# Determinants Influencing Fishing Income to the Coastal Households of Indian Ocean

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### Abstract

This paper assesses the determinants influencing fishing income of households living in coastal areas of Indian Ocean by using Mafia District, Tanzania as a case study. Data collected by using survey and participatory rural appraisal (PRA) to 120 randomly households. Collected data were analysed both statistically and contently. The result revealed that, there are several economic activities conducted in the study area, where 41.47% of the households indicated that fishing is the major economic activity for their livelihood with average income per day of 24.41 USD (51 250 TZS); whereas, fish related activities contributes 7.14 USD (15 000 TZS) and other economic activities wealth 2.38 USD (5000 TZS) per day. The paper concludes that fishing contributes higher household's income compare to other activities. The paper recommends the government or other stakeholders to provide credit or subsides in improved fishing gears so as to acquire sustainability.

**Keywords:** Fishing; Fishing income; Fishing determinants

## Introduction

Many millions of people around the world find a source of income and livelihood in the fisheries and aquaculture sector. Global fish production has grown for the last five decades in an increasing of food fish supply at an average of 3.2 percent annually, outpacing world population growth by 1.6 percent [1]. Basically the world per capita apparent fish consumption has increased from an average of 9.9kg in the 1960s to 19.2kg in 2012. This impressive development has been driven by a combination of population growth, rising incomes and urbanization, and is facilitated by the strong expansion of fish production and more efficient distribution of channels. By the year 2012 about 58.3 million people engaged in the primary sector of capture fisheries and aquaculture, where 37 percent engaged in full time, 84 percent of all people employed in the fisheries and aquaculture sector are in Asia, followed by Africa which has more than 10 percent [1]. In Africa, the total employment in the whole fisheries sector is at 25.4 million people, 7.8 million were employed in fishing and 17.6 in post-harvest [2].

Annual per capita fish supply in the rest of the world was about 15.4kg in 2010; 11.4kg in the 1960s and 13.5kg in the 1990s [1]. In Tanzania the average per capita annual fish and shellfish consumption is estimated to be 5.5kg [3]. MLFD [4]

reported that, in Tanzania more than 4 million people engaged in fishing and fisheries related activities, while more than 400 000 fisheries operators are directly employed in the sector.

The Tanzania 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 Yellow fin tuna, Skipjack tuna, Big eye tuna, Long tail tuna, and Kawakawa. Small scale fishing however is conducted by artisanal fishers who fish for fin fish, mollusks and crustaceans within the inshore. Tanzania as the Eastern Africa Region, among 13 African countries and 57 countries in the world produced over 200000 metric tons in 2010 [5].

The total annual fish production in Tanzania was 347,157 metric tons in 2010 (MLFD [4]) and reported as the main source of protein to nearly 9 million people living along the coast, and provides source of employment and livelihood to a substantial number of people (MLFD [4]).

The contribution of fishing activities has remained fairly constant over the last decade ranging between 4.4% and 5.7% per annum and a period average of 4.6%. 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 destruction of nursery grounds. Currently, the sector accounts for about 10% of the national exports (Planning Commission, 2012; MLFD [4]).

Small-scale or artisanal fisheries is still developing rapidly through export markets and adopting new technologies like satellite positioning systems which make easier for fishers to search fish [6]. In fact, a large number of the people in Tanzania who are living in coastal zone are surrounded by rich marine resources. They utilize the resources for subsistence and as a source of income in the households. Among of the resources, fish being the most important compared to others [7]. Different fishing gears are being used to capture those marine resources though they are none sophisticated. At least each household is engaging in fishing activity either direct or indirect often benefits from such resources. Although fishing has been conducted for several years, still continues to be an important source of household income and food as well.

Mafia Island is among of the District in Tanzania where the dwellers are practicing fishing and the activity is being supported by the fish processing industry which is located at Kilindoni village where some of the fish products are being sold. Despite the fact that fishing seems to be the main economic activity as explained in the district profile, there is no reliable information that explains the determinants influencing fishing income to the coastal households of Indian Ocean using Mafia Island as case study.

