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Research Article

Perception of marine fisheries resources in Tanzania from past to present: Evidence through local knowledge

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Abstract

How communities interact with natural resources is a critical topic of discussion around the world. In this study, we approach the phenomenon from the fishers' perspective. This study aims to explore the perception and knowledge of local fishers regarding fishing practices. With the help of interviews and focus group discussions with residents of three fishing communities located along the Indian Ocean coast in Tanzania, the research discovered that these local fishers are not just engaged in catching fish; they also possess a valuable understanding of the ocean and fishing practices. The study concludes that incorporating the perception and knowledge of these local fishermen into future fisheries management initiatives could be highly beneficial.

1. Introduction

Fisheries resources remain critical in supporting livelihoods worldwide for health and wealth support (FAO, 2014). Employment in the fisheries sector continues to proliferate, with an estimated 58.3 million people engaged in fisheries in 2012 (FAO, 2014). Globally, FAO estimates that fisheries provide livelihoods to about 10 - 12 percent of the world's population. Despite the importance of fisheries, studies have demonstrated that many stocks of fish resources are in crisis (Anticamara et al., 2011; FAO, 2014). The ocean waters that border Tanzania are no exception to this trend of declining fish stocks (Erriksonn et al., 2010; Silas & Gullstrom, 2020).

Research has revealed that local communities possess valuable knowledge about the functions of the ecological systems they most frequently interact with (Gadgil et al., 1993; Berkes et al., 2000). Local communities and indigenous people have value systems that commonly link them to the natural world (Awuah-Nyamekye, 2009; Evans & Jackson, 2001; Infield et al., 2013). A study from Ghana, for example, demonstrates how the Akan indigenous religion and culture have been shaping how their community perceives the environment and how they have been relating to it over time (Awuah-Nyamekye, 2009). In a more contemporary context, Greider and Garkovich (1994) demonstrate how people's understanding of nature relies on cultural expressions used to define them in that space. In other words, the natural environment of any given cultural group carries symbolic meanings and definitions that are reflective of the respective and often dominant cultural group. As a result, interactions with a natural resource, such as a marine environment, are equally shaped by the distinct and culturally-bounded meanings that people attach to the resource.

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Local knowledge is defined as "a body of knowledge built up by a group of people through generations of living in close contact with nature" (Johnson, 1992). Local knowledge is of utmost importance in effectively managing a diversity of natural resource contexts (Bulengela et al., 2020; Folke, 2009; Goldman et al., 2018; Sumeldan et al., 2021; Watson et al., 2003). Local communities can provide valuable and unique information about the current and historical state of natural resources that can often be difficult to ascertain in other ways. The communities can provide information that extends the science beyond biological or ecological parameters to include critical variables such as the social and cultural dynamics between people and the resource, including critical traditions and norms that are not easily captured through typical natural science methodologies (Sumeldan et al., 2021). Berkes et al. (2000) have noted the value of a diversity of traditional practices for ecosystem management, such as multiple species management, resource rotation, succession management, landscape patchiness management, and other ways of responding to and managing pulses and ecological surprises. These traditional practices, which had not received much acceptance until more recently, have proven to be critical for sustainable resorce management.

Studies on local knowledge have also shown the its value more directly in fisheries management (Johannes et al., 2000; Leite & Gasalla, 2013). In their investigation of fishers' local knowledge, Johannes et al. (2000) found that fishers can provide critical information on such things as inter-annual, seasonal, lunar, diel, tide-related, and habitat-related differences in the behavior and abundance of target species and on how this knowledge, in turn, influences fishing strategies. Local knowledge of fisheries can also help improve the management of fish stocks and rebuild marine ecosystems (Adrianto et al., 2011; Johannes, 2000). Describing the value and uniqueness of local knowledge, Thomas (2017) asserts that "this body of knowledge may offer insights unavailable from any other sources".

Many studies have demonstrated the role of human actions and their negative impacts on fisheries (Pauly et al., 2002; Petit & Shipton, 2012; Stobutzki et al., 2006). For example, it has been shown that fish stocks are being overexploited in many places worldwide (FAO, 2020; Pauly et al., 2002). However, it has been recognized that human influences on the environment, including fisheries resources, are different in all places. This is due to social and contextual factors such as norms and values, which shape the unique fishing practices of respective fishing communities (Cinner & McClanahan, 2006; Eythorsson, 1993; Santha, 2008). Equally important are cultural changes that influence how fishers relate to natural resources (Cinner & McClanahan, 2006; Santha, 2008). As a result, researchers have argued that understanding and incorporating local knowledge and perceptions are vital for future management and policy decisions that may help slow or even reverse the fisheries crisis (see Bassett & Peimer, 2015; Carmack & Macdonald, 2008; Roberts, 2007; Thornton & Scheer, 2012).

The idea of undertaking a study of the Indian Ocean in Tanzanian fishing communities was inspired by a desire to explore fishers' perceptions and knowledge regarding the fisheries of the area. This desire emanated from current narratives about changes in fish captures in ocean environments that have narrowly incorporated fishers' knowledge and perceptions (Braulik et al., 2020; de la Torre-Castro, 2006; Katikiro et al., 2015). This study illustrates the value and utility of fishers' perception and knowledge and culturally bounded narratives as a vital, and the most significant, data source for fisheries management planning. This study asks how fishers perceive fisheries in the Indian Ocean. What influences their decisions regarding fishing practices? This study applied a qualitative approach to explore fishers' knowledge and perceptions of fishing.

