



Research

Socioeconomic determinants of mangrove exploitation and management in the Pangani River Estuary, Tanzania

Baraka P. Nyangoko^{1,2} , Mwanahija S. Shalli² , Mwita M. Mangora² , Martin Gullström³  and Håkan Berg¹ 

ABSTRACT. Mangrove forests in Tanzania are gazetted as state forest reserves, implying that exploitation is controlled by the state. However, their continued degradation and loss is largely associated to the inadequate enforcement of management measures against uncontrolled extractive exploitation to support local livelihoods. Local management institutions are therefore advocated to enhance mangrove conservation. This study explored socioeconomic determinants of exploitation patterns and management of mangroves in the Pangani River Estuary, using two coastal communities (Bweni and Pangani Magharibi) as case study sites. Data were collected through focus group discussions, key informant interviews, household questionnaires, and field observations. Quantitative data were analyzed for both descriptive and statistical inferences, while qualitative information was subjected to content analysis. Residence time of household, household main occupation, household size, and cost of alternatives to mangroves as a source of domestic fuel were all factors positively associated with mangrove resource use. The two communities differed in their perceptions on the role of local institutions in management of mangroves. Over half of respondents (56%) in Bweni agreed that interventions by Beach Management Units (BMUs) enhanced mangrove conditions, whereas only about 16% of the respondents in Pangani Magharibi had similar perceptions. Overall, 55% of the respondents were not impressed with the performance of government institutions in implementing conservation measures for sustainable use of mangroves. Exploration and promotion of feasible alternative livelihood activities and improved stakeholders' collaborative arrangements are recommended for sustainable exploitation and management of mangroves in the study area.

Key Words: *mangrove exploitation; mangrove management; Pangani Estuary; socioeconomic benefits*

INTRODUCTION

Mangrove forests offer a range of important ecosystem services of both socioeconomic benefits and ecological merits (Tanner et al. 2019). Among the many local benefits, mangroves are traditionally exploited by coastal communities as a source of firewood, charcoal, and building materials (Mangora and Shalli 2014, Nchimbi et al. 2020). Ecologically, they protect the coastline from erosion (Wagner and Sallema-Mtui 2016), store a significant amount of carbon (Alavaisha and Mangora 2016, Gullström et al. 2021), and serve as nursery ground for fish and invertebrates, i.e., supporting fisheries productivity (Nagelkerken et al. 2008, Mwandya et al. 2010, Kimirei et al. 2016). The nursery role of mangroves is supported by availability of food for young fish (i.e., directly from mangrove leaves and detritus or indirect as periphyton and phytoplankton in estuaries) and the structural complexity of mangrove sub-habitats (e.g., roots and tree trunks) providing shelter for fish, crustaceans, and mollusks from predation (Gajdzik et al. 2014).

Despite their economic and ecological values, the balance between mangrove resource exploitation and conservation is challenging in many regions where they occur (Friess et al. 2019). Globally, 336,300 ha of the mangrove area were lost between 2000 and 2016, with the Southeast Asian region suffering from about 80% of those losses that were associated with human activities (Goldberg et al. 2020). Africa has lost about 55,000 ha of mangroves over a 20-year period, from 1996 to 2016 (Spalding and Leal 2021), and nearly 3000 ha per year of mangroves have been lost in the Western Indian Ocean (WIO) region (Tanzania, Kenya, Mozambique, Madagascar) during the last 25 years (Bosire et al. 2016, as cited in Maina et al. 2021). The widespread mangrove loss is likely to

continue and spread in many other nations if mangroves are not sustainably managed and monitored (UNEP 2014). Over-exploitation and conversions of mangrove areas to farmland, salt pans, and aquaculture, as well as poor enforcement of management prescriptions are cited as the main human-induced drivers of mangrove degradation, especially in developing countries (Mangora 2011, Suman 2019). With regard to these anthropogenic drivers of mangrove degradation, various conservation measures, e.g., restoration programs and participatory management approaches, are advocated at international, national, and local levels to reverse the loss of mangroves, and to promote sustainable utilization and conservation (Romañach et al. 2018). However, the degree of reliance on mangroves and their associated ecosystem services is context-specific and depends on the socioeconomic characteristics of resource users (Brander et al. 2012), management policies, and initiatives instituted to conserve mangroves (Badola et al. 2012, Romañach et al. 2018). For example, Handavu et al. (2019) revealed that socioeconomic variables such as household income, household size, and gender, which may vary from one community to another, are among the most critical factors driving the use of various forest products. At the same time, lack of transparency and inadequate attention to community voices in conservation of natural resources destabilize management strategies (Bennett and Dearden 2014). Appropriate engagement shapes communities to recognize and appreciate the role played by mangroves in supporting local livelihoods, identify impacts of mangrove overuse and the rationale for rehabilitation of the degraded areas to achieve sustainability (Arumugam et al. 2021).

¹Department of Physical Geography, Stockholm University, Stockholm, Sweden, ²Institute of Marine Sciences, University of Dar es Salaam, Buyu Campus, Zanzibar, Tanzania, ³School of Natural Sciences, Technology and Environmental Studies, Södertörn University, Huddinge, Sweden

In Tanzania, mangroves are legally gazetted as state forest reserves, and occur along almost the entire coastline (Semesi 1992, Wang et al. 2003, Mangora et al. 2016). The largest fractions are found in estuarine- and river mouths spreading across the country from the northern to southern districts (Semesi 1992, Wang et al. 2003, Mangora et al. 2016). Coastal communities in the different parts of Tanzania have depended on mangrove forests for generations to support their livelihoods and well-being (Mainoya et al. 1986, Semesi 1992, 1998). In recognizing their values and importance, the government in collaboration with development partners developed the national mangrove management plan in 1991 (Semesi 1992), and implemented it through the Mangrove Management Project (MMP), which began in 1994 to accentuate sustainability (Wang et al. 2003) before it phased out in 2004 (Cooksey et al. 2006). Capitalizing on this management plan, different stakeholders attempted to design a number of other collaborative arrangements and restoration initiatives in different parts of the country to enhance mangrove management and conservation (Mangora 2011). Joint forest management (JFM) is one of the participatory forest management (PFM) efforts developed to promote sustainable utilization of forest resources, including mangroves following its inclusion in the National Forest Policy of Tanzania of 1998, and the Forest Act 2002 (Beymer-Farris and Bassett 2012, Treue et al. 2014, Mwansasu 2016). However, in practice JFM has not yet been fully executed to prevent mangroves from being degraded because of a range of factors. First, under JFM, the government owns the forest, and for state forest reserves, this means that all decisions about, e.g., human access and use rights are made by the government (Beymer-Farris and Bassett 2012, Mwansasu 2016). Second, it is difficult to achieve effective collaborative management for mangrove forests because of the absence of specific formal agreements on community rights to use mangrove resources and the lack of shared management responsibilities (Mshale et al. 2017). These issues have exacerbated conflicts between the government (forest owners) and local communities (users of resources; Ngomela 2007, Mangora 2011). Moreover, implementation of a management plan faces various challenges that jeopardize fully secured sustainable use of mangrove resources, mainly because of increasing pressures from human exploitation, inadequate engagement of local communities, and inconsistent management interventions and enforcement (Mangora 2011, Mshale et al. 2017). Furthermore, these management challenges exhibit significant spatial and temporal variations that are much influenced by the prevailing socioeconomic conditions of the communities around mangroves (Nyangoko et al. 2021). Nchimbi et al. (2020) also demonstrated that community interests in conservation can remain high if their opinions are appropriately included in the management planning and if there are alternative livelihood options that would meet the needs of local users, while otherwise the loss of this resource is likely to continue.

Mangroves are estimated to cover an area of 158,100 ha in mainland Tanzania (MNRT 2015), and nearly 19,000 ha of mangrove area were lost between 1990 and 2015 (FAO 2015, as cited in Njana 2020). Generally, Tanzania's mangroves are disappearing at a rate of around 0.7% per year (FAO 2007), with some local areas being more degraded than others (Wang et al. 2003, Alavaisha and Mangora 2016). For example, the Rufiji

Delta, which holds the largest mangrove area (45,519 ha) in the country, loses about 378 ha of its mangroves each year, corresponding to loss rate of 0.5% annually (Monga et al. 2018). Mangrove loss is also exemplified by the Wami River Estuary, where intensive harvesting of these resources for charcoal production and fuel-wood needs prior to its gazettement under management authority of Saadani National Park (protected area), has threatened not only ecosystem integrity but also local fisheries (McNally et al. 2011). This could match the case of the Pangani River Estuary, where the contribution of mangrove forests to local livelihoods and mangrove degradation has been reported over the last few decades (Turpie et al. 2005, Ngomela 2007), but the link between socioeconomic variables of dependent communities and mangrove resources extraction, as well as how local people perceive strategies for managing mangrove ecosystems is not well captured. In an effort to further contribute to the design of appropriate mangrove management interventions, which would promote common ground for collaborative arrangements with local communities, the present study explored the influence of socioeconomic drivers on mangrove resource use, and community perceptions on effectiveness of mangrove management of the Pangani River Estuary. Specifically, the study was set to answer the following questions: (1) What are the socioeconomic drivers that determine the exploitation pattern of mangrove resources of the Pangani River Estuary? (2) What are the community perceptions on effectiveness and enforcement of mangrove forest management interventions for the Pangani River Estuary?