## Methodology

### 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 20km off the Tanzanian coastline east of the Rufiji Delta. It is approximately 50km long by 15km across, and is surrounded by a barrier reef teeming with marine life. The study area also has a protected area which is dominated by hard and soft coral reef, sheltered back reef systems, inter-tidal flats with hard and soft substrate, mangrove forests, extensive sea grass beds, algal sponge and soft coral sub tidal beds. The area is critical for the dugong (Dugong dugong) vulnerable and sea turtle (Cheloniamydas, Eretmochelys imbricate, Lipidochelys livaceae, Dermochelys coriaceae) which have been recognized as critical site for biodiversity. It is popular for marine tourism especially scuba diving [8].

### Data collection

The primary data was collected through questionnaire survey, checklist, field observation and Focus Group Discussion. And secondary data were collected from archive information related to study. The study employed cross sectional design. Both purposive and simple random sampling procedures were adopted in this study. 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. Sampling units 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 household per village.

Semi-structured questionnaire were used to obtain primary data. Questionnaire was designed to collect demographic characteristics of the households, household income from both fishing and its related activities and determinants of fishing income. Also, checklist of questions was used to guide interviews with key informants. The key informants included village chair person, village elders and district fisheries officers.

### Data analysis

**Determinants of fishing income:** Household questionnaire was used to capture information on determinants of fishing income. Data collected to answer this objective were socio economic and demographic factors which were age, sex, family size, education level, marital status, fishing gear, fishing season, number of labour per vessel, financial support and type of where fish are sold. Garoma et al. [9] used also 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 as it enables in identifying the most suitable factors for determining fishing income. Thus, principal component factor analysis (PCA) was applied to identify internal structure behind variables represented to a research concept by examining correlation among variables and also reduce number of variables [10]. This application was further ensured as minimizing of Multicollinearity effect on regression analysis [11]. Selection criteria for extracting factors were fixed as firstly communality is greater than or equal to 0.5 [9,12]. Secondly, Eigen value is to be greater than 1.000 according to Kaiser criterion and then factor coefficient is to be greater than 0.5 [13].

Later, extracted factors identified by PCA were analyzed using stepwise method of linear multiple regression and then path coefficients were measured by standard coefficients of regression model in order to understand direct, indirect and correlated impact of predicted determinants of fish income. The criterion was set at significance level at $\alpha$-0.05 and 0.01 for selection of regression coefficients and path coefficients. Details of each step of the statistical process were interpreted along with analysis of results…………………………1=fishing gear,=number of labor per vessel,=fishing season,=Financial support,=Education level, coefficient i=0,1,2,..5,=stochastic error term, $\beta 1$-$\beta n$=are independent variable coefficients ($\beta$) showing marginal effects (negative or positive) of the unit change in the independent variables on the dependent variables, Y=ith is the income of the fishing activity in study area.

**Justification of the multiple regression model:** Multiple regression model which is also known as Ordinary Least squares Regression is often used in modeling method for data analysis and has been successfully applied in many studies [9] and Gujarat (1992) 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 number of 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.

**Table 1:** Variables in the multiple regression model.

| Variables | Description | Types | Values |
|---|---|---|---|
| Dependent variable | | | Number of options |
| Fishing income | | | Available to choose |
| Explanatory variables | | | |
| $F_{gear}$ | Fishing gear | categorical | Categorical based on kind of gear |
| $N_{labour}$ | Number of labour | continuous | Number of fishers |
| $F_{season}$ | Fishing season | categorical | Categorical based on fishing season |
| $E_{level}$ | Education level | categorical | Categorical based on number of years |
| $F_{support}$ | Financial support | categorical | Categorical based on type of credit received |

## Education level of household head

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 a new innovation. It is also believed that a person with higher education level is expected to use sophisticated gears that can make an improvement in fishing practice hence increasing income [10]. It is therefore expected that a positive relationship should exist between the household that has gone to school to have higher income Table 2.

