CONSERVATION EDUCATION, ALTERNATIVE LIVELIHOOD AND HABITAT RESTORATION: THE BEST STRATEGIES FOR CONSERVATION OF MAGOMBERA FOREST RESERVE.

ABSTRACT

The Magombera forest is a home of endemic and endangered biological species such as Udzungwa red colobus monkey (*Procolobus gordonorum*) and the Magombera chameleon (*Kinyongia magomberae*). However, the forest is facing high threat of disappearing through resources extraction pressure from adjacent local communities. The project aimed at improving conservation of Magombera forest by involving the adjacent communities through provision of conservation education, restoration initiatives and bee keeping as alternative livelihoods. The study revealed that the concept of forest conservation is well supported. Nevertheless, people are extracting resources from the forest for their subsistence. The dependence of the people on the forest is due to lack of alternatives to the forest resources, inability of the people to produce alternatives source of income and little conservation education. The project resulted in a community having a positive attitude change towards conservation. The improved bee keeping was introduced to the community and successfully adopted. About 89% of indigenous trees planted for restoring the degraded area of the forest survived, only 11% of trees planted could not survive. There is a need to expand the scale of the project by involving many participants particularly youths that showed strong interest in the project .

Keywords: Magombera forest, Alternative livelihood, Improved beekeeping, Restoration

1. INTRODUCTION

Habitat degradation will continue to be a major challenging and severe threat to biodiversity conservation all over the World unless deliberate efforts are taken [1]. Various wildlife habitats in Africa have been destroyed, posing high

extinction risks for many species. According to [2], habitat loss threatens 85% of all species described in the IUCN's (International Union for Conservation of Nature) Red List. Much of this destruction is attributed to anthropogenic activities [3]. There are hundreds, possibly thousands of empirical studies that show species richness declining with small fragment size [4]. Tanzania has lost thousands of hectares of forests through deforestation and degradation arising mainly from anthropogenic factors such as unsustainable harvesting of forest products, bush meat, charcoal making, agriculture expansion, wild fires, urbanization and mining [5]. For instance, Kalunga forest which is among the lowland forests in Kilombero valley has been cleared for agriculture because of its fertile soil and flat terrain [6]. These activities affect ecosystems that are home to many wild species. Magombera forest is among the forests which face these challenges.

Magombera Forest is part of the Udzungwa ecosystem in the southern end of the Eastern Arc Mountain Range in South-central Tanzania. The Magombera Forest is located at about 6km from the Udzungwa Mountains National park [6]. The forest is diverse in terms of flora and fauna. It harbors endemic and endangered species of plants and animals like Leopards, Elephants, Buffaloes, Iringa red Colobus monkey, Magombera chameleon, *Polyalthia verdcourtii* (Huberantha verdcourtii) tree, the large-leaved Memecylon tree as well as internationally threatened species such as Udzungwa dwarf galago, and hippopotamus [2, 7]. It is an important resource for local communities who depend on the adjacent land for rice and sugarcane farming by providing invaluable ecological services including protection from floods and soil erosion.

The forest was gazetted in 1955 because of its biodiversity value and water catchment area [6]. Over the years after its gazettement, it has been reduced in size and degraded through encroachment and mainly human activities such as trees cutting, deadwood collection, hunting, poaching, tree debarking, fishing and wildfires [6]. The conservation value of Magombera Forest first became known in the 1970s and received international news attention through the scientific discovery of a new chameleon species in 2009, the Magombera chameleon (*Kinyongia magomberae*).

After a decade of consultation, planning and cooperation between the Government of Tanzania, conservation NGOs and initiatives (Rainforest Trust, Tanzania Forest Services Agency, Tanzania Forest Conservation Group, Udzungwa Forest Project among others) local government, and the Kilombero Sugar Company, the forest was formally declared as a Nature Forest Reserve on 11th January 2019 [8]

Regardless of its importance, awareness by adjacent communities is inadequate concerning conservation of the forest resources and sustainable utilization like beekeeping. Insufficient conservation awareness and skills in sustainable utilization of the forest, has led to the unsustainable utilization of the resource.

