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Full Length Research Paper

Assessment of types of damage and causes of human-wildlife conflict in Gera district, south western Ethiopia

Leta Gobosho Amaja, Debela Hunde Feyssa and Tariku Mekonnen Gutema*

College of Agriculture and Veterinary Medicine, Jimma University, Ethiopa.

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Human-wildlife conflict (HWC) exists in different forms all over the world and is experienced more in developing countries. The conflict between human and wildlife ranks among the main threats to biodiversity conservation and has become frequent and severe in different parts of Africa. In the author s' previous study, five species of wildlife were identified as the main crop raiding species in Gera, southwestern Ethiopia. The current study was conducted to assess causes of HWC and types of damage in this area. Data were collected through semi- structured questionnaires, focus group discussion, direct observation and key informant interview. Descriptive statistics was used to analyze the socioeconomic profile of the respondents. One-way ANOVA and Chi-square test were used to analyze causes of HWC. The result showed that 50 and 22% of the respondent reported that the prevalence of HWC is manifested through crop damage and livestock predation, respectively. There was a significant difference between causes of HWC (F=4.2, P=0.000). In this study, habitat disturbance and increase in population of wildlife was the highest and least causes of HWC, respectively. HWC is increasing in both severity and frequency in the study area. Therefore, to minimize the conflict occurring in the whole scope of society in the proper selection of investment site (mainly modern coffee production in the area) is crucial. Furthermore, the wildlife authorities and local institutions are encouraged to address the needs of the local communities or to find the source of alternative livelihood to the society.

Key words: Forest disturbance, Human-wild animal's conflict, crop raiding.

INTRODUCTION

Human-wildlife conflict (HWC) has existed for as long as humans and wild animals have shared the same landscapes and resources (Lamarque et al., 2009; Hoffman, 2011). However, currently, wildlife habitats are fast becoming human-dominated, which means that more wild species are compelled to exploit new human resources to survive (Strum, 2010; Castro and Nielsen, 2003; Warner, 2000). HWC results in negative impact on people or their resources, and wild animals or their habitat. Though human wildlife conflict exists in both

*Corresponding author. E-mail: jtarikumg@gmail.com.

developed and developing countries, it is more serious in developing nations (IUCN, 2005; Lamarque et al., 2009; Fairet et al., 2012).

HWC is among the most important threats to the survival of many wildlife species (Madden, 2008; Johansson, 2002). In Africa and other developing areas of the world, fast growing human population, settlements and accompanied habitat fragmentation are reducing the wildlife habitats (Hill et al., 2002; Pariela, 2005; Blair, 2008; Mwamidi et al., 2012). This is increasing the interactions between humans and animals (Madden, 2008; Blair, 2008; Lamarque et al., 2009; Mwamidi et al., 2012). Especially, transforming natural landscapes of the earth from predominantly wild to anthropogenic has created competition between humans and wildlife for space and resources and it has reached unprecedented levels (Hanks, 2006; Ellis et al., 2010; Kate, 2012). For instance, in Ghana, the decrease in the forest area available to elephants in Kakum conservation area by about half since the 1970s, was the reason for increasing crop raiding activities and cause of HWC (Barnes et al., 2003).

A wide variety of wildlife comes into conflict with farming activities for search of human resource which causes crop damage and wildlife mortality (Conover, 2002). The major types of wildlife damage on the human being are predation of domestic animals, crop damage and sometimes killing of humans (Madden, 2008). The number and type of damage caused by wildlife varies according to the species, the time of year, and the availability of natural prey and crop raiding species (Warren, 2008; Datiko and Bekele, 2011; Mwamidi et al., 2012).

In spite of diverse and unique nature of the Ethiopian landscape and ecological diversity, the natural resources of the country are declining by human activities (Bekele et al., 2011; Tefera, 2011). This has increasingly restricted wild animals' movement of the country to a few protected areas/habitats (Kumssa and Bekele, 2008).

The forest area of southwestern Ethiopia is under great threat due to over-exploitation (Hundera, 2007; De Beenhouwer, 2011) which forces wild animals to compete with humans for their resource and results in conflict between them. There are some major driving forces that increase pressures on forests in southwestern Ethiopia. The most important pressure causing deforestation is rising in population pressure and overexploitation of the remaining forest cover. Agricultural activities are expanding, leading to forests encroachment, habitat destruction and further to the HWC which in turn makes the farmers to loss crops to pests/problem causing animals (Joseline, 2010; Mwamidi et al., 2012).

These pressures on land resources and reduction of core habitat for wild animals and elimination of corridors for migration increase the probability of contact, and possibly create conflict between farmers and wild animals (Quirin, 2005). Though, majority of the Gera land has been covered by natural forest in the past, nowadays, it has been shrinking in size due to increasing subsistence agriculture and modern coffee production which results in conflict (Hundera, 2007; Quirin, 2005; Strum, 2010).

Leta et al. (2015) identified the major wildlife species involved in the HWC and local management methods in Gera, Southwestern Ethiopia. However, there were no scientific studies carried out on types of damage and causes of human-wild animals' conflict for wildlife conservation in the study area. Therefore, the main objective of this study was to assess types of damage and the major causes of HWC in Gera district. This can contribute to reduction in HWCs in the study area.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Gera district, Oromia National Regional State, Jimmazone, Ethiopia (7°15'N - 8° 45'N latitude and 35° 30'' E - 37° 30' E longitudes). It is located at about 448 km south-west of Addis Ababa and 93 km south-west from the zonal town, Jimma.

The total population of Gera district is 86,849. About 83,375 of them are rural and 3,474 were urban (living in small town, Gera) (CSA, 2007). The land cover categories of the district comprise about 26.5% potential arable or cultivable land of which 23.4% are under annual crops, 7.0% pasture, 56.6% forest and the remaining 9.9% classified as degraded, built-up or otherwise unusable. The study area is characterized as humid, subtropical climate, with a yearly rainfall of about 1800 to 2080 mm per annum and a short dry season with relatively high cloud cover. A peak rainfall occurs between June and September, which is the long rainy season of the district and a smaller peak occurs between March and April, short rainy season. Differences in temperature throughout the year are small with a mean minimum and maximum annual temperature of 11.9 and 26.4°C (Schmitt, 2006; De Beenhouwer, 2011).

The southwestern forests of Ethiopia are characterized as moist montane forest ecosystems (NBSAP, 2003). High forest, woodland and plantation forests are available in Gera district. Even though the majority of the natural forests are under the government protection, it is presently under great threat because of over exploitation (Hundera, 2007). Despite the absence of wildlife protected areas in this study area, different wildlife species have been recorded from the study area, such as, African Buffalo (*Syncerus caffer*), Lion (*Panthera leo*), Colobus monkey (*Colobus guereza*), Grivet monkey (*Chlorocebus aethiops*), Olive baboon (*Papio anubis*), Leopard (*Panthera pardus*), *Phacochoerus africanus*, Warthog (*Potamochoerus larvatus*), African civet (*Civettictis civetta*) and Menelik's bushbuck (*Tragelaphus scriptus*) are found in the study area.

Site selection and sampling design

Based on preliminary survey (September-Novemebr, 2012), the study district (Gera) was purposively selected because of the presence of serious HWC in the area. Out of the 24 kebels (units in a district) in Gera district, 2 (Ganjicha and Wanjakersa) were selected using stratified random sampling. Each village found in the selected two kebeles were categorized into three groups based on their proximity towards to forest edge as near (<0.5 km), medium (0.5-1 km) and far (>1 km) and one village from each group were selected. The total villages from each kebeles were three and the study covers a total of six villages from the two kebeles.

After getting the total number of household (HH) heads living in each selected kebeles, the sample size was determined using probability proportional to sample size sampling technique (Cochran, 1977; Bartlett et al., 2001).

$$no = \frac{Z^2 * (P)(q)}{d^2} \quad n_1 = \frac{no}{(1 + no/N)}$$

Where: n_o= desired sample size of Cochran's (1977) when population is greater than 10000; n_1 = finite population correction factors (Cochran's formula, 1977) less than10000; Z = standard normal deviation (1.96 for 95% confidence level); P = 0.1 (proportion of population to be included in sample, that is, 10%); q = 1-P (0.9); N = total number of population; d = degree of accuracy desired (0.05).

Based on the distance of farmland from forest edge, 33.3% HHs from each stratification were used for the formal interview. For the structured interview, HHs sample strategy was established by collecting complete landholders list record from their respective administration office. The sample includes all HH head living in the two kebeles. Finally, the selections of sample HH were proportional to each stratification, which was based on farm land distance from forests, to keep uniformity. Accordingly, the total numbers of HH head living in both kebeles were 915 (435 from Ganjichala and 480 from WanjaKersa) from the report of kebeles administration (2012). From all the stratification, the HH head having farm land in the selected stratification was randomly taken for a formal interview.

Based on Cochran (1977) population correction factors, a total of 120 sample HH head were selected using simple random sampling techniques from the total population. Allocations of the number of sample HHs to each kebele, was proportional to the number of HH head living in each selected kebele, accordingly, 57 HH from Ganjichala and 63 HH from Wanjakersa were selected for this study.

Data collection methods

Pilot survey

A pilot survey was conducted in the selected kebeles from December 2012 to January 2013 based on the information gathered during the preliminary survey. During the pilot survey, 30 HHs were randomly selected and interviewed. The main purpose of the pilot survey was to evaluate the questionnaire and to check whether it was applicable and suitable in the study area, to check whether the questionnaire can be understood by the respondents, to identify the period and the occurrence of human-animals conflict and cause of HWC in the study area. Based on the pilot survey results, the questionnaire was revised and developed following Yihune et al. (2009) and Fairet et al. (2012). HH survey (individual-interviews), focus group discussions, key informant interviews and direct observation were used. The current status of HWC in the study area was investigated through observations, FGD and questionnaires following Anderson and Pariela (2005). To find out why wild animals are involved in crop raiding and livestock depredation which create conflict between farmers and wild animals, variables such as nature of human habitat disturbance, distance of farmland from residence and farmland expansion to forest area were assessed using the questionnaire similarly used by Kivai (2010).

The presence or the absence of human activities which creates forest disturbance or fragmentation was assessed. Human activity assessed includes cutting understory vegetation (plants between the forest canopy and the ground cover) selective cutting of trees, burning and complete clearing of forest mainly for expansion of cultivation. These activities were recorded using quadrat methods. A total of 30 and 20 quadrats having 10 x 10 m size were randomly used in Ganjichala and Wanja-Kersa sampled forests. The area coverage of Ganjchala and WanjaKersa sampled forest were 12.0 and 7 km^2, respectively. The size of the forest was taken from the district Agricultural Office.

The overall status of the forest (disturbance level) due to human activities was assessed during the study time, through observation by giving the scale of 1-4. Scale 1 was recorded if slight activities of human action were observed in a form of cutting of trees to have a track (road like for moving in the forest on foot) in the forest for the case of traditional honey harvest, Scale 2 was recorded when moderate levels of human activities (clearing the understory, cutting tree branches, leftover of burned tree) were observed, Scale 3 was used when extensive human activities (cutting big size trees, continuous burning, but no section of the forest was completely cleared) were observed. Finally, forests in which human activities in a form of complete clearing were observed, were assigned scale 4 as used by Muoria et al. (2003). Data was analyzed using SPSS version 16.0 computer software. One-way ANOVA and Chi-square were used to analyze the cause of HWC and status of HWC and management options.

RESULTS

Socio economic characteristics

The result revealed that the major economic activities of the sampled HH in the study area were subsistence agriculture, which includes crop farming, livestock rearing and/or a mixture of animal rearing and crop farming. About 70% of the respondents earns their income from mixed agriculture (crop farming, animal rearing and bee farming). The remaining 16.7% depends only on crop farming and 13.3% depends on both crop farming and other income sources such as daily labor works.

The size of farmlands owned by sampled HH ranged from 0.5 to 3 ha with an overall mean of 1.8 ha. There was significant difference among HH heads in sizes of farm land they hold ($\chi^2 = 16.00$, df = 5, $P < 0.01$) in which 25.8 and 7.5% possessed 2 and 0.5 ha, which is the highest and the lowest, respectively.

Cattle were the predominant livestock in each site followed by sheep and goat. The overall mean number of cattle, sheep and goat holding per HH were 4.56 ± 0.16, 3.55 ± 0.08 and 3.75 ± 0.19, respectively. While for those of horse, donkey and mule, the overall mean values were 0.34 ± 0.047, 0.64 ± 0.053 and 0.16 ± 0.033, respectively.

Types of damage among sites

In these studies, the type of damage and magnitude by wildlife on the resources of the community significantly differ ($\chi 2 = 25.55$, df = 2, $P < 0.05$ (0.00) from site to site. Of the total respondents interviewed, 50% reported that there were both problem of crop damage and livestock predation, while 22% reported only crop damage, and 28% did not face any conflict. There is no HWC in Agalo (Table 1) while both crop damage and livestock depredation existed in Wanja, Chala, Seke and Gado

Table 1. Percentage of respondents that faced different types of conflict by wild animals in each village.

Villages	No. (120)	Both crop damage and livestock depredation (%)	No conflict at all (%)	Crop damage only (%)	Livestock depredation only (%)
Bonche	19	100	0.0	0.0	0.0
Chala	20	68	0.0	32	0.0
Seke	19	32.3	52.7	15	0.0
Wanja	21	72	0.0	28	0.0
Gado	20	27	15	58	0.0
Agalo	21	0.0	100	0.0	0.0
Mean		50	28	22	0

Figure 1. Habitat disturbances due to increased subsistence agriculture in forest edge (A) coffee plantation (B).

Table 2. Causes of human-wild animals' conflict as revealed by respondents among sampled villages (all the numbers in the table are numbers of people that responded).

Sample sites	Identified causes of HWC				
	Habitat disturbance	Combined effect	Proximity to natural forest	Increased subsistence agriculture	Increase in wild animals population
Bonche	7	2	4	3	3
Chala	8	3	3	4	2
Seke	7	2	3	5	2
Wanja	3	3	6	5	4
Gado	2	4	4	5	5
Agalo	6	2	5	5	3
Mean	5.3[a]	2.6[d]	4.2[b]	4.5[b]	3.2[c]
Std. D	2.3	0.8	1.2	0.8	1.1

*Means having the same letter have no significant difference.

sites.

Crop damage is the most observed problems in the community (72%) in the study sites. Except one site, Agalo, crop damage was observed in all the selected sites.

Cause of human-wildlife conflicts

The study revealed that the major cause of human-wild animals' conflict in the study area were habitat disturbance (due to expansion of subsistence agriculture around forest edge, coffee plantation (Figure 1), proximity to natural forest and the contribution of all mentioned cases (Table 2).

Causes of HWC showed significant difference among the respondents (F=4.2, P=0.000). In the study sites, the highest cause of HWC, was disturbances of habitat followed by proximity to natural forest and increased subsistence agriculture.

Table 3. Human activities observed in sampled forest of the study area.

Human activities (scale 1-4)	Observation of each activity in the Sampled study area (%)	
	Ganjichala	WanjaKersa
Slight activities (1)	no	20
Cutting of under stories (2)	60	80
Clear cutting with few tree remaining (3)	40	no
Clear cutting (4)	no	no

No = indicates not observed.

A variety of human activities was observed in the sampled forest of the study area. The result of observation of human activities was significantly different between the two study kebeles. Human activities in the form of cutting understory vegetation (plants between the forest canopy and the ground cover) for subsistence coffee production, was a significant difference between the kebeles (t=16.925, P=0.000) and it is more in Wanjakersa (Table 3). Clear cutting with few trees remaining for the search of sun light for intensive coffee production by investors was observed in Ganjichala only, which increased the magnitude of HWC due to lack of food.

DISCUSSION

The study showed that the type of damage and magnitude on the resources of the community by wildlife differs from place to place in the study area. This agrees with the studies in other parts of Ethiopia. According to Datiko and Bekele (2011) and Mwamidi et al. (2012), the number and type of damage caused by wildlife vary based on the species, the time of year, and the availability of natural prey and crop raiding species. Even though both agricultural damage and livestock depredation were observed in the study area, crop loss due to wildlife was the most serious problem in the study sites. It differs from site to site depending on distance from the forest and others.

This study also showed that human population growth and anthropogenic effect such as deforestation, inappropriate site selection for investment (coffee production) in forested area and expansion of subsistence agricultural activities have led to increase in HWC. However, habitat disturbance was the major causes identified as HWC in this study. The result was in agreement with different studies in Ethiopia and other countries in the world (Hill et al., 2002; Barnes et al., 2003; Pariela, 2005; Blair, 2008; Datiko and Bekele, 2011; Mwamidi et al., 2012; Edward and Frank, 2012) which reported increased habitat disturbance as the cause of HWC. Jones (2012) reported that habitat destruction and fragmentation was the main cause of human primate conflict in Indonesia. Priston et al. (2012) reported that an anthropogenic habitat alteration caused crop raiding in southeast Sulawesi, Indonesia by primates.

Conclusion

The study revealed that there is a serious HWC in Gera, Jimma Zone, southwestern Ethiopia because of habitat disturbance. Agricultural product loss, which can affect food security of the community, is the major type of damage identified. On the other hand, the negative attitude of the community towards wildlife due to the serious HWC has a great impact on the biodiversity conservation. Therefore, it is recommend that there is a need to develop strategies of reducing HWC by local people, researchers, wildlife authorities and policy makers by finding mitigation measures for HWC. The strategies can include leaving sufficient conservation areas, better buffer areas for wildlife to move and sufficient connectivity of wildlife habitats so that they can freely move to get their living from the ecosystem. Furthermore, it needs training the community on how to reduce the causes of conflict with the wildlife. Specific strategies based on contemporary situations can be included as the conflict is dynamic in nature.

Conflict of interests

The authors have not declare any conflict of interest.

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Full Length Research Paper

Floristic composition and plant community types of Agama Forest, an "Afromontane Forest" in Southwest Ethiopia

Admassu Addi[1]*, Teshome Soromessa[2], Ensermu Kelebessa[1], Abyot Dibaba[1] and Alemayhu Kefyalew[1]

[1]College of Natural Sciences, Department of Plant Biology and Biodiversity Management Addis Ababa University, P. O. Box 3434, Addis Ababa, Ethiopia.
[2]Center for Environmental Science, Addis Ababa University, and P. O. Box No: 1176, Addis Ababa, Ethiopia.

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Tropical Afromontane forests are among the most species-rich ecosystems on earth and comprise exceptional species richness and high concentrations of endemic species. The natural forest of Agama, an Afromontane forest, was studied with the objectives of determining its species composition, diversity and community types. Systematic sampling design was used to collect vegetation data. Soil samples were taken from each relevé at a depth of 0 to 30 cm and soil pH, sand, clay and silt were analyzed. The plant communities' classification was performed using the hierarchical cluster analysis. We evaluated species richness, eveness (Pielou J' index) and diversity (Shanon-Wiener index). Sorensens's similarity ratio was used to compare Agama forest with other similar forest in Ethiopia. A total of 162 plant species, 130 genera and 70 families were recorded from which Acanthaceae and Rubiaceae were the richest families. Furthermore nine endemic plant species were identified. In this study, four plant community types were identified and described. Post-hoc comparison of means among the community types showed that altitude was differed significantly between community types, indicating altitude is the most important factor in determining community type. Phytogeographical comparison of Agama Forest with other vegetation using Sorensens's similarity ratio revealed the highest similarity with Masha and Godre forest. In conclusion Agama forest presents high richness, diversity and endemism, with different plant communities according to altitude. Thus conservation of plant biodiversity is highly recommended.

Key words: Diversity, altitude, phytogeography, richness, endemism.

INTRODUCTION

Afromontane vegetation is an archipelago-like centre of endemism and confined in mountains of Africa. The Afromontane region comprises about 4000 plant species, of which about 3000 are endemic to regions (White, 1983). The largest concentrations of Afromontane vegetation found in Ethiopian highlands and very recently

*Corresponding author. E-mail: admassuaddi@gmail.com.

this region was designated as the “Eastern Afromontane hotspot,” which is one of the 34 regions globally important for biodiversity conservation (Conservation International, 2005). The Ethiopian highlands are the largest mountain complex in Africa and comprise over 50% of the African land area covered by Afromontane vegetation (Tamrat Bekele, 1994;Demel and Tamrat 1995). The Afromontane vegetation of Ethiopian highlands comprises a center of plant biodiversity and endemism (Vivero et al., 2004) due to variation in climate and altitude. Altitudes of the country range from 125 m below sea level in the Dallol depression to 4,620 m above sea level at Ras Dejen. As a result, the country possesses rich biodiversity that occur from the highest mountain to the lowlands. Accordingly, the flora of Ethiopia is estimated to contain between 6,500-7,000 species of higher plants, out of which about 12% are endemic (Tewolde, 1991).

These floral resources found in different vegetation types comprising in forests, woodlands and bush lands and others. The flora of Ethiopia have been investigated by several scholars since the beginning of the 19th C to the mid of the 20th C. Some studies have provided substantial contribution to describe vegetation types of Ethiopia. Pichi-Sermolli (1957); Chaffey (1979); Friis (1992); Sebsebe et al. (1996); Zerihun (1999); Friis and Sebsebe (2001) and Sebsebe et al. (2011).These studies were carried out in different parts of the Ethiopia and contributed in generating valuable botanical information for the Ethiopian flora.

The vegetation composition and structure of forests in southern and southwestern part of the country was also studied Lisane work Negatu L., (1987); Kumlachew and Tamrat (2002); Tadesse (2003); Feyera (2006); Ensermu and Teshome (2008). These studies have described floristic composition and analyzed plant communities and their relation with environmental factors. According to above studies several plant communities were identified, with characteristic plant species of *Ilex mitis*, *Syzygium guineense*, *Pouteria adolfi-friederici*, *Olea welwitschii, Psychotria orophila,* and *Schefflera abyssinica* in southwest Ethiopia*. These species are also reported by (Friis, 1992) as the characteristic species of Afromontane rainforest in southwest Ethiopia*. The vegetation of southwest Ethiopia varies with altitude and affecting the diversity of plant species. The study of variation of modern pollen rain (Bonnefille et al., 1993) along the ecological gradients containing range of vegetation types in southwest Ethiopia. This indicated that the vegetation types vary with altitude and altitudinal variation is an important environmental factor contributing for diversity of vegetation communities. Afromontane forests are the place of origin of the *Coffea arabica* and encompass a variety of commercially valuable spices and honey from wild bee. Furthermore the forests also play a pivotal role in providing water resources for the flow of the Baro-Akobo river system which is an important tributary of the Nile and it accounts for 42% of the water in the White Nile (NTFP, 2006). It is also important for carbon sequestration which has implications for climate change management.

In spite of the ecological and economic role of Ethiopian forests, the forest cover of Ethiopia has declined by human impact. About 35%, of the country’s area was once covered by natural high forests, (EFAP, 1994). By the early 1950s, high forests were reduced to 16% and the country’s forests have declined at fast rate and reached 3.6% by 1980, 2.6% by 1987 (IUCN, 1990), 2.4% in 1992, (Sayer et al., 1992), and were finally reduced to 2.3% in 2003 (Shibru, 2003). Because of this shrinkage of the forest resources, most of the remaining forests of Ethiopia are restricted to the south and southwest parts of Ethiopia, which are less accessible, and less populated (Kumelachew and Tamrat, 2002). These forests are continuously threatened by human activities such as clearing forest for coffee and tea plantation, subsistence farming and periodic movements of immigrants from northern and southern parts of Ethiopia looking for fertile land, resulting in the loss of forest cover in the region.

Recognizing the above mentioned threats to forest biodiversity of afromontane rain forests, the government designed different strategies to conserve the remaining forest resources in the region. Participatory forest management (PFM) was one of the solutions to solve the problem of open access to forest resources and to promote sustainable forest management. For instance farm-Africa introduced the Participatory Forest Management approach in southwest Ethiopia particularly in Bonga and the implementation process has been developed since 1996. Agama forest is part of Bonga forest delineated for PFM since 1996 (Aklilu et al., 2014). Though the forest has been under protection since its demarcation, still it has been continuously exploited for agricultural land expansion, timber harvesting, firewood collection and charcoal production due to lack of awareness on principles of PFM. Botanical assessment such as inventory of floristic composition, providing information on species diversity and community structure is necessary for the forest management and sustainable resource utilization by the community members. Therefore the current study aimed to assess the floristic composition and diversity of an Afromontane forests (Agama forest), to analyze community types of the forest and to evaluate the ecological relationships between plant communities and environmental parameters and to analyze phytogeographical relationship of Agama forests with other similar Afromontane forests types in Ethiopia and finally to recommend conservation action for protecting the forest biodiversity of the region.

MATERIALS AND METHODS

Descriptions of the area

The Agama forest is part of eastern African Biodiversity hot spot

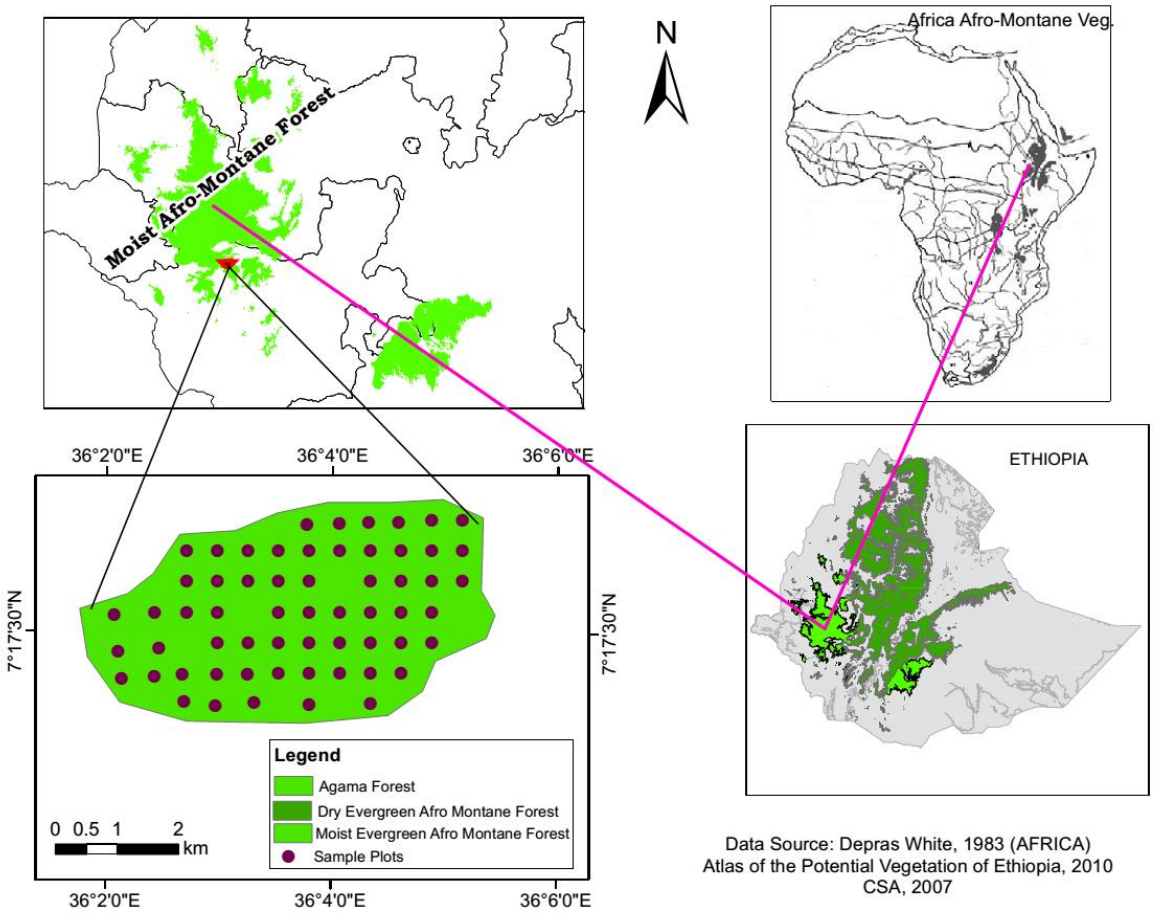

Figure 1. Location Map of Agama forest

and located in east Africa, in southwest Ethiopia (Figure 1) and it has a total area of 1868.5 ha. The area lies at 7°16'N and 36°11' E, and altitude between 1700 m to 2370 m.a.s.l. (Aklilu et al., 2014). The Geology of area belongs to the Precambrian basement complex, the Tertiary Volcanic Rocks from the trap series, and Quaternary Sediments consists of a variety of sedimentary, volcanic and intrusive rocks (Tafesse, 1996). The major soil groups, according to the FAO/UNESCO legend of soil classification, are Nitisols, Acrisols and Vertisols (Anon., 1988).

The vegetation of the area belongs to Afromonatin rain forest and transitional rain forests (Friis et al., 2011).The forest was stratified into four different layers, namely, upper canopy, sub-canopy, shrub layer and the ground layer and *Pouteria adolfi-friederici* occupied emergent trees of the upper canopy. The area receives very high annual rainfall reaching up to 1830 mm in some peak years. The rainfall pattern shows low rainfall in January and February, gradually increasing to the peak period in July and then decreasing in November and December. Maximum and minimum monthly mean temperatures of the area are 26.6 and 9.5°C respectively.

Data collection

A systematic sampling design was used to collect vegetation and environmental data, following Kent and Cooker (1992). Vegetation data were collected using quadrates of 25 m x 25 m (625 m^2), for woody plant species within which a 2 m x 2 m sub-plot was used for recording herbaceous species and soil sample collection. Ten line transect were established and the distance between each transect was 1km.The vegetation was sampled following the transect and located at 1 km apart and were laid systematically at every 500 m. The number of plots per transect is vary depending on length of the transect and accessibility of the sample plots. All level of altitudinal ranges starting from 1700 m up to 2300 m were covered during the sampling. A total of 60 releves were sampled and all vascular plant species found in each relevé were recorded and identified. The cover of all the vascular plant species found in each relevé was estimated and rated according to modified 1-9 Braun Blanquet approach (Vander, 1979). The specimens were collected and identified at the National Herbarium (ETH), Addis Ababa University using the published volumes of Flora Ethiopia and Eritrea by comparing with the authentic specimens in the National Herbarium.

Environmental data and soil analysis

The environmental parameters recorded in this study were altitude, slope, aspect, disturbance, soil pH and soil texture (sand, silt, clay), Altitude was measured by Garmin GPS and slope and aspect were measured using Silva Clinometer and 15T Silva Ranger Compass respectively. Soil analysis was performed in the soil laboratories of

Addis Ababa University, following the procedures, (Sahlemedhin and Taye, 2000). The soil samples were analyzed for texture, using Hydrometer method of mechanical analysis and Sodium hexametaphosphate were used as dispersing agent. The pH measure was taken using Digital pH meter and it was standardized using buffer solutions of pH 4.0 and 9.2. Disturbance was determined on the basis a five point scale following Anderson and Currier (1973). Disturbance scores were based on visible signs of, tree cutting, grazing and presence of beehives. The points of scale were 0–5, with 0= (No disturbance), 1= (0-20% of the quadrat disturbed), 2= (21-40% of the quadrat disturbed), 3= (41-60% of the quadrat disturbed), 4= (61- 80% of the quadrat disturbed), 5 = (81-100% of the quadrat disturbed).

Phytogeographical comparison

Agama forest was compared with five other afromontane rain forests in Ethiopia for the purpose of investigating forest similarity and differences among the afromontane rainforests of Ethiopia. These included Godre,Gera, Masha, Harenna, Jibbat and Yayu. Godre and Masha forests are close to Agama forest found in Bench Maji and Sheka zones in Southern Ethiopia Nations and Nationalities People's Regional State. Jibbat forest is a transitional forest between dry evergreen afromontane and moist evergreen afromontane forest and found in western Shewa in Oromia region. Harenna Forest is located in the Bale Mountain National Park in south eastern Ethiopia.

Data analysis

An agglomerative Hierarchical Cluster Analysis was performed using Similarity Ratio (S.R), using R software version 2.1.5.2 (Venables et al., 2012). The cut point of the Clusters was decided after visual inspection of the level of aggregation/homogeneity of relevé. Plant community types were further refined in a Synoptic table. The resulting groups were recognized as community types and the species occurrences were summarized by synoptic cover abundance values. The community types were named based on the tree and shrub with high synoptic value.

Ordination was computed using Detrended Correspondence Analysis (DCA) is a technique that is used to display sample plots (sites). In DCA similar samples are plotted close together and dissimilar samples are placed far apart (Hill et al., 1980) (Figure 4).
Richness was calculated and Shannon and Wiener (1949) index was applied to quantify species diversity. Shannon diversity index (H') was based on frequency of species $H = \sum_i^s \mathrm{pilnpi}$ Where, "**H"** = Shannon and Wiener diversity index, S= number of the species Pi=the proportion of individuals or the abundance of species i^{th} = the proportion of total cover in the sample and ln = natural logarithms. The Pielou's (1966) J' evenness index (J) was calculated using the formula: $J = \frac{\mathrm{H}}{\mathrm{In}(S)}$ where J = evenness H' = Shannon–Wiener Diversity Index S= total number of species in the sample and ln = natural logarithms.

A similarity analysis was carried out to evaluate the relationship between forests based on presence of trees, shrubs and herbs. Evaluation was conducted using Sorensen's similarity index. It is described using the following formula (Kent and Coker, 1992). Ss = 2a/ (2a+b+c), Where, Ss = Sorensen's similarity coefficient a = Number of species common to both samples; b= Number of species in sample 1; c = Number of species in sample 2. All the environmental parameters such as altitude, slope, aspect, disturbance and soil data were analyzed as follows: aspect was codified according to Zerihun Woldu et *al*. (1989): N = 0; NE = 1; E = 2; SE = 3; S = 4; SW =3.3, W= 2.5; NW = 1.3; Ridge top = 4. In order to examine the significant differences and similarities between the community types identified, Tukey's multiple tests were performed to detect significant differences between the community types for different environmental parameters (altitude, slope, aspect, and pH and soil texture). Pearson's correlation was calculated to evaluate the relationship between the environmental parameters, anthropogenic disturbances (timber, charcoal and encroachment and grazing).

RESULTS

Floristic composition and endemic plants

A total of 162 plant species (Annex I) belonging to 130 genera and 70 families were recorded and identified in the sample plots in Agama forest (Table 1). Herbs, trees, shrubs, and liana, constituted 50.95, 24.34, 17.19 and 7% of species abundance respectively (Figure 2). Acanthaceae was the richest family representing 8.44% of total floristic composition, followed by Rubiaceae and Asteraceae with 6.49% of species. Euphorbiaceae (4.01%), Roseaceae (3.06%), and Poaceae (3.08%) were also important families in terms of species richness. The remaining families represented less than 3% of species each. Based on the information available on the published Floras of Ethiopia and in Vivero et al. (2005) a total of 9 endemic plant species were recorded (Table 2), comprising more than 5.73% of the recorded species.

Plant community types

A total of 162 clusters were derived from the output at dissimilarity level above 0.80 (Figure 3). These clusters were designated as local plant community types and given names after two dominating woody species, usually a tree and a shrub with higher synoptic value (Table 3). The cluster numbers in the dendrogram correspond to the community types. The description of the plant community types is based on the dominant and characteristic species.
Community I: *Macaranga capensis-Sapium ellipticum* community-This community type is distributed between the altitudinal ranges of 1945-2343 m a.s.l. and the slope gradient vary 30 to 65%. It is dominated by the upper canopy of, *Macaranga capensis,Sapium ellipticum, Allophylus abyssinica*, *Apodytes dimidiata, Ficus sur* and *Croton macrostachyus*. The shrubs and herbs include *Galiniera saxifraga, Flacourtia indica, Buddleja polystachya, Canthium oligocarpum, Aframomum corrorima, Desmodium repandum, Piper capense* and *Aspilinum anisophylum are* the major plant species found in this community. The climbers/lianas of this community are *Tilicora rouplii*,*Culcasia falcifolia* and *Vernonia wollastonii.* Some of the plant species in this community like *Cyathea manniana* and *Phonix relinata* are found along the small streams.
Community II: *Millitia ferruginia–Olea capensis* community-This community is found between 1781-2085

Table 1. Plant Families with their number of genera and species occurred in Agama forest.

Family	Genera	Species number	%	Family	Genera	Species number	% Richness
Acanthaceae	10	14	8.58	Fabaceae	5	6	4.01
Adianthaceae	1	1	0.61	Flacourtiaceae	1	1	0.61
Amaranthaceae	1	1	0.61	Myrtaceae	1	1	0.61
Amaryilidaceae	1	1	0.61	Moraceae	2	4	2.45
Apiaceae	1	1	0.61	Icaccinaceae	1	1	0.61
Apocynaceae	1	1	0.61	Lamiaceae	2	2	1.22
Araceae	1	1	0.61	Lauraceae	1	1	0.61
Araliaceae	2	2	1.22	Oleaceae	2	3	1.94
Asclepiadaceae	1	2	1.22	Orchidaceae	4	4	2.45
Asparagaceae	1	2	1.22	Pittosporaceae	1	1	0.61
Asteraceae	6	10	6.13	Piperaceae	2	2	1.22
Boraginaceae	2	2	1.22	Plantaginaceae	1	1	0.61
Caryophylaceae	1	1	0.61	Polygonaceae	1	1	0.61
Celastraceae	1	1	0.61	Poaceae	4	5	3.08
Combreataceae	1	1	0.61	Primulaceae	1	1	0.61
Commelinaceae	1	1	0.61	Rhamnaceae	1	1	0.61
Cucurbitaceae	2	2	1.22	Ranuaculaceae	2	3	1.94
Cyperaceae	2	3	1.84	Rhizophoraceae	1	1	0.61
Dracenaceae	1	3	1.84				
Euphorbiaceae	6	6	4.01				
Loganiaceae	1	1	0.61	Selaginellaceae	1	1	0.61
Malvaceae	2	2	1.22	Scrophulariaceae	1	1	0.61
Melistostomaceae	1	1	0.61	Spindaceae	1	1	0.61
Melianthaceae	1	1	0.61	Verbenaceae	1	1	0.61
Meliaceae	1	1	0.61	Violaceae	1	1	0.61
Menispermaceae	1	1	1.61	Verbenaceae	1	1	0.61
Rubiaceae	8	10	6.13	Vitaceae	1	1	0.61
Roseaceae	3	5	3.06	Ulmaceae	2	2	1.22
Rutaceae	4	4	2.45	Zingiberaceae	1	1	0.61
Sterculiaceae	1	1	0.61				
Spotaceae	1	1	0.61				

ma.s.l. and its slope gradient vary 15 to 45%. The most characteristic species of this community are *Millettia ferruginea*,*Vepris dainellii,Albizia gummifera,* and *Lepidotrichilia volkensii.* The shrub layer includes *Coffea arabica*, *Dracaena afromontana, Erythrococca trichogyne.* The dominant herbs are *Achyranthes aspera*, *Acanthus eminens, Alecmella abyssinica, Desmodium repandum* and the grass *Oplismenus hirita*. This community is abundant with coffee plants and anthropogenic influences are higher as compared with other communities.

Community III: *Syzygium guineense-Olea welwitschii* community-This community is found between 1810-2230 m a.s.l. and slope gradient vary 12-50%. The indicator species of this community are Olea *welwitschii* and *Syzygium guineense.* The tree species include *Elaeodendron buchananii*, *Ekbergia capensis*, *Olea.capensis* and *Polyscias fulva.* The shrubs are *Bersama abyssinica Cantium oligocarpm*, *Clausena anisata* and *Oxyanthus speciosus.* The herbs are *Alecmella abyssinica*, *Achryanthes aspera*, *Hypoestes triflora*, *Piper capense* and *Oplismenus hirtellus* This community is also dominated with *Piper capense*, one of the spice plant commonly collected by women for income generation.

Community IV*: Vepris dainellii-Schefflera abyssinica*-The community is distributed in the altitude range of 1798–2115m a.s.l. and the slope gradient varies 10 to 50%. The emerging dominant tree species in the community are *Elaeodendron buchananii, Syzygium guineense, Schefflera abyssinica* and *Vepris dainellii*. The shrubs in this community are *Dalbergia lactea,Maytenus gracilipes* and *Dracaena afromontana*. The field layer is dominated by *Desmodium repandum, Pteris pteridioides* and *Asplenium anisophyllum* and *the climbers* include *Clematis hirsuta, Landolphia buchananii, Hippocratea*

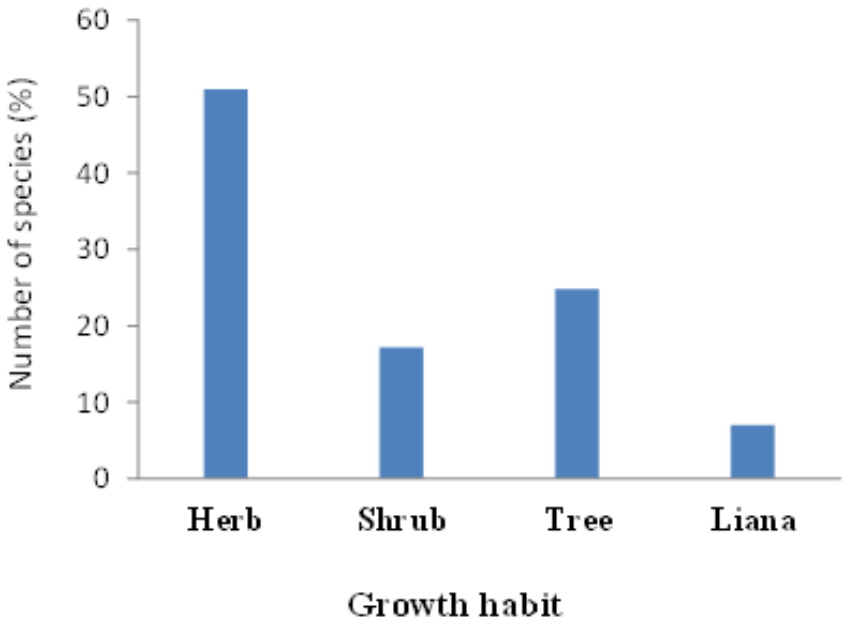

Figure 2. Growth habit of plant species in Agama Forest.

Table 2. Endemic species and their habit in Agama Forest, southwest Ethiopia.

Species	Family	Habit
Aframomum corrorima	Zingeberaceae	Herb
Clematis longicauda	Ranunculaceae	Liana
Millettia ferruginea	Fabaceae	Tree
Pittosporum viridiflorum	Pittosporaceae	shrub
Rinorea friisii	Violaceae	Tree/Shrub
Scadoxus nutans	Amaryllidaceae	Herb
Tiliacora troupinii	Menispermaceae	Climber
Vepris dainellii	Rutaceae	Tree/Shrub
Vernonia filigera	Asteraceae	Shrub

pallens, Jasminum abyssinicum and *Urera hypselodendron.*This community is comprises important honey tree(*Schefflera abyssinica*) known for white honey and contributing for the income of the local communities in the area. which needs conservation attention.

Species diversity, richness and equitability

From analysis of vegetation data using the Shannon-Wiener diversity index, community II had the highest species diversity (4.18), followed by communities IV (4.08) and III (3.96) and I (3.94). Community II had the highest number of species (110) followed by communities III (103) and IV (103), and I (79). Community I had thehighest evenness value (0.902) followed by communities II (0.89), Community IV (0.88) and III (0.85).

Plant community-environment relationship

The community types identified from cluster analysis showed significant difference with respect to altitude, slope, soil texture and number of species (Table 4). Community I was significantly different from the rest of the communities in terms of altitude and slope. All the communities identified in this study occur in slightly acidic soils (pH 4 and 5). There is no significant difference between plant communities for soil pH and sand content. Community types II differed in clay and silt content from community type 1, 3 and 4.

The result of Pearson's correlation of the environmental parameters shows that some of the environmental parameters were correlated (Table 5). Altitude is positively correlated with sand with R^2 = 0.64 and negatively correlated with clay and silt (-0.732 and -0.47)

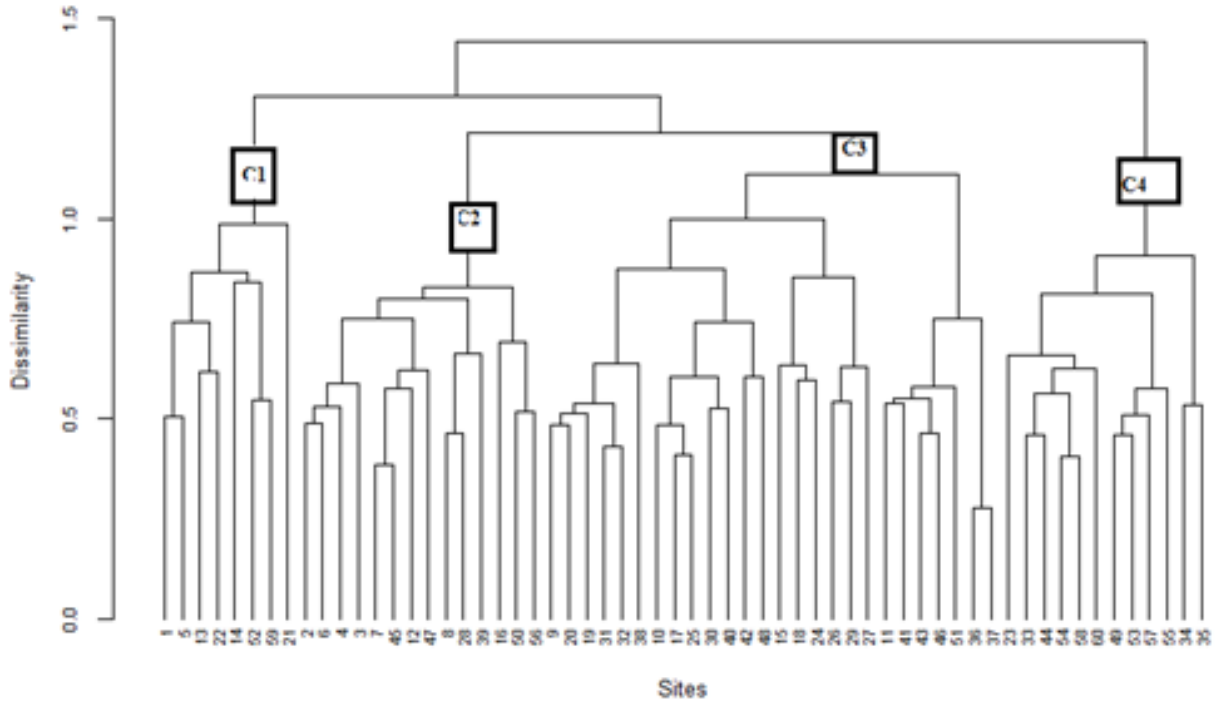

Figure 3. Dendrogram of the cluster analysis results of species abundance found in 60 plots. The plot code and the arrangement of the plots along the dendrogram from left to right are as follows:(C1= *Macarnga capensis-Sapium ellipticum*,C2= *Millitia ferruginia–Olea capensis community*,C3= *Syzygium guineense -Olea welwitschii* community and C4= *Schefflera abyssinica –Vepris dainellii*).

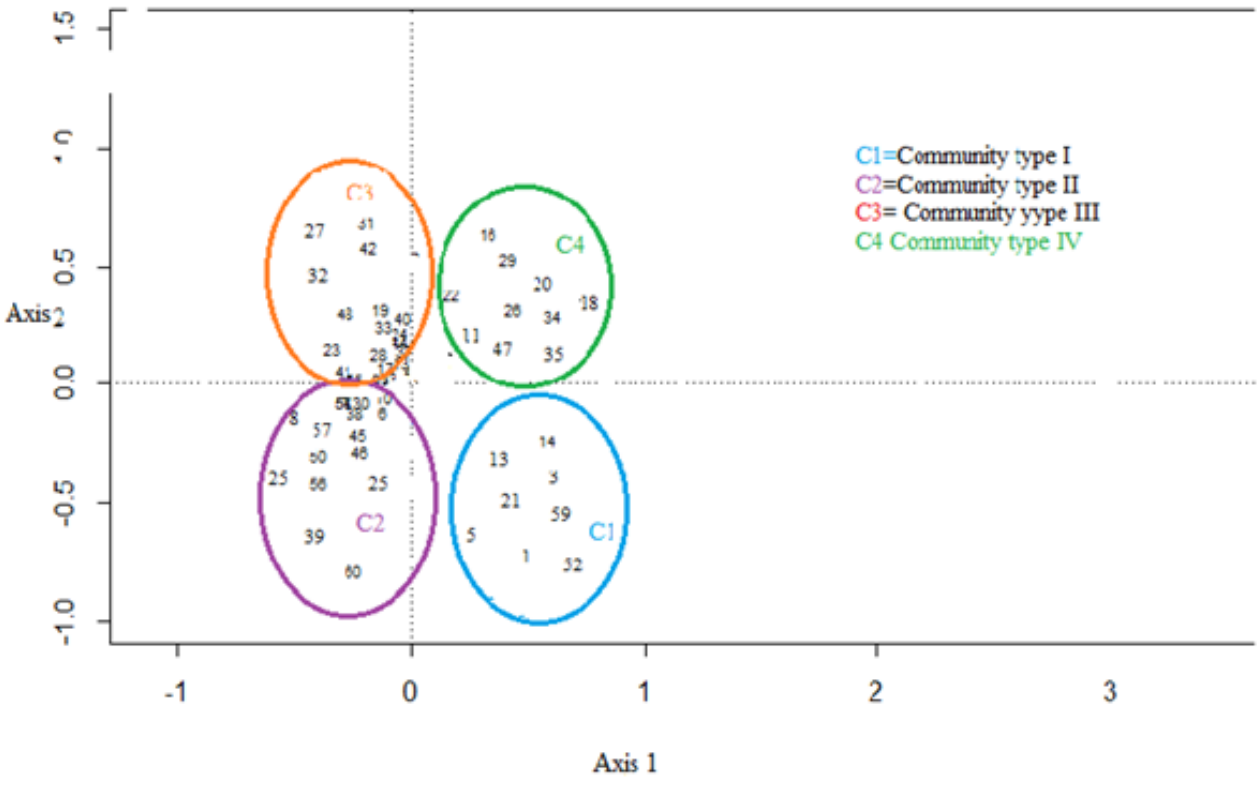

Figure 4. Distribution of relevés on the first and second axis of Detrended correspondence analysis.

Table 3. Synoptic cover value of plant for species reaching ≥ 1% in at least one community.

Community type	I	II	III	IV
Plot size	10	23	19	8
Macaranga capensis	**5.83**	1.65	1.30	0.00
Sapium ellipticum	**5.66**	3.13	0.80	2.5
Cyathea manniana	**4.66**	0.21	0.00	0.00
Desmodium repandum	**4.50**	3.47	4.00	3.00
Galiniera saxifrage	**4.02**	2.84	2.00	2.83
Canthium oligocarpum	**4.08**	2.57	2.80	1.83
Phonix reclinata	**4.01**	3.23	0.30	4
Ficus sur	**3.66**	2.26	0.20	0.66
Allophyllus abyssinicus	**3.16**	1.52	0.30	0.00
Ilex mitis	**3.54**	1.42	2.90	1.33
Millettia ferruginea	2.5	**6.84**	0.70	3.50
Olea capensis	4.00	**6.39**	5.20	6.66
Coffea arabica	2.5	**4.02**	0.90	2.33
Dracaena afromontana	2.16	3.55	**3.50**	3.51
Syzygium guineense	5.83	4.47	**8.1**	5.33
Olea welwitschii	2.83	3.23	**7. 90**	6.83
Bersama abyssinica	2.5	3.39	**4.60**	1.83
Vepris dainellii	3.66	4.21	5.70	**8.16**
Schefflera abyssinica	3.66	3.31	0.50	**7.5**
Oxyanthus speciosus	0.83	4.28	5.10	**6**
Landolphia buchananii	1.5	2.86	1.80	**5.16**
Maytenus gracilipes	0.83	2.07	3.60	**4**
Dalbergia lactea	2.33	0.92	0.90	**3.83**

respectively.

Phytogeographical comparison

The Agama forests in southwestern Ethiopia are floristically related more to the Masha and Godre forest since they are situated in the same climatic region and geographical location. Accordingly Masha and Godere forests share similar Sorensen similarity Index of (0.59) and (0.46) respectively (Table 6). Furthermore Harenna and Jibbat forests are less similar with lower similarity index (0.38 and 0.32) respectively.

DISCUSSIONS

Agama forest is one of the moist Afromontane rainforest and rich in plant biodiversity. It comprises an economically important plants used for coffee, spices and honey. These plant species are *Coffee arabica*, *Aframomum corrorima*, *Piper capense* and *Schefflera abyssinica* are the most frequent species in almost in all sample plots. Even though the size of the study area was limited; it had high number of plant species which is more or less comparable with that reported for the Afromontane and transitional rainforest vegetation in southwestern Ethiopia (Kumelachew and Tamrat, 2002) and Gara Ades forest in southeastern Ethiopia (Uhligsit and Uhlig, 1990). Agama forest contains a number of flowering plant species that are endemic to Ethiopia. The endemic plant species identified (9 species) in this study is in agreement with similar studies with Abreham (2009) for Masha Andracha Forest, Derje (2002) for Gura Ferdea forest and Ensermu and Teshome (2008) for Bonga forest. Some of this species are in the IUCN Red Data list, were identified in Agama Forest. The number of endemic plant species recorded for the study area is small compared to dry afromontane forests, since the southwest moist montane forests are poor in trees/shrubs endemicity (Kumelachew and Simon, 2002).

Species diversity and evenness are used to interpret the relative variation among the communities. Lower evenness in Community III indicates the dominance of a few species such as *Pouteria adolfi-friedericii* (Engl.) Baehni, *Schefflera abyssinica* (Hochst. ex A. Rich.) Harms, *Vepris dainellii* (Pichi-serm.) Kokwaro, *Dracaena afromontana* Mildbr, and *Acanthopale aethiogermanica* Ensermu in the community and similar observation was reported by Abraham (2009) for Masha forest. On the other hand, high evenness in community I, II and IV indicates little dominance by any single species but

Table 4. Post-hoc comparison of means between environmental variables and plant community.

Environmental variables	Plant Community Types			
	I	II	III	IV
Altitude (m)	2193±41.37[b]	1905±21.62[a]	1960±25.2[a]	1913±38.95[a]
Slope (%)	33.6±5.3[b]	16.3±2.8[a]	14.7±4.6[a]	25±3.5[a]
Aspect	1.99±.42 [a]	2.29±0.32 [a]	2.46±0.43 [a]	1.3±0.21 [a]
Disturbance	2.35±1.88 [a]	2.36±.20[a]	2.66±.21[a]	2.15±.24[a]
pH	4.8±0.12 [a]	5.06±0.106 [a]	5.22±0.09 [a]	4.76±0.15 [a]
Sand (%)	66.9±2.15[b]	51.0±1.8[a]	54.4±2.3[a]	48.9±5.4[a]
Clay (%)	18.36±1.26[a]	29.4±0.85[b]	24.9±1.73[ab]	31.4±3.92[b]
Silt (%)	14.65±1.37[a]	21.16±1.05[b]	19.10±1.18[ab]	19.60±2.02[ab]

Table 5. Pearson's correlation between environmental variables measured in Agama forest.

Variables	Altitude	Slope	Aspect	Disturbance	PH	Sand	Clay	Silt
Altitude	-							
Slope	0.166	-						
Aspect	-.005	0.043	-					
Disturbance	0.135	0.396	-0.003	-				
PH	-.095	0.037	0.012	-0.096	-			
Sand	0. 640**	-0.115	-0.219	0.67**	0.013	-		
Clay	-0.73**	-0.215	0.143	0.993**	0.114	0.775**	-	
Silt	-0.479	0.048	0.02	-0.583**	0.109	0.882	0.549	-

Table 6. Phytogeographical Comparison of Agama forest with other forests in Ethiopia, according to Sorensen similarity Index.

Forests	Sorensen index	Dissimilarity	References
Godre	0.46	0.54	Dereje Denu,2006
Masha	0.59	0.41	Abreham Assefa, 2009
Yayu	0.40	0.60	Tadesse Woldmariam,2004
Harenna	0.38	0.62	Lisanework Nigatu,1987
Jibat	0.32	0.78	Tamart Bekele, 2002

Values in a row with different letters are significantly different (P<0.05).

repeated coexistence of species over all plots in a community *(Vepris dainellii*). The highest species richness and diversity were observed in community II. The possible reason may be the altitude since it is found at mid altitudes which provides with optimal conditions of environmental factors that favor vegetation growth (Rosenzwieg, 1995). Some species may exclusive to live in mid, low and high altitudes depending on their physiological need and adaption (Austrheim, 2002). Community type **I** showed the lowest species richness and diversity. This difference is the result of differences in site productivity, habitat heterogeneity and anthropogenic influences such as selective removal of economically important trees and grazing by livestock. Local people reported that this community was used as settlement area for indigenous people before introduction of PFM. The altitude was relatively the important environmental factor that separates the four plant communities studied. Community I was significantly different from the rest of the communities since it is found at higher altitude (2343 m) and the communities II, III and IV are found at intermediate altitudes. This study is in agreement with Bonnefille et al. (1993) reported that the presence of altitudinal Zonation is delimiting vegetation types in southwestern Ethiopia and affecting atmospheric pressure, moisture and temperature which have again a strong influence on the growth and development of plants and the distribution of vegetation. Studies by Herdberg in 1951 also confirmed the altitude effect on vegetation in eastern African mountain.

The acidity of the soil in southwest Ethiopia is relatively higher as compare to other parts of the country due to intense breakdown of organic matter and leaching of the soil by heavy rainfall. This results in leaching of appreciable amounts of exchangeable basic ions like calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K) from the surface of soil (Achalu et al., 2012). The soil pH decreases with increasing altitude and this could affect the chemical reaction between plant roots and nutrients, the availability of nutrients in the soil for plant use and microbial activity (Donahue et al., 1983). These could be the possible reasons for the decline of species richness and diversity with altitude. The differences in soil texture among the communities are not strongly significant due to limited size of the study area and the altitude ranges are not strongly significant to show variation among the plant communities.

The Agama forest was more floristically related to the Masha and Godre forests due to geographical proximity and located in similar climatic zone. Proximity of the areas favors seed dispersal and migration which result in a high floristic similarity. On the other Jibbat and Harenna forests are found in south eastern parts of the country and it has low floristic similarity due to variation in altitude soil, and climatic factors (rainfall, temperature). On top of this human influence on the forest resource also causes variation in floristic diversity. Bonnefille and Hamilton (1986), reported that the destruction of montane forest in southeastern Ethiopia as far back as ca. 2000 years and these historical factors may have led to the variation in floristic diversity between the southwest (Agama) and southeastern (Harenna).

CONCLUSION AND RECOMMENDATION

The Agama forest, in southwest Ethiopia, has high floristic richness and diversity. Four community types were identified at an altitude between 1800 and 2371 m. The communities at the bottom and middle of the altitudinal gradient were richest while the community restricted to the top had less species. The Soil of Agama forest is acidic (with low pH) caused by excessive rainfall. The Agama forest is rich in plant biodiversity as compare to its limited size thus conservation of forest through, strengthening of existing PFM and provision of environmental education for forest user groups are highly recommended.

Conflict of interests

The authors have not declared any conflict of interests.

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Appendix I. checklist of plant species identified from Agama Forest.

S/N.	Plant species	Family	Growth form
1	*Acanthopale ethio-germanica* Ensermu	Acanthaceae	Shrub
2	Acanthopale pubescens (Lindau ex Engl.0.46) C.B. Clarice	Acanthaceae	Herb
3	*Acanthus eminens* C.B.Clarke	Acanthaceae	Shrub
4	Achyrospermum schimperi (Hochst. ex Briq.) Perkins,	Lamiaceae	Herb
5	*Achyranthes aspera* L.	Amaranthaceae	Herb
6	*Adianthum thalictroides schltd*	Adianthaceae	Herb
7	*Aerangis brachycarpa* (*luch.) Th. Dur.&Schinz,*	Orchidaceae	Herb
8	*Aframomum corrorima* (Braun) Jansen	Zingiberaceae	Herb
9	*Ajuga alba* (Guerke) Robyns	Lamiaceae	Herb
10	*Albizia gummifera* (Gmel.) C.A. Sm.	Fabaceae	Tree
11	*Alblzia schimperiana Oliv.*	Fabaceae	Tree
12	*Alecmella fischeri Engl*	Roseaceae	Herb
13	*Alecmella abyssinica* Fresen	Roseaceae	Herb
14	*Alectra vogelii* Benth.	Scrophulariaceae	Herb
15	*Allophyllus abyssinicus (Hochst)Radlk*	Spindaceae	Tree
16	*Ammocharis tinneana* (Kotschy &Peyr.)Milne-Redh.	Orchidaceae	Herb
17	*Apodytes dimidiata* E. Mey. ex Arn	Icaccinaceae	Tree
18	*Asparagus africanus* Lam.	Asparagaceae	Herb
19	*Asparagus setaceus (Kunth)* Jessop	Asparagaceae	Herb
20	*Aspilia mossambicensis (Oliv.)* Wild	Asteraceae	Herb
21	*Asplenium aethopicum (Brum.f.)* bech	Aspleniaceae	Herb
22	*Asplenium anisophyllum* Kunze	Aspleniaceae	Herb
23	*Asplenium bugoiense* Hieron	Aspleniaceae	Herb
24	*Asplenium erectum* Willd.	Aspleniaceae	Herb
25	*Asplenium friesiorum* C.Chr.	Aspleniaceae	Herb
26	*Asplenium sandersonii* Hook	Aspleniaceae	Herb
27	*Asystasia gangetica (L.) T.* Andders. Subsp*. Micrantha (Nees).* Ensermu	Acanthaceae	Herb
28	*Bersama abyssinica* Fresen.	Melianthaceae	Tree/Shrub
29	*Bothriocline schimperi* Olivo & Hiern ex Benth.	Asteraceae	Herb
30	*Brillantaisia madagascariensis* T. Anders.	Acanthaceae	Shrub
31	*Buddleja polystachya* Fresen.	Loganiaceae	Tree/shrub
32	*Bulbophyllum josephii (Kuntze)* Summerh*.,*	Orchidaceae	Herb
33	*Canthium oligocarpum* Hiern	Rubiaceae	Tree
34	*Cassipourea malosona* (Baker) Alston	Rhizophoraceae	Tree
35	*Carex chlorosaccus* C.B. Clarke	Cyperaceae	Herb
36	*Carex spicato-paniculata Bock.* ex *C.B. Clarke*	Cyperaceae	Herb
37	*Cayratia gracilis (Guill. & Perr.]* Suesseng*.*	Vitaceae	Herb
38	*Celtis africana* Burm.	Ulmaceae	Tree
39	*Chamaecrista mimosoides (L.)* Green	Mimosoideae	Liana
40	*Clausena anisata* (Wild.) Benth.	Rutaceae	Shrub/Tree
41	*Clematis longicauda* Steud. ex A. Rich	Ranuaculaceae	Liana
42	*Clematis simensis* Fresen.	Ranuaculaceae	Liana
43	*Coffea arabica* L.	Rubiaceae	Shrub/Tree
44	*Cordia africana* Lam.	Boraginaceae	Tree
45	*Combretum paniculatum* Vent.	Combreataceae	Liana
46	*Commelina diffusa* Burm.f.	Commelinaceae	Herb
47	*Coniogramme africana* Hieron	Hemionitidaceae	Herb
48	*Crassocephalum crepidioides (*Benth.) S. Moore	Asteraceae	Herb
49	*Croton macrostachys* Del.	Euphorbiaceae	Tree
50	*Cryptotaenia africana (Hookf)* Drude	Apiaceae	Herb

Appendix I. Contd.

51	*Cucumis dipsaceus Ehrenb.* ex Spach	Cucurbitaceae	Herb
52	*Culcasia falcifolia* Engl.	Araceae	Herb
53	*Cyathea manniana* Hook.	Cyatheaceae	Tree
54	*Cyperus fischeria* A.Rich.	Cyperaceae	Herb
55	*Dalbergia lactea* Vatke	Fabaceae	Shrub
56	*Desmodium repandum* Vahl	Fabaceae	Herb
57	*Dicliptera maculata* Nees,	Acanthaceae	Herb
58	*Didymochlaena truncatula* (Sw.) J. Sm	Aspidiaceae	Herb
59	*Dissotis canescens* (Graham) Hook.f.	Melistostomaceae	Herb
60	*Dombeya torrida* (J.F.Gmel.) Bamps	Sterculiaceae	Tree
61	*Dracaena afromontana* Mildbr.	Dracenaceae	Shrub
62	*Dracaena fragrans* (L.) Ker-Gawl.	Dracenaceae	Shrub
63	*Dracaena steudneri* Scw.ex Engl.	Dracenaceae	Tree
64	*Drynaria volkensii* Hieron	Polypodiaceae	Herb
65	Dryopteris concolor (langsd.&Fisch.) Kuhn in Vonder Decken	Dryopteridaceae	Herb
66	*Ehretia cymosa* Thonn.	Boraginaceae	Tree
67	*Ekebergia capensis* Sparrm.	Meliaceae	Tree
68	*Elaeodendron buchananii*	Celastraceae	Tree
69	*Elatostemma monticolum* Hook. f.	Urticaceae	Herb
70	*Embelia schimperi* Vatke	Myrsinaceae	Liana
71	*Erythrococca trichogyne* (Muell. Arg.) Prain	Euphorbiaceae	Shrub/Tree
72	*Euphorbia ampiphyla Pax.*	Euphorbiaceae	Tree
73	*Ficus sur* Forssk.	Moraceae	Tree
74	*Ficus ovata* Vahl	Moraceae	Tree
75	*Ficus thonningii* Blume	Moraceae	Tree
76	*Fagaropsis angolensis*	Rutaceae	Tree
77	*Flacourtia indica* (Burm.f.) Merrill	Flacourtiaceae	Tree
78	*Galiniera saxifraga* (Hochst.) Bridson	Rubiaceae	Tree
79	*Tacazzea conferta* N.E. Br.	Asclpidaceae	liana
80	*Tacazzea apiculata* Oliv	Asclpidaceae	liana
81	*Habenaria quartiniana* A. &ch.,	Orchidaceae	Herb
82	*Helicbrysum stenoptel1lm* DC.	Asteraceae	Herb
83	*Hippocratea pallens* Oliv.	Celastraceae	shrub
84	*Holothrix praecox* Rchbf.	Orchidaceae	Herb
85	*Hyparrhenia hirta (L.) Stapf,* var. *brachypoda* Chiov.	Poaceae	Herb
86	*Hypoestes forskaolii* Roem. & Schult.	Acanthaceae	Herb
87	*Hypoestes triflora* (Forssk.) Soland.ex Roem. & Schult.	Acanthaceae	Herb
88	*Ilex mitis* (L.) Radlk.	Aquifoliaceae	Tree
89	*Indigofera mimosoides* Bak.	Fabaceae	Shrub
90	*Isoglossa laxa* Oliv.	Acanthaceae	Herb
91	*Isoglossa somalensis* Lindau	Acanthaceae	Herb
92	*Jasminum abyssinicum* DC.	Oleaceae	Liana
93	*Landolphia buchananii* Stapf.	Apocynaceae	Liana
94	*Lepidotrichilia volkensii* (Gurke) Leory	Meliaceae	Tree
95	*Loxogramme lanceolata* auct,non(sw.) presl	polypodiaceae	Herb
96	*Lycopodium dacrydioides* Bak	Lycopodiaceae	Herb
97	*Lysimachia ruhmeriana* Vatke	Primulaceae	Herb
98	*Macaranga capensis* (Baill.) Sim	Euphorbiaceae	Tree
99	*Maesa lanceolata* Forssk.	Myrsinaceae	Shrub /Tree
100	*Maytenus gracilipes* (Welw.ex Oliv.) Exell	Celastraceae	Shrub
101	*Mikaniopsis c1ematoides* (.S'ch. *Bip.* ex *A. Rich.) Milne-Redh.*	Asteraceae	Herb
102	*Millettia ferruginea* (Hochst.) Baker	Fabaceae	Tree

Appendix I. Contd.

103	*Monothecium glandulosum* Hochst.,	Acanthaceae	Herb
104	*Ocotea kenyensis* (Chiov.) Robyns & Wilcz	Lauraceae	Tree
105	*Olea capensis* subsp. *macrocarpa* (C. A. Wright) Verdc.	Oleaceae	Tree
106	*Olea welwitschii* (Knobl.) Gilg & Schellenb.	Oleaceae	Tree
107	*Oplismenus hirtellus* (L.) P. Beauv.	Poaceae	Herb
108	*Oxyanthus speciosus* DC.	Rubiaceae	Shrub
109	*Panicum monticola* Hook. f.	Poaceae	Herb
110	*Pavonia* urens *Cav.*	Malvaceae	Shrub
111	*Pavetta abyssinica* Fresen. var. abyssinica	Rubiaceae	Shrub
113	*Pentas lanceolata* (Forssk.) Defl.	Rubiaceae	shrub
114	*Pentas schimperiana(A.Rich)vatke*	Rubiaceae	Herb
115	*Peponium vogelii* (Hook.f.) Engl.	Cucurbitaceae	Herb
116	*Peperomia tetraphylla* (Forster.) Hook. & Arn.	Piperaceae	Herb
117	*Phaulopsis imbricata* (Forssk.) Sweet	Acanthaceae	Herb
118	*Pittosporum viridiflorum* Sims	Pittosporaceae	Shrub
119	*Phonix reclinata* Jacq.	Araceae	Tree
120	*Phyllanthus ovalifolius* Forssk.	Euphorbiaceae	Herb
121	*Pilea rivularis* Wedd.	Urticaceae	Herb
122	*Piper capense* L.f.	Piperaceae	Herb
123	*Plantago palmata* Hook.f.	Plantaginaceae	Herb
124	*Poecilostachys oplismenoides (Hack.)* W. D*. Clayton*	Poaceae	Herb
125	*Polygonum nepalense* Meisn.	Polygonaceae	Herb
126	*Polyscias fulva* (Hiern) Harms	Araliaceae	Tree
127	*Pouteria adolfi-friederici* (Engl.) Baehni	Sapotaceae	Tree
128	*Premna schimperi* Engl.	Verbenaceae	Shrub
129	*Prunus africana (Hook. f.)* Kalkm*.*	Roseaceae	Tree
130	*Psychotria orophila* Petit	Rubiaceae	Shrub
131	*Pteris pteridioides* (Hook.) ballard	Pteridaceae	Herb
132	Pycnostachys eminii Gurke,	Lamiaceae	Shrub
133	*Rhamnus prinoides* L'Herit.	Rhamnaceae	Shrub/Tree
134	*Rinorea friisii M. Gilbert*	Violaceae	Tree
135	*Rothmannia urcelliformis* (Hiern) Robyns	Rubiaceae	Tree
136	*Rubus apetalus* Poir.	Roseaceae	Shrub
137	*Rubus steudneri* Schweinf.	Roseaceae	Liana
138	*Rytignia neglecta* (Hiern) Robyns	Rubiaceae	Shrub
139	*Scadoxus multiflorus (Martyn) Raf*'	Amarylidaceae	Herb
140	*Sapium ellipticum* (Krauss) Pax.	Euphorbiaceae	Tree
141	*Schefflera abyssinica* Harms	Araliaceae	Tree
142	*Selaginella kalbreyeri* Bak.`	Selaginellaceae	Herb
143	*Setaria megapbylla (Steud.) Th. Dur. &* Schinz	Poaceae	Herb
144	*Sida collina Schlechtend.*	Malvaceae	Herb
145	*Stellaria mannii Boolc.,*	Caryophylaceae	Herb
146	*Stephania abyssinica* (Dill & A. Rich.) Walp	Menispermaceae	Herb
147	*Syzygium guineense* (Willd.) DC.	Myrtaceae	Tree
148	*Teclea nobilis* Del.	Rutaceae	Shrub/Tree
149	*Thalictrum rhynchocarpum* Dill. & A. Rich	Ranunculaceae	Herb
150	*Tiliacora troupinii* Cuf.	Menispermaceae	Liana
151	*Trema orientalls (L) Blo,*	Ulmaceae	Tree
152	*Trilepisium madagascariense* DC.	Moraceae	Tree
153	*Tristemma mauritianum* J. F. Gmel	Melistostomaceae	Herb
154	*Urera hypselodendron (A. Rich.) Wedd.,G*	Urticaceae	Herb
155	*Vepris dainellii* (Pich.-Serm.) Kokwaro	Rutaceae	liana

Appendix I. Contd.

156	*Vernonia amygdalina* Del.	Asteraceae	Tree
157	*Vernonia auriulifera* Hiern	Asteraceae	Shrub/Tree
158	*Vernonia hochstetteri Sch*. Bip. ex Walp	Asteraceae	Shrub/Tree
159	*Vernonia filigera* Oliv. & Hiern	Asteracea	Herb
160	*Vittaria guineensis* Desv	Vittariaceae	Herb

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Bumpy road to improved mangrove resilience in the Douala Estuary, Cameroon

Jean-Hude, E. Moudingo[1,3]*, Gordon, N. Ajonina[2], Mbarga, A. Bindzi[3] and Bertin N. Tchikangwa[1]

[1]Department of Conservation, BP: 6776 Yaoundé, Centre Region, Cameroon.
[2]Cameroon Wildlife Conservation Society (CWCS). Coastal Forests and Mangrove Conservation Programme. BP 54 Mouanko, Littoral Region, Cameroon.
[3]Department of Plant Biology /Forestry Sciences, Faculty of Science, University of Yaoundé I, BP: 812 Yaoundé, Centre Region, Cameroon.

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Mangrove stands in the Western and Central African countries especially that of Cameroon are declining due to diverse drivers. Actually, *Rhizophora racemosa* stands in the Cameroon Estuary have been degraded through over-exploitation for fish smoking, pole-wood extraction and fuel wood harvesting by local people in the midst where there is no specific law protecting this ecosystem. Recently, community-based mangrove replanting efforts facilitated by the Cameroon Wildlife Conservation Society in the Douala-Edea Reserve (DER), all dominated by over 80% foreigners was carried for the period of 14 months. These communities out-planted only close to 4 ha (40%) of degraded mangrove compare to the initiate target of 10 ha. In a bid to understand the reason for not meeting the targeted goal, the perceptions of local communities geared towards mangrove restoration were assessed through a questionnaire survey, which was administered to a stratified random sample of 400 people, with 100 individual per village (Mbiako, Youme II, Yoyo I and II). The outcome revealed different levels of perception. Overall, a significant proportion that is, 34.5% (*P*<0.005, Rs=0.155) rated mangrove forest as very "little degraded"; 52.5% (*P*<0.005, Rs = -0.099) favoured its restoration; while 60.8% (*P*<0.005, Rs=-0.199) were not aware that mangrove could be nursed to restore degraded areas. Participation in nursery-out planting activities was significantly varied as 89.8% (*P*<0.005, Rs=-0.210) never participated in the process, of which 78.8% (*P*<0.05, Rs=0.161) conditioned their participation on some factors which includes greater sensitisation, more training and incentives. Recommendations ranged from putting in place a community day for mangrove, delineation of roles and responsibilities of members in committee, to graduated sanctions for disturbance of restored sites by guided rules.

Key words: Cameroon wildlife conservation society (CWCS), foreign nationals, communities out-plant, mangrove (*Rhizophora racemosa*), Douala-Edea Reserve (DER).

INTRODUCTION

Mangrove forests occupy less than 1% of the world's forested surface (Saenger et al., 1997). The stands which have "salt-tolerant" plants are less diversity compared to terrestrial forested stands and their understory. A recent study using digital image conducted by Giri et al. (2010) confirmed that mangroves are confined at approximately between 32°N and 38°S with some island extend above this range. With such a geographical range, these

intertidal zones protect the shoreline, serves as breeding ground for fishes and for migratory birds and as carbon sink. They also provide long and short-term socio-economic benefits (Traynor and Trevor, 2008).

Global estimate showed a decline of over 25 % of its original mangrove surface that is from 188, 000 km^2 in 1980; FAO, 2007) to 137,760 km^2 in 2000 (Giri et al., 2010). Even with these figures, this milieu is still at the mercy of ever increasing significant threats due to many causes among, which are feeble institutional and capacity of stakeholders, urbanisation, unsustainable extraction of wood, etc. Henceforth, its rapid debility continues (ITTO, 2010). Even though at a sizable declining trend, mangroves are and still one of the most productive ecosystems (Kathiresan and Bingham, 2001) in terms of goods and services (for example, cultural, provisioning, regulating and supporting) (Millennium Ecosystem Assessment, 2005). As a carbon sink, mangroves, including associated soils, could sequester approximately 22.8 million metric tons of carbon each year (Giri et al., 2010).

In Africa, the Western-Central countries with mangrove represent 6.3%, of which Cameroon mangrove occupies over 2000 km^2 compare to Nigeria with 7386 km^2 [8]. Throughout the Cameroon coast, extensive natural monoculture stands of Rhizophora species (*Rhizophora mangle*, *Rhizophora harrisonii and Rhizophora racemosa*), *Avicennia germinans*, *Conocarpus erectus* and *Laguncularia racemosa* occur (UNEP, 2007; Ajonina et al., 2008; Letouzey, 1968) alongside *Nypa fruticans*. Douala-Edea Reserve (DER) gazetted in 1932 covers part of the inshore Cameroon Estuary and have a surface area of 1600 km^2 (Ajonina, 2001) with more than 10% occupied by mangrove forest.

Usually, wood from this mangrove forest is usually referred locally as 'tanda' (sing.) or 'matanda' (pl.) in the Duala language-Cameroon, or either as 'egba' or 'odo nowe' in the Nigerian language (Letouzey, 1968; Vivien and Faure, 1985). Due to lack of proper protection, the reserve was encroached by local and foreign fishermen alongside their families. Presently, over 6000 individuals inhabits in hamlets and villages, which straddles across the mangrove zone. Over 80% of the total population are foreign nationals, from neighbouring Benin, Ghana, Nigeria, etc. Primarily livelihood activities, which are gender sensitive, include fishing, fish smoking and mangrove fuel wood harvesting. Fishing is primarily conducted by men and the youth, fish smoking mainly by women [10] and wood harvesting by men and women. Fish related processing accounts for over 40% mangrove stand loss in Cameroon (Millennium Ecosystem Assessment, 2005). UNEP (2007) has estimated up to 30% annual loss (3000 ha per year) of Cameroon mangrove forests from 1986 to 2006. Coupled with these induced factors such as "no specific law" enacted for the Cameroon threatened mangrove (FAO, 2007) and the ill-equipped conservation office, mangroves degradation and deforestation in the DER at a rate of roughly 42 ha/year (Ajonina et al., 2005) with over 84% due to wood harvesting destined for fish smoking. Very few fish smokers in the DER have adopted the "improved oven" introduced in 2003 by a national NGO, namely Cameroon Wildlife Conservation Society (CWCS), to minimize the quantity of mangrove wood used for fish smoking. Traditional oven takes up average time of 21 h as opposed to the "improved oven" that takes up lesser time of 5 to 8 h conserving 40 to 50% wood used (Feka et al., 2009). The common fish smoked is ethmalose (*Ethmalose frimbriate*) or 'bonga'. Actually, there has been an increase in the number of "traditional ovens", from 340 to over 850 between 1997 and 2008, as opposed to some 50 "improved ovens" in the DER.

In order to reverse the trend in mangrove stand degradation in the reserve, CWCS and its partners used a Participatory Wetland Appraisal (PWA) to involve coastal communities in mangrove restoration (replanting) activities as a win-win option between October, 2007 and January, 2009. The PWA gave locals the opportunity to practice the approach "learning by doing" so as to arrest and reverse mangrove deforestation and degradation. Actually, local community participation has yielded somewhat desirable results in nursery and outplanting activities. Despite, the creation of an entity called 'Village Mangrove Restoration Steering Committee (COPVAM-French acronym) to assist CWCS (Ajonina et al., 2009; Moudingo et al., 2015), the targeted goal for restoration which was not met. Hence, of the initial target of 10 ha to restore, communities participated in restoring only 4 ha (40%) (Moudingo et al., 2015). However, little or no study has been done in DER, in understanding the dynamics of community participation in *in situ* mangrove restoration efforts through indirect seeding. This study was therefore conducted as part of an effort to do so.

MATERIALS AND METHODS

Study area

The study area has been described in Ajonina and Usongo [10]. The reserve takes its name "Douala-Edea" from the Douala (Wouri) and Edea (Sanaga-maritime) Divisions tributaries. It is located within the Douala-Edea basin of the coastal Atlantic Ocean. The dense hydrological network naturally defines the boundaries of the reserve. The reserve is limited in the North by R.Wouri estuary, East by R. Sanaga, Dipombé and Kwakwa, South by R. Nyong, and

*Corresponding author. E-mail: m_ekindi@yahoo.fr

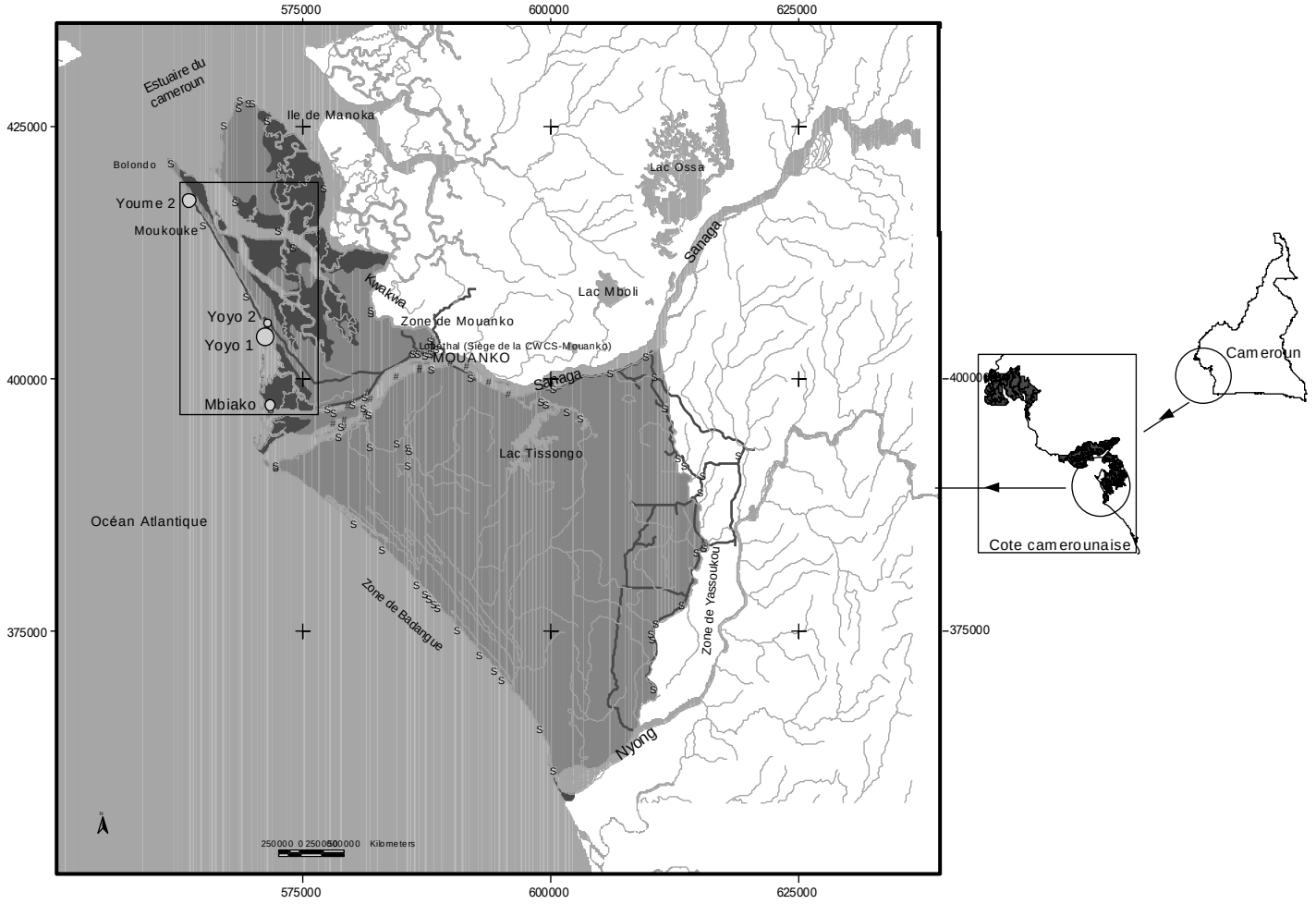

Figure 1. Map showing the distribution of mangrove, study villages in the DER.

West by the Atlantic Ocean covering about 100 km (52 nautical miles) coastline from R. Nyong to the Wouri estuary. The reserve is within the Littoral Region administratively, and sandwiched by the Edea (Yassoukou village) and Mouanko sub divisions (Figure 1). This study overlaps on four mangrove forest villages (Mbiako, Yoyo I, Yoyo II and Youme II) covering over 80% of Douala-Edea mangrove forests estimated at more than 16,000 ha where CWCS has been working for over 13 years. These villages are located between Latitude 3°35' to 3°48' N and Longitude 9°38' to 9°48'E. In the area, there are more than sixty villages and fishing hamlets in the mangrove zone, mostly (80%) inhabited by foreign nationals from Benin, Ghana, Nigeria, etc. Fishing, fish smoking, mangrove fuel wood harvesting, trading and poaching is their main livelihood activities.

The climate is under the influence of the proximity of the Ocean. Annual rainfall varies between 3000 to 4000 mm, with the month of September registering the heaviest rainfall and the month of December the least. Average yearly temperatures range between 24 to 29°C. The soil varies from very sandy to very high clayey, while that in the mangroves is firm in some places, muddy and slushy in other places, so that walking is practically difficult, if not impossible. The salinity presents a very high spatial-temporal variation. Excess water during the rainy season frequently reduces salinity. Salt measurements during the months of August and February revealed 1.5 g/l and 12 g/l respectively (Mbog, 1999).

METHODOLOGY

Relevant data on community perception in efforts was obtained using semi-structured questionnaires that was aligned to the three WPA stages. Four types of questions structure were addressed in the DER, Cameroon. It consisted of open-ended, closed-ended questions with either ordered, and/or unordered response categories and partially close-ended where many possible responses are addressed. The interviews were conducted for 3 months (between October to December 2009) and administered to a systematically sampled people of 400 (Yoyo I and II, Youme II, and Mbiako had 100 individual each) in 45 households facilitated by the linear settlement pattern. Stratified random sampling method was used to select people of various age groups, profession and sexes to provide a balanced picture of their roles in the different stages of mangrove restoration activities (Figure 2). The interviews were conducted during the day on foot (from 7'30 am to 5 pm), with a break of few minutes. French and 'broken English' (commonly used) languages were used in the interview, and were later translated into English language during analysis.

The survey ended when the quorum of the first hundredth person in each village was reached, giving a total sampling intensity of 16.1% of the selected four villages Hence, to achieve the stated objectives, the question exploited the sensitization, community organization to nursery-outplanting steps geared toward *in situ*

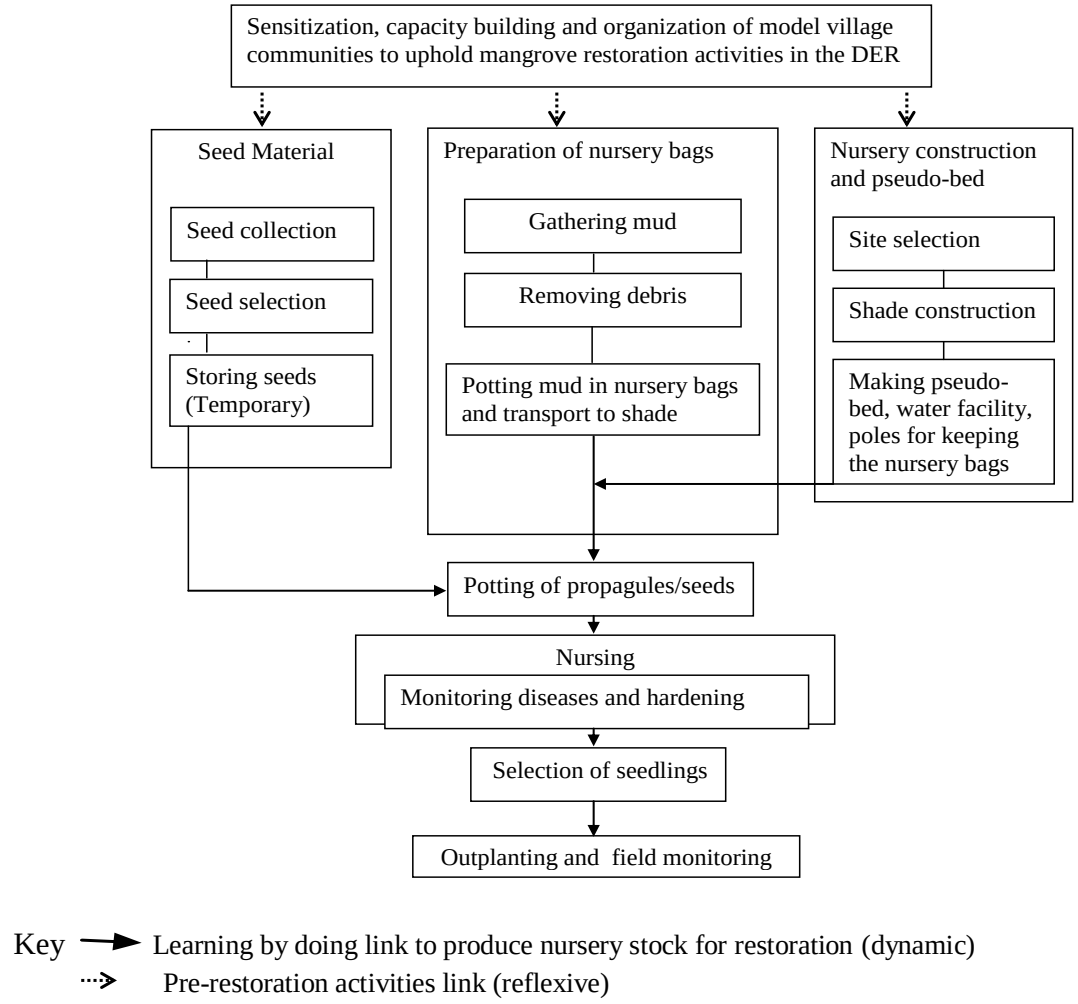

Figure 2. Chart of stages towards mangrove restoration using nursery seedlings in the DER.

indirect seeding (replanting) using *R. racemosa*, to assess community participation. The site was accessible and had a suitable and regular tidal dynamic. Soil was muddy with little or no standing tree. Salinity for ranged from mesohaline to polyhaline. The data were analysed using simple descriptive statistics especially frequency counts and percentages. The user-friendly statistic software packages (Microsoft Office Excels and the Statistics Package for Social Sciences, SPSS) provided many opportunities to analyse participatory data matrix (PDM). The PDM consisted of response variables as column and explanatory variables as rows. The response variables consisted of community characteristics (site, gender, nationality, occupation, and origin and education level, longevity in site, marital status and age group) and participation indicators while the explanatory variables consisted of subjects (individuals). PDM analysis involved interpretation and categorisation of responses. Pearson's chi-square (χ^2) test (95 and 99.5% respectively) and Spearman's correlation (Rs) (Agresti and Finlay, 2009) were used to test the significance of responses, especially the observed community participation as revealed by PDM and the expected community involvement as predicted by the counts. Spearman's correlation coefficient (Rs), was used to test the direction and strength of the relationship between two variables with participation variables.

RESULTS

Community characteristics

The socio-economic characteristics of the 400 respondents distributed in the four villages are presented in Figure 3. Of a sample of 400 people interviewed, over 40% were between 30 to 39 years, more or less equal representation of men and women who were mostly married (above 50%) with first school or no formal education.

Analysis of community perception and participation

Community perception in rating mangrove forest status

Overall, of the 400 interviewed, a significant ($P<0.005$; $\chi^2= 170.671$, d.f= 12; Rs= 0.155) proportion 138 (34.5%)

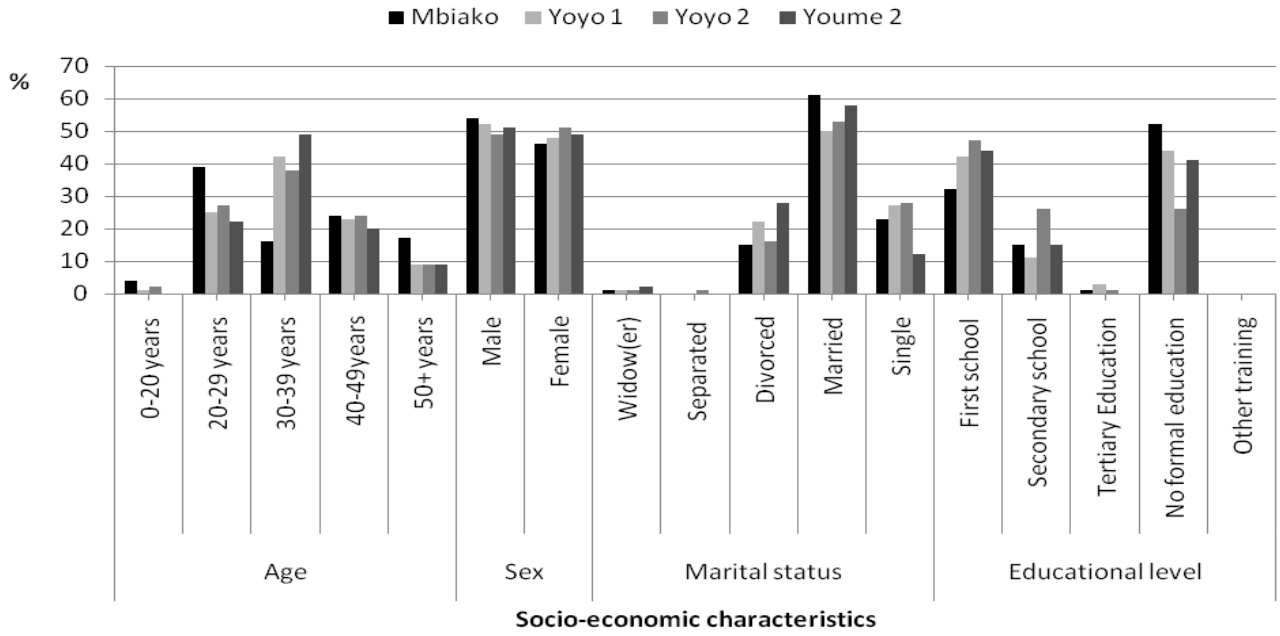

Figure 3. Socioeconomic characteristics of the respondents in DER, Cameroon.

said that the mangrove forest was very little degraded with *R*. *racemosa* present in near to pristine condition (Tables 1 and 2). Of these 138, the majority supported the responses within and across community characteristics. Of these 138, over 60 persons were from Youme II. In addition, no significant difference was found within and across some community characteristics (longevity in site, marital status and age group). Rs revealed that all the association had weak correlations. Actually, the mangrove areas in the selected communities have decreased noticeably. Results revealed that communities were aware that mangrove are degraded, especially those from Yoyo II. The reason for this acknowledgement stemmed from the fact that this population carry out activities such as fish smoking, and cooking which require a good quantity of mangrove wood and its harvest is on-going to meet subsistence requirements. Presently, this population now go longer distances to fetch mangrove wood for these activities.

At village level, there were significant differences and weak correlations (Table 2). Of the 100 individuals interviewed, a large proportion had no significant difference within and across community characteristics in Mbiako and Yoyo II. The results at this level also showed that more of those interviewed in Mbiako said that mangrove was very little degraded. While, in Yoyo II a significantly larger number within communities said that mangrove was considerably degraded. Besides, in Youme II a significant proportion said that mangrove was very little degraded. A significant difference was observed with some community characteristics such as occupation ($P>0.05$; $\chi^2=18.343$, .d.f=9, Rs=-0.093) and education level ($P>0.05$; $\chi^2=15.939$, d.f= 6; Rs=-0.132) among those who said the mangrove was very little degraded.

On the other hand, in Yoyo I a significant number of individuals interviewed, 21 ($P<0.05$; $\chi^2=21.021$, d.f= 8; Rs=-0.384) Nigerians, 15 ($P<0.05$; $\chi^2= 21.021$, d.f= 12; Rs=0.21) fishermen, 31 ($P>0.05$; $\chi^2= 10.906$, d.f= 4; Rs=-0.187) non-indigene and 15 ($P<0.005$; $\chi^2=31.403$,d.f=12; Rs=0.227) non-scholars said that their mangrove was not at all degraded.

Community awareness on mangrove out planting

Tables 2 and 3 (Question 3) show that of the 400 interviewed, 210 (52.5%) ($P<0.005$, $\chi^2= 48.312$, d.f= 3;Rs=-0.099) answered 'yes' to the question "should we grow mangrove?" (*R*. *racemosa*). Of these 210, most were from Yoyo II, 81 (20.3%). Whereas a significant proportion, 190 (47.5%) answered "no" on planting mangrove. Representative community characteristics of those who said "no" on planting mangrove include 122 (30.5%) ($P<0.005$; $\chi^2= 41.009$, d.f= 3; Rs= 0.319) Nigerians; 184 (46.5 %) ($P<0.005$; $\chi^2=13,279$, d.f= 1; Rs= 0.182) non-indigenes and 89 (22.3%) ($P<0.005$; $\chi^2= 13.317$, d.f= 3; Rs= -0.161) without formal education. No significant difference was observed for some community characteristics. Rs showed that all correlations were weak (Table 2). Actually, overall analyses prove that selected community members in all sites will participate in *R*. *racemosa* out planting. At village level, the results showed discrepancies amongst and within community characteristics (Table 2). Of the 100 individuals

Table 1. Analysis of community perception of mangrove forest degradation in all the four villages in the Douala-Edea, Cameroon.

			Community characteristics																																		
			Sites										Gender				Nationality								Occupation								Origin			
S/N	Question	Response	Mbiako	%	Yoyo 1	%	Yoyo 2	%	Youme 2	%	Total	%	Male	%	Female	%	Cameroonians	%	Nigerians	%	Ghanaians	%	Others	%	Fishing	%	Fish smoking	%	Wood cutting	%	Other	%	Indigene	%	None-indigene	%
2	Can you rate the degradation of the area(s) where mangrove is being harvested?	unsure	15	3.8	31	7.8	16	4.0	8	2.0	70	17.5	38	9.5	32	8.0	19	4.8	41	10.3	9.0	2.3	1.0	0.3	17	4.3	18	4.5	0	0.0	35	8.8	4.0	1.0	66	16.5
		not at all	13	3.3	31	7.8	5	1.3	3	0.8	52	13	34	8.5	18	4.5	14	3.5	31	7.8	7.0	1.8	0.0	0.0	23	5.8	14	3.5	0	0.0	15	3.8	5.0	1.3	47	11.5
		very little	39	9.8	23	5.8	12	3.0	64	16.0	138	34.5	58	14.5	80	20	34	8.5	88	22	14	3.5	2.0	0.5	32	8.0	65	16.3	2	0.5	39	9.8	4.0	1.0	134	33.5
		considerable	30	7.5	13	3.3	41	10.3	25	6.3	109	27.3	57	14.3	52	13	48	12	53	13.3	7.0	1.8	1.0	0.3	27	6.8	36	9.0	10	2.5	36	9.0	11	2.8	98	24.5
		extremely	3	0.8	3	0.5	26	6.5	0	0.0	31	7.8	19	4.8	12	3.0	24	6.0	5	1.3	2	0.5	0	0.0	5	1.3	5	1.3	2	0.5	19	4.8	10	2.5	21	5.3
		χ^2-Statistics	170.671										10.404				41.07								49.604								29.202			
		P	0.00										0.034				0.00								0.00								0.00			
		df	12										4				12								12								4			
	χ^2-Tabulated	95%	21.03										9.49				21.03								21.03								9.49			
		99.5%	28.30										14.86				28.30								28.30								14.86			
		Significant	**										*				**								**								**			

			Community characteristics																																			
			Education level								Longevity in site (years)										Marital status										Age group (years)									
S/N	Question	Response	None	%	Primary	%	Secondary	%	Higher learnig	%	<10	%	10-20	%	20-30	%	30-40	%	40>	%	Single	%	Married	%	Seperated	%	Divorced	%	Widow(er)	%	<20	%	20-29	%	30-39	%	40-49	%	50>	%
2	Can you rate the degradation of the area(s) where mangrove is being harvested?	unsure	32	8.0	23	5.8	12	3.0	3	0.8	36	9.0	14	3.5	10	2.5	8	2.0	2	0.5	21	5.3	33	8.3	15	3.8	0	0.0	1	0.3	4	1.0	20	5.0	24	6.0	15	3.8	7	1.8
		not at all	24	6.0	25	6.3	2	0.5	1	0.3	22	5.5	12	3.0	12	3.0	4	1.0	2	0.5	13	3.3	31	7.8	8	2.0	0	0.0	0	0.0	1	0.3	17	4.3	23	5.8	9	2.3	2	0.5
		very little	63	15.8	62	15.5	13	3.3	0	0.0	58	14.5	24	6.0	33	8.3	13	3.3	10	2.5	24	6.0	79	19.8	32	8.0	0	0.0	3	0.8	1	0.3	41	10.3	47	11.8	34	8.5	15	3.8
		considerable	40	10	43	10.8	26	6.5	0	0.0	46	11.5	23	5.8	21	5.3	8	2.0	11	2.8	22	5.5	63	15.8	22	5.5	0	0.0	2	0.5	1	0.3	27	6.8	42	10.5	22	5.5	17	4.3
		extremely	4	1.0	12	3.0	14	3.5	1	0.3	15	3.8	12	3.0	3	0.8	0	0.0	1	0.3	10	2.5	16	4.0	4	1.0	1	0.3	0	0.0	0	0.0	8	2.0	9	2.3	11	2.8	3	0.8
		χ^2-Statistics	47.547								19.509										22.091										18.974									
		P	0.0								0.243										0.14										0.27									
		df	12								16										16										16									
	χ^2-Tabulated	95%	21.03								26.30										26.30										26.30									

Table 1. Contd

99.5%	28.30	34.27	34.27	34.27
Significant	**	ns	ns	ns

*Significant at α=95%, **Significant at α=99.5%, ns for (Not Significant for given degree of freedom).

interviewed, a large number of responses show no significant differences across the community characteristics in Yoyo II and Youme II. In Yoyo II, 44 (P>0.05; χ^2=1.881,.d.f= 1;.Rs=0.137) females, 45 (P>0.05; χ^2= 7.43, d.f= 3; Rs=0.189) Cameroonians, 36 (P>0.05; χ^2= 0.767, d.f=3; Rs=0.072) people of others occupation, 65 (P>0.05; χ^2= 2.29, d.f= 1;.Rs=0.151) non-indigenes and 35 (P>0.05; χ^2=2.699, d.f= 3; Rs=-0.044) primary school leavers, answered that mangrove should be planted. Whereas in Youme II, 29 (P>0.05; χ^2=0.623,d.f= 1; Rs=0.079) males, 36 (P>0.05; χ^2=4.033,.d.f=3;.Rs=0.13) Nigerians, 19 (P>0.05; χ^2= 5.894,d.f= 3; Rs=-0.08) fish smokers, 53 non-indigenes with no statistics due to their limited presence and 23 (P>0.05; χ^2= .0.499, d.f= 2,Rs=-0.06) non-scholars were against mangrove planting. Moreover, analysis within and across community characteristics revealed that Yoyo II and Youme II had no significant differences compared to Yoyo I and Mbiako for respondents who said *R*. *racemosa* should not be planted. In Mbiako results show that, 33 (P<0.05; χ^2= 3.904, d.f=1;.Rs=0.18) males, 31 (P<0.05; χ^2=10.881, d.f=3;Rs=0.27) Nigerians, 25 (P<0.05; χ^2= 9.762,d.f= 3.Rs=-0.23) fishermen and 31 (P<0.05; χ^2= 11.536,.d.f= 3....Rs=-0.29) married, and in Yoyo I, 38 (P<0.05; χ^2= 7.131, d.f=1; Rs=-0.267) females, 26 (P<0.05; χ^2= 11.459, d.f=3; Rs=-0.258) fish smokers and 48 (P<0.05; χ^2= 4.963, d.f=1; Rs=0.22) non-indigenes answered that mangrove should not be planted.

Furthermore, of the 400 interviewed, respondents gave reasons for "why mangrove should or should not be planted". The clustered rank showed that 93 (23.3%) answered that mangrove regeneration was natural (Figure 4). Many held the view that natural regeneration of mangrove was satisfactory whereas others, 87 (21.8%), believed that the replenishment of mangrove forest was done by divine hands as their responses were that 'God' plants mangrove. Figure 4 shows that across villages, communities perceived the importance of mangrove from different points of view.

Community awareness on the role of nursery in mangrove restoration

Of the 400 interviewed, in site and across community characteristics of a significant (P<0.005; χ2= 23.098, d.f= 3; Rs=-0.199) large proportion, 243 (60.8%), demonstrated that they were not aware that mangrove was nursed for outplanting (Question 4: Tables 2 and 4). They did not seem to know the importance of why *R*. *racemosa* should be nursed. Of these 243, most were from Yoyo I, 76 (19%). Conversely, 157 (39.7 %) agreed that mangrove can be nursed and saw the importance of doing so. Majority, 53 (13.30%) of those who agreed were from Youme II. During the interview, all respondents provided reasons as to why they did not know the importance of nursing *R*. *racemosa*. The reasons provided were arranged and clustered to give the percentages presented in (Figure 4). Overall, the attribute that received a strong response support, was 268 (67%) for a 'no answer' or 'no idea'. Of this 67 %, Yoyo I (21%) and Mbiako (18.5 %) had outstanding percentages for those who had 'no idea'.

According to Figure 5, only respondents in Youme II knew more about the positive role of nursery in R. *racemosa* restoration. These results showed that only a few communities were aware of the role of nursery in restoration of mangrove, while many saw that the activities were not of prime concern to them. Rs coefficient showed that all correlations were weak. Community awareness for *R*. *racemosa* nursing issues in the DER, Cameroon was poor.

Discrepancies were found among and within the four villages (Figure 5). However, 15.6% acknowledged the positive role of the NGO (CWCS) working in the mangrove conservation through restoration. Moreover, of the 100 interviewed in each selected villages (Mbiako, Yoyo I and Yoyo II) significant proportions were not aware that mangrove could be nursed for restoration. Of these, in Mbiako, the study had 44 (P<0.005; χ2= 9.805, d.f= 1;.Rs=0.31) males, 33(P<0.05; χ2= 9.647, d.f= 3;.Rs=0.21) Nigerians, 29 (P<0.005; χ2=, 23.22, d.f= 3;Rs=0.189) fishermen, 33 (P<0.005; χ2= 16.993, d.f= .4; Rs=-0.27) of those who have been in site for less than ten years and 31 (P<0.05; χ2=12.729,.d.f= 4;.Rs=-0.30) of those aged 20 to 29. Moreover, many in Mbiako, 74 (18.5 %) did not know the importance of nursery (Figure 4). In Yoyo I we had 41 (P<0.05; χ2= 4.488, d.f= 1;Rs=-0.21) females, 47

Table 2. Spearman correlation matrix for all the four villages in the Douala-Edea, Cameroon.

S/N	Question	Village/sites	Community							
			Gender	Nationality	Occupation	Origin	Education	Longevity	Marital status	Age
2	Can you rate the degradation of the area(s) where mangrove is being harvested?	0.155	-0.013	-0.231	0.058	-0.152	0.017	0.017	0.021	0.106
3	According to you should we plant mangrove?	-0.099	0.042	0.319	-0.167	0.182	-0.161	0.018	-0.068	-0.144
4	Are you aware that matanda can be nursed?	-0.199	0.111	0.066	-0.021	-0.006	-0.033	-0.154	-0.031	-0.148
5	Have you ever taking part in mangrove nursery work?	-0.21	-0.015	0.075	-0.019	0.074	-0.083	-0.044	0.044	-0.026
8	How can you rate your participation?	0.182	-0.067	0.031	-0.047	0.018	0.001	0.198	-0.064	0.152
9	Do you need incentives for taking part in mangrove restoration?	0.161	-0.046	-0.062	0.045	0.049	0.111	-0.14	0.072	0.05
2	Can you rate the degradation of the area(s) where mangrove is being harvested?	Mbiako	-0.093	-0.053	-0.11	0.022	0.033	0.229	0.107	0.211
3	According to you should we plant mangrove?		0.198	0.276	-0.232	0.138	-0.102	-0.103	-0.296	-0.275
4	Are you aware that matanda can be nursed?		0.313	0.218	-0.028	0.011	0.032	-0.273	-0.254	-0.307
5	Have you ever taken part in mangrove nursery work?		-0.212	0.313	-0.054	0.339	-0.322	0.114	0.121	0.028
8	How can you rate your participation?		-0.048	0.031	-0.035	0.02	-0.129	0.397	0.137	0.416
9	Do you need incentives for taking part in mangrove restoration?		-0.18	-0.108	0.117	0.051	0.182	-0.097	0.229	0.098
2	Can you rate the degradation of the area(s) where mangrove is being harvested?	Yoyo 1	0.076	-0.384	0.208	-0.187	0.227	-0.116	0.086	0.155
3	According to you should we plant mangrove?		-0.267	0.483	-0.258	0.223	-0.231	0.216	0.025	-0.142
4	Are you aware that matanda can be nursed?		-0.212	0.339	-0.519	0.193	-0.329	0.139	0.136	-0.03
5	Have you ever taken part in mangrove nursery work?		-0.107	0.248	-0.226	0.297	-0.21	0.091	0.207	0.01
8	How can you rate your participation?		0.007	-0.223	0.26	-0.132	0.122	0.041	-0.149	0.054
9	Do you need incentives for taking part in mangrove restoration?		0.115	-0.103	0.169	-0.018	0.087	-0.072	0.024	0.154
2	Can you rate the degradation of the area(s) where mangrove is being harvested?	Yoyo 2	0.037	-0.288	0.07	-0.227	0.159	-0.012	-0.108	0.133

Table 2. Contd.

3	According to you should we plant mangrove?		0.137	0.189	0.072	0.151	-0.044	-0.082	-0.086	-0.144
4	Are you aware that matanda can be nursed?		0.101	-0.1	0.157	-0.115	-0.019	-0.081	-0.003	0.026
5	Have you ever taken part in mangrove nursery work?		-0.208	0.102	-0.104	0.043	-0.205	-0.009	-0.023	-0.07
8	How can you rate your participation?		0.005	0.136	-0.145	0.122	0.107	-0.056	-0.137	-0.056
9	Do you need incentives for taking part in mangrove restoration?		-0.058	0.078	-0.111	0.077	0.084	-0.2	0.062	-0.061
2	Can you rate the degradation of the area(s) where mangrove is being harvested?		0.067	0.025	-0.093	u	0.132	-0.09	-0.012	-0.056
3	According to you should we plant mangrove?		0.079	0.133	-0.082	u	-0.062	-0.039	-0.009	-0.018
4	Are you aware that matanda can be nursed?		0.202	-0.297	0.322	u	0.267	-0.36	0.12	-0.251
5	Have you ever taken part in mangrove nursery work?	Youme 2	0.219	-0.153	0.147	u	0.121	-0.181	0.105	-0.049
8	How can you rate your participation?		-0.218	0.279	-0.284	u	-0.182	0.356	-0.168	0.135
9	Do you need incentives for taking part in mangrove restoration?		-0.057	-0.067	-0.015	u	0.047	-0.183	-0.063	0.008

u - no statistical analysis (area inclusively habited by non-nationals).

Table 3. Overall analysis of community perception of mangrove planting in the Douala-Edea, Cameroon.

			Community characteristics																															
			Sites										Gender				Nationality								Occupation								Origin			
S/N	Question	Response	Mbiako	%	Yoyo 1	%	Yoyo 2	%	Youme 2	%	Total	%	Male	%	Female	%	Cameroonians	%	Nigerians	%	Ghanaians	%	Others	%	Fishing	%	Fish smoking	%	Wood cutting	%	Other	%	Indigene	%	None-indigene	%
	According to you should we plant mangrove?	Yes	48	12	34	8.5	81	20.3	47	11.8	210	52.5	106	26.5	104	26	102	25.5	96	24	11	2.8	1	0.3	40	10	72	18	13	3.3	85	21.3	28	7.0	182	45.5
		No	52	13	66	16.5	19	4.8	47	13.3	190	47.5	88	22	102	25.5	37	9.3	122	30.5	28	7.0	3	0.8	64	16	66	16.5	1	0.3	59	14.8	6	1.5	184	46
		χ^2-Statistics					48.321								0.691						41.009								19.829						13.279	
3		P					0.00								0.406						0.00								0.00						0.00	
		df					3								1						3								3						1	
	χ2-Tabulated	95%					7.81								3.84						7.81								7.81						3.84	
		99.5%					12.84								7.88						12.84								12.84						7.88	
		Significant					**								ns						**								**						**	

Table 3. Contd.

S/N	Question	Response	Community characteristics																																					
			Education level								Longevity in site (years)										Marital status										Age group (years)											
			None	%	Primary	%	Secondary	%	Higher learnig	%	<10	%	10-20	%	20-30	%	30-40	%	40>	%	Single	%	Married	%	Seperated	%	Divorced	%	Widow(er)	%	<20	%	20-29	%	30-39	%	40-49	%	50>	%
3	According to you should we plant mangrove?	Yes	74	18.5	85	21.3	48	12	3	0.8	96	24	44	11	37	9.3	16	4.0	17	4.3	43	10.8	116	29	47	11.8	1	0.3	3	0.8	2	0.5	48	12	80	20	52	13	28	7.0
		No	89	22.3	80	20	19	4.8	2	0.5	81	20.3	41	10.3	42	10.5	17	4.3	9	2.3	47	11.8	106	26.5	34	8.5	0	0.0	3	0.8	5	1.3	65	16.3	65	16.3	39	9.8	16	4.0
		χ^2-Statistics				13.317										3.193										2.721								9.549						
		P				0.004										0.526										0.605								0.049						
		df				3										4										4								4						
	χ2-Tabulated	95%				7.81										9.49										9.49								9.49						
		99.5%				12.84										14.86										14.86								14.86						
		Significant				**										ns										ns								*						

*Significant at α=95%, **Significant at α=99.5%, ns for (Not Significant).

(P<0.005; χ2= 14.65,.d.f= 2;.Rs=0.33) Nigerians, 29 (P<0.005; χ2= 31.676,.d.f=3;Rs=-0519) fish smokers, and 37 (P<0.005; χ2= 27.571, d.f=3; Rs=-0.329) non-scholars, who did not know the role of nursery in mangrove restoration. Finally, in Yoyo II the study had 30 (P<0.05; χ2= 7.81, d.f=3; Rs=0.157) with other occupations who answered that they were not aware that mangrove can be nursed and planted.

On the other hand, Youme II respondents showed a significant difference with respect to within and across community characteristics in that they were aware the mangrove could be propagated by seedlings from nursery. Of the 100 interviewed in Youme II, 31 (P<0.05; χ2=4.064, .d.f=1;.Rs=0.20) females, 47 (P<0.005; χ2= 22.806, d.f=3; Rs=-0.297) Nigerians, 29 (P<0.005; χ2= .27;991,d.f= 3; Rs=0.32) fish smokers, 53 non-indigenes, 28 (P<0.05; χ2=7.184, d.f=2; Rs=0.267) non-scholars and 44 (P<0.005; χ2= 30.601, d.f=3; Rs=0.12) married agreed that *R*. *racemosa* can be nursed for restoration. Of those who were aware, 71 (17.75%) knew the importance of nursery.

Community participation in mangrove nursery-outplanting activities

Overall, of the 400 individuals interviewed, a significant (P<0.005, χ2= 32.04, d.f =3; Rs=-0.21) large proportion, 359 (89.8%), answered that they did not participate in nursery and outplanting activities (Question 5: Tables 2 and 5). Of these 359, most were from Yoyo II, 96 (24%). Whereas a few, 41 (10.3%), said that they took part in nursery and outplanting, of which most were from Youme II, 25 (6.3%). Rs showed that all correlations were weak (Table 2). The level at which the people of the four selected communities participated proved to be inconsistent and dismal across in general. Also, sub-statement No. 5.1 shows that most, 364 (91%), inhabitants interviewed did not participate in nursery and outplanting activities geared towards mangrove restoration inside the DER (Figure 6).