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

| Social economic attribute | | Village (%) | | | | Total (%) | X |
|---|---|---|---|---|---|---|---|
| | | Kilindoni | Kiegeani | Chunguruma | Bweni | | |
| Sex | Male | 83.3 | 80 | 90 | 93.3 | 87 | S |
| | Female | 16.7 | 20 | 10 | 6.7 | 13 | |
| | Single | 6.7 | 13.3 | 10 | 8.3 | 10 | |
| | Married | 90 | 86.7 | 90 | 90.8 | 89 | NS |
| Marital status | Widowed | 3.3 | 0 | 0 | 0.8 | 1 | |
| | 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 | |
| Age | Above 58 | 0 | 6.7 | 6.7 | 0 | 3 | NS |
| | None | 26.7 | 10 | 3.3 | 10.8 | 12 | |
| | Primary | 63.3 | 46.7 | 76.7 | 63.3 | 63 | |
| Education level | Secondary | 10 | 43.3 | 20 | 25.8 | 25 | S |
| | 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 | |
| Family size | More than four | 50 | 26.7 | 30 | 37.5 | 36 | NS |

S = Significant at α < 0.01; NS= Not significant at α <0.05.

Fishing gear is a categorical variable which was measured by a kind of gear used by fisher. Efficient and effective use of any gear on a water body with success, the fisher needs a kind of mobility to enable him/her reach both near and distant fishing grounds or markets. This necessitates the acquisition of a craft [14]. It is expected that a household which uses modern fishing gear is likely to have more income.

### Number of labour per vessel

The number of labour 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 the small-scale fishermen. Any increase in the number of fishermen may result in a decrease in output hence, income accruing to each fishermen declines because the revenues have to be shared by more people [15]. It is expected that minimum number of crew per vessel the more income received.

### Financial support

Financial support is a categorical variable which was measured by the number of credit received to support the fishing activity. All forms of support have positive impact on fishing operations which helps in reducing costs, raising prices or increasing income.

### Favorable fishing season

Fishing season is a categorical variable which was measured by the type of fishing season which are NE and SE monsoon wind. It is expected that during SE monsoon there will be low catch while in high catch in NE monsoon season.

## Results and Discussion

### Socio-economic characteristics of household head

Socio and economic factors play an important function in utilization of various resources with the aim of improving economic status. If done without consideration of the environmental impact can lead to unhinged natural resource utilization resulting into depletion. The socio-economic characteristics of respondents that were included are sex, marital status, age, education level and marital status.

### Economic activities

Economic activities involve the production, distribution and consumption of goods and services at all levels within a society and they can be assessed currently and forecasted to measure the significance impact of a particular activities [16]. 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. Also findings (Table 3) shows the respondents' economic activities conducted in the study area. Almost all respondents mentioned fishing as one of the daily activity conducted within the household with the following main distribution 41.47%,

14.85% are fishing and agriculture respectively.

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

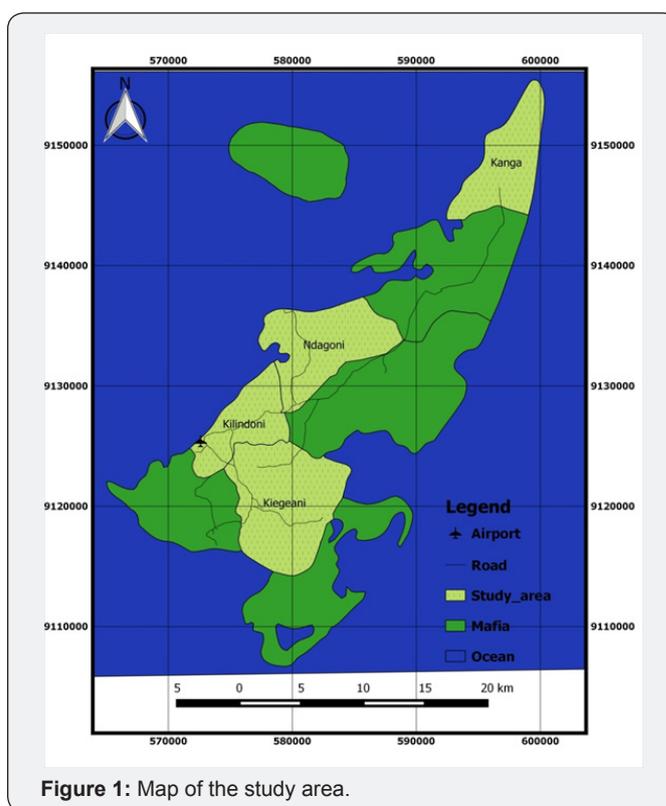| Economic activities | % |
|---|---|
| Fishing | 41.47 |
| Agriculture | 14.85 |
| Fishing and agriculture | 12.5 |
| Fishing with related activity | 11.58 |
| Fishing related activities | 9.54 |
| Fishing and livestock | 8.6 |
| Fishing and handcraft | 0.83 |
| Petty business | 0.63 |
| Total | 100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



**Figure 1:** Map of the study area.

**Household income from different sources:** The findings show that 44.4% (Figure 1) of the income from households were from full -time fishing, 33.4%, in agriculture, 14.3%,in animal keeping, 5.9% in fish related activity and 2.0% was household which were engaging in handcraft and petty business. These findings imply that any activity affecting fisheries is also affecting the livelihood of the great proportion of the community in the study area. It has been seen that fishing is the activity that is the easiest to perform since it is the commonly accessed natural resources compared to others.

The findings of this study are in line with different studies conducted in coastal areas on fisheries. FAO [17] reveals that fishing is the activity that contributes large percent compared to other activities in coastal communities.
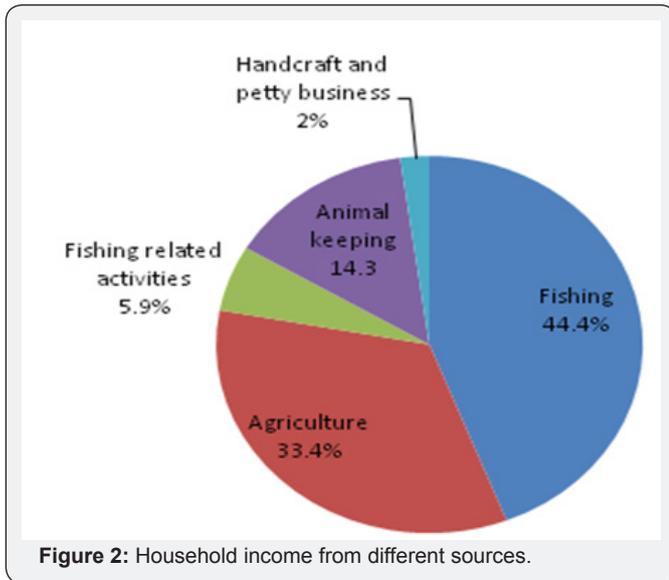
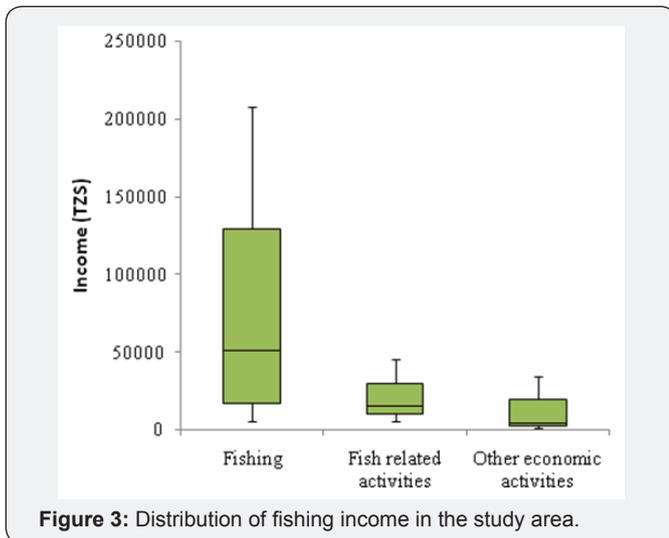**Figure 2:** Household income from different sources.



