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ORIGINAL RESEARCH ARTICLE



## Elusive fish catch and vulnerable livelihoods: Status of fishing and fisheries industry among marine south coast communities of Kwale, Kenya

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### ABSTRACT

The aim of this study was to examine the status in fishing and fisheries industry among marine coastal communities of Kwale along Kenyan coast. In this study, we used a cross-sectional descriptive survey design to examine trends in fish and fisheries resources productivity and diversity and the types of fishing vessels and gears used by fishermen among marine Kwale communities. Quantitative data was collected using household survey questionnaires among fisherfolk households randomly selected from two subcounties in Kwale. Key informant interviews and focus group discussions were conducted on purposively sampled respondents to generate qualitative data to corroborate the quantitative survey data. Study established that fishing is still the principal source of livelihood, with 31% of people engaged in fishing as their main source of livelihood and being mainly artisanal fishers. There is a declining trend in fish productivity and diversity during the period 2014 to 2019. Out of all fisherfolks, 96.6% of fishers are commercial artisanal fishermen, selling their fish to different groups. The most preferred fishing vessel is wooden row boats (dhow) at 66.3% preference. There is a general decline in fish productivity within fishing grounds based on catches, indicated by 84.9% of the survey respondents. There is a general decline in fish abundance and diversity among coastal Kwale as indicated by 70.6% of respondents. Eleven (11) types of simple traditional fishing gears were identified, with majority (32%) of fishers preferring handline/hook (Mshipi) as their most preferred type of fishing gear. Destructive fishing gears such as spear guns are still in use despite the government regulations. This study concludes that fishing and fisheries resources among marine communities in Kwale of Kenyan coast is in a general declining trend in terms of productivity, abundance and diversity. This signals excess pressure on fishing resources, requiring immediate effective management strategies to contribute to sustainable marine ecosystems resources utilization. The study recommends enforcement of effective management strategies on fishing and fisheries resources through effective policy formulation and enforcement as well as awareness creation and a mind shift among communities towards alternative livelihood sources to reduce pressure on fish stock.

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## INTRODUCTION

Fishing is a significant source of livelihood for coastal communities along the Kenya coast supporting small-scale fishers, traders and processors including women who play a key role in the value chain of landed fishery products (KMFRI, 2018). Coastal and marine fisheries have always been critical for social, nutritional and economic wellbeing and livelihoods of coastal communities in Kenya and many developing countries around the world, as well as on a global scale (Zeller *et al.*, 2007). They provide food security, job opportunities, income and livelihoods as well as traditional cultural identity (Everett *et al.*, 2017; Hicks *et al.*, 2019). This makes their sustainability of great economic and ecological significance. It has been estimated that small-scale artisanal coastal fisheries can provide up to 99% of the protein source to coastal households, provide over 80% of households' income and therefore play a key role in food security in developing countries. The marine fisher communities in the southern coast of Kenya are dependent on fishing as their main source of livelihood. Unfortunately, the fish catch has become elusive predisposing myriad dependent households to economic vulnerabilities (Obura *et al.*, 2017). There is lack of sufficient data regarding trends in fishing and fisheries resources in Kwale County, Kenya, information that is critical for sustainable management of these valuable resources (Plan International, 2018). Majority of marine fishing on the Kenya coast is regarded as 'small-scale artisanal' operating in the near-shore waters, using traditional fishing vessels and gears (Sonia and Benard, 2017). Offshore deep sea fishing is relatively underexploited due to lack of local capacity and is mainly exploited by foreign vessels with Kenya licenses (Samoilys, 2017). The artisanal fishery contributes 6% to the coastal economy, and is the main source of livelihood for more than 60,000 households.

The marine fishery is associated with a variety of threats. The coastal regions of Kenya are reported to be experiencing poverty rates of up to 60% (The World Bank, 2019). The open access nature of the fishery and lack of opportunities for livelihood diversification is contributing to growing pressure on marine resources and fish-based livelihoods. This is evidenced in a general decline in catches everywhere having been reported in the very recent times (AU-IBAR, 2016). This symbolizes danger not only to the marine resources, but also to the livelihoods that depend on the resources. Factors such as degradation of mangrove areas, uncontrolled harvesting, destruction of coral reefs from pollution by inadequate sewage systems, and use of destructive fishing equipment/methods, have been attributed to decline in fish stocks in the inshore waters where artisanal fishery is carried out (GoK, 2017). Illegal activities that have dominated the region include drugging fish during harvesting. The degradation of these ecosystems has led to a decline in fish catch production, which is a sign of the damage to the environment, as well as damaging the community through decreasing income for families who depend on fishing for their livelihoods. While the fish stock dwindles, the number of small scale artisanal fishers has continued to grow due to population growth and high

levels of poverty in the coastal regions (Wanyonyi *et al.*, 2016).