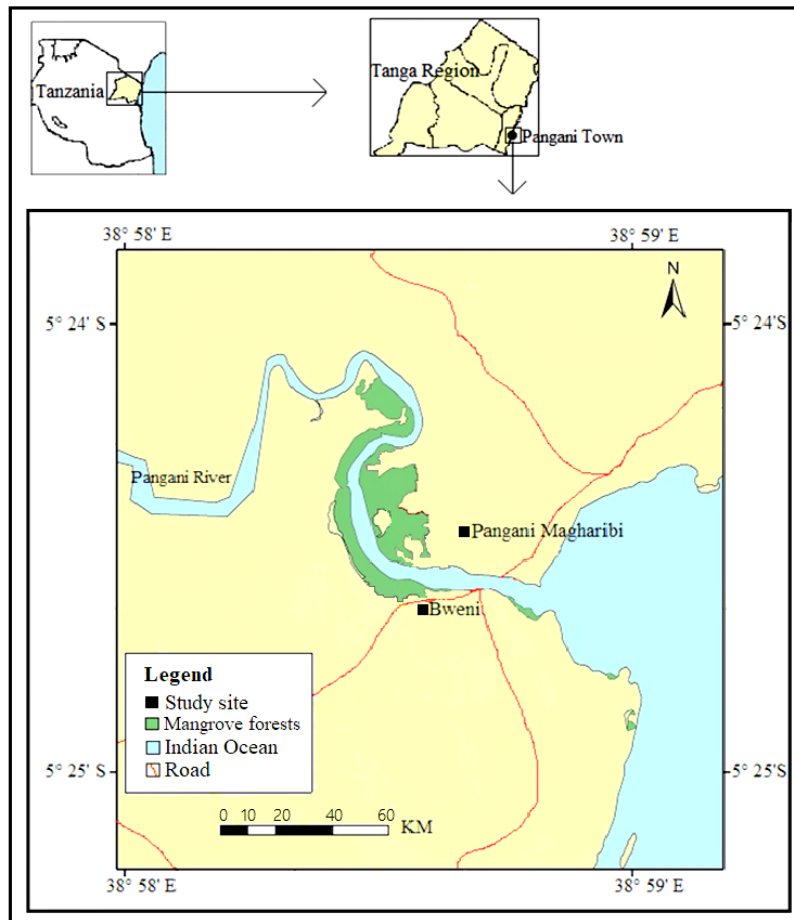
METHODS

Study area

This study was conducted in two peri-urban communities; Bweni and Pangani Magharibi in Pangani Township of the Tanga region in northern Tanzania (05°24'00"-05°25'36" S; 38°58'47"-38°59'60" E (Fig. 1). The two communities are situated close to mangroves of the Pangani Estuary, which represents the terminal end of the Pangani River (Fig. 1). The Bweni site is more connected to rural settings and situated on the southern bank of the Pangani River. Pangani Magharibi is a more urbanized area on the northern bank of the Pangani River. Regardless of any differences in the main source of livelihoods between the two sites, these communities are generally characterized by livelihood occupations, such as subsistence rain dependent farming, artisanal fisheries, small businesses (e.g., food vending and kiosks), small scale livestock keeping and utilization of both mangrove and inland terrestrial forest resources.

The area covered by mangroves in the Pangani Estuary is about 753 ha (Turpie et al. 2005). The actual size of the degraded area is unknown (Ngomela 2007), but cutting of mangroves for timber has affected these ecosystems (Turpie et al. 2005). Thus, the re-imposed ban on mangrove harvesting in 2016 across the country may have reduced reliance on mangroves and improved their conditions, but this needs to be further verified. Eight mangrove species occur in the estuary, which is dominated by *Avicennia marina*, *Ceriops tagal*, and *Rhizophora mucronata*. Other mangroves species found in the area are *Bruguiera gymnorrhiza*, *Heritiera littoralis*, *Lumnitzera racemosa*, *Xylocarpus granatum*, and *Sonneratia alba* (Lamtane et al. 2014). The area experiences hot and humid tropical conditions with average temperatures of

Fig. 1. Map showing the location of the studied sites. Bweni and Pangani Magharibi are situated on the southern and northern banks of Pangani River, respectively.



20.5 °C and 30 °C during coolest and hottest months, respectively, and receives an average total annual rainfall of about 1240 ± 333 mm (Njana 2015). According to the national population census of 2012, Bweni and Pangani Magharibi had a total population of 1263 and 6262 people, which increased from 1187 and 4929 people recorded in 2002, respectively (URT 2013). Two local natural resource management institutions, the Beach Management Unit (BMU) and the Village Natural Resource Committee (VNRC), exist in the study area, but their functions differ. The BMU exists in each site and primarily focuses on management of fisheries resources and their associated habitats, including mangroves. Their responsibilities include patrolling, enforcing rules and regulations, and raising awareness about fisheries management and associated aquatic environments. The two sites share the same VNRC, which focused on protecting both inland terrestrial forests and mangrove resources, with the mandate to raise awareness and implement by-laws pertaining to overall environmental protection and pollution control throughout the studied communities.

Research design and data collection

The field work was carried out from late April to early May 2016, at both community and household levels, to explore the influence of socioeconomic drivers on mangrove resource use and community perceptions on mangrove forest management interventions in the communities of Bweni and Pangani Magharibi. Mixed social research methods, including focus group discussions (FGDs), key informant interviews (KIIs), and household questionnaire surveys (HQSS; Katikiro 2016) were used to gather data. Direct field observations were conducted to enrich the data. Prior to the actual data collection, a reconnaissance survey was carried out, during which consultative meetings were performed with community leaders, influential elders, local natural resources management committee leaders (BMUs and VNRC), and a few households, to introduce the study, seek consent, and collect important preliminary information that facilitated the design of actual survey tools.

Focus group discussions and key informant interviews

One FGD was conducted at the community level in each study site, which included a mixed group of mangrove resource users

(fishers, mangrove cutters, food vendors, and farmers). Each group discussion involved a small active group of eight participants (two individuals from each occupation) of mixed gender and age for the efficient discussions, as suggested by Hennink (2014). Discussions were moderated using prepared checklists adopted from Ansong and Røskoft (2011) and Roy et al. (2013), and modified to meet the purposes of the study. During the discussions, participants identified all important socioeconomic activities in the study area, and local uses of mangrove resources. Participants were also asked to indicate how they perceived the conditions of mangroves over time and reasons for changes (based on time line analysis). In addition, a wealth ranking exercise (Endamana et al. 2016) was conducted to understand the relationship between the wealth status of community members and patterns of exploitation of mangrove resources. Accordingly, three wealth groups (poor, middle, and rich) were identified by participants to reflect households' assets in their community based on wealth decisive factors (type of houses, source of household energy, farm size, monthly income, number of meals taken per day, and livestock keeping). The participants were also asked to give opinions on (a) the performance of natural resource management institutions, (b) conservation programs and projects involved in mangrove management in the study area, (c) how they perceive those interventions, and (d) what should be done to conserve mangroves, while improving livelihood of dependent communities. The information generated from the FGDs were crosschecked by conducting in-depth interviews with 14 key informants, including (i) the Pangani District Forest Officer (DFO), (ii) the District Forest Manager (DFM) for Tanzania Forest Services (TFS), (iii) the village chairperson in each site, (iv) two influential people in each site, (v) two BMU leaders in each site, and (vi) two VNRC leaders in the study area (Appendix 1). A key informant was regarded as an individual who had deep knowledge about the study site, socioeconomic patterns, and historical perspectives of management of natural resources (Orchard et al. 2016). The DFO and DFM were, however, selected as key informants based on their expertise and duties in managing mangrove forests regardless of how long they had lived in the study area.

Household survey

A semi-structured questionnaire (Appendix 2) was administered to 30 households randomly selected in each site. Household heads were targeted because they are responsible for decision making and obliged to provide basic needs in their families (Boafo et al. 2016). In their absence, any other adult representative member conversant with household deeds was asked to speak for the household. The questionnaire used was adopted from the study by Adhikari et al. (2004), and modified based on the information obtained from the FGDs and KIIs. The information collected included socioeconomic and demographic characteristics, resources collected from mangroves to support livelihoods, and perceptions on local and state management interventions. To determine whether households are dependent on mangrove resources for their livelihoods or not, respondents were asked to mention at least one key resource that they extract from mangroves to support their subsistence or commercial needs. Based on the description by Newton et al. (2016), those respondents who revealed that they extract resources from the mangrove forest in some way were classified as mangrove

dependent, and vice versa as mangrove non-dependent. The perceptions on effectiveness and enforcement of management interventions were assessed based on predefined mangrove management and conservation statements explored at the community level, where respondents were asked to depict a statement and rank their responses as either strongly disagree, disagree, neutral, agree, or strongly agree per given statement.

Field observations

With the assistance from two local residents in each study site, a physical visit to the mangrove forests was carried out to observe mangrove conditions and resources collected from the forests, followed by observations on different socioeconomic activities that took place in the study area to verify the gathered information from the FGDs, KIIs, and HQSs.

Data analysis

Information collected from the household survey was analyzed statistically using SPSS v. 16. Binary logistic regression was used to deduce relationships between socioeconomic drivers and exploitation pattern of mangrove resources in the study area. Data from the studied sites (Bweni and Pangani Magharibi) were combined to increase the strength of associations between predictors and response variables that fit the logit model. The model was chosen because it can simultaneously analyze impacts of both continuous and categorical explanatory variables to reduce bias for their influence (Sperandei 2014). The variables included in this model are summarized in Table 1. Descriptive statistics (percentage distributions) were used to analyze respondents' perceptions on effectiveness and enforcement of mangrove forest management interventions between the two study sites. Content analysis (Yates and Leggett 2016) was used to analyze qualitative information collected from the FGDs and KIIs. With regards to this, all information noted were grouped together followed by establishment of major themes, which were further subdivided into sub-themes, and finally to the smallest meaningful units that represented issues described by respondents in relation to mangrove exploitation and management.

RESULTS

Socioeconomic and demographic profiles of the households

The socioeconomic and demographic characteristics of respondents in the studied communities are summarized in Table 2. Almost 67% of the respondents were male and about 47% were in the age group of 36 to 55 years. Over 70% of the respondents were married. The average household size was five persons. In terms of education, 53% of the respondents in Bweni and 40% in Pangani Magharibi had completed the primary level of education. Fishing was the main livelihood occupation in Bweni, accounting for ~37% of the responses, while in Pangani Magharibi farming (33%) was the main livelihood occupation. The average household monthly income was estimated to be 187,500 Tanzanian shillings. In Bweni, 50% of the respondents reported to have stayed in the area for over 15 years, while only 33% had stayed for such a long period in Pangani Magharibi.

Socioeconomic drivers of mangrove resource exploitation

The common uses of different mangrove resources reported by respondents during the FGDs in both studied communities are summarized in Table 3. Building materials and firewood were the

Table 1. Variables used in the logit regression model

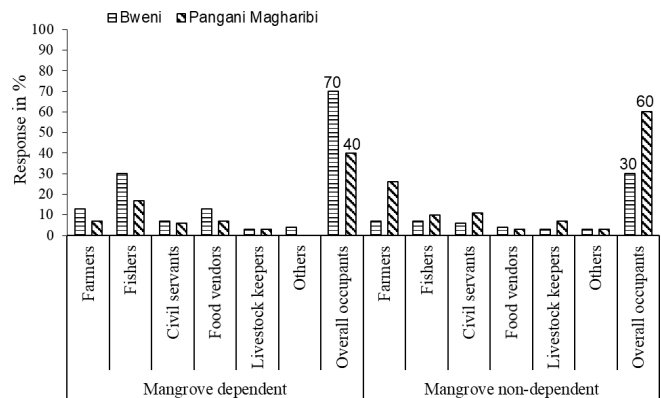
Variables	Description	Module of quantities
Dependent variable (mangrove resource use)	Whether household livelihoods depend on any resource from mangroves	Categorical, if yes = 1, no = 0
Independent variables		
Gender	Gender of household head	Categorical, 1 = Male, 0 = Female
Age	Age of household head	Continuous, actual age of respondent in years
Household size	Individual members in household	Continuous, number of family members
Education	Highest level of education of head of household	Continuous, number of years spent in school
Occupation	Main occupation of household	Categorical, 1 = Fisher, 0 = Others
Residence time	Time household settled/ lived in the area	Continuous, years lived in the area
Cost of alternative resources for fuel	Cost of gas/kerosene/electricity to substitute use of mangroves as fuel wood	Continuous, monthly bills paid for alternative source of energy (Tanzania shillings)
Income	Average monthly household income	Continuous, actual monthly income earned by all family members (Tanzania shillings)

most commonly extracted products in the area. The dependence pattern on mangrove resources by occupation in the study area are summarized in Figure 2. In Bweni, 70% of the households were mangrove dependent (i.e., they extracted mangrove products for their livelihoods only), whereas 60% in Pangani Magharibi were mangrove non-dependent (i.e., they did not extract mangrove products for their livelihoods). In both sites, fishers and farmers were most dependent on mangrove resources compared to people with other occupations. Based on the binary logistic regression model testing the influence of selected socioeconomic factors on mangrove resource extraction (Table 4), only four predictors were significantly associated with the extraction of mangrove resources for livelihoods in the study area, including residence time of household, household main occupation, household size, and cost of alternative resources to substitute use of mangrove wood as cooking fuel. Because the coefficients of these independent variables were all positive, a unit increase in these factors would increase the number of people who were engaged in mangrove resource extraction. An analysis of households' wealth status based on wealth decisive factors (Table 5) indicated that poor households often exert more pressure on mangrove resources than rich households.

Perceptions of mangrove forest management interventions

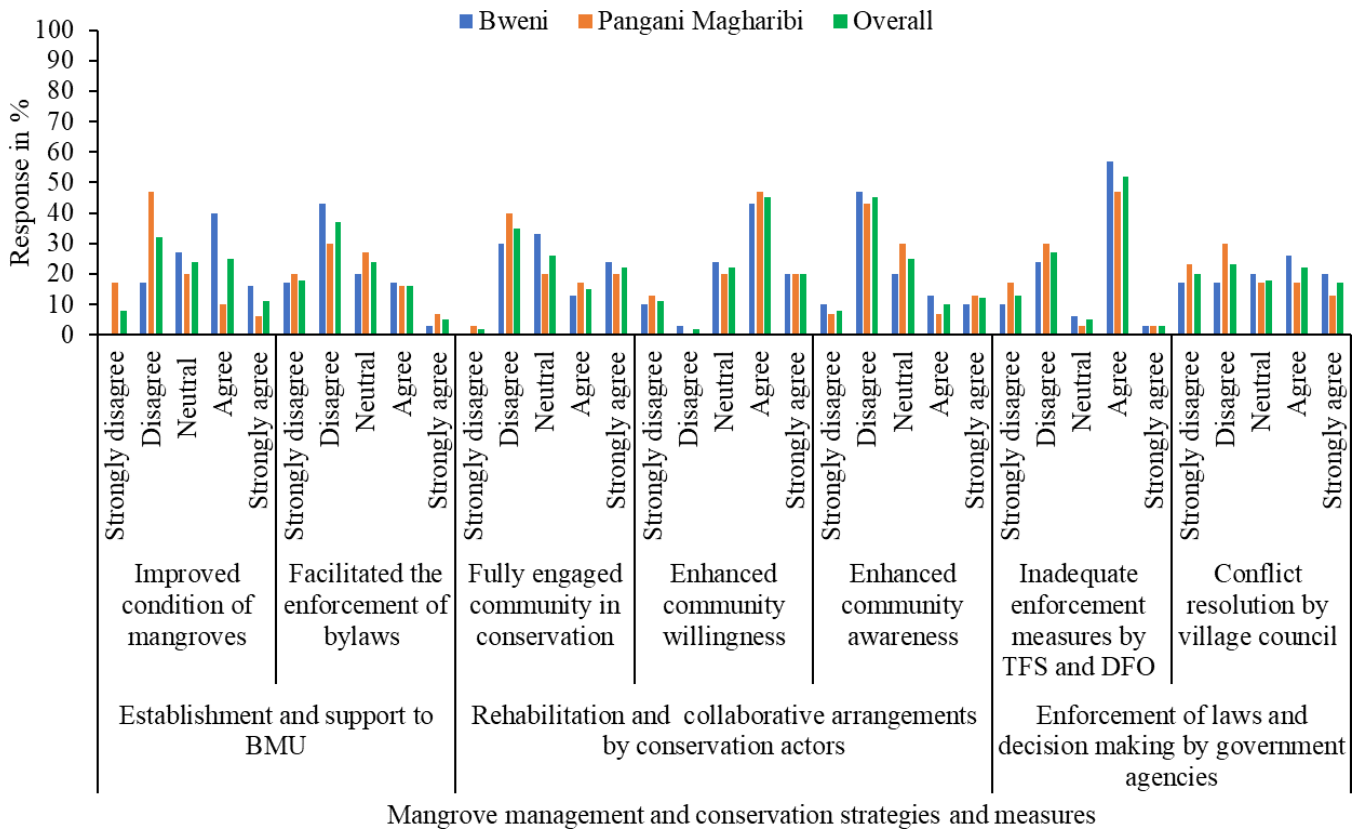
Table 6 summarizes legal, institutional, and policy instruments related to mangrove management in the study area. Thirteen institutions and conservation projects/programs responsible for management of mangroves resources in the study area were identified during the FGDs and KIIs. Some of these conservation and management programs have been phased out, while others are still in operation. The past donor funded projects/programs like the Mangrove Management Project (MMP) and Tanga Coastal Zone Conservation and Development Program (TCZCDP) were reported to be effective during their implementation phases. This implies that the efforts from these projects/programs on, e.g., awareness raising, capacity building, and participatory monitoring have led to improved management and conservation of mangroves, which is a result of the collaborative work with local communities, who got empowered to take control of their own resources, which in turn has reduced

Fig. 2. Household dependence patterns on mangrove resources by occupation in the study area (n = 30 per site). Extraction of poles, firewood, fish, and honey were mentioned as preferred resources by mangrove dependent occupants.



mangrove degradation. However, it was observed that many people in the area were unaware about the existence of a recent climate change adaptation project entitled “Developing core capacity to address adaptation to climate change in productive coastal zones of Tanzania,” which implies little sensitization, participation, and engagement of the communities. Historical narratives and community perceptions on the conditions of mangroves and drivers of changes over time (Table 7) indicate that severe mangrove degradation occurred between 1965 and 1993, while from 1994 to 2004, the degree of such degradation was reduced to a moderate level, and from 2005 to present, there has been a resurgent degradation of mangrove forests. Generally, the two studied communities had different perspectives on the effectiveness of mangrove forest management interventions for sustainable mangrove utilization and associated conditions (Fig. 3). The majority of the respondents in Bweni (57%) either agreed or strongly agreed with the perception that BMU interventions have led to improved conditions for mangroves, whereas only ~17% of respondents in Pangani Magharibi had similar opinion.

Fig. 3. Percentage responses on perceptions of effectiveness and enforcement of mangrove forests management interventions in the study area based on household surveys (n = 30 per site). BMU = Beach management unit, TFS = Tanzania Forest Services, DFO = District Forest Officer.



Overall, 55% of the respondents (i.e., agreed or strongly agreed responses in both study sites) indicated that state management agencies (the DFO and TFS) are weak in their enforcement of regulations for conservation and sustainable use of mangroves.

DISCUSSION

Socioeconomic drivers influencing on mangrove resource use

Dependence on forest resources, especially by rural and suburban communities, is shaped by socioeconomic factors operating at the household and community levels (Handavu et al. 2019). The results of this study demonstrate this viewpoint, albeit the level of influence of these factors varied, and were associated to different reasons and implications. The observed similarity between gender of household heads in terms of mangrove resource use implies that many people regardless of their gender extract resources from mangroves. However, some respondents during the FGDs and KIIs mentioned that men tend to exploit more resources (e.g., harvesting poles for making boats and fish traps throughout the year) than women (e.g., occasional collection of firewood and crabs) because men are traditionally responsible for household welfare and are obliged to ensure security of household basic needs. As such, men were mostly associated with illegal exploitation of mangroves on the grounds of sustaining household welfare. Examples of these illegal

activities are cutting of mangrove trees for charcoal making and digging in mangrove areas for fishing bait. Our results conform to the findings of Feka et al. (2011) and Eneji et al. (2015), who also reported that exploitation of forest resources is carried out by both men and women, and that men tend to extort a multitude of resources from forests, while women only exploit a few resources for subsistence use. The age of household heads also had no significant influence on mangrove extraction, as both young and old people indicated that irrespective of their age, they would extract resources from mangroves as long as they had the physical ability to visit the mangrove forest. Our findings are similar with the study by Garekae et al. (2017), who also found that the elderly tend to reduce forest extraction activities because of a decline in physical strength. Household size was positively related with mangrove resource use. This implies that large households, especially in rural and suburban areas, tend to exploit more natural resources than small households because of an increased demand by the household members. As poverty prevails in poor coastal societies, large families may not be able to afford basic necessities and hence exert pressure on the nearest resources for products like firewood, mangrove crabs, prawns, and medicines. This finding is in agreement with the observation that households with large families, especially those with limited income opportunities, are highly reliant on forest resources to meet their basic needs (Handavu et al. 2019).

Table 2. Socioeconomic and demographic characteristics of households in the study area.

Variable	Category	Response in %		
		Bweni	Pangani Magharibi	Overall
Gender	Male	70	63	66
	Female	30	37	34
Age	18–35	33	47	40
	36–55	50	43	46
	> 56	17	10	14
Marital status	Married	80	73	77
	Single	7	13	10
	Divorced	3	7	5
	Widow	10	7	8
Household size	1–4	40	43	41
	5–8	60	54	57
	> 8	0	3	2
Level of education	Informal	7	3	5
	Primary	53	40	46
	Secondary	30	37	33
	Collage	10	20	15
Main occupation	Farmer	20	33	27
	Fishers	37	27	32
	Civil servants	13	17	15
	Food vendors	17	10	13
	Livestock keepers	6	10	8
	Others	7	3	5
	Income per month (Tanzania shillings)	< 150,000	40	27
	150,000–300,000	33	40	37
	300,000–450,000	17	20	18
	> 450,000	10	13	12
Residence time	< 8 years	27	20	23
	9–15 years	23	47	35
	> 15 years	50	33	42

The level of education did not significantly influence the mangrove exploitation, which matches the results of the FGDs and KIIs that many people regardless of their educational status extract resources from mangroves. This was mainly attributed to limited employment opportunities in the studied communities, where a completion of secondary education alone was no guarantee of getting formal government or private employment. This in turn leads to less reliable sources of income and increased poverty, and thus a similar pattern of resource use among those with informal, primary, and secondary education to provide for subsistence needs and income generation. Contrary, Inoni (2009) reported that higher levels of education make harvesting of forests unattractive to the local elites. This contradiction stems from the fact that, unlike the Pangani community, the studied society by Inoni was characterized by more livelihood options like large-scale dairy farming, which provided employment for rural dwellers who had some form of formal education, and thus were less dependent on mangrove resources as an income source.

According to Giliba et al. (2011), an increase in the number of years of residence around a forest in rural areas significantly influences the use of forest products, which is in agreement with the findings of this study. People with long residence time know their environment better than people with shorter residence time, and thus, they are more likely to go into forests to extract mangrove resources to secure their livelihoods. In addition, because the study area is dominated by fishers (Table 2), who have stayed there for a long time (over 15 years), they are often expected

to be more reliant on mangrove resources compared to other types of occupations. This is due to the nature of their livelihood activities, as many fishermen in the area own boats and canoes, which are made of wood from mangrove trees. Fishers could also use their fishing boats to harvest and carry building poles, firewood, and other mangrove products, which is difficult for other occupants who do not own a boat or canoe. With regards to this, household main occupation was found to be positively related to mangrove resource use. This implies that an increase in number of fishers in the studied communities would increase the number of people who are engaged in mangrove resource extraction, which is consistent with the findings of Adhikari et al. (2010), who indicated that fishing communities rely on mangroves to collect fisheries products. Some respondents in the study area mentioned that the use of small fiberglass boats would replace wooden boats made from mangrove trees, and would facilitate offshore fishing, and thus reduce the pressure on mangroves. Because some of the respondents were engaged in mud crab fishing, training and development of crab fattening, using small bamboo cages in mangrove areas, could supplement the income for marginalized fishers without degrading the mangroves.

The costs of alternative energy sources for cooking significantly influenced the extraction of mangroves for firewood. This was associated with increased costs of purchasing gas, kerosene, or electric stoves in the studied communities. For instance, the price for refilling an Oryx gas cylinder of 5 kg as an alternative energy

Table 3. Common local uses of mangrove resources in the study area, based on focus group discussions and key informant interviews.

Uses	Community narrative on the uses
Firewood	Species <i>C. tagal</i> and <i>R. mucronata</i> are preferred for firewood because of their good burning quality and they produce little smoke. The <i>A. marina</i> is also used as an alternative because <i>Ceriops</i> and <i>Rhizophora</i> species have become scarce in the study sites. Dead and/or live trees are collected or cut for firewood use by households in both sites. However, the demand of fuelwood was higher in Bweni than Pangani Magharibi. Primarily women collected firewood for household use. Few men collect firewood to sell. The commercial use of these resources required authorization from village authorities and then applying for a permit from the District Forest Manager for Tanzania Forest Services. There is a danger of forest degradation in the area because firewood collection is carried out almost daily. Nowadays, firewood collection for selling is banned by the government. Despite the ban, signs of illegal cutting are still evident.
Building	The poles from <i>C. tagal</i> and <i>B. gymnorhiza</i> species are preferred for house building, making local furniture, supporting peg in fences and vegetable gardens because the wood is strong, resistant to insects, and lasts longer. Timber from <i>S. alba</i> is used for making furniture and boats. Poles are commonly harvested products in the area, and primarily collected by men. Poles are demanded for both commercial and domestic uses. However, compared to firewood, demand for poles for household use is not on a daily basis. Recently, permit or licences for pole harvesting has been suspended to reduce mangrove degradation.
Traditional medicines	The species <i>X. granatum</i> and <i>A. marina</i> are exploited for traditional health care by a few members of the community, but presently their use is very low compared to the past. <i>Xylocarpus granatum</i> leaves are boiled for treatment of stomach-ache and skin rashes. Fruits of <i>A. marina</i> are grinded for treatment of wounds.
Charcoal making	The species <i>R. mucronata</i> and <i>C. tagal</i> are harvested for charcoal making. Charcoal from mangroves produces high calorific value and less ash. Although charcoal making is forbidden, it is done in secret by a few men.
Boat making	The species <i>H. littoralis</i> and <i>S. alba</i> are harvested for making fishing boats/canoes. Each species has its own role but sometime their roles are substituted/interchanged depending on availability of materials. Timber/poles from <i>S. alba</i> are preferred to make the boat hull (main body) and boat keel (bottom) because of their large size and good bending capability. <i>H. littoralis</i> poles are used to make boat boom (pole for direction) because of their strength and hardness.
Fisheries	Mangrove areas serve as nursery, feeding, and breeding sites for a variety of fish, and thus support fisheries. Crab collections, shrimps, and finfish fishing were the most cited mangrove-fishing activities, and were dominated by men.
Honey production	Traditional beekeepers set their bee hives in the mangrove forest to be colonized by wild bees for production of honey. This activity is dominated by men.

source for cooking, which could replace the use of mangroves as wood fuel, was 25,000 Tanzanian shillings (TZS; in April 2016) in the study sites. This is too expensive when compared with an average monthly income (187,500 TZS in 2016) of households in the studied communities. Under such circumstances, poor communities living around mangrove areas, who are in the majority, will continue to rely on forest resources as a cheap source of fuel. This finding concurs with the results of Kilahama (2008) and Doggart et al. (2020), who reported that a small increase in the kerosene price and electricity tariffs adds a burden to users, and thus exerts a demand for cheap charcoal from forests and woodlands. Based on the discussions in the FGDs and KIIs, community members in the study area perceived that improving the bad conditions of the road between Tanga and Pangani with tarmac would be an option that not only would reduce the costs for transporting affordable alternative energy sources, but could also lead to multiple benefits such as investments in the tourism industry and transportation of agricultural and fisheries products to the market areas (i.e., Tanga and Moshi cities). Promoting the planting of fast-growing genetically improved coconut palms was also mentioned by participants as an important initiative to provide husks and trees that tentatively could reduce the demand for firewood and building materials. Other interventions mentioned by key informants included introduction of biogas technology and low-cost solar stoves to substitute traditional biomass-based fuels from mangrove trees. To accomplish this, the government should engage in an open dialogue with the

communities and provide them with the knowledge and skills required for biogas installation and usage as well as on how to cook with a solar stove.

In this study, mangrove exploitation was not significantly influenced by household monthly income, implying that many people regardless of their income (low-income, middle, and high-income), partly relied on mangrove resources (i.e., honey, fish, crabs, and poles) as a source of income to meet their livelihoods. This was associated with limited income-generating opportunities and a low level of education among the majority of respondents, which limit their ability to pursue formal employment in the area and neighboring cities (e.g., Tanga), a finding that is in conformity with what has been reported elsewhere (Okello et al. 2019). The promotion of alternative livelihood activities is seen by local communities in the study area as a viable way to improve rural livelihoods and reduce dependence on the forests. With regard to this, participants of the FGDs in the studied communities mentioned that with a growing demand for meat products and eggs in Pangani Township and Tanga City, the provision of low-interest loans by the government would aid in the establishment of poultry farming (broilers and layers), which would provide food for household consumption, while also contributing to household income. There was also an extensive interest in modern beekeeping among community members, where many interested groups showed up and sought technical support from the Pangani District.

Table 4: Binary logistic regression model for socio-economic factors influencing on mangrove resource exploitation in the study area (n = 60).

Drivers	β	SE	Sig	Exp (β)
Gender of household head	1.12	1.55	0.07	3.08
Age of household head	-0.10	0.07	0.14	0.90
Household size	1.12	0.55	0.04 [†]	3.07
Level of education	-0.19	0.28	0.09	0.82
Household main occupation	3.80	1.78	0.03 [†]	4.67
Residence time of household	1.35	0.15	0.02 [†]	1.42
Cost of alternative resources	1.02	0.02	0.03 [†]	2.02
Household income	-0.03	0.02	0.12	0.96
Constant (Intercept)	-2.77	3.15	0.38	0.06

[†]indicates significant factors influencing mangrove resource exploitation at $p < 0.05$, SE is standard error, β is the coefficient of regression. A positive sign (+) of the coefficient (β) indicates that a unit increase in a specific variable could increase the number of people involved in mangrove resource extraction by a factor of the observed odds ratio (Exp β). Mangrove extraction (dependent variable) was assessed by yes or no responses, where respondents were asked if they had extracted any resources from mangroves for their livelihoods or not.

Perceptions of mangrove forest management interventions

It is becoming increasingly clear that for collaborative management to be successful, it must be people-centered and include social-economic and political issues of communities (Saunders et al. 2010, Datta et al. 2012). Such inclusion allows communities to take part in management (Wells et al. 2010) and reduces the conservation costs in the face of limited human and financial resources (Mshale et al. 2017). In this study, we assessed the effectiveness and enforcement of mangrove forest management interventions in the Pangani Estuary. Institutionally, the Fisheries Act of 2003 provided frameworks for Beach Management Units (BMUs) to monitor fisheries activities and related ecosystems such as mangroves. In Bweni, community perceptions on the improved status of mangroves as a result of the work by the BMU were positive, indicating the relative success of the BMU interventions in meeting its objectives. Results of the FGDs and KIIs revealed that awareness raising about the importance of mangroves, patrolling and mangrove planting were the main strategies used by the BMU for conservation of mangrove-associated resources. The success of this work was partly due to good collaboration between BMU members and the local community, whereby people become willing to report any illegal activity to the BMUs. A similar result was reported by Okoth (2015), who found that patrolling by BMUs had reduced cutting of mangroves and contributed to some improvement of the mangrove condition in Bagamoyo on the coast of Tanzania.

