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SOCIO-ECONOMIC AND ECOLOGICAL OUTCOMES OF WOODLAND MANAGEMENT IN MUTEMA-MUSIKAVANHU COMMUNAL AREAS IN SAVE VALLEY, SOUTHEASTERN LOWVELD OF ZIMBABWE

C. Mashapa[1*], E. Gandiwa[1] and N. Muboko[1]

[1]School of Wildlife, Ecology and Conservation, Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe
[*]Corresponding Author: clayiemashapa@yahoo.co.uk

ABSTRACT

This study assessed institutional governance, socio-economic and ecological outcomes of community woodland management in Mutema-Musikavanhu communal areas in Save Valley, southeastern lowveld of Zimbabwe. The study was conducted using household interviews (n = 300), focus group discussions (n = 80) and key informant interviews (n = 20) administered in October to December 2017. The interview questions drew responses on the linkages between local level institutions and communal woodland management for socio-economic outcomes. Using remote sensed imagery of the study area, land use and land cover maps for the period 1990 to 2015 were produced. Woody vegetation structural attributes, abundance and composition were measured to assess the ecological outcomes of communal woodland management. The study findings showed that the local level institutional design influenced socio-economic outcomes that enabled villagers to make up to 12.82% of their Global Annual Income from woodland ecosystem services and goods. Ecological outcomes record showed a decrease of land cover under woodland by over 29%, whereas land under agriculture increased by over 31% during the period 1990 to 2015. The study recorded a *J*-shaped stage structure of basal area which indicated low recruitment levels and an ageing population of woody vegetation across the study area. Communal woodland management in the study area was likely constrained by weak participation of government forestry extension service and discrepancy in woodland ecosystem benefits sharing among local villagers. Based on the study findings, it was concluded that, provided community woodland resource ownership is secured with equity on access to all members of a society and integrated with active local government regulation, then the likelihood that communities would defer woodland resource use for the future generations is less threatened.

Key words: communal, ecosystem services, institutions, livelihoods, woodland.

INTRODUCTION

Woodlands provide ecosystem services, including provisioning, supporting and cultural services for human well-being. Human development and woodland sustainability are interlinked and threatened by anthropogenic-driven challenges of our time (Dezécache *et al*., 2017). As a result, there is a consensus that we are in a new world state of human-dominated ecological epoch (Lewis and Maslin, 2015). Direct human interactions with the natural environment, especially in the domain of socio-ecological systems, are complex and happen at multiple scales (Gbedomon *et al*., 2016). In southern Africa, two factors exist in community based natural resource management (CBNRM) on communal land tenure (Roe *et al.*, 2003). Firstly, the unit of proprietorship in communal areas is a collection of common interests and secondly, related complication is the need for the equitable distribution of the benefits of participating in CBNRM (Mbereko *et al*., 2015). Collective proprietorship in CBNRM is specifically relevant following the ‘tragedy of the commons’ concept (Hardin, 1968) which argued that individual decisions in a community are influenced by self-interests. World-wide it is reported that mismanagement of woodlands already threatens and will continue to threaten, future global food and energy security (Hardin, 1968; World Bank, 2008), hamper capacities for conservation of biodiversity and woodlands thereby threatening livelihoods (Ingram, 2017).

In Zimbabwe, state-centric technical approaches to conservation proved not to be the panacea implied in protectionist agendas in relation to wildlife and woodlands. CBNRM approaches were partly driven by emerging evidence in the 1990s of the failures of state-controlled conservation of wildlife and woodlands (Jones and Murphree, 2004; Mbereko *et al*., 2015). Common to CBNRM is the identified need for devolution of power and authority across local level institutions constituted of traditional leaders and government structures (Roe *et al.*, 2003; Mhuriro-Mashapa *et al*., 2017). CBNRM programmes in Zimbabwe are implemented across different resources including veld products in wildlife and woodland resources (Jones and Murphree, 2004). In this diversification, the issues of CBNRM and the accompanying institutional arrangements and livelihoods have remained critical. Dealing with these issues has involved different forms of partnerships ranging from co-management arrangements, decentralization/devolution of power and authority to lower tiers of government, local communities or private sector (Mbereko *et al*., 2015). Despite the focus of CBNRM across sectors in Zimbabwe and other countries in southern Africa, concerns for biodiversity and woodlands degradation continue to be preeminence (Roe *et al*., 2003).

The socio-economic and ecological outcomes of community woodland management in situations where property rights are conferred to communal people have been less investigated in Zimbabwe. Community woodland management approach is expected to alleviate poverty among woodland resource users, empower them and improve the condition of the woodland ecosystem (Maryudi *et al*., 2012; Kathri *et al*., 2016). In this study, we revisited the linkages between communal woodland property rights, local institutions at work and the socio-economic benefits and conservation of woodland resources in Mutema-Musikavanhu communities in southeastern lowveld of Zimbabwe (Fakarayi *et al*., 2014; Mashapa *et al*., 2014). This study addressed the concept of CBNRM in Mutema-Musikavanhu communities and their capacity to manage woodland resources for socio-economic benefits. The objectives of the study were three folds, namely, (i) to analyze the institutional arrangement and the approaches promoted for communal woodland management, (ii) evaluate socio-economic benefits of livelihood activities based on woodland ecosystem services, and (iii) to assess ecological outcomes related to land use and land cover changes in a communal woodland management context in Mutema-Musikavanhu communities, southeastern lowveld of Zimbabwe.

MATERIALS AND METHODS

Study area: The study was conducted in Mutema-Musikavanhu communal areas in Save Valley, southeastern lowveld of Zimbabwe (Figure 1). The two wards of Mutema and Musikavanhu communities had higher human density (over 36 peoples per km^2) as compared to the Zimbabwe national average of about 33 peoples per km^2 (ZimStats, 2013). The mean annual rainfall is about 550 mm with an annual temperature range of 18 to 35°C (Mhuriro-Mashapa *et al*., 2017). In this study area, first settlers were hunters, gatherers and subsistence farmers who delimited large lands (including woodlands) and considered these as under their control based on family clan lineage and traditional leaders of Mutema and Musikavanhu chieftainship (Moyana, 1984), who in turn exerted customary ownership rights including use, allocation and intergenerational transmission common for the non-gazetted forestry and communal lands of Zimbabwe (Madondo, 2000). The vegetation of Save Valley, southeastern lowveld of Zimbabwe is typical of the semi-arid deciduous African savanna with *Colophospermum mopane* and *Acacia* woodland being common vegetation types (Seydack *et al*., 2012).

