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Fishing contributions to the household income in Mafia District, Tanzania

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Abstract. *Mpemba A, Mombo FM. 2019. Fishing contributions to the household income in Mafia District, Tanzania. Ocean Life 3: 74-85.* The fishing sector is responsible for providing critical income for many families within fishing communities. Fishing activities explain the levels of income which, in the end, indicate whether a given fishing household is benefiting. This study was undertaken to assess the contribution of fishing to household income in Mafia District, Tanzania. The data were collected from randomly sampled 120 household heads using several methods such as questionnaire survey, Focus Group Discussions (FGD), checklist and field observation. The collected data were analyzed using inferential statistics, descriptive statistics, and content analysis. A box plot was used to establish the significant relationship between household income contributions from fishing and other economic activities. In addition, content analysis was used in the analysis of qualitative data. The results revealed that several economic activities are conducted in the study area, where 41.47% of respondents indicated that fishing is the major economic activity in their households. The results showed that average household incomes from conducting fishing alone as the main economic activity was 51,250 TZS, fish-related activities were 15,000 TZS and other economic activities were 5,000 TZS per day. Since the study has revealed that fishing contributes to higher income in the household than other activities, therefore the study recommends that most of the households in the study area do not have access to credit for improving their activities, especially fishing the government should provide improved fishing gears for fishers with a low-interest rate.

Keywords: Economic, fishing, household, Mafia District, Tanzania

INTRODUCTION

Fishing has been a major source of food for humans and a provider of employment and economic benefits to those engaging in it (FAO 2005; Hosseini et al. 2018). It has been estimated that fisheries and aquaculture assure the livelihoods of 10 to12 percent of the world's population (FAO 2014). World Bank (2012) found that in Africa, the total employment in the fisheries sector was 25.4 million people, with 7.8 million employed in fishing and 17.6 in post-harvest. MLFD (2010) reported that more than 4 million people in Tanzania are engaged in fishing and fishery-related activities, while more than 400,000 fisheries operators are directly employed in the sector.

Tanzania is endowed with water resources, sharing three of the largest inland lakes in Africa, namely Lake Victoria, Lake Tanganyika and Lake Nyasa. In addition, the country is reasonably rich in marine and inland fishery resources, making the fisheries sector important in the economy (Sobo 2012).

Tanzania is among the main producers of fish for inland fisheries in Africa, mostly in Lake Victoria and Lake Tanganyika. The major commercial species in Lake Victoria are Nile perch (*Lates niloticus* Linnaeus, 1758); *Rastrineobola argentea* (Pellegrin, 1904), commonly known as "Dagaa" and Nile tilapia (*Oreochromis niloticus* Linnaeus, 1758); while the major commercial species in Lake Tanganyika are the Centropomidae (*Lates stappersii* Boulenger, 1914) (commonly known as "Migebuka") (FAO 2012). For marine fisheries commercial marine fisheries are mainly concentrated in the Exclusive Economic Zone (EEZ), targeting the tuna and tuna-like species. The major tuna and tuna-like species contributing to the catches include Yellowfin tuna, Skipjack tuna, Big eye tuna, Long tail tuna, and Kawakawa (Anon 2005). In addition, however, small-scale fishing is conducted by artisanal fishers who fish for fins, mollusks, and crustaceans within the inshore (FAO 2012).

The total annual fish production in Tanzania was 347,157 metric tons in 2010 (MLFD 2010) and was reported as the main source of protein for nearly 9 million people along the coast. In turn, fishing provides a source of employment and livelihood to many people (MLFD 2010). Starting from a low 2.9% annual growth in 2000, the sector's growth rate increased to around 6% between 2002 and 2005 and has since steadily dropped to 1.5% in 2010. The decrease in growth between 2009 and 2010 has been attributed to illegal fishing and the destruction of nursery grounds. Currently, the sector accounts for about 10% of the national exports (Planning Commission President's Office 2012; MLFD 2014).

Tanzania is rich in marine and inland fishery resources, making the fisheries sector important in the economy. Fisheries provide substantial employment, income, livelihoods, recreation, foreign earnings, and revenue to the country (Sobo 2012). Marine and inland fisheries are significant regarding food security and nutrition in a household. In addition, fish significantly contributes to

animal protein consumption (FAO 2008). Fisheries also provide both direct and indirect employment. Through employment, the income earned from fisheries and associated activities such as fish processing, fishing agreements, license fees, and distant water fishing fleets serviced at regional ports contributes to government budgets and the gross domestic product (FAO 2008).

These household incomes explain the levels of income in these fishing communities, which ultimately indicate whether a given fishing household is poor or otherwise. For example, in Lake Victoria, the household engaged in fishing (fishers) received net income that ranged between $1300 and $2100, while gear owners earned $5200 and $8400 per month (Bilame 2012). It is also reported that about 40-55% of the income of coastal fishing households in Tanzania is generated by fishing (Ninnes 2004).

Marine and inland fisheries are significant in food security and nutrition for many households, as fish contributes significantly to animal protein consumption (FAO 2008). Mafia Island is among the districts in Tanzania where the fish processing industry supports the dweller's fishing practice and activity. However, even though fishing seems to be the main economic activity, as explained in the district profile, there is no reliable information that explains the contribution of fishing to household income.

The objectives of the study were to determine household income contributed by fishing activity and examine determinants of fishing income. Furthermore, the study's findings are useful for future reference to other researchers who are interested in working further in fisheries studies.