Experience has shown that, alternative livelihoods and awareness by the local communities through training and applying community-based conservation approaches can reduce threats to the natural resources [9]. In addition, if the local communities are empowered to sustainably utilize the resources, they will definitely support its conservation. As means of ameliorating the human-forest conflict, there is a need to take a sustainable utilization approach in ways that benefit the

local communities while conserving natural resources [10,11]. Apart from sustainable utilization, restoration of degraded areas through planting of natural trees is also very crucial especially the areas affected by tree cutting. This study included both restoration initiatives, provision of sustainable alternative livelihood and conservation education to community members adjacent to the forest. This study therefore aimed at enhancing conservation of Magombera forest through creation of conservation awareness to the communities, empowering them through beekeeping project and restoration initiatives to restore degraded areas of the forest.

2. MATERIALS AND METHODS

2.1 Study area

This project took place at Magombera Forest Reserve. The forest lies about 6km eastwards from the Udzungwa Mountains National park in Kilombero District, Morogoro Region Tanzania (Figure 1). Magombera is composed of a moist forest, swamp, dry woodland and grassland. The climate is of high humidity, annual rainfall reaching 1500mm with an average temperature of 32℃. The forest is bordered by the four villages of Magombera, Kanyenje, Katurukila and Msolwa stesheni. Seventy-five community members from these villages were part of the project team

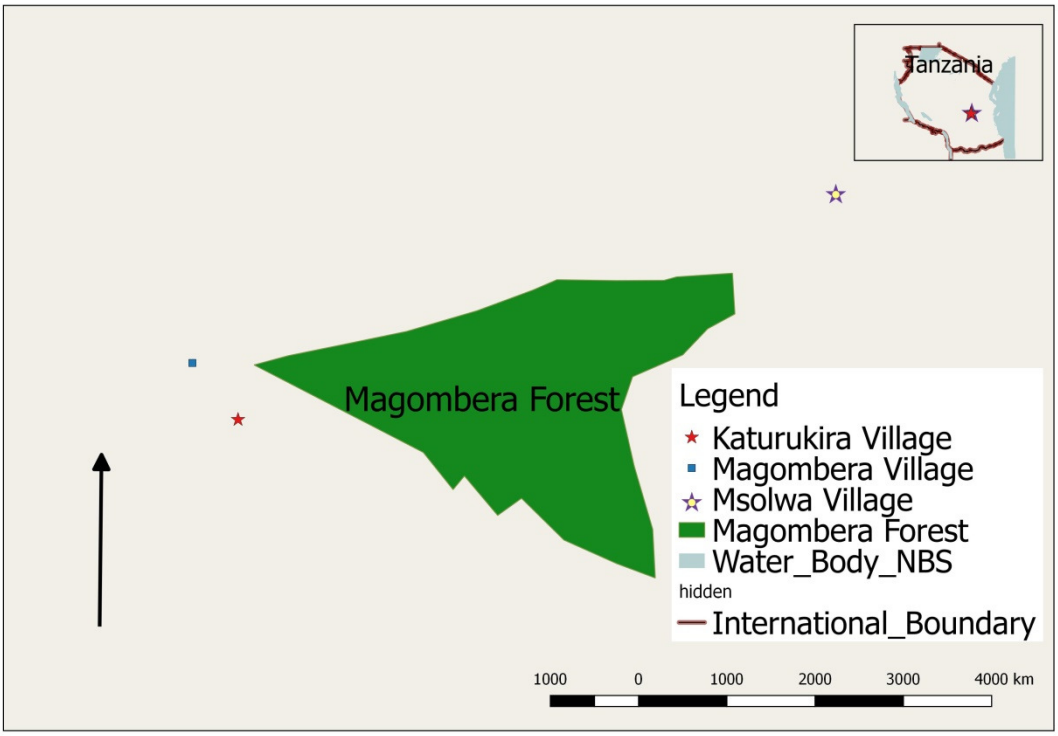

Figure 1. Map showing the Magombera Forest and neighbouring villages (source Ngongolo *et al.,* 2019)

2.2 Methods

2.2.1 Assessment of the knowledge , attitudes and practice of people on conservation and improved beekeeping

Selection of seventy-five participants favored government leaders, villagers involved in beekeeping activities and students from primary and secondary schools adjacent to the forest. The list of individuals provided by the local government leaders were entered in the excel regardless of gender, education level, sex and age. Simple random selection was performed to obtain the required number of participants from each village.

Closed and open- ended questionnaires and direct questions and answers methods were used to assess their knowledge on conservation of the forest and biodiversity in general. Questions were formulated in such a way that assessed individual's awareness about what species are inhabiting Magombera forest, which practices destroy them, why conserve them and how to conserve them. Fixed response questions were used to interview the selected participants regarding their attitudes towards conservation, causes of their dependence on the forest and their response towards proposed conservation and alternatives to forest resources.