Data collection

Sampling procedure and sample size: Between October and December 2017, a purposive sampling technique was used to identify study respondents through referrals based on their village class status and involvement in CBNRM in relation to communal woodland management. Study respondents, 300 households and 20 government extension workers, were selected to participate in the study. A focus group discussion (FGD) was held with 80 villagers. Households as study respondents were stratified into three key groups based on inhabitant status and village classification: (1) family clan members of the traditional paramount chieftainship leaders (VC1); (2) family clan members of the traditional village leaders (VC2); and (3) family clan members of villagers with no traditional leadership role (VC3). Key informants of the study were derived from government extension workers (n = 20). The characteristics of study respondents are presented in Table 1.

Institutional arrangements promoted for woodland management: To understand the role of local institutions and how they are promoted for communal woodland management, the study respondents (n = 80) were interviewed through FGD. FGDs were guided by three main open-ended questions meant to solicit responses from the people: (1) what are your expectations from the government and/or traditional leaders on the promotion of local level institutions on communal woodland management, and (2) how do you describe and comment on the relationship between local level traditional institutions and government institutions towards communal woodland management and why? The FGD were administered with a group of 10 peoples (5 males and 5 females) drawn from VC1, VC2, VC3 and government extension workers from each of the two study strata (Table 1). Eight FGDs (n = 80) were held across the study strata. The FGD respondents were further asked to state the strengths, weaknesses, opportunities and threats of communal woodland management across the study area.

Evaluation of the socio-economic benefits of woodland utilization by people: The contribution of woodland resource income to household Global Annual Income (*GAI*) of the three defined classes of villagers as woodland resource users (Table 1) was used as proxy to indicate the economic outcomes of woodland management in the study area (Gbedomon *et al*., 2016). Based on study respondents' inhabitant status and village classification (Table 1), individual interviews were administered to households (n = 300) to record and evaluate all woodland ecosystem productive activities conducted between May 2017 and October 2017.

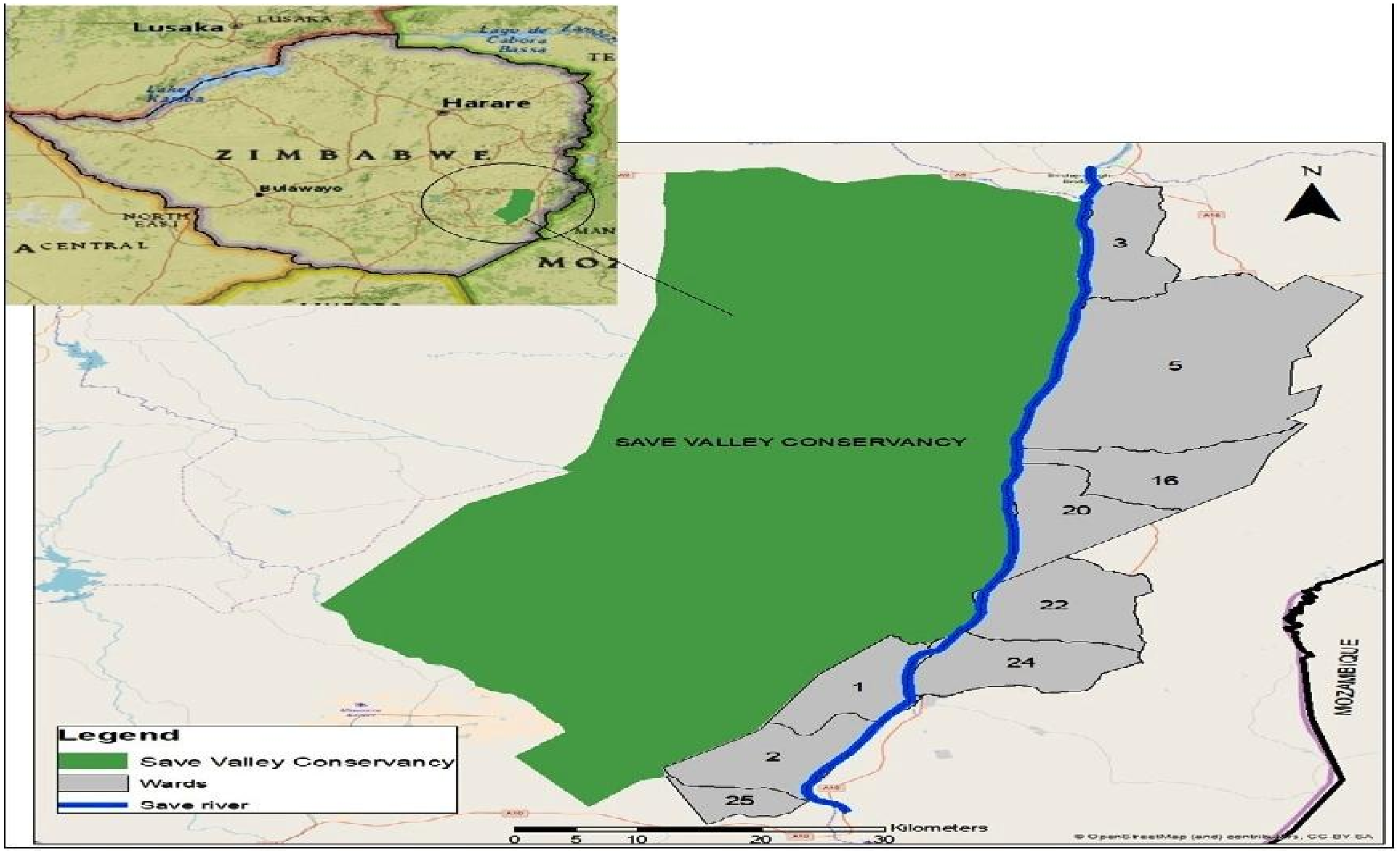

Figure 1. The study area of Save Valley, southeastern lowveld of Zimbabwe, showing Save Valley Conservancy and the surrounding communal areas. Note: Ward 3 is Mutema communal area and Ward 16 is Musikavanhu communal area.

Table 1. Distribution and characteristics of study respondents across Mutema-Musikavanhu communities in Save Valley, southeastern lowveld of Zimbabwe.

Study stratum community area	Population	Estimated number of households	Average household size	Distribution of study respondent								Total sample (*n*=320)
				Family clan Paramount chief leaders (VC1)		Family clan of village leaders (VC2)		Villagers with no leadership role (VC3)		Government Extension workers (key informants)		
				Males	Females	Males	Females	Males	Females	Males	Females	
Mutema	11 078	2 560	4.3	10	8	43	43	16	26	5	5	156
Musikavanhu	11 807	2 748	4.3	11	11	47	43	21	21	5	5	164

Woodland ecosystem productive activities included both non-timber and timber products and woodland ecosystem services e.g., firewood, timber, traditional medicine and innovative activities related to the woodlands (beekeeping, handcrafting, livestock production, woodland management, and other service provision) were recorded and their household income assessed, including the value of domestic consumption.

Ecological outcomes of community based woodland management: Land use and land cover changes were quantified throughout the study area using remotely sensed satellite images acquired from the National Aeronautics and Space Administration (NASA), (LANDSAT TM, path 170 raw 73) using ArcGIS 9.0 software (ESRI, 2004), following the method of Fakarayi *et al*. (2015). Land cover images for the study area were classified based on three techniques: unsupervised K-means, supervised spectral angle mapper and visual interpretation (Giri and Jenkins, 2005). We preferentially selected images taken during cloudless days of March, April and May for the years 1990, 1995, 2000, 2005, 2010 and 2015. Co-registration was done so that corresponding pixels from different dates were matched, which aided in the comparison of specific land cover units over time (Fayad, 2016). Geo-referencing of all land cover images was done based on the Ground Control Points (GCPs) collected using hand-held Geographical Positioning System (GPS). To assess woody vegetation status across the study area, 60 sample plots of 30 m × 20 m were randomly set up across the two study strata, where within each sample plot, woody species and diameter at breast height (dbh) were recorded in December 2017, for all woody plants.

Data analysis

Institutional arrangements promoted for woodland management: Qualitative data from both FGDs interviews were analyzed using content analysis where the key issues were grouped into themes (Mutanga *et al*., 2017). A thematic coding framework was designed based on the emerging themes which were coded using Microsoft Word version 2013. After coding, a text file was generated for each code that listed the relevant data. Systematic analysis of text files generated a description of the local level institutional arrangements for communal woodland management (Allendorf, 2010). Focus group discussant responses were sorted into different influencing determinants of promotion of institutions of communal woodland management (Maryudi *et al*., 2012).

Evaluation of the socio-economic of woodland utilization: Following the methods of Gbedomon *et al*. (2016) household economic benefits derived from woodlands were analyzed. Annual incomes of all woodland ecosystem productive activities were aggregated to get the *GAI* of individual household study respondent.

$$GAI_k = \sum_{i=1}^{m} AL_i \text{ with } AL_i = GO_i - OC_i$$

Where, GAI_k is the global annual income of study respondent k; AI_i is the annual income of woodland ecosystem productive activity i (i = 1 to m, m being the total number of woodland ecosystem productive activities of study respondents k); GO_i is the gross output of woodland ecosystem productive activity i and OC_i is the operating costs related to woodland ecosystem productive activity i. Cash flow (*CF*) or monetary income was also determined for each woodland ecosystem productive activity and aggregated for each study respondent.

$$CF_k = \sum_{i=1}^{m} CF_i \text{ with } CF_i = SV_i - MC_i$$

Where, CF_k is the cash flow of study respondent k; CF_i is the cash flow of woodland ecosystem productive activity i (i= 1 to m, m being the total number of woodland productive activities of study respondents k); SV_i is the sales value of woodland ecosystem productive activity $_i$ and MC_i is the monetary costs of woodland ecosystem productive activity i. It was then possible to calculate the contribution of Mutema-Muskivanhu communal woodlands to the *GAI*, by aggregating the incomes of woodland ecosystem productive activities dependent on the woodland resources and woodland ecosystem services.

$$\%RF_i = \frac{GAI_{woodland_i}}{GAI_i} \text{x } 100$$

Where $\% RF_i$ = contribution of the Mutema-Musikavanhu communal woodlands to *GAI* of study respondent *'i'; GAI woodland*$_i$ = Global annual income linked to Mutema-Musikavanhu communal woodlands *and* GAI_i = income of all woodland ecosystem productive activities of study respondent *'i'*.

$$\%RF_i = \frac{CF_{woodland_i}}{CF_i} \text{x } 100$$

Where, $\% RF_i$ = contribution of the Mutema-Musikavanhu communal woodlands to *GAI* (monetary) of individual household study respondent *'i'; CFwoodland*$_i$ *= Global annual income (monetary)* linked to the Mutema-Musikavanhu communal woodlands and CF_i = Monetary income of all woodland ecosystem productive activities of individual household study respondent *'i'*.

Ecological outcomes of community based woodland management: Using STATISTICA in SPSS version 20, a simple linear regression analysis was done with year as an independent variable and land use category as a dependent variable, to determine a trend of land use and land cover change across the study area for the period

1990 to 2015. The stem diameter size class distribution (SCDs) was established to analyze pattern in woody vegetation growth (Cunningham, 2001). A matrix $m \times n$ (m being the total number of woody species recorded over the n sample plots, $n = 60$) of woody species coefficient of abundance was drawn. For each study stratum of Mutema and Musikavanhu communal area, as well as for the overall woodland of Mutema-Musikavanhu communities, three floristic diversity parameters (species richness, Shannon diversity index and Pielou evenness) were calculated (Gbedomon *et al*., 2016). Woody species diversity and structure data were tested for normality using the Shapiro-Wilk test. To test whether woody vegetation diversity and structure was different between the two study strata of Mutema and Musikavanhu, we performed Mann–Whitney *U* tests (one-tailed) since all data was not normally distributed (Sokal and Rohlf, 1995). All data were tested at 0.05 level of significance.

RESULTS

Institutional arrangements promoted for woodland management: VC1 ($n = 40$; 13.3%) oversee regulating access to land and woodland resources, enacting rules and regulations as well as restrictions for land and woodland ecosystem productive activities. As soon as VC1 review rules and regulations on certain livelihood activities based on woodland resource utilization from their initial user rights, then the same would automatically apply to the other two Villager Class (VC) groups (VC2 and VC3). VC2 ($n = 176$; 58.7%), serve as a lower traditional leadership rank at village level of the Mutema-Musikavanhu chieftainship and taking charge of day to day community leadership and control against illegal utilization of woodlands at village level. Each traditional village head of VC2 appoint 3 to 5 unpaid natural resource overseers (*mupurisa waSabhuku*) who monitor community social co-existence, woodland resource use and advises traditional village heads on what action to take in cases of infringements of 'laid down procedures' of woodland ecosystem productive activities. The laid down procedures were unwritten and thus open to various interpretations. The natural resource overseer would charge penalty fees or refer to the village head who could take the issues up with the paramount chief if the infringement is deemed serious. VC3 ($n = 84$; 28%) comprised of recent and temporary inhabitant households of Mutema-Musikavanhu communities who were only granted very restrictive access rights to woodland ecosystem productive resources and services.

Majority of FGD study respondents ($n = 75$; 93.8%) reported that the local government system in Mutema-Musikavanhu communal area in Save Valley, southeastern lowveld of Zimbabwe had formal institutional hierarchies, that is a decentralized local government extension service system encompassing rural district development committees, ward development committees (WADCOs), and village development committees (VIDCOs) and a multi-sectoral hierarchy of government extension departments all fanning out at the local level into several administrative institutions mandated to promote community based woodland management. However, the majority of FGD study respondents ($n = 62$; 77.5%) reported that outcomes of these CBNRM approaches, range from relative success in the late 1990s to current failure, partly associated with the government treasury's lack to fund the government extension department of natural forestry and subsequent failure to deploy related government personnel at village level. The local government and its extension workers were reported ($n = 54$; 67.5%) weakly involved in decision-making concerning communal woodland governance while more deployment in the study area was biased towards promoting agricultural extension service delivery.

Socio-economic benefits of livelihood based on woodland ecosystem services: User rights for woodland resources varied among the three user groups of the village classes. The mean Global Annual Income was US$ 942 ± 57.34 for woodland resource users from VC1, US$ 1640 ± 46.30 for users from VC2 and US$ 559 ± 47.08 for users from VC3. There was significant difference in the total global annual income (p = 0.001) between the three local groups of woodland resource users. There was also significant difference ($p = 0.004$) among these village class group of local people regarding the contribution of the woodland ecosystem productive activities to their *GAI*. Mutema-Musikavanhu communal woodlands contributed on average to12.82%, 9.04% and 0.04% to the *GAI* of local people from VC1, VC2 and VC3 respectively. Based on user rights discrimination around the woodland ecosystem productive activities, the contribution of Mutema-Musikavanhu communal woodlands to the *GAI* rose with an increase in access to woodland resources. However, in relation to the monetary income (cash flow), local woodland resource users from VC2 derived up to 8.23% of their income from woodland ecosystem productive activities, which was more than four times as compared to local users of VC1 who use woodland resources mainly for home consumption. Local woodland resource users of VC3 derived no cash from Mutema-Musikavanhu woodlands resources.

Woodland ecosystem productive activities were pooled in two categories: conventional activities (firewood collection, livestock grazing) and innovative activities (hunting, timber harvesting, wild fruits harvesting beekeeping, and service provision such as honey processing, handcrafting, carpentry, medicinal plant gathering). Unlike woodland resource users from

Table 2a. Land use and land cover change in Mutema communal area.

Land use and Land cover over time	1990 Area (ha)	1990 to 1995: % change	1995 Area (ha)	1995 to 2000: % change	2000 Area (ha)	2000 to 2005: % change	2005 Area (ha)	2005 to 2010: % change	2010 Area (ha)	2010 to 2015: % change	2015 Area (ha)	% change over 1995 to 2015
Woodland	4,713.27	-0.76	4,677.63	-19.85	3,749.23	-2.29	3,663.51	-16.62	3,054.55	-21.61	2,394.32	-49.20
Agriculture	6,236.24	+0.58	6,272.42	+16.13	7,284.38	+0.72	7,336.51	+10.60	8,114.01	+05.83	8,587.19	+37.70
Grassland	49.18	-35.82	31.56979	+57.15	49.61243	+104.26	101.34	-71.21	29.17359	+374.64	138.47	+181.50
Water	210.39	+8.11	227.4709	-44.67	125.8666	-14.41	107.7247	-89.46	11.35023	+685.00	89.09937	-57.65

Table 2b. Land use and land cover change in Musikavanhu communal area.

Land cover and land use change over time	1990 Area (ha)	1990 to 1995: % change	1995 Area (ha)	1995 to 2000: % change	2000 Area (ha)	2000 to 2005: % change	2005 Area (ha)	2005 to 2010: % change	2010 Area (ha)	2010 to 2015 % change	2015 Area (ha)	% change over 1995 to 2015
Woodland	7,087.03	-7.44	6,559.96	-3.96	6,299.98	-7.03	5,857.01	-8.82	5,340.40	-6.68	4,983.80	-29.68
Agriculture	6,885.01	+7.62	7,409.70	+4.62	7,751.97	+5.66	8,191.02	+4.54	8,562.86	+5.68	9,049.35	+31.44
Grassland	177.27	+1.22	179.43	-28.96	127.4706	+4.37	133.0382	+103.49	270.72	-62.12	102.5413	-42.16
Waterbody	46.35	+0.49	46.58	-65.14	16.23693	-10.14	14.59026	+48.57	21.67647	+176.67	59.97332	+29.40

VC2 whose important part of woodland resource-based income came from innovative activities (80.50%), woodland resource users from VC1 were mainly involved in conventional activities (60.80%). Similarly, woodland resource users from VC3 were associated with conventional activities especially firewood collection. Restrictions concerning timber harvesting seem to be weakly observed and conventional activities provided almost no cash for VC3, while timber harvesting, firewood collection and service supplies were main sources of cash regardless of access rights. They provided an average users from VC1 with 50.5% of cash from woodland resources and users from VC2 with 75.80%.

