has been disturbed support the findings of the present study. However, field observation for the VFA's under PFM showed more regenerants for different species indicating that continued proper management of the VFA's would lead to evenness of all the species i.e. the individual tree species would be evenly distributed. In contrast, Blomley and Ramadhani [37] reported that there was no indication that PFM improves tree species diversity. The differences between the present study and that of Blomley and Ramadhani [37] could be attributed to variation in woodland species composition as a result of differences in climatic and edaphic conditions [38] (Table 2 and Figure 1).

CONCLUSION

The current study has shown that PFM has a clear effect on tree species abundance and diversity. VFA's under PFM had higher tree species abundance and were more diverse than non-PFM VFA's. This appears to be due to regulated access and the forest development works communities exercised in the VFA's under PFM. Therefore, it is recommended that the government

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mainstream PFM as one possible scheme in managing the country's dwindling forest and woodland resources. However, further studies are needed in the study area to assess the impact of PFM in livelihoods of the communities.

Table 2: Tree species abundance (Tree ha^{-1}) for different village forest areas in Kasungu district, Malawi.

Name of tree species	Tree species abundance (Trees ha^{-1})							
	VFAs under PFM				VFAs without PFM			
	Chikondawanga	Dekadeka	Gondoli	Mona	Chaguma	Chileta	Jumbo	Perekamoyo
Acacia amythethophylla	508	75	50	253	50	-	-	50
Acacia nigriscens	25	26	226	-	-	-	-	273
*Acacia polyacantha***	126	-	-	75	-	-	-	-
*Albizia antunesiana***	27	-	-	121	-	-	-	-
Albizia harveyi	22	-	77	75	104	-	-	-
*Annona reticulata**	-	-	-	-	75	-	-	125
*Annona senegalensis***	51	123	-	102	-	-	-	-
*Azanza garckeana***	75	-	75	250	-	-	-	-
Bauhinia petersiana	173	75	-	-	201	-	173	54
*Bauhinia thonningii***	22	-	50	-	-	-	-	-
*Brachystegia spiciformis****	651	1121	752	673	1875	1988	1757	1225
*Brachystegia utilis****	253	753	925	625	705	2013	753	2675
Bridellia canthatica	122	-	102	77	22	25	-	-
Byrsocarpus orientalis	-	75	-	-	-	-	-	74
Cartunarigum spinosa	-	1400	425	-	-	275	775	1523
Cassia sengueana	58	173	-	-	-	24	-	-
Clerodendrum myricoides	75	75	125	126	-	25	74	103
Combretum apiculatum	50	-	1056	50	-	627	-	-
Combretum collinium	-	51	-	575	125	-	-	200
Combretum zeyheri	76	375	-	126	723	175	474	452
Cusonia arborea	201	453	75	100	451	125	475	-
Dalbergia nitidula	150	275	100	125	125	-	524	625
Delox regia	25	-	109	203	126	-	-	75
*Dichrostachys cenerea****	127	323	325	75	400	25	375	123
Diplorhynchus condylocarpon	-	475	173	-	-	1553	826	905
*Diospyros mespiliformis***	52	-	-	75	-	-	-	-
Flacourtia indica	25	102	50	73	50	-	25	174
*Julbernardia paniculata****	33	725	351	475	2475	725	3175	4976
Lannea discolor	25	351	-	50	250	122	273	100
*Loncho capasa***	50	-	126	207	-	-	-	-
*Markhamia obtusifolia***	374	-	-	1325	-	-	-	-
Ochna schweifurthiana	25	-	150	76	-	-	71	-
*Pericopsis angolensis****	56	200	50	125	153	103	50	25
*Piriostigima thonningii***	-	-	125	72	-	-	-	-
Pseudolachnostylis maprouneifolia	51	50	102	25	74	-	23	122
*Pterocarpus angolensis***	59	101	25	25	-	-	-	-
Steganotaenia alliecea	250	-	123	-	125	405	75	700
Sterculia africana	53	-	-	71	-	300	-	-
Terminalia sericea	25	25	50	50	-	277	204	25
*Tilapia nilotica****	76	504	75	123	50	50	1875	154
Vangueria infausta	50	-	53	75	152	-	-	-
*Vernonia amygdalina***	-	122	25	25	-	-	-	-
*Ximenia americana***	452	-	-	54	-	-	-	-
Ziziphus mucronata	51	-	104	75	122	-	126	-

Note: ***Common tree species encountered in all eight VFA's; ** Tree species encountered in VFA under PFM only; *Tree species encountered in Non-PFM VFAs only.

