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Contribution and challenges of mangrove conservation to community's wellbeing in eastern Tanzania

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Abstract. *Ngowi N, Zakayo G. 2023. Contribution and challenges of mangrove conservation to community's wellbeing in eastern Tanzania. Intl J Bonorowo Wetlands 13: 15-21.* There have been several mangrove conservation programs implemented in Tanzania to reverse degradation of mangrove ecosystem in the country. However, after their introduction in 1990s, many small-scale farmers relying on the mangrove ecosystems lost their livelihoods. To ensure that the people's well-being and ecological integrity of the mangrove ecosystem is sustained, this study investigated the impact of nature conservation practices on financial sustainability, and food security of local communities as well as ecological integrity of the mangrove ecosystem. The study employed mixed - method approach where a survey was used to collect quantitative data from 90 household respondents selected randomly for a questionnaire survey. This was supplemented by data collected through personal observations and interviews administered to 30 local people (mainly key informants and focus group discussion). Quantitative data were analyzed through crosstab IBM SPSS version 20. Qualitative data were analyzed using content method. The results indicated that the conservation practices introduced brought a significant difference in financial stability ($p<0.05$) by increasing incomes of the implementing households to US $80.29 compared to US $69.20 for the non-implementing households. However, 83% of the implementing households still faced food insecurity by having meal only twice per day, although it was slightly higher compared to 80% for the non-implementing households. The 85% of the implementing and 65% of non-implementing households perceived that the conservation practices had improved the ecological integrity of the mangrove ecosystem by increasing the vegetation cover. The results of this study suggest that conservation practices in the mangrove ecosystem have increased financial sustainability and ecological integrity but failed in enhancing food security. This study recommends the integration of rights of local communities on usage of land for paddy and fish farming to achieve sustainable economic growth in the estuary.

Keywords: Ecosystem, estuary, integrity, mangrove, nature

INTRODUCTION

Tanzania, like many other countries, faces the problem of loss of wetland ecosystem services (Dalu et al. 2022; Ngowi 2018). Being part of the wetland's ecosystem, mangroves are vegetation found in tropical regions that are salt-resistant and thus can survive on the coastal saline habitats (Duke and Schmitt 2015). Globally, there are estimated 16 million hectares of mangroves (Monga et al. 2018) and home of a diverse ecosystems (Machava-António et al. 2022). Asian Continent has the largest extent of mangrove ecosystem, accounting for 40% of total global mangrove areas, while Africa accounts for 19% or 3.2 million ha (Friess et al. 2019). In East Africa, mangrove ecosystem is a unique type of forest cover, covering about 37% of the entire mangrove on the continent (Ajonina et al. 2013) with Tanzania contribute to 14% of all the mangrove ecosystem of East Africa (Nyangoko et al. 2020; Japhet et al. 2019).

Mangrove ecosystem offers various ecosystem services, from providing various fisheries, timber and non-timber products, regulating climate via sequestration of carbon, protecting coastal areas from abrasion, strong waves, storm and tsunami, serving as habitat of various marine and terrestrial organisms and providing socio-cultural benefits for coastal communities (Cahyaningsih et al. 2022). In many regions, mangrove ecosystem is one of the major providers of livelihoods of coastal communities through fishing activities (Hlaing et al. 2017). Despite its global importance, the deforestation and degradation of mangroves is increasing worldwide due to ecological and economical drivers (Monga et al. 2018). The socioeconomic drivers caused by increasing human activities through unsustainable uses of the mangrove ecosystems (e.g. cutting mangroves for burning lime or smoking fish, mangroves conversion for paddy or rice farming, aquaculture, and dynamite fishing) have intensified particularly among the world poor whose wellbeing directly depends on mangrove ecosystem. For instance, Mungai et al. (2019), Mshale et al. (2017), and Ajonina et al. (2008) show that in the past 25 years, about 8% of mangrove ecosystem in Eastern Africa covering Kenya, Mozambique, and Tanzania has been lost at an average of 3,000 hectares in a year. The major drivers for mangrove degradation among others in the region are associated with humans as well as natural factors, such as climate change and siltation (Nyangoko et al. 2022). Due to this, different practices have been introduced in many mangrove ecosystems worldwide to address the problem of degradation.

Mshale et al. (2017) notes that in the Rufiji estuarine ecosystem of eastern coastal Tanzania, three key nature conservation practices were implemented in the three districts of Rufiji-Mafia-Kilwa area between 2006 and 2012. These are: Rufiji Environmental Management Project (REMP), and Marine and Coastal Management practises between 2005 and 2011. According to UNDP (2012), the long-term goals of these conservation activities included the wise use of lower wetlands ecosystem, biodiversity conservation, maintenance of ecosystem functions, restoration of natural resources, and enhancement of the rural communities' wellbeing.

Inspite of the fact that some of the conservation practices introduced have contributed immensely to the restoration of mangrove ecosystem in Tanzania (Duvail et al. 2006), less attention is given to improving households' wellbeing (Mshale et al. 2017). In order to nature conservation practices and achieving their intended purpose, there should be a good balance between the wellbeing of implementers involved in the conservation practices and the requirements of ecosystem services. Chinangwa et al. (2016) show that the livelihood assets include resource base of the community available in the form of - human, natural, financial, physical, and social capital which help to understand people's resilience and provide the direction of changing wellbeing from bad to good (Chinangwa 2016). Chinangwa et al. (2016) provided the description of the five livelihood capital assets as follows: (i) Natural: The natural resources or ecological services that form the basis for human survival and economic activities (e.g., forests). (ii) Financial: Bases that enable a household to pursue particular livelihoods strategy (e.g., income). (iii) Physical: Basic infrastructure (e.g., housing). (iv) Social: Aspects of the society or community upon which households depend, when pursuing livelihood strategies that require coordinated actions (e.g., networks, social relations, and associations). (v) Human: Skills, knowledge, labour, good health, and physical capability that enable one to pursue livelihood strategies. Ngowi (2018) on the other hand described livelihoods as capabilities and activities required for a means of a living including coping with and recover from stress and shocks and maintain or enhance its capabilities now and in future without destroying the natural resource base.

Therefore this research examines the contribution and challenges of conservation actions and or interventions on the major components of human livelihoods affecting the wellbeing of households in ecologically vulnerable mangrove area of Kibiti area in eastern Tanzania. The results of this research will be used as baseline information for developing the policies of estuary resources conservation practices for inclusive sustainable economic growth in the area.

MATERIALS AND METHODS

Conceptual framework

We employed Sustainable Livelihood Analytical Framework (Figure 1) developed by the Department for International Development (DFID) (1999) with modification to uncover the impact of conservation activities on three variables namely; financial sustainability, food security, and ecological integrity.

From Figure 1, three domains (A, B, and C) are interrelated. This study investigated on how these three domains influence the domain D - variables in terms of the wellbeing of those involved in the conservation actions: (i) Financial sustainability – maintenance of sufficient income to cover local community expenses beyond the conservation action period; (ii) Food security – physical and economic access of sufficient food to all people all the times; and (iii) Ecological integrity – the expected processes occurring within the frequency and intensity of any environment which is both influenced by human actions such as land use cover land use change and changing climate. The implementation of conservation practices namely Rufiji Environmental Management Project, and Marine and Coastal Management (Domain A) using relevant public policies (Domain B) helped to avoid degradation of estuary resources, thus improving the natural and ecosystem function of estuary resources (Domain C). Ecological degradation intensifies the conflict between human and the environment (Lin et al. 2022). The decline in pressure and degradation influenced the wellbeing of implementers through financial sustainability, food security, and ecological integrity (Domain D).

Study area

The study was conducted in Kibiti estuary located in Eastern Tanzania (Figure 2; Japhet et al. 2019). The district has a total area of 109,555 km^2 and is mainly bordered by the Indian Ocean to the East, North and South East. The study area forms an estuarine environment with the highest concentration of mangrove ecosystem in Eastern Africa (Monga et al. 2018). For instance, a study by Dai et al. (2022) shows that Kibiti District where the studied area is located is covered by the largest mangrove area in Tanzania. More than half of the mangrove species are found in the villages located on the northern parts of the studied area followed by villages on the south having about a quarter, and the remaining species are in the villages located at the centre. Table 1 is the list of mangrove species found in the studied area. There is limited information on the occurrence of *Xylocarpus moluccensis* (Lam.) M.Roem and *Pemphis acidula* J.R. Forst. & G. Forst species in this area.