From the foregoing it is worth noting that despite significance of coastal artisanal fisheries to general livelihoods of coastal communities, the fisheries resources as well as livelihoods dependent upon them are adversely impacted by an array of both anthropogenic and natural factors. There is growing concern about over-exploitation and the associated declining catches within inshore marine fisheries in Kenya. However, our understanding of the status of these fisheries and defining their most suitable management options remains challenging. There is lack of sufficient data on general trend in abundance and diversity of fisheries and types of fishing vessels and gears used. This information would be important for determining the immediate threats to these resources, thereby facilitate in strategic management measures for sustainability. Furthermore, an understanding of the trends of fish diversity and production within Kwale marine communities remain largely elusive to the fisheries manager on the ground, yet Kwale has one of the highest densities of artisanal fishers. Fishing which has been the main source of livelihood for Kwale coastal communities households is threatened by overexploitation resulting into declining fish yields that has predisposed reliant families to acute deprivation and further exposing the natural ecosystems to human invasion and overexploitation. The inshore fisheries that artisanal fishermen have access to are consequently increasingly overexploited meaning they yield progressively smaller catches. The resulting meager earnings of the artisanal fishermen translate into severe deprivation within their households, manifested in the unfavorable socio-economic conditions in which many of their communities exist. The current level of fishing pressure and declining catches in the small-scale fisheries calls for an investigation into the status of fishing and fisheries amongst fishing communities. In the wake of all the above, it becomes imperative to perform an assessment of trends in fishing and fisheries resources. The aim of this study was to investigate trends in fishing and fisheries resources among coastal Kwale communities in Kenya. This study focused on establishing the current status of fishing and fisheries industry among Kwale marine communities along Kenyan coast, an area with limited research data. The findings of this research is of significance in contributing to improved understanding of trends in fish catches and fish diversity, information valuable for informed policy formulation and for determining management options for coastal fisheries and marine resources. The study is significant for formulation of effective policies for management and development strategies for marine resources and coastal communities. This information would be useful to the stakeholders in the sector including researchers, managers and investors with a view of advocating for sustainable utilization of the coastal and marine fishery resources for posterity. The overall objective of this study was to examine the status of fishing and fisheries industry among Kwale marine communities in Kenya. Specifically, the study sought to determine the trend in fish catches, diversity and fisheries industry among Kwale marine communities; and to investigate the types of fishing gears used by Kwale marine fisher folk.

## MATERIALS AND METHODS

### Study site

This study was conducted among coastal communities in Msambweni and Lunga sub-counties in Kwale County, Kenya, focusing on seven fish landing sites and three community groups. Kwale County is one of the six counties in the coastal region of Kenya, lying between Latitudes 30.05° to 40.75° South and Longitudes 38.52° to 39.51° East. The average temperature of the county is 24.2°C and rainfall amounts range between 400 mm and 1,680 mm per year. Kwale has abundant fisheries reserves along the coastline. Major fish reserves include: Shimoni, Vanga, Msambweni, Diani, and Tiwi. The fish landing sites included in this study included Majoreni and Shimoni in Lunga sub-county and Bodo, Nyumba Sita, Mwandamo, Chale-Jeza, and coastline of Gazi in Msambweni sub-county. In addition, the study covered three community groups upstream of River Uмба in Lunga and R. Mkurumudzi in Msambweni, thus Amani River Ramisi, Mkurumudzi Water Resource Users Association (WRUA) and Jirani Charcoal Producers groups (CPG).

### Data collection

**Research design and sampling:** A descriptive cross sectional survey design, integrating qualitative and quantitative methodologies, was adopted to enable different forms of cross-checking on responses, this mixed approach allows for triangulation of sources of data hence securing validity and reliability of findings. It ensures complementarity, internal reliability and corroboration of facts and opinions, whilst taking care of different data sets. It has been further observed that mixed methods research offers a practical approach to addressing research problems and questions and the potential for increased applicability because these problems and questions are examined in different ways (Graff, 2017) and this led to choose of this method in this study. Target respondents in this study comprised stakeholders in the community, representing resource users, researchers, and managers within Kwale County. Respondents for household (HH) questionnaire survey were sampled using a multi-stage (two-stage) stratified cluster sampling design. The two sub-counties were taken as the strata. First stage of sampling involved random selection of a given number of villages/wards from each of the two sub-counties, by using Population Proportional to Size (PPS) sampling methodology. In second stage of sampling, systematic random sampling was adopted to select households within the randomly selected villages.

The sample size for the respondents to be included in the study was calculated using probability based sampling based on Yamane's sample size for proportions (1967:886) at 95% confidence level,  $P=0.05$ , as follows (Equation 1).

$$N = \frac{N}{1 + N(e)^2} \quad (1)$$

Where  $n$  is the sample size,  $N$  is the population size, and  $e$  is the

level of precision (Equation 2)

$$N = \frac{4145}{1 + 4145 (0.05)^2} = 365 \quad (2)$$

It was estimated that the Non-Response Rate (NRR) that could result from households that could be either absent, not accessible, refuse to be surveyed, or any other reason that could prevent survey teams from reaching the selected respondent was 10%. This was taken into account as recommended by SMART (2012) to adjust the sample size using the following Equation 3.

$$\text{Final } N = \frac{\text{Number of HH needed}}{1 - \text{NRR}} \quad (3)$$

Where: 1 is a constant and NRR=Non-response Rate (Equation 4).

$$\text{Final } N = \frac{365}{1 - 0.1} = 405 \quad (4)$$

The study reached 346/405 respondents representing 85.4% response rate. This was an acceptable response rate considering that De Vaus (1986) has suggested that good sampling and survey design with 80% response rate and 90% response rate would be ideal but 60% response rate is acceptable (Gay and Airasian, 2000), and any response rate 'less than 70% and higher than 60% might lead to an adequate generalizability of studies' (Brehm, 1993).