A series of questions were presented and the respondents were asked to agree or disagree. These allow easier interpretation than open-ended questions [12]. Participants responded to pre-prepared questions which were in Swahili language to ease understanding. For knowledge on improved beekeeping, questionnaire and closed ended questions were used . Likert scaling was used to assess the different levels of agreements from respondents where 1=strongly Disagree, 2=Disagree, 3=don't know, 4=Agree and 5=Strongly agree. Friedman Test Statistic was used to test the variation on the understanding of the benefits among the respondents. The variables assessed were knowledge and attitude on conservation and knowledge on beekeeping.

2.2.2 Provision of Training

The training involved 30 adults communities members, 5 government leaders, 20 primary school pupils and 20 secondary school students. Trainers were qualified personnel from University of Dodoma (UDOM), Save Nature for Life (SANALI), Tanzania Wildlife Research Institute (TAWIRI) and district forest and beekeeping officers. The training was participatory including in-class sessions and field work in the forest. Among others, the training included importance of the forest, threats facing the forest, how to conserve the forest, benefits accrued from forest conservation and beekeeping techniques (e.g. location of apiary, processing, packaging and marketing). In addition, fliers on such topics were prepared in English and the local language (Swahili), and posted in strategic locations in the villages with high public visibility such as the dispensary, market, schools, clubs, a church, a mosque, as well as government and NGO offices. In order to determine the effectiveness of training, the same pre- and post- questions were asked.

2.2.3 Tree planting

Indigenous trees were planted as part of the practical training. The species of trees to be planted was determined by assessing the species makeup in the forest. Seedlings were purchased from Udzungwa Forest Project (UFP). Before planting, the number of stumps were counted to determine the number of tree cuts. Four random transects of 5000 meters each were established. In each transect 5 plots with $50m^2$ were chosen at 500m intervals. Six hundred seedlings were planted in the forest. The number of seedlings planted in a particular plot were determined by the level of degradation of the plot. The process of planting trees was done in cooperation with the community members. After ten months, a survey was undertaken to determine the number of trees that survived.

3. RESULTS

3.1 Knowledge and attitude of people on conservation

Seventy-five people were involved in the assessment. The dominant age in the interviewed cohorts were above 30 while low response was from age group below 30 years (Fig 1). It was observed that most of the participants know how valuable the forest is. About 83% of the participants agreed that the forest has positive value. For instance, participants mentioned values of the forest such as medicinal value and aesthetic value. Likert scaling indicated that participants were knowledgeable and agreed to the benefits accrued by the forest. Variation on the understanding of the benefits among the participants was observed to be statistically insignificant (Friedman Test Statistic = 0.367, P =0.98, df= 4). The training enabled to raise local communities' knowledge on the values of the forest.

Despite the fact that community members had some knowledge on the values of the forest, they had little knowledge on how well to conserve the forest. Moreover, their attitude towards conservation of the forest was negative. There was a positive change of local community members' attitude towards conservation after the training .

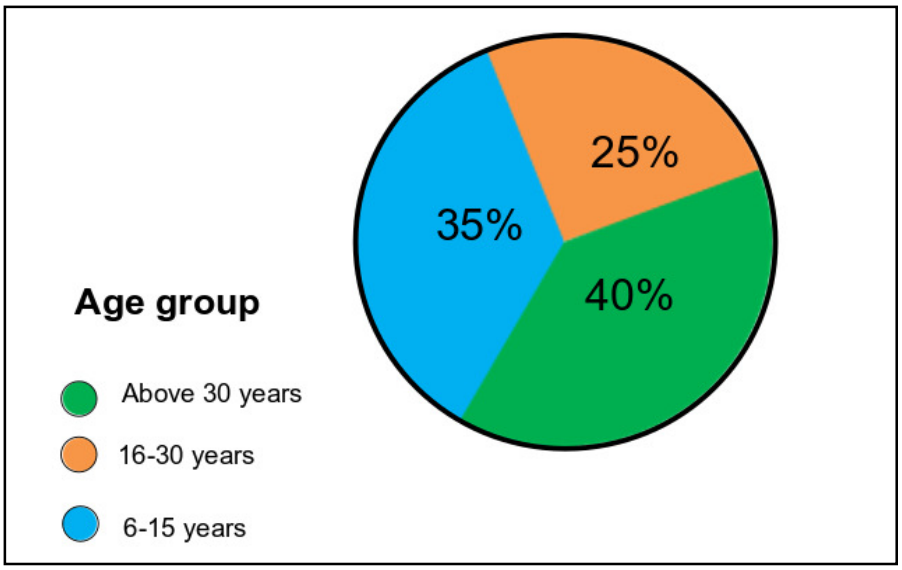

Figure 2. Percent of age groups involved in the study.

