Community perception of forest protection and its implications: Insights from the peri-urban forest reserve in Kazimzumbwi, Tanzania

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ABSTRACT

Due to the ecosystem services they provide, forest resources are essential for the development of human society. The protection of forests is inevitable because of their importance in ensuring sustainability. This study seeks to examine community perception on forest protection by integrating it with remote sensing data and investigates socio-economic and environmental implications of protection to the surrounding communities. This study used a case study design and was guided by Elinor Ostrom's socio-ecological theory. The study used a sample of 301 respondents for quantitative data and 12 respondents for qualitative data, making a total of 313 respondents. Respondents were selected from two wards of Kazimzumbwi and Kisarawe using simple random and purposeful sampling techniques. Various tools were used to collect the information, including the use of semi-structured questionnaires, key informants' interviews, satellite images that were downloaded from the United States Geological Survey (USGS) archives, and reviews of literature. The quantitative data were analysed using descriptive statistics with the statistical Package of Social Sciences 12 while quantitative data were analysed using thematic analysis. The satellite data was analysed using the random forest (RF) algorithm and mapped in ArcGIS 10 software to examine the forest cover changes in Kazimzumbwi Forest Reserve from 1994 to 2024. The results showed that the majority of respondents were aware of forest protection, which was identified using several local knowledge indicators that indicated an increase in trees. Such an indicator was proved by a satellite image that shows the increase in bushland and open woodland and the decrease in the area occupied by grassland in the area. In a similar vein, respondents acknowledged the existence of social, economic, and environmental impacts in the area that were mainly reflected by economic hardship and a decrease in farmland. The increase in energy prices, control of soil erosion, climate regulation, improvement in biodiversity, fear and insecurity, rise in crime, lack of compensation, and enhancement of social services were all noted as significant issues. The study recommends the need to strengthen the governance system by engaging local communities in decision-making and establishing sustainable livelihood support to the community surrounded by the protected forest. It also recommends for implementing continuous environmental education provision among the key stakeholders to ensure sustainable commitment to the protection.

Keywords: Community, Forest Protection, Implication, Kazimzubwi, Perception, Tanzania

I. INTRODUCTION

Forests are essential since they perform a crucial role on the Earth's surface, as they have a climate-regulating function, mitigate climate change, reduce atmospheric pollution, and assist in carbon sequestration (MacDicken, 2015). Because of its importance worldwide, several protected areas have been established by the government to enforce the implementation of policies that aim to safeguard endangered forest biodiversity species and natural resources in general. Despite these important protection initiatives, various multifaceted socio-economic and environmental implications affect the local people living around that potential resource and depend on it as a basis for their livelihoods (Vezina et al., 2020; Corbera et al., 2020).

Several studies have been conducted globally on the intricate association that exists between forest conservation and protection against local community wellbeing. For instance, Vezina et al. (2020) revealed that in Indonesia the conversion of the Sebangau production forest to a national park forced the local community to change their livelihood strategies towards agriculture and fishing, as well as promoting the use of non-timber products. In a similar vein, studies in the Philippines revealed the existence of local management arrangements for tenure security as well as species composition that always shaped the forest protection and supported livelihoods (Chechina, 2015).

The situation observed on the global scale reflects what occurred beyond Asian countries. The study conducted in South Africa, specifically in KwaZulu-Natal Province, by Nsukwini and Bob (2019) indicated that the local communities near protected areas experienced costs that included crop and animal losses, safety risks, and other impacts, such as a lack of employment opportunities and regulated resource access due to the existence of forest protection. In a similar vein, the persistence of inadequate compensation schemes usually amplified the cost to the communities that lived adjacent to both the state and the community (Nsukwini & Bob, 2019). Although forest protection can secure

ecological benefits for society, it can also create social, economic, and environmental impacts for the communities that surround the protected forest.

The protection of forests has become central to ensuring global environmental governance. At the same time, several policy frameworks are embedded in multilateral agreements such as the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, and the Sustainable Development Goals (Kreienkamp, 2021). Both frameworks insisted on ensuring sustainable forest management, biodiversity protection, and climate-related forest instruments such as REDD (Krause et al., 2019). The study conducted by Pham et al. (2021) in Africa revealed that despite the international initiatives undertaken, protected areas are more affected by insufficient law enforcement, lack of financing, and social and political barriers.

Shackleton (2004) revealed that forests are important resources, as they support the lives of many people. Also, it offers ecological stability, which influences the growth of national economies. A similar study found that despite its potentialities, it is still affected by anthropogenic activities coupled with poor governance mechanisms. The continued degradation of forest landscapes is attributed to limited enforcement capacity, insecure tenure arrangements, high rural poverty, and an increasing overdependence on forest resources (Isah, 2023). For instance, more than one million hectares are lost annually in the Democratic Republic of Congo (DRC). In this country, despite the effectiveness of community initiatives, more than one million hectares of forest are lost annually to forestry (Verhegghen et al., 2016). Furthermore, the study conducted in Kenya, particularly in Kakamega Forest, confirmed that the initiation of the Forest Act of 2005, which encouraged participatory forest management, has strengthened forest users' associations in improving forest regeneration that finally reduced illegal logging (Kokwee, 2022). Similar results were observed in Ethiopia across Bale Mountain, where there was a notable increase in forest density and a reduction in forest clearing as a result of improved governance that was influenced by the participatory forest management programs (Gelo & Koch, 2014).

According to Food and Agriculture Organization, in 2020, Sub-Saharan countries experienced forest loss of more than 3.9 million hectares annually that is influenced by charcoal dependency, agriculture intensification, and weak governance systems. Such degradation is more profound in some countries including Tanzania, Uganda and Mozambique despite the existence and adaptation of various community-based forest management models (Magessa, 2020).

Moreover, a study conducted in Tanzania by Chamshama and Vyamana (2010) revealed that the country's forest cover spans approximately 38.8 million hectares of land. Several policy reforms have been implemented over the past two decades, including the National Forest Policy of 1998, which advocates the need for participatory forest governance through Joint Forest Management and Community-Based Forest Management. The 1998 policy advocates the need to ensure community involvement in forest management and protection. Literature indicates that community-based forest management has contributed to the forest recovery and reduced illegal harvesting of the forest and its materials in the regions of Tanga, Dodoma, and Morogoro (Kalumanga et al., 2018). Furthermore, the establishment of the Forest Act of 2002 enhanced the efforts to protect forests by specifying community roles, rights, and responsibilities in forest management. Such efforts seem to bring a positive impact since they managed to improve the ecological stability and reduced illegal extraction of forests (Mabhuye et al., 2023). Similarly, the REDD strategy has been adopted in the country with the aim to improve forest protection by mitigating forest loss (Mabhuye et al., 2023). Furthermore, the Environmental Management Act of 2004 also reinforced forest conservation through improved environmental oversight and mandatory environmental impact assessments (Kijazi & Kant, 2011).

Although various policies and strategies have been adopted in the country, the forest's landscape is still affected by degradation practices caused by several factors, such as economic pressures, rapid urbanization, fuelwood dependence, and challenges in enforcing regulations. Studies conducted by Mabhuye et al. (2023) and Blomley et al. (2017) in sub-Saharan Africa, Tanzania inclusive, focused much on analysing policies as well as assessing the pattern of forest degradation using remotely sensed data in forest protected areas and thus bypassing the local people's perception on forest protection and the implications of forest protection to the surrounding community. Therefore, this study was conducted in order to address such knowledge gap by focusing on the peri-urban forest of Kazimzumbwi.

1.1 Statement of the Problem

Tanzania is endowed with forest resources that play a critical role in social, economic, and environmental development. The forests have been affected by severe degradation caused by the combination of anthropogenic and natural factors. Due to the alarming rate of degradation, several policies, rules, and legal frameworks have been formulated to protect it. Kazimzumbwi Forest Reserve is one of the forests in Tanzania that have been declared a protected area.

Several studies have been conducted in forest protected areas in Tanzania; however, these studies primarily focused on policy analysis and the use of remote sensing and Geographical Information System [GIS] to detect the magnitude of forest degradation while giving limited attention to local community perception of the protection and its implication. Thus, the current study seeks to uncover the gap left by those bodies of literature by integrating the local

community perception with remote sensing data and analyzing the socioeconomic and environmental implications of forest protection in Kazimzumbwi Forest Reserves.

1.2 Research Objectives

i. To analyse community perception on the Kazimzumbwi Forest Protection and integrate it with remote sensing data
ii. To investigate socio-economic and environmental implications of the protection on the surrounding communities.

II. LITERATURE REVIEW

2.1 Theoretical Review

The study used a social ecological theory that was initiated by Elinor Ostrom in 2009 to explain the dynamics and interdependence that exist between the society and natural resources such as forests, fisheries, and water sources. The theory was made up of four major key assumptions that include interdependence, where the social and ecological systems are compact to the extent that changes in one obviously affect another (Berkes & Ross, 2013). Secondly, there is persistence of complex adaptation mechanisms that are characterised by nonlinear dynamics such as feedback loops, uncertainty, and the capacity to influence the adaptation of the disturbance over time (Cumming & Allen, 2017). Third, the theory further believed that the sustainability of the resources is influenced by interactions among various institutions that operate at local, regional, and national levels rather than by a single authority (Ostrom, 2017), and finally, it acknowledges the recognition that community perceptions, values, and experiences usually shape how forest protection rules are interpreted and implemented by the community (Berkes & Ross, 2013).

Based on the current study, one can assert that the theory is very relevant in examining the local community's perception of forest protection and its implications since it integrates the socio-perception and the ecological outcomes. The Kazimzumbwi Forest Reserve, which is located in a peri-urban area, is a common-pool resource that is affected by intense pressure emanating from urban expansion, livelihood dependence, and governance complexity. Therefore, the theory is particularly valuable for explaining how local communities' attitudes and perceptions influence compliance with forest protection initiatives (Ostrom, 2009). On the other hand, the theory analyses the interaction that exists between the governance structures and the benefits provided by the forest ecosystem and integrates it with the laws, rules, and regulations that shape the community's accessibility to forest-protected areas (Cumming & Allen, 2017). Moreover, the theory encourages the analysis that captures how local perceptions are influenced by broader institutional arrangements and ecological changes, making it an appropriate theoretical view for understanding forest protection outcomes in peri-urban contexts where social–ecological tensions are more pronounced (Mattei Faggin et al., 2017).

2.2 Empirical Review

Forest protection initiatives across Africa have increasingly been promoted as dual mechanisms for environmental conservation and socio-economic improvements in adjacent communities. Several studies have been conducted in different parts of the world in an attempt to understand the complex relationship between forest protection and its implication for the local communities. The study results obtained varied according to the context in which they had been conducted, but formed the basis for the current study.

2.2.1 Community Perception on Forest Protection by Integrating with Remote Sensing

Kimaro and Chidodo (2021) conducted a study and used remote sensing data together with community perception in analyzing forest change over time in Magamba forest reserve in Tanzania. In their study, they found out that the local communities observed the decline in forest cover depicted by satellite images corroborated with community perceptions, as they identified the fuelwood extraction and agriculture expansion around reserve edges as the key drivers towards that change. Hence, they assert that the community perception complemented and validated the remotely sensed data. Similarly, Uisso et al. (2019) examined community perception in forest management and conservation initiated under the REDD initiative program. In their study, they used forest conditions data obtained from remote sensing and participatory land plans by stratified household by wealth group while using the survey method to capture the community's awareness and perceptions of forest conservation. In their study in the Kilosa district, the broad community holds a positive attitude towards forest protection and management, though the information captured by satellite images revealed degradation that was influenced by agriculture intensification, charcoal production, and livelihood activities. Thus, there was a discrepancy between the community perceptions and the satellite image. Furthermore, Iheaturu et al. (2025) conducted their studies in nine West African forest patches (Togo, Benin, Nigeria, and Cameroon) by integrating remote sensing data with community household surveys to compare the local people's perception of forest change aligned with forest loss or regrowth. They finally found out that in some sites there was alignment between the satellite image and local community perception, though there were some discrepancies that were observed in some areas.

2.2.2 Socio-Economic and Environmental Implications of the Protection to the Surrounding Communities.

Forest protection initiatives across Africa have increasingly been promoted as dual mechanisms for environmental conservation and socio-economic improvement of adjacent communities. Various studies conducted in different parts of Africa. The study conducted by Amuyou et al. (2021) revealed that forest protection has created positive outcomes for the surrounding communities, as it reduced the deforestation rate and enhanced carbon stock conservation. However, the restriction on accessibility affects community income because residents are deprived of access to certain forest products. Such an imbalance of outcomes affected the community's perceptions, especially those of households with limited livelihood alternatives, who could see protection as economically restrictive rather than beneficial. Generally, the study concludes that inadequately addressing the livelihood impact can undermine the environmental impact of forest protection. Furthermore, in Sub-Saharan Africa, Pouliot et al. (2012) studied in Burkina Faso and Ghana revealed that the restrictions posed by protection policies often reduced the perceived economic value of the forest, which caused the community members to prioritize agriculture and parklands. Similarly, the study noted the existence of the economic hardships to the communities, especially where the accessibility of resources is burned without considering the compensation of livelihood options. The study highlights a contradiction in environmental protection policies, which aimed to reduce degradation but inadvertently contributed to ongoing degradation due to intensified agriculture and dependence on fuelwood. Evidence from Tanzania indicated that community participation can partially mitigate the costs associated with forest protection (Luswaga & Nuppenau, 2020). Environmentally, areas with higher participation levels experienced improved forest conditions, including reduced illegal harvesting and better regeneration. The study indicates that participatory approaches enhance perceptions and environmental outcomes; however, they do not inherently lead to substantial livelihood transformation without the addition of concrete economic incentives.

The reviewed literature generally reveals that we can study forest change by integrating remote sensing data and community perceptions. Moreover, the studies revealed that forest protection delivers clear environmental benefits, but its socio-economic implications experienced by the local communities after protection remained contested and highly context-dependent. Thus, the current study aimed at examining the community perception of forest protection and analysing its implication by integrating the respondent's opinion and satellite images in the Kazimzumbwi Forest Reserve in Tanzania.

III. METHODOLOGY

3.1 Research Design

The study employed a case study design since it permitted the use of a mixed research approach that allows the integration of both quantitative and qualitative data collection as a complement to each other, so as to study the research objectives investigated.

3.2 Study Location

This study was conducted at Kazimzumbwi Forest Reserve, which is 20-25 km southwest of Dar es Salaam region within the 7°10'0"S and longitude 38°49'60"E. The area occupied by the forest reserve is adjacent to Kisarawe Township. The forest was selected because it is one of the oldest coastal forests in Tanzania, which is significantly important for biodiversity conservation and has necessitated the adoption of various policies and strategies by the government for its protection. The forest covers a total area of 5377 hectares.

3.3 Target Population, Sample and Sampling Procedures

Kisarawe district has a total number of 17 wards. Out of it, 10% of the wards were selected, which yielded two wards. Thus, Kisarawe and Kazimzumbwi wards were selected purposefully based on the proximity of the selected wards to the forest. The second stage was the selection of the streets to be surveyed. A total of seven streets were selected from all wards at the ratio of 10% to ensure adequate representation. Thus, in Kisarawe ward, a total of four streets were selected, and in Kazimzumbwi ward, three wards were selected randomly, an anonymous child was used to pick the wards. Third is the selection of the sample size to be studied. Kisarawe ward has a total of 3,047 households, while Kazimzumbwi ward has 2,618 households; hence, the total number of households was 5,665 in two sampled wards.

3.4 Sample Size Determination Formula

The study employed Yamane's (1967) formula of calculating

$$n = \frac{N}{1 + N\left(e^2\right)}$$

Where:

n = sample size
N = total population
e = level of precision (sampling error)

Using precision level of 5.5% $(e = 0.055)$, a total of 310 households were selected based on the number of households present in the two wards as follows (Table 1)

$$n = \frac{5665}{1+5665\left(0.055^2\right)}$$

$$n = \frac{5665}{1+5665(0.003025)}$$

$$n = \frac{5665}{1+17.13}$$

$$n = \frac{5665}{18.13}$$

$$n \approx 312$$

In order to ensure fair representation of the number of the households to be included in the study a proportional sampling was applied as follows: Kisarawe Ward

$$n_1 = \frac{3047}{5665} \times 310$$

$n_1 \approx 167$ Households

Kazimzumbwi Ward

$$n_2 = \frac{2618}{5665} \times 310$$

$n_1 \approx 143$ Households

Table 1

Distribution of Households in the Study Ward

Ward	Number of Households	Sample Size
Kisarawe	3047	167
Kazimzumbwi	2618	143
Total	**5665**	**301**

3.4 Data Collection Methods

The current study integrates both spatial and non-spatial data collection methods. Various tools were used to collect information, including household questionnaires, key informants' interviews and Remote Sensing Technique and Geographical Information System (GIS)

3.4.1 Household Questionnaires

A total of 310 semi-structured questionnaires were collected from the heads of the households studied in Kisarawe and Kazimzumbwi wards. The questionnaires consisted of both closed and open-ended questions. The questionnaires were designed to explore the respondents' experiences of Kazimzumbwi Forest and their perceptions about the forest's protection. Moreover, the questions solicited information on socio-economic demographics and their reactions before and after the forest was declared protected, as well as the social, economic, and environmental impacts resulting from the protect

3.4.2 Key informant's Interviews.

The interviews were conducted with five local government officers, one Tanzania Forest Services officials as well as the six elderly person in the two wards who were believed to have much knowledge of the study area, who have lived before and after protection. The key informants were selected purposefully, and the information were capture through the use of an interview guide. The key informants provide in-depth information on the local indicators of forest protection, techniques employed in the protection as well as social economic and environmental implications experienced by the surrounding community.

3.4.3 A Remote Sensing Technique and Geographical Information System (GIS)

Spatial data included satellite images produced at different times, which were downloaded from the United States Geological Surveys (USGS-GLOVIS) and Earth Explorer. The satellite images were used to map and explore changes in land use, to determine the state of the forest, to assess the rates and trends of the change in the forest cover. The land-use map of 2004, forest type maps, the forest boundaries and other socio-economic data that covered the whole study area were also used in the geospatial analysis of land-use/land-cover changes.

Landsat images was used to detect the forest land cover changes. Basically, a 30 years' land use cover change images was used to complement the data collected from respondents in order to provide the actual ground verification. The satellite map of 2004 and rapid eyes of 2024 were used concurrently. The images used were obtained from the department of urban planning in Tanzania (DoSUP) down loaded Department of Survey and Urban Planning (DoSUP) Tanzania. Downloaded from Earth Resources Observation and Science (EROS) at (http://glovis.usgs.gov) of the Geological Survey of the United States of America. Similarly, population data, which were obtained from the National Bureau of Statistics in 2012 were used to assess the influence of population on land use change and resource use consumption.

3.5 Data Analysis

3.5.1 Non-Spatial Data

All non-spatial data were carefully examined for consistency. The data were also edited to ensure that they were accurate, consistent, and well-arranged so that they could be coded and entered in the data analysis software. Data from the interviews were put into specific categories. Then, the data were carefully cross-checked so as to get rid of all unnecessary information. As for the satellite data, image restoration, image enhancement, and image classification were conducted. Image restoration involved correcting and calibrating the images to get high-quality images and to remove degradation effects. Further radiometric restoration and geometric restoration were done. The images were enhanced by optimizing their appearance. This involved contrast stretching, composite generating, and digital filtering. Then, the images showing forest cover changes were manually put into five groups, namely woodland, bushland, grassland, and agricultural lands.

A supervised classification was conducted using ArcGIS and categorized the images into five broader classes. This technique was chosen because of its precision in land-cover categorisation. The first step was to select training sites; Arc G.I.S. image classification software was used to identify the categories of land cover in all the images. The second step involved creating a signature file. The classification of land cover was based on the spectral signature defined in the training set, and minimum-distance classification was used for the classification algorithms. Finally, five categories of land cover, which include forest (land covered by low-density trees), woodland (land covered with low-density and scattered trees as well as farms), bushland (land covered with bushes and shrubs), grassland (land covered by grass), and agricultural land (land on which farms are located), were obtained.

The satellite images were analysed using Quantum GIS (open-source software). Before a change was detected, the images that had been classified were checked for accuracy levels by doing post-processing. Then, an error matrix table was produced to show a land-use/land-cover classification report and overall accuracy levels of the satellite images. The accuracy level accepted for this study was 80%. Then, a semi-auto classification plug-in was used to calculate the changes in land use. The product of this process was a change trajectory map showing what has changed and what has not changed, and cross-tabulation statistics tables showing the extent of the changes and annual changes. The summation of loss and gain was used to calculate and identify the net changes of each type of land use. Overall changes were calculated by dividing net changes by the number of years from 1998 to 2018 to arrive at the annual land-use changes. The following formula was used to calculate the annual land-use changes;

$$r = \frac{\left[\ln\left(A_{t_1}\right) - \ln\left(A_{t_v}\right)\right]}{t_1 - t_v} \times 100$$

Where:

r = rate of annual change

A_{t_1} = land use area in the initial

A_{t_v} = land use area in final year or time

t_1 = initial time (year)

t_v = final time (year)

ln = constant (Kashaigili & Majaliwa, 2013)

The data obtained using the socio-economic survey were quantitatively analysed using the statistical package for the social sciences (SPSS) version 20 software to obtain the frequencies and percentages of responses while the quantitative data from the key informant interviews were thematically analysed. The data obtained from the analysis of land use and the satellite images were presented in the form of tables and maps, which show forest -cover changes. The data obtained using the questionnaire and interviews were presented as descriptive statistics which include frequencies, percentages arranged based on key research findings

IV. FINDINGS & DISCUSSION

4.1 Demographic Characteristics of the Study Respondents

Understanding the demographic characteristics of the study respondents is essential since people's views, experiences, and dependence on forest resources vary across social groups. Variables such as age, gender, and education influence how the individuals perceived the protection efforts. Table 2 in the current study examines the age, sex, and educational level of the respondents.

Table 2

Demographic Characteristics of the Study Respondents

Age of Respondents	**Frequency**	**Percentage**
20- 39	63	21.2
40-59	173	55
60-79	73	23.5
79+	1	0.3%
Total	**310**	**100**
Sex of the Respondents		
Male	179	57.7
Female	131	42.3
Total	**310**	**100.0**
Occupation	**Frequency**	**Percentage**
Crop farming	205	48.3%
Small business	169	39.9%
Formal employment	27	6.4%
Other	23	5.4%
Total	**310**	**100.0**
Education level	**Frequency**	**Percentage**
No formal education	61	19.7
Primary education	179	57.7
Secondary education	63	20.3
Tertiary education	7	2.3
Total	**310**	**100.0**

The study predominantly focused on the age groups of 40-59 years and 60-79 years. The years clearly demonstrated that most of the respondents engaged in the study were adults, and they had adequate knowledge and experience in the study area, and they could provide valuable contributions on the implications of forest protection.

Similarly, the study noted that there was a dominance of male respondents (57.7%) over the female respondents (42.3%). This discrepancy was influenced by the fact that the study was conducted in coastal communities where men are more publicly visible and are often regarded as household heads, which makes them participate mostly in surveys. Also, men are also engaging in various activities such as timber extraction and engaging more in forest management committees that finally link them with forest protection.

In terms of occupation, the study also found that the majority of the heads of households, 48.3%, engaged in crop farming as their main source of livelihood, followed by 39.9% engaged in small businesses such as selling charcoal. They are directly engaging in crop farming since the protected forest influenced the quality of the soil water supply and local climatic conditions that affect crop production.

Furthermore, in terms of educational qualification, the study exhibits that more than 50% of the respondents had primary education, followed by 20.3% who had secondary education. Given their level of education, it is an undeniable fact that their knowledge and implication of forest protection are shaped by their practical experience rather

than formal environmental education that might limit their understanding of the protection policies and call for the need to use simple, locally appropriate communication and education strategies in forest protection.

4.2 Community Perception on Forest Protection versus Remote Sensing Data

The study sought to establish the respondents' awareness of the status of the forest after being declared as a protected area. When the respondents were asked about their awareness of the forest change after the protection, a substantial number of respondents (78.1%) said yes, they are aware of forest protection, while a smaller percentage (21.9%) of respondents said they are not aware. Those who replied yes were respondents who are aware of the valuable indicators of forest protection intervention and who have stayed in the study area for more than 10 years. The observed higher level of change signifies the existence of conservation that is noticeable by local stakeholders and that can influence the local community's compliance with the protection programs.

The findings obtained in this study align with the study conducted in Ghana by Sobeng et al. (2023), as they found that the majority of the respondents, approximately 64% of the respondents in Tano-Offin Forest Reserve, observed forest changes that were influenced by the enforcement of forest rules that reflect a broad awareness of protection outcomes among surrounding communities. This was also revealed from key informants from Kazimzumbwi ward who expressed that

> *Before forest protection the forest was looking like a desert, but for now, the forest has increased due to the education given to societies about the preservation and protection of the forest and currently people have stopped burning the forest for about the past three years now (Elderly, Kazimzumbwi ward, March 2024)*

The study was also interested in understanding the indicators that were used by the respondents to assert the fact that there is noticeable change in the forest area after the protection. The interviewed respondents revealed several indicators that include the increase in tree species in the forest area which was acknowledged by the majority of the respondents (55%). Followed by 37.6% who asserted that forest utilization and accessibility have been reduced, while the smallest proportion of the respondents reported that the forest is shrinking in size since some trees are drying (Table 3). For those who asserted that the increase in forest tree species and the decrease in forest utilization were influenced by the fact that after protection and conservation various rules and regulations were enforced that prohibited the illegal utilization of the forested land. Insisting on these, one of the respondents reported that;

> *When I reached this Kimani area, the forest looked like a desert, but for now, the forest has increased due to the education given to societies about the preservation and protection of the forest; they have not been burning the forest for about the past three years now*. (Elderly, Kisarawe ward, March 2024)

Table 3

Local Indicators of Forest Change after Protection of Kazimzumbwi Forest

Indicators	Frequencies	Percentages
Increase in tree spices	323	55.1
Forest utilization has decreases	220	37.5
Trees are dying	39	6.6
Animals have increased	2	0.3
Total	**584**	**100**

NB: The total exceeded 310 due to multiple answers from respondents

To ensure that the forest is effectively protected, the study explored techniques used in forest protection. The findings revealed that several techniques have been used. For instance, the majority of the respondents acknowledged the use of regular patrols as one of the important techniques that enhanced protection of the forest area, as it was reflected by 38.4% of the respondents (Table 4). The use of regular patrol by Tanzania Forest Service officials usually prohibited the community encroachment on the forest, and hence the forest remained conserved. Insisting on the importance of patrol, one of the respondents from Kisarawe reported that

> *Involving the community police in doing patrols in the forest helped to stop the overexploitation of the forest and hence facilitated the increase of the forest in Kisarawe and Kazimzumbwi wards. Additionally, providing education to communities about the importance of forests for future generations contributed to the development and protection of forests in the study areas*. (Tanzania Forest Services Official March 2024)

According to 31.6% of the respondents, strict enforcement of laws and rules aimed at forest protection is another effective technique. Several rules that have been stated in the Forest Act of 2002 are used to safeguard the forest. Among the dominant rules are restrictions on cutting and removing damaged trees as well as the prohibition of harvesting forest products, such as avoiding harvesting honey without a permit. Usually, the violation of these rules calls for several penalties, such as fines and being sentenced to jail. Similarly, the smallest proportion of respondents indicated that local

communities need to diversify their income sources and should not rely solely on forest utilization for their livelihoods. Insisting on the changing of livelihood activities, one respondent from Kisarawe ward asserted that

> *Before protection, the main source of income for our households was farming and selling timber and charcoal provided from this forest, but after it was protected, we were not allowed to even enter the forest. Thus, we have switched to farming near our homestead and keeping livestock like chickens, as well as selling the charcoal from the nearby villages and burning it from the tree stumps provided by our farms* (Ward Executive Officer, Kisarawe, March 2024).

The findings obtained in this study relate to the studies conducted by Faisal (2019) and Mukul et al. (2014), the formulation of clearly defined laws together with the use of regular patrols are very important in enhancing forest protection in society.

Table 4

Techniques for Used in Forest Protection

Factor	Frequency	Percentages
Establish of rules and laws that influences the protection	98	3I.6
Regular use of the Patrols from different authority	120	38.7
Increase in the public awareness among community members	68	21.9
Encouraging the local community to engage in other livelihood generating activities	24	7.8
Total	**310**	**100**

To verify the respondent's opinion which claimed the increase in tree species, a 30-year land use cover change analysis was conducted to determine the change in the major forest land cover. In the analysis, four forest land covers were examined from 1994 to 2024. The Landsat light images clearly showed the dominance of four main land use/cover types in Kazimzumbwi Forest that comprised closed forest, open woodland, shrubs, and bare land, as well as built-up areas. A detailed analysis revealed that there was a continuous decrease in the size of land occupied by the forest cover from 54.7% to 31.7% in 2004 and to 17.8% in 2024, with the annual decrease rate from -5.31 in 1994-2004 to -2.84 in 2004-2024 (Table 5 and Figure1). In a similar vein, the data revealed a substantial increase in the area occupied by grassland from 4.7% to 33.5% between 1994 and 2004, accompanied by a sharp decrease to 18.6% by 2024. Meanwhile, the area occupied by shrubs in the forest area increased from 7.5% to 19.5% and 23.3% over the period of 30 years, with an annual increase of 7.84% and 1.93% for the periods between 1994-2004 and 2004-2024, respectively.

Table 5

Land Use/ Cover Change Transitional Matrix for Kazimzumbwi Forest Reserve from 1994-2024

	1994		**2004**		**2024**		**change detected (ha)**		**Rate of change per annum (%)**	
LULC type	ha	%	ha	%	ha	%	1994-2004	2004-2024	1994-2004	2004-2024
Closed forest	2722.28	54.7	1577.58	31.7	886.64	17.8	-1144.70	-690.94	-5.31	-2.84
Open woodland	1399.65	28.1	601.068	12.1	1390.09	27.9	-798.58	789.02	-8.11	4.28
Shrubs	372.28	7.5	791.796	15.9	1160.98	23.3	419.51	369.18	7.84	1.93
Grassland	235.89	4.7	1666.42	33.5	925.22	18.6	1430.53	-741.21	21.59	-2.9
Bare land	245.07	4.9	338.298	6.8	540.01	10.9	93.23	201.71	3.28	2.37
Built-up	0.00	0.0	0		72.23	1.5	0	72.23		
Total	4975.17		4975.17		4975.17					

It was noted that the information obtained from the respondents concurred with the land use/land cover categories matrix obtained from the satellite image. The findings clearly demonstrated the substantial increase of the shrublands from 7.5% in 1994 to 23.3% in 2024. The increase of the shrublands was at the expense of the decrease in other land use categories, mainly grassland and closed forest. (Table 5 & figure 1). Thus, the increase of trees explained by the respondents was the observable woody vegetation that was noticeable in the forest and around their farmland that could provide the essential ecosystem services demanded by the communities. Furthermore, the increase in trees was associated with the dramatic increase from 789.02 hectares in 2004 to 2024 in open woodland that had demonstrated a substantial recovery after the dramatic loss of 1994 that was indicated by -798.58 hectares. These changes of increase in woodland were an indicator of forest recovery. Furthermore, as suggested by the land use image, there is also a change that was observed in the closed forest that has changed from -5.31hactares in 1994-2004 to -2.84 hectares, which shows an indicator of forest regeneration in the study area that corresponds with the respondent's opinion.

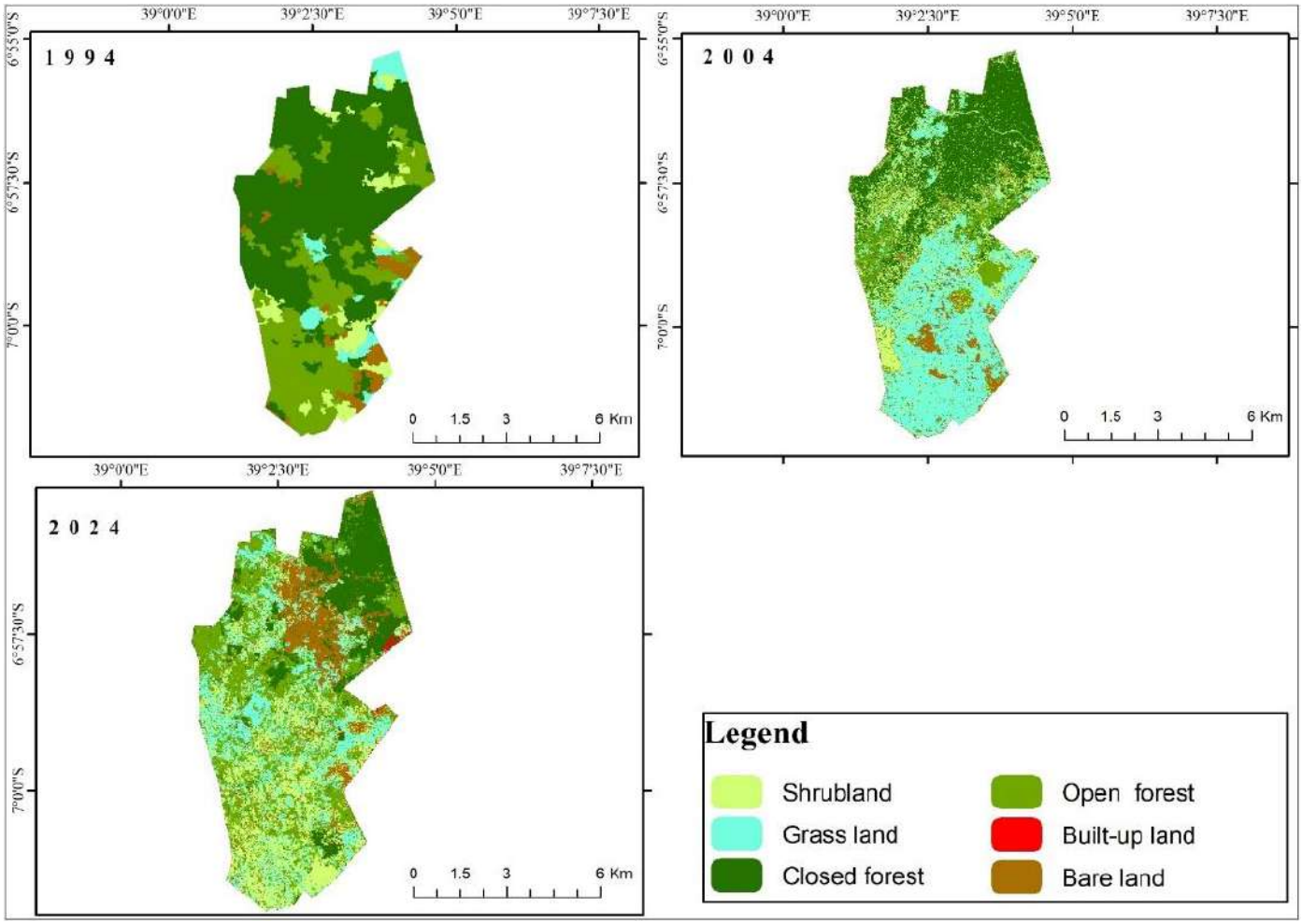

Figure 1

Land Use/ Cover Change of Kazimzumbwi Forest Reserve from 1994-2204

4.3 Socio-Economic and Environmental Implications of the Protection to the Surrounding Local Communities

Forest protection is of paramount importance, as it reduces the degradation of both plants and animals. Furthermore, it regulates the persistence of illegal exploitation. However, the protection processes usually create multiple implications for the community in socio-economic and environmental terms for the local communities whose daily survival historically depended on it. In the study area, several implications were identified by the respondents regarding Kazimzumbwi forest protection. Findings revealed that about 45.1% of respondents claimed that the protection of the Kazimzumbwi has caused economic hardship for the surrounding communities due to the loss of income from the forest-based activities. The protection of the forest limited access for communities to obtain timber and non-timber products, which were initially their main sources of livelihood (Table 6). The findings concurred with Latham et al. (2017), who conducted a study in Tanzania and discovered that the protection of forests in rural Africa, including Tanzania, affects the ability of communities to access forest products on which they depended, creating pressure for these households to search for alternative sources of livelihood and resulting in economic hardship for forest-dependent families. Moreover, it was affects the ability of the communities to access forest products that they depended on; such a situation caused the pressure on the communities' households to search for alternative sources of livelihood that created an economic hardship for the forest dependents' families (Latham et al., 2017),

On the other hand, 18.7% of the respondents asserted that the protection of the forests increases government sources through the contribution of tourism activities since a variety of animal species reside in that forest. Only a small proportion of the respondents, 3.9stated that they were not aware of any economic implication of forest protection; this group comprised the household heads who arrived recently at the study area, and they lack enough knowledge of the implications of the protected forest. The findings are in alignment with Mlawa et al. (2023) and Nobi et al. (2021) who demonstrated that protected forests typically attract both domestic and international visitors who pay fees, licenses, and other related charges. This was clearly observed in the Sundarban mangrove forest, where tourism activities generated nearly fifty-three USD (Nobi et al., 2021). This indicates that by protecting a forest, the government can generate significant revenue through ecotourism.