Respondents for Key Informant Interviews (KII) and Focus Group Discussion (FGDs) were purposively sampled from stakeholders, by selecting individuals considered valuable for their expert opinion and knowledge on research issues under investigation, based upon their positions of authority held relative to the fishing community, and also for particular characteristics.

### Data collection tools and procedures

Household survey was conducted by administering household questionnaires to heads of the randomly selected households. The survey lasted not more than one and half hours. The questionnaire captured information on socio-demographic characteristics of the households and respondent's views and opinions based on the objectives of the study. The household survey was the most important source of information aimed at providing a profile of the community members and their households. To gain in-depth understanding of issues under investigation, key informants were also interviewed and FGDs were conducted as well. Key informant interviews were conducted with personalities that were considered as integral to the study to enable a full understanding of the issues under investigation. These included people with experience in fishing, fish trade, conservation issues, and fisheries management as following (Table 1).

Using FGD guide FGDs were conducted with between 6-8 participants drawn from the community. The composition of the groups interviewed took into account gender considerations thus, the male and the female were interviewed separately (FAO, 2016). Children FGDs were designed to be participatory,

**Table 1.** List of key informants interviewed in the study.

Key informant	No.
Kenya Marine and Fisheries research institute (KEMFRI),	2
Fisheries Officers	1
Ministry of Agriculture (Crop division)	1
Ministry of Agriculture (livestock division)	1
Ministry of Trade (Country Trade Officer)	1
Ministry of Water and Irrigation	1
National Environment Management Authority (Environment Officer)	1
Department of Children Services (County Children Officer)	1
Ministry of Culture and Social services	3
Ministry of Education	1
Forestry department	1
Kenya Wildlife Service	1
Total	15

**Table 2.** Focus Group Discussion sessions conducted.

Focus group discussion session	Male/Boys	Female/Girls
FGD Majoreni Adult/Women/ Men	10	7
FGD at Gazi adult Women /Men	12	10
FGD at Darigube (Ramisi)	12	10
FGD at Nyumba sita (Boys) 10-14 years	13	8
FGD at Nyumba sita (Boys) 15-19 years	7	5
FGD at Majoreni Girls 10- 14 years	8	6
FGD at Majoreni Girls 15- 19 years	7	7
FGD at Mwazaro Adult women/Men	8	7
FGD at Kibuyuni	9	7
Total	86	67

conducted separately for boys and girls using child friendly version of tools including Social mapping and body mapping methodologies under ethical code of conduct that ensure total protection of best interest of the child. This explored girls' and boys' different views about ways in which their lives have been affected by declines in fish stocks and environmentally unsustainable practices, and risks faced by girls and boys in their local communities. This information was crucial for identifying child protection issues in the target local communities associated with fishing and fisheries. All FGDs were held in a non-intrusive environment in which the respondents felt comfortable, selection to the groupings was voluntary and the discussions lasted no more than one and half hours. The FGDs were

audio recorded and later transcribed for analysis after consent (Table 2).

### Data analysis

Quantitative data collection was done through open data kit software called Kobocollect. Data was analysed using descriptive statistics with Statistical Package for Social Sciences (SPSS). The analysed data was presented in the form of single-variable and multi-variable frequency tables, pie-charts and graphs. Inferential statistics was undertaken using Analysis of variance (ANOVA), regression and correlation analysis as well as student T-test at a significance level of 95%. Qualitative data from KIIs and FGDs was analysed using thematic/content analysis method.

**RESULTS AND DISCUSSION**

**The nature and characteristics of fishing and fishery resources**

Results from household surveys established that fishing is still a popular occupation and livelihood strategy for majority of coastal communities of Kwale, with 106 (31%) out of the 346 respondents, being fisher folks. These were people engaged in fishing as their main source of livelihood and fishing being mainly artisanal in nature. Our results concur with those of other studies that have always confirmed that fishing is a major activity amongst coastal communities of Kenya (KMFRI, 2018; Everett et al., 2017; Hicks et al., 2019; GOK, 2017). These studies indicate that fishing is a principal livelihood in coastal areas, the Kenyan coastal fisheries being characterized by artisanal fishers. The artisanal fisheries make a vital contribution to food security, livelihoods and cultural identities in coastal communities (GoK, 2015; Samoilys et al., 2017). The fishers employ multiple techniques for fishing. It was established that 72% of the respondents use one fishing technique per trip of fishing while the remaining 28% used a combination of techniques. Results indicate that ownership of fishing vessels varied, with a high percentage of respondents owning their own fishing vessels, family owned (48.1%), followed by 30.2% with rented vessels with pay, 13.2% have rented vessels without pay and only 8.5% used vessels owned by employers as shown in Figure 1.

**Types of fishing vessels used for fishing**

A total of four (4) main fishing vessels are used along coastal waters of Kwale County (Figure 2). Results from the survey

established that the most preferred vessel was wooden row boats (dhow) at 66.3%, closely followed by wooden sail boat (canoes) at 26.7%. Wooden boat with motor and motorized wooden boat are less preferred with 6.9% and 4.0 % preferences respectively. This shows that motorized wooden boat is the least preferred fishing vessel amongst fishermen at Lunga-lunga and Msambweni sub counties of Kwale County (Figure 2). Tuda and Wolff (2015) and Samoilys (2016) described fisheries along south coast of Kenya as being characterized by artisanal fishing in which fishers use nonmechanized fishing vessels which do not allow exploitation of deep waters. Having simple fishing vessels confine the fishers along the coastline, a major contributor to overfishing in these waters.

**Trends in fishing**

Upon examining the fishing patterns amongst those who engage in fishing as their primary source of livelihood, the study found out that four main fishing grounds, the deep sea/open ocean, coastline, reef and mangrove ecosystems, are exploited. A majority, totaling 56.6%, indicated fishing in the deep sea or open ocean, followed by 31% who usually fish along the coastline and 10.6% fishing along the reef. Mangrove ecosystems are the least exploited as fishing grounds, with only 1.8% indicating they do their fishing in these ecosystems (Table 3). Our results agree with Plan 2018 and GoK (2015) surveys in which it was established that coastal Kwale fishing communities mainly concentrate their fishing activities within marine habitats along the coastline. Reduced fishing within mangrove ecosystems is because these areas have been very degraded and have become less productive for fisheries resources.

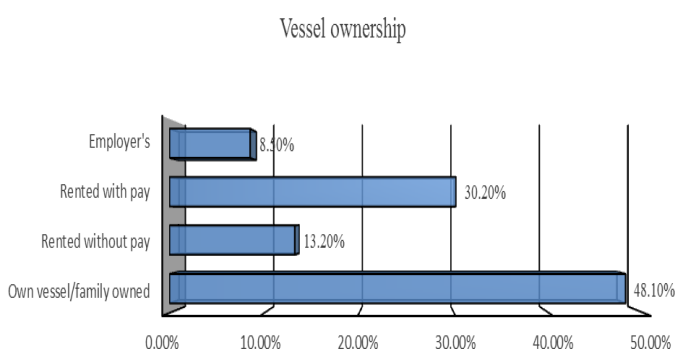


Figure 1. Ownership of fishing vessels.

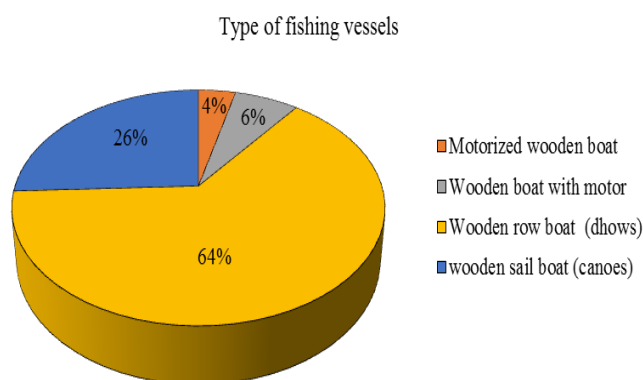


Figure 2. Pie chart showing fishing vessels by percentage.

Table 3. Distribution of location of fishing grounds.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Along the coastline	35	10.1	31.0	31.0
	Deep sea/ Open Ocean	64	18.5	56.6	87.6
	Along the reef	12	3.5	10.6	98.2
	In the mangrove	2	.6	1.8	100.0
	Total	113	32.7	100.0	
Missing	-9999	233	67.3		
Total		346	100.0		

**Table 4.** Fish productivity grounds analysis.

		Productivity of fishing grounds (Fish catch)			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Decrease	101	29.2	84.9	84.9
	Increase	9	2.6	7.6	92.4
	Stable	4	1.2	3.4	95.8
	Remain The same	5	1.4	4.2	100.0
	Total	119	34.4	100.0	
Missing	-9999	227	65.6		
Total		346	100.0		

**Table 5.** The time of day when fishing is conducted.

		At what time of the day do you go fishing?			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only during the day	65	18.8	57.0	57.0
	Only during the night	8	2.3	7.0	64.0
	During both day and night	41	11.8	36.0	100.0
	Total	114	32.9	100.0	
Missing	-9999	232	67.1		
Total		346	100.0		

### Trends in productivity of fishing grounds

The study also analyzed trends in productivity of fishing grounds in terms of catches during the previous five years (2014-2019). Quantitative household (HH) surveys and qualitative (KIIs & FGDs) analysis revealed a general decline in fish productivity within fishing grounds. From (HH) surveys, 84.9% of the respondents indicated that there was a decrease in fish productivity in the fishing grounds, with only 7.6% reporting an increase in productivity. However, 4.2% indicated productivity as remaining much the same over time while still 3.4% describing productivity as having been stable over time (Table 4). This observation was explained further in FGDs where fisher men observed a systematic decline in fishing productivity and fish variety being experienced. Generally, catch rates in artisanal fisheries in Kenya have declined over the last decades (Samoilys *et al.*, 2017). This has been suggested to indicate declining fisheries resulting from high fishing pressure, the use of destructive fishing methods and habitat deterioration (Tuda and Wolff, 2015).

