# Entangling Economics of Fishing to the Sustainability of Coastal Households of Indian Ocean

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# Entangling Economics of Fishing to the Sustainability of Coastal Households of Indian Ocean

**Adili Yohana Zella [a*] and Antonia Mpemba [b]**

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## ABSTRACT

Fisheries and aquaculture are socio-economic activities that employ millions of people around the world as a source of income and livelihoods. However there are uncertainties in this sector which alter attainment of sustainability of coastal households. This study assesses the determinants influencing fishing income of households living in coastal areas of Indian Ocean by using Mafia District, Tanzania as a study case. 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; economics of fishing; fishing determinants; fishing sustainability.*

## ABBREVIATIONS

*AIMS : Assessing the Impacts of Microenterprise Services*
*BOT : Bank of Tanzania*
*df : Degree of freedom*
*DFID : Department for International Development*
*DFSO : District Fisheries Officer*

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*EEZ : Exclusive Economic Zone*
*FAO : Food and Agriculture Organization*
*GDP : Gross Domestic Product*
*MCAT : Millennium Challenge Account-Tanzania*
*MLDF : Ministry of Livestock Development and Fisheries*
*Mt : Metric tones*
*NE : North East*
*OECD : Organization for Economic Co-operation and Development*
*PCA : Principle Component Factor Analysis*
*SE : South East*
*SPSS : Statistical Package for Social Sciences*
*TANPESCA : Tanzania Processing and Exporting Seafood*
*TZS : Tanzanian Shillings*
*URT : United Republic of Tanzania*
*USAID : United States Agency for International Development*
$\chi 2$ *: Chi square*

## 1. INTRODUCTION

### 1.1 Background Information

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 9.9 kg in the 1960s to 19.2 kg 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 [1]. 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 15.4 kg in 2010; 11.4 kg in the 1960s and 13.5 kg in the 1990s [1]. In Tanzania the average per capita annual fish and shellfish consumption is estimated to be 5.5 kg [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 [5]. 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 [6].

The total annual fish production in Tanzania was 347,157 metric tons in 2010 [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 [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) [7].

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 [8]. 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, [9]. 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 entangling economics of fishing to the sustainability of coastal households of Indian Ocean. Thus, this study tries to fill that gap with specific attention on various livelihoods' economic activities and determinants influencing fishing income of the households living in coastal areas of Indian Ocean.

## 1.2 Conceptual Framework

The conceptual framework underlying this study (Fig. 1) is based on the fact that, household income is the function of fishing and its related activities. Income as the output of activities measures both cash and in-kind contributions. Fishing activity contributes in household income directly through selling fish. This activity also depends on several factors including availability of market, favorable fishing season, financial availability, type of fishing gear and the level of education.

Davis [10] comments that fishermen are constantly faced with making decisions where the financial gain or loss is highly uncertain, such as the choice of species to fish, type of gear to use, and optimal fishing location. His findings indicate that there is relationship between the incomes accrued from fishing with fishing ground, and the gear that has been used to increase fishermen's income in household. Saarrankan [11] also found that the knowledge and skill of fishing methods, fishing gears, and marketing, particularly skill of identifying fish shoals, changing weather, ocean currents, and winds are vital to the fisherman to be successful in fish catches. Through fishing related activities, households receive their income by practicing these activities including fish trade, making of fish vessels and fish processing, casual work like carrying fish from the vessel to the market, ice making and distribution.

