The efficacy of management practices in combating mangrove forest degradation: A case study from Pangani District-Tanzania

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Abstract

Mangrove degradation management poses a global challenge, particularly in developing countries. In Tanzania, various local government institutions (LGIs) have been established to address mangrove forest degradation. The study assesses the role of local government Institutions (LGIs) in managing mangrove forest degradation in Pangani-Tanga, and the challenges they encounter in improving their efficacy. Data were collected through structured interviews with 358 households, in-depth interviews, and focus group discussions with key informants. The study identifies the key LGIs involved in mangrove management at the district and village levels, such as the District Environmental Office, District Forestry Office, Fisheries Office, and Beach Management Units (BMUs). These institutions have made strides in enhancing mangrove management through different practices such as education, training, and restoration activities. In general, these practices were moderately practiced. However, it still varied in some study sites, for instance issuing permits for cutting mangroves in Kumba was low by 30.3% compared to Bweni and Mkwajuni. Furthermore, the mangrove condition varies in Pangani, with the condition worsening in Kumba village at 32.4% compared to Mkwajuni at 47.3% possibly due to urbanization and over-dependence. But across the three villages, the mangrove condition is moderate by 53.5 %. The study also notes significant challenges LGI faces, including limited funding, high demand for mangrove products like charcoal, and conflicting interests among stakeholders. The study concludes that LGIs have contributed moderately to improvement in mangrove conditions, but ongoing challenges limit their effectiveness. The study recommends community-led initiatives, alternative livelihood options, and strict law enforcement to strengthen long-term mangrove conservation and reduce overdependence on mangrove resources.

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Introduction

Mangrove forests are dense ecosystems characterized by a distinctive assembly of salt-tolerant trees and shrubs, thriving in the crucial interface between land and sea within salty marshes and bogs (Tomlinson, 2016). Notable for their biological importance, these habitats play a critical role in supplying numerous services, such as economic value, carbon sequestration, coastal

protection, and the provision of habitat for various marine species (Valiela *et al.,* 2018). Mangrove forests span 167,000 to 181,000 square kilometers over 105 nations, making up around 75% of tropical and subtropical shorelines worldwide (Ellison, 2019). Nations like Tanzania, Indonesia, and the Philippines acknowledge mangrove forests as distinct ecosystems with significant ecological and socioeconomic value. Mangrove forests can store approximately 1000 tons of carbon per hectare, and they are also more capable of capturing carbon than other terrestrial forests due to their salt tolerance (Suman, 2019. These ecosystems act as pollutant absorbers as well as barriers to prevent coastal erosion. In addition, they serve as vital habitats for a variety of marine animals, such as fish, crabs, prawns, and shellfish (Menendez *et al.,* 2020; Nyangoko *et al.,* 2021).

Despite their vital significance, mangrove forests face several difficulties that are mostly brought on by human activity, such as farming, fishing, logging, deforestation, urbanization, and the production of charcoal (Hamilton et, 2016, Huber *et al.,* 2023). About 20% of mangrove forests are degraded, which is a serious worldwide issue (Zu Ermgassen *et al.,* 2020). With over 1.9 million hectares lost primarily as a result of changes in land use, Asia has experienced the greatest net loss. With large losses during the previous 25 years, North and Central America have also made a big contribution to the decline in mangrove areas (Wagner *et al.,* 2016). In Indonesia, despite having more mangrove forests than other Asian countries, 40% of mangroves have been degraded as a result of shrimp farms (Spalding *et al.,* 2019).

Degradation of mangrove forests is widespread in developing nations, especially posing a global challenge including Africa. Access to natural resources, particularly mangrove forests, is crucial to the livelihoods of coastal inhabitants (Okello *et al.,* 2024; Enoh *et al.,* 2024). Because there are few other economic options for coastal populations in Sub-Saharan Africa, mangroves are essential for producing wood and non-wood items (Nyangoko *et al.,* 2021). According to estimates, this region has the greatest rate of world global mangrove deforestation between 1990 and 2015 by 0.9% (Thomas *et al.,* 2017). This high rate of deforestation emphasizes how urgently we need management and conservation plans that work.

Using Tanzania as an example, mangrove forest degradation has persisted throughout the past few decades in a number of the country's regions, with an annual deterioration rate of roughly 0.7%. Roughly 19,000 hectares of mangroves disappeared between 1990 and 2020 (Njana, 2020; Erftemeijer *et al.,* 2022). These different regions in Tanzania in Rufiji, Bagamoyo, and Pangani have seen mangrove deterioration. Because of their accessibility, areas closest to large urban centers such as Dar es Salaam, Tanga, Mtwara, and Zanzibar suffer the most deterioration (Erftemeijer *et al.,* 2022). Mangrove forests are frequently threatened by unregulated harvesting for personal and commercial gain, illegal clearing, and conversion to other uses like rice fields and salt pans (Mwansasu, 2016). Additionally, natural occurrences such as global climate change exacerbate the situation by affecting sea levels, flooding, storms, and temperatures (Gayo, 2022).