### Time for fishing

The research conducted revealed daytime as the most preferred time for fishing, with majority (57%) conducting their fishing activities during the day only. A large group also preferred fishing both during the day and night (36%) while only 7% of the fishers go fishing at night only (Table 5). It can therefore be deduced that a majority of the fishermen and women conduct their fishing activities during the day only while a good number prefer to do their fishing both during night as well as day (Table 5).

### Choice of fishing gears used among Kwale marine communities

The study sought to understand the type of fishing gears preferred for use by the fishermen. A total of eleven (11) varieties of

key fishing gears (Table 6) are used by Kwale fisher folks, with handline/hook and line (Mshipi) type of fishing gear confirmed as the most preferred (32%). This was followed by those using fishnets at 17.9% as their preferred type of fishing gear. Further, 13.6% were found to prefer using a type of fishing gear known as Malema/Madema and 8.0% of the respondents showed that they use Gill nets (Jarife). Other respondents totaling to 6.8% indicated that they used spear guns (Bunduki) as their preferred type of gear for fishing, 6.2% used fish line gears while 3.7 percent used long line. 3.1% used ring net, 2.5% preferred fence traps, 1.9% made use of beach seines (Juya), 0.6% used scoop nets/hand nets and other types formed about 3.7%. Scoop net/hand net is the least preferred gear. Study revealed that choice of gear used by the fishermen and women is determined by a variety of factors including affordability, legality, cost effectiveness, availability and employer provision. Findings confirmed that 63.6% of the fisher folk indicated that what they are currently using is what they can afford to own. A total of 12.9% of the respondents said that what they are using is determined by the legally allowed gear.

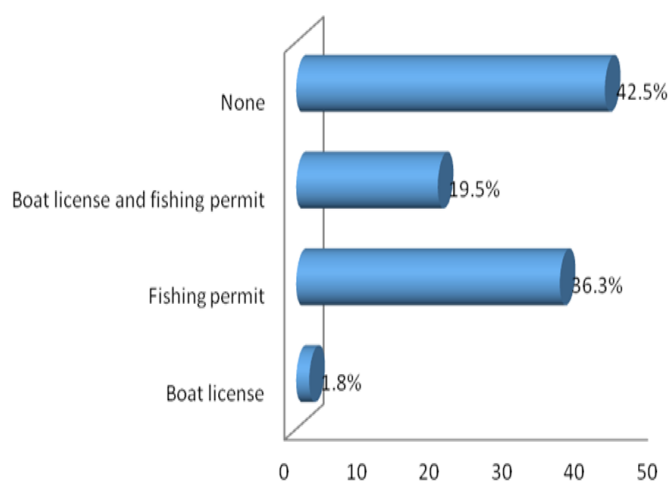
From the study, it was established that 9.3% of the respondents choice of gear was determined by what is cost effective and similar percentage (9.3%) showed that they do not have a choice but to use what is available. Only 5% showed that their choice of gear was determined by what the employer provided. From the data obtained, affordability is the highest factor, which determines the choice of gear to be used for fishing. It was confirmed that locals only have simple fishing gears such as dhows which are gears that can be used for subsistence fishing only. However, People from Pemba in neighboring Tanzania are many during high season since they have superior boats and nets. Our results found 11 different types of fishing gears utilized by fishers in Kwale. All the fishing gears are simple traditional artisanal types. This concurs with results of Samoilys *et al.* (2016) who

**Table 6.** Types of fishing gear used in fishing.

Types of fishing gear used		Responses		Percent of cases
		N	Percent	
Types of fishing gear used <sup>a</sup>	Malema/Madema	22	13.6%	19.5%
	/Gill nets (Jarife)	13	8.0%	11.5%
	Hand line/ hook and line (Mshipi)	52	32.1%	46.0%
	/Beach seines (Juya)	3	1.9%	2.7%
	Fence traps	4	2.5%	3.5%
	Long line	6	3.7%	5.3%
	Ring net	5	3.1%	4.4%
	Scoop net/hand net	1	0.6%	0.9%
	Spear guns (Bunduki)	11	6.8%	9.7%
	Fishnet	29	17.9%	25.7%
	Fish line	10	6.2%	8.8%
	Others specify	6	3.7%	5.3%
Total	162	100.0%	143.4%	

a. Dichotomy group tabulated at value 1.

Source: Survey Data

**Figure 3.** Types of licenses and permits held by fishers.

recorded over 13 different artisanal fishing gears (gillnets, handlines, speargun etc.) amongst artisanal fishers along the coastline of Kenya. They established that artisanal fisheries on the Kenyan coast need urgent regulatory measures to stop the fisheries from tipping over, due to declining fisheries resources diversity, which they attributed to climate change, use of illegal destructive gears amongst other factors. The use of destructive fishing gears which are not legalized is a major contribution to unsustainable fishing on Kenyan coast. Malema, hook, Gillnets, handline and spear gun are among the most dominant fishing gears along the Kenyan coast as observed by other studies (Samoilys et al., 2017). Sonia and Bernard (2017) in their study recorded Malema, Hook and line and Gillnet, speargun as main fishing gears among artisanal fisheries in Vanga and Msambweni, South Coast of Kenya. They established that harmful fishing gears have penetrated into the artisanal fisheries in

Kenya, posing great management challenges. The continued use of spears in fishing, despite their discouraged use due to perceived environmental and societal negative impact, has raised a lot of concern and debate in the Kenyan artisanal marine and coastal fisheries sub-sector. They confirmed that spearfishing has negative environmental and ecological impacts, e.g. in terms of catch composition, diversity and size-frequency.

### Legality of fishing

From the analysis conducted on legality, 55.8% of the respondents had been licensed to carry out fishing (legal fishers) while 44.2% were not licensed. Arguably slightly less than half of the fishermen and women among Lunga and Msambweni in Kwale County fishing community are illegal fishers because they are not licensed by the government's fisheries department to carry out fishing. Legally, only 55.8% are known by Fisheries department, the rest are unknown. Further analysis showed that 42.5% of the respondents did not have any of the licenses such as fishing permit, boat license or both fishing permit and boat license. Fishers with both boat license and fishing permit formed 19.5%, while 36.3% had fishing permit only and still only 1.8% had boat licenses only. Thus, majority are fishing with unlicensed vessels. From the data obtained, it can be adduced that just less than half of those carrying out fishing in Kwale County are not licensed or had not obtained any fishing permit from regulators. Many of the fishermen and women interviewed had fishing permit type of license and very few had boat license (Figure 3). Majorly the fishers have neither fishing permit nor boat license. Other studies indicate that majority of the fishers and the fishing crafts operating at the Kenyan coast are not licensed, due to weak regulations (FID, 2015). Survey report on marine fisheries in Kenya by (GoK, 2015) showed that most of the fishers do not have fishing license and it is estimated that up to 82% of the fishers are not licensed.

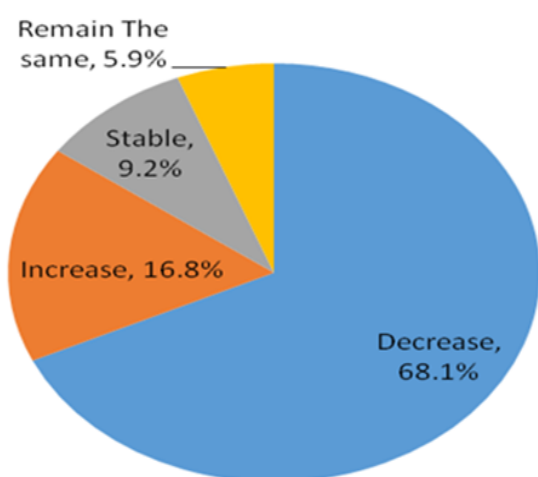


Figure 4. Pie chart showing fishing capacity of the households.

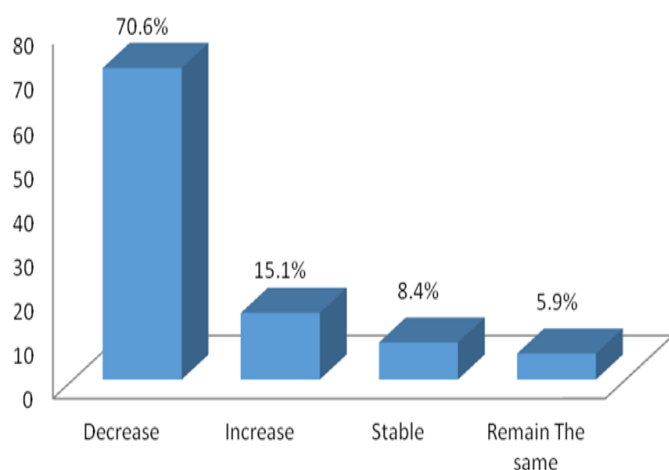


Figure 5. Graphical representation of variation in fishery resources over time.

### Trends in diversity of fish resources

The study analyzed trend in artisanal fisheries resources diversity. Reports from households, key informants and FGDs indicated a general declining trend in diversity of fish and shell fish captured over the last five years (2014-2019). When asked about their opinion about the diversity of fisheries resources and in particular the variety of fish and shell fish over the last five years, 70.6% of the respondents showed that there was a decrease in the abundance and variety of fish resources while 15.1% indicated that there was an increase in the fish resources. Further, 8.4% said that the variety of fish and shell fish have been stable and only 5.9% indicated that the resources have remained the same (Figure 5). It is shown from the research data that majority of the fishermen and women of Kwale County were of the view that there has been a declining trend in diversity of fish resources. The decline has subsequently affected the household fishing capacity. Up to 68.1% of the fishing household reported that their capacity to fish had decreased while 16.8% experienced an increase in fishing capacity. Only 5.9% indicated that their capacity had remained the same and 9.2% felt that their capacity had remained stable (Figure 4). Samoily et al. (2016) recorded declining trends in fish densities and decline in

number of species in the fishery catches, in Kenya's reef fisheries. They concluded that the sustainability of current fishing practices on Kenya's coral reefs appears questionable. Our results illustrate a similar signal, with general decline in diversity of fisheries resources, demanding an immediate regulatory measure to make these resources sustainable and also for the good of the fishers.

### Factors contributing to the decline in fish stock

A composite of factors was identified through HH surveys, KIIs & FGDs as contributing to decline in fish productivity and diversity. Key factors, as represented by percentage of respondents included illegal fishing gear (17%), bad weather/ high waves (13.6%), competition among fishermen (13.2%), overfishing (12.3%), environmental degradation of fish breeding grounds (mangroves) (8.5%), invasion by foreign fishers (8.1%) and poor or inadequate fishing gears (8.1%) as well as poor fishing vessels (7.2%). The data has shown that among the highest causes of decline in fish stock in Kwale County is attributed to illegal fishing gear at the top of the list followed closely by bad weather and competition among fishermen. There are many other factors, but of lesser magnitude (Figure 6). An array of factors has been described to cause threat to fisheries resources and fishing industry along Kenyan coastal waters. Samoily et al. (2016) attributed decline to fish diversities and densities in coastal waters of Kenya to use of destructive fishing gears and use of illegalized fishing gears by illegal fishers. Increasing numbers of fishers entering the fishery each year and inadequate protection of marine resources due to inadequate enforcement have been indicated as threat to some key fishery taxa, all putting populations at risk from overexploitation (GoK, 2015). Johnstone et al. (2018) in their study established destruction of habitats and overexploitation as some of the factors contributing pressure on fisheries resources at the coastal waters of Kenya.

### Trends in fish catch and sales volume

Most of the fish that is caught is sold to consumers. The study established that 96.6% of the fishermen and women sold the fish as opposed to 3.4% that caught them for subsistence. Thus, most fishers in Kwale County are artisanal commercial fishers, implying fishing is a major economic activity. According to respondents, the fish is sold to a variety of customers (Table 7), most of whom are middlemen (36.2 %) and *Mama Karanga* (mothers processing fish) (16.4%). Others to whom fish is sold as indicated by respondents include: direct sales to individual consumers (14.1%) either at their door steps or along the road side, to commercial whole sale distributors (13%), to commercial retail distributors as well as to the market (8.5%). A paltry 3.4% of those interviewed said that they sell their fish to restaurants /hotels. Therefore, from the study we can conclude that most fishermen sell their fish to middlemen and *Mama Karanga*. Yet, the middlemen have been accused of exploitation. In the FGDs, the middlemen were seen as agents of exploitation as they purchase fish cheaply from the fishermen and later sell it to consumers such as hotels and restaurants at exceedingly high prices.



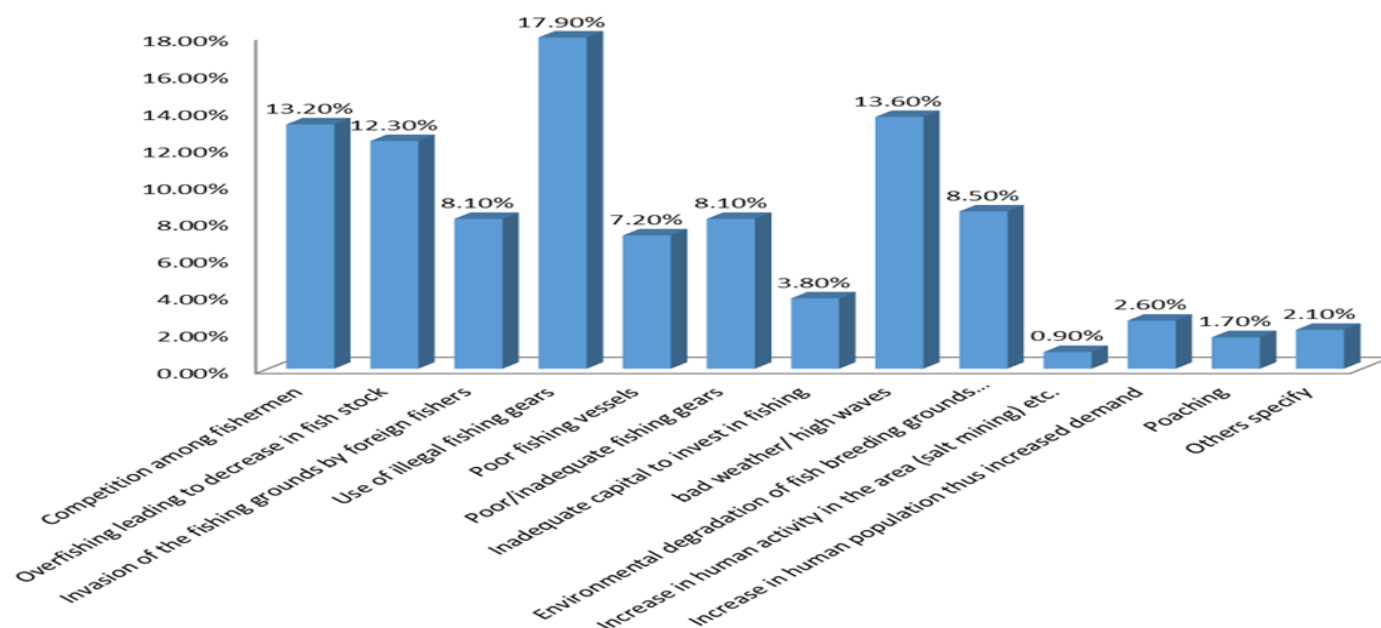


Figure 6. Graphical representation of the causes of the decline in fish stock.