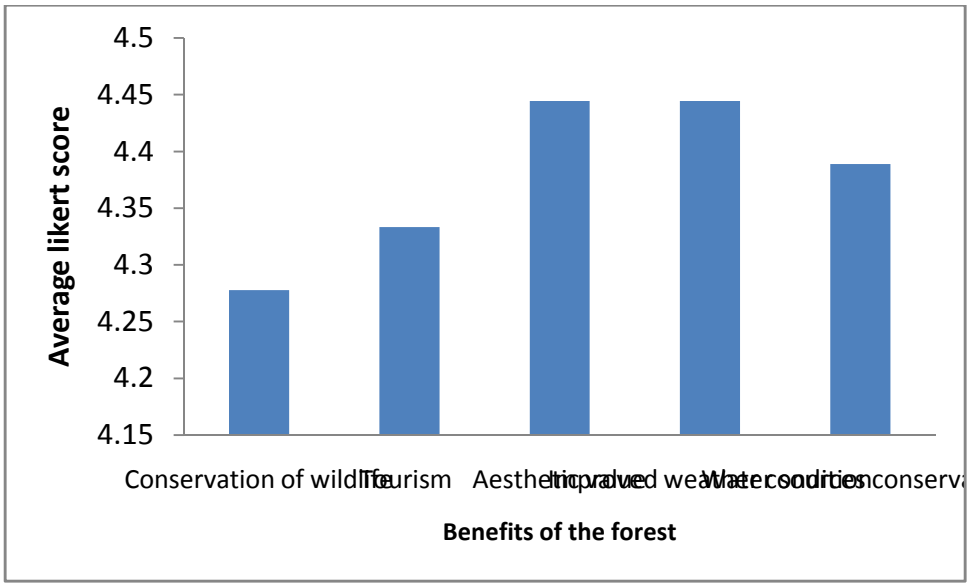

Figure 3. The likert scaling on the benefit of the Magombera forest. Where by 1-strongly Disagree, 2-Disagree, 3-don't know, 4-Agree, 5-Strongly agree

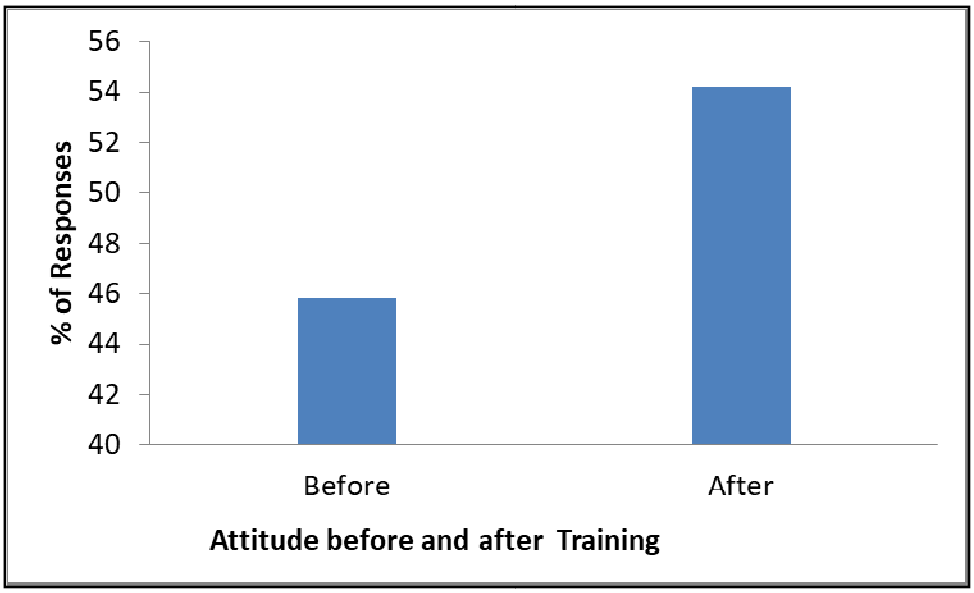

Figure 4. Attitude of people towards conservation of the forest before and after training. The percent of responses were low before training indicating a negative response towards conservation and high response after training indicating positive attitudinal changes.