MATERIALS AND METHODS

Description of the study area

Mafia District comprises a chain of small islets, with the main island centered at 7°50′S and 39°45′E some 20 km off the Tanzanian coastline east of the Rufiji Delta. It is approximately 50 km long by 15km across and is surrounded by a barrier reef teeming with marine life (Figure 1). The study area also has a protected area dominated by hard and soft coral reefs, sheltered back reef systems, inter-tidal flats with a hard and soft substrate, mangrove forests, extensive seagrass beds, algal sponges, and soft coral sub-tidal beds. The area is critical for the dugong (*Dugong dugong* Gmelin, 1788) and sea turtles (*Chelonia mydas Linnaeus*, 1758), *Eretmochelys imbricata* (Linnaeus, 1766), *Lipidochelys livaceae* (Eschscholtz, 1829), *Dermochelys coriacea* (Vandelli, 1761) which have been recognized as a critical site for biodiversity. It is popular for marine tourism, especially scuba diving (MCAT 2008).

Climate topography and soil condition

The island consists of a Pleistocene reef covered by sandy and loam soil. It experiences two monsoon seasons, the north-east (NE) (*Kaskazi*) and south-east (*Kusi*) (SE). NE Monsoon wind season starts at the end of November to March. The SE is the longer and windier period, from early July to mid-September. This is reported to be more variable than the NE monsoon, which brings strong winds. Mafia has a relatively dry tropical climate with approximately 1,800 mm of rain each year divided into two seasons of long rains in late March-May and short rains in November-early December (Kamukuru 2003).

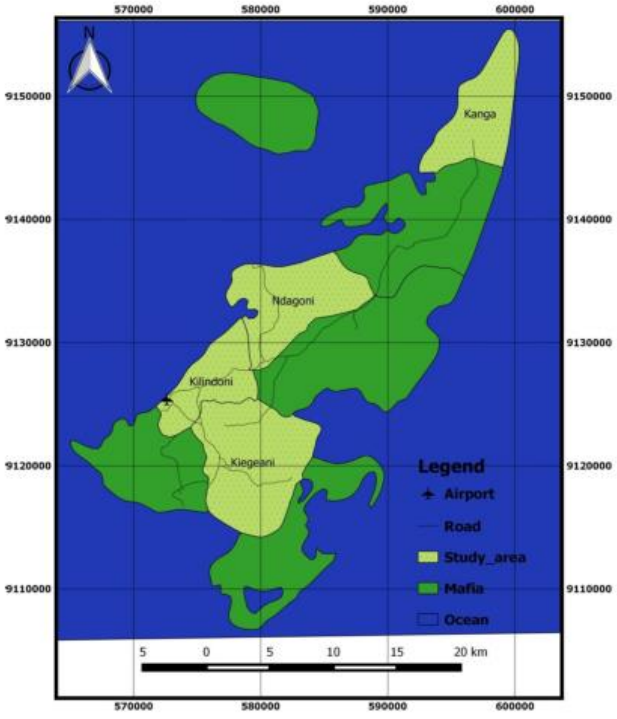

Figure 1. Map of the study area in Mafia District, Tanzania

Population and ethnicity

According to URT (2012), the overall district population was 46,438 inhabitants living in 20 villages. Different ethnic groups inhabit the island, the majority being from Kilwa Chronicle as the Mwera from Songo Island.

Accessibility

The study area is accessed by boat, which takes about three to four hours from Mafia to Rufiji. Islanders typically use jahazis, widely referred to in English as dhows, to commute between Kilindoni and outlying villages on Mafia and for inter-island travel. Flights flying into and out of Mafia every day take only 45 minutes from Dar es Salaam and 1 hour from Zanzibar or the Selous.

Data collection

Primary data was collected through a questionnaire survey, checklist, field observation and Focus Group Discussion. Secondary data was collected through relevant literature reviews (published and unpublished documents). Relevant sources used were Mafia District Fisheries Office, internet, and Sokoine National Agriculture Library, Tanzania.

Research design

The research design for this study was cross-sectional. This design allows data to be collected from a sample to represent a large population at a single point in time. This is appropriate for descriptive study and determination of a relationship between and among variables and is economical in terms of time and financial resources (Babbie 1993). A subject population was selected, and data were collected from these individuals to answer questions of interest.

Sampling procedure

Both purposive and simple random sampling procedures were adopted in this study. First, four wards were selected purposively in the district (Kilindoni, Ndagoni, Kiegeani and Kanga) then a random sampling procedure was adopted to select 4 villages, namely Kilindoni, Kiegeani, Chunguruma, and Bweni.

Sample size

The sampling unit for the study was the household. According to TANGO International (2004), a household is a core analytical unit that defines regular roles, rights, and responsibilities across gender and age. A total of 120 households were randomly selected to obtain 30 households per village, as 30 respondents is the minimum number recommended to represent a population under study (Yurdugul 2008).

Questionnaire survey

A semi-structured questionnaire was used to obtain primary data. This questionnaire was designed to collect demographic characteristics of the households, household income from fishing and its related activities, and determinants of fishing income.

Checklist of questions

A checklist of questions was used to guide interviews with key informants. The key informants included the village chairperson, village elders, and district fisheries officers.

Field observation

Supplementary information was collected through personal observation in the field to cross-check some of the information obtained through the questionnaire. This was true, especially on the type of fisheries resources harvested, type of fishing gears used, fishing related activities conducted. According to Neuendorf (2002), observation and interaction within the society enable a researcher to discover discrepancies between what participants say and what is believed should happen and what happens or between aspects of the formal system.

Focused group discussion (FGD)

FGDs were conducted in each village with 10 people, where 8 were household members, 1 fisheries officer and 1 village elder. A set of questions was used to guide the discussion, including the history of fishery in the study area, different fish captured with their contribution to household income, types of fishing-related activities conducted, the contribution of fish-related activities to household's income, and determinants of fishing income.