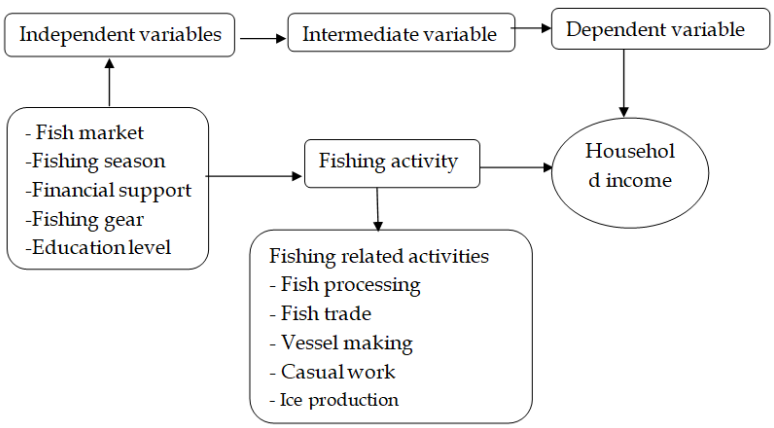


**Fig. 1. Conceptual framework of the study**

## 2. LITERATURE REVIEW

### 2.1 Fisheries Concept

According to Panayotou [12] a fishery is typically defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, purpose of the activities or a combination of the foregoing features". The definition often includes a combination of fish and fishers in a region, the latter fishing for similar species with similar gear types. Fisheries are activities leading to harvesting fish; it may involve capture of wild fish or raised fish through aquaculture [13].

### 2.2 Role of Fisheries in Household

Marine and inland fisheries are very significant in household in terms of food security and nutrition where fish provides a significant contribution to animal

protein consumption. Fisheries also provide both direct and indirect employment. Through employment the income earned from both fisheries and the associated activities such as fish processing, fishing agreements, license fees, and from the activities of distant water fishing fleets which are serviced at regional ports contributes to government budgets and to the gross domestic product (GDP) [14].

## 2.3 Overview of Fisheries in Tanzania

Tanzania has both marine and inland fisheries potential. The marine water covers 64000 square (sq) km which includes the Indian Ocean and the Exclusive Economic Zone which covers 223000 sq km. The fresh water includes the shared waters of East African great lakes namely Lake Victoria, Tanganyika and Nyasa. The country has also other small natural lakes, manmade lakes, river systems and many wetlands with fish potential. All these water cover 58 000 sq km. The country has coastline of about 800 km declared as its Exclusion Economic Zone but has not yet exploited [15].

Tanzania has potential to produce over 730 000 metric tons of fish from both captured and aquaculture whereby Lake Victoria have 200 000 mts, Lake Tanganyika 300 000 mts, Lake Nyasa 100 000, marine waters 100 000 mts and other lakes 30 000 mts [15]. Fresh water fisheries accounts for 80% of the landed catch of about 280000 to 320000 tons annually and aquaculture contributes only a very small amount estimated at about 1200 to 1500 metric tons annually [15].

Fish production and value in the country have indicated oscillating increased trend over the recent past years with the highest quantity of 375534.6 metric tons of fish landed in 2005. For the last five years fisheries sector has been estimated to contribute between 1.6% to 3.1 GDP [16]. For example in the year 2013 fish production was 367 854 metric tons valued at TZS1 444 432 520, during the same period, the country earned over 6117769193.74US $ million as foreign exchange from export of fish and fishery product [7].

### 2.3.1 Marine capture fisheries

The marine fishery in Tanzania consists of two categories namely artisanal and industrial. The artisanal and industrial fishing differ in their social and economic perspectives, and to a large extent they serve separate markets or economies. Due to that artisanal fishers supply local or informal markets important for food security, and the industrial fleets supply more affluent domestic or export markets, important to Gross Domestic Product (GDP), [17]. Artisanal operates only within the territorial waters (12 nautical miles stretch) and catch is mostly of pelagic fin fish used for domestic and commercial. The marine industrial fleet included both the territorial waters and beyond in the Exclusive Economic Zone (EEZ). The main target species in the territorial waters are shellfish (shrimps and lobsters), cephalopods and crabs. In the EEZ industrial is exclusively industrial fleet and the bulk of the catch is exported. This fishery is mainly conducted by

licensed foreign vessels flying the flags of major fishing countries. The fishing vessels used usually is purse seiners and long liners (FAO, 2007).