3.2 Knowledge on improved beekeeping

Seventy-five individuals were participated in the beekeeping project. It was observed that 89% of participants had no knowledge of improved bee keeping. Among these, 90% were peasants and 10% were students. Seventy percent of peasants who had no knowledge of improved bee keeping, were females and 30% were males. Only 11% had little knowledge on improved bee keeping. Among these, 74% were students and 26% were peasants. After training, the number of participants with improved knowledge of beekeeping was high as well as improved attitudes towards forest conservation.

3.3 Habitat degradation and Restoration initiatives

About 87 stumps were observed, counted and identified. Dominant cutting was observed to *Calycosiphonia spathicalyx* while low cut was observed to *Tricalysia pallens* (Table 1).

Six hundred trees were planted and almost 89% of trees survived. Only 11% of trees planted could not survive. The restoration initiatives were observed to be successful as far as the number of surviving trees and their growth .

Table 1 Number of stumps of trees observed and counted as per tree cuts. The higher the number of the stumps, the higher the level of destruction of the particular species and the higher the demand of local community member on the particular plant species.

Scientific name	No. of stumps
Calycosiphonia spathicalyx	28
Erythrophleum suaveolens	17
Isoberlinia scheffleri	15
Mallotus oppositifolius	6
Dalbergia melanoxylion	5
Bombax rhodognaphalon	4
Diospyros ferrea	4
Milicia excelsa	3
Cola microcarpa	2
Pachystela brevipes	1
Tabernaemontana pachysiphon	1
Tricalysia pallens	1
Total	**87**

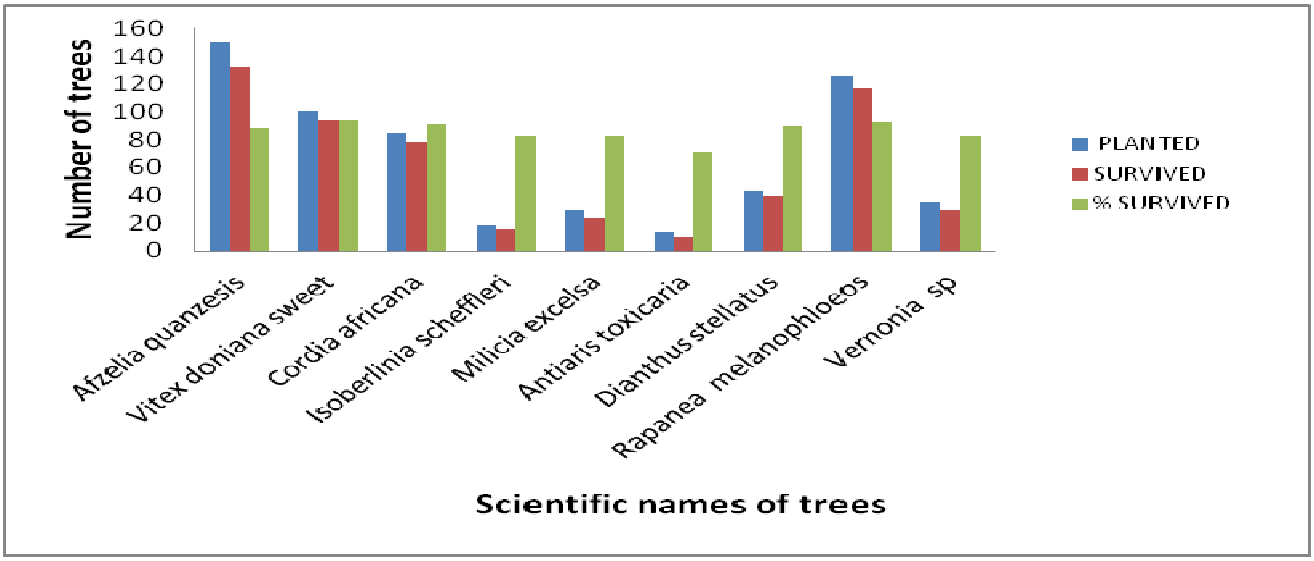

Figure 5. Species and number of seedlings planted and their observed survival rates.