This study aims to explore fishers' perception and knowledge regarding fisheries in the study area. To capture this, the study applied a cultural perspective. Cultural perspective focuses on the fact that cultural values and social constructions of nature, including landscape, are at the center of relationships between nature and communities (Li et al., 2016; Posey, 1999; Schama, 1996). Local communities and indigenous people have value systems that link them to the natural world (Awuah-Nyamekye, 2009; Evans & Jackson, 2001; Infield et al., 2013). A study from Ghana, for example,

demonstrates how the Akan indigenous religion and culture have been shaping how their community perceives the environment and how they have been relating to it (Awuah-Nyamekye, 2009). This perspective is believed to help capture how communities interact with the ocean and how this interaction shapes and influences their fishing practices.

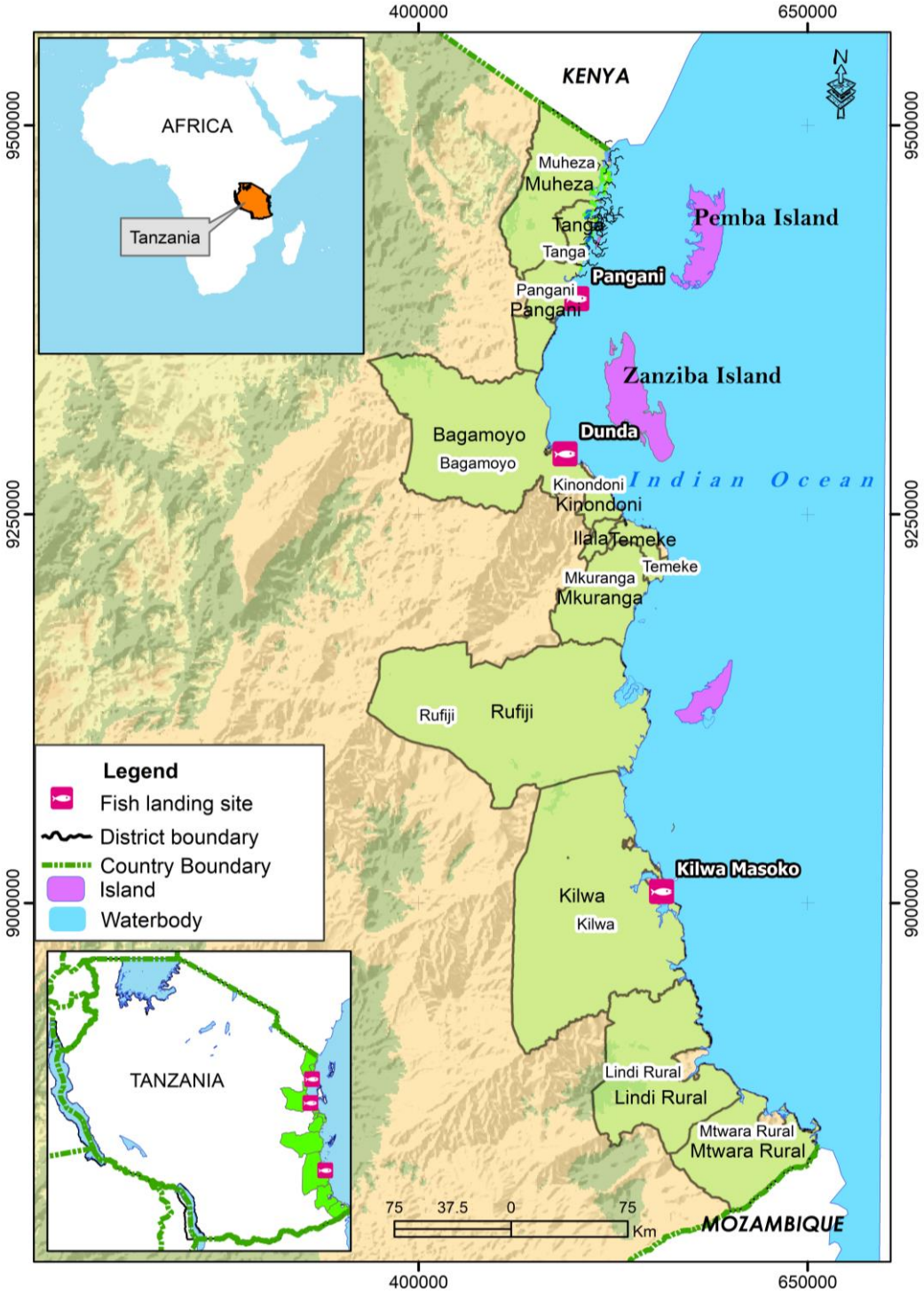

Figure 1 Map showing the study communities.

2. Materials and Methods

2.1 Study communities

This study was conducted at three fishing communities along the Tanzanian coast on the Indian Ocean: Kilwa in the Lindi region, Pangani-kipungwi in the Tanga region, and Bagamoyo in

the Coast region. These sites were selected because they are among the oldest fishing communities in Tanzania on the Indian Ocean. The study aimed to explore local knowledge and how such knowledge influences the fishing practices of the study communities. Thus, the older fishing communities are assumed to be the most salient locations to provide a rich and vital understanding of historical fishing activities and local knowledge over time (**Figure 1**).

2.2 Data collection

This study focused on socio-cultural factors regarding fish catches in coastal communities, such as cultural values, norms, and local knowledge. This study adopted a qualitative research approach to obtain data on fishing practices and local knowledge of coastal ecosystems in Tanzania. Data were generated over six months between January and June 2021. In the process, the researcher relied heavily on participant observation, in-depth interviews, and focus group discussions for all data collection.

Table 1 Number of interviews, distribution among landing sites, and demographics of respondents.

Method	Category of participants	Landing sites					
	Gender	Kipumbwi		Kilwa		Bagamoyo	
		Male	Female	Male	Female	Male	Female
In-depth interviews	Fishers/boat owners	6	1	7	0	8	0
	Fish processors	1	3	1	3	1	3
	BMU leaders	1	1	1	1	1	1
	Fisheries officers	1	0	1	0	1	0
	Elders/community leaders	1	1	1	0	1	0
Focus Group Discussions (FGDs)	FGD-Fishers and boat owners	5	0	8	0	7	0
	FGD-Fish processors & traders	0	6	0	6	0	7

Forty-six interviews were conducted in the three study communities over six months. Data collection was done in two phases. This enabled the researcher to conduct preliminary data analysis (after the first round) and identify gaps and collect more data during the second phase. Discussions focused on fishers/boat owners, fish processors, fisheries officers, Beach Management Unit (BMU) leaders, and community leaders. A Beach Management Unit consists of a group of devoted, local stakeholders in a fishing community, whose main function encompasses the management, conservation, and protection of fish in their locality through collaboration with the government (URT, 1997). In addition to key informant interviews, six Focus Group Discussions (FGDs) were conducted, two for each village. The first group was with fishers/boat owners, and the second group was with fish processors and traders. FGDs were conducted during the first and second phases of fieldwork. Participants for each focus group were selected from individuals who participated in the key informant interview sessions. Individuals recruited to participate in the focus groups demonstrated a more in-depth understanding of the lake fishery. The FGDs aimed to explore the shared experiences of fishing community members and their perceptions and knowledge regarding ocean fishery as more of a collective, more clearly illustrating shared norms and cultural expectations. Cultural perspective guided this study to explore fishers' knowledge and perceptions regarding fisheries of the area.

Observation was also utilised throughout the entire process of data collection. The researcher observed major livelihood activities, daily routines of community members, how people interacted with the ocean, fishing gear used, fish landing, fish processing activities, and fish selling. The

observation method was used as commentary and as a means to confirm what was said by respondents.

2.3 Data analysis

Data processing encompassed several stages. The N-Vivo version 11 software helped sort and organise raw data collected in the fieldwork; this included coding and identifying themes and sub-themes. Then, data were analysed using a thematic approach. During the analysis, three main themes emerged which are related to the objective of this study; namely, a perceived decline in fish catch, declining environmental quality of the ocean, and unsustainable fishing practices-changing fishing practices.

2.4 Ethical considerations

Before data collection began, all procedures for gaining permission to conduct the study involving human subjects were followed. This included receiving final research clearances from all relevant authorities through the Mwalimu Nyerere Memorial Academy. In the field, researchers ensured informed consent by providing clear explanations of the objective of this study to the informants and ensuring that each participant understood that their participation was voluntary and that the information they shared would remain confidential and only be used for this study. Pseudonyms were used in the study to ensure confidentiality.

3. Results

In reading data and making comparisons, several concepts and themes were identified. Examples of concepts identified include "*bahari ndo shamba letu*"- the Ocean is our farm, "*uvuvi wa kisasa*"- new fishing practices, and "*uvuvi wa mwambani*"- the fishery in the coral reefs. In coding the interviews, several themes emerged related to local knowledge and perceptions about the ocean environment and fishery. Quotes related to each theme were grouped to form a typical representation of informants' narratives. A total of three themes emerged:

- Perceived decline in fish catch
- Declining environmental quality of the ocean
- Unsustainable fishing practices: changing fishing practices

3.1 Perceived declined fish catches

Fishers in the study area identified a diversity of species that could readily be found in the Indian Ocean, including *Jodari* (tuna and tuna-like fish), *Uono* (small pelagic) *Changu* (reef fishes), *Pweza* (prawns), *nguva* (large mammal dugong), *Msusa* (common silver-biddy), *Kolekole* (jacks), and *Taa* (sharks). Respondents shared that the abundance of these species 20 years ago was much higher compared to the present time. In a focus group discussion, one elder who had fished for over 40 years noted that;

> *"When I was fishing, there was plenty of fish. We were catching jodari and nguru in large quantities. Nevertheless, nowadays, we do not understand what has happened. We do not know why the catch has gone down. It is scarce nowadays to catch these fish". (67 Person, FGD Kipumbwi)*

To better understand the perceived causes of changes in fish abundance, fishers were asked to share their views about what they believed to be causing such declines in fish catches over time. Fishers consistently mentioned three causes. First, introducing new technology such as powerful engines, kerosene pressure lamps, and ring nets were all noted as contributing to a shift in the fishery from a historic subsistence fishery to commercial fishing. This shift to a more commercial-style

fishery via technology inevitably led to increased catches that threatened the sustainability of the overall fishery.

Second, fishers noted the growth of the fish market and the increasing perception of fish as not only a source of subsistence food but also as a source of external income. It was noted that, from the 1980s, there was a growing demand for fish in different places such as Dar es Salaam, Arusha, and even neighboring countries, particularly the Democratic Republic of the Congo (DRC). This increasing demand for fish attracted more people from the mainland to the ocean communities to engage in fishery as a livelihood.