Table 6
Economic Impact of Protection to the Local communities

Economic Impact	Frequency	Percentages
Economic hardship	140	45.1
Employment opportunity	22	7.1
Food insecurity	45	14.5
Generation of government revenue	58	18.7
High price of energy sources i.e. charcoal and firewood	15	4.8
Loss of farmland	18	5.8
Not aware	12	3.9
Total	**310**	**100**

Moreover, the household's heads observed the importance of forest protection to the environment. Based on the findings it was revealed that the majority (39.7%) of the respondents responded that forest protection regulates the climatic conditions, as it moderates the temperatures, increases humidity, and influences rainfall patterns. The findings aligned with the studies conducted by Soares-Filho et al. (2010) as they found out that the Brazilian Amazon protected areas demonstrated significant carbon stocks emitted to the atmosphere and thus contributed to the regional climate regulation and mitigating greenhouse gas concentration that influenced the local temperature and rainfall pattern. Similarly, Osewe et al (2023) adds that the protected forests in Tanzania provide vital ecosystem services including water regulation and shade that help regulate microclimatic conditions experienced by nearby communities.

Another 24.5% asserted that the protection of the forest controls soil degradation by retaining tree and vegetation cover that controls surface runoff that occurs during heavy rain. Furthermore, a smaller proportion asserts that they do not know the environmental implication of the forest protection (Table 7)

Table 7
Environmental Implication of forest Protection

Implication to Environment	Frequency	Percentages
Control soil degradation	76	24.5
Good climatic condition i.e. fresh air and temperature reduction and enough rainfall	123	39.7
Improved biodiversity conservation	42	13.5
Don't know	69	22.3
Total	**310**	**100**

In a similar way, the local communities perceived the social implications of the protection for the local community. When investigating the social implication, the findings exhibit that the majority of respondents asserted fear and insecurity (28.0%) as a major implication that occurred in the community due to the protection. Usually fear occurred in the area due to the protection measures that have been established without sufficient involvement of the key stakeholders in the decision-making (Table 8). Also, the imposition of law enforcement coupled with strict rules creates anxiety in the local communities who early depended on forests as their main source of livelihood. Similarly, since the protection increases the growth of biodiversity, some animals invade the local community's residence as well. In supporting this, one respondent asserted that;

Currently, there are many animals such as leopards, lions, and big snakes, and sometimes they do come near to our doors; hence, we keep closing our door due to the fear of these animals." (Elderly, Kisarawe ward, March 2024)

Table 8
Socio Impact of Forest Protection

Socio Implication	Frequency	Percentages
Increase in crimes	68	22.0
Fear and insecurity	87	28.0
Lack of Compensation	55	17.7
Cause improvement of socio services	59	19.0
I don't know	41	13.2
Total	**310**	**100**

Furthermore, 22.0% of the respondents claimed the increase in crimes was due to the forest protection. The increase in crimes in the forest reserve was influenced by the fact that since the community members are denied accessibility to the forest, which their livelihoods depended on before, it pushes some individuals into engaging in other illegal activities such as illegal logging, charcoal burning, and wildlife poaching. On the other hand, the increase in dense vegetation due to the protection, coupled with limited patrol coverage, usually increases the number of robbery

events as well as the increase in illegal trade in nearby villages. However, 13.2% of respondents said they do not know the social impact of forest protection. This group lacks the necessary information on the impact of forest protection since they are immigrants to the area.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study revealed that the local community was aware of forest protection, as evidenced by local indicators observed in the study area and clearly verified through remote sensing data. The study noted that the implications of forest protection for surrounding communities are multi-dimensional, producing both environmental benefits and socioeconomic challenges. While forest protection contributes to climate regulation, soil erosion control, and generating government revenue, it consecutively creates economic hardship, fear, and insecurity and limited livelihood options for the local people. Thus, the findings underscore the need to enhance adequate participation in decision-making to ensure long-term conservation sustainability.

5.2 Recommendations

The study recommends strengthening the governance system by engaging the local communities in the decision-making process that relates to forest management, policy formulation, and benefit sharing. Also, there is a need to establish sustainable livelihood support systems coupled with fair compensation to reduce economic hardship experienced by communities affected by forest initiatives. Furthermore, there is a need to integrate community-based security-based approaches that can help to reduce fear, crime, and conflicts between enforcement authority and local residents**.** Likewise, there is a need to balance the forest conservation goal with community livelihood needs in order to promote sustainable and regulated forest use as well as implement continuous environmental education and capacity building among the key stakeholders in order to increase awareness, cooperation, and enhance long-term community commitment to forest protection efforts.

Declaration of Interest

The author declares that she does not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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