Although BMUs are not a part of the Joint Forest Management (JFM) from a forest policy standpoint, the observations from Bweni still demonstrate that an interest in improving mangrove forest conservation for collaborative management can be achieved only if the local community and different institutions are actively involved in management processes. Mikoko Pamoja in Gazi Bay, Kenya, is a community-based project, where forests are co-managed in partnership with government and non-government organizations, and exemplifies the importance of investing in collaborative mangrove management (Wylie et al. 2016). Sales of carbon-credits from this multibeneficial, community-led initiative has reduced mangrove degradation and improved mangrove conservation via rehabilitation, monitoring, and surveillance, and also created employment opportunities for local residents, and contributed to the planting of fast-growing inland trees to replace

wood harvested from mangroves for building (Herr et al. 2019). Furthermore, The Tanga Coastal Zone Conservation and Development Program (TCZCDP) in Tanzania (run from 1994 to 2007) also provided a prime case study of collaborative management that actively engaged communities in natural resource management. The program empowered coastal communities in the Tanga region to control their own resources, resulting in increased mangrove cover and reduced degradation during its operation (Wells et al. 2010). This success was accomplished through good consultation with local communities, capacity building, patrols, and the establishment of non-consumptive uses of forest products such as beekeeping and seaweed farming. Moreover, the experience drawn from the Kinondoni Coastal Zone Management Program in Dar es Salaam, which was initiated in 2001 with the support from the Swedish government, also portrayed a well-established co-management approach, where communities secured the coastal areas and its resources. The program provided education, seminars, and established beekeeping and vegetable gardening as alternative livelihoods, which enabled mangrove reliant villagers to reduce a lot of mangrove cutting (Himberg 2016).

The participants of the FGDs also mentioned that in the past, the Village Natural Resources Committee (VNRC) was successful in providing awareness and enforcing its bylaws (Table 6). This success was due to the existence of donor funded initiatives (i.e., TCZCDP and the Marine and Coastal Environment Management Project, which provided patrolling tools and financial motivation to the members of the VNRC. Phasing out of these donor-funded programs/projects jeopardized the capability of the VNRC to achieve its purpose, leaving it inactive and thus likely contributing to resurgent degradation of terrestrial and mangrove-based resources. This calls for a need for long-term government commitments, with the priority in participatory forest management (PFM) by people, rather than relying on short-term international donor agencies. The majority of respondents (~47%) in Bweni were also positive about the capability of the village council to collaborate with some members of local communities to resolve disputes associated with mangrove utilization. The good relations were built on regular consultative meetings between the village council and the community, where local issues were discussed. The situation was different in Pangani

Table 5: Household wealth status categorization and their influence on the use of mangrove resources in the study area, based on focus group discussions and key informant interviews.

Wealth status	Wealth decisive factors	Bweni	Pangani Magharibi	Mangrove use pattern
Poor	Type of house	Mud walls thatched with grasses	Mud walls roofed with corrugated iron sheets	High to very high
	Source of energy	Firewood and lantern	Firewood and lantern / electricity	
	Farm size	< 1 acre	No farm	
	Number of meals	1 per day	1–2 per day	
	Household income	50,000 to 100,000 TZS per month	100,000 to 200,000 TZS per month	
Middle	Livestock keeping	1–3 chickens	3–5 chickens	Low to Moderate
	Type of house	Burnt bricks walls roofed with corrugated iron sheets	Burnt bricks walls roofed with corrugated iron sheets	
	Source of energy	Charcoal, firewood, and electricity	Charcoal, firewood, and gas/electricity	
	Farm size	1 acre	1–2 acres	
	Number of meals	2–3 per day	2–3 per day	
Rich	Household income	150,000 to 250,000 TZS per month	200,000 to 300,000 TZS per month	Very low to Low
	Livestock keeping	3–10 chickens, 1–2 goats, and 1–5 cattle	6–14 chickens, 3–4 goats, and 1–5 cattle	
	Type of house	Concrete block / burnt bricks walls roofed with corrugated iron sheets	Concrete block walls roofed with corrugated iron sheets	
	Source of energy	Charcoal and/or gas, solar, electricity	Charcoal, gas, and/or electricity	
	Farm size	2–5 acres	3–10 acres	
	Number of meals	3 per day	3 per day	
	Household income	350,000 to 450,000 TZS per month	450,000 to 600,000 TZS per month	
	Livestock keeping	15–30 chickens, 3–1 goats, and 5–10 cattle	10–20 chickens, 5–15 goats, and 5–10 cattle	

TZS = Tanzanian shillings

Magharibi because of poor cooperation between the BMU members and both the village council and the local communities. This poor relationship was attributed to political affiliations, whereby most of the respondents claimed that a majority of the BMU members were inclined to political fractions rather than technical conservation, prompting continued mismanagement and irresponsible use of mangroves. The mismanagement of mangroves due to political influence as revealed in this study seems to be a national challenge; for instance, in the Rufiji Delta, politicians, particularly at the local levels, have issued statements advocating for overharvesting of mangroves for political gain (Mshale et al. 2017).

Despite the improved status of mangroves close to Bweni from 2005 to 2016, as reported by some community members during the FGDs, most of the respondents in both study sites admitted that formulated bylaws and their enforcement had not been fully executed. This was due to the existence of social ties and lack of working facilities. Social affection often hinders punishments related to illegal mangrove exploitation because BMU members fear creating a bad social relationship with members of their communities. The present findings concur with Kanyange et al. (2014), who also reported that close friendship between BMU members and culprits of resource degradation are among the issues leading to poor resource management along the coastline of Kenya and Tanzania. Another challenge mentioned by local elders in the studied communities includes friction between BMUs and VNRCs that represent an institutional conflict that may render less enforcement of management measures. Conflicts between the BMU, VNRC, and communities are also driven by the fact that not all local residents could fully understand all bylaws implemented by these local institutions, and thus some community members regard BMUs and VNRC as “puppet

committees” that are working for the interest of the government to hinder the way local people benefit from mangroves.

We speculate that mismanagement of mangroves in the study area and across the country could also be associated with marginalization of women in local management institutions, with women often lacking decision power and hence their perceptions and interests on conservation are sometimes ignored or excepted. Active involvement of both genders, particularly women, in decision making has the potential to improve mangrove resource conservation because women have more conservationist preferences than men (Barrero-Amórtegui and Maldonado 2021). Although the context of the Tanzania Forest Policy framework advocates PFM for managing forest resources, evidence from the studied communities and across the country shows that existing policies and laws (e.g. National Forest Policy of 1998, Forest Act No. 14 of 2002, Fisheries policy of 1997, Fisheries Act No. 22 of 2003, and Fisheries Regulations of 2009) that emphasize co-management to ensure sustainable use of mangrove resources have failed to prevent mangroves from being degraded. This is because the PFM in Tanzania has not been exercised as intended, and the mechanisms for shared management responsibilities and partnerships between government agencies and local communities are not explicitly stipulated in the legislation. Moreover, for state forest reserves, all decisions including human access and use rights are made by the government rather than the people who live within the forest areas, which in turn creates a sense of dis-ownership of the resources (Mangora 2011) and impedes cooperation between government agencies and local communities (Brenner et al. 2018). Inadequate devolution of management rights and decision making to communities demonstrates the existence of a top-down management approach, in which local people have little control

Table 6. Legal, institutional, and policy instruments related to mangrove management in the study area.

Institution/project	Period	Role
Mangrove Management Project (MMP)	1994 to 2004	Funded by NORAD and aimed at promoting sustainable utilization and conservation of mangroves through community sensitization and awareness to build capacity in management and restoration of degraded areas of mangroves. The project developed the National Mangrove Management Plan, which is still implemented, albeit outdated. The MMP was part of large program called Management of Natural Resources Program (MNRP), which aimed at improving livelihoods of rural communities through sustainable natural resource management. The MMP was implemented in three phases: phase I focused on capacity building (1994–1998), phase II emphasized collaboration among stakeholders (1998–2002), and phase III focused on improvement of livelihoods to communities living adjacent to forest (2002–2004). It lessened mangrove degradation, but after it was phased out, resurgent degradation occurred.
Tanga Coastal Zone Conservation and Development Program (TCZCDP)	1994 to 2007	Funded by Irish Aid and centered on building capacity in local communities and government institutions to promote integrated coastal zone ecosystems and marine resources management for sustainable development. The project was phased out in 2007.
Fisheries Policy	1997 to present	This policy provides guidance that promotes protection of aquatic fauna, flora, and their related habitats such as coastal mangrove forests through prevention of habitat destruction, pollution, and over exploitation. It still exists, and some revision was made in 2015.
National Forest Policy	1998 to present	This policy aims at ensuring and enhancing sustainable use of forest biodiversity by involvement of local communities and other management stakeholders.
Natural Resources Committees (VNRC)	1999 to present	This local institution operates under local government authority framework and aims at managing all environmental resources at the community level and acts as a link between local communities and government officers like the District Forest Officer (DFO). The VNRC was active in past years, but it is now inactive after phasing out of short-term international donor agencies. VNRC has its bylaws that were signed by village councils to operate within the study communities.
Forest Act No. 14	2002 to present	This legal framework advocates forest management by improving efficiency in the use of forest products in a sustainable manner through encouraging local communities and private sector involvement.
Fisheries Act No. 22	2003 to present	The legal framework provides guidelines for management and conservation of fisheries and their related habitats such as mangrove forests.
Environmental Management Act (EMA) No. 20	2004 to present	The act recognizes the contribution of different sectors in protecting the environment. It promotes coordination and cooperation among stakeholders in different sectors including forests (mangroves) to enhance protection, conservation, and management of environment and natural resources. However, in practice, it is not clear how collaboration is harmonized to promote mangrove conservation.
The Marine and Coastal Environment Management Project (MACEMP)	2005 to 2012	The program was funded by the Global Environmental Facility and aimed at improving institutions and regulatory frameworks for managing marine resources especially fisheries and other resources within economic exclusive zones including mangroves through community participation. It was phased out in 2012.
Beach Management Units (BMUs)	2005 to present	These local community institutions were formulated under the fisheries policy and legal framework for managing fisheries and other marine resources like mangroves, coral reefs, and seagrasses in a responsible manner. They are operational under specified bylaws.
Fisheries Regulations	2009 to present	The regulations provide guidelines for monitoring fisheries activities and their related ecosystems such as mangroves. These regulations still exist, and some amendments were made in 2015.
Tanzania Forest Services (TFS)	2010/2011 to present	The state agency mandated to ensure quality supply of forest and bee products including mangrove forests, collection of revenue, and law enforcement.
Climate change adaptation project (Developing capacity to address adaptation to climate change in productive zones of Tanzania)	2016 to 2019	Funded by Least Developed Countries Fund (LDCF) through UNEP, and implemented under the Vice President's Office. The project seeks to respond to impacts of climate changes on coastal zones. It aims at reducing vulnerability of climate change to local communities by building local level capacity and knowledge to effectively analyze the threats and potential impact of climate change. Adaptation measures included construction of a sea wall and restoration of mangroves to safeguard the wall. The project started in 2013 and was expected to end in 2019. The initial stage of seawall construction began in November 2013, but rehabilitation of degraded mangroves started in 2016. Few members of the community were aware of the project.