Ecological outcomes of community based woodland management

Land use and land cover change: The land use and land cover were classified into five classes: woodland, agriculture, grassland and water body (Table 2a; b). The Mutema-Musikavanhu communal woodlands had been conceded for farming purpose with increase of agricultural land between the year 1995 to 2015 (> 31.44% of agricultural land) probably at the loss of woodlands (< 29.68%).

A simple linear regression was calculated to predict land use and land cover change based on years and significant regression equations were found as shown below for Mutema and Musikavanhu communities, respectively. This trend analysis showed land use and land cover change of significant increase of land under agriculture and with a corresponding significant decline of woodland cover across the study area.

Regression equations for land use and land cover change in Mutema communal area: Woodland: y = 1.931E5 - 94.57*x; r = -0.976, **p = 0.001**; r^2 = 0.953; *result was decline in woodland cover*

Agricultural: y = -1.910E5 + 99.038*x; r = 0.976, **p = 0.001**; r^2 = 0.952; *result was increase in agricultural land cover*

Grassland: y = -5551.759 + 2.806*x; r = 0.599, p = 0.209; r^2 = 0.359; *result was non-significant change on grassland cover*

Waterbody: y = 14694.916 - 7.274*x; r = -0.848, p = **0.033**; r^2 = 0.719; *result was decline in waterbody cover*

Note: Significant change at p < 0.05

Regression equations for land use and land cover change in Musikavanhu communal area: Woodland: y = 1.733E5 - 83.530*x; r = -0.997, **p = 0.001**; r^2 = 0.994; *result was decline in woodland cover*

Agricultural land: y = -1.605E5 + 84.116*x; r = 0.999, **p = 0.001**; r^2 = 0.997; *result was increase in agricultural land*

Grassland: y = 1243.063 - 0.538*x; r = -0.084, p = 0.874; r^2 = 0.007; *result was no change on grassland cover*

Waterbody: y = 128.531 - 0.047*x; r = -0.023, p = 0.966; r^2 = 0.001; *result was no change on waterbody cover*

Note: Significant change at p < 0.05

Land use and land cover maps of Mutema and Musikavanhu study area from satellite images of the years 1990, 1995, 2000, 2005, 2010 and 2015 are shown in Figure 2a; b respectively. By the year 2015 more fields of land under cultivation were scattered across the study area than in the year 1990.

Woody vegetation status across Mutema-Musikavanhu communal area: One hundred and ninety-two (192) woody species were recorded across the study strata whereas, 98 described as trees and 155 shrubs. Overall 46 families and 151 genera of woody plants were recorded in Mutema-Musikavanhu communal area, southeastern lowveld of Zimbabwe, for a sampling effort of 5%. The dominating taxonomical families of woody plants were *Leguminosae–Caesalpinioidae-Combretaceae* (16.80%). The most occurring species were *Colophospermum mopane* (12.11%), *Acacia nigrescens* (11.65%), *Acacia weiwitchii* (10.75%), *Combretum apiculatum* (9.15%). *Kirkia acuminate* (7.72%), *Commiphora mollis* (6.99) and *Adansonia digitata* (5.95%). Understorey shrubs include *Markhamia acuminata*, *Cassia abbreviata*, *Sclerocarya caffra*, *Pterocarpus rotundijolius* and *Commiphora pyracanthoides, Gardenia resiniflua* and *Monodora junodii.*

Basal area (Mann-Whitney (*U)* = 634, *p* = 0.004) and plant density (*U* = 634, *p* = 0.001) of woody species was significantly higher in the Mutema communal study stratum as compared to the communal woodlands of Musikavanhu community study stratum (Table 3). In contrast, there were no significant differences between the communal woodlands of Mutema and Musikavanhu communal woodlands strata in the following woody vegetation variables: (1) species richness (*U* = 891, *p* = 0.056); (2) Shannon diversity (*U* = 989, *p* = 0.731); (3) Pielou eveness (*U* = 1 100, *p* = 0.072).

The diameter size class distribution (SCD) of wood plant across the study strata (Figure 3) indicated a negative skewed "*J* "shape. The most frequent (> 50%) individuals woody plant had diameters greater 0.35m. Figure 4, juvenile woody plants of less than 0.35m DBH were scarce across the study stratum.