At village level (Question 5: Table 2), of the 100 interviewed the results showed a significant difference with respect to within and across community characteristics. Most community characteristics in selected villages revealed that a significant number had not participated in mangrove nursery and outplanting activities (Figure 6). Youme II inhabitants participated more than those in Mbiako, Yoyo I and Yoyo II in nursery and outplanting activities in the DER. For instance within and across community characteristics in Mbiako, significant differences were observed. 49 (P<0.05; χ2=4.483,.d.f= 1; Rs=-0.219) males, 54(P<0.005; χ2= 12.886, d.f= 3; Rs=0.075) Nigerians, 37 (P<0.05; χ2= .10.908, d.f= 3; Rs=-0.054) fishermen, 86 (P<0.005; χ2= 11.483, d.f=1; Rs=0.339) non-indigene and

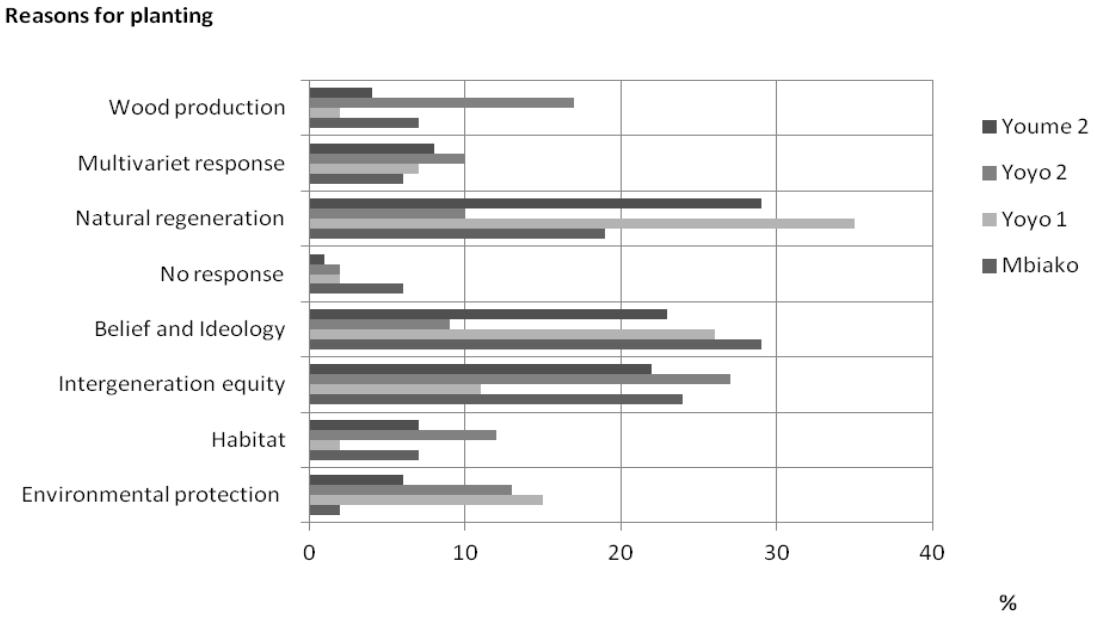

Figure 4. Portrayal of cluster distributions of community reasons on mangrove restoration in four selected villages in the Douala-Edea, Cameroon.

and 52 (P<0.005; χ2= 17.851, d.f=3; .Rs=-0.339) non-scholars reported that they did not participate in *R. racemosa* nursery and outplanting activities. In Yoyo I, 54 (P<0.005; χ2=11.336, d.f= 2; Rs=0.248) Nigerians, 34 (P<0.005; χ2= 18.161, d.f= 3; Rs=0.33) those with other occupations, 90 (P<0.005; χ2= 8.804, d.f= 1; Rs=0.297) non-indigenes and 43 (P<0.05; χ2=8.682 d.f= 3; Rs=-0.21) non-scholars answered that they did not participate in nursery and outplanting activities. Also in Yoyo II, significant differences were recorded within and across most of the community characteristics (nationality (P>0.05; χ2=1.049,.d.f=educational level (P>0.05; χ2= 5.402, d.f= 3; Rs=-0.205), longevity in site (P>0.05; χ2= 3.32, d.f= 4; Rs=-0.009), marital status (P>0.05; χ2=0.356,.d.f=4; Rs=-0.023) and age group (P>0.05; χ2= 1.462, d.f=4; Rs=-0.07)) replied that they "did not participate" in nursery and outplanting activities.

Finally, in Youme II, of the 100 interviewed, a significant large number within and across communities,32 (P<0.005; χ2=22.803, d.f= 3; Rs=0.147) with other occupations (homemakers, traders, canoe makers, farmers, hunters and wine tapers) and 37 (P<0.05; χ2=11.091, d.f= 3; Rs=0.105) married respondents answered that they as well did not participate in nursery and outplanting activities. The statistical analysis (Rs) revealed weak correlation within and across community characteristics (Table 2). Analysis revealed incidental community participation in nursery and outplanting activities geared towards mangrove (replanting) restoration in the DER. In the village Youme II (made up 100% foreign nationals), most interviewed took part in nursery and outplanting stages.

Ego-rating of participation

Overall, of the 400 interviewed a significant (P<0.005; χ2=72.867, d.f= 12; Rs=0.182) proportion, 231(57.8 %) rated their participation as 'poor' (Question 8: Tables 2 and 6). Of these 231, most (18.5 %) were from Yoyo I. Whereas, of the few 120 (30 %) who answered that their participation were 'fair', most were from Yoyo II, 48 (12 %). Also no significant difference was revealed within some community characteristics (gender (P>0.05; χ2=8.877, d.f= 4; Rs=-0.015), nationality (P>0.05; χ2=18.535, d.f= 12; Rs=-0.075), education level (P>0.05; χ2=14.667, d.f= 12; Rs=-0.083) who answered that their participation was 'poor'. Rs shows that all correlation association were weak (three negative and six positive). The majority of the respondents from selected communities were not involved in the *R. racemosa* restoration process for one reason or the other. The reason for poor participation is that, many were more concerned with overcoming livelihood difficulties rather than with conservation and restoration ethics.

At village level (Question 8: Table 2), of the 100 interviewed the results showed a significant difference with respect to within and across community characteristics for selected villages. In Mbiako a larger number within communities, 51 (P<0.005; χ2=27.557, d.f= 3; Rs=0.02) non-indigenes, 32 (P<0.05; χ2=34.915, d.f= 12; Rs=0.397) those who have stayed in site for less than 10 years, 32 (P<0.005; χ2=31.569, d.f= 3; Rs=0.416) those aged between 20 and 29 held the view that their participation was poor. Also in Yoyo I, within communities 41 (P<0.05; χ2=16.176, d.f= 8; Rs=-0.223)

Table 4. Overall analysis of community awareness on mangrove nursing in the Douala-Edea, Cameroon.

			Community characteristics: Sites										Gender				Nationality								Occupation								Origin			
S/N	Question	Response	Mbiako	%	Yoyo 1	%	Yoyo 2	%	Youme 2	%	Total	%	Male	%	Female	%	Cameroonians	%	Nigerians	%	Ghanaians	%	Others	%	Fishing	%	Fish smoking	%	Wood cutting	%	Other	%	Indigene	%	None-indigene	%
4	Are you aware that matanda can be nursed?	Yes	32	8.0	24	6.0	48	12	53	13.3	157	39.3	87	21.8	70	17.5	54	13.5	97	24.3	6	1.5	0	0.0	27	6.8	72	18	13	3.3	45	11.3	13	3.3	144	36
		No	68	17	76	19	52	13	47	11.8	243	60.7	107	26.8	136	34	85	21.3	121	30.3	33	8.3	4	1.0	77	19.3	66	16.5	1	0.3	99	24.3	21	5.3	222	55.5
		χ^2-Statistics	23.098										4.946				14.425								38.107								0.016			
		P	0.00										0.00				0.002								0.00								0.899			
		df	3										1				3								3								1			
	χ2-Tabulated	95%	7.81										3.84				7.81								7.81								3.84			
		99.5%	12.84										7.88				12.84								12.84								7.88			
		Significant	**										**				**								**								Ns			

			Community characteristics: Education level								Longevity in site (years)										Marital status										Age group (years)									
S/N	Question	Response	None	%	Primary	%	Secondary	%	Higher learning	%	<10	%	10-20	%	20-30	%	30-40	%	40>	%	Single	%	Married	%	Separated	%	Divorced	%	Widow(er)	%	<20	%	20-29	%	30-39	%	40-49	%	50>	%
4	Are you aware that matanda can be nursed?	Yes	65	16.3	57	14.3	31	7.8	4	1.0	58	14.5	34	8.5	30	7.5	17	4.3	18	4.5	27	6.8	100	25	27	6.8	0	0.0	3	0.8	2	0.5	35	8.8	54	13.5	44	11	22	5.5
		No	98	24.5	108	27	36	9.0	1	0.3	119	29.8	51	12.8	49	12.3	16	4.0	8	2.0	63	15.8	122	30.5	54	13.5	1	0.3	3	0.8	5	1.3	78	19.5	91	22.8	47	11.8	22	5.5
		χ^2-Statistics	6.425								15.076										8.482										9.12									
		P	0.093								0.005										0.075										0.058									
		df	3								4										4										4									
	χ2-Tabulated	95%	7.81								9.49										9.49										9.49									
		99.5%	12.84								14.86										14.86										14.86									
		Significant	ns								**										ns										Ns									

*Significant at α=95%, **Significant at α=99.5%, ns for (Not Significant).

Nigerians, 25 (P<0.005; χ2=61.694, d.f= 12; Rs=0.26) with other occupations, 35 (P<0.05; Rs=0.416) persons aged between 30-39 years shared the responses of those interviewed in Mbiako. The analysis also showed that for respondents in Youme II, a significant number (26 (P<0.05; χ2=21.953, d.f= 12; Rs=-0.218) of Cameroonians, 27 (P<0.005; χ2=44.528, d.f= 12; Rs=-0.284) with other primary occupations (homemakers, traders, canoe makers, farmers, hunters and wine tapers), 29 (P<0.05; χ2=27.728, d.f= 16; Rs=0.356) with longevity in site for less than 10 years, and 22 (P<0.05; χ2=32.221, d.f= 12; Rs= -0.168) married) said their participation wassimilar to those interviewed in Mbiako and

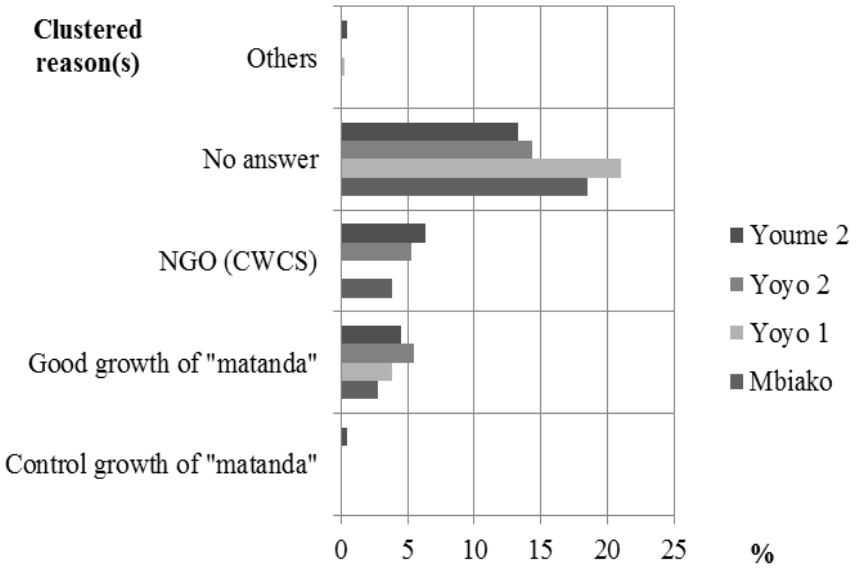

Figure 5. Cluster responses distributions of community awareness on the role of nursery in mangrove restoration in four selected villages in the Douala-Edea, Cameroon.

Yoyo I. No statistical analysis was recorded for the community by origin for the Youme II village since all inhabitants were recently settled there. On the other hand, in Yoyo II, community participation was significantly divided between 'poor' and 'fair' participation.

A larger number within communities characteristic namely 26 ($P<0.05$; $\chi2=27.304$, d.f= 12; Rs=-0.145) with other primary occupations (homemakers, traders, canoe makers, farmers, hunters and wine tapers) and 25 ($P<0.05$; $\chi2=57183$, d.f= 16; Rs=-0.137) married respondents answered that their participation was 'poor'. Whereas most, 48 ($P<0.05$; $\chi2=11.231$, d.f= 4; Rs=0.122) non-indigenes answered that their participation was 'fair'. Rs shows weak correlation association (Table 2).

Community participation and incentives

Responses of the 400 individuals revealed that participation was significant ($P<0.05$; $\chi2=10.562$, d.f= 3; Rs=0.161) with a large proportion, 315 (78.8%) conditioned on incentives (getting compensation for work done) (Question 9: Tables 2 and 7). At village level, of these 315, most were from Mbiako, 87 (21.8%). Also, there was significant difference in within and across community characteristics of those interviewed; 135 (33.8%) ($P<0.05$; $\chi2=9.853$, d.f= 3; Rs=0.11) non-scholars, 127 (31.8%) ($P<0.05$ $\chi2=11.046$, d.f= 4; Rs=-0.14) with longevity in site for less than 10 years, and 101 (25.3%) ($P<0.005$; $\chi2=17.703$, d.f= 4; Rs=0.05) aged between 20 to 29 years, answered that they needed incentives for participating in mangrove restoration in the DER. No significant difference within and across some community characteristics (gender, nationality, occupation, origin, marital status) was revealed. Rs showed weak correlation associations. Hence, the majority of selected communities wish those conditions be met to have full participation in mangrove ecosystem restoration.

Furthermore, concerning community motivation, Figure 7 shows that, 97 (24.3%) and 96 (24%) wanted 'encouragement' (cash and kind) and salary in participating in mangrove restoration, respectively. The statistical analysis (Table 2) and the graph (Figure 7) provide strong evidence that community participation in mangrove restoration in the DER is conditioned by externalities such as incentives.

At village level, of the 100 interviewed the results showed that there was no significant difference across and within community characteristics for selected villages except for a few in Youme II. Community perceptions showed that incentive flow will enhance community participation in mangrove restoration in the Douala Estuary, Cameroon.

However, Rs showed a weak association for variables within and across community characteristics. Most of these villages shared the same motivation and concerns on incentives at different percentages, for example 30 (7.5%) in Mbiako, 14 (3.5%) in Yoyo I, 30 (7.5%) in Yoyo II and 23 (5.8%) in Youme II said that they needed encouragement (Figure 7).

Thus, the major factors to consider, when involving communities in the DER wetlands restoration, according to the survey are community well-being (salary, food,

Table 5. Overall analysis of community perception in mangrove nursery-outplanting work in the Douala-Edea, Cameroon.

S/N	Question	Response	Community characteristics																																	
			Sites										Gender				Nationality								Occupation								Origin			
			Mbiako	%	Yoyo 1	%	Yoyo 2	%	Youme 2	%	Total	%	Male	%	Female	%	Cameroonians	%	Nigerians	%	Ghanaians	%	Others	%	Fishing	%	Fish smoking	%	Wood cutting	%	Other	%	Indigene	%	None-indigene	%
	Have you ever taken part in mangrove nursery work?	Yes	5	1.3	7	1.8	4	1.0	25	6.3	41	10.3	19	4.8	22	5.5	17	4.3	23	5.8	1	0.3	0	0.0	6	1.5	18	4.5	7	1.8	10	2.5	6	1.5	35	8.8
		No	95	23.8	93	23.3	96	24	75	18.8	359	89.8	175	43.8	184	46	122	30.5	195	48.8	38	9.5	4	1.0	98	24.5	120	30	7	1.8	134	33.5	28	7.0	331	82.8
		χ²-Statistics	32.04										0.085				3.575								29.197								2.21			
5		P	0.00										0.77				0.311								0.311								0.137			
		df	3										1				3								3								1			
	χ2-Tabulated	95%	7.81										3.84				7.81								7.81								3.84			
		99.5%	12.84										7.88				12.84								12.84								7.88			
		Significant	**										ns				Ns								**								ns			

S/N	Question	Response	Community characteristics																																					
			Education level								Longevity in site (years)										Marital status										Age group (years)									
			None	%	Primary	%	Secondary	%	Higher learnig	%	<10	%	10-20	%	20-30	%	30-40	%	40>	%	Single	%	Married	%	Seperated	%	Divorced	%	Widow(er)	%	<20	%	20-29	%	30-39	%	40-49	%	50>	%
	Have you ever taken part in mangrove nursery work?	Yes	14	3.5	14	3.5	13	3.3	0	0.0	16	4.0	9	2.3	8	2.0	4	1.0	4	1.0	8	2.0	29	7.3	3	0.8	0	0.0	1	0.3	0	0.0	9	2.3	20	5.0	6	1.5	6	1.5
		No	149	37.3	151	37.8	54	13.5	5	1.3	161	40.3	76	19	71	17.8	29	7.3	22	5.5	82	20.5	193	48.3	78	19.5	1	0.3	5	1.3	7	1.8	104	26	125	31.3	85	21.3	38	9.5
		χ²-Statistics	7.72								1.165										6.247										5.291									
5		P	0.052								0.884										0.181										0.259									
		df	3								4										4										4									
	χ2-Tabulated	95%	7.81								9.49										9.49										9.49									
		99.5%	12.84								14.86										14.86										14.86									
		Significant	ns								ns										ns										ns									

*Significant at α=95%. **Significant at α=99.5%. ns for (Not Significant).

etc.), capacity building and material needs due to the difficult environment of activities. The future management of mangrove through replanting in the reserve canbe improved, if financial incentives and/or payment for environment services play a key role in alleviating poverty.

However, it might be too early to make an evaluation on these expected co-benefits, because, since time immemorial, forest protection in general received finances. However these finances targeted only terrestrial forest under protection leaving out mangrove forest.

Community recommendations to enhance participation

Of the 400 inhabitants interviewed, a majority, 148 (37%) cluster responses showed that greater sensitization should employed to enhance

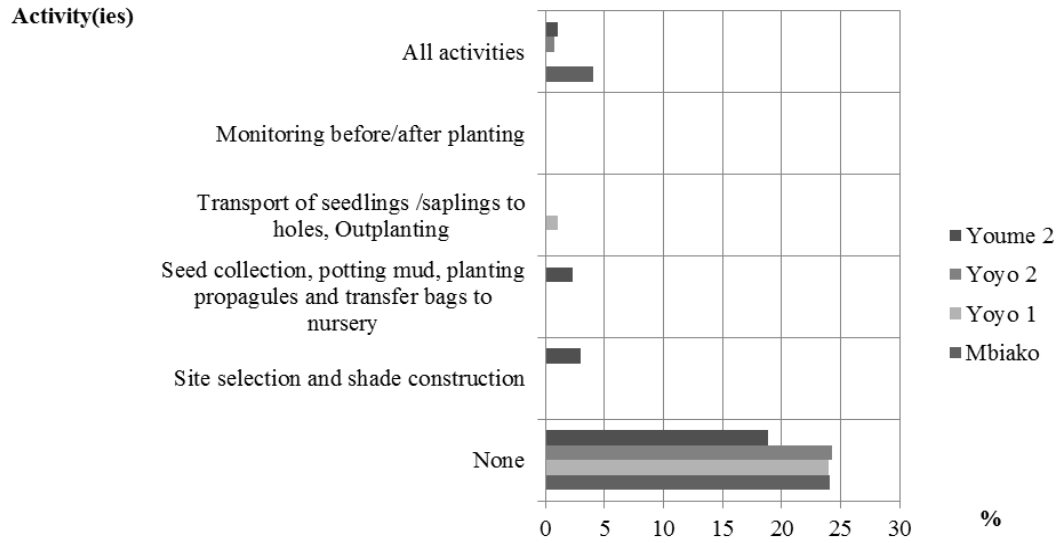

Figure 6. Portrayal of community participation in nursery and outplanting in the Douala-Edea, Cameroon.

community participation.Globally, 135 (33.75 %) answered that training of community would also boost Community participation (Figure 8). The results showed that inhabitants interviewed in the DER requested for greater sensitization, more training sessions, Community Day for Mangrove and clear collaboration since most were not aware of the processes geared towards mangrove
restoration.