Reconnaissance

A preliminary survey was conducted to pre-test the questionnaire before the main survey. This was important since it helped to check and identify weaknesses and ambiguities before embarking on a detailed interview.

Data analysis

Qualitative data analysis

Qualitative information was analyzed by using content analysis. Using this method, the information collected through verbal discussions with key informants and focused group discussion was analyzed. This method enabled the researcher to include a large amount of texture information and systematically identify its properties (Neuendorf 2002). Textual information was categorized to provide meaningful information; the basic idea was to reduce the total content of communication to a set of categories representing some characteristics of research interest (Singleton et al. 1993).

Quantitative data analysis

Both descriptive and inferential statistics were used during data analysis. Questionnaires were coded, cleaned, and data from both open and closed questionnaires were categorized. Information such as socio-economic characteristics, income sources, and contribution of each economic activity to household income, were analyzed descriptively into frequencies, percentages, and mean and presented in tables and graphs.

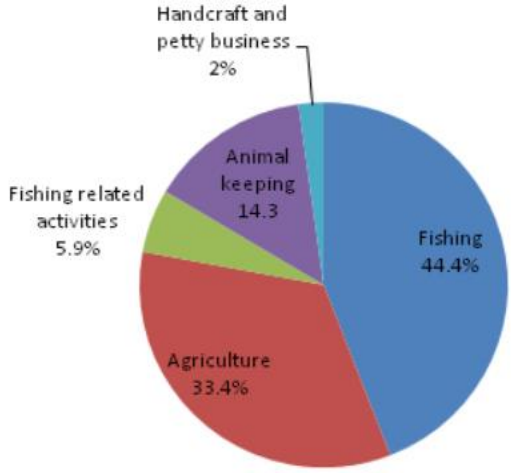

Figure 2. Household income from different sources

Household income contributed by fishing activity

Household income from fishing activities was analyzed and plotted using a box plot to obtain the income distribution from households involved in fishing only. Mean, median and mode were obtained and presented in a box plot (Figure 2).

Household income contributed by fishing-related activities

The dimension of fishing activities was measured as household involvement in fish processing, vessel making, fish trade, and fishing supporting activities. Descriptive statistics captured the contribution through percentage, mean and standard deviation.

Determinants of fishing income

A household questionnaire was used to capture information on determinants of fishing income. To answer this objective, data collected were socio-economic and demographic factors which were age, sex, family size, education level, marital status, fishing gear, fishing season, number of labor per vessel, financial support, and type of where fish are sold. Garoma et al. (2013) also used a multiple regression approach to determine quantitatively the amount of income earned from fish catch and factors affecting fish income.

A stepwise regression method was selected to identify the most suitable factors for determining fishing income. Thus, principal component factor analysis (PCA) was applied to identify the internal structure behind variables represented in a research concept by examining correlation among variables and reducing the number of variables (George and Mallery 2010). This application was further ensured to minimize the multicollinearity effect on regression analysis (Nishantha 2011). Selection criteria for extracting factors were fixed as the first commonality is greater than or equal to 0.5 (Costello and Osborne 2005; Yong and Pearce 2013). Secondly, the Eigen value is greater than 1.000 according to the Kaiser criterion and then the factor coefficient is greater than 0.5 (Shapiro and Wilk 1965).

Later, extracted factors identified by PCA were analyzed using the stepwise method of multiple linear regression and then the standard regression model measured path coefficients to understand the direct, indirect, and correlated impact of predicted determinants of fish income. The criterion was set at significance levels of α-0.05 and 0.01 for the selection of regression coefficients and path coefficients. Finally, details of each step of the statistical process were interpreted, along with an analysis of the results.

$$Y_{Income} = \beta_0 + \beta_1 F_{gear} + \beta_2 N_{labour} + \beta_3 F_{season} + \beta_4 E_{level} + \beta_5 F_{sup\,port} + \mu_1$$

Where, F_{gear}: fishing gear, N_{labor}: number of labor per vessel, F_{season}: fishing season, $F_{sup\ port}$: Financial support, E_{level}: Education level, coefficient-i: 0,1,2,..5, μ_1: stochastic error term, β1-βn: are independent variable coefficients (β) showing marginal effects (negative or positive) of the unit change in the independent variables on the dependent variables, Y: i^{th} is the income of the fishing activity in study area.

Justification of the multiple regression model

A multiple regression model, also known as Ordinary Least squares regression, is a common modeling method for data analysis and has been successfully applied in many studies. For example, Garoma et al. (2013) supported that the method is useful in analyzing the data with numerical (quantitative) dependent variables.

Variables description

The study assumes that household income is influenced by some socio-economic factors used in this study as the explanatory variables. The basis for the assumption was theoretical considerations found in the literature. The variables used in the model are summarized in Table 1.

Education level of household head

The education level of the household is a categorical variable and was measured by the number of years of formal schooling of the household head. Education plays a major role in adapting and innovation. It is also believed that a person with a higher education level is expected to use sophisticated gears that can improve fishing practice, hence increasing income (Jabri et al. 2014). Therefore, it is expected that a positive relationship should exist between the household that has gone to school to have higher income.

Fishing gear

Fishing gear is a categorical variable measured by the kind of gear used by the fisher. Efficient and effective use of any gear on a water body with success is key as the fisher needs mobility to enable him/her to reach both near and distant fishing grounds or markets. This necessitates the acquisition of a craft (Ogundiwin 2014). It is expected that a household that uses modern fishing gear is likely to have more income.

Table 1. Variables in the multiple regression model

Variables	Description	Types	Values
Dependent variable			Number of options
Fishing income			Available to choose
Explanatory variables			
Fgear	Fishing gear	Categorical	Categorical based on kind of gear
Nlabor	Number of labors	Continuous	Number of fishers
Fseason	Fishing season	Categorical	Categorical based on fishing season
Elevel	Education level	Categorical	Categorical based on number of years
Fsupport	Financial support	Categorical	Categorical based on type of credit received

Number of labor per vessel

The number of laborers per vessel is a continuous number which was measured by the number of crew per vessel. An increase in the number of crew per boat may lead to negative marginal returns for small-scale fishermen. Any increase in the number of fishermen may result in a decrease in output, hence, income accruing to each fisherman declines because the revenues must be shared by more people (Canbäck et al. 2006). Therefore, the more income received, the minimum number of crew per vessel is expected.

Financial support

Financial support is a categorical variable measured by the number of credits received to support the fishing activity. All forms of support positively impact fishing operations, which helps reduce costs, raise prices, or increase income.

Favorable fishing season

Fishing season is a categorical variable measured by the type of fishing season, which are NE and SE monsoon winds. Therefore, it is expected that there will be a low catch during SE monsoon during a high catch during NE monsoon season.

RESULTS AND DISCUSSIONS

Based on the analysis of information obtained from the communities in the four villages in the study area and various stakeholders, experience, and literature consulted are described below. Information includes identification of various economic activities, assessment of the economic contribution of fishing activities to the household income, the contribution of fish-related activities to household income, and determinants of fishing income.

Socio-economic characteristics of household head

Socio and economic factors play an important function in utilizing various resources, aiming to improve economic status. However, without considering the environmental impact, this can lead to unhinged natural resource utilization resulting in depletion. The socio-economic characteristics of respondents included sex, marital status, age, education level, and marital status (Table 2).

Sex of household

The social relationship between males and females influences socio-economic activities. The results show that 87% of respondents were male, while 13% were female (Table 2). The results also showed a significant difference between the sex in a study area ($p<0.01$). Gender determines the nature of the activity performed in fishing activities; males are more involved due to the nature of work since it involves more energy (Béné et al. 2003). Although the results show the dominance of the fisheries sector by men, the contribution of women in active fishing cannot be undermined. Williams (2002) reported that women had been restricted in fishing activity due to socio-cultural factors, low technical know-how, and lack of credit facilities.

Marital status

Findings showed that 89% of the households were married, 10% single and 1% widowed. It is also observed that there is no significant difference between marital status and household income from fish in a study area ($p <0.05$).

Age of household head

Most heads of household age (38%) ranged between 34-41 years. 28% ranged between 42-49 years, while 15% ranged between 26-33 years. Other 12% ranged between 50-57 years, 4% ranged between 18-25 years, as well as 3% of respondents, were above 58 years. It is also observed that there is no significant difference between age groups in the study area and the village when ($p<0.05$). Age is an important criterion that normally influences the working ability of an individual. Productivity increases with age and decreases with a late life cycle (Jeyarajah and Santhirasegaram 2015). Fisheries act of 2003 and its regulation of 2009 allow a man with more than 18 years to participate in fishing activities. Age also impacts experience, wealth, and decision-making (Hoppe 2002).

Education level of household head

Table 2 shows that 63% of the respondents have attained primary education, 25% secondary, and 12% have non-formal education. Results also show a significant difference between education levels in a study area ($p<0.01$). These findings imply that the education level for most households was still low because primary education is still considered basic education, which might directly influence the utilization of natural resources, especially

fisheries in the coastal area. Priya and Sreeranganadhan (2015) reported that fishers do not need high education and specialized skills since they have their traditional way of learning, and it is handled from generation to generation.

The findings of Yuerlita and Sylvain (2010) show that percentage of primary school education to households in the fishing community was higher than other levels of education in West Sumatra, Indonesia. Therefore, it could be argued that education is an important factor in providing better livelihood options, as it offers the opportunity for better-paid jobs and hence better livelihood outcomes that can reduce the dependence on fishing.

Households size

Findings show that 38.3% of households had an average household size of 4 people (Table 2). This average household size is within the national average household (URT 2012). It is also observed that there is no significant difference in household size in the study area ($p<0.05$). A large household size implies resource utilization because a large household size means high consumption units within the household (Hatibu 2010). This can lead to more extraction of resources.

Economic activities

Economic activities involve the production, distribution and consumption of goods and services at all societal levels. They can be assessed and forecasted to measure the significant impact of a particular activity (NACE 2008). Findings in the study area show that the main economic activities conducted were fishing, fishing-related activities and agriculture, while petty business and animal keeping were subsidiary activities. Findings in Table 3 show the respondents' economic activities conducted in the study area. Almost all respondents mentioned fishing as one of the daily activities conducted within the household (41.47%), followed by agriculture (14.85%).

Household income from different sources

The findings show that 44.4% (Figure 2) of the household income was from full-time fishing, 33.4% in agriculture, 14.3% in animal keeping, 5.9% in fish-related activity, and 2.0% were households engaging in handcraft and petty business. These findings imply that any activity affecting fisheries also affects the livelihood of a great proportion of the community in the study area. Furthermore, it has been seen that fishing is the activity that is the easiest to perform since it is a commonly accessed natural resource compared to others.

This study's findings align with different studies conducted in coastal areas on fisheries. For example, FAO (2012) reveals that fishing is an activity that contributes a large percentage compared to other activities in coastal communities.

