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A Logit Analysis of Socio-economic Factors Influencing People to Become Fisherman Around Lake Malombe in Malawi

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Abstract: This study identifies the socio-economic factors that influence people's decision to become a fisherman using the logit model. Fisheries management experts recognize that the underlying causes of fisheries resource over-exploitation and coastal environmental degradation are often of social and economic in nature. Therefore the primary concerns of fisheries management, therefore, should address the relationship of fisheries resources to human welfare and the conservation of the resources. Addressing these issues provides not only a socially and politically accepted solution, but also a long term solution to fisheries management. It must also be recognized that the solution to the management of fisheries resources might not lie within the fisheries sector alone as the real causes of the problems might lie outside the fisheries sector. Therefore a multi-sectoral approach to development might be worth pursuing. This reduces dependence on natural resources for livelihood.

Key words: Integrated development approach, Lake Malombe, logit model, over fishing, participatory fisheries management

INTRODUCTION

Malawi was once classified as high fish consuming country with a large proportion coming from capture fisheries. The supply of fish per capita is, however, steadily falling as the population is rising. In 1976 per capita annual supply was 12.9 kg, however this had fallen to 9.9 in 1986 and stood at 5.6 kg in 2000 [1]. This has been due to decline in fish catches over the years against human population growth rate of 2%. This is a serious problem considering that 60-70% of the total animal protein consumed comes from fisheries. The fisheries sector contributes about 4% to the Gross Domestic Product (GDP) and is a source of employment to over 200,000 people and supports about 14% of the population residing along the lakes [2]. The number of fishermen has been increasing over the years and this has put the fisheries resources under severe pressure. Management of the fisheries has also been a problem as the government centered top down approach has not been effective as witnessed by decline in fish catches.

One of the worst hit areas in terms of declining fish catches is Lake Malombe. The lake which covers an area of 390 sq. km is fished by around 4,000 fishermen and crew members [3]. The lake provides a clear manifestation of risks associated with over-fishing because fish production in this lake has dropped from 13,600mt per annum in 1986 to 4,000mt per year in 2000. Of importance to note is that the most economically important species of fish which was *Chambo* (*Oreochromis* spp.) has almost collapsed from 8,484mt in 1982 to 96mt in 1998. During the same period the number of people involved in fishing has almost doubled from 648 people to 2698 people [4].

There are now initiatives to reduce the number of fishermen in Lake Malombe as one way of addressing over fishing. Currently community participation in fisheries management is been tried in Lake Malombe to replace the top down government controlled approach [5]. In order to limit the number of fishermen entering the fishing industry, it is important to identify the socio-economic factors that make the people go into the fishing industry. Addressing these socio-economic factors would be the socially accepted way of reducing fishing effort consequently addressing the problem of over fishing. Therefore this paper discusses the socio-economic factors that make people become fisherman in Lake Malombe and makes recommendations in addressing the push-factors as a long term solution to addressing over fishing in the lake.

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MATERIALS AND METHODS

Sources of information: Both primary and secondary sources of information were used to collect the relevant data. The primary sources used included informal discussions with experts and key informants like chiefs and members of the Fisheries Department as well as the fisherman who are the centre of focus. The unit of inquiry in this survey was the boat owner or fisherman in charge of a fishing unit. Secondary sources of information consisted of published and unpublished documents. Structured questionnaire with open-ended questions was administered to solicit information from the respondents. Some of the information collected using the questionnaire is shown below

Characteristic	Code
Group	
Gender	
Age	
Marital status	
Family size	
Literacy level	
Land holding	
Access to credit	
Other income generating activity	
Has a relative a fisherman	
Has social status	

Codes used: Group (1=fisherman, 0= otherwise) Gender (0 = woman, 1= man) Age (1=<20 years, 2= 20-40 years, 3= 40 -64 years, 4= >65) Marital status (1=single, 2=married, 3=widowed, 4=divorced) Literacy level (1= literate, 0= not literate)