> *"This landing site alone has over 200 boats. Furthermore, on every landing site, one visit will find several boats or more. All boats go fishing in the deep waters (vyombo vyote vinaelekea eneo moja). The number of fishers has also gone up. Here we have more than 2000 fishers. Every boat has an average of 20 people. Nowadays, young people aged 15 to 18 engage in fisheries; this was not common in the past. Hardships in the families have forced these young boys to confront fisheries. People from different parts of the country are coming to the ocean to immerse themselves in fisheries. These include people from upcountry, such Sambaa, Maasai, Zigua, Sukuma. Almost every tribe is represented here (kila kabila unalolijua wewe wapo) (IDI, Kipumbwi).*

Participants' third reason for the decline in fish abundance was introducing what people called "*uvuvi wa kisasa*"- new fishing techniques. When referring to *uvuvi wa kisasa*, respondents referred to new fishing practices that were not perceived as environmentally friendly. These new fishing techniques were more directly associated with destroying the ecosystem and the fish resources. Examples of such fishing practices included dynamite fishing, *juya* (beach seine), and ring nets that use minimal mesh. During an interview, one respondent commented that;

> *"This new generation of fishers is very problematic; they do not care about the environment; all they know is to get fish (kupata tu riziki). They do not care about the gear they use to catch fish. For example, the use of dynamite (uvuvi wa mabomu) has destroyed coral reefs. Nowadays, fishers have also introduced ring nets that catch fish day and night. So, there is no room for fish to rest and reproduce; they are searched day and night. That is critically affecting fish availability in our area". (IDI, fishers, Kilwa).*

3.2 Declining environmental quality of the ocean over 15 years

This study explored the significance of several habitat issues: mangrove cover and coral reef. The motivation behind this focus was to explore the local community's knowledge about the marine environment and observed changes over time. Respondents shared different observations on the issues overall, with some habitat issues being perceived as better than 15 years ago, and some being perceived as having declined significantly; these perceptions also varied by community landing site.

3.2.1 Mangrove cover and beach tree cover

Mangrove and beach tree cover were perceived to have declined in the past 15 years. Conversations with community members in Kipumbwi revealed that people did not cut down the mangroves in the past. People used to collect only the dry branches of mangrove trees. However, in more recent years, people have started to cut down the mangroves, which has a direct negative impact on the health of the fishery ecosystem. In a focus group discussion, one respondent commented that;

> *"In the past, people did not tend to cut down mangroves. People valued the trees based on the benefits they were getting from the trees. People were using the mangroves but were taking those that dried out themselves (walikuwa wanafuata koko zilizokimaa hadi zikakauka). So, they could collect them in one area and then search for the same in other places. Generally, there was no cutting down of mangroves. Nowadays, people are cutting down the mangroves". (FGD, Kipumbwi)*

Several factors were attributed to the decline in mangrove and beach tree cover quality. One of the essential factors mentioned was the increase in demand for mangrove trees that fueled the mangrove market, leading to the increased harvesting of the trees. Hamis, one of the elderly villagers, had the following to say;

> *"About 20 years ago, this area had dense coverage of mangroves. Recently, mangroves have declined intensely because of cutting them down. In the past, people were not cutting down the mangroves. People are cutting them for building purposes but primarily for business. Mangrove demand has increased recently, especially in Zanzibar and Dar es Salaam. People are selling mangroves for fuel, especially firewood and charcoal. The growth of fishing activities has also accelerated the cutting down of mangroves because the trees are strong/hard and, thus, very useful for building boats". (IDI, elders, Kipumbwi)*

Despite the decline of the mangroves and beach trees in the past, respondents noted that there had been some efforts to improve mangrove coverage in the area in the past four years. Such measures include engaging local communities in planting new mangroves and planning to protect the existing mangrove areas better. Informants noted that these efforts have resulted in a slight improvement in the mangroves in recent years. At the time of this study, researchers observed some of these improvements and noted that there appeared to be good coverage of mangroves returning to the area. However, this was not followed equally among all four study sites. In Bagamoyo and Kilwa, respondents noted that they still saw a general decline in the area's mangrove cover and beach trees. Most of affected areas include Bagamoyo, Milingotini, Mbweni, Kigamboni and Kuyuni (**Figure 2**).

Figure 2 Clearing of mangroves in Bagamoyo, along the Indian Ocean, taken during fieldwork.

In discussions with the informants, they noted that mangroves and beach trees are vital for fish well-being and reproduction. Respondents shared how mangrove and beach trees serve as

essential sources of food and habitat for most fish species and provide numerous other benefits to the marine environment. In an interview with elders, one respondent made the following comment;

> *"Mangroves have many benefits to the marine environment. First, they help to protect the beach from being washed by waves (inasaidia bahari isipande juu). Mangroves also serve as breeding sites for many fish species. The trees serve as a habitat for many fish species, such as mikunga, Kamba, taa, kaa and many others. The shades of mangroves form good feeding places for fish. So many fish feed in the mangroves. Lack of mangrove cover affects fish in many ways: no food, no home, and their life is disturbed. Some are forced to go into the deep waters. Sometimes, moving from one point to another- there is no place where they can settle down and enjoy their life (wanakosa utulivu na kufurahia maisha yao)". (Community leader, Bagamoyo)*

Clearing mangroves and beach trees, therefore, has significant negative impacts on both fish reproduction and the overall health of the fishery. Informants of this study linked the perceived decline in fish catches in the ocean to harvesting mangrove and beach tree cover. The decline of fish species such as *kaa*, *kamba*, and *mikunga* directly resulted from the increased clearing of mangroves and beach trees.

3.2.2 Coral reefs

Among the various marine environmental issues that the participants raised, coral reefs were perceived to be suffering the most from decline and destruction. Respondents noted that, 20 years ago, coral reefs were better off than they are now.

> *"In the past, coral reefs were in perfect condition. Fishers were not fishing in the coral reefs, but fishers are currently mainly fishing in the coral reef areas. This has destroyed the coral reefs". (IDI, fish processor, Bagamoyo)*

The quote above implies that there was a period when fishers were not fishing in the coral reefs and that they actively avoided them. Fishing was primarily done a short distance from the beach, so as not to disturb the coral reef areas. People were not fishing in the coral reefs but in the shallow waters (*kwa hiyo wao walikuwa hawavui kule, walikuwa wanavua kwenye mchanga*). To better understand why fishers avoided the coral reef areas in the past, respondents were asked why people avoided these areas. Respondents shared that this was seen as a way to actively preserve the fish, because fish reproduced in the coral reefs, and that this practice was customary among the fishers. As Musa shares:

> *"People were not fishing in the coral reefs because those were the places where fish were reproducing. So, it was customarily known that people should not fish in the coral reefs. People were supposed to fish in the shallow waters and catch a lot. However, with time, people started disregarding the norms (taratibu watu waanza kupuuza mila zilizokuwa zinakataka kuvua mwambani) and fish in the coral reefs. This was mainly due to the decline in fish catches in the 1990s". (Musa, BMU, Kilwa)*

The discussions with fishers revealed that what is destroying the coral reefs is not the act of fishing in the coral reefs *per se*, but rather the use of specific unsustainable fishing practices close to the coral reefs. Informants mentioned two primary fishing practices that they see as contributing to the decline of coral reefs. Respondents also perceived fishing with nets in the coral reefs as causing significant damage to the reefs. Commenting on the matter, Hamza, a retired fisherman at Kipumbwi landing site, had this to say;

> *"Fishing in the coral reefs is mainly done during the daytime; this fishing practice destroys coral reefs because fishers tend to lay their nets between two close coral reefs. They usually*

> *attach their fishing nets to the rocks/coral reefs using nails (wanakuwa wanagonga gonga ile miamba hata kwa misumari). Since the coral reefs have soft materials, it is easier for them to break down. So, when this fishing is repeated several times in the same place, considerable portions of coral reefs are likely to break apart". (IDI, fishers, Kipumbwi)*

This study was also interested in understanding local perceptions about the role of coral reefs in fish availability and productivity. Respondents were asked to share their perceptions about the linkages between coral reefs and fish availability. Throughout the various conversations, respondents consistently believed that coral reefs serve as critical habitats for fish, providing essential breeding grounds and cover for young fish, much like the mangrove and beech tree groves. Mzee Ali, a long-time prawn fisher, had the following to say;

> *"Coral reefs (mwambani) are places many fish species like to stay; it is hard to mention all of them. Some are Kamba, prawn, tuna fish, and so many others. Nevertheless, most fish species generally like to live in the coral reefs because they get "houses to live in" (wapata nyumba za kukaa)- safe places to stay; they obtain their food, there is a conducive place for reproduction. Now, when these places are destroyed, what do we expect? Where will they go to reproduce? How about food? It is total disorganization of their lives". (IDI, fisher, Kilwa)*

Respondents expressed a great deal of concern about the state of the coral reefs. They often spoke about coral reefs as a vital environmental component in fish availability whenever they talked about fisheries. During various observations of different groups of fishers during their leisure time, the informal discussions often focused on the decline in fish catches, the negative impacts of unsustainable fishing practices, such as using dynamite, and how those practices have destroyed most coral reefs.

3.3 Unsustainable fisheries: Changing fishing practices

Another critical theme related to the previous discussion about coral reefs was the perception that the increasingly unsustainable fishery (as noted in the last discussion) resulted in a further decline in fish catches and an increase in fish migration. Respondents indicated that, in the past 15 years, new fishing practices have been introduced in the Indian Ocean, and that such patterns have been destructive, leading to fish migration. Such fishing practices include dynamite fishing and illegal fishing nets in the coral reefs. Respondents indicated that the use of dynamite in the fishery was introduced in the ocean in the late 1980s. One member of a focus group discussion had this comment;

> *"In the ocean, there are big rocks (matumbawe). Some are bigger than this house (pointing at a home). Now dynamite fishers could hit that rock/coral reef. When it is hit, it blasts, and the small pieces of the rocks kill fish. Dynamite fishers, when they reach the fishing grounds, one of the fishers dives, and when he sees fish, he comes back to take the dynamite and place it at the coral reef. After that, he goes back to the fishing boat. Then, the boat moves about 100m from the coral reef where the dynamite is placed. The fishers would then wait for some minutes for the dynamite to blast. When the dynamite blasts, they return to the point and find plenty of fish dead. They then collect fish until the boat is complete and sometimes leave other fish uncollected. They kill many fish, and the coral reef is wholly destroyed (jiwe lote limesambalatika)". (FGD, Fishers, Kipumbwi)*