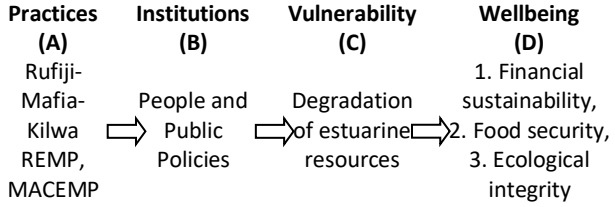

Figure 1. Peoples' well-being analytical framework modified from DFID (1999)

The human population in the studied area is about 49,000 people with the growth rate of 1.9% per year. There are three major ethnic groups namely Wandengereko, Wamatumbi and Wamakonde living in the area (Nyangoko et al. 2020).

Methodological framework

This research adopted an explanatory sequential design Ngowi (2018) to collect quantitative data first followed by qualitative data (Figure 3). The use of the explanatory sequential approach to data collection as the first step helped to inform the qualitative step, and the later was used to explain the results of the first step. More emphasis was given to the quantitative methods than the qualitative methods where explorative approaches were used to provide a better understanding of the problem being investigated than using either stories or the trend line data alone.

Table 1. A list of mangrove species in the studied area

Family name	Species name	Common name	Local name
Avicenniaceae	*Avicennia marina* (Forssk.) Vierh	White mangrove	Mchu
Lythraceae	*Sonneratia alba* J. Smith	Apple mangrove	Mpira
Rhizophoraceae	*Ceriops tagal* (Perr.) C.B.Rob	Indian mangrove	Mkandaa
Combretaceae	*Lumnitzera racemosa* Willd	White-flowered mangrove	Mkandaa dume
Rhizophoraceae	*Bruguiera gymnorrhiza* (L.) Lam	Black mangrove	Msinzi
Rhizophoraceae	*Rhizophora mucronata* Lam	Red mangrove	Mkoko
Meliaceae	*Xylocarpus granatum* J.Koenig	Cannonball mangrove	Mkomafi
Malvaceae	*Heritiera littoralis* Aiton	Glass-looking/tulip mangrove	Msikundazi

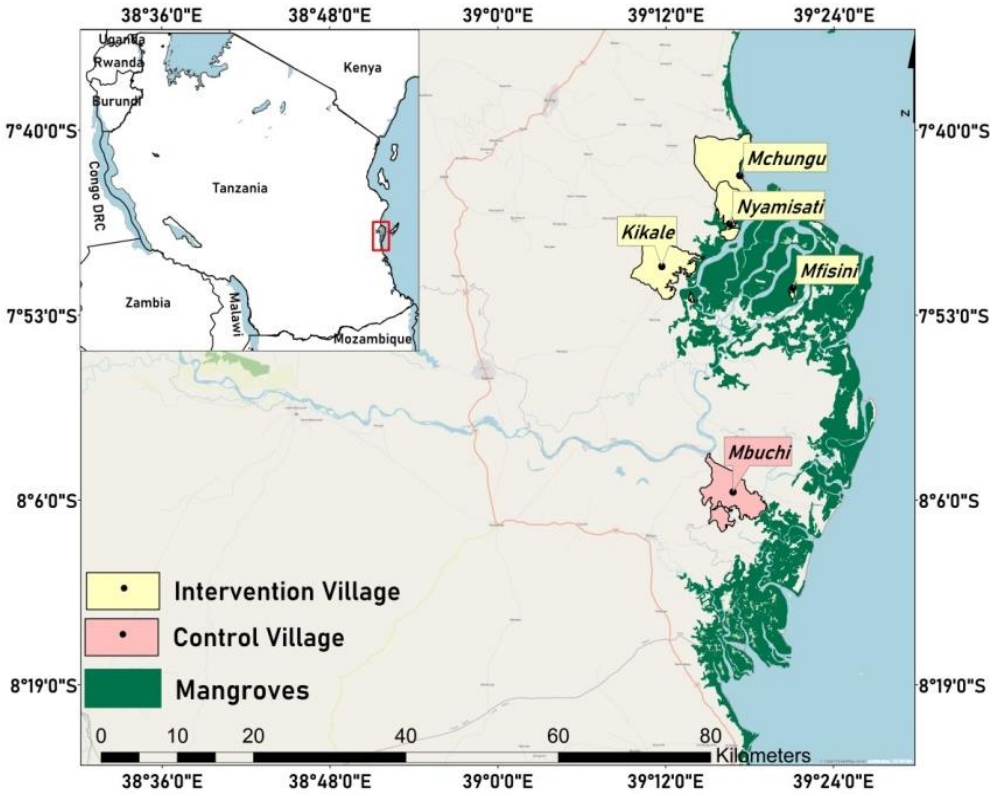

Figure 2. The map of Kibiti estuary in eastern Tanzania showing the sampled villages

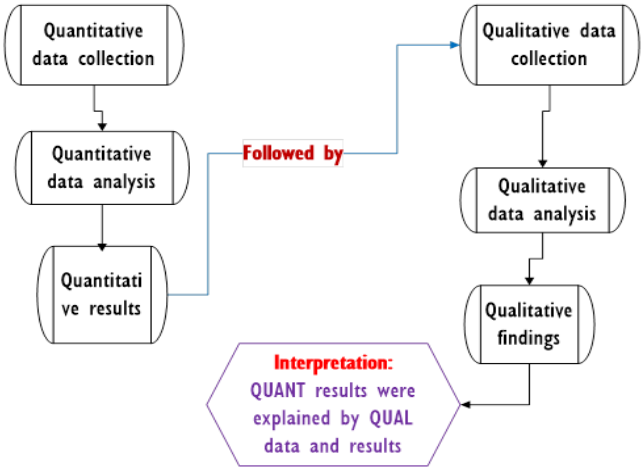

Figure 3. Methodological framework in data collection and analysis following Ngowi (2018)

Data collection procedure

Initially, identification of the specific study villages and prioritization of conservation actions introduced in the estuary ecosystem of the studied area was made through discussions with different actors (administrations, development agents, and individuals) with specific knowledge of the subject being investigated and who could share non documented information such as project activities or able to summarize issues pertaining to mangrove history, and trends in the availability of resources during the implementation of conservation efforts. The discussions aimed to provide a clear picture on the benefits of the efforts to the different groups of people. Following the discussion, four villages: (i) Kikale, (ii) Nyamisati, (iii) Mchungu, and (iv) Mfisini were selected from the intervention site and the fifth village (v) Mbuchi was taken as a control one. The non-random sampling method was employed to identify conservation actions and key informants involved in this study. The probability formula by Israel (1992):

$$\mathbf{n} = \frac{\mathbf{N}}{\mathbf{1} + \mathbf{N} \cdot (\mathbf{e})^{\mathbf{2}}}$$

It was used to obtain a sample of 90 heads of households (respondents) who implemented the conservation actions/interventions from a total of 8,460 households (Namangaya and Mushi 2019). From the formula, **n** are respondents, **N** is the Number of households, and **e** is the sampling error at 5%. In addition, 30 respondents were drawn from the control group for comparison purposes. The control group approach was used to select respondents not affected by the intervention actions. Different studies, for instance Ngowi (2018), used the control group method to investigate changes in livelihoods resulting from Wetland Friendly Investment Approach (WFI) program in Iringa District, Tanzania. A ten-section questionnaire developed to cover socio-economic and demographic characteristics of respondents collected information on mangrove conservation actions and well-being of people of the area.

Primary data

Primary qualitative information was collected through a checklist of interview questions involving 10 key informants, and 20 members who participated in the Focus Group Discussions (FGD) representing elders, youth group, male-headed and female-headed families each having 4 - 5 members. The selection was based on their long period of living in the study area, good experience with the conservation practices introduced in the area, ability to identify mangrove plants and narrate the history and functions of the mangrove ecosystem of the area. The direct observation method was used to obtain information from the mangrove sites. This method involved making observation as researchers walk along the set transects in the field where conservation actions were implemented. A timeline on the historical changes of the mangrove cover and or use and drivers for the change was drawn with assistance of the elderly villagers. Photographs were taken to corroborate this information as appropriate. The qualitative information was used to supplement themes not considered in the quantitative data. For example, existing threats and drivers for the mangrove change. The perception-based approach Nyangoko et al (2022) was used to listen, learn, and understand the experiences of the local people of the studied area on their environment.

Secondary data

Secondary data involved the review of literature mainly published works (journal articles, books and book chapters, reports), and information from websites.

Data processing and analysis

Statistical analysis using IBM SPSS version 20 statistical software for quantitative categorical data, and test for independent sample analysis (mainly for data collected using the questionnaires) in which p=0.05 was used as cut off point for statistical significance between people who were involved in the conservation actions and those who did not. Qualitative data were analyzed through content analysis method which also assisted the analysis and interpretation of the quantitative information.