A total number of 185 respondents were interviewed (91 fishermen and 93 non-fishermen). Group discussions with crew members and fish traders were also undertaken. The cross-referencing of these sources and overlap in the interview design provided a means of data triangulation

Data Analysis-Logit Model: In the model the dependent variable was dichotomous in nature, taking the value 1 or 0 i.e. a qualitative variable which is incorporated into the regression model as a dummy variable. In this case the value 1 indicated a person was a fisherman while the value 0 indicated the person was not a fisherman. Although Ordinary Least Squares (OLS) can be used to compute the estimates for the binary choice models, certain assumptions of the classical regression model are violated. These include non-normality of the disturbances, heteroscedastic variances of the disturbances and questionable value of R^2 as the measure of goodness of fit [6].

The most commonly used approaches to estimating such models include the use of linear probability models (LPM), probit model and logit model. Consider the following simple model:

$$Y = \alpha + \beta X_i + \varepsilon_i \quad (1)$$

where $Y_i = 1$ if a person belongs to one group and 0 if a person does not belong to that group
X_i = value of attribute e.g. Income, for the inth individual
ε_i = error term which is independently distributed random variable with mean zero

Models such as above, which express the dichotomous Y_i as a linear function of the explanatory variable Xi, are called Linear Probability Model. However Linear Probability Models when used in binary choice dependent variable have of problem of generating predicted values which may fall outside 0,1 interval thereby violating the basic tenets of probability. The other problems are heteroscedacity and generally lower R^2 values [7].

Therefore the probit and logit models have been recommended to overcome the problems associated with Linear Probability Models. The models use Maximum Likelihood Estimation (MLE) procedures. The logit model is based on cumulative logistic probability function, which is quite similar in form to the cumulative normal function but computationally easier to use [8]. Both logit and probit are transformation such that a cumulative distribution is estimated, thereby eliminating the interval 0, 1 problem associated with LPM. The logistic cumulative probability function is represented by

$$P_i = f(Z_i) = 1/(1+e^{-zi}) \quad (2)$$

where P_i is the probability that the inth person will be in the first category, $Zi = \alpha + \beta X_i + \ldots, + \beta X_n$, ($X_i$ is the vector of attributes associated with the inth person, â is the vector of parameters to be estimated) and e represents the base of natural logarithms which is approximately equal to 2.718. In this equation Z_i can range from positive infinity to negative infinity. The probability of a person becoming a fisher lies between 0 and 1.

If we multiply both sides of the equation by $1+ e^{-zi}$ we get

$$(1+e^{-zi}) P_i = 1 \quad (3)$$

Dividing by P_i and then subtract 1 leads to

$$e^{-zi} = 1/P_i = 1-P_i/P_i \quad (4)$$

By definition however, $e^{zi} = 1/e^{zi}$ so that the equation (3) becomes

$$e^{zi} = P_i /1-P_i \quad (5)$$

Now by taking the natural logarithm of both sides;

$$Z_i = \log (P_i /1-P_i) \qquad (6)$$

Or

$$\log (P_i /1-P_i) = Zi = \ " + \$X_1 + ,\ldots,+\$X_n \qquad (7)$$

This is the logit probability model. In can thus be noted that the logistic model defined in the equation is based on the logits of Z_i, which is the stimulus index. In the study, factors influencing people to venture into fishing business were examined through a Logit regression model.

The model was specified as follows;

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9)$$

Where Y = To become a fisherman
X_1 = Age
X_2 = Gender
X_3 = Access to credit
X_4 = person does some other income generating activity
X_5 = literacy level
X_6 = family size
X_7 = social status of the person
X_8 = Relative was/is a fisherman
X_9 = Land holding size

Estimation of the model: A bivariate (Chi-squared) analysis was carried out to find out how each of the explanatory variables relates to the dependent variable. This analysis was also carried out to find out if the influence of each of the variables was significant. The regression was first run to include all the variables. This was done because some variables on their own may not be significant. However, their interaction with other variables may show that they contribute to influencing people to becoming fisherman. Variables that were insignificant were dropped from the model so were those that were highly correlated with the other variables. This was done to avoid multicollinearity. