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1 **Impact of Forest Co-Management Programmes on Forest Conditions in**
2 **Malawi**

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10
11 **ABSTRACT**

12 *Forest co-management programmes aim to conserve forest resources. However, there is little*
13 *evidence of its effectiveness. We assess the impact of co-management approaches on forest*
14 *conditions in Zomba-Malosa and Ntchisi forest reserves in Malawi using a multiple-site,*
15 *plot-based, control-intervention design. We used tree density and species richness as*
16 *indicators of forest condition. Evidence of human activities was used as potential indicators*
17 *of current and future impacts. Local peoples' perceptions of co-management impacts were*
18 *also sought to validate the inventory information. Co-managed plots have higher tree density*
19 *than state managed plots. Indicators of human activities including felled trees, farming and*
20 *settlement plots were observed in both co-managed and state managed forest plots. A*
21 *majority of respondents, 84% (Zomba-Malosa) and 73% (Ntchisi) perceive the co-*
22 *management programme to have a positive impact on forest conditions against a general*
23 *worsening trend. Despite having potential to improve forest conditions, the findings suggest*
24 *that outcomes of a co-management may vary depending on pre-existing conditions and how*
25 *communities understand and interpret the programme. Hence programmes should not be*
26 *implemented as a universal package. Furthermore, even with method triangulation, lack of*
27 *baseline data limited the quantification of impacts, hence integration of participatory*
28 *research into the programme, is recommended.*

29 **KEYWORDS.** co-management, conservation, biodiversity, sustainable use, forest reserves.

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6

7 **INTRODUCTION**

8 Traditionally, management of forests was separated from development programmes and
9 much effort was expended in separating people from vulnerable environmental resources
10 (Mayers, Ngalande, Bird, & Sibale, 2001; Zulu 2008; 2010). Particularly in Africa,
11 conservation has been dominated by an authoritarian approach, where permission to use
12 forest resources could only be acquired from government officials. This approach has also
13 been labelled a '*fines and fences*' approach (Hughes & Flintan, 2001) or '*fortress*
14 *conservation*' (Hulme & Murphee, 1999), because of restricted rights of access and use,
15 accompanied by sanctions for non-compliance. Controlled access to protected areas escalated
16 conflicts between local communities and management authorities, especially in places where
17 local communities were heavily dependent on the forest for their subsistence (Buffum, 2012;
18 Negendra 2007). Thus, the approach negatively affected communities' livelihoods and
19 welfare, and in some cases consequently resulting in overexploitation of forest and natural
20 resources (Agrawal *et al.* 2013; Buffum 2012). Therefore, convinced that state controlled
21 natural resources management approaches were ineffective in conservation of forests and
22 natural resources, governments and their development partners, between 1970s and the
23 present day, have concentrated on a search for alternative and sustainable forest management
24 measures (Arnold, 1995). One such approach is forest co-management, which explicitly
25 recognizes the basic needs and involvement of local people in and around forests (Zulu 2008,
26 Persha *et al.* 2011; Kamoto, 2009; Western & Wright 1994; Gibson & Mark, 1995).

1 One of the primary policy objectives for implementing community forest management
2 programmes, including forest co-management is to improve forest conditions through
3 sustainable management and utilization (Agrawal & Chhatre, 2006; Blomley et al., 2008;
4 Malawi Government, 2008). Persha *et al.* (2011) suggest that involvement of local
5 communities in forest management could improve forest conditions because; 1) their
6 proximity to the resource gives them a comparative advantage in monitoring resource use; 2)
7 they are more knowledgeable of the local environment, which is relevant in designing and
8 implementing management strategies and; 3), they have a vested interest in the long term
9 maintenance of the forest, as their livelihoods depend on it (Bene *et al.* 2009; Brown, 1999).
10 Although, co-management presents communities as good custodians of resources, other
11 theories e.g. Bradshaw (2003) and Tacconi (2007), suggest that the approaches can be
12 detrimental to the resources especially where communities are interested in conservation. In
13 such cases, the management and utilization rights given to them through the co-management
14 programme may be perceived as an opening for exploitation thus, resulting in resource
15 (Sunderlin *et al.* 2005). Therefore, co-management effectiveness in achieving sustainable
16 forest management cannot be guaranteed (Nygren, 2004). Additionally, guaranteeing a
17 positive co-management impact on forest conditions is difficult because, although some
18 studies have shown that co-management approaches can conserve and improve forest
19 conditions (e.g. Yadav, Dev, Springate-Baginski, & Soussan, 2003; Phiri, Chirwa, Watts, &
20 Syampungani, 2012), the evidence-base still remains very weak (Bowler et al., 2012 & 2010).
21 Therefore, there is a need for more empirical studies to quantify the impact of forest co-
22 management programmes on forest conditions.

23 The weak evidence-base is further exacerbated by the baseline data (before project) thus
24 few before-after comparisons quantitative studies are available (Sherestha & Mcmanus, 2008;
25 Bowler et al., 2012). Furthermore, Studies on outcomes of and impact of co-management

1 programmes are done on one site, without a control (Non-CFM sites) (Bowler *et al.* 2012;
2 Shrestha and Mcmanus, 2008). For example, the systematic review by Bowler *et al.* (2010),
3 found only 12 studies with a comparison design between participatory management and state
4 management. Hence, there is insufficient evidence to attribute the observed changes in forest
5 condition to either the implementation of co-management programmes or other contributing
6 factors (Shrestha & Mcmanus, 2008; Bowler *et al.*, 2012 & 2010).

7 Therefore, a multi-site, plot-based comparative design was used to assess the impact of
8 co-management approaches on forest conditions and to identify human activities that may
9 account for observed differences (*if any*) and thus predict the potential direction or trend of
10 impact of co-management of forest. In addition to a multi-site, plot-based comparative forest
11 assessment, local peoples' perceptions with regards to; the status of forest before and after the
12 co-management programme and; the programmes' impacts on the forest condition were also
13 sought to validate the observed effects. Pandit and Bevilacqua (2011) argue that local
14 people's perceptions are a useful tool for constructing baseline data in the absence of
15 historical data and to validate the comparison study. Furthermore, the use of methods
16 triangulation and multiple data types has been proposed to give a more robust impact
17 assessment (Lund, Balooni, & Puri, 2010; Pandit & Bevilacqua, 2011). However, few studies
18 have used multiple data types or methods in assessing the impacts of forest co-management
19 approaches (Lund, Balooni, & Puri, 2010). Therefore, given the paucity of empirical
20 evidence on co-management, and the rarity of baseline data, this study using the case of
21 Malawi makes useful empirical and methodological contributions towards the evidence base
22 of forest co-management impacts on forest conditions. Furthermore, Malawi is one of the
23 most highly deforested countries in southern Africa with a deforestation rate of 2.8% (UNDP,
24 2011) and similarly, there is ongoing deforestation in many of the sub-Saharan African
25 countries, including Mozambique (Siteo *et al.* 2012), and Madagascar (Clack, 2012)

1 therefore, lessons from Malawi could be a good in the promotion and implementation forest
2 co-management in the region.

3 STUDY METHODOLOGY

4 Study Area

5 We assess the impact of co-management on forest condition using data from Zomba-
6 Malose and Ntchisi forest reserves. These reserves are 2 of the 12 forest reserves within
7 which the Malawi Government, through the Department of Forestry, are implementing an
8 Integrated Forest Management and Sustainable Livelihood Programme (IFMSLP), with
9 funding from European Union (Malawi Government, 2008). The forest reserves are
10 demarcated into forest management blocks. Government jointly manages the forest blocks
11 with communities living adjacent to the demarcated forest blocks. Though co-management
12 approaches advocate for a bottom-up approach (Ribot, 2003), the IFMSL programme in
13 Malawi, works with communities in a top-down manner, because government officials select
14 the participating communities. The process includes sensitization meeting with potential
15 communities, followed by demarcation of the forest reserve into sections called forest blocks
16 and sub-blocks, with participation of both forest staff and community representatives. Next,
17 block committees are established followed by the development of constitutions to govern the
18 community group. With the facilitation of district forest extension staff, block management
19 plans are then developed, including identification of activities, roles and responsibilities and
20 rules for use of forest resources. Finally, co-management agreements between government
21 (Department of Forest) and local communities are signed by their respective representatives.
22 Following signing of contract agreements, participating communities participate in a number
23 of forest management activities including boundary marking and construction, firebreak
24 maintenance, controlled early burning, firefighting, controlled harvesting, reforestation and

1 monitoring and patrolling. In return, for participating in sustainable forest management
2 activities, the programme legitimizes participants' access and use of forest reserves to collect
3 various forest products (e.g. firewood and Non-timber products) in accordance to what has
4 been stipulated in the management plans and the contract agreement. The committee is
5 mandated to control who and how these products are accessed, by issuing permits.

6 The programme is being implemented in phases; thus, within the reserve there are
7 some blocks that are currently being co-managed by adjacent communities and government
8 after the signing management agreements, and some blocks are still under state management
9 as the process is still underway (Malawi government: *IFMSLP mid-term review, 2008*;
10 *Personal communication, Department of forestry officers -July, 2011*). To answer the questions in
11 this study, the study sites had to fulfil the following criteria: 1) the forest block should be
12 under full co-management, which means that communities living in and around the reserves
13 have signed a management agreement with the government and are thus recognized as full
14 participants. Following meetings with forest staff at the Department of Forestry's
15 headquarters and regional and district offices, Zomba-Malosa and Ntchisi forest reserves co-
16 management programmes fully meet the requirement of the study.

17
18 Zomba- Malosa forest reserve has an area of 14,536 hectares demarcated into 12
19 management blocks, whilst Ntchisi Forest Reserve covers an area of 9,720 hectares and has
20 19 management blocks. Zomba district is located in the southern region of Malawi and it
21 covers a total of 2580 square kilometres, 14.7% of which are forests and woodland (Malawi
22 Government-Atlas, 2012). Agriculture forms a large part of the economy and livelihoods for
23 the majority of the population in Zomba (National Statistics Office-NSO, 2012). Zomba-
24 Malosa forest reserve is the only gazetted forest in Zomba and covers an estimated area of
25 15,756 hectares consisting of both miombo woodlands and pine plantations (Malawi

1 Government, 2007). The reserve supports the livelihoods of communities living around the
2 forest, as Government reports that approximately, 22.2% of all the enterprises in the district
3 are forest based and an estimated 90% of Zomba's population depend on forests for their
4 livelihood (NSO, 2012; Malawi Government, 2009). However, the reserve is being
5 encroached in the peripheral areas for both settlement and agriculture (Mauambeta *et al.*
6 2010). Additionally, the forest reserve is located near a major road, hence forest resources
7 such as charcoal, firewood and timber are easily sold to travellers thus contributing to
8 deforestation of the reserve (Malawi Government, 2007).

9 Ntchisi district is located in the central region of Malawi, and it covers a total of 1 655
10 square kilometres, 19.5% of which are forests and woodland (Malawi Government-Atlas,
11 2012). The larger percentage is under agriculture and rural settlement (78.3%) and the
12 remaining 2.2% is urban built-up human settlement (Malawi Government-Atlas, 2012). The
13 agricultural sector is estimated to account for almost 80% of the district economy and
14 livelihoods (Haarstad *et al.* 2009; Malawi Government, 2005). The most common
15 commercial crop grown in the area is tobacco, which requires a substantial amount of
16 farmland, as well as wooden poles for processing. It is also estimated that approximately 2.6
17 % of the households in the district depend on forests and forest products for their livelihoods,
18 and approximately, 22.7% of all the enterprises in the district are forest based (NSO, 2012).
19 Key forest based activities that the local communities are involved in include harvesting
20 timber, poles and fuel wood. Ntchisi forest reserve is the largest covering an estimated area of
21 9,720 hectares, whilst Kaombe and Mndilasadzu forest reserves are estimated to be 3,880 and
22 1,550 hectares, respectively. The reserve is also a source of non-timber forest products
23 (NTFP) such as mushrooms, fibre and edible caterpillars. Harvesting of edible caterpillars is
24 said to be a significant cause of tree felling in the reserve (*personal communication, District*
25 *forest extension officer-July, 2012*). Additionally, Additionally, as a tobacco growing

1 district, in Ntchisi tobacco farming is one of the major cause of deforestation, due to
2 the high wood use for curing (e.g. Wiyo *et al.* 2014, Jumbe and Angelsen 2011).

3

4 Study Design and Approach

5 A before-after control-impact (BACI) study design has been suggested as most suitable for
6 assessing the impacts of forest co-management approaches (Bowler *et al.*, 2012). However, in
7 this study, as is commonly the case, we were unable to access baseline data, previous
8 inventory data, forest resource mapping and before and after satellite images of the forest
9 area which would have facilitated in assessing forest cover changes in this study. Therefore,
10 the study took advantage of the IFMSLP implementation plan to design a comparative
11 control-impact (CI) study (Baker, 2000; Blomley *et al.*, 2008). The IFMSLP is being
12 implemented in phases; thus, some communities are co-managing blocks having already
13 signed management contracts with government, whilst some blocks are still under state
14 control as communities living adjacent to them have not yet signed any management
15 agreement with government. Therefore, within a forest reserve, blocks that are currently
16 under co-management were regarded as treatment, while those that are still under state
17 management act as control. Data on forest conditions were collected using forest inventory
18 procedures adapted from Hetherington (1975); Malimbwi (1994), Ahrends (2005), Mwase,
19 Bjørnstad, Bokosi, Kwapata, and Stedje (2007), Blomley *et al.*, (2008), Gobeze, Bekele,
20 Lemenih, and Kassa (2009), Obiri, Hall, and Healey (2010) and Phiri, Chirwa, Watts, and
21 Syampungani, (2012). Forest inventories were also used to collect data on human activities in
22 the forest and verify information on forest management activities provided by communities
23 during the focus group discussions, key informant and household interviews. Human
24 activities such as tree felling for timber and fuelwood, grazing, encroaching for settlement
25 and agriculture activities have been highlighted as major contributors to deforestation in both

1 Zomba-Malosa and Ntchisi forest reserve (e.g. Wiyo et al. 2015; Mauambeta et al., 2010)
2 Therefore, the study hypothesised that the presence and level human activities should differ
3 between co-managed forest plots and those under state management (i.e. few indicators of
4 human activities were expected to be observed in co-managed forest plots). Additionally,
5 community perceptions of the impact of co-management on forest conditions were elicited
6 through face to face interviews with a random sample of household heads (a total of 213)
7 from the two communities (Agrawal & Yadama 1997; International Forestry Resources and
8 Institutions, 2008). A number of factors may vary between the forest blocks currently under
9 co-management and those still under state management, which may confound any
10 comparison between the sites (Bowler et al., 2010). The confounding factors considered in
11 the design of this study include proximity to the nearest main road (i.e. access to markets for
12 forest products), distance between forest boundary and nearest villages, conditions of the
13 forest before the programme (i.e. degraded, suffering from deforestation). Additionally,
14 considering that the forest blocks currently under co-management (i.e. treatment sites) are in
15 close proximity to some management blocks that are still under state management (i.e.
16 control sites), there is a risk of leakages or displacement effects (Vyamana, 2009), hence
17 confounding the impact assessment results. Although distance between the forest boundary
18 and the nearest villages was considered in the design of the study, after the initial analysis of
19 the data, it was observed that in all sites (Zomba-Malosa and Ntchisi) the distance between
20 the forest boundary and the nearest villages ranged from 1.5 to 2 kilometres, hence I regarded
21 the distances as close enough not to bias the study results. Similarly, despite all effort, we
22 were unable to access baseline data, information on selection criteria for the co-management
23 programme targets sites and any information with regard to differences in forest composition
24 and status prior to the programme. Hence it is difficult to control for confounding factors that
25 are a direct effect result of pre-existing differences in the comparison sites (co-managed and

1 state managed), prior to the programme starting and not to the difference in management
2 differences.

3 Data Collection, Methods and Procedures

4 FOREST INVENTORY

5 In each of the two forest reserves, three co-managed forest blocks and three state managed
6 forest blocks were randomly selected. Within each sampled forest block, three transect lines
7 moving away from the forest boundary line to the centre of the reserves were randomly
8 located along the boundary (Figure 1). This was on the assumption that forests are more
9 degraded or more harvested along the boundary line than in the centre of the forest, due to
10 differences in accessibility.

11 **FIGURE 1 -HERE**

12 Along each transect line three rectangular plots (50m*20m) were placed 50 m apart.
13 The first plot 50m into the forest reserve, was starting from the boundary line, thus the second
14 plot was located 100m and the third at 200m from the boundary line. However, where
15 accessibility was hindered by thickets, rocks, permanent rivers and steep slopes, the transect
16 line went only up to the accessible point. Therefore, only a total of 106 plots were sampled
17 instead of a targeted 108 plots, for both forest reserves.

18 Tree and seedling and saplings counts were collected as indicators of forest condition
19 (Table 1). The seedling and saplings counts included those from roots, stump and seeds.
20 Names of trees and all woody species were first recorded in their vernacular names, and then
21 later their scientific or English names were identified. The vernacular names were identified
22 in the field, with the help of district forest assistants, field assistants and local representatives
23 from adjacent communities.

1 Changes in tree population and seedling and saplings may take time to respond to
2 different management approaches (Yadav, Dev, Springate-Baginski, & Soussan, 2003).
3 Considering that the programme had only been implemented for 7 years at the time of the
4 study, use of vegetative parameters may be inadequate to answer the questions of the study.
5 Therefore, the study also collected additional parameters including, level and presence of
6 human activities and disturbances, and forest management activities (Table 1), on the
7 assumption that good forest management practices and controlled human activities in the
8 forest facilitate improvement of forest conditions and may help explain current forest
9 conditions in the absence of baseline data (Phiri, Chirwa, Watts, & Syampungani, 2012).

10 **Table 1-HERE**

11

12 HOUSEHOLD INTERVIEWS

13 Household surveys were used to collect information on communities' perceived changes in
14 forest conditions since the co-management programmes started. The questionnaire included
15 both closed and open ended questions to gather communities' perceived status of the forest
16 before and after the programme, perceived impact of the programme on the forest condition
17 and basic socio-economic information about households.

18 Due to differences in resource use and extraction among different gender groups, as
19 well as influences of cultural norms and practices among rural communities (Colfer and
20 Capistrano, 2005; Fisher *et al.* 2012; Mawaya and Kalindekafe, 2007), difference in
21 responses between household heads and other adult members of the community, were
22 expected. Therefore, respondents were grouped into household heads and other adult
23 members of household. The household heads were usually male, however, in some cases
24 widows, divorcees, or women whose husbands are working away were regarded as household

1 heads as they do all almost all of the work customarily done by men. However, after the
2 initial analysis of the data showed no obvious difference in opinions and perceptions between
3 household heads and other adult members of the community, household heads and other adult
4 members were treated as one category (i.e. community members). A total of 213 community
5 members in participating communities were interviewed, 106 households in Zomba-Malosa
6 and 99 in Ntchisi. In each village, a random approach was used in selecting the households to
7 participate in the survey interviews, so as to ensure that all the different socio-economic
8 characteristics of a heterogeneous community that may influence community perceptions on
9 co-management impacts are included and tested in the study. In each village, a village
10 register was requested and provided by the communities' village heads. Attention was paid to
11 ensure that the lists do not follow a particular order or social hierarchy (e.g. wealthy status or
12 kinship), so as to ensure that the selected sample is representative of the true population
13 characteristics. The total household list formed the sampling frame from which every fourth
14 household on the list was selected to form part of the study. Where all members of the
15 household were absent, or unwilling to participate, the next household on the list was chosen.
16 For each individual, the interviews were done in isolation to reduce the risk of influencing
17 each other's answers.

18

19 DATA ANALYSIS

20 ANOVA was used to compare means of indicators for forest condition in state
21 management and co-management blocks, and for the different locations. To assess the
22 relationship between tree density and seedlings and saplings density in both state managed
23 and co-managed forest block linear regression was used. Finally, for categorical data,
24 especially in assessing the presence of human activities, chi-square test we used for analysis.
25 The tests were done to assess if forest conditions may be affected by pre-existing forest

1 conditions, and socio-economic variables of participating communities (Bowler et al., 2012).
2 Therefore, the data for each forest reserve in the different districts was analysed separately, to
3 ensure that forest or district specific effects are not masked. Descriptive statistics were used
4 to compare and present the perception-based data. All the data were analysed using STATA
5 11.

6 RESULTS

7 Forest Condition in Co-managed and State managed Forest Blocks

8 FOREST DENSITY IN CO-MANAGED AND STATE MANAGED FOREST BLOCKS

9 Tree density per plot was significantly higher ($p < 0.001$) in Ntchisi than Zomba-
10 Malosa forest reserve, whilst seedlings and saplings density was significantly lower ($p =$
11 0.04) in Ntchisi than Zomba-Malosa forest reserve (Figure 2). In both Ntchisi and Zomba-
12 Malosa, tree density per plot was significantly higher in co-managed than in state managed
13 blocks ($p < 0.001$, $p = 0.01$ respectively, Figure 2a.). Although the difference was not
14 significant, the mean density per plot for seedlings and saplings was higher in co-managed
15 plots than in state managed forest blocks in Ntchisi ($p = 0.43$, Figure 2b.). However, in
16 Zomba-Malosa forest reserve, the mean density per plot for seedlings and saplings was
17 significantly higher in state managed than in co-managed forest blocks ($p < 0.001$, Figure
18 2b.). In both Zomba-Malosa and Ntchisi forest reserve, tree and seedlings and saplings
19 density did not significantly differ with plot location along the transect moving away from the
20 forest boundary (i.e. boundary, and middle or toward centre) in either state managed or co-
21 managed forest blocks.

22 **FIGURE 2-HERE**

1 RELATIONSHIP BETWEEN TREE DENSITY AND SEEDLING AND SAPLING DENSITY IN CO-
2 MANAGED AND STATE MANAGED FOREST BLOCKS

3 There is an inverse relationship between tree density and seedlings and saplings
4 density in both state managed and co-managed forest block in Ntchisi and Zomba-Malosa
5 forest reserve (Figure 3). However, linear regression results showed that the inverse
6 relationship was only statistically significant in co-managed blocks in Ntchisi forest reserve
7 ($p = 0.02$) and state managed blocks in Zomba-Malosa forest reserve ($p = 0.09$).

8 **FIGURE 3-HERE**

9 VARIABILITY IN TREE AND SEEDLING AND SAPLING DENSITY WITHIN MANAGEMENT TYPE

10 Statistically significant differences in seedling and sapling density per plot were
11 observed among forest blocks under co-management in Ntchisi and Zomba-Malosa, as well
12 as among forest blocks under state management in Ntchisi forest reserve (Table 2).
13 Statistically significant differences in tree density per plot were observed among forest blocks
14 under state management in Zomba-Malosa forest reserve (Table 2).

15 **TABLE 2- HERE**

16 TREE AND SEEDLING AND SAPLING SPECIES RICHNESS IN CO-MANAGED AND STATE
17 MANAGED FOREST BLOCKS

18 Tree species richness per plot was significantly higher in Ntchisi forest reserve than in
19 Zomba-Malosa forest reserve ($p < 0.001$). There was no statistically significant difference in
20 tree species richness ($p < 0.09$) or seedling and sapling species richness ($p < 0.13$) between co-
21 managed and state managed forest block in Ntchisi forest reserve (Figure 4). In Zomba-
22 Malosa, co-management forest blocks have a significantly higher tree species richness than
23 state managed forest blocks ($p < 0.001$, Figure 4a.). A total of 24 tree species were observed
24 in co-managed forest blocks, whilst only 7 tree species were observed in state managed forest
25 blocks in Zomba-Malosa forest reserve. However, co-managed forest blocks have

1 significantly lower seedling and sapling species richness than state managed forest blocks (p
2 = 0.01, Figure 4b.). In both Zomba-Malosa and Ntchisi forest reserves, tree and seedling and
3 sapling species richness did not differ significantly with plot location along the transect
4 moving away from forest boundary in both state managed or co-managed forest blocks.

5 **FIGURE 4-HERE**

6 PRESENCE OF HUMAN ACTIVITIES OR DISTURBANCES

7 Indicators of human activities or disturbances observed in the both co-managed and state
8 managed forest block of Ntchisi and Zomba-Malosa forest reserves include: tree stumps, pole
9 stumps, felled trees, farming plots, settlement plots, charcoal pits, debarked trees, lopped
10 trees, hunting pits, evidence of fire and evidence of grazing (Table 3).

11 **Table 3-Here**

12 In Ntchisi, a significantly higher number of tree stumps (p=0.00), and pole stumps
13 (p=0.01) were recorded per plot in co-managed forest blocks than in state managed forest
14 blocks. In Zomba-Malosa, the number of tree stumps (p=0.03), pole stumps (p=0.04),
15 farming plots (p=0.00) and charcoal pits (p=0.04) per plot was significantly lower in co-
16 managed forest block than in state managed forest blocks. However, the number of felled
17 trees (p=0.04) and debarked trees (p=0.00) per plot was significantly higher in co-managed
18 forest block than in state managed forest blocks in Zomba-Malosa forest. Chi-square test
19 show that in Ntchisi forest there was no significant difference statistically in the presence or
20 evidence of fire between co-managed and state management forest blocks, ($\chi^2= 0.025^a$, p=
21 0.875). In Zomba-Malosa presence or evidence of fires was higher in state managed forest
22 blocks than in co-managed forest blocks and the difference was statistically significant at
23 10% level of significance ($\chi^2= 3.441$, p= 0. 064). The presence of human activities and
24 disturbances per plot did not differ significantly with plot location along the transect moving

1 away from forest boundary (i.e. boundary, and middle or toward centre) in either state or co-
2 managed forest block, in either Ntchisi or Zomba-Malosa forest reserves.

3 PERCEIVED IMPACTS OF CO-MANAGEMENT ON FOREST AND FOREST CONDITIONS

4 In Ntchisi district, approximately 73% of respondents perceive that the co-management
5 programme to have had positive impact on forest conditions. Respondents perceive increase
6 in seedlings and saplings or regrowth (47%), 42% a decline in illegal cutting (42%) since the
7 programme started. Additionally, 11% cited the introduction of reforestation and afforestation
8 schemes as an indicator of positive impact. The majority of respondents that perceived a
9 decline in tree population in Ntchisi district attributed the decrease to careless cutting during
10 the edible caterpillar (Matondo) harvesting season (48%), charcoal and firewood for tobacco
11 curing (28%) and poor leadership among committee members or programme leaders (24%).

12 In Zomba-Malosa district, approximately 84% of respondents perceive the co-
13 management programme to have had a positive impact on forest conditions. Respondents
14 cited increase in seedlings and saplings or regrowth (39%), increase in tree stems (16%), a
15 decline in illegal harvesting (19%), introduction of reforestation and afforestation
16 programmes (17%), and improved river flow and water availability (9%), as some of the
17 indicators of a positive impact. Respondents who perceived a decline in tree population
18 attributed it to charcoal production for sale (74%), timber and pole cutting (15%), poor
19 leadership among committee members or programme leaders (8%) and encroachments for
20 settlement and farming (3%). However, the perceived positive impact has yet not translated
21 into increase in forest tree stocks, a majority of respondent 50% (Ntchisi) and 63% (Zomba-
22 Malosa) indicated that the population of trees was higher before the programme started
23 (before 2005) as compared to the current status.

1 MANAGEMENT ACTIVITIES UNDER CO-MANAGEMENT AND STATE MANAGEMENT

2 A number of forest management activities are being carried out in both the co-managed and
3 state managed blocks in both forest reserves. These include, fire break establishment (both
4 within the forest and around the edge of the forest), boundary marking, establishment of
5 forest nurseries and tree planting (Table 4). In Ntchisi, management activities such as
6 firebreak construction, boundary marking and planted trees in and around the forest block
7 were not present in either co-managed or state managed forest blocks (Table 4). Only 2
8 communal forest nurseries were observed in communities that are participating in co-
9 management programme (Table 4). A total of 11 VFA's located within communities
10 participating in the forest co-management programme were also observed.

11 **Table 4-Here**

12 In Zomba-Malosa, management activities such as firebreak construction and
13 maintenance, boundary marking and establishment of forest nurseries are mostly done in co-
14 managed blocks and in communities that are participating in the co-management programme
15 (Table 4). However, no planted trees were observed in or around co-managed forest blocks
16 (Table 4). A total of 37 Village Forest Areas (VFA's) of varying sizes were observed mostly
17 composed of mature natural trees in communities living around Zomba-Malosa forest
18 reserve. The majority of the VFA's, were located in communities participating in the co-
19 management programme (Table 4).

20 DISCUSSION

21 The higher tree density per plot in Ntchisi forest reserve than in Zomba-Malosa forest
22 reserves, show that Ntchisi forest reserve is a closed canopy forest whilst Zomba-Malosa is
23 an open forest. Co-managed forest blocks in both Ntchisi and Zomba-Malosa forest reserve

1 have had higher tree density than state managed forest blocks. Additionally, a majority of
2 respondents in both Zomba-Malosa and Ntchisi also perceive the co-management programme
3 to have a positive impact on forest conditions, against a general worsening trend in forest
4 stocks. Due to lack of information on forest conditions before the programme started, the
5 observed difference in forest conditions between blocks under co-management and those
6 under state management could be attributed to: 1) selection bias at the start of programme
7 (i.e. that the tree density and forest conditions were not equal at the start of the programme,
8 and/or; 2) differences in subsequent management, assuming that the forest conditions and tree
9 density were equal throughout the reserve at the start of the programme (e.g. Gobeze, Bekele,
10 Lemenih, & Kassa, 2009; Phiri, Chirwa, Watts, & Syampungani, 2012).

11 Considering that the programme has only been implemented for seven years at the
12 time of the study, the higher tree density and species richness in co-managed forest blocks
13 could suggest that co-management has resulted in conservation of the mature trees present at
14 the start of the programme, if equal forest conditions and tree density throughout the reserves
15 at the start of the programme is assumed. Government are limited in both human and
16 financial resources, to effectively monitor forest resources against over exploitation hence
17 involvement of local communities in co-management is hypothesised to facilitate forest
18 management (i.e. in terms of human resources) and contribute to conservation. Therefore, the
19 lack of community involvement in the management of the state managed forest blocks of
20 Ntchisi and Zomba Malosa forest reserves may have resulted in continued exploitation of the
21 mature trees hence the decline in tree density and species richness. Furthermore, this may
22 imply occurrence of leakages or displacement effects in the blocks under different
23 management types (Vyamana, 2009). As such, it is possible that the introduction of the forest
24 co-management programme in phases and having co-managed and state managed block
25 within a single reserve has had negative effects on state managed forest areas. Therefore, the

1 higher tree density in co-managed forest blocks could suggest that stricter harvesting and
2 management conditions in these blocks resulted in opening up of the state managed block for
3 exploitation, hence translating into low forest density and species richness. In case of Zomba-
4 Malosa forest reserve, this is further supported by the higher presence of human disturbances
5 and activities in state managed forest block than in co-managed forest block in forest reserve.
6 However, in the case of Ntchisi forest reserve, there is no further evidence to support that the
7 higher tree density and species richness in co-managed forest blocks is a direct result of either
8 the co-management programme or occurrence of leakages, since the results on human
9 disturbance show a higher presence of human disturbances and activities in co-managed
10 forest blocks than in state managed forest block of forest reserve. Therefore, the higher tree
11 density and species richness in co-managed forest blocks in Ntchisi forest reserves could be a
12 factor of existing forest conditions and tree density prior to and at the start of the programme.

13 Respondents in Zomba further attributed the decline in presence of human activities
14 and disturbance (e.g. tree felling, charcoal making and encroachment) in forest reserve, to
15 improved monitoring and enforcement of harvesting laws by the block committee and
16 communities living in and around the reserve. Thus, suggesting that co-management can
17 result in sustainable forest management (Blomely et al., 2008; Phiri, Chirwa, Watts, &
18 Syampungani, 2012). Additionally, there is a lot of statistically significant variation in tree
19 density per plot within some forest blocks under state management in Zomba-Malosa. Such
20 that whilst other no tree counts were recorded in some plots within a block, a high number of
21 trees was recorded in other plots in the same blocks. In plots where a high number of tree
22 densities were recorded, the species were largely *Uapaca Kirkiana* (e.g. Anglican block). It is
23 argued that *Uapaca Kirkiana* fruits significantly contribute rural diet during the food shortage
24 period and sales generate cash incomes for purchasing household goods, farm inputs and
25 meeting social obligations, hence rarely felled (Akinnifesi et al., 2004; Kadzere et al., 2006).

1 The higher seedling and sapling density in state managed blocks in Zomba-Malosa
2 forest reserve indicate that state managed blocks are more heavily exploited than co-managed
3 blocks, as higher presence of seedlings and saplings is often correlated with lower numbers of
4 full grown trees. This is also evident in the low number of tree counts observed in state
5 managed blocks of Zomba-Malosa forest reserve. This corroborate findings by Werren,
6 Lowore, Abbot, Siddle, and Hardcastle (1995) showing that seedlings and saplings as well as
7 smaller trees flourish when the tree density is minimal or in the absence of bigger trees,
8 because there is less competition for light and nutrients. In Zomba-Malosa forest reserve, the
9 heavy exploitation in state managed blocks than in co-managed blocks could also be as a
10 result of differences in the block proximity to the main road and accessibility to markets for
11 forests products. For example, in Zomba-Malosa forest reserves, two of the state managed
12 blocks included in this study, Anglican and Minama management blocks, are located close to
13 the main road; **M3** which connects to the country's central road-**M1** at both ends, i.e. Balaka
14 and Blantyre respectively, whilst all the co-managed blocks are further away from the main
15 road. Therefore, community members living adjacent to Anglican and Minama management
16 blocks, (as well as non-community members) can easily harvest forest products (e.g.
17 charcoal, firewood and timber) and easily sell by the roadside to travellers from other areas or
18 transport to other markets in other area (e.g. Zomba town and Blantyre city). Therefore, the
19 easy access to main road and increasing demand for forest products by travellers could
20 contribute to the differences in tree density and deforestation levels between co-managed and
21 state managed forest blocks in Zomba-Malosa forest reserve. However, the high density of
22 seedlings and saplings in the state managed forest block indicate a potential for tree
23 population recovery, given proper silviculture management practices and sufficient
24 enforcement of rules and regulations (Obiri, Hall, & Healey, 2010).

1 In Ntchisi forest, evidence of human disturbance was significantly higher in plots
2 under co-management than in state managed plots. However, the opposite was observed in
3 Zomba-Malosa forest reserve. This could indicate that, in Ntchisi, co-management may have
4 opened up the reserve for utilization and markets, as during the focus group and key
5 informant interviews, communities in Ntchisi indicated that co-management has brought or
6 introduced new forest based income sources including, timber sales, firewood sales and
7 pottery (clay pots) sales. However, in Zomba-Malosa communities may have reacted to the
8 management and utilization rights under co-management by taking charge and conserving the
9 forest. Therefore, it is possible that co-management programmes may not always be
10 understood or interpreted equally by different communities and hence even though the
11 approach is similar may not always produce equal results (Poteete & Ostrom, 2004; Bowler
12 et al., 2012 & 2010). However, it is also important to note that this could be due to the
13 difference in harvestable forest stocks between Ntchisi and Zomba-Malosa forest reserves.

14 The increase in human activity in co-management forest blocks in Ntchisi forest could also be
15 attributed to limited labour and high time cost for effective monitoring to prevent illegal
16 harvesting in the forest blocks as participation is voluntary. Additionally, the higher presence
17 of physical signs of human activity in co-managed forest blocks of Ntchisi forest reserve and
18 the decline in tree density since the co-management programme began as perceived by the
19 majority of the respondents in Ntchisi, could also be attributed to poor leadership among
20 programme leaders, since approximately 24% of respondents in Ntchisi who perceived a
21 decline in forest status attributed the decline to poor leadership. Poor leadership has also been
22 highlighted as one major contributing factor to failures of participatory forest management
23 programmes by Ostrom (1990), Poteete and Ostrom (2004), Tacconi (2007) and Zulu (2008).

24 A majority of respondents in Ntchisi perceive tree density to have been higher before
25 co-management began. This could be attributed to the fact that, during state management,

1 access and utilization was limited, hence this allowed for conservation and an increase in tree
2 density in the reserves. Instead, the co-management programme supports forest-based
3 enterprises among the participating communities, hence resulting in increased exploitation.
4 Therefore, the higher evidence of human disturbance and activity observed in co-managed
5 forest blocks in Ntchisi forest also explains why the majority of community members in
6 Ntchisi perceived tree density to have been higher before the co-management programme
7 began and think there has been a decrease in tree density since the co-management
8 programme began. Furthermore, the perceived decline in tree density since co-management
9 began could be as a result of other factors such as increase in demand of forest products due
10 to population growth in the communities, over time.

11 Participating communities are allowed to collect dead trees for firewood in protected
12 sections of co-managed forest blocks, but some individuals may debark or lop a tree heavily
13 and let it die, just to come back and collect it as dead wood. Therefore, long term
14 improvement in tree and woody populations could be compromised by heavy debarking and
15 lopping. Thus, there is a need for a proper monitoring mechanism and to ensure that
16 management and utilization rules and regulations are adhered to by all local communities.
17 Additionally, there is a need to identify alternative trees and wood sources, so as to reduce the
18 current pressure on the existing reserves, and also to allow for the recovery or regeneration of
19 harvested forest areas. One such alternative tree and wood source is the establishment of
20 VFA's, which were observed in communities living around both Zomba-Malosa and Ntchisi
21 Forest reserve. Furthermore, VFA's could also present the communities with an investment
22 opportunity for a sustainable flow of forest products for subsistence and commercial value.

23 The results show that forest boundaries were clearly marked and firebreaks
24 constructed in co-managed forest blocks of forest reserve. However, neither marked and
25 constructed boundaries nor were firebreaks observed in Ntchisi forest reserve. Lack of

1 marked boundaries in Ntchisi forest reserves was attributed to the fact that natural relief
2 forms such as rivers and streams are used to mark block boundaries. However, a number of
3 stream and small rivers, both annual and seasonal, flow through Ntchisi forest reserve; hence
4 unless one is well aware of the reserve, it is difficult to recognise the boundaries especially
5 the inner boundaries. This therefore results in difficulties in identification of and exclusion
6 from protected sections, thus making adherence to and enforcement of forest harvesting laws
7 difficult (Ostrom, 1990).

8

9

CONCLUSION AND RECOMMENDATION

10 This study finds that forest co-management has the potential to improve forest conditions,
11 however, the direction of impact may not always be positive, and vary depending on pre-
12 existing forest conditions how participating communities understand and interpret the
13 programme. For that although we expected that human activities and disturbance will be
14 minimal in co-managed forest blocks, some of the activities (e.g. the number of felled trees
15 and debarked trees per plot) was significantly higher in co-managed forest block than in state
16 managed forest blocks in Zomba-Malosa forest. Thus this shows that co-management
17 outcomes will vary depending on pre-existing forest conditions as well as on how
18 participating communities understand and interpret the programme. Hence forest co-
19 management programmes may not always be a solution to degradation, but it can also
20 enhance degradation in other areas. Therefore, co-management programmes and activities
21 should not be considered as a universal package, however, should be designed to take into
22 account the socio-economic characteristics of specific participating community and pre-
23 existing condition of the forest.

24 Biological indicators of conservation (e.g. tree density and species richness) take time to
25 respond to management programmes; therefore, the inclusion of physical signs of human
26 activities in the forests as indicators to predict potential impact of the programme on forest
27 condition is essential in evaluation studies. This study supports the use of method
28 triangulation and multiple data types in forest co-management impact studies as it allows for
29 a more robust assessment, and should be widely applicable to other evaluation studies.
30 However, the study also demonstrates that, even with method triangulation, it is difficult to

1 determine the effectiveness of co-management on forest conditions from one-time study data.
2 Thus, we recommended integration of participatory research as key component of the
3 programme, to allow for evaluation and attribution of the observable changes both in time
4 and space to the programme. We further, recommend a follow-up forest inventory study to
5 allow for; attribution of the differences in forest condition to differences in management
6 approaches. We further recommend identification of major drivers of the degradation,
7 specific for each location, as this will inform future designs for effective implementation of
8 co-management programmes.

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TABLES

Table 1: Parameters for assessing impact of co-management on forest conditions

Indicators	Parameters	Reference
Change in forest and forest resources condition	1. List of tree species ¹ ,	Blomley et al. (2008), Ahrends 2005, Meshack et al. (2007)
	2. Tree counts ²	
	3. Regeneration (seedlings and saplings) counts ³	
Presence of human activities or disturbances	1. Tree stumps	Blomley et al. (2008), Ahrends (2005), Antinori and Rausser (2007)
	2. Pole stumps	
	3. Number of felled trees present	
	4. Number of Pit-saw timber harvesting sites,	
	5. Counts of Charcoal production pits,	
	6. Number of trees debarking	
	7. Number of farming plots.	
	8. Settlement plots (1= yes; 0= no evidence)	
	9. Presence of fire (1= yes; 0= no evidence)	
	10. Hunting pits	
Evidence of good forest management practices	1. Marked boundaries and fire breaks	
	2. Number of forest nurseries	
	3. Evidence/counts of planted village forest and afforestation	

Note

¹ List of tree species, on assumption that since its one reserve the species should be the same.

² Trees are defined as all trees with straight stems at least 3 m in length and exceeding 15cm DBH (Doody et al., 2001).

³ Seedlings and saplings are defined as woody plants with height ≤ 1.5 m, and > 1.5 m but less than 2m, respectively, with DBH < 10 cm (Kelbessa and Soromessa, 2004 in Gobeze, Bekele, Lemenih, & Kassa, 2009). In this study Seedlings and saplings are referred to as regeneration

Table 2: Summary of ANOVA results on tree and seedling and sapling density between blocks within management type in Ntchisi and Zomba-Malosa forest reserves

Forest Name	Management type	Variable-(Density)	ANOVA-Significance	
			F	(<i>p-value</i>)
Ntchisi	State management	Tree	1.300	0.291
		seedlings and saplings	9.907	0.001
	Co-management	Tree	1.300	0.291
		seedlings and saplings	5.590	0.011
Zomba-Malosa	State management	Tree	4.737	0.019
		seedlings and saplings	0.984	0.389
	Co-management	Tree	1.687	0.206
		seedlings and saplings	8.379	0.002

Table 3: Average counts of human activity indicators observed in state managed and co-managed blocks in Ntchisi and Zomba-Malosa forest reserves

Indicator	Ntchisi forest reserve		Zomba-Malosa forest reserve	
	State management (n=27)	Co-management (n=26)	State management (n=26)	Co-management (n=27)
Tree stumps	5.78	12.27**	13.73	6.81**
Felled trees	1.04	1.73	1.88	0.74**
Debarked trees	1.59	2.04	0.54	2.48**
Lopped trees	3.11	1.88	4	5.00
Farming plots	0	0	1.31	0.08**
Settlement plots	0	0	0.12	0
Charcoal pits	0	0	1.96	0.13**
Fires (categorical scale yes=1; no=0)	0.56	0.58	0.73	0.48*
Grazing(categorical scale yes=1; no=0)	0.29	0**	0	0

**-presence of indicator significantly different in plots under state management and co-management at 5% level of significance

Table 4: Total number of forest management activities observed in and around state and co-management forest blocks and surrounding communities in Zomba- Malosa and Ntchisi forest reserves

Activity	Ntchisi		Zomba-Malosa	
	State management (n=26)	Co-management (n=27)	State management (n=26)	Co-management (n=27)
Firebreaks	0	0	2	10
Marked boundaries (constructed)	0	0	2	11
Number of forest nurseries	3	2	2	2
Presence of planted trees	0	0	6	0
Village Forest Areas	4	11	14	23

n = total number of plots.

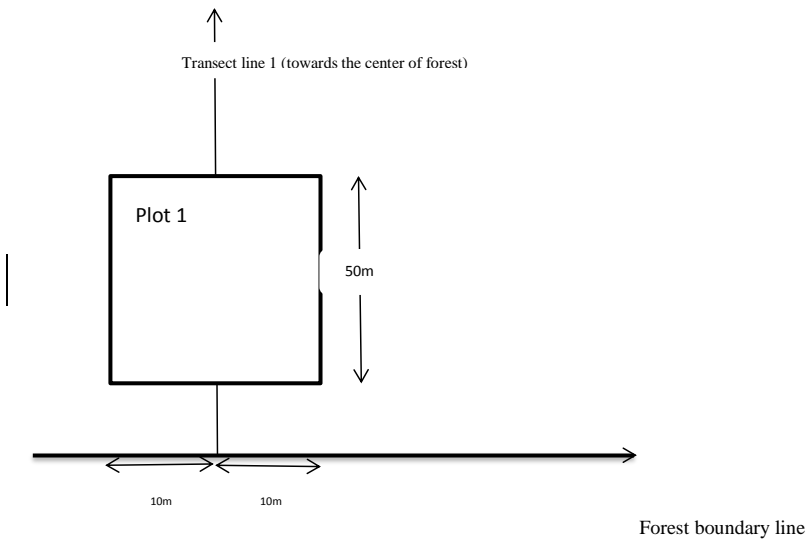
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Figure 1: Transect and plot layout within a block

Figure 2: Mean number of; a) trees; and b) seedlings and saplings per plot in forest block under Government and co-management in Ntchisi and Zomba-Malosa Forest Reserves.

Figure 3: Scatter plots showing the relationship between tree and seedling and sapling density in Ntchisi and Zomba-Malosa forest reserves.

Figure 4: Mean number of: a) tree species; and b) seedling and sapling species, per plot in forest block under Government and co-management in Ntchisi and Zomba-Malosa Forest Reserves.



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