**Figure 3:** Distribution of fishing income in the study area.

**Contribution of fishing income:** The study found that the average estimated income obtained from household engaged only in fishing was 24.41 USD (51 250 TZS) per day which gives an estimate of 4392.86 USD (9 225 000 TZS) per annum (Figure 2). In the Figure 3, the distribution of income shows that, there are some exceptions for the minority who receive much higher than others. This might be due to the fact that they posses their own fishing gears compare to the majority who act as workers. At the end of the day, they must pay back to the owner; this was explained by discussants in both four focus group discussions (FGDs).

Full time household fishers in the study area showed different income that is received per household per day. In Figure 4, it is illustrated that Kilindoni village received the biggest amount of 161.91 USD (340 000 TZS) whereas, Bweni received 27.24 USD (57 200 TZS), Chunguruma 24.76 USD (52 000 TZS) and Kiegeani 2.83 USD (5 950 TZS). It is also observed that in Kilindoni majority of the households received income

that ranged from 101.67 USD (213 500 TZS) to 330. 71 USD (694 500 TZS) in Chunguruma 10.29 USD (21 600 TZS) to 29.64 USD (62 250 TZS), Bweni 7.83 USD (16 450 TZS) to 22.48 USD (47 200 TZS) and Kiegeani 1.12 USD (2 350 TZS) to 2.96 USD (6 225 TZS).
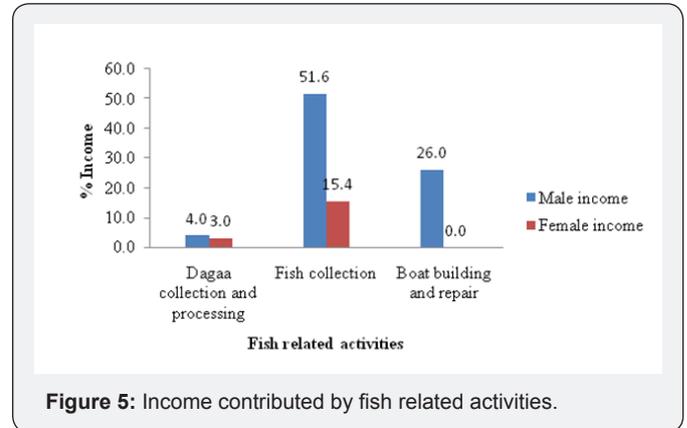


**Figure 5:** Income contributed by fish related activities.

**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 sex (Figure 5). Dagaa fishery involved a chain of activities including carrying of dagaa from the vessel to landing site, drying and packaging. Other beneficiaries from fishing including fish mongers, (middle men), fish processor (salt drying and smoke drying) as well as vessel makers and repair. Fish collection contributed 67% where the activity done by middle men, vessel building contributed 26%, dagaa collection and processing contributed 7%. A fish trader generally earns more than any other people involved in other coastal activities [18].

**Comparison of fishing income with other economic activities:** Results from the study showed that the average income from house hold that conducts fishing is much higher than other household which practice other economic activities in the study area (Table 4).

**Table 4:** Comparison of fishing income with other economic activities.

| Economic activity | Mean | Std | Std. Error Mean | t | Df | Sig. |
|---|---|---|---|---|---|---|
| Fishing | 61550 | 36078.28 | 5245.58 | 3.575 | 118 | 0.048 |
| Other activities | 17000 | 7821.37 | 1541.63 | | | |

### Determinants of fishing income

The determinants of fishing income in Mafia district were fishing gear, number of labour, fishing season, education level and financial support. However the independent variable such as education level and financial support were negatively influencing fishing income, whilst the other independent variables were positively influencing 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 5).

**Table 5:** 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 labour | -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 |

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 have impact on increasing fishing income, as the fisher uses modern gear likely to have more income (Table 5). The findings of this study concur with the study conducted by Canback et al. [15] 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 with an increase in output, this results into average cost in the long run increases by a greater amount and is proportional to the increase in the input.

**Number of labour per vessel:** The study found that the relationship between the number of labour per vessel and fishing income was negative and statistically significant ($P < 0.01$).This implies that for a vessel with less number of fisher per vessel has less income (Table 5). Inoni and Oyaide (2007) found comparative results in Delta state in Nigeria that labour 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 labour increases, other things being equal, and fish catch will increase as the income increases.
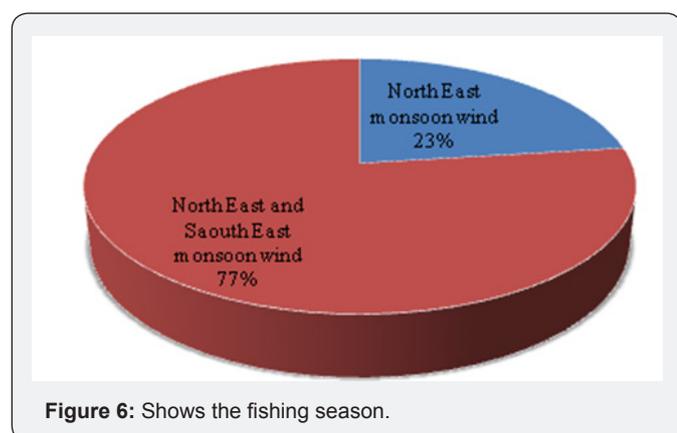


**Figure 6:** Shows the fishing season.

**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. From the findings (Figure 6) it is shown that, 77% of the fishers were fishing in both NE and SE Monsoon and 23% of fishers was fishing during 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 decrease density and activity due to deeper thermo cline and cooler waters in the SE monsoon. Generally, the findings of this study support the findings by McClanahan [19] that catch was low during the SE monsoon and high during the NE monsoon with a peak at March at the end of NE monsoon.

Also, the study conducted by Yaakob & Chau [20] reported that there was a close relationship between weather and fishing operation 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 [21].

**Education level:** The findings from the study revealed that education was insignificant in explaining the influence of education level in fishing income. The results are not in line with that of other studies which reported that education had positive significant impact in fisheries activities through finance management which helped in improving general fishing activities including fisheries businesses, methods of fishing and fish processing, to sustain and develop fisheries resources [22].

**Financial support:** The findings from the study revealed that financial support was insignificant in explaining the influence in fishing income. Artisanal fishing seems to be attractive activity for poor who are living along the coast since it has very low start up cost [23]. The research done by Frocklin [24] reported that capital is needed in fishing activities. It doesn't matter in 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, which in turn increases the quality of life [25-27].

## Conclusion and Recommendation

This study has attempted to show the determinants influencing fishing income generated by coastal households of Indian Ocean for their livelihoods. Fishers received higher income from fishing compared to other activities. Alongside with the incomes that were generated from fisheries, there were none fishing activities which also played a great role in increasing

household's income. Therefore, there is a need to strength fisheries in a sustainable manner in a way that it enables both fishers and other people who benefit indirect through fisheries to attain a win-win solution in order to raise household incomes that could raise the standard of living. Therefore the Tanzania government and other stakeholders should smoothening access to financial credits and field gears to strengthen fishing activities to coastal dwellers.

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