However, several initiatives by local communities and non-governmental organizations have been undertaken to restore the mangrove forests in Pangani. Despite these efforts, the mangrove forests degrade (Erftemeijer *et al.,* 2022). Therefore, research was important to assess the roles of government institutions in managing mangrove forests, as forest management is one of their core functions (Alfandi *et al.,* 2019). The study provides insights into the effectiveness of local government institutions in managing and restoring mangrove forests in the Pangani district, highlighting areas for policy improvement and enhanced community involvement. The outcomes of this research can have far-reaching implications for coastal zone management, environmental conservation, and the communities' livelihoods dependent on mangrove ecosystems in the Pangani region and beyond.

Materials and Methods

Study area
The study was conducted in the Pangani district of Tanga, geographically located at 05°24'00"E

and 38°58'47" S. Pangani is one of six administrative districts in the Tanga region, covering 1,830.8 square kilometers, with 753 hectares of mangroves along the Pangani River and 1,756 hectares' district-wide. The district was selected for its unique marine ecosystem, which includes all eight mangrove species, dominated by *Avicennia marina, Ceriops tagal, and Rhizophora mucronata* (Nyangoko *et al.*, 2022). The coastal community relies on mangrove forests for their social and economic benefits including building materials, charcoal, and firewood. Despite their importance, mangrove forests are heavily exploited, prompting the government to establish local institutions like the Beach Management Units (BMUs) as a tool for natural resource management like mangrove forests.

Table 1

*Proportionate sample size of the study sites*

Wards	Villages	No. of Household	Proportionate sample
Pangani Magharibi	Kumba	900	900/1357*358= 237
Ubangaa	Mkwajuni	359	359/1357*358=95
Bweni	Bweni	98	98/1357*358 = 26
	Total	1,357	
			358

Study design
The current study adopted the cross-sectional design for gathering both quantitative and qualitative data at the same time under a mixed research approach. This design also allows wider use and application of descriptive and inferential statistical analysis (Yates and Legget, 2016). Various perspectives, and experiences of people enhance the understanding of this study subject was addressed using the qualitative portion of the chosen approach (Creswell *et al.,* 2018, Abutabenj *et al.,* 2018).

Figure 1

A study map showing the study sites in Pangani district
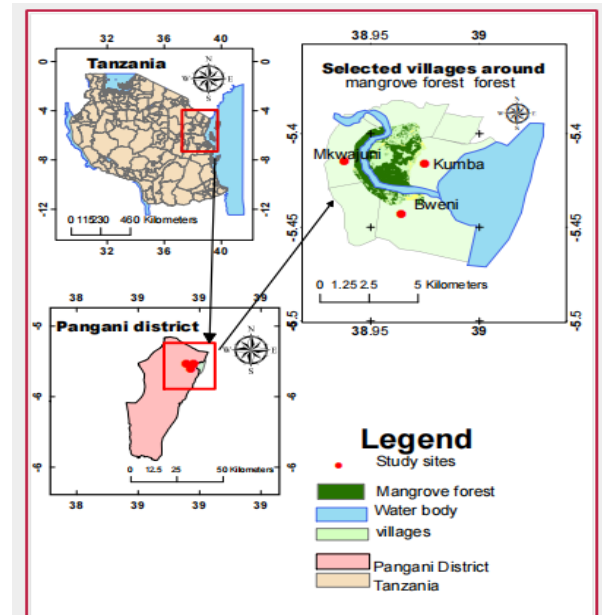
Sample size determination
This sample was got from Yamane formula so as to ensure equal representation of the population in giving information to obtain relevant and reliable information from them. The sample size from households was estimated and determined by using Yamen formula (Equation 1). In total, the selected study wards had a total number of 3434 households; (2140) Pangani Magharibi, (414) Bweni and (880) Ubangaa respectively.

$$n = \frac{N}{1+N\,(e)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (Equation\ 1)$$

Where, **N** stands for the total number of households (3434) the study area, **n** represent the sample size of the study and **e is -** level of precision (0.05) in this study. Therefore, based on the Yamen formula, the sample size of this study:

$$N = \frac{3434}{(1+3434(0.05)^2)} = 358$$

Therefore, the sample size of the study was 358 respondents.

The proportionate sample size from each selected village will be determined by using an equation adopted from Kothari (2014);

$$n_h = \left(\frac{Nh}{N}\right)n \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(Equation 2)}$$

The proportionate sample of each village in selected wards, Nh=Number of households of each selected village, N = Total households of all selected villages, n = total sample size.

Table 2

Summary of key informants involved in the field study

Name of key informants	key informants involved
Beach Management Units (BMUs)	3
Village executive officers	3
Ward executive officers	3
Pangani District Land Use Officer	1
Pangani District Fisheries Officer	1
Pangani District Forest/Mangrove Officer	1
Pangani District Environmental Officer	1
	1
Total =	13

Data collection and analysis

Data was collected using a combination of techniques, including key informant interviews, household surveys, focus group discussions, field observations, and documentary reviews (see Table 2) (Ntibona *et al.,* 2022). This approach ensured the validation of the information gathered. Participants were informed of the study's purpose, and their consent was obtained. An in-depth interview guide was used with key informants to gather detailed insights into their experiences with environmental interventions, particularly in mangrove forest conservation.

Table 3

Socio-demographic characteristics of respondents

Variable	Response	Sampling sites/villages			Overall (%)
		Pangani magharibi (%)	Mkwajuni (%)	Bweni (%)	
Age of the respondents	18-35	44.3	42.11	34.62	40.34
	36-45	27	28.42	50	35.14
	46-55	15.19	7.37	7.69	10.08
	56-65	9.28	15.79	7.69	10.92
	>66	4.22	6.32	0	3.51
Gender	Female	39.66	28.42	44.62	37.6
	Male	91.58	45.38	50.34	62.4

Level of education	Informal education	1.69	6.32	0	2.67
	Primary education	42.62	35.79	57.69	45.37
	Secondary education	43.04	30.53	42.31	38.63
	Tertially	12.66	27.37	0	13.34
Family size	>=5	80.17	54.74	61.54	65.48
	<=5	19.83	45.26	38.46	34.52
Residence duration	<=10	15.19	26.32	11.54	17.68
	>10	84.81	73.68	88.46	82.32
Economic activity	Fishing	27.85	36.84	50.7	38.46
	Fish-farming	2.95	16.32	17.69	12.32
	Farming	6.3	36.71	10.5	17.85
	Small business	42.49	21.54	20	28.01
Main sources of energy	Firewood	29.11	34.5	50	37.8
	Charcoal	49.37	55.53	34.62	46.5
	Gas	14.77	5.26	11.54	10.52
	Electric current	6.75	3.16	3.85	4.59

A household questionnaire survey was conducted among community members to assess their perceptions of the influence of local government institutions (LGIs) on the management activities of mangrove forests. Households from the wards of Pangani-Magharibi, Ubangaa, and Bweni were interviewed to gather views on the performance of natural resource management institutions and programs.

Additionally, three focus group discussions (FGDs) were held in three villages, each with eight participants representing different social groups, including women, men, and village elders as suggested by Henneck (2013). This method facilitated participatory discussions and provided diverse perspectives on the mechanisms used by LGIs to improve mangrove conditions, as well as insights into the challenges hindering effective management. Special care was taken to ensure female participants could share their perspectives, generating rich qualitative data on community percept

attitudes toward mangrove management practices.

An observation guide assessed various management activities in the mangrove forests. The observations focused on verifying management activities, evaluating the condition of the mangroves, and examining the social and economic activities within the mangrove area and their impacts on the community and marine ecosystem. This process involved visiting the mangrove forest and observing the role of LGIs in managing the mangroves. A documentary review was conducted to collect secondary data from existing literature related to the research objectives. This included published documents and reports.

Data analysis
The analysis of the collected data was achieved through descriptive statistics which it involved entering data into the Statistical Package for Social Sciences (SPSS) software. In this study,

descriptive statistical operations included frequencies and percentages. Qualitative data was analyzed through content analysis according to the approach proposed by Graneheim and Lundman (2004). Data was compiled, transcribed, and organized into themes and phrases. The discussed themes were analyzed, and the findings were presented as paraphrased quotes.

Target population, sampling procedure
The target population of the study comprised local government officials and community members from the Pangani coast, including a variety of respondent categories such as timber makers, firewood collectors, small-scale farmers, fishermen, and officers from the Departments of Environment, Forestry, Fishery, and Land, as well as Ward and Village leaders involved in mangrove conservation.

The village executive officials, community members, forest officers, and representatives of organizations from Bweni, Mkwajuni, and Kumba villages made up the sampling frame for the study. Households drawn from the sample frame served as the sampling unit, while heads of households chosen from the three Pangani Magharibi, Bweni, and Ubangaa wards served as the unit of analysis. Every member of the

population had an equal opportunity and likelihood of being chosen for the sample since the homes in the research area were chosen using simple random selection as suggested by Creswell (2016).

A purposive sampling technique was used to select three wards (Pangani Magharibi, Bweni, and Ubangaa) and three villages (Kumba, Bweni, and Mkwajuni) from the study area. The key informants consisted of three Ward Executive Officers (WEOs), three Village Executive Officers (VEOs), three Beach Management Units (BMUs), the Mangrove Forest officer, the District Environmental officer, and the District Land Use officers were purposively selected due to their experience and adequate knowledge of the management of mangrove forests, totaling 13 key informants. The study targeted Pangani coast stakeholders, including government officials and community members. These include environmental and forestry departments, to gather crucial information on mangrove management. Simple random sampling was used to select 358 households, ensuring equal chances for all participants and reducing bias as recommended by Cresswell, (2018). Three wards (Pangani Magharibi, Bweni, and Ubangaa) and three villages (Kumba, Bweni, and Mkwajuni) were purposively selected.