## 2.4 Household Income

Schwarze [18] defined income as the output of activities which measures both cash and in-kind contributions. All the goods and services produced in activities are valued at market producer prices regardless of their use. According to AIMS [19] household income, levels and diversification of income sources are critical determinants of household welfare. Income levels affect a household's consumption and investment options. Diversification of income sources is a household strategy that can increase income, lower risk by lowering dependence on a single income stream, or smooth income fluctuations over time.

Generally household income, rather than personal income, is the preferred measure for analysis of people's economic well-being. This is because the major determinant of economic well-being for most people is the level of income they have and other family members living in the same dwelling receive. While income is usually received by individuals, it is normally shared with other household members (Canberra Group, 2011). Household income covers from employment (both paid and self-employment), property income, production of household services for own consumption and current transfers received (Canberra Group, 2011).

### 2.4.1 Households income from fishing

Artisanal fishing is responsible for approximately 90% of all fishing jobs worldwide and it provided critical income for millions of families [20]. In any fishing communities, fisheries have a direct link to household incomes. This household income explains the levels of income in which at the end indicates whether a given fishing household is benefiting or not [21].

### 2.4.2 Household income from fishing related activities

The overall fisheries and aquaculture sector employ more than 3.7 million people in African countries. Female employees represent 19 percent of the total workforce. It has been observed that women are of more importance in fisheries processing activities, but they seem to be low, since they are underestimated processors working as part-time (Graaf and Garibald, 2014). However, since women are associated with reproductive work, gender inequalities in access to fisheries resources affect not only the livelihoods of women, but also the entire household (Weeratunge et al., 2010). In Tanzania, Jiddawi and Othman [9] also reported that women, and sometimes children, play a significant role in collecting seashells, sea cucumber and octopus in the intertidal for a few hours each day usually during low spring tides, using hands and sticks or rods.

Middlemen and traders play an important role in the artisanal fishery, by providing opportunities for fishermen who cannot afford to buy their own gear or

vessels [9,22]. Middlemen usually own gear (seine or gill nets) or vessels (dhows or boats with engines), which they rent to fishers. Fisheries activities have multiplier effects that manifest through the indirect fishing activities. During high catch season both fishers and other people who engage in fishing related activities they both generate high income; this is true for the low catch season. This is to say that sustained fishery activities have a significant impact on reducing poverty through both direct and indirect fishing incomes [21]. According to FAO [23] majority of households in the developing countries are involved in fishing activities either fishers or in fishing related activities whether fulltime, temporary or occasional. These households have not generated high economic returns instead have helped them to sustain their livelihoods and have prevented them from falling deeper into deprivation.

## 2.5 Determinants of Fishing Income

It has been revealed that fishing is the main family business for the people who are living along the coastal zone since it requires minimum skills, and has a readily available market although it require a little bit huge amount of initial capital [24].

### 2.5.1 Socio-economic characteristics

Socio-economic characteristics that determine fishing income include age, education level and family size of fishers. Age is an important criterion that normally influences the working ability of an individual. Productivity increases with age and decreases with late life cycle (FAO, 2012). Individual's education helps to add the required skill for a person to find some alternatives means that will help to acquire more production. Jabil et al. [25] found that majority of small scale fisheries have a primary level of education, few with middle and less with advanced level of education.

Also size is considered as an important indicator that affects the income of the fisher. Family size determines the income and expenditure of the family. Many studies reveal that the average family size of small-scale fisheries households ranges from 4 to 7, (Jeyarajah, 2015). Income is the most important factor to understand the status of the Socio- economic situation and the livelihood of the fishermen (Jeyarajah, 2015).

### 2.5.2 Fishing seasonality

Tanzanian coastal winds prevail from November to March NE and SE winds from April to October. Generally, the months of June through September experienced strongest wind speeds during the SE Monsoon, with peaks in July smaller peaks in January. There are also two minimum monthly means generally occurring during the months of March and November during the NE Monsoon [26].