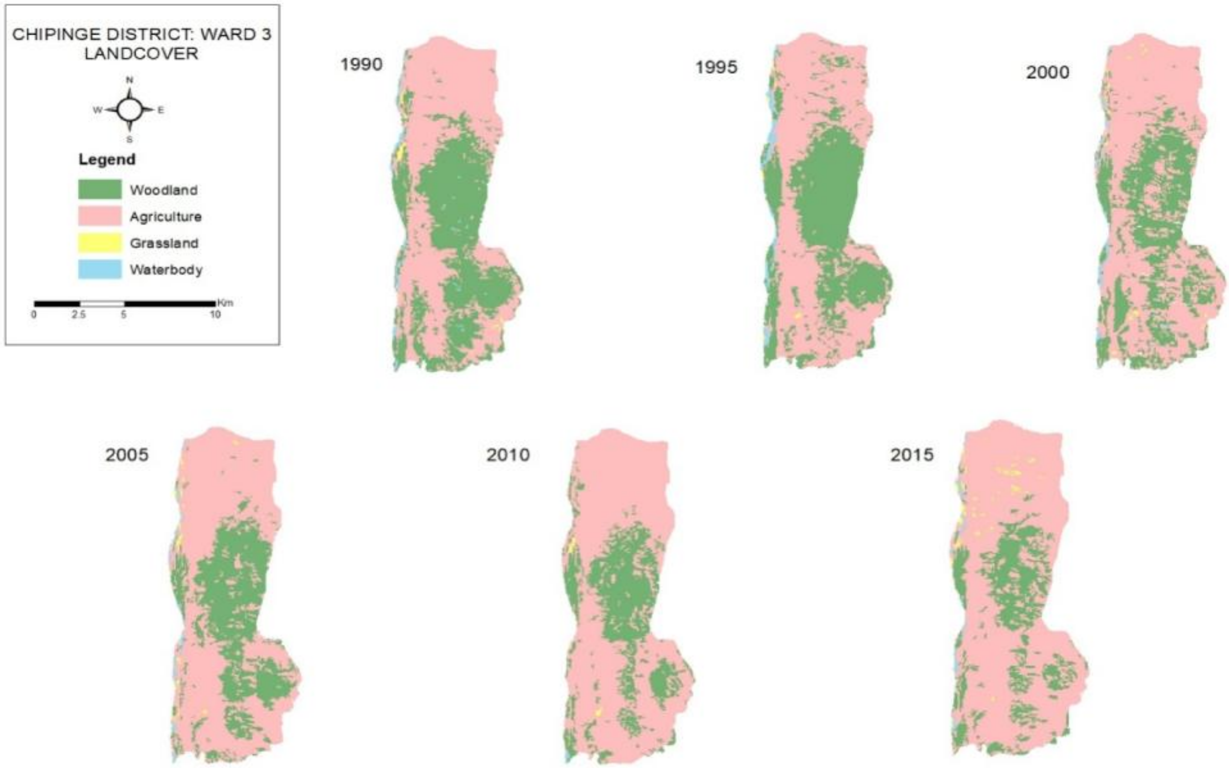

Figure 2a. Land use and land cover map of Mutema communal area in Save Valley, southeastern lowveld of Zimbabwe for the period 1990 to 2015. Note Chipinge District, Ward 3 = Mutema communal area

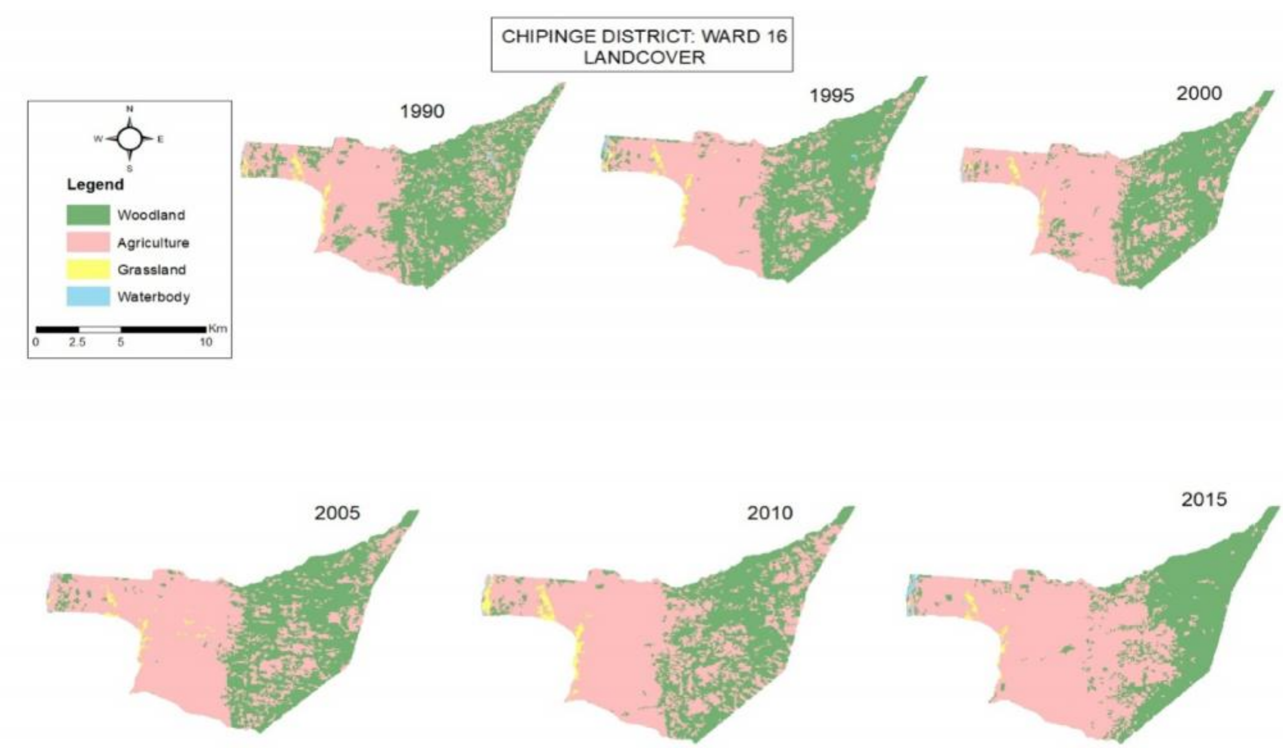

Figure 2b. Land use and land cover map of Musikavanhu communal area in Save Valley, southeastern lowveld of Zimbabwe for the period 1990 to 2015. Note Chipinge District, Ward 16 = Musikavanhu communal area

Table 3. Comparison of measured woody vegetation variables in Mutema-Musikavanhu communal areas. Data are expressed as the median and range.

Variable	Mutema stratum	Musikavanhu stratum	*p*-value
Species richness (S, species)	82.00 (17.29)	62.00 (37.40)	0.065
Shannon diversity (H′)	1.39 (2.12)	0.89 (1.98)	0.731
Pielou eveness (Eq)	0.84 (0.11)	0.83 (0.05)	0.0712
Woody plant density (N, stems·ha^{-1})	103.93 (23.46)	146.00 (28.33)	0.001*
Basal area (G, m^2·ha^{-1})	36.06 (77.22)	18.34 (98.69)	0.043*

NB: * represent significant difference at $p < 0.05$

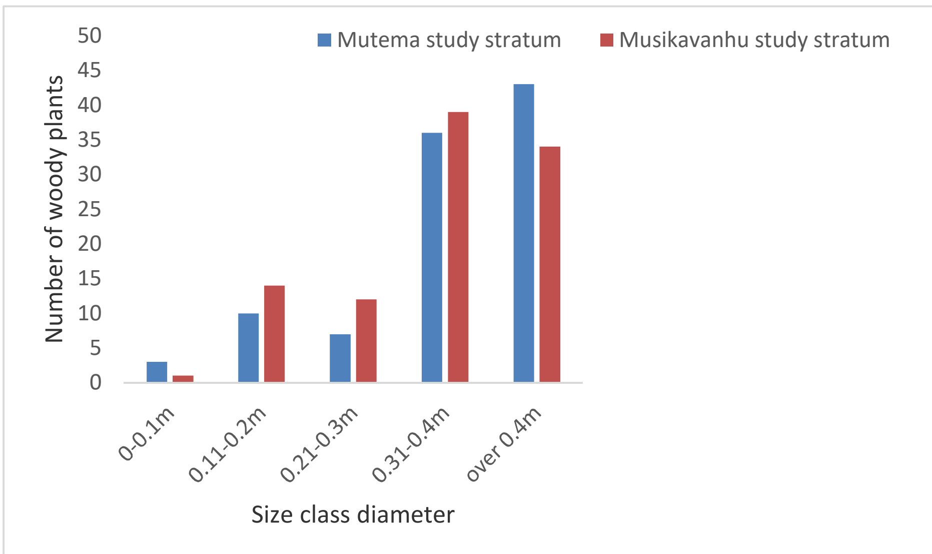

Figure 4. The size class distribution of woody species within Mutema-Musikavanhu communal areas in Save Valley, southeastern lowveld of Zimbabwe.

DISCUSSION

Local institutional arrangement for communal woodland management: The study recorded institutional arrangements that link local level traditional leaders and government stakeholders (local woodland resource users and local government extension agents). The originality of this scheme of CBNRM is the reinforcement of the traditional leadership customary institutions combined with the promotion of household income generating activities out of the woodland ecosystem productive activities as opposed to the benefits normally derived from wildlife based CBNRM. The present CBNRM driven by the woodland resources is maintained by a class of villagers, namely, the local traditional leaders and its family clan lineage are in position of maintaining their authority on land and woodland resources to regulate, monitor and enforce the rules for community based woodland management (Jones and Murphree, 2004). These are key functions for woodland conservation in CBNRM as spearheaded by local leaders in the study area, however, they were weak and might not be sufficient to counter threats of woodland degradation as consequences of 'the tragedy of the commons" For instance, corrupt leaders were reported bribed to permit woodland degrading activities, large livestock herds on the move for pastures causing over-browsing especially during the dry season, powerful logging people for brick making, timber and firewood harvesting for sale (Levang *et al*., 2007; Andersson *et al*., 2013; Dezécache *et al*., 2017).

It seems insurmountable to progress towards sustainable community-based woodlands management a reality where woodlands are actually under the control of a few family clan lineages of traditional leaders (VC1 and VC2) (Baynes *et al*., 2015). Consequently, at the local level, traditional institutions administering land tenure and woodland resources have been characterized by conflicts, particularly between the traditional leaders and government agents/elected leadership of the VIDCOs and WADCOs (Madondo, 2000). These new bodies of WADCO and VIDCO and the government extension department of agriculture and natural forestry recognize some rights to local people over communal woodland resources, advocated for more involvement of local communities in CBNRM and consequently promote the development of community woodland management with less collaboration with the traditional leaders. Elsewhere, Nemarundwe *et al*. (1999) reported that in the communal areas of Zimbabwe, villagers aligned themselves with either the traditional leadership or the local government extension agents, namely the VIDCOs and WADCOs to extend their users rights for community woodlands, this depicts a chaotic institutional arrangement where no single authority seems to have legitimate and unchallenged powers to regulate and monitor woodland ecosystem productive activities. In this environment, community based woodland management regulations cannot be comprehensively enforced based on the two opposing camps.

Traditional institutions for CBNRM focus on utilizing and managing resources based on the indigenous ecological knowledge of the community. This is done within the framework of local community worldview, in other words, in accordance with their ethics, norms and beliefs which is the pull factor of collective acceptance to conserve locally available resources. Hence, local government institutions could at least take this as their point of entry if they are to be successful in instituting enduring CBNRM systems. In the case of the present study area, agencies associated with the state were pre-occupied with controlling land settlement and agricultural land use while showing little action or presence for community woodland management or the implications of land use for the status of woodlands. The Zimbabwe Government department of Forestry Commission and its extension services could support community based woodland management in Mutema-Musikavanhu communities by effectively enforcing its mandate at local level state and non-state institutions.

Socio-economic benefits of livelihood activities based on woodland ecosystem services: Woodlands offer a variety of socio-economic benefits to Mutema-Musikavanhu communities in Save Valley, southeastern lowveld of Zimbabwe. With CBNRM in general, local people are expected to receive benefits from woodland ecosystem productive activities that alleviate poverty (Khatri *et al.,* 2017). The present study noted that local people in the study area derive important benefits from the woodlands. This positive economic outcome is to be associated and managed with two important elements: safe user rights preventing a "tragedy of the commons" and innovative economic activities practiced on woodland ecosystem productive activities (Hardins, 1968; Dezécache *et al*., 2017). However, there were no management and utilization licenses imposed on communal woodland ecosystem productive activities in the study area. Furthermore, discrimination over utilization of woodland resources and a discrepancy was observed in benefits derived from woodland ecosystem productive activities among local woodland resource user groups.

The supreme traditional leaders' clan of the chieftainship family lineages (VC1) harvest many products at willy-nilly from the woodlands they have rights upon, but mostly for home consumption. This is likely the case as the paramount chief family lineage have access to alternative source of income mainly from agribusiness/farming as they are the custodian of land and responsible for subsistence agricultural land allocation at village level (Mhuriro-Mashapa *et al.,* 2017). The second group (VC2) consisted of village heads' kin and allies of the chieftainship who tended to compensate their initially lower rights by seizing new economic opportunities and engage in innovative activities of woodlands resource utilization. The study reported that the VC2 group engaged in household income generation where over 8% of their monetary income was derived from innovative utilization of woodland resources including, hunting, and service provision such as honey processing, carpentry and medicinal plant gathering. Recent and temporary settlers from the VC3 group of villagers have been excluded from both benefits as well as discriminated from use of woodland resources.

The study findings suggested that the ongoing community woodland management strategy has a negative effect on Mutema-Musikavanhu woodland resources as restriction and discrimination tend to promote poaching of woodland resources which can trigger the "tragedy of the commons" as VC3 groups of people are likely to compete for maximum utilization of woodland resources for immediate benefits at the expense woodland resources for future generations (Hardin, 1968; Dezécache *et al*., 2017). The excessive extraction of woodland resources for various uses by local communities can also leads to over exploitation and local extirpation of woody species (Fargeon *et al*., 2016). A few traits of such phenomenon are already common in the study area, for example, *Warburgia salutaris*, which is well known for its medicinal properties is almost locally extinct because of over-harvesting around Mutema-Musikavanhu communal areas in Save Valley, southeastern lowveld of Zimbabwe (Shumba, 2001; Mashapa *et al*., 2014). *Bivinia jalbertii*, a species which yields a pole of timber that can last for many years and is endemic to the Nyoni Hills near Ngundu in Save Valley is also under threat (Shumba, 2001). Furthermore, harvesting of fruit trees for sale of fruits such as *Uapaca kirkiana*, *Adansonia digitata* and *Afzella quanzensis* roots for medicinal purposes is common in the study area (Mashapa *et al*., 2014). However, over-harvesting of fruits from these woody species can lead to the removal of potential propagules (seeds) from their natural habitat thereby negatively affecting woodland regeneration. Therefore, the *Leguminosae-Caesalpinioidae-Combretaceae* woodlands of Save Valley southeastern lowveld of Zimbabwe deserve attention for government supported CBNRM.

Ecological outcomes related to land use and land cover changes: Ecological outcomes of communal woodland management in the study area are related to land use land cover changes over time. With the evolution of Zimbabwe's land reform, rural resettlement and land clearance for homestead and agriculture post 2000, woodland cover was regressive from 1990 to 2015 (Figure 2a, b). This is likely as traditional leaders, the custodians of land could allocate more communal land to newly inhabitants (VC3) for settlement and cultivation, thereby triggering woodland conversion into agricultural land. Elsewhere in Driefontein Grassland protected area of Zimbabwe, woodland and wetlands were converted into agricultural land by local people, post 2000 era of Zimbabwe's land reform and fast track rural resettlement (Fakarayi *et al*., 2015). Human anthropogenic activities are known to convert woodland to agricultural land use as well as grassland in Zimbabwe and Mutema-Musikavanhu communal woodlands is no exception (Kahuni *et al*., 2014; Zisadza-Gandiwa *et al*., 2014).

The woody vegetation structure of size class diameter (SCD) of the communal woodland of Mutema-Musikavanhu communal area indicated a very high coefficient of asymmetry suggesting very low progressive trend of woody species population (Fandohan *et al*., 2011). The Mutema-Musikavanhu communal woodland conservation does seem to be compromised given lack of woody species regeneration capacity as depicted by the recorded negative skewed-*J* (SCD). This indicated the existence of irregular growth patterns of woody species dominated by adult trees across the woodlands of Mutema-Musikavanhu communal areas in Save Valley, southeastern lowveld of Zimbabwe. This suggested a woody plant recruitment bottleneck which can be attributed to human anthropogenic factors in a community where communal woodlands contributed a range of 0.04 to 12.82% to the Global Annual Income of local people across the study area. The study finding is consistent with conclusions from local research (Muboko *et al*., 2013; Zisadza-Gandiwa *et al*., 2013; Muboko *et al*., 2015; Mbereko *et al*., 2015) which also reported the negative ecological outcome of woody vegetation management in Save Valley, southeastern lowveld of Zimbabwe. All these observations support the theory that assumes the need to capacitate local communities to retain and capitalize on state supported indigenous knowledge that makes them the most efficient defenders of CBNRM (Gritten *et al*., 2015).

The observed negative ecological outcome of significant woodland loss and expansion of agricultural land categories can be attributed to the economic factors as people try to earn a living through agricultural production. Local people in the study area also aimed to reduce poverty through engaging in woodland resource utilization and this was influenced by the power and the legitimacy of the institutional design put in place, which successfully mixed tradition and modern views at conflict (Dezécache *et al*., 2017). The observed discrepancy in the distribution of benefits of communal woodland resources revealed a paradox in the participatory approach of community based woodland management and this could be the driver of the "tragedy of the commons" on woodlands as the common resource property (Hardin, 1968): those who are the most dependent and involved in woodland conservation may not be the ones who profit the most, at least from an economic point of view. There is a risk that those who strongly control but derive little cash money from the woodland ecosystem (i.e. local woodland resource users from VC1) might find it more rational to convert woodlands within their custodians to other uses more profitable for them like agriculture than its conservation in the case of the present study (Feintrenie *et al*., 2010; Lemenih *et al*., 2014). Local people and the traditional leadership ought to shape rules, regulations and user rights over their communal woodland and seize with equity, the economic opportunities of woodland ecosystem productive activities integrated with long-term national and local government support (Baynes *et al*., 2015; Khatri *et al*., 2017).

Conclusion: This study assessed institutional arrangements and evaluated the socio-economic and ecological outcomes of a community based woodland management in Save Valley, southeastern lowveld of Zimbabwe. Strong intervention of local government extension agents and clearly defined roles and responsibilities for the involvement of local traditional leadership in communal woodland management is a promising way for sustainable and equitable communal woodland management which can be linked to livelihood economic wellbeing (Baynes *et al*., 2015; Ingram, 2017). Local common people are not yet embraced as valuable community woodland managers and the role of local (indigenous) institutions in woodlands governance is still neglected giving room for monopoly of communal woodland management by traditional leaders. There is a need to make the best out of these traditional regulation systems, which if weakly supported by government institutions, land conversion from woodland to land under agriculture and grassland is likely to continue trigger woodland degradation outcomes in Mutema-Musikavanhu communities in Save Valley, southeastern lowveld of Zimbabwe. Thus, important lessons and principles regarding the community-based woodlands governance, the distribution of benefits and the need for a supportive local government extension service back stopper can be drawn from this study to improve the approach elsewhere. While it is context dependent, our study converges to the conclusion that, provided communal woodland management is secured with equity on access to all members of a society and integrated with active government regulation in collaboration with local level traditional institutions, the likelihood that communities would defer woodland use for the future generations is less threatened.

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