Table 3. Percentage of the respondent in economic activities conducted in the study area

Economic activities	%
Fishing	41.47
Agriculture	14.85
Fishing and agriculture	12.5
Fishing with related activity	11.58
Fishing related activities	9.54
Fishing and livestock	8.6
Fishing and handcraft	0.83
Petty business	0.63
Total	100

Table 2. Social economic characteristics of respondent (n= 120)

Social economic attribute		Village (%)				Total (%)	x^2
		Kilindoni	Kiegeani	Chunguruma	Bweni		
Sex	Male	83.3	80	90	93.3	87	
	Female	16.7	20	10	6.7	13	S
Marital status	Single	6.7	13.3	10	8.3	10	
	Married	90	86.7	90	90.8	89	NS
	Widowed	3.3	0	0	0.8	1	
Age	18-25	6.7	0	0	3.3	4	
	26-33	30	13.3	10	6.7	15	
	34-41	20	46.7	43.3	43.3	38	
	42-49	20	30	30	33.3	28	
	50-57	23	3.3	10	13.3	12	
	Above 58	0	6.7	6.7	0	3	NS
Education level	None	26.7	10	3.3	10.8	12	
	Primary	63.3	46.7	76.7	63.3	63	
	Secondary	10	43.3	20	25.8	25	S
Family size	One	3.3	3.3	3.3	3.3	3	
	Two	3.3	13.3	3.3	5	6	
	Three	10	16.7	20	15.8	16	
	Four	33.3	40	43.3	38.3	39	
	More than four	50	26.7	30	37.5	36	NS

Note: S= Significant at $\alpha < 0.01$, NS= Not significant at $\alpha < 0.05$. Source: Field survey (2015)

Contribution of fishing income

The study found that the average estimated income obtained from households engaged only in fishing was 51,250 TZS per day, giving an estimate of 9,225,000 TZS per annum (Figure 3). In this figure, the income distribution shows that there are some exceptions for the minority who receive higher than others. This might be because they possess their fishing gear, compared to the majority who act as workers. However, at the end of the day, they must pay back the owner; both four FGDs explained this.

Contribution of fishing income by a village. Full-time household fishers in the study area showed different incomes per household per day. For example, in Figure 4, it is illustrated that Kilindoni village received the biggest amount of all, that is 340,000 TZS, whereas, Bweni received 57,200, Chunguruma, 52,000 and Kiegeani 5,950 TZS. It is also observed that in Kilindoni, most households received income ranging from 213 500 to 694,500 TZS in Chunguruma 21,600 to 62,250 TZS, Bweni 16,450 to 47,200 and Kiegeani 2,350 to 6,225 TZS (Figure 4).

Contribution of income by fish type. There are more than 460 fish species found on Mafia Island, few of them are mostly harvested due to their accessibility during fishing and marketability in and outside the island. The study found that 84.8% of the income is contributed by fish species (tuna species, groupers, emperor, mackerels), 11.5% by dagaamcheli (*Stolephorus commersonnii* Lacepède, 1803), while squid contributed only 0.1% of the total fishing income (Table 4). It has been observed that most of the fish harvested were pelagic, epipelagic and estuary simply because most of the fishers have no advanced fishing gear, hence, they only fish in territorial waters (McClanahan et al. 2009). The findings of this study are in line with different studies conducted in Unguja, which found that fish contributed to high income in fisher households; an example of these fish was like tuna, kingfish, sword, octopus, lobster, and shark, while those of low value were an octopus, mackerel, rabbitfish (Fröcklin et al. 2013). Also, FAO (2008) reported that most of the common catches in coastal communities in the Indian Ocean are small and large pelagic species, including herrings, tuna-like species, followed by demersal species like lobsters, shrimps that make a significant contribution to income.

Fishing activities by gender. Women's roles in world fisheries have increased (Bennett 2005), but traditionally, fisheries have been associated with men. Men focus primarily on capture fisheries rather than women-dominated pre- and post-harvest activities, such as processing and marketing the catch (Weeratunge et al. 2010). This study has revealed that more than 90% of fishers were male, while less than 10% were female (Figure 5).