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REFERENCES

1. Klooster D Institutional Choice, Community, and Struggle: A Case Study of Forest Co-Management in Mexico.World Development. 2000; 28: 1 – 20.
2. Hardin G The Tragedy of the Commons. Science. 1968; 162: 1243 – 1248.
3. Dhakal M and Masuda M Role of participatory forest management in rural livelihood improvement: a case of Nawalparasi district, Nepal. Tropics. 2008; 17: 159 – 168.
4. Kumar S and Kant S Bureaucracy and new management paradigms: modeling foresters' perceptions regarding community-based forest management in India.Forest Policy and Economics. 2005; 7: 651 – 669.
5. Gobeze T et al. Participatory forest management and its impacts on livelihoods and forest status: the case of Bonga forest in Ethiopia.International Forestry Review. 2009; 2: 346 – 358.
6. Matiku P et al. The Impact of Participatory Forest Management on Local Community Livelihoods in the Arabuko-Sokoke Forest, Kenya .Conservation and Society. 2013; 11: 112 -129.
7. Islam K.K et al. Actors' Power, Livelihood Assets and Participatory Forestry in Bangladesh: Evidence from the Sal Forests Area. Open Journal of Forestry. 2014; 4: 1 -9.
8. Kibria A S M G et al. Effects of participatory forest management on livelihood capitals of the community in Cox's Bazar, Bangladesh .Journal of Forest Research. 2014; 19: 42 – 51.
9. Kimoro J and Lulandala L Human Influences on Tree Diversity and Composition of a Coastal Forest Ecosystem: The Case of Ngumburuni Forest Reserve, Rufiji, Tanzania.International Journal of Forestry Research. 2013; 2013.
10. Mukama K et al. Participatory Forest Carbon Assessment and REDD+: Learning from Tanzania, International Journal of Forestry Research. 2012.
11. Chakraborty R N Stability and outcomes of common property institutions in forestry: evidence from the Terai region of Nepal. Ecological Economics. 2001; 36: 341 – 353.
12. Iversen V et al: High value forests, hidden economies and elite capture: Evidence from forest user groups in Nepal's Terai. Ecological Economics. 2006; 58: 93 – 107.
13. Shaanker UR et al. Livelihood gains and ecological costs of NTFP dependence: assessing the roles of dependence, ecological knowledge and market structure in three contrasting human and ecological settings in south India. Environmental Conservation. 2004; 31: 242 – 253.
14. Gibson C C et al. Local Enforcement and Better Forests [An article from: World Development] [HTML][Digital].World Development. 205; 33: 273 – 284.
15. Mbuvi M T E et al. Status of Participatory Forest Management Impacts on Poverty for Buyangu Non- PFM area Adjacent Community: Kakamega Forest: Kakamega District..Status of Participatory Forest Management Impacts on Poverty for Buyangu Non-PFM area, KEFRI, Kenya. 2009.
16. AAS (2012) Forest resource mapping project under the Japanese grant for the forest preservation programme to Republic of Malawi: Final report for implementation phase, Department of Forestry, Malawi.
17. Mauambeta D D C et al. Status of forests and tree management in Malawi, CURE, Malawi. A Position Paper Prepared for the Coordination Union for Rehabilitation of the Environment (CURE). 2010.
18. GoM (1996) National Forest Policy of Malawi, Government Press, Zomba.
19. GoM (1997) Forestry Act, Government Press, Zomba.
20. GoM (2005) Standard and Guidelines for Participatory Forestry in Malawi, Government Press, Zomba.
21. GoM (2003) Community Based Forest Management: A Supplement to the National Forest Policy of Malawi, 1996, Government Press, Zomba.
22. Olivier R and Mwase W Final Evaluation of Improved Forest Management for Sustainable Livelihoods Programme in Malawi. 2012.
23. Phiri A T et al. Farmers' evaluation of integrated soil fertility management methods in Northern Kasungu Central Malawi. Journal of Agricultural Extension and Rural Development. 2012; 4: 340 – 346.

24. Orwig D A and Abrams M D Multi-year ecosystem response to hemlock woolly adelgid infestation in southern New England forests.Canadian Journal of Forestry Research.2008; 38: 834-843.

25. Mahan C et al.Ecosystem profile assessment of biodiversity: sampling protocols and procedures. Environmental Resources Research Institute. 1998.

26. Myers W L and Shelton R L Introduction to insect pest management. Survey Methods for Ecosystem Management, John Wiley and Sons, New York.1980.

27. SAS 9.1.3 Qualification Tools User's Guide, SAS Institute Inc., Cary, NC, USA.2004.

28. Kindt R and Coe R Tree diversity analysis. A manual and software for common statistical methods for ecological and biodiversity studies. World Agroforestry Centre (ICRAF), Nairobi.2005.

29. Missanjo E et al. Evaluation of Natural Regeneration and Tree Species Diversity in Miombo Woodlands in Malawi Journal of Biodiversity Management and Forestry. 2014;3: 4.

30. Kassa H B et al. Building future scenarios and uncovering persisting challenges of participatory forest management in Chilimo Forest, Central Ethiopia. Journal of Environmental Management. 2009; 90: 1004 – 1013.

31. Prasad R. (1999) International Journal of Forestry and Forest Industry, 50(198), 58 – 62.

32. Bekele, T et al. Impacts of Participatory Forest Management Practices in Adaba-Dodola Forest Priority Area of Oromia. Ethiopian Journal of Natural Resources. 2004; 6: 89-109.

33. Mgumia F.H. and Oba G. Potential role of sacred groves in biodiversity conservation in Tanzania, Environmental Conservation .2003;30: 259 – 265.

34. Webster R.D. and Fittipaldi F The Interest in Impact Assessment Methods: Environmental Methods Review: Retooling impact assessment for the new century published by Fargo, North Dakota, USA.2007; 24.

35. Spinage C A African Ecology: Benchmarks and Historical Perspectives, Berlin, New York, USA.2012.

36. Lameed G A and Ayodele A E Effect of quarrying activity on biodiversity: Case study of Ogbere site, Ogun State Nigeria. African Journal of Environmental Science and Technology.2010; 4:740 – 750.

37. Blomley T and Ramadhani H. (2005) The Arc Journal, 21, 3 – 5.

38. Gondwe M.F. (2011) Evaluation on productivity of miombo woodland in Malawi (MSc. thesis), Chancellor College, University of Malawi, Zomba, Malawi.