Dynamite fishery was perceived to be a dominant practice from about the late 1980s to the early 2000s. Respondents noted that the government had made many efforts to abolish the use of dynamite in the fishery, which appears to be a rare practice nowadays. However, the damage to the coral reefs from that practice remains today, as most reefs have not recovered. It was also noted that the fishery contributes to fish migration. In a focus group discussion, one respondent commented that;

> *"Disturbances may result in fish migration. No one likes disturbances. Imagine settling somewhere, and a person comes and disturbs you; you will not be happy. So, this is the same as fish. Fishing practices such as dynamite fishery cause much disturbance to fish. Usually, fish like calm places. When they reside in a particular coral reef, for example, and one day that place is smashed, those who would survive will not return to that place. They would move to a distant place and even deeper waters (wanatoka pale waingia kwenye maji marefu kama pima kumi, kumi na tano, anahamia kule). This is the habit of fish; they do not like threats. They will likely migrate to distant places when you threaten their lives and calmness". (FGD, fisher, Bagamoyo)*

These destructive practices were also linked to other negative impacts, mainly due to noise produced by power generators used for light attraction fishery, especially ring nets that primarily target *uono*- the small pelagic as another type of fishery migration of most fish species, particularly *uono*. In the past ten years, respondents shared how the use of power generators for lighting has gradually increased in the Indian Ocean. The increase in power generators was also directly associated with the decline in fish catch. Power generators were initially introduced to increase the light intensity, which was assumed to attract more fish and improve their catches. Historically, fishers used kerosene and solar power lights, which did not produce the same noise levels. In interactions with respondents, it was revealed that;

> *"The old-generation fishers (wazee wa zamani) had a fishery that did not threaten fish. That is why fish were moving up to the shallow waters. In the past, fish were many, and people were catching a lot. Fish abundance was indeed high compared to the present, but fishers also had a friendly relationship with fish. For example, elders tended to play with dolphins; they did not fish them. Even when they felt other fish species, they did not use violent methods like nowadays. If you get to the fishing grounds, it is a mess; you are in a factory- noise everywhere because of power generators that produce more intense light for the fish attraction". (IDI, fishers, Kilwa)*

The quote above implies that fish like to reside in a calm environment. Thus, prolonged disturbances such as noise may force fish to migrate to other distant places in search of quiet habitats. Thus, migration was associated with the decline in fish catches.

In the interactions with respondents, they further noted significant changes that had taken place in the society and the fishery, influencing how they fish and the productivity of the overall fishery. Describing the situation, Juma, an elder who has been fishing in the ocean for about 50 years now, noted that;

> *"In the past, we were fishing using simple tools such as madema and wavu wa kuchota- scoop nets. We were able to get fish for our meals. Later on, we started fishing for sale. We could sell some fish to meet home needs. Nowadays, some things were not there in the past. We had no fishing practices such as juya (beach seine), utupa and dynamite fishery. These new fishing practices destroy everything (kuna mambo yameningia yanachafua kila kitu). The unstainable fishery is widespread in the ocean, even in this village. People are fishing day and night, trying to catch whatever can be detected. In the past, we did not have such a "needy fishery" (uvuvi wa kinjaa njaa)". (IDI, fishers, Kipumbwi)*

This narrative illustrates how dramatically things have changed, demonstrating how fish abundance in the ocean used to be relatively high and sufficient to meet their needs, and most of the fishing gear used was perceived to be environmentally friendly.

In discussions with respondents at the three research sites, it was generally noted that fishing practices in the past were more sustainable than in recent years. Respondents described this as "*vijana*"- young fishers less concerned with the sustainability of the fishery. The young fishers are

perceived as individuals who do not care about the ocean environment or the sustainability of the fishing but instead focus on just meeting their daily needs by any means possible, no matter how destructive to the long-term health and sustainability of the fishery. As a result, they are perceived as often engaging in unsustainable and illegal fishing practices.

Respondents were also asked what they see as the reasons for the emergence of these "new" fishing practices that they perceive as unstainable. Conversations with respondents revealed that changes had occurred in the broader society, such as increased fish demand in neighboring and distant communities such as Dar es Salaam, Tanga, Arusha, and the Democratic Republic of Congo. This increased demand for fish subsequently attracted people to the ocean to participate in the increasing commercial fishery which has emerged to meet the demand. The new commercial fishery is only concerned with economic gain and is perceived as having little or no concern for the sustainability of the fishery. One respondent commented:

> *"These young fishers are not interested in the ocean or the sustainability of the ocean. In the past, as we fished, we thought about the possibility for us to fish tomorrow (kesho nitavua nini). So, we were careful not to destroy whatever we could fish tomorrow. However, these young people focus on getting some money no matter what. I view the fishery nowadays as income-motivated- seeking quick cash. They focus on earning some money and never bother about the future of the ocean". (IDI, community leader, Kipumbwi)*

Conversations with elders, especially retired fishers, revealed that, apart from the increased commercial fishery, *vijana*- the young anglers- were perceived as having lost a sense of 'valuing the ocean' that elders had. The search for money was described as their primary goal of fishing.