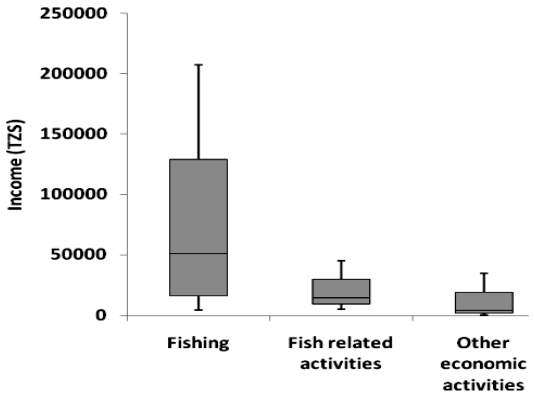

Figure 3. Distribution of fishing income in the study area

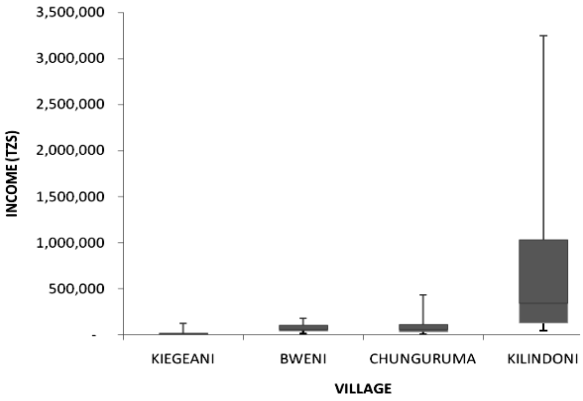

Figure 4. Distribution of fishing income by village

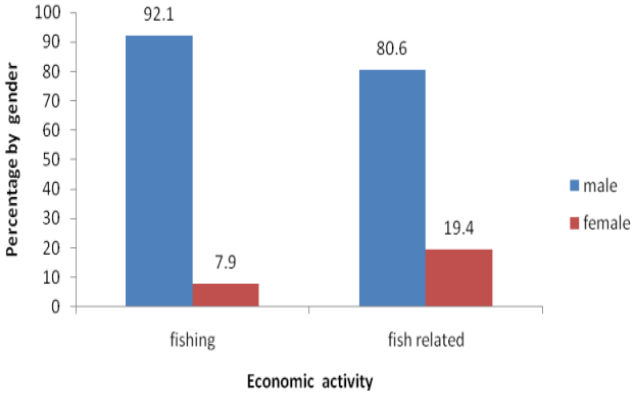

Figure 5. Showing fishing activity by gender

Table 4. Contribution of income by fish type

Fish type	Fish income (TZS)	
	Average mean	Std
Fish (all species)	423,000 (84.8)	90,900.21
Dagaa	243,344 (11.5)	51,899.53
Lobster	90,500 (2)	37,361.89
Ray	72,500 (1.1)	14,446.4
Octopus	6,800 (0.5)	8,300.85
Squid	12,000 (0.1)	5,047.67

Note: In brackets is percentage

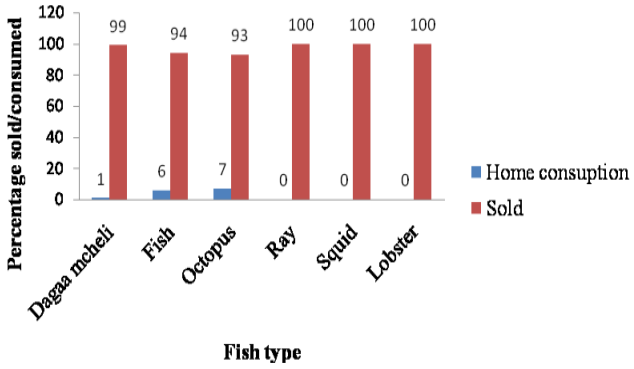

Figure 6. Showing the uses of fish in the study area

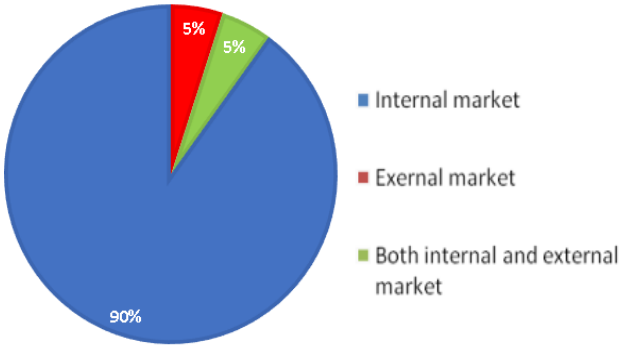

Figure 7. Shows type of market

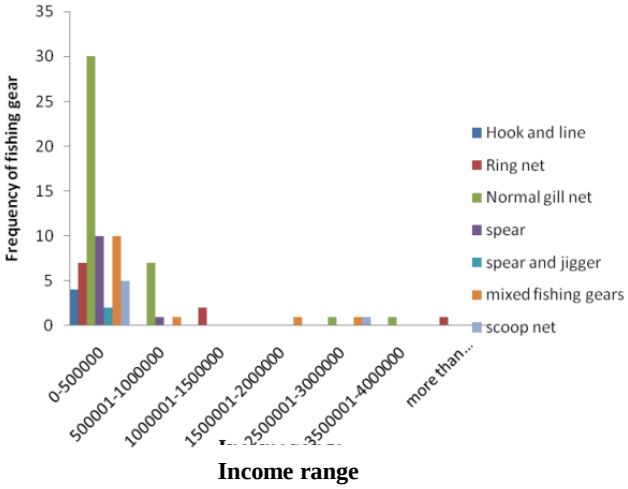

Figure 8. Income contributed by the type of fishing gear

From direct observation during the study, female fishers were found in Kiegeani village only, and they specifically harvest octopus. It is then observed that males conducted more than 80% of fish-related activities while females conducted less than 20%. These activities include fish and dagaa processing (drying, packaging, and transporting), vessel making, and repair. The findings of this study are in line with studies conducted by Williams (2002), who reported that women also perform diverse unpaid tasks such as mending nets, collecting bait, preparing food for fishers, and keeping accounts, which are unacknowledged or undercounted as employment. Therefore, this activity is dominated by men.

Different uses of fish in the study area. The study found different uses of fish in the study area. Ray, squid, and lobster were harvested for commercial purposes, while dagaa, fish, and octopus were used for home and commercial purposes. It has also been observed that dagaa was used in a small percentage of households compared to fish and octopus (Figure 6).

Fish market. The study found that fishers have three options for selling fish. First, they sell within Mafia, second, outside of the Mafia, and thirdly, both within and outside of Mafia. 90% of fish are being sold within the study area, 5% outside the study area, and 5% in both within and outside Mafia Island (Figure 7). The large amounts of fish sold within the study area are taken by the processing industry located at Kilindoni village. This fish processing industry sells its fish in other areas of the country and exports lobster and octopus to Portugal and France. Also, the dagaa market is largely sold while processed (salt drying) in Mtwara, Dar es Salaam, Kilimanjaro, and Singida and sometimes in Malawi and Congo.

