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

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10 **ABSTRACT**

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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 the 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 way of livelihoods. The study revealed that the concept of forest conservation is well supported, nevertheless, people are extracting resources from the forest for their sustenance. 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 to a positive community's attitude change towards conservation. The modern bee keeping was introduced to the community and successfully adapted. 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 with the project .

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13 *Keywords:* Magombera forest, alternative livelihood, Modern beekeeping, Restoration

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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 and posing high extinction risks of many species. According to [2, 24], habitat loss threatens 85% of all species described in the IUCN's 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 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, charcoal making, agriculture expansion, wild fires, urbanization and mining [5]. For instance, Kalunga forest which is among the lowland forests in Kilombero valley have been cleared for agriculture because of their fertile soil and flat terrain [6]. These activities affect ecosystems that are home to many wild species. Magombera forest is among the forests which faces these challenges.

Magombera Forest is part of the Udzungwa ecosystem in the southern end of the Eastern Arc Mountain Range in South-central Tanzania. It 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 Colobas monkey, Magombera chameleon, , *Polyalthia verdcourtii* (Huberantha verdcourtii) tree and the large-leaved Memecylon tree [2, 7]. Magombera forest is also the home for other internationally threatened species of plants and animals such as Udzungwa dwarf galago, and hippopotamus. The Forest is also an important place for local communities who depend on the adjacent land for rice and sugar farming. The forest provides invaluable ecological services including protection from floods and soil erosion. The canopy of the forest is mostly intact, however limited regeneration and continued forest use threatens the future of the forest. The vegetation is composed of mature trees with closed canopy, saplings, herbs and grasses.

The forest was gazetted in 1955 because of its biodiversity value and water catchment area [6]. Over 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, trees 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 Tanzania Forest Services Agency, the Tanzania Forest Conservation Group, local government, communities, the Udzungwa Forest Project (UFP) and the Kilombero Sugar Company, the forest was formally declared as a Nature Forest Reserve on 11th January 2019 [8]

Regardless of the important of the forest, awareness on the conservation of the forest to the local communities adjacent to the forest and the knowledge on sustainable economic utilization of the forest like bee keeping are inadequate. The little conservation awareness and insufficient skills in sustainable utilization of the forest has led to unsustainable utilization of the forest.

Experience has shown that, alternative livelihood and awareness to the local communities through training and community-based conservation approach can reduce the threat of the forest [9]. In addition, if the local communities are empowered in the sustainable utilization of the forest like bee keeping, they will definitely provide support in the forest conservation. As means of ameliorating the problems from human to the forest, there is a need to find a sustainable utilization way to benefit the local communities while conserving the forest like introduced bee keeping project in Magombera forest [10, 11]. The restoration of degraded areas of the Magombera forest through planting of natural tree is also very crucial, and hence this study included both restoration initiatives, provision of sustainable alternative livelihood and conservation education to community member adjacent to the forest. This study therefore aimed at enhancing conservation of Magombera forest through creation of conservation awareness to the local communities neighboring the forest, empowering them through bee keeping project and restoration initiatives to restore degraded areas of the forest.

2. MATERIAL AND METHODS / METHODOLOGY

2.1 Study area

This project took place at Magombera Forest Reserve by involving community members adjacent to the forest. The forest lies about 6km eastwards from the Udzungwa Mountains National park. The vegetation cover is composed of natural trees herbs and grasses. The forest is bordered by four villages namely Magombera, Kanyenje, Katurukila and Msolwa stesheni. Seventy-five community members from the fore mentioned villages adjacent to the forest were involved in the project team.

2.2 Methods

2.2.1 Assessment of the knowledge and attitude of people on conservation

Closed and open- ended questionnaires and direct questions and answers methods was used to assess the knowledge of community members on conservation of the forest and biodiversity generally. Questions was formulated in such a way that can assess community's awareness about what species are inhabiting Magombera forest, which practices destroy them, why conserving them and how well to conserve them. Stratified random sampling [12] were used to select participants. Fixed response questions were used to interview the selected households regarding their attitudes towards conservation, causes of their dependence on forest and response towards proposed Conservation and alternatives to forest resources.

75 A series of questions were presented and the respondents were asked to agree or disagree. These allow easier

76 interpretation than open-ended questions [13]. Seventy five Participants responded to pre-prepared questions which were

77 in Swahili language.

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79 ### 2.2.2 Assessment of the knowledge of people on modern bee keeping

80 Questionnaire and direct questions and answers methods was used to assess the knowledge of community members.

81 Participants responded to pre-prepared questions which were in Swahili language.

82 ### 2.2.3 Provision of Training

83 The training involved 30 local communities, 5 local government leaders 20 primary school's students and 20 secondary

84 school's students. Trainers were qualified personnel from University of Dodoma (UDOM), Save Nature for Life (SANALI),

85 Tanzania Wildlife Research Institute (TAWIRI) and district forest and beekeeping officers. The training includes the

86 participatory training in class and field work in the forest. Among others included importance of forest, threats facing the

87 forest, how to conserve the forest, the benefits accrued from forest conservation, bee keeping techniques (location of

88 apiary, processing, packaging and marketing). In addition, fliers on such topics was prepared in English and local

89 language (Swahili) and posted in strategic locations in the villages with high public visit like dispensary, market, schools,

90 clubs, church, mosque, government and NGO offices.

91 ### 2.2.4 Habitat degradation and Restoration initiatives.

92 To determine the level of habitat degradation, we count the number of tree cuts. Four transect each with 5000m was set

93 randomly in the forest. In each transect 5plots with size of 50m^2 each was set at interval of 500m apart. In each plot, the

94 number of trees cut down was determined. This helped to determine the potential of the forest for bee keeping. Through

95 this project, there was an initiative for restoring degraded area by planting trees. Trees planted in the degraded area were

96 determined by assessing the species diversity in reference site. Six hundred trees were planted in degraded areas of the

97 forest. The process of planting trees was done in cooperation of the community members.

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100 ## 3. RESULTS AND DISCUSSION
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102 ### 3.1 Knowledge and attitude of people on conservation

103 Seventy-five people were involved in the assessment. The dominant age in the interviewed cohorts were above 30 while

104 low response was from age group below 30 years (Fig 1). It was observed that most of the participants know how

105 valuable the forest is. About 83% of the participants agreed that the forest has positive value. For instance, participants

106 mentioned values of the forest such as medicinal value and aesthetic value. Likert scaling indicated that participants were

107   knowledgeable and agreed to the benefits accrued by the forest (Fig 2). Variation on the understanding of the benefits

108   among the participants was observed to be statistically insignificant (Friedman Test Statistic = 0.367, P=0.98, df= 4). The

109   training enabled to raise local communities' knowledge on the values of the forest.

110   Despite the fact that community members had some knowledge on the values of the forest, they had little knowledge on

111   how well to conserve the forest. Moreover, their attitude towards conservation of the forest was negative. There was a

112   positive change of local community members' attitude towards conservation (Fig 3).
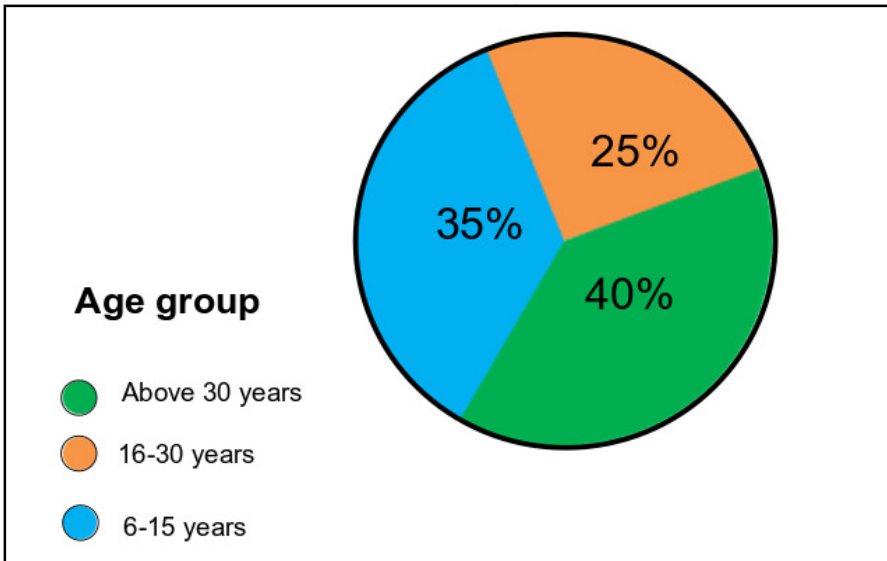
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114   **Figure** 1. Percent of age group involved in the study.
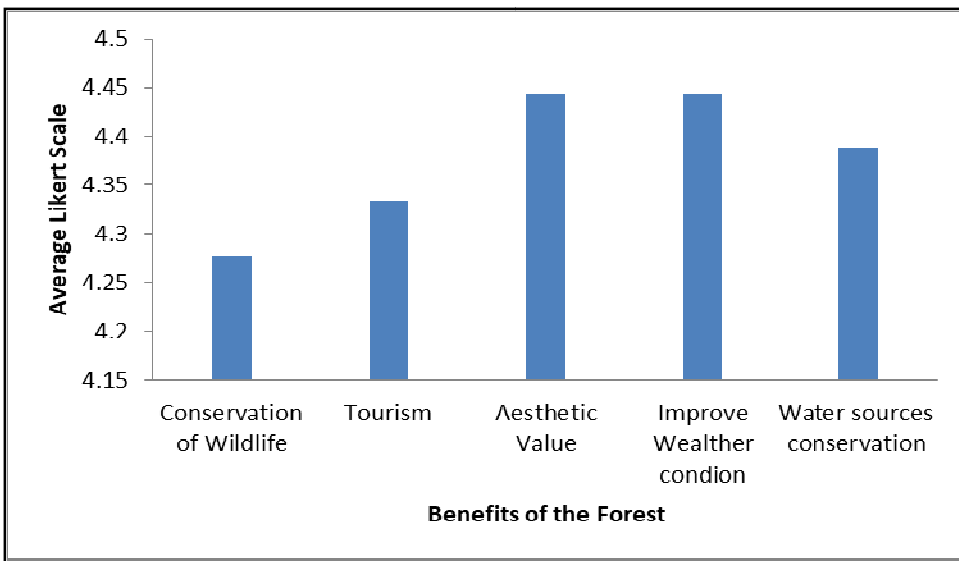
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116   Figure 2. The likert scaling on the benefit of the Magombera forest. Note; Likert scaling, 1-strongly Disagree, 2-Disagree,