This study was also interested in further exploring the difference between elder and young fishers regarding their specific fishing practices. Respondents described elder fishers as "*walikuwa na hekima*"- they had wisdom. On the other hand, young fishers were defined as people with little understanding. Both elders and young fishers attributed this label of 'wisdom' to only those seen as elders. In a focus group discussion. Gula, a young fisherman who was taught to fish by his grandfather, commented that;

> *"A good example is that dynamite fishery was not there in the past. The fishery emerged only about 20 years ago. In their fishing activities, elders were guided by wisdom (hekima). Their fishing gear was sustainable. For example, they used lines (mshipi) and nets with big mesh sizes. Nevertheless, these young fishers are not guided by wisdom. For instance, as one fish in a particular area may realize that one cannot get matured fish, instead of discontinuing the fishery, one may find individuals forcing others to fish, even immature fish (wamenyana tu ili upate riziki). However, when one uses beach seine to catch whatever can be caught, he/she is destroying even the small ones you could catch in a few days to come (hawa ungewala baadae lakini sasa umewaua). However, elders used wisdom in their fishery. They were very concerned about the impact of their fishery". (FGD, fishers, Bagamoyo)*

The quote illustrates that elders were perceived as being very careful in choosing fishing gear and conscious of the need to utilize ocean resources sustainably. Thus, in their choice of fishing gear, they ensured they would select fishing gear that would not destroy juvenile fish, as Hamza puts it.

> *"If you talk to elders, they would say they that during their days, it was scarce to find juvenile 'uon o'- small pelagic in their catches (walivyokuwa wanavua hukuti dagaa mchele). They were not fishing the small ones. They used to call them "mapambo ya Bahari"- the flowers of the ocean…. The small ones (immature) were the food for big fish. So, elders were leaving the small ones to be eaten by big ones so that they could catch*

those big ones when they went fishing on the subsequent trip. However, nowadays, the small ones are all captured". (IDI, fish processors, Kilwa)

The wisdom noted in the elders was also linked to what respondents referred to as "*ndago*"- the practice of seasonal migration from one area to another. In conversation with respondents, it was revealed that, in the past, fishers had a tradition of seasonal migration from one fishing location to another in search of fish, following the natural patterns of the fish and not causing undue disturbances that were seen as influencing fish migration. As one member of a focus group discussion put it;

"They (elder fishers) used to fish at point A for some days, then moved to another location. They could not return to the first point for a month or two. They were very clever. This is because, usually, fish do not like disturbances. Fishing several times could make fish move to distant places. Since they fish once or twice and move to another location, uncaught fish would not feel threatened by fishers. Therefore, the uncaught fish would remain in the area (this is opposed to current fishing practices where fishers may fish several times at the same point); when they return to the first point, they can catch again. Thus, elders were sensible about fish behavior and maintained their fishery in this way". (FGD, fishers, Kipumbwi)

Another member of the focus group discussion added that;

"The practice of seasonal migration of fishers (madago) was functional in fisheries. It was good that when fishers moved away from point A to another location and returned to point A after some months, they could find much fish (wanakuta samaki tena wamesha jaa hapa). But these young fishers can focus on one point for several months. You may find almost all of them going to fish at the same point every day. What do you expect? They cannot expect a good catch". (FGD, fishers, Kilwa)

In conversations with respondents, it was also noted that even though local people have a vast knowledge about the ocean environment and fisheries in general, community members felt that scientists, particularly fisheries officers, do not value the ability of community members. The so-called *wataalam*- experts or scientists- were perceived as not respecting the local knowledge or making any meaningful contributions to management practices and policies. In a focus group discussion, respondents had the following to say;

"These fisheries officers feel that they know everything about the ocean. Nevertheless, when you ask them about the marine environment, some cannot answer you; they do not know. Sometimes, we want to share our knowledge about the ocean with them, but most are not ready to listen. Sometimes, when you tell them, they could try to defend what they feel is the situation. They are not prepared to accommodate other people's views of things. Furthermore, they are the same persons who want us to cooperate in fisheries co-management. We wish they could consider us as people who know the ocean". (FGD, fishers, Bagamoyo)

Another added that;

"We fishers know the ocean and the fishery. It is not that we have attended school, but we know things by merely engaging ourselves in fisheries (katika kuwepo katka kazi hii tunajua vitu). You may have participated in college and studied fisheries, but we can ask questions you may fail to answer. However, these fisheries officers do not bother to listen to us; they feel that they know everything". (FGD, fishers, Bagamoyo)

Based on their long interaction with the ocean, local people perceive they have important and valuable knowledge about the ocean environment. Moreover, this local knowledge could contribute

to a better understanding of the Indian Ocean and improved fisheries management. However, experts, particularly fisheries officers, disregard their knowledge and perceptions about the ocean.

4. Discussion

This study aimed to explore fishers' perception and knowledge regarding the fishing practices of the area. As indicated in the findings, fishers interact with the ocean not merely to exploit marine resources, but to become part and parcel of the environment. In this manner, they possess valuable knowledge about the ocean environment (Gadgil et al., 1993). In their interaction with the ocean, they learn about key ecosystem processes, such as changes in mangrove and beach tree covers, coral reefs, fish migration, and changing fishing practices. This knowledge has potential implications for the future of sustainable fisheries management.

Findings from this study indicate that fishers have a better understanding of the environmental conditions of the ocean and changes. For example, fishers could narrate the critical role of mangrove cover and beach tree cover in fisheries. As indicated in the findings, informants in this study provided a thorough description of the benefits of mangroves and beach tree cover to fish and fish catches. They also explained factors affecting a decline in mangroves and beach tree cover and their implications for fisheries. Previous literature has asserted the value of local knowledge in designing future fisheries management with local support (Johannes et al., 2000; Santha, 2008). Thus, since fishers realize the importance of mangrove cover and beach tree cover and acknowledge that their interactions with the resource have adversely affected the help, fishers can likely cooperate in search of possible ways to improve mangrove cover and contribute to improved fisheries.