Generally Mafia is experiencing tropical oceanic climatic conditions with varied seasons that favor fishers to participate in different types of fisheries like octopus,

finfish, shellfish and dagaa common known sardines. From March to May and August to October conditions are very ideal for fishing activities which benefiting a large number of fishers community [27].

*2.5.2.1 Effect of season on the operability of fishing vessels*

Usually heavy weather induces boat motions and boat motions, and has an obvious impact on the ability to fish. Effect of motion appears to interfere the operation of fishing, causing the fishing vessel to stop fishing at sea. These are danger to the vessel, gear does not fish, and vessel cannot stay on gear, loose gear on deck, and water on deck and motion impact on crews' ability to work [28].

*2.5.2.2 Effect of season on fishing effort and landing*

Yaakob and Chau [28] reported that as the mean wave height increased, the fish landings decreased. Also, the effect of monsoon on fish landings was in November and ended by February where by June and July was low even though the wave heights were not that high. Also the water was too clear for successful fishing.

*2.5.2.3 Effect of season on fish availability and price*

Fisheries research in Kenya and Tanzania show that there are distinct seasonal changes in fish catches. Catch is low during the SE monsoon and high during the NE monsoon with a peak at March at the end of NE monsoon. The factors that are observed in seasonality include reduced effort by fishermen during the SE monsoon wind due to rough sea conditions, fish migration and decrease of density and activity due to deeper thermocline and cooler waters in the SE monsoon. This resulted into the rise in demand and the price increases [29].

**2.5.3 Availability of market**

Fish market is among of the fishing input since fishing income depends not only on the amount of catch, but also on its unit price at a the market (landing site) as well as on the cost of inputs used in the production process [12]. In many areas, fish market is imperfectly competitive and approaching oligopoly, where the numbers of sellers are small relative to that of buyers. The product is also differentiated according to species, size and freshness. The most common marketing practices are auction sales, contract sale and sale on a first come first saved basis [30].

Sobo [31] reported that in Tanzania there is no effective central marketing agency in the villages. The fish traders visit different fish landing sites daily to buy fish and transport them to markets in major towns. Price is set depending on the demand for fish and distances of villages from the major coastal towns. Hence the price of fish is influenced by the variable costs of transportation. Prices tend to be lower farther away from the major urban centers.

### 2.5.4 Number of fishers per vessel

Fish catching and trading are labour intensive activities therefore large supply of labour is required. According to census of 2012 the district has a population of 46438 whereby more than 80% of the population is engaging in fishing and its related activities (URT, 2013). Being an important dagaa fishing along the coastal area in Tanzania there is a large influx of people from neighboring districts avail employment and business opportunities. Thus the migration of people is solving labour problem. It has been noted that as the number of crew increases in a vessel also the income decreases simply because the catch must be divided according to the number of crew (Jabri et al., 2014).

### 2.5.5 Financial support

All forms of support have an impact on key aspects of the fisheries sector; their impacts are reflected in the economic operations of fishers by reducing costs, raising prices or increasing income. Generally economic impacts affect both environmental and social aspects of the sector and, because the fisheries system is dynamic with many feedback and interactive mechanisms, there are likely to be further rounds of economic, environmental and social effects [32].

Financial institutions are of very important in supporting fishing activities since people who are involved in the fishing activities and operating such activities are to be provided the loan facilities from the financial institutions and invest for this activity, banks, Co-operative Banks and Credit Societies, encouraging investment of such kind (Financial institutions, 2010).

### 2.5.6 Frequency of fishing

Number of trips in fishing determines the catch as well as the income. Increase in fishing frequency may be an indication of dwindling fisheries resources and possible depletion of resources in nearby fishing grounds, while in other ways the frequency determines the available stock (Inoni and Oyaide, 2007).

### 2.5.7 Fishing gear

Aghazadeh, [33] reported that the variability of catch among fishermen is based on the quantities of input they use, the type of fishing gear they employ, and the location of fishing ground in which they operate. There are may be wide differences in fishing incomes among fishermen operating the same type of gear in different locations as well as among fishermen operating different types of gear in the same location. Even fishermen who are operating the same type of gear in the same location may have diverging incomes. These income differentials may be attributed to some factors including quantity of catch and differences in fish prices received and input prices paid.

## 3. METHODOLOGY

### 3.1 Description of the Study Area

Mafia District (Fig. 2) comprises a chain of small islets, with the main island centered at 7°50′Sand 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. 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 dugon*g) 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 [34].

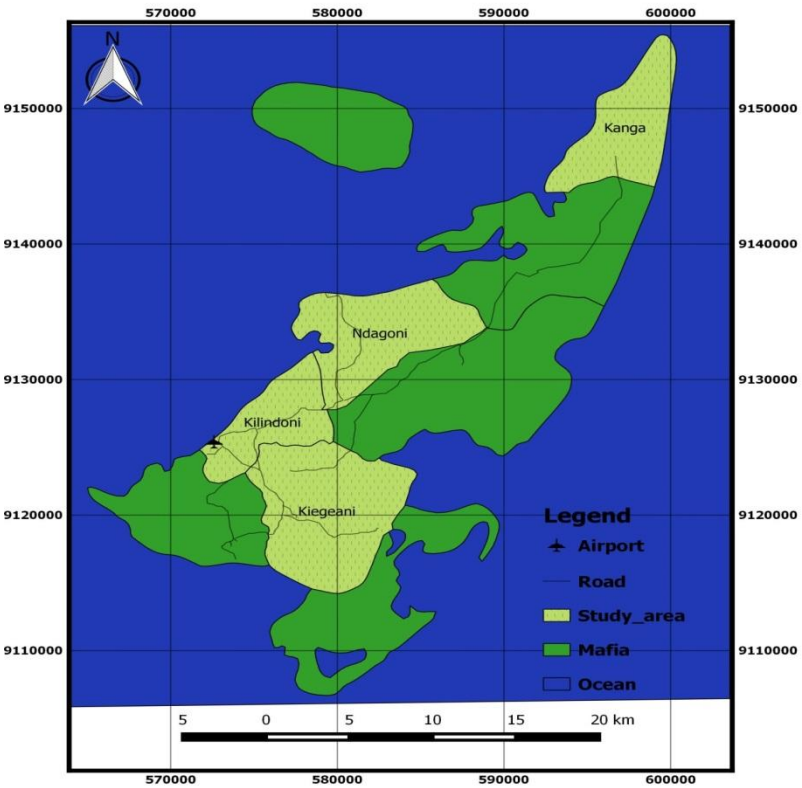


**Fig. 2. Map of the study area**

## 3.2 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.

## 3.3 Data Analysis

### 3.3.1 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. (2013) 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 [35]. This application was further ensured as minimizing of Multicollinearity effect on regression analysis [36]. Selection criteria for extracting factors were fixed as firstly communality is greater than or equal to 0.5 [37,38]. 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 [39].

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.

$$Y_{Income} = \beta_0 + \beta_1 F_{gear} + \beta_2 N_{labour} + \beta_3 F_{season} + \beta_4 E_{level} + \beta_5 F_{\sup port} + \mu_1 \quad 1$$

$F_{gear}$= fishing gear, $N_{labour}$= number of labour per vessel, $F_{season}$= fishing season, $F_{\sup port}$ = Financial support, $E_{level}$= Education level, coefficient i=0,1,2,..5, $\mu_1$ =stochastic error term, $\beta_1$-$\beta_n$ = 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.

### 3.3.2 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 Garoma et al. (2013) and Gujarat (1992) supported that the method is useful in analyzing the data with numerical (quantitative) dependent variables.

*3.3.2.1 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** Available to choose |
| Fishing income | | | |
| **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 |

*3.3.2.2 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 (Jabir et al., 2014). It is therefore expected that a positive relationship should exist between the household that has gone to school to have higher income.

*3.3.2.3 Fishing gear*

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 [40]. It is expected that a household which uses modern fishing gear is likely to have more income.

*3.3.2.4 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 [13]. It is expected that minimum number of crew per vessel the more income received.

*3.3.2.5 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.

*3.3.2.6 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.

## 4. RESULTS AND DISCUSSIONS

### 4.1 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 as shown in Table 2.

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

| Social economic attribute | | Village (%) | | | | Total (%) | |
|---|---|---|---|---|---|---|---|
| | | Kilindoni | Kiegeani | Chunguruma | Bweni | | $\chi^2$ |
| **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 |

*S = Significant at $\alpha < 0.01$; NS= Not significant at $\alpha < 0.05$*

## 4.2 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 [41]. 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 distribution41.47%, 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** |

### 4.2.1 Household Income from different sources

The findings show that 44.4% (Fig. 3) 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 (2013) reveals that fishing is the activity that contributes large percent compared to other activities in coastal communities.

### 4.2.2 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 (Fig. 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).

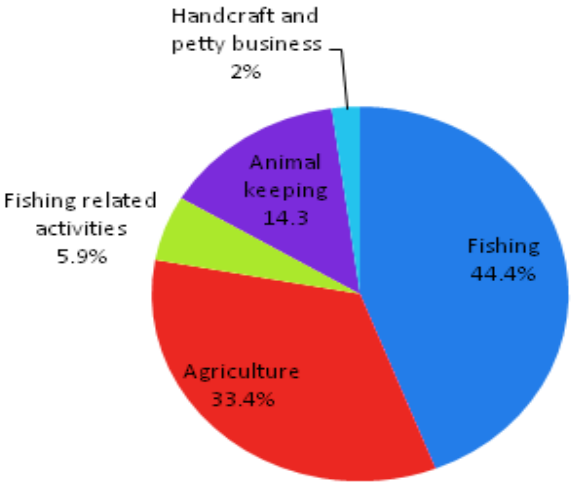


**Fig. 3. Household income from different sources**

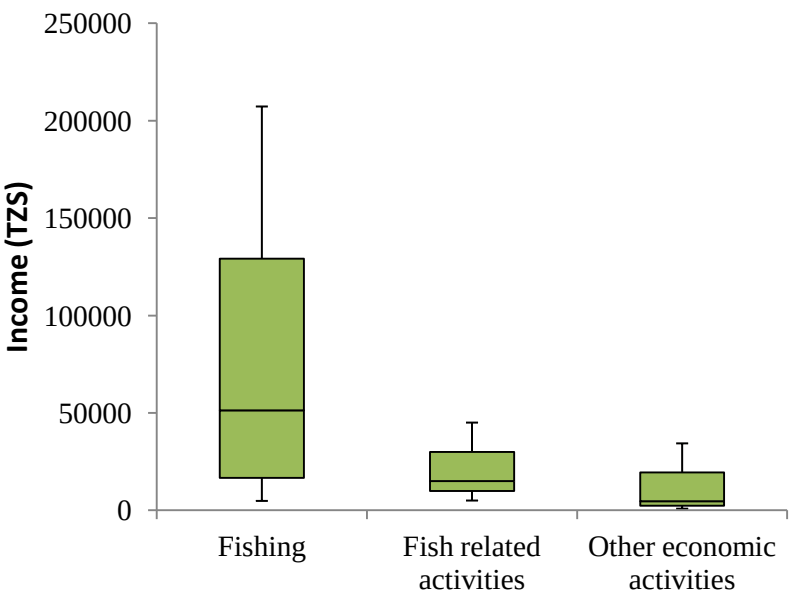


**Fig. 4. Distribution of fishing income in the study area**

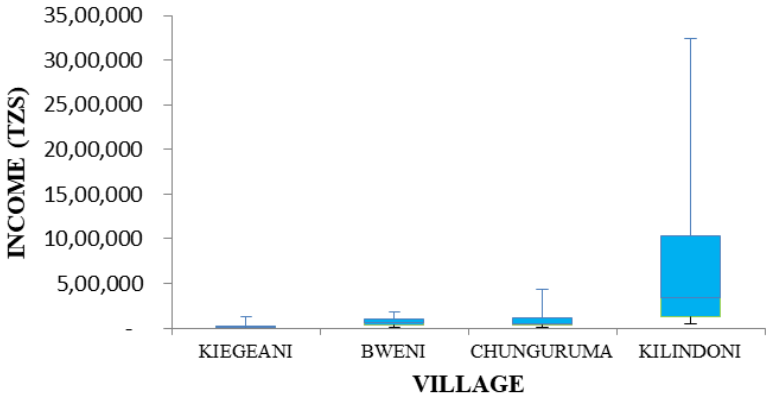


**Fig. 5. Distribution of fishing income by village**

*4.2.2.1 Contribution of fishing income by village*

Full time household fishers in the study area showed different income that is received per household per day. In Fig. 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).

**4.2.3 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 (Fig. 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 (Frocklin et al., 2013).

**4.2.4 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).

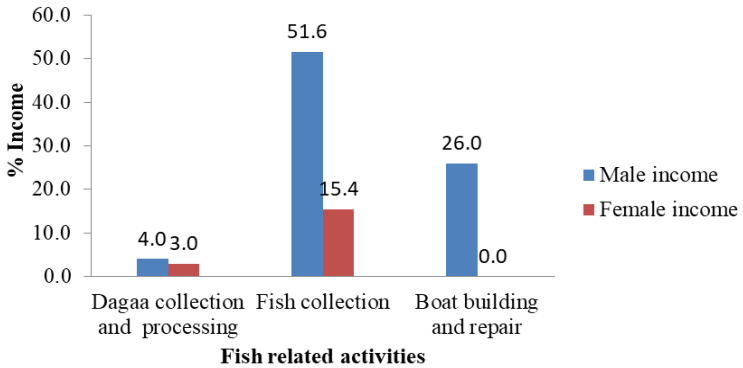


**Fig. 6. Income contributed by fish related activities**

**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 | | | |

The results above show that there is significant difference between households income received from fishing with those received from other economic activities, $p<0.05$.

## 4.3 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 labour 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%*

### 4.3.1 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. [13] 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.

### 4.3.2 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.

### 4.3.3 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 (Fig. 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 thermocline and cooler waters in the SE monsoon. Generally, the findings of this study support the findings by McClanahan [29] 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 and Chau [28] 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 [42].

### 4.3.4 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 (Mensah et al., 2014).

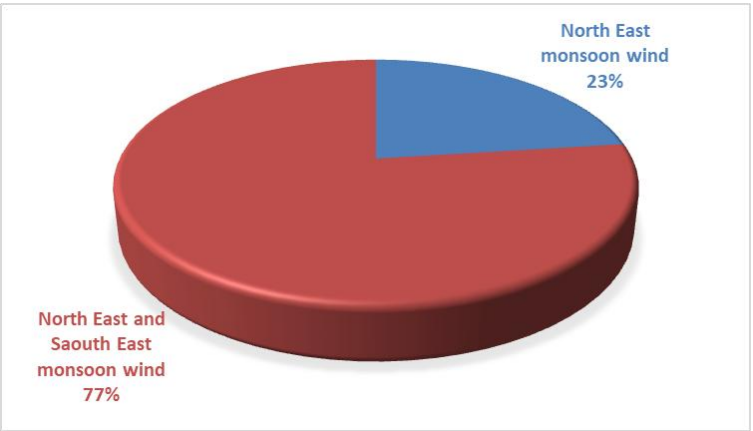


**Fig. 7. Shows the fishing season**

### 4.3.5 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 (Silva, 2006). The research done by Frocklin et al. (2013) 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.

## 5. CONCLUSIONS AND RECOMMENDATIONS

This study has attempted to show the economics of fishing to the coastal households of Indian Ocean with special attention on determinants influencing fishing income generated by coastal households 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.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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