DISCUSSION

The results of the surveys can be discussed based on the two points; the lack of information characterising community participation in mangrove ecosystem conservation and the gap between community participation and local residents' knowledge of conservation.

Results at the local level show that compared to other villages, Youme II kept a profile of interest during all activities though not headed by an administrative authority such as a chief. Restoration done by non-nationals (Nigerians) went well in this village probably because everyone in the community was answerable to the council of elders. Statistical analysis (Rs) provided prove that Youme II is inclusively habited by non-nationals. Hence, nationality is not a barrier for restoring *R. racemosa* through nursery in the DER, Cameroon estuary. It can be seen that at the local and global levels, respondents acknowledged that mangrove deforestation and degradation is ongoing due to their activities (amongst which we have wood harvesting for fish smoking and cooking). These results support the work conducted by some researchers (Ajonina and Usongo, 2010; Feka and Ajonina, 2011; Feka et al., 2009). Especially, at the local level (except in Mbiako), many people (for example, non-indigenes etc.) acknowledged that mangrove was deforested and degraded at different degrees by their activities. When extrapolating such perception of mangrove deforestation and degradation, the study support the works of Ajonina (2008) for a loss 30% of mangrove forest in Cameroon at large. Knowledge is surely necessary for these local people if they are to use these natural ecosystems in a sustainable manner. This is why additional results showed that most local residents agreed for its restoration (Table 3), even though they were ignorant that mangrove were nursed in site to restore degraded anddeforested areas. Though selected communities restored successfully close to 4 hectares of *R. racemosa*, their participation was varied and dismal as revealed in Table 5.

The limitations in meeting the target of restoring 10 hectares of mangrove forest with *R. racemosa* and the inconstancies in community participation have hidden causes which are either induced or direct. Among other reasons include their educational level (Figure 3) coupled with their livelihood activities that are limiting factors for community's participation in mangrove restoration in the DER as well as in some hinterland regions in Cameroon. Despite the fact that they were lagging behind in a domain like education, some respondents in the DER understood the importance of restoring *R. racemosa* to some degree though they were lacking in knowledge and skill for propagating the mangrove species. Globally, the selected communities were not significantly ($P<0.005$; $\chi 2=72.867$, d.f= 12; Rs=0.182) mobilised toward mangrove restoration activities as they rated their participation as 'poor' (Tables 2 and 6).

Furthermore, at the local level almost all people

Table 6. Overall analysis of ego-assessment in community in mangrove restoration in the Douala-Edea, Cameroon.

S/N	Question	Response	Community characteristics																																		
			Sites										Gender				Nationality								Occupation								Origin			
			Mbiako	%	Yoyo 1	%	Yoyo 2	%	Youme 2	%	Total	%	Male	%	Female	%	Cameroonians	%	Nigerians	%	Ghanaians	%	Others	%	Fishing	%	Fish smoking	%	Wood cutting	%	Other	%	Indigene	%	None-indigene	%
		Unsure	2	0.5	6	1.5	2	0.5	1	0.3	11	2.8	7	1.8	4	1.0	3	0.8	6	1.5	2	0.5	0	0.0	2	0.5	4	1.0	0	0.0	5	1.3	2	0.5	9	2.3
		Poor	60	15	74	18.5	46	11.5	51	12.8	231	57.8	101	25.3	130	32.5	89	22.3	117	29.3	21	5.3	4	1.0	69	17.3	61	15.3	2	0.5	99	24.8	20	5.0	211	52.8
	How can you rate your participation?	Fair	35	8.8	14	3.5	48	12	23	5.8	120	30	68	17	52	13	33	8.3	72	18	15	3.8	0	0.0	28	7.0	55	13.8	5	1.3	32	8.0	7	1.8	113	28.3
		Good	0	0.0	2	0.5	1	0.5	13	3.3	16	4.0	10	2.5	6	1.5	2	0.5	13	3.3	1	0.3	0	0.0	3	0.8	10	2.5	2	0.5	1	0.3	0	0.0	16	4.0
		Very good	3	0.8	4	1.0	3	0.8	12	3.0	22	5.5	8	2.0	14	3.5	12	3.0	10	2.5	0	0.0	0	0.0	2	0.5	5	1.3	5	1.3	7	1.8	5	1.3	17	4.3
8		χ^2-Statistics	72.867										8.877				18.535								59.475								9.642			
		P	0.00										0.064				0.1								0.00								0.047			
		df	12										4				12								12								4			
	χ2-Tabulated	95%	21.03										9.49				21.03								21.03								9.49			
		99.5%	28.30										14.86				28.30								28.30								14.86			
		Significant	**										ns				ns								**								*			

S/N	Question	Response	Community characteristics																																			
			Education level								Longevity in site (years)										Marital status										Age group (years)									
			None	%	Primary	%	Secondary	%	Higher learnig	%	<10	%	10-20	%	20-30	%	30-40	%	40>	%	Single	%	Married	%	Seperated	%	Divorced	%	Widow(er)	%	<20	%	20-29	%	30-39	%	40-49	%	50>	%
		Unsure	8	2.0	2	0.5	1	0.3	0	0.0	5	1.3	1	0.3	4	1.0	0	0.0	1	0.3	1	0.3	7	1.8	2	0.5	1	0.3	0	0.0	0	0.0	2	0.5	2	0.5	6	1.5	1	0.3
		Poor	87	21.8	100	25	40	10.0	4	1.0	118	29.5	52	13	44	11.0	11	2.8	6	1.5	59	14.8	109	27.3	58	14.5	0	0.0	5	1.3	3	0.8	81	20.3	90	22.5	36	9.0	21	5.3
	How can you rate your participation?	Fair	54	13.5	49	12.3	16	4.0	1	0.03	40	10.0	24	6.0	23	5.8	18	4.5	15	3.8	23	5.8	79	19.8	18	4.5	0	0.0	0	0.0	4	1.0	23	5.8	33	8.3	44	11.0	16	4.0
		Good	8	2.0	6	1.5	2	0.5	0	0.0	4	1.0	4	1.0	3	0.8	3	0.8	2	0.5	3	0.8	13	3.3	0	0.0	0	0.0	0	0.0	0	0.0	5	1.3	5	1.3	3	0.8	3	0.8
		Very good	6	1.5	8	2.0	8	2.0	0	0.0	10	2.5	4	1.0	5	1.3	1	0.3	2	0.5	4	1.0	14	3.5	3	0.8	0	0.0	1	0.3	0	0.0	2	0.5	15	3.8	2	0.5	3	0.8
8		χ^2-Statistics	14.687								36.713										57.867										48.387									
		P	0.259								0.002										0.000										0.000									
		df	12.000								16										16										16									
	χ2-Tabulated	95%	21.03								26.30										26.30										26.30									
		99.5%	28.30								34.27										34.27										34.27									
		Signifcant	ns								**										**										**									

*Significant at α=95%. **Significant at α=99.5% ns for (Not Significant).

Table 7. Overall analysis of community perception and incentives in mangrove restoration in the Douala-Edea, Cameroon.

			Community characteristics																																	
			Sites										Gender				Nationality								Occupation								Origin			
S/N	Question	Response	Mbiako	%	Yoyo 1	%	Yoyo 2	%	Youme 2	%	Total	%	Male	%	Female	%	Cameroonians	%	Nigerians	%	Ghanaians	%	Others	%	Fishing	%	Fish smoking	%	Wood cutting	%	Other	%	Indigene	%	None-indegene	%
9	Do you need incentives for taking part in mangrove restoration?	Yes	87	21.8	83	20.8	75	18.8	70	17.5	315	78.8	166	41.5	149	37.3	106	26.5	172	43	33	8.3	4	1.0	88	22	103	25.8	11	2.8	113	28.3	29	7.3	286	71.5
		No	13	3.3	17	4.3	25	6.3	30	7.5	85	21.3	40	10	45	11.3	33	8.3	46	11.5	6	1.5	0	0.0	16	4.0	35	8.8	3	0.8	31	7.8	5	1.3	80	20
		χ^2-Statistics	10.562										0.852				2.399								3.54								0.951			
		P	0.014										0.356				0.494								0.316								0.329			
		df	3										1				3								3								1			
	χ2-Tabulated	95%	7.81										3.84				7.81								7.81								3.84			
		99.5%	12.84										7.88				12.84								12.84								7.88			
		Significant	*										ns				ns								Ns								ns			

			Community characteristics																																					
			Education level								Longevity in site (years)										Marital status										Age group (years)									
S/N	Question	Response	None	%	Primary	%	Secondary	%	Higher learnig	%	<10	%	10-20	%	20-30	%	30-40	%	40>	%	Single	%	Married	%	Seperated	%	Divorced	%	Widow(er)	%	<20	%	20-29	%	30-39	%	40-49	%	50>	%
9	Do you need incentives for taking part in mangrove restoration?	Yes	135	33.8	131	32.8	44	11	5	1.3	127	31.8	73	18.3	64	16	27	6.8	24	6.0	75	18.8	175	43.8	58	14.5	1	0.3	6	1.5	5	1.3	101	25.3	100	25	71	17.8	38	9.5
		No	28	7.0	34	8.5	23	5.8	0	0.0	50	12.5	12	3.0	15	3.8	6	1.5	2	0.5	15	3.8	47	11.8	23	5.8	0	0.0	0	0.0	2	0.5	12	3.0	45	11.3	20	5.0	6	1.5
		χ^2-Statistics	9.853								11.048										5.491										17.703									
		P	0.02								0.026										0.241										0.001									
		df	3								4										4										4									
	χ2-Tabulated	95%	7.81								9.49										9.49										9.49									
		99.5%	12.84								14.86										14.86										14.86									
		Significant	*								*										ns										**									

*Significant at α=95%. **Significant at α=99.5%. ns for (Not Significant).

interviewed in Mbiako, Yoyo I and Yoyo II replied that they did not take part in nursery -outplanting work, while approximately one quarter of respondents in Youme II answered the other way. Within these communities, movement for survival of nationals or non-nationals from one hamlet, village or region to another is common and frequent. This surely has reduced the chances of getting persons who have worked on mangrove restoration. Worst still, though nationality is not a barrier to mangrove replanting, non-nationals who frequently participated in CWCS mangrove restoration activities might have returned to their home country or refused to provide the adequate response for fear of reprisal. Consistent with this,

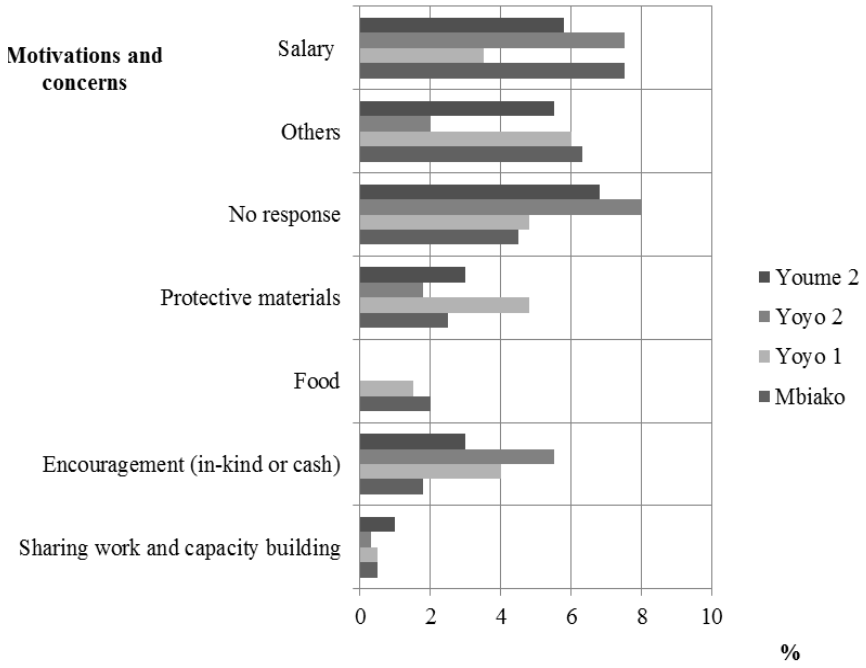

Figure 7. Portrayal of community perception of incentives (motivations and concerns) distributions in mangrove restoration in the Douala-Edea, Cameroon.

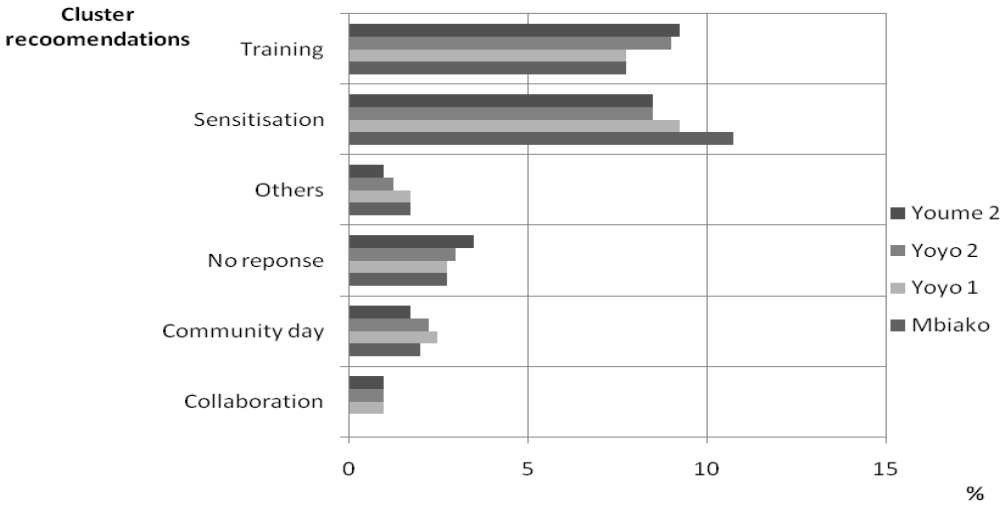

Figure 8. Community recommendations to strengthen participation in mangrove restoration in the Douala-Edea, Cameroon.

what came up in the correlation test is the fact that the results clearly showed this was some kind of "bad faith" on the part of some non-nationals who claimed that they have been off-site and just returning whereas the majority have been leaving there for 10 years or so. The psychology of some of these communities' respondents may also be questioned. Also, the fear of the mangrove milieu and the traditional beliefs towards mangrove for instance that the mangrove trees are planted by "God" might equally have been a barrier for communities involvement. But, that is nullified by Youme II participating effectively. In the light of this, measures to involve local mangrove community should include scoping studies in order to understand the community past history and attitude.

Actually, this initiative in assessing the community

participation was unprecedented, and proves that there are some changes in the attitude and perception of members of some communities with respect to restoration of mangrove in the DER, Cameroon estuary. Essentially, of the 400 respondents a significant ($P<0.005$, $\chi 2= 32.04$, d.f =3; Rs=-0.21) large proportion, 359 (89.8%) did not participate in nursery and outplanting activities (Tables 2 and 5).

Community characteristics equally shown in Table 6 and Figures 7 and 8 prove that *R. racemosa* restoration in the DER, Cameroon estuary has a long trail to follow. Some have interest in mangrove restoration but did not participate at all in nursery and outplanting activities for reasons presented in Tables 5, 6 and 7. This discrepancy is better illustrated in Figure 6 as some respondents participated in one activity or more while others did not participate at all in mangrove nursery activities. For example, community members participated in one of the following activity of nursery and outplanting activities: nursery site selection, shade construction, gathering and potting mud in bags, transport of bags, propagules collection and potting, dibbling and Outplanting (Moudingo et al., 2015). Thus, *R. racemosa* restoration in the DER, Cameroon estuary followed a stepwise process; therefore participation was also a stepwise process.

Participating in at least one step of the restoration means that one has participated. People or community participated in restoration for either financial, material or personal satisfaction (Figure 7).

Generally, economic factors should affect conservation attitudes of local people; the richer the people are, the more aware and mobilised they are of conservation or they have a high degree of perception on conservation (Harada, 2003) action through replanting. Those who are rich usually reach higher level of education and have a wider level of understanding compared to a person with no formal education. Hence, very few people will work with empty stomach or work without expecting any compensation either in cash or kind. Hence, selected communities said that financial and material conditions should be put in place to encourage their participation in mangrove outplanting using *R. racemosa* in the DER, Cameroon (Tables 2 and 7).

In this study, meaningful relationships between the levels of affluence as proposed by Harada (Harada, 2003) and the perception of conservation action were found (Figures 7 and 8). Meeting targeted goal in building the resilience of an ecosystem like that of the mangrove through community efforts is not straightforward andIndividual, companies or government can compensate needs external inputs such as financial incentives. coastal communities through NGO like CWCS Cameroon Ecology or the Cameron Mangrove Network and its partners to sustain livelihood, and conservation and enhancement of carbon stocking in the midst of climate change abatement.

Conclusion

The prominence of mangrove forest and its resources to man, the role in re-establishing ecological roles and services cannot be overstated. However, results from the perception study showed that the first trial for selected communities was unprecedented, though community participation (within and across characteristics) showed significant discrepancies in the stages geared towards mangrove restoration. The communities understood the status of mangrove forest and the need to uphold the forest resources, but were not aware that *R. racemosa,* like most angiosperms can be nursed for restoration. This poses the problem as to what degree the communities should be sensitized for full engagement in such initiative. It is obvious that the pathway is not easy, as long as 60.8% of the communities are not aware that mangrove can be restored using nursery stock, 57.8% rate their participation to be “poor” and as many as 89.9% say that they never took part in restoration activities.

According to 78.8% of interviewees, community participation can be fully geared into mangrove restoration, if they are provided with food, salary or encouragement, and if they are well sensitised and trained. Can sustained financial mechanism overturn such problems and meet the demands of the livelihood of these poor coastal communities? Yes, it can. Results from this work portray a very complex picture of community participation in mangrove restoration practices and awareness in a diverse community of foreign nationals and tribes within Cameroon, living in the four mangrove covered villages. The road to restoring mangrove resilience to pristine conditions is not only “rough and sloppy” but it is equally “uneven and unsteady” as the mangrove environment itself. However, it was a valuable learning process working with the CWCS team and the locals in identifying some of the salient problems that shaped mangrove restoration efforts in the DER, Cameroon The originally perceived idea of community participation in mangrove restoration proved to be too time consuming and complex. Actually, communities said they participated at one stage like nursery construction and not at the others such as growth monitoring because of lack of protective material and incentives. We had passive and active community participation in using the species *R. racemosa* to restore degraded mangrove area in the DER. In the light of this, if we looked at mangrove restoration as an on-going and open process where people participate in different restoration stages, then mangrove restoration is a holistic and dynamic process. More attention has to be accorded to both human and financial resources if we want to meet the Millennium Development Goals, since both triggers the development of sustainable solutions to adaptation and mitigation strategies to climate change. If this synergy is properly developed and mainstreamed, then there will be no barrier in combining mitigation and

adaptation strategies; hence we will move from strategies to action. In the absence of flexible finances such as Payments for Ecosystem Service or Reduced Emissions from Deforestation and Forest Degradation (REDD+), can mangrove restoration efforts be sustained?

RECOMMENDATIONS

Recommendations to strengthen community participation in future programmes and initiatives in the DER should be put in place. Cameroon estuary in order to sustain their livelihood security, and strengthen the mangrove ecosystem and associated coastal ecosystem should include sensitization, community organization, and nursery and outplanting programs among others.

Conflict of interests

The authors have not declared any conflict of interests.

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Abbreviations

CWCS, Cameroon Wildlife Conservation Society; **DER,** Douala-Edea Reserve; **COPVAM-French acronym,** Village Mangrove Restoration Steering Committee; **PDM,** participatory data matrix; **χ2,** Pearson's chi-square; **Rs,** Spearman's correlation; **d.f,** degree of freedom; **Probability,** (P at either *Significant at α=95% or **Significant at α=99.5%).

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