RESULTS AND DISCUSSION

Connecting nature conservation to financial sustainability

The results in Figure 4 show that about 50% of the income of the households through various nature-based activities ranges between 201,000/= and 300,000/= Tanzanian Shillings (TShs) (equivalent to US $87.99 and US $130.43). Majority of these being those who are involved in the conservation actions.

The results in Table 2 show that the mean income of the households in the intervention area, i.e. those who were involved in the conservation actions was about Tanzanian Shillings 184,667/= (equivalent to US $80.29 with a standard deviation of TSh. 59,816/= (US $26.00) as opposed to the control site (those who were not involved in the conservation actions) which had a mean of TSh. 159,167/= (US $69.20) and standard deviation of TSh.

47,162/= (US $20.50). This equivalence is calculated at an exchange rate of 1.00 US $ = 2300/=Tanzanian Shillings). This implies that the income per month for the households who engaged in the conservation is categorized as moderate or average compared to those who did not.

The results in Table 3 show that there is a difference in the mean income between the implementing and non-implementing households ($p=0.036<0.05$). This research found that households of the control site had lower income (159166.67 ± 47162.29) than the income of intervention households (184666.67 ± 59816.19). A study of Nyangoko et al. (2022) show that in Rufiji delta, income dynamics are also determined by a number of activities including change in fishing season, cutting and/or selling of mangrove poles and rice farming in the mangrove ecosystem. For instance, the study shows that about 60% of income in the study area was from mangrove-based farming, fishing, and non-mangrove-based crop farming. Increased households income through licensing of timber harvesting by the local community enhanced reinvesting of funds into construction of community residential buildings and support of Village Environment and Natural Resources Committees (VEC and or VNRCs) activities for sustainability of the income and the mangrove ecosystem.

Food security

The results in Figure 5 show that majority of households (83%) in the intervention area ate twice in a day, 10% ate once, while very few (5%) ate three times and 2% had four meals in a day. On the control site (non-implementing households), results show that 80% ate twice, 15% ate once, and 5% ate three times while none ate four meals per day. These results show that 83% of the respondents involved in the conservation actions had more meal frequency compared to non-implementers, implying that local community in the mangrove ecosystem are living in the state of food insecurity despite introduction of the conservation actions in their areas. These results are supported by Mangora (2011) on poverty and institutions, which shows that poverty is the driver of mangrove ecosystem degradation. Furthermore, William et al. (2005) show among developing countries mangrove conservation practices and improvement of the wellbeing cannot go simultaneously.

From MACEMP's point of view, the Coastal Village Funds (CVF) run by the local community was found to have not significantly increased food security, and opportunities for a long-term positive effect on food security in the area. There is a need for observing land rights in relation to the usage of land by local communities. Land use for paddy/rice farming, inter-planting with maize and beans was proved to increase households' food security.

Ecological integrity of mangrove resources

With respect to the perceptions of the local community on the significance of conservation practices to ecological integrity of mangrove ecosystem, 85% of the implementers and 65% of non-implementers said that conservation practices had increased the vegetation cover of the mangrove ecosystem (Figure 6). These results are supported by Monga et al. (2018) which shows that from 2010 to 2015 afforestation and natural regeneration practices had increased the coverage of mangrove ecosystem. Furthermore, they are also consistent with a study by Ntibona et al. (2022) which shows that paddy farming and illegal cutting of mangrove poles had significantly reduced post 1990s after introduction of conservation practices. This was made possible through the campaign of replanting mangroves while at the same time strengthening the management capacity of local institutions such as district councils and village forest committees.

This research shows that there were positive impacts associated with the conservation practices in the mangrove ecosystem. According to participants of group 2 involved in the focus group discussion, conservation practices introduced in the Rufiji delta had increased recovery of mangrove ecosystem as well as wildlife. In their own words, Mchungu villagers said, "*The mangrove forest ecosystem has been increasing since conservation practices started in 1990s and these trees are well protected through government, non-government organisations and other stakeholders*". This quotation reflects that people know that conservation practices had improved mangrove ecosystem of the area but failed in addressing the conflicts, which arise on the replanting of mangroves versus agriculture land in the mangrove habitat.