Fishers also demonstrated a keen awareness of the negative impact of current fishing practices on the coral reefs and how these practices have affected the fishery's present and future. Findings from this study indicate that coral reefs' condition was perceived as much healthier up to about 20 years ago. However, introducing unsustainable fishing practices, such as dynamite and certain nets, has led to a significant decline in the coral reefs and a subsequent decline in fish availability. Available studies indicate similar observations. For example, community-based ecological monitoring studies conducted at selected sites in the district stated the declining health of some of Bagamoyo's reefs. Interviews with fishers in 1996 revealed that stocks of prawns, fish, crabs, sea cucumbers, and mollusks had dropped dramatically over the past 30 - 40 years. The causes of this decline were identified in 1999 as over-harvesting of resources, trampling by fishers during shell and sea cucumber collection, destruction by anchors, and dynamite fishing (CRC, 2006).

Fishers acknowledged that changes in the availability of different fish species were attributed to increased fishing efforts in the ocean. As noted in the findings, a perceived increase in commercial fishery in the past 20 years has attracted more people to the ocean. These increased fishing efforts were observed as regarding the number of fishing boats. These findings are consistent with Dickens' (2004) concept of "commodifying the environment," explaining how people's perceptions and relationships with the natural world have changed over time, resulting in a significant shift in humanity's relationship to nature that now emphasizes the natural world as a 'commodity' for economic gain. In this manner, it is argued that people have lost an understanding of their relationship with their natural world and the ecosystems in which they are deeply entrenched. An individual, for example, may use natural resources such as fish for self-satisfaction and personal gain with little to no concern for the harm that this may bring to the resource and its future sustainability. Related to the commodification is the perception among elders that young fishers have lost a sense of valuing the ocean in the same manner that elder fishers had. As a result, young fishers are perceived as wanting to catch fish by any means, regardless of the negative impact of their practices.

However, it is essential to note that, despite the changing perceptions about fish resources in the research area, valuable knowledge and experience can be utilized for future management of fish resources in the ocean. For example, fishers acknowledged that the practice called *ndago* is seasonal migration from one area to another. This practice ensured sustainable fisheries as, while they moved

from one point to another, fish could reproduce and grow; thus, when they returned to the first point, fishers could get a better catch. Based on this beneficial fishing practice, fishers are likely to support management options such as the seasonal closure of the fishery. To do this however, fishers should be listened and be active participants in the process.

This study has also revealed that fishers perceived themselves as holding *hekima*- wisdom and knowledge about the marine environment. However, fishers perceived scientists or *wataalam* (experts, as they call them) as not feeling that local community members have some valuable knowledge to improve fisheries and the marine environment. Fishers thought they knew the ocean environment based on long-time interactions with it. Fishers believed their knowledge could better understand the ocean environment and improve fisheries management. As indicated in the findings, fishers were uncomfortable with how scientists perceived them. Past literature has emphasized that local people possess valuable knowledge about the functions of the ecological systems they most frequently interact (Berkes et al., 2000; Bulengela et al., 2020; Gadgil et al., 1993). Research has also noted that, for the marine environment to be improved and fisheries to be better managed, it is vital to integrate local knowledge and scientific knowledge (Bulengela et al., 2020; Charnley et al., 2007; Leite & Gasalla, 2013; Santha 2008; Watson et al., 2003).

The application of cultural perspective was vital as the perspective focus on social construction of nature- that as people interact with nature, they form a way of interacting with nature. In their investigation of the value of fishers' local knowledge and perceptions, Moshy and Bryceson (2016) assert that this knowledge has contributed new insights to understanding marine ecological changes. In the same way, our study emphasizes that fishers' knowledge and perception about fisheries is vital for understanding oceanic environmental changes. This study also calls for scientists and fisheries managers to see the need to include fishers' perceptions and knowledge in future decision-making processes for sustainable governance of marine resources. Studies have also established that fisheries management is likely to benefit much if there is a collaboration between scientists and fishers (Bassett & Zimmerer, 2003; Berkström et al., 2019). Additionally, the cultural perspective was helpful in illuminating cultural practices associated with the ocean and fisheries. Fisher's interaction with the ocean and how such interaction influenced fishing practices was reflected in respondents' narratives.

5. Conclusions

This study has highlighted the knowledge and perceptions of fishing communities in the study area. Findings from this study have revealed rich and valuable insights about fishers' knowledge and perception. This knowledge and perception are vital for improved fisheries management. Even though local people possess practical knowledge, they feel that their knowledge is not valued by fisheries managers, particularly the fisheries officers.

Based on the observed value of fishers' perception and knowledge, this study argues that involving local communities in coastal resource management is vital to resource sustainability. Knowing how these communities perceive the environment is critical for planning and working together to achieve sustainable marine resources. Thus, this study calls on scientists and fisheries managers to consider fishers as individuals who hold valuable knowledge, and that integrating such knowledge into fisheries management can yield better results in future fisheries management.

Ethical approval

All procedures used in studies involving human participants were conducted to the ethical standards of the institutional and national research committee, and with the 1964 Helsinki Declaration and its later amendments, or comparable ethical standards. This article does not contain any procedures with animals performed by any of the authors.

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