The study by Sobo (2012) found that in most coastal zones, including Tanzania, there is no effective central marketing agency in the villages. Fish traders (mongers) usually visit different fish landing sites daily to buy fish and transport it to markets in major towns. Price is set depending on the season, demand for fish, and the distance of villages from the major coastal towns. For this reason, the price of fish is influenced by the variable transportation costs. Prices tend to be lower farther away from the major urban centers.

Contribution of income by fishing gear. The study shows that fishers normally use different fishing gear to catch various fish species. Among the gear used by fishers in the study area were hook and line, spear and jigger, ring net, normal gillnet, scoop net, and others used a mix of different gears at a time. Fishing gears have an impact on fishing income. Normal gill nets were preferred mostly since they capture almost all types of fish species. It has been observed that the ring net contributed a wide range of income from 1,000,000 to more than 5,000,000 TZS per catch per crew (Figure 8).

Fish species captured at different water level

Fish species are captured by using different gears at different water levels. There is a relationship between fish species, gear used, and water level. Figure 9 shows the water levels with the kind of fish species captured. Pelagic waters contributed 53%, where 38% are benthopelagic species and 9% are offshore dwellers. The pelagic species included *Anchoviella* spp. (dagaa), *Lethrinus* spp. (changu), *Siganus oramin* (Bloch & Schneider, 1801) (Tasi), *Restrelliger* spp. (vibua), *Carcharinus* spp. (papa). Almost fishing gears are capturing all these species, benthopelagic species including *Cephalopholis* spp. (chewa), *Aluterus* spp. (kikande), *Palinurus* spp. (kambakoche) *Pastinachus* spp. (taa), *Octopus* spp. (pweza). These species are

captured by normal gillnet and hook and line. Off-show dwellers included Tuna (jodari) and Gymnosarda spp. mostly known as Kingfish (nguru); these are captured by ring net and hook and line.

Contribution of income from fish-related activities

Findings revealed that there were several activities conducted that related to fishing, and those activities were performed by both sexes (Figure 10). Dagaa fishery involved a chain of activities, including carrying dagaa from the vessel to the landing site, drying, and packaging. Other beneficiaries from fishing include fish mongers (middlemen), fish processors (salt drying and smoke drying) as well as vessel makers and repair. Fish collection contributed 67%, whereas intermediaries do the activity, vessel building contributed 26%, dagaa collection and processing contributed 7%. A fish trader generally earns more than anyone involved in other coastal activities (Fröcklin et al. 2013).

Comparison of fishing income with other economic activities

The study showed that the average income from a fish household is much higher than other households that practice other economic activities in the study area (Table 5). The results above show a significant difference between households' fishing income and those from other economic activities, $p<0.05$.

Contribution of income from agriculture

Findings showed that coconuts, followed by paddy, were the main crops that contributed more to household income. Coconut contributed 24 times higher than paddy simply because almost every household has a coconut tree and harvested every three months. However, Table 6 revealed that coconut, paddy and cassava standard deviations are higher than their average mean. This could be because there was no normal distribution of income among the household simply because some of the households interviewed possessed large amounts of coconut trees and big farms of paddy and cassava compared to the majority; that made a big variation among them.

Uses of agricultural crops

The findings from the study observed that cassava, coconut, and paddy are both used commercially and domestically, while cashew nuts are used for commercial only (Figure 11).

Determinants of fishing income

The determinants of fishing income in the Mafia District were fishing gear, number of labor, fishing season, education level, and financial support. However, the independent variables, such as education level and financial support, negatively influenced fishing income, while the other independent variables positively influenced fishing income. Linear regression analysis results show that fishing gear, the number of labor, and fishing season significantly influenced the fishing income ($p<0.01$). On the other hand, some factors that would be thought to influence fishing income were not significant (Table 7).

Table 6. Contribution of income from agriculture

Crops	Agricultural income (TZS)	
	Average mean	Standard deviation
Coconut	2,459,416.67	3,987,031.21
Paddy	69,687.5	165,918.23
Cashew nut	600,000	24,860.97
Cassava	110,000	153,215.53

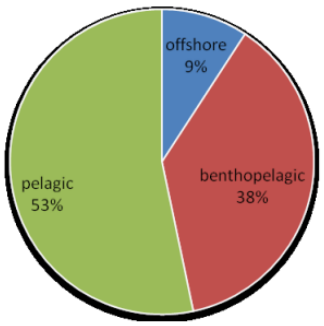

Figure 9. Water level with fish species capture

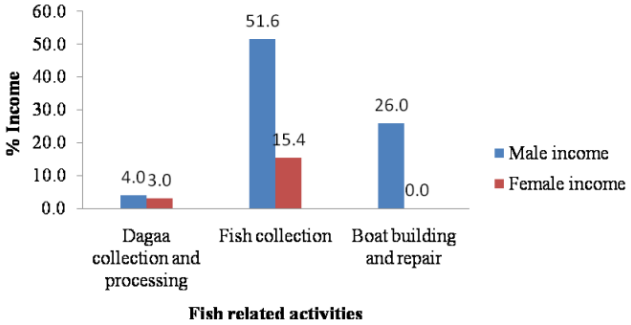

Figure 10. Income contributed by fish related activities

Table 5. Comparison of fishing income with other economic activities

Economic activity	Mean	Std	Std. error mean	t	df	Sig.
Fishing	61 550	36078.28	5245.58	3.575	118	0.048
Other activities	17 000	7821.37	1541.63			

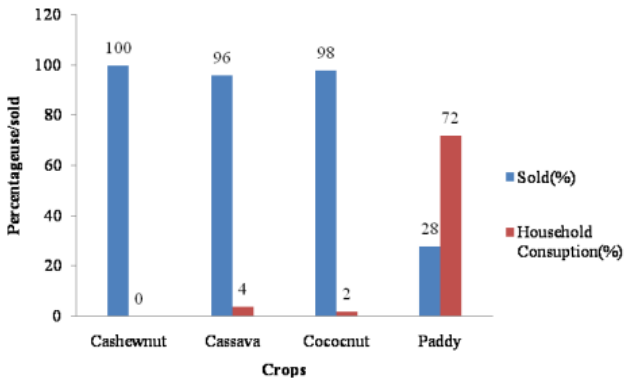

Figure 11. Uses of agricultural crops in the study area

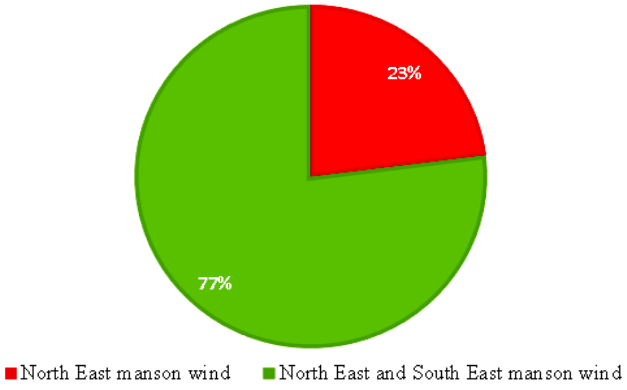

Figure 12. Shows the fishing season

Table 7. Linear regression results for determinants of fishing income

Variable	B	SE	β	t-value	P -value	Significance
Constant	0.398	0.157	0.041	1.023	0.031	S
Fishing gear	0.437	0.125	0.447	3.509	0.001	S
Number of labor	-0.055	0.028	-0.18	-1.95	0.054	S
Fishing season	0.242	0.121	0.258	2.008	0.048	S
Education level	0.007	0.127	0.005	0.055	0.957	NS
Financial support	0.092	0.148	0.056	0.625	0.534	NS

Note: S= significant at p<0.01, NS= Not significant at <0.05, Adjusted R^2= 76.4%, R^2= 73.4%

Fishing gear. The findings from the study showed that the relationship between fishing gear and fishing income was positive and statistically significant (P<0.01). This implies that fishing gears impact increasing fishing income, as the fisher who uses modern gear is likely to have more income (Table 7). The findings of this study concur with the study conducted by Canbäck et al. (2006), who found that fishermen might be in a diseconomy of scale situation, which can be turned around by offering bigger boats or other productive technologies. This means that an increase in output, which results in the average cost in the long run, increases by a greater amount and is proportional to the increase in the input.

Number of labor per vessel. The study found that the relationship between the number of laborers per vessel and fishing income was negative and statistically significant (p<0.01). This implies that a vessel with fewer fishers per vessel has less income (Table 6). Inoni and Oyaide (2007) found comparative results in Delta state in Nigeria that labor input was the factor around which small-scale fishing revolves, without an adequate number of men ready to undertake a fishing trip, there will be no catch. Therefore, the result implies that as the supply of labor increases, other things being equal, fish catch will increase as the income increases.

Fishing season. Findings from the study showed that the relationship between fishing season and fishing income was positive and statistically significant (p<0.01). This implies that the type of monsoon wind prevailing was influencing fishing income. The findings (Figure 12) show that 77% of the fishers were fishing in both NE and SE Monsoon and 23% of fishers were fishing only in NE monsoon. During SE monsoon, the catch is low, while in NE is high. The variation of catch due to reduced effort by fishermen during the SE monsoon wind was caused by rough sea conditions, fish migration and decreased density and activity due to deeper thermocline and cooler waters in the SE monsoon. Generally, the findings of this study support the findings by McClanahan (1988) that catch was low during the SE monsoon and high during the NE monsoon, with a peak in March at the end of NE monsoon. Also, the study conducted by Yaakob and Chau (2005) reported that there was a close relationship between weather and fishing operations as well as fishermen's income. The economy of the artisanal fishers is closely linked to cycles of the moon and tides, seasonal changes in the climate and the breeding patterns of the fish and other species on which they depend (Vieira et al. 2013).

Education level. The findings from the study revealed that education was insignificant in explaining the influence of education level on fishing income. The results are not in line with that of other studies, which reported that education had a significant positive impact on fisheries activities through financial management, which helped in improving general fishing activities, including fisheries businesses, methods of fishing and fish processing, to sustain and develop fisheries resources (Mensah et al. 2014).

Financial support. The findings from the study revealed that financial support was insignificant in explaining the influence on fishing income. Artisanal fishing seems to be an attractive activity for poor

individuals living along the coast since it has a very low startup cost (Silva 2006). The research done by Fröcklin et al. (2013) reported that capital is needed in fishing activities. It doesn't matter which sources it comes from, either in micro-credit, savings, or lent. This shows that access to initial capital is a key factor for income enhancement, increasing the quality of life.

This study has attempted to show the incomes generated from fisheries and how those incomes contribute to general household income. The study has further shown how the incomes of fishers and other people who engage in fishing activities are received. Fishers received higher income from fishing compared to other activities. However, alongside the incomes generated from fisheries, there were no fishing activities, which also greatly increased the household's income. Therefore, there is a need to strengthen fisheries sustainably in a way that enables both fishers and other people who benefit indirectly through fisheries to attain a win-win solution to raise household incomes that could raise the standard of living.

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