Results

Socio-demographic factors related to mangrove forest degradation
The socio-demographic characteristics are summarized in (Table 3), indicating more male respondents (61.45%) than females of 358 respondents that were interviewed. Most participants were aged between 18-45 years, an active group in conservation efforts, yet also key in resource use. Larger household sizes (72.07% with more than five members) increase degradation. In the study area most practiced economic practices like fishing, and farming, followed by small businesses. Additionally, 82% of respondents had lived in Pangani for more than 10 years. These socio-demographic factors highlight the pressures on mangrove forests and the challenges faced in managing their sustainable use. Nearly 65 % of respondents

reported a household size of more than 5 people, while 34.5% reported less than 5 people in the household size in Pangani. In terms of literacy, 45 % of respondents had primary education and 38.6 % had secondary education. Generally, about 45 % of the respondents had lived in the Pangani estuary for more than 10 years. Small-scale fishing 38% and farming 17.8% are the main economic activities practiced in the study area including small-scale business 28% was the major livelihood occupation of most respondents in crops farming in

Pangani. The main source of energy for cooking is charcoal during an interview its source was mainly mangrove forest especially in Kumba with 55%, followed by firewood mainly used in Mkwajuni village. In overall the leading source of

energy used is Charcoal with 46% used in all three villages.

Table 4

Summary of LGI's involved in mangrove forest management and roles

LGI's involved	The role played in the management of mangrove forests
District Environmental Department.	Establish the Beach Management Units
	Provide environmental awareness on mangrove protection through education programs.
	Enforce environmental laws related to mangroves
District forestry department.	Provide education to the BMUs concerning the importance and value of mangrove forest
	Enforcement of laws and by-laws related to mangrove forest
District Fisheries Department.	Protect mangrove areas by enforcing fisheries laws and policies since the mangrove trees are one of the fish spawning areas
Head of Land department.	Influence the village councils to prepare land use plans and by-laws to protect mangrove areas.
	Identify all mangrove areas in maps for use in protecting mangrove forest areas.
Ward and village councils.	Provide awareness to the community through village meetings on the value of mangrove forests. Workshop training of BMUs.
	Work hand in hand with the BMUs to control the illegal cutting of mangrove forests.
	Have a mandate to sell the mangrove products caught from the mangrove cutters.
Community-based management units (BMUs)	Conduct regular patrols to control illegal cutting activities happening near mangrove forests
	Capture those who cut down mangrove trees without permits. Charge fines range from 5,000 to 50,000 depending on the number of mangrove trees that are cut. Conduct restoration programs of replanting mangrove seeds

Local Government Institutions (LGIs) Involvement in the management of mangrove forests

Local government institutions (LGIs) are important stakeholders in managing the environment, particularly mangrove forests. During Key Informant interviews, it was found

local government institutions (Table 4) were involved in the management of mangrove forests in different ways. It was also noted that various stakeholders were involved in managing the mangrove forests. This included the District Environmental officer from the environmental department, the Mangrove Forest officer from the forestry department, the District Fisheries officer from the department of Fisheries, the Head of the land department, Ward Officers (Pangani Magharibi, Bweni, and Ubangaa) and Village Executive (Kumba, Bweni, and Mkwajuni) as well as officials from Beach Management units. However, the LGIs play various roles that are important in influencing the management of mangrove forest conditions and distribution of various roles and enforce laws, monitoring and evaluation, issuing permits and licenses related to cutting mangrove forests, and regular patrols. Village government committees also work to safeguard illegal activity in the mangrove forest area. Not excluding the Local government NGO's who work with the LGIs to support its management activities through providing funds. The BMU exists in all three study areas and primarily focuses on the management of fisheries resources and their associated habitats, including mangrove forests. Their roles include patrolling, enforcing, and raising awareness about fisheries management and associated aquatic environments.

Table 5

Community perceptions on best management activities to improve mangrove forest condition

Responses	Sampling sites/villages			Overall (%)
	Kumba (%)	Mkwajuni (%)	Bweni (%)	
1. Education on restoration programs				
Not practiced	0	0	0	0.0
Less practiced	28.02	53.68	51.54	41.1
Moderate practiced	49.37	44.21	38.46	44.0
Highly practiced	42.62	2.11	0	14.9
2. Monitoring and evaluation				
Not practiced	0	2.11	0	0.7
Less practiced	26.44	60.4	38.4	38.4
Moderate practiced	32.74	33.6	61.5	42.7
Highly practiced	0	15.7	38.82	18.2
3. Enforcement of laws and policies				
Not practiced	0	0	0	0.0
Less practiced	40.93	37.89	3.85	27.6
Neutral	42.62	26.32	46.15	38.4
Highly practiced	16.46	50	31.5	32.7
4. Permits and license				
Not practiced	0	0	0	0.0
Less practiced	40.3	28.95	14.3	27.8
Neutral	31.65	45.79	47.69	41.7
Highly practiced	14.05	35.25	42.31	30.5

5. Collaboration with other stakeholders				
Not practiced	29.96	14.74	15.38	20.0
Less practiced	57.81	69.47	56.92	61.4
Moderate practiced	12.24	30.53	7.69	16.8
Highly practiced	0	5.26	0	1.8

Perceptions of LGI management practices on mangrove forest conditions.
According to the study, the conditions of mangrove forests were related to various functions carried out by local government Institutions. It was noted that, Pangani's mangrove forest management is being moderately improved and the degree of management practices varied across the villages. For instance, in case of permits were issued in Kumba by 30.3% highly issued in Bweni by 45.7%, and Mkwajuni by 47.6%. The finding further revealed that education and restoration programs were the most commonly used management practices for mangrove forests. These programs were moderately conducted, accounting for around 44% of the management practices as seen in (table 5). This implies that, in contrast to initiatives for education and restoration, other forms of management techniques were more common in Kumba village. After the training, local government organizations, especially the Beach Management Units (BMUs), hosted village meetings as the main venue for the teaching initiatives. The coastal community members were involved in training and supported by the BMUs in learning the value of mangroves and the significance of restoration or protection initiatives. By raising community knowledge, these educational programs helped to improve the state of Pangani's mangroves. However, due to the lack of other means of support, the community continued to cut down mangrove trees despite being informed about the value of mangroves and receiving training on their restoration.
One respondent added;

"The BMUs provide education programs that focus on sustainable mangrove management practices, such as controlled harvesting and replanting of seeds. Despite efforts to engage local communities in conservation initiatives, challenges persist due to the overdependence of communities on mangrove resource products, such as firewood "Businessman men in Ubangaa, 17th, August, 2023,11.09 am".

By providing training in restoration, the BMUs have moderately improved mangrove conditions by 60%. The improvement was even higher in Mkwajuni, reaching 77%, followed by Bweni at 49%. Through these educational programs, the BMUs have enabled the communities to take ownership of their natural resources and become agents of change in safeguarding the mangrove forests.

Based on the results, the restoration initiatives helped to raise the mangrove forests' state of health especially in Bweni and Mkwajuni village. Learning about the importance of mangrove ecosystems was made easier for the local populations by the educational initiatives. The restoration initiatives include collection of fallen mangrove seeds and replanting in nursery beds ((Figure 2)

During discussion, one of the key informants had the following to say:

"We have established four nursery beds of 15,000 mangrove seedlings to be planted in degraded areas in Pangani-Magharibi. District Forest officer, Pangani-Magharibi, 01st, September, 2023, 3.33 pm".

Monitoring and evaluation; Monitoring and evaluation in Kumba is less done with 28.4%, and there is no regular monitoring done in the mangrove area. Overall it is moderate with 42.7%. One of the BMU leaders suggested monitoring to be done often to identify the mangrove condition. Monitoring and evaluation are among of the activities conducted by community in collaboration with BMUs, during

key informant interview, one of the BMU had the following to say:

"Monitoring and evaluation activities enable the identification of specific threats to the mangrove forests, such as illegal timber logging, expansion of fish farms, or pollution from nearby industries, urbanization, or construction activities, particularly in the Pangani Magharibi area. Monitoring these threats is crucial for designing effective mitigation strategies: District Forest Officer, Pangani Magharibi, 13th September 2023, 10.05 am".

Enforcement of laws, by-laws, and policies; There are moderate laws and by-laws enforcement across all the villages in some villages the LGIs try to enforce the by-laws such as charging fines. It is mostly enforced in Bweni and Mkwajuni with about 46.1% and 42.6% in Kumba. It was noted that there are several laws and by-laws used by the local government in Pangani. Their provision of a legal framework for protecting mangrove forests and regulating illicit human activities that impact these ecosystems helps manage and maintain the health of mangrove forests The illicit operation operations include land conversion for fish farms, logging for lumber, illegal mangrove product harvesting, and urbanization close to mangrove forests. For example, the amount of unlawful mangrove cutters that violate by-laws can result in fines of between 5,000 and 50,000 Tanzanian Shillings. There is a law that promotes the preservation and sustainable management of natural resources, particularly the preservation of mangroves, is the Environmental Management Act of 2004.

"Enforcement of laws and regulations facilitates the sustainable management of mangrove resources by setting limits on harvesting, fishing, and extraction activities thereby helping to avoid over-exploitation. - District Fishery officer, Bweni village, 9th September 2023. 10:07 am".

Permits and license; Permits and licenses are less issued in Kumba village and more in Mkwajuni by 35.3% and 42.3% in Bweni. Most mangrove cutters in Pangani tend to disregard the need for permits before cutting mangroves, as these permits restrict their ability to cut daily or regularly, contrary to the desires and practices of

By continuously monitoring key parameters like water quality and sedimentation rates, managers can anticipate changes and take proactive measures to protect mangroves. Involves various stakeholders in monitoring activities to foster a sense of ownership and empower them to participate in mangrove conservation effort the local people. Since mangrove resources are their source of survival they expect to cut it most of the time to get the resource for different uses like charcoal, firewood, and timber.

Collaboration with other stakeholders; According to the findings, collaboration with other stakeholders is limited, although it varies across different villages. For instance, in Bweni village, the collaboration with other stakeholders is highly done by a few stakeholders due to different conflicts of interest within the mangrove forest conservation area.

Perceptions of community on the status of mangrove forest condition
The respondents were asked to assess the condition of the mangrove forests, with options limited to highly protected, moderate, least protected, and not protected. In general, the mangrove condition was reported to be moderate. The findings further revealed that the status of mangrove protection differs among the three villages. For instance, Kumba recorded the lowest level of mangrove forest protection at 32.4% as seen in (Table 5) compared to the higher levels observed in Mkwajuni and Bweni. The possible reason for this disparity could be that Kumba is more urbanized and populated compared to the two rural villages being a peri-urban ward in Pangani-Magharibi. Additionally, the community in Pangani is heavily dependent on mangrove resources for charcoal production, and most people do not possess the necessary permits and licenses for cutting mangroves, except on Saturdays. In contrast, village leaders in the two rural areas of Mkwajuni and Bweni strictly prohibit any illegal cutting of mangroves.

Table 6

Community perceptions on mangrove forest condition in the study area

Response	Respondents in terms of villages (%)			Overall
	Kumba	Mkwajuni	Bweni	
Not Protected	0	0	0	0
Least protected	32.49	6.32	11.54	16.7
Moderate protected	60.34	46.32	53.85	53.5
Highly protected	7.17	47.37	34.62	29.7

Challenges that hinder (LGIs) in managing mangrove forest degradation in Pangani

There are several challenges that hinder local government institutions from effectively managing the mangrove forest: *Financial factosr*: Inadequate funding challenges were brought up during the focused group discussions. The funding for mangrove forest management comes from various sources, including both international and local NGOs, as well as forest organizations. Community-based organizations, such as the Beach Management Units (BMUs), receive their payments from the top local government leaders. However, the payments to support the BMU members are often delayed or not paid at all, leading to ineffective management activities. This lack of reliable funding impacts the capacity of the Local Government Institutions (LGIs) to run management activities effectively, as evidenced by the responses provided by the respondents as follows:

". Financial support is a serious problem, as the Beach Management Unit members are not paid regularly. At times, we are forced to use the money collected as fines from illegal mangrove cutters to buy necessary materials for management activities, such as boots, and also to sustain our expenses. BMU leader, Ubangaa, 13th, August, 2023, 14.25 pm"

Another respondent added:

"There are inadequate funds from different stakeholders to support the mangrove management projects. At times, the money collected as fines is not channeled to the village committee but is instead used by the individuals for personal issues, rather than being directed towards restoration programs. This lack of proper utilization of funds contributes to the persistent degradation of mangrove forests". BMU leader from Kumba village, 17th, August 2023, 11.45 am"

Inadequate technical and material support; According to the findings from the study shows that there is insufficient technical expertise to support the management activities, and there are not enough materials to support the Beach management units during the conduct of patrols.

"There is inadequate equipment, such as boats, vehicles, and gunboats, for conducting daily patrols in the muddy mangrove areas, as noted in an interview with a member of the BMU". ." BMU leader, Pangani Magharibi, 9th August, 2023.11.15 pm"

Social conflict with the villagers; Social conflicts have been identified between the coastal communities and Beach Management Units (BMUs) during the focus group discussions (FGDs). Conflicts arise when local community members are apprehended for illegally harvesting mangrove resources and fined. This situation is problematic, as some residents of coastal areas refuse to report illegal activities and are unwilling to cooperate with the BMUs due to a lack of alternative sources of income. As a result, they heavily depend on the resources found in mangrove forests. As a result, the coastal community's lack of collaboration makes it difficult for the BMUs to properly carry out their

management duties. One of the BMU leaders narrated the following:

"*Before becoming a member and leader of the Beach Management Unit (BMU), I used to engage in the illegal cutting of mangrove trees. This is because I grew up in an environment where such activities were common. Most people involved in illegal cutting of mangroves are poor depending solely on mangroves for survival. It's heartbreaking when I see a single mother struggling to survive by cutting mangroves and becomes hard to simply charge fines to such people when I remember I come from the same background and environment." BMU leader, Pangani- Magharibi, 12th August, 2023.14.35 pm*".

Market demand for mangrove products; Most consumers raise the demand for mangrove products such as charcoal especially in Kumba village which is in Peri-urban area. Consumers prefer charcoal produced from mangrove trees because it produces less smoke, burns longer, and is denser than charcoal made from other types of wood. This is why both consumers and local producers often choose to use it, in which it contributes to the worsening of mangrove forest condition. This challenge was noted by one of the village elders in Pangani-Magharibi during the Focus Group Discussions narrated;

"*The high demand for mangrove products like charcoal and timber, driven by wealthier consumers, poses a significant challenge. Despite increased fines, consumers are willing to pay more, encouraging continued exploitation. Mangrove cutters, often from poor families, rely on this trade for their livelihood, creating a complex situation where economic interests drive degradation. Addressing this issue requires a multi-faceted approach that balances the needs of consumers with those of the communities being dependent on mangrove resources. (FGDs, village elder, Pangani Magharibi, August 25, 11:32 am*"

The quote above conveys the message that there is a need to reformulate the laws and regulations governing the use of mangrove products. Current laws on mangrove product use focus on those cutting the trees, overlooking consumers who drive demand. This imbalance places the burden of enforcement on cutters, while consumers face little accountability despite their role in unsustainable exploitation. To effectively address mangrove degradation, laws must be reformulated to hold both consumers and cutters responsible for conservation. A balanced approach would create a more comprehensive framework for managing and protecting mangrove ecosystems, ensuring that all parties contribute to the preservation of these crucial resources.

In Tanzania, mangrove forest management is primarily governed by the Forest Act of 2002 and the Forest Regulations of 2019 while the Forest Regulations of 2019 set standards for sustainable practices and oversight. These laws require mangrove product producers to obtain licenses and adhere to sustainable harvesting protocols, and they regulate processing, transportation, and sale. Despite these measures, a significant weakness is the lack of enforcement and monitoring, which undermines their effectiveness. Regulations are not adequately enforced on the ground, leading to continued illegal activities and overexploitation of mangrove resources. This is due to the insufficient penalties or monitoring mechanisms to control such practices.

Overdependence on Mangrove forest resources; According to a BMU leader interviewed, the local communities cannot afford to rely on other forms of income generation activities and other sources of energy. A focused group discussion (FGD) revealed that their alternatives are limited by the high cost of other energy sources, which forces them to keep using mangrove resources as low-cost energy sources. This dependency draws attention to the connection between poverty and scarce possibilities for subsistence, which reduces the effectiveness of managing mangrove forests. This indicates that there is a need to establish alternate sources of income and other sources of energy.

Discussion

The socio-demographic characteristics
The study finds that socio-demographic characteristics have a major impact on Pangani's mangrove management. There are clear gender differences, with men engaging in mangrove exploitation more often than women due to cultural beliefs. A man is responsible for ensuring

the provision of the family's basic needs including an illegal cut of mangrove products for survival. Eneji *et al.* (2015) and Berthod, (2018) explained societal conventions in which men, who are typically the breadwinners, turn more to criminal activity to pay for the fundamental necessities of their families. The aged between 18-35 were more engaged in mangrove conservation, especially the BMU members who were youths. Research by Monga *et al.,* (2018) and Nyangoko *et al.,* (2021) emphasizes that individuals in this age range 30-55 have the physical capacity and leadership abilities required for successful mangrove management, which is consistent with participation in management practices. The problem is exacerbated by family size and poverty, as mangrove products serve as a crucial source of income and energy for larger households with limited resources, as supported by the research of Abdul Aziz (2015) and Handavu *et al.,* (2019). The majority of the respondents had primary and secondary education meaning were illiterate. It was discovered that those with higher education levels had a more favorable involvement in the upkeep of mangrove forests. This result is in line with what Ntibona *et al.,* (2022) and Xue *et al.,* (2022) have reported.

There was a higher level of engagement in conservation efforts among long-term inhabitants, defined as those who have resided in the area for more than ten years, as they tend to possess greater knowledge and experience regarding their local ecosystem. Long-term residency in a place promotes improved resource management, according to Nyangoko *et al.,* (2022), which validates this finding. These revelations emphasize the necessity of focused management plans that take into account gender dynamics, financial constraints, and long-term inhabitants' experience to achieve more sustainable mangrove protection. More firewood and charcoal was utilized than gas cookers or electric systems, making charcoal the most common energy source. This means due to poverty most people are unable to afford gas cookers and electric cookers rather than using firewood and charcoal which is cheap.

The roles of Local Government Institutions on the management of mangrove forests
It was observed that important LGIs, including the Fisheries Office, the District Environmental Office, the District Forestry Office, and the Beach Management Units (BMUs), were involved in mangrove forest management. Local Government Institutions (LGIs) in Pangani. However, this study indicates that mangrove deterioration remains a challenge along the Pangani coast, despite the efforts of local government institutions. Consequently, the mangroves in Pangani continue to degrade. Similar findings were also reported by previous scholars (Nyangoko *et al.,* 2021; Nyangoko *et al.,* 2022).

All three villages under the study implement some degree of education and restoration programs. However, the mangrove situation in Kumba village is worse than in the other two. This deterioration may be attributed to factors such as urbanization and agricultural conversion, which negatively impact the health of the mangrove forests. The study revealed a lack of regular monitoring of mangrove forests to determine the effectiveness of various interventions. This is mainly caused by low community involvement and ownership (Friess *et al.,* 2020; Lee *et al.,* 2019a; Spalding *et al.,* 2024). There is weak cooperation and information-sharing, enforcement efforts that threaten mangrove ecosystems. There is a failure to identify degraded areas of mangrove forests and prioritize conservation efforts. This oversight, along with an inability to balance development activities, such as construction, with the regulation of the marine environment, worsens the condition of the mangroves (Giri *et al.,* 2019; Primavera, 2021).

Challenges hindering local government institutions in managing mangroves
Different mechanisms are used by Local Government Institutions (LGIs) to manage the mangrove forest conditions but continue to face numerous challenges that undermine the efficacy of their management strategies. The local communities are forced to rely largely on mangrove resources for their livelihoods because of their over-dependence on them as a result of poverty and a lack of alternative sources of

income (Mangora, 2017; Friess *et al.,* 2019; Nyangoko *et al.,* 2021). In addition, there are instances of bias or favoritism, as well as low participation from coastal communities in management processes, due to their perception that they have nothing to gain from their involvement. A lack of funding to enforce and implement laws, coupled with weak policy and law enforcement as a result of corruption (Gayo, 2020).

Tanzania's legal and policy frameworks for mangrove protection provide a solid foundation but still have their weaknesses such as weak enforcement, coordination, and community engagement. Addressing these issues requires a more focused, resource-backed approach that enhances local capacity and ensures that all stakeholders are aligned in their efforts to protect mangrove ecosystems (Giri *et al.,* 2019; Lee *et al.,* 2020; Primavera, 2021). In Pangani, the focus of existing laws on producers rather than consumers contributes to the continuation of unsustainable practices, a gap highlighted in recent literature advocating for comprehensive regulatory approaches. The study recommends a review and strengthening of the existing policy and regulatory frameworks related to mangrove management to ensure they are up-to-date, comprehensive, and effectively enforced. There is a need to have regular monitoring by using technologies which integrated with local knowledge (Nyangoko *et al.*, 2021; Ntibona *et al.,* 2022).

Conclusion

The study intended to explore the efficiency of local government institutions in the management of mangrove forest degradation by identifying the roles and mechanisms used in managing mangrove forests. It also assessed the challenges that hinder the management of mangrove forest by local government institutions to improve their condition. Local government institutions in Pangani, Tanga, are involved in managing mangrove forests through patrols, fines, and enforcement of regulations. However, they face significant challenges, including limited financial resources, social conflicts, poverty, and high demand for mangrove products like charcoal. Socio-economic factors such as local economic

activities, age, gender, and household size, along with the impact of the success of these management efforts. While initiatives like education and restoration programs have had a moderate positive effect, ongoing threats from urbanization, farming, and fishing practices undermine progress. Effective land use planning is crucial to balance development with conservation. Future research should focus on evaluating the long-term impacts of land use changes on mangrove ecosystems, predicting future mangrove conditions, and exploring innovative management strategies. This will help in enhancing the resilience and health of mangrove forests, ensuring their critical ecological services are preserved and their contribution to coastal ecosystem health is maximized.

Recommendation

To strengthen long-term mangrove conservation in the Pangani coast, the study recommends the following: *Enhance community-led initiatives*: Encourage and empower local communities to take a more active role in mangrove conservation and management. Involve them in decision-making processes and provide them with the necessary resources and support. *Promote alternative livelihood options*: Develop and implement alternative livelihood options for local communities to reduce their dependence on mangrove resources, such as ecotourism, sustainable aquaculture, and the production of non-timber forest products. *Increase funding and resources*: The study recommends government provide adequate funding and resources to the LGIs to enable effective mangrove conservation and management activities such as law enforcement, monitoring, and restoration efforts.

To improve coordination and collaboration: to enhance coordination and collaboration among the various stakeholders, including government agencies, NGOs, and local communities, to ensure a more integrated and effective approach to mangrove conservation. *Strengthen policy and regulatory frameworks*: The study recommends a review and strengthening of the existing policy and regulatory frameworks related to mangrove management to ensure they are up-to-date, comprehensive, and effectively enforced. There is

a need to have regular monitoring by using advanced technologies which integrated with local knowledge.

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