117   3-don't know, 4-Agree, 5-Strongly agree.

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119   **3.2 Knowledge on modern bee keeping**

Seventy-five community members were participated in the bee keeping project. It was observed that 89% of participants had no knowledge on modern bee keeping. Among these, 90% were peasants and 10% were students. 70% of these peasants who had no knowledge on modern bee keeping were females and 30% were males. Only 11% had little knowledge on modern bee keeping. Among these, 74% were students and 26% were peasants. After training, it was observed that the number of participants who got the knowledge of beekeeping were high and the level of knowledge to participants also increased (Fig 3). All participants engaged in beekeeping project after the training.
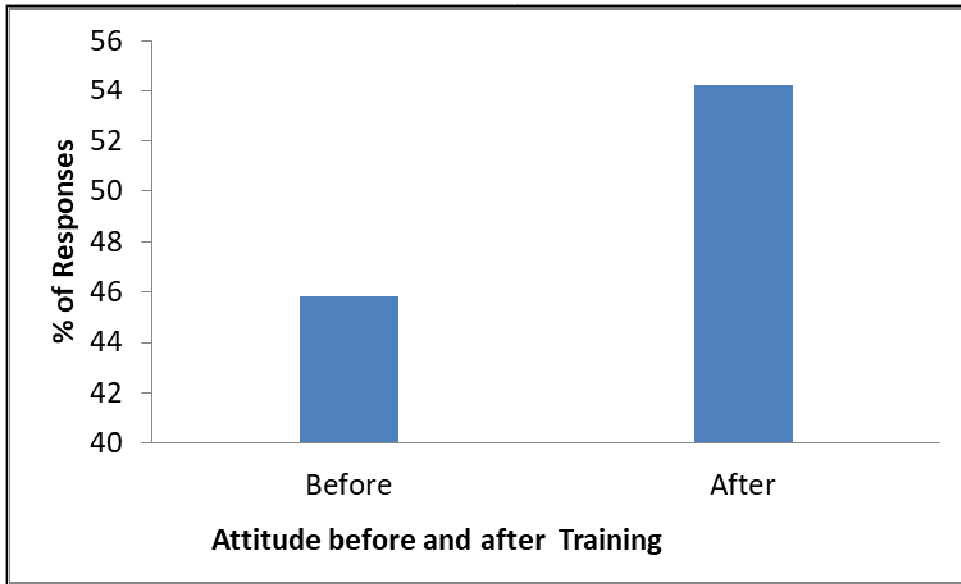

Figure 3. Attitude of people towards conservation of the forest before and after training. The percent of responses were low before training indicating negative response towards conservation and high response after training indicating positive attitude changes.

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 planted grow and proceed well only 11% of trees planted could not survive. (Fig 4). The restoration initiatives observed to be successful as far as the number of survived trees and the success of their growth is concerned.