over the mangrove resources (Ngomela 2007), and thus promotion of the joint forest management (JFM), as emphasized by the Tanzania National forest policy, remains to be a theory on paper (Mangora 2011). The poor people who deeply depend on these resources for their livelihoods are perceived by policy makers in the context of enforcement of legal provisions as culprits of degradation, instead of being partners of conservation (Nyangoko et al. 2021). Government restrictions, including banning measures enacted in 2016, had also enraged a large number of mangrove-reliant households and deprived them of their livelihoods (Nyangoko et al. 2021). This has resulted in friction between the government and mangrove-dependent

communities, a situation that has reduced the willingness of local people to participate in rehabilitation and conservation initiatives. The results of the FGDs exposed that forest officers rarely visit local communities and when they do, it is often for different missions (e.g., attending field work or escorting researchers to villages) rather than for community consultations. Accordingly, government agencies (TFS and DFO) are perceived weak in enforcing measures and regulations regarding conservation and sustainable use of mangroves. This result agrees with the note that inadequate government budget allocation, few forest extension staff, and lack of field equipment are challenges that affect effectiveness of collaborative arrangements. Specifically, the DFO

Table 7. Community perceptions on conditions of mangroves and drivers of changes over time in the study area.

Year	Condition of mangrove	Factors attributed to the conditions over time
1960–1964	Not degraded	Small population size, low demand of mangrove resources, plenty of alternative sources of wood resources from trees and shrubs grown in terrestrial forests.
1965–1993	Highly degraded	Rapid population growth, emergence and proliferation of commercial exploitation of mangrove resources, and poor management by government agencies.
1994–2005	Improved with moderate degradation	Implementation of conservation initiatives including MMP (1994–2004), TCZCDP (1994–2007), creation of VNRC in 1999 and MACEMP program in 2005, as well as the revision of forest policy and legislation to include community in the management (e.g., National Forest Policy of 1998 and Forest Act of 2002)
End of 2005 to 2016	Resurgent degradation	Weak management and enforcement after phasing out of the donor funded project (MMP) in 2004, and MACEMP in 2013. Mangroves on the side of Bweni were only slightly degraded because of good cooperation between BMU and the local community compared to Pangani Magharibi, which became highly degraded because of high population pressure and poor joint efforts among stakeholders.

claimed that “We cooperate with local communities but not too much because we are few in numbers and we do not have enough money or equipment to perform regular patrols and provide training to local communities.”

Inadequate staffing and funding to effectively enforce laws and regulations related to mangrove resources remains to be a general challenge throughout the country. This is evidenced by Mshale et al. (2017), who explained that shortage of forest staff and inadequate facilities are among the major issues that undermine the management and conservation of mangrove forests in the Rufiji Delta. There is also a lack of adequate coordination among government institutions across the country to harmonize different actor interests involved in managing mangroves resources (Nyangoko et al. 2021). For example, although the forestry department designates all mangrove forests as reserves, the fisheries department issues permits for prawn farm development, and the Ministry of Minerals issues permits for salt extraction in the same designated mangrove forest reserve areas (Mangora 2011). Thus, in the absence of well-designed management measures, different actors will engage in a range of activities that threaten mangrove ecosystems (Maina et al. 2021).

Overall, an understanding of how socioeconomic drivers influence mangrove resource exploitation, and how local people perceive effectiveness of mangrove management, such as those shown in this study, enrich policy knowledge on interaction between people, mangroves, and conservation actors. Poor or lack of collaboration tends to exacerbate the problems of mangrove overuse and non-compliance, contributing to degradation of natural capital and negative perceptions on mangrove management efforts.

CONCLUSION

This study explored socioeconomic determinants of exploitation and management of mangroves in the Pangani River Estuary. Residence time of household, household main occupation, household size, and cost of alternative resources to substitute mangroves as a source of domestic fuel, were positively associated with mangrove exploitation. Most of the respondents in Bweni appreciated the role of local institutions in enhancing mangrove conservation, while only a few in Pangani Magharibi had such

similar opinion, albeit not congruent with the National Forest Policy that categorically places mangroves under the joint forest management strategy. Moreover, over half of the respondents indicated that state management agencies are weak in implementing conservation measures for sustainable use of mangroves. Considering these socioeconomic and management challenges, especially those related to resource extraction and legal capacities of local natural resource management institutions, provides a good opportunity to improve management interventions. Collaboration among all stakeholders, awareness raising, and enforcement mechanisms should be strengthened to address the need of both local people and ecosystem protection. To achieve this, the government through the forest services agency needs to reverse the existing forest policy and define clear legal mechanisms for engaging communities around mangroves. This may facilitate active participation of local people in the management and allow for the inclusion of a sense of ownership of resources through formally shared management rights that define agreements on areas of use and access rights as a bottom-up approach. To effectively support these communities, a call is made for government through responsible state agencies and departments to promote alternative income generating activities, recognize and appreciate the traditional and cultural reliance of communities on the mangrove resources, so that the best collaborative arrangements can be put in place for a win-win situation. More importantly, with help of village leaders and elders through open dialogue at the community level, marginalized local people, often the most poor and natural capital dependent, should be identified, empowered through measures such as soft loans, monitored and trained to begin working on small livelihoods projects that are vested in local contexts.

Responses to this article can be read online at:
<https://www.ecologyandsociety.org/issues/responses.php/13227>

Author Contributions:

B.P.N. was the lead author and responsible for coordinating all contributions from co-authors. The conception and design of the study was carried out by B.P.N., M.S.S., and M.M.M., analysis was conducted by B.P.N. and M.S.S., interpretation of data was done by B.P.N., M.S.S., M.M.M., M.G., and H.B., writing - review and editing was done by B.P.N., M.S.S., M.M.M., M.G., and H.B. All authors give final approval of submitted version of the paper.

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Data Availability:

The data that support the findings of this study are available on request from the corresponding author, [B.P.N]. The data are not publicly available to respect the privacy of the responding communities.

LITERATURE CITED

- Adhikari, B., S. P. Baig, and U. A. Iftikhar. 2010. The use and management of mangrove ecosystems in Pakistan. *Journal of Environment and Development* 19(4):446-467. <https://doi.org/10.1177/1070496510384392>
- Adhikari, B., S. Di Falco, and J. C. Lovett. 2004. Household characteristics and forest dependency: evidence from common property forest management in Nepal. *Ecological Economics* 48(2):245-257. <https://doi.org/10.1016/j.ecolecon.2003.08.008>
- Alavaisha, E., and M. M. Mangora. 2016. Carbon stocks in the small estuarine mangroves of Geza and Mtimwani, Tanga, Tanzania. *International Journal of Forestry Research* 2016:2068283. <https://doi.org/10.1155/2016/2068283>
- Ansong, M., and E. Røskaft. 2011. Determinants of attitudes of primary stakeholders towards forest conservation management: a case study of Subri forest reserve, Ghana. *International Journal of Biodiversity Science, Ecosystem Services and Management* 7(2):98-107. <https://doi.org/10.1080/21513732.2011.613411>
- Arumugam, M., R. Niyomugabo, F. Dahdouh-Guebas, and J. Hugé. 2021. The perceptions of stakeholders on current management of mangroves in the Sine-Saloum Delta, Senegal. *Estuarine, Coastal and Shelf Science* 248:107160. <https://doi.org/10.1016/j.ecss.2020.107160>
- Badola, R., S. Barthwal, and S. A. Hussain. 2012. Attitudes of local communities towards conservation of mangrove forests: a case study from the east coast of India. *Estuarine, Coastal and Shelf Science* 96:188-196. <https://doi.org/10.1016/j.ecss.2011.11.016>
- Barrero-Amórtegui, Y., and J. H. Maldonado. 2021. Gender composition of management groups in a conservation agreement framework: experimental evidence for mangrove use in the Colombian Pacific. *World Development* 142:105449. <https://doi.org/10.1016/j.worlddev.2021.105449>
- Bennett, N. J., and P. Dearden. 2014. Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy* 44:107-116. <https://doi.org/10.1016/j.marpol.2013.08.017>
- Beymer-Farris, B. A., and T. J. Bassett. 2012. The REDD menace: resurgent protectionism in Tanzania's mangrove forests. *Global Environmental Change* 22(2):332-341. <https://doi.org/10.1016/j.gloenvcha.2011.11.006>
- Boafo, Y. A., O. Saito, G. S. Jasaw, K. Otsuki, and K. Takeuchi. 2016. Provisioning ecosystem services-sharing as a coping and adaptation strategy among rural communities in Ghana's semi-arid ecosystem. *Ecosystem Services* 19:92-102. <https://doi.org/10.1016/j.ecoser.2016.05.002>
- Brander, L. M., A. J. Wagtendonk, S. S. Hussain, A. McVittie, P. H. Verburg, R. S. de Groot, and S. van der Ploeg. 2012. Ecosystem service values for mangroves in Southeast Asia: a meta-analysis and value transfer application. *Ecosystem Services* 1(1):62-69. <https://doi.org/10.1016/j.ecoser.2012.06.003>
- Brenner, L., M. Engelbauer, and H. Job. 2018. Mitigating tourism-driven impacts on mangroves in Cancún and the Riviera Maya, Mexico: an evaluation of conservation policy strategies and environmental planning instruments. *Journal of Coastal Conservation* 22(4):755-767. <https://doi.org/10.1007/s11852-018-0606-0>
- Cooksey, B., L. Anthony, J. Egoe, K. Forrester, G. Kajembe, B. Mbano, and S. Riedmiller. 2006. Management of natural resources programme, Tanzania TAN-0092. Final evaluation report. Royal Norwegian Embassy, Dar es Salaam, Tanzania.
- Datta, D., R. N. Chattopadhyay, and P. Guha. 2012. Community based mangrove management: a review on status and sustainability. *Journal of Environmental Management* 107:84-95. <https://doi.org/10.1016/j.jenvman.2012.04.013>
- Doggart, N., R. Ruhinduka, C. K. Meshack, R. C. Ishengoma, T. Morgan-Brown, J. M. Abdallah, D. V. Spracklen, and S. M. Sallu. 2020. The influence of energy policy on charcoal consumption in urban households in Tanzania. *Energy for Sustainable Development* 57:200-213. <https://doi.org/10.1016/j.esd.2020.06.002>
- Endamana, D., K. A. Angu, G. N. Akwah, G. Shepherd, and B. C. Ntumwel. 2016. Contribution of non-timber forest products to cash and non-cash income of remote forest communities in Central Africa. *International Forestry Review* 18(3):280-295. <https://doi.org/10.1505/146554816819501682>
- Eneji, C. V. O., A. M. Mubi, M. A. Husain, and D. A. Ogar. 2015. Factors influencing gender participation in forest resources management in the Cross River National Park enclave communities, Nigeria. *Journal of Environmental Protection and Sustainable Development* 1(5):234-244.
- Feka, N. Z., M. G. Manzano, and F. Dahdouh-Guebas. 2011. The effects of different gender harvesting practices on mangrove ecology and conservation in Cameroon. *International Journal of*