Table 2. The monthly income of the households between the intervention vs control site

Location site	Respondents (n)	Mean	Std. deviation	Std. error mean
Control	30	159166.6667	47162.29012	8610.61672
Intervention	90	184666.6667	59816.19787	6305.18088

Table 3. Test for independent samples

T-test for equality of means						
T value	DF	Sig.	Difference in means	Std. error	95% Confidence Interval	
					Lower	Upper
-2.123	118	.036	-25500.00000	12009.79146	-49282.65676	-1717.34324
-2.389	62.575	.020	-25500.00000	10672.30182	-46829.72756	-4170.27244

Note: Sig.= 2 tailed

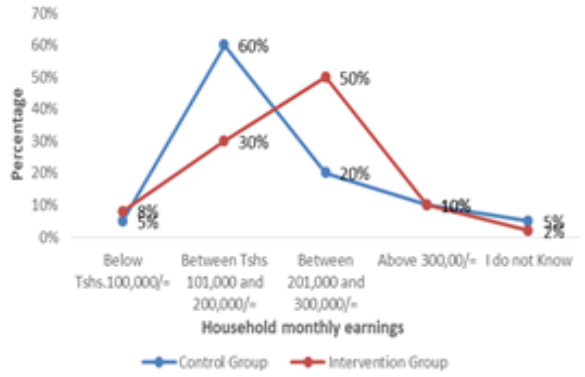

Figure 4. Distribution of household monthly earnings between the intervention vs control site

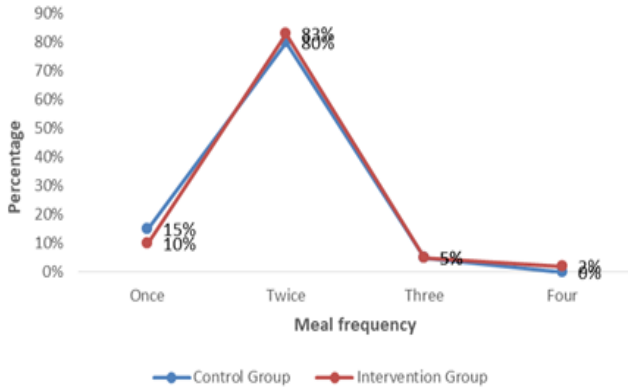

Figure 5. Distribution of meal frequency between the intervention vs control sites

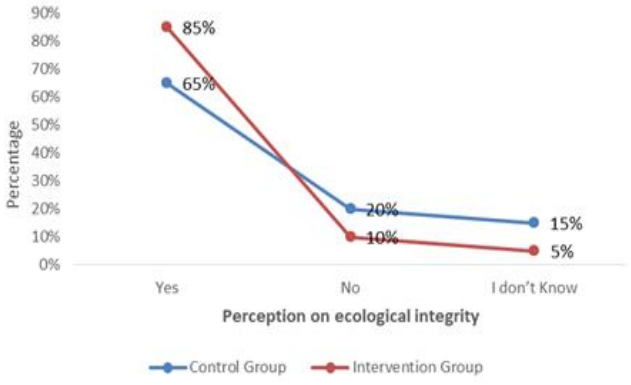

Figure 6. Community perceptions on ecological integrity between the intervention vs control locations

This research investigated financial sustainability, food security, and ecological integrity of the conservation of mangrove ecosystem in eastern Tanzania. The results show that established farming groups failed to progress well due to a lack of knowledge about running cooperative groups. On the income aspects, it was found that the implementing households had higher mean income compared with the non-implementers and that the difference between the two is significant (p<0.05). These results reveal that conservation practices in mangrove ecosystem have made significant contributions in increasing the income and network of cooperation among women farming group members, which in return were found to have: (i) Equally increased financial stability in the mangrove ecosystem; (ii) Increased ecological integrity by reducing degradation of mangrove ecosystem, thus managed to mobilized resources for enforcing policies/by-laws; (iii) Failed to increase food security through the frequency of meals household members consumed in a day.

Based on the findings from this study, in order to improve the local community wellbeing and security of natural resources for sustainable economic growth, three paths are recommended to be followed: (i) Reviewing strategies adopted in the conservation practices; (ii) Observing the rights of the local communities' use of land for paddy farming; and (iii) Integrating fish farming and ecotourism in mangrove ecosystem of the area. These are useful for the planning and decision making of the programs implemented in the studied area.

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