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	N0. 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**
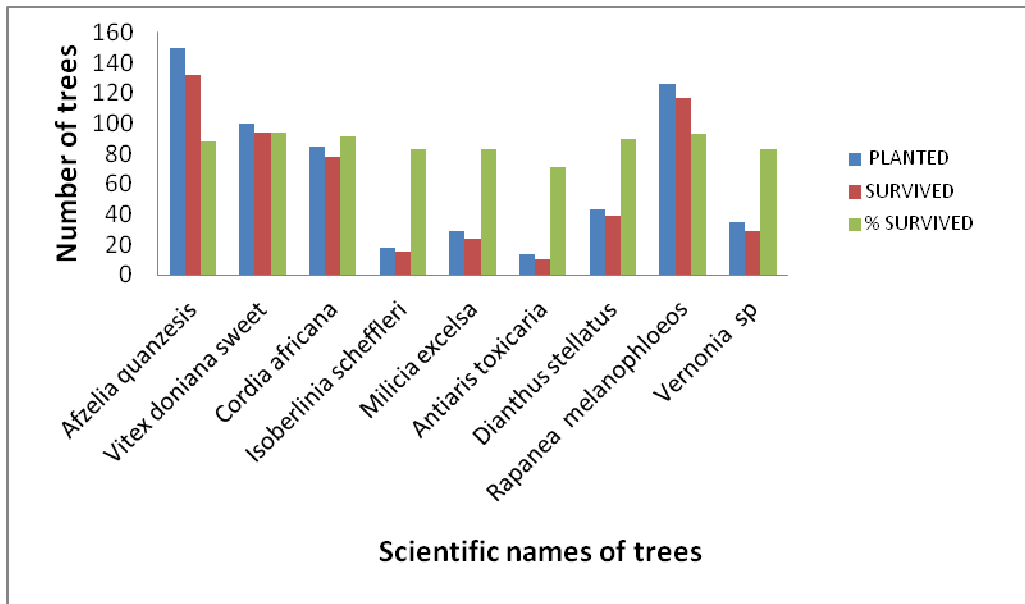
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Figure 4. Species and number of trees planted for restoration initiatives and their observed survival rates.

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142   **4. DISCUSSION**

143   **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 [13], in this study the concept of conserving forests was well supported. Don't know' responses would have been because of communities that are impoverished and do not have the leeway to support the conservation practice even if they support the concept. As [14] pin point 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, 15] 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.

4.2 Knowledge on modern bee keeping

Most people had no knowledge about modern 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., felling trees). Introduction of modern 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], 21]. It's the good idea to choose livelihood activities that had already been used to some extent in the project region. Encouragingly, most case-study projects had chosen alternative livelihoods that were pre-existing in communities, this increase 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 project in Cameroon, and the other cane-rat rearing projects in West Africa [17, 22]. 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 modern bee keeping. This facilitate the success of this modern bee keeping project in their village.

4.3 Habitat destruction and Restoration Initiatives

174   The habitat degradation observed to affect the Magombera forest. Much of this destruction is attributed to anthropogenic

175   activities such as tree cuts and farm extension. It is self-evident that populations and species will suffer when their habitat

176   becomes degraded or is lost completely [18,19, 20]. In this context, the destroyed habitats need to be restored to rescue

177   the species with time. To make the initiative meaningful and successful, the involvement of local community members is

178   very important. This makes people to have the sense of ownership to the forest and the project. In this project,

179   involvement of local communities in restoration initiatives was found to be good and restoration initiative was successful.

180   However, some plant species did not grow well. This could be due to biotic and abiotic factors. Seedling establishment

181   can be limited by several factors. High seed predation and low germination rates in some species, competition with

182   pasture grasses, stressful microclimatic conditions, lack of soil nutrients, reduced mycorrhizal inoculum, and herbivory

183   affect seedlings establishment [21] A number of other studies have also demonstrated that some native species show

184   growth rates in disturbed areas similar to those of more commonly used exotic species [20]; this might also be the same

185   case to the well grown species in this project.

186   **4. CONCLUSION**

188   Conservation education and sensitization on the importance of biodiversity should be provided to the communities living

189   nearby the protected area so that they can participate positively in protecting and conserving the area. Involvement of

190   public (Community-based biodiversity conservation approach) in managing the protected area could be the best option

191   because people will have the sense of ownership to the protected areas and be ready to protect biodiversity and provide

192   information concerning poachers and other threats which may destroy biodiversity. This can only happen if people are

193   aware and are involved. Additionally, alternative ways of livelihood relevant to a particular community should be taught to

194   the community so as to reduce their dependence on the forest for their livelihood.

198   **COMPETING INTERESTS**

200   **T**he authors declare that they have no competing interests

203   **CONSENT (WHERE EVER APPLICABLE)**

205   Not applicable.

206   **ETHICAL APPROVAL (WHERE EVER APPLICABLE)**

208   Not applicable.

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