Table 7. Showing statistical analysis of chain of people involved in fishing.

		Who the fish is sold to		
		Responses		Percent of cases
Whom fish is sold to <sup>a</sup>		N	Percent	
Individuals (door-to-door, along roadside)		25	14.1%	21.7%
Market		15	8.5%	13.0%
Shop Middleman/agent		64	36.2%	55.7%
Restaurants/hotels		6	3.4%	5.2%
Mama Karanga		29	16.4%	25.2%
Commercial wholesale distributor (Tajiri)		23	13.0%	20.0%
Commercial retail distributor		15	8.5%	13.0%
Total		177	100.0%	153.9%

a. Dichotomy group tabulated at value 1.

This is an illustration of how much value is linked to fishing as an economic livelihood of cultural importance. This indicates that they cannot fully exploit the deeper oceans/seas and this contributes to concentration of fishing being mainly along the coastline, with inevitable unsustainable fishing pressure on available fisheries resources. Some fishers (56.6%), mostly foreigners, are now venturing into the deep sea, an indication that the coastline, reefs and mangrove ecosystems have been overexploited. The observed declining trend in fish productivity and diversity illustrates that fishing and fisheries in Kwale County is already succumbing to fishing pressure and is becoming unsustainable. The downward trend coupled with illegal fishing vessels/gears and unlicensed fishers signal danger to the fisheries resources and communities' livelihoods. We suggest that fish resources and fisheries activities by Kwale marine communities under current practices are unsustainable. Some fish resources are indicated to have greatly reduced in the last five years (2014-2019), a signal to extinction if not checked. The study further revealed that most fishers are illegally practicing fishing, having neither fishing licenses nor vessel permits from fisheries department. This can lead to use of illegal fishing vessels and gears which contribute to destruction of fisheries resources. Use of

destructive fishing gears such as spear guns (Bunduki) and ring net and unlicensed fishing collectively drive fishing into banned areas, destruction of ecosystem and overexploitation through increased fishing pressure is inevitable. This will lead to further decline in fisheries productivity and diversity.

Declines in densities may reflect impacts of fishing pressures, climate change and may also suggest that the fisheries management regulations on these fished sites are inadequate. Yields provide a perspective on the status of fisheries that can help to understand the status of the fishery and provide a guide for government. Proper enforcement of the ban on illegal and destructive fishing gear will protect fish stocks, especially threatened species, but this requires fishers' cooperation in policing. In addition, gear regulations such as hook size and mesh size could be tried to affect a minimum size limit (Tuda et al., 2016) in fished areas to help restore fish populations. Fishing and fisheries along the coastal areas of Kwale County is affected by an array of anthropogenic and natural factors, with anthropogenic factors taking lead. This has serious implications on management and policies issues. It may require more stringent enforcement of regulation on fishing gears, fishing vessels and areas in order to protect vulnerable species and ecosystems.

## Conclusions and recommendations

From the findings of this study it can be concluded that fishing is a major livelihood strategy practiced by coastal communities of Kwale and is a major economic activity, with 96.6% of fisherfolk practicing artisanal commercial fishing. It is also concluded that the marine coastal fisheries in Kwale Kenya is characterized by artisanal fishing employing simple traditional fishing gears like handlines, fishnets and jarife. The fishing is characterized by simple fishing vessels of wooden row boats (dhow) and wooden sail boat (canoes) at 66.3% and 26.7% preferences respectively, most of the vessels being family owned (48.1%) and rented vessels (43.4%). It can also be concluded that a composite of factors are contributing to the observed declining trends in fish and fisheries resources productivity, abundance and diversity. These factors include use of destructive and illegal fishing gears (e.g., speargun), illegal fishing, overfishing, competition from increased number of fishermen, poverty along the coast, climate change and destruction of marine ecosystems. It is our conclusion that current pressure on fisheries resources in this region will continue to push fish productivity and diversity to critical downward trend, threatening some species with extinction if not urgently checked. It can be concluded that fishing and fisheries in coastal Kwale is characterized by illegal practices, both in fishing and use of vessels and gears that are not licensed. This together with high poverty levels contribute to massive environmental degradation already noted among marine ecosystems, a further threat to fish productivity and diversity. Based on results from this study we recommend that County Government of Kwale and the Fisheries Department enforce a more efficient and sustainable management of the marine aquatic resources in coastal Kenya (Kwale) in order to contribute greatly to health and economy of the county and communities. To safeguard the future of Kwale's marine fish resources and populations, as well as the fishers that dependent on them, we recommend a combination of management options, changes in gear regulations, and more marine ecosystems conservation. Such mechanisms should improve the resilience of fish populations and marine ecosystems/resources to the combined and interacting effects of fishing and climate. We also recommend that policy makers should focus on educating the fishermen to acquire better fishing equipment and legalized fishing gears that reduce overfishing and encourage sustainable fishing practices to increase yields in diversity and productivity of fishing grounds and fisher households. Environmental conservation of the coastal ecosystems especially the mangroves should be emphasized and/or enhanced and communities be encouraged to shift their mindsets towards supplemental/ enhanced livelihoods.

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## Conflicts of interest

The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analyses and interpretation of data, in the writing of manuscripts, or in the decision to publish the results.

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