4. DISCUSSION

4.1 Knowledge and attitude of people on conservation

Contrary to the assumptions of many conservationists that rural populations are almost entirely antagonistic to conservation and ignorant of conservation issues [12], in this study the concept of conserving forests was well supported. 'Don't know' responses come from mostly impoverished communities that do not have the leeway to support a particular conservation practice even if they support the concept. As [13] pin points the real values of conservation i.e. water, soil and environmental buffering are appreciated but often elicit a ``not in my backyard'' response, which in the context to this study indicates not ``at the expense of my livelihood''. It has been shown that, raising awareness about conservation to the local communities surrounding the forest through participatory training and providing alternative way of livelihood reduces the threats to the forest [9, 10, 11]. When the local communities are empowered in the sustainable utilization of the forest such as bee keeping, they are able to provide support in the forest conservation. [6, 14] argued that the provision of alternative protein and income-generating sources is one of the best strategies at the community level to reduce wild meat consumption and trade while aiming to improve local livelihoods. Other studies e.g. [15] suggested the use of pre- existing informal traditional management and control systems to maximize local participation and for success of biodiversity conservation.

4.2 Knowledge on improved bee keeping

Most people had no knowledge about improved beekeeping. Very few people were practicing traditional beekeeping which is not environmentally friendly and less profitable. For example, they used methods that resulted in ecological degradation (e.g., falling trees). Introduction of improved beekeeping as the alternative livelihood to local community surrounding Magombera forest save as a means of ameliorating the environmental and livelihood problems. Alternatives should always be locally relevant, and market analyses should be conducted for alternative income generating activities [16]. It's a good idea to choose livelihood activities that have already been used to some extent in the project region. Encouragingly, most case-study projects have chosen alternative livelihoods that were pre-existing in communities, increasing the likelihood of uptake and success of the project. A good example of the importance of choosing locally-relevant activities was provided by the relative success of the DABAC (Developpement d'Alternatives au Bracconage en Afrique Centrale) project in Cameroon, and the other cane-rat rearing projects in West Africa [17]. The reason that why it worked very well in Cameroon, is because they are already livestock rearers. They know already about chickens and rabbits, and in this respect the cane rat is just a small modification on something that already exists. In comparison, cane rat rearing was unsuccessful in other Central African countries where participants did not have a history of livestock rearing. Gabon wasn't a very favorable environment for (cane rat farming), in the sense that the Gabonese are not naturally livestock rearers, and even less rearers of wildlife. So already, it is not an obvious autonomous economic activity

for the Gabonese. The same applies to Magombera village community members; they had the knowledge of traditional bee keeping before the introduction of the improved bee keeping. This facilitated the success of this project in their village.

4.3 Habitat destruction and Tree planting

The habitat degradation observed in the Magombera forest is largely attributed to anthropogenic activities such as tree cuts and farm extension. It is self-evident that populations and species will suffer when their habitat becomes degraded or is lost completely [18,19, 20]. In this context, the destroyed habitats need to be restored to restore the species with time. To make the initiative meaningful and successful, the involvement of community members gives them a sense of forest ownership. In this project, communities involvement in tree planting was found to result in positive attitudinal changes of the participants towards forest conservation. However, some plant species did not grow well. This could be due to biotic and abiotic factors. Seedling establishment can be limited by several factors. High seed predation and low germination rates in some species, competition with pasture grasses, stressful microclimatic conditions, lack of soil nutrients, reduced mycorrhizal inoculum, and herbivory affect seedling establishment [21] A number of other studies have also demonstrated that some native species show growth rates in disturbed areas similar to those of more commonly used exotic species [19]; this might also be the case to the well grown species in this project. To increase the effectiveness of conservation projects, some studies suggest sustainable harvesting program with the local swayers and charcoal makers [15]. Such program will be operated in the exotic trees planted adjacent to Magombera Forest Reserve as an alternative for Magombera Forest.

4. CONCLUSION

Conservation education and sensitization on the importance of biodiversity should be provided to the communities living adjacent to a reserved area so that they can participate positively in protecting and conserving the area. Involvement of public (Community-based biodiversity conservation approach) in managing the protected area could be the best option because people will have the sense of ownership and be ready to protect biodiversity and provide information concerning poachers and other threats which may destroy biodiversity. This can only happen if people are aware and involved. Additionally, alternative ways of livelihood relevant to a particular community should be promoted to the community to reduce their dependence on the forest for their livelihood.

COMPETING INTERESTS

The authors declare that they have no competing interests

CONSENT (WHERE EVER APPLICABLE)

Not applicable.

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

Not applicable.

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