- Biodiversity Science, Ecosystem Services and Management 7 (2):108-121. <https://doi.org/10.1080/21513732.2011.606429>
- Food and Agriculture Organization (FAO). 2007. The world's mangroves 1980-2005. A thematic study prepared in the framework of the global forest resources assessment 2005. FAO, Rome, Italy.
- Friess, D. A., K. Rogers, C. E. Lovelock, K. W. Krauss, S. E. Hamilton, S. Y. Lee, R. Lucas, J. Primavera, A. Rajkaran, and S. Shi. 2019. The state of the world's mangrove forests: past, present, and future. Annual Review of Environment and Resources 44:89-115. <https://doi.org/10.1146/annurev-environ-101718-033302>
- Gajdzik, L., A. Vanreusel, N. Koedam, J. Reubens, and A. W. N. Muthumbi. 2014. The mangrove forests as nursery habitats for the ichthyofauna of Mida Creek (Kenya, East Africa). Journal of the Marine Biological Association of the United Kingdom 94 (5):865-877. <https://doi.org/10.1017/S0025315414000290>
- Garekae, H., O. T. Thakadu, and J. Lepetu. 2017. Socio-economic factors influencing household forest dependency in Chobe enclave, Botswana. Ecological Processes 6:40. <https://doi.org/10.1186/s13717-017-0107-3>
- Giliba, R. A., E. K. Boon, C. J. Kayombo, L. I. Chirenje, and E. B. Musamba. 2011. The influence of socio-economic factors on deforestation: a case study of the Bereku forest reserve in Tanzania. Journal of Biodiversity 2(1):31-39. <https://doi.org/10.1080/09766901.2011.11884727>
- Goldberg, L., D. Lagomasino, N. Thomas, and T. Fatoyinbo. 2020. Global declines in human-driven mangrove loss. Global Change Biology 26(10):5844-5855. <https://doi.org/10.1111/gcb.15275>
- Gullström, M., M. Dahl, O. Lindén, F. Vorhies, S. Forsberg, R. O. Ismail, and M. Björk. 2021. Coastal blue carbon stocks in Tanzania and Mozambique: support for climate adaptation and mitigation actions. International Union for Conservation of Nature, Gland, Switzerland.
- Handavu, F., P. W. C. Chirwa, and S. Syampungani. 2019. Socio-economic factors influencing land-use and land-cover changes in the miombo woodlands of the Copperbelt province in Zambia. Forest Policy and Economics 100:75-94. <https://doi.org/10.1016/j.forpol.2018.10.010>
- Hennink, M. M. 2014. Focus group discussions: understanding qualitative research. Oxford University Press, New York, New York, USA.
- Herr, D., J. Blum, A. Himes-Cornell, and A. Sutton-Grier. 2019. An analysis of the potential positive and negative livelihood impacts of coastal carbon offset projects. Journal of Environmental Management 235:463-479. <https://doi.org/10.1016/j.jenvman.2019.01.067>
- Himberg, L. M. 2016. Mangroves and urbanization: systems in transition: a study of social-ecological systems of mangroves in Dar es Salaam, Tanzania. Thesis. Norwegian University of Life Sciences, Ås, Norway.
- Inoni, O. E. 2009. Effects of forest resources exploitation on the economic well-being of rural households in Delta State, Nigeria. Agricultura Tropica et Subtropica 42(1):20-27.
- Kanyange, N., P. Kimani, P. Onyango, S. Sweenarain, and Y. Yvergniaux. 2014. Performance assessment of beach management units along the coastline of Kenya and Tanzania. Indian Ocean commission smartfish technical report SF/2014/47. Food and Agriculture Organization, Rome, Italy.
- Katikiro, R. E. 2016. Improving alternative livelihood interventions in marine protected areas: a case study in Tanzania. Marine Policy 70:22-29. <https://doi.org/10.1016/j.marpol.2016.04.025>
- Kilahama, F. 2008. Impact of increased charcoal consumption to forests and woodlands in Tanzania. Tanzania Association of Foresters, Dar-es-Salaam, Tanzania. <http://coastalforests.tfcg.org/pubs/Charcoal&Forests.pdf>
- Kimirei, I. A., M. M. Igulu, M. Semba, and B. R. Lugendo. 2016. Small estuarine and non-estuarine mangrove ecosystems of Tanzania: overlooked coastal habitats? Pages 209-226 in S. Diop, P. Scheren, and J. Machiwa, editors. Estuaries: a lifeline of ecosystem services in the Western Indian Ocean. Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-319-25370-1_13
- Lamtane, H. A., A. J. R. Nyirenda, A. W. Mwandya, N. A. Madalla, and B. V. Mnembuka. 2014. Assessment of mangrove status and fish community in Pangani estuary. Sokoine University of Agriculture (SUA), Tanzania. <http://www.taccire.sua.ac.tz/handle/123456789/463>
- Maina, J. M., J. O. Bosire, J. G. Kairo, S. O. Bandeira, M. M. Mangora, C. Macamo, H. Ralison, and G. Majambo. 2021. Identifying global and local drivers of change in mangrove cover and the implications for management. Global Ecology and Biogeography 30(14):2057-2069. <https://doi.org/10.1111/geb.13368>
- Mainoya, J. R., S. Mesaki, and F. F. Banyikwa. 1986. The distribution and socio-economic aspects of mangrove forests in Tanzania. Pages 87-95 in E. P. Kunstadter, E. C. F. Bird, and S. Sabhasri, editors. Man in the mangroves. United Nations University, Tokyo, Japan.
- Mangora, M. M. 2011. Poverty and institutional management stand-off: a restoration and conservation dilemma for mangrove forests of Tanzania. Wetlands Ecology and Management 19 (6):533-543. <https://doi.org/10.1007/s11273-011-9234-2>
- Mangora, M. M., B. R. Lugendo, M. S. Shalli, and S. Semesi. 2016. Mangroves of Tanzania. Pages 33-49 in J. O. Bosire, M. M. Mangora, S. Bandeira, A. Rajkaran, R. Ratsimbazafy, C. Appadoo, and J. G. Kairo, editors. Mangrove of the Western Indian Ocean: status and management. WIOMSA, Zanzibar Town, Tanzania.
- Mangora, M. M., and M. S. Shalli. 2014. Sacred Mangrove Forests: who bears the pride? Pages 291-305 in M. Behnassi, S. A. Shahid, and N. Mintz-Habib, editors. Science, policy and politics of modern agricultural system. Springer, Dordrecht, The Netherlands. https://doi.org/10.1007/978-94-007-7957-0_20
- McNally, C. G., E. Uchida, and A. J. Gold. 2011. The effect of a protected area on the tradeoffs between short-run and long-run benefits from mangrove ecosystems. Proceedings of the National Academy of Sciences of the United States of America 108 (34):13945-13950. <https://doi.org/10.1073/pnas.1101825108>

- Ministry of Natural Resource and Tourism (MNRT). 2015. National forest resources monitoring and assessment of Tanzania mainland. MNRT, Dar es Salaam, Tanzania. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKewji5_65xqL4AhXNbsAKHQ_NODm-YQFnoECAIQAQ&url=https%3A%2F%2Fwww.tfs.go.tz%2Fuploads%2FNFAFORMA_REPORT.pdf&usq=AOvVawlwNQ58F4Gbm-KL90ZUZ6P38
- Monga, E., M. M. Mangora, and J. S. Mayunga. 2018. Mangrove cover change detection in the Rufiji Delta in Tanzania. *Western Indian Ocean Journal of Marine Science* 17(2):1-10. <https://doi.org/10.4314/wiojms.v17i2.1>
- Mshale, B., M. Senga, and E. Mwangi. 2017. Governing mangroves: unique challenges for managing Tanzania's coastal forests. CIFOR and USAID Tenure and Global Climate Change Program, Washington, D.C., USA.
- Mwandya, A. W., M. Gullström, M. H. Andersson, M. C. Öhman, Y. D. Mgaya, and I. Bryceson. 2010. Spatial and seasonal variations of fish assemblages in mangrove creek systems in Zanzibar (Tanzania). *Estuarine, Coastal and Shelf Science* 89(4):277-286. <https://doi.org/10.1016/j.ecss.2010.08.002>
- Mwansasu, S. 2016. Causes and perceptions of environmental change in the mangroves of Rufiji Delta, Tanzania: implications for sustainable livelihood and conservation. Dissertation. Stockholm University, Stockholm, Sweden.
- Nagelkerken, I., S. J. M. Blaber, S. Bouillon, P. Green, M. Haywood, L. G. Kirton, J. O. Meynecke, J. Pawlik, H. M. Penrose, A. Sasekumar, and P. J. Somerfield. 2008. The habitat function of mangroves for terrestrial and marine fauna: a review. *Aquatic Botany* 89(2):155-185. <https://doi.org/10.1016/j.aquabot.2007.12.007>
- Nchimbi, A. A., M. S. Shalli, N. S. Jiddawi, and M. M. Mangora. 2020. Corrigendum to "Socioeconomic determinants of mangrove exploitation and seagrass degradation in Zanzibar: implications for sustainable development." *Journal of Marine Sciences* 2020:7635268. <https://doi.org/10.1155/2020/7635268>
- Newton, P., D. C. Miller, M. A. A. Byenkya, and A. Agrawal. 2016. Who are forest-dependent people? A taxonomy to aid livelihood and land use decision-making in forested regions. *Land Use Policy* (57):388-395. <https://doi.org/10.1016/j.landusepol.2016.05.032>
- Ngomela, A. 2007. The contribution of mangrove forests to the livelihoods of adjacent communities in Tanga and Pangani districts. Thesis. Sokoine University of Agriculture, Morogoro, Tanzania.
- Njana, M. 2015. Biomass estimation and carbon storage in mangrove. Dissertation. Sokoine University of Agriculture, Morogoro, Tanzania.
- Njana, M. A. 2020. Structure, growth, and sustainability of mangrove forests of mainland Tanzania. *Global Ecology and Conservation* 24:e01394. <https://doi.org/10.1016/j.gecco.2020.e01394>
- Nyangoko, B. P., H. Berg, M. M. Mangora, M. Gullström, and M. S. Shalli. 2021. Community perceptions of mangrove ecosystem services and their determinants in the Rufiji Delta, Tanzania. *Sustainability* 13(1):63. <https://doi.org/10.3390/su13010063>
- Okello, J. A., V. M. Alati, S. Kodikara, J. Kairo, F. Dahdouh-Guebas, and N. Koedam. 2019. The status of Mtwapa Creek mangroves as perceived by the local communities. *Western Indian Ocean Journal of Marine Science* 18(1):67-81. <https://doi.org/10.4314/wiojms.v18i1.7>
- Okoth, D. O. 2015. Performance of BMU in mangrove protection: a case of Mlingotini Village in Bagamoyo District. *Journal of Coastal Zone Management* 18(03):410.
- Orchard, S. E., L. C. Stringer, and C. H. Quinn. 2016. Mangrove system dynamics in Southeast Asia: linking livelihoods and ecosystem services in Vietnam. *Regional Environmental Change* 16(3):865-879. <https://doi.org/10.1007/s10113-015-0802-5>
- Romañach, S. S., D. L. DeAngelis, H. L. Koh, Y. Li, S. Y. Teh, R. S. Raja Barizan, and L. Zhai. 2018. Conservation and restoration of mangroves: global status, perspectives, and prognosis. *Ocean and Coastal Management* 154:72-82. <https://doi.org/10.1016/j.ocecoaman.2018.01.009>
- Roy, A. K. D., K. Alam, and J. Gow. 2013. Community perceptions of state forest ownership and management: a case study of the Sundarbans mangrove forest in Bangladesh. *Journal of Environmental Management* 117:141-149. <https://doi.org/10.1016/j.jenvman.2012.12.004>
- Saunders, F., S. M. Mohammed, N. Jiddawi, K. Nordin, B. Lundén, and S. Sjöling. 2010. The changing social relations of a community-based mangrove forest project in Zanzibar. *Ocean and Coastal Management* 53(4):150-160. <https://doi.org/10.1016/j.ocecoaman.2010.01.006>
- Semesi, A. K. 1992. Developing management plans for the mangrove forest reserves of mainland Tanzania. *Hydrobiologia* 247:1-10. <https://doi.org/10.1007/BF00008199>
- Semesi, A. K. 1998. Mangrove management and utilization in Eastern Africa. *Ambio* 27(8):620-626.
- Spalding, M. D., and M. Leal. 2021. The state of the world's mangroves 2021. Global Mangrove Alliance. <https://www.mangrovealliance.org>
- Sperandei, S. 2014. Understanding logistic regression analysis. *Biochemia Medica* 24(1):12-18. <https://doi.org/10.11613/BM.2014.003>
- Suman, D. O. 2019. Mangrove management: challenges and guidelines. Pages 1055-1079 in G. M. E. Perillo, E. Wolanski, D. R. Cahoon, and C. S. Hopkinson, editors. *Coastal wetlands: an integrated ecosystem approach*. Elsevier, Amsterdam, The Netherlands.
- Tanner, M. K., N. Moity, M. T. Costa, J. R. Marin Jarrin, O. Aburto-Oropeza, and P. Salinas-de-León. 2019. Mangroves in the Galapagos: ecosystem services and their valuation. *Ecological Economics* 160:12-24. <https://doi.org/10.1016/j.ecolecon.2019.01.024>
- Truee, T., Y. M. Ngaga, H. Meilby, J. F. Lund, G. Kajembe, S. Iddi, T. Blomley, I. Theilade, S. A. O. Chamshama, K. Skeie, M. A. Njana, S. E. Ngowi, J. A. K. Isango, and N. D. Burgess. 2014. Does participatory forest management promote sustainable forest

utilisation in Tanzania. *International Forestry Review* 16 (1):23-38. <https://doi.org/10.1505/146554814811031279>

Turpie, J., Y. Ngaga, and F. Karanja. 2005. Catchment ecosystems and downstream water: the value of water resources in the Pangani basin, Tanzania. IUCN-The World Conservation Union, Gland, Switzerland. <https://lib.icimod.org/record/12146>

United Nations Environment Programme World Conservation Monitoring Centre (UNEP). 2014. The importance of mangroves to people: a call to action. J. van Bochove, E. Sullivan, T. Nakamura, editors. UNEP, Cambridge, UK.

United Republic of Tanzania (URT). 2013. 2012 Population and housing census. Bureau of Statistics, President's Office Planning Commission, Dar es Salaam, Tanzania. <https://www.nbs.go.tz/index.php/en/census-surveys/population-and-housing-census>

Wagner, G. M., and R. Sallema-Mtui. 2016. The Rufiji estuary: climate change, anthropogenic pressures, vulnerability assessment and adaptive management strategies. Pages 183-207 in S. Diop, P. Scheren, and J. Machiwa, editors. *Estuaries: a lifeline of ecosystem services in the Western Indian Ocean*. Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-319-25370-1_12

Wang, Y., G. Bonyng, J. Nugranad, M. Traber, A. Ngusaru, J. Tobey, L. Hale, R. Bowen, and V. Makota. 2003. Remote sensing of mangrove change along the Tanzania coast. *Marine Geodesy* 26(1-2):35-48. <https://doi.org/10.1080/01490410306708>

Wells, S., M. Samoily, S. Makoloweka, and H. Kalombo. 2010. Lessons learnt from a collaborative management programme in coastal Tanzania. *Ocean and Coastal Management* 53 (4):161-168. <https://doi.org/10.1016/j.ocecoaman.2010.01.007>

Wylie, L., A. E. Sutton-Grier, and A. Moore. 2016. Keys to successful blue carbon projects: lessons learned from global case studies. *Marine Policy* 65:76-84. <https://doi.org/10.1016/j.marpol.2015.12.020>

Yates, J., and T. Leggett. 2016. Qualitative research: an introduction. *Radiologic Technology* 88(2):225-231.

Appendix 1. Focus group discussions and key informant interviews in the study area.

Table A1: Demographic information for the participants of focus group discussions and key informant interviews in the study area.

Site	Method	Gender	Age	Occupation/Responsibility
Bweni	Focus group discussion	M	36	Fisher
		M	36	Fisher
		M	45	Mangrove cutter
		M	40	Mangrove cutter
		F	25	Food vendor
		F	30	Food vendor
		F	38	Farmer
	Key informant Interviews	M	42	Farmer
		M	40	Village Chairperson
		F	40	BMU Chairperson
		M	43	BMU Secretary
		F	74	Elder
		M	63	Elder
		M	36	VNRC Chairperson
Pangani Magharibi	Focus group discussion	F	34	VNRC member
		M	50	Fisher
		F	39	Fisher
		M	32	Mangrove cutter
		M	35	Mangrove cutter
		F	29	Food vendor
		M	33	Food vendor
	Key informant interviews	F	27	Farmer
		M	44	Farmer
		M	46	Village Chairperson
		M	30	BMU Chairperson
		F	28	BMU Secretary
		F	28	Elder
		F	24	Elder
M	39	District Forest Officer		
M	50	District Conservation Manager		

Appendix 2. Household Questionnaire

The aim of this research is to understand the factors that drive mangrove resource extraction, as well as community perceptions on the effectiveness and enforcement of mangrove management measures in the Pangani River Estuary. Your participation in this study is a source of necessary data that will help to achieve the stated goal. You are kindly asked consent to participate and provide sincere information. Information provided will be treated confidentially and only used for this research.

Name of respondent Questionnaire No.....
Village/site Date.....

1. Gender of the household head? 1= Male 2= Female
2. Are you the head of the household? 1= Yes 2= No
3. If no, state your relationship to head of household.....
4. Age of household head?.....
5. Marital status of household head? 1= Married 2= Single, 3= Divorced, 4= Widow
6. What is highest level of education (years of study) of the household head?.....
7. What is the main occupation of household head?
8. What is the size of your household?
9. How long have you been settled/ lived in this area?.....
10. Average household income per month (Tanzania Shillings)
11. Does your household livelihood depend on any resources extracted from mangroves for livelihoods? 1=Yes 2=No
12. If yes, which resources does your household collect from the mangroves and why?
13. Who often collect or harvesting above resources in your family?
14. If you could use Oryx/ kerosene/ electricity to replace extraction of mangroves as source of energy for cooking, how much could you pay for one month in Tanzania Shillings?
15. Please give reasons for the stated amount in above
16. List mangrove forests conservation initiatives found in your area (past and present) and narrate on their success and failure.
17. From question I- VII, you're required to indicate your feelings /opinions/thought by reading the statement given then decide you answer based on your knowledge of mangrove management and conservation in the study area (1 = strongly disagree, 2= disagree, 3 = neutral, 4 = agree or 5 = strongly agree.
 - I. The establishment of beach management units (BMUs) has improved conditions of mangroves in your area
 - II. BMUs are active in facilitating the enforcement of forests and environment by-laws
 - III. Promotion of collaborative arrangement for mangrove conservation by government fully involved local people

- IV. You are willing to contribute and compensate for the management of mangrove forests in your area due to collaborative
 - V. Government institutions through Tanzania Forest Services Agency and District Forest Office are strong in enforcing regulations related to mangroves.
 - VI. Village governments are capable in solving conflicts related to mangrove uses
 - VII. Establishment of management initiatives like community collaborative management arrangements such as joint forest management in your area has enhanced community awareness about conservation.
18. What do you think should be done to conserve mangroves while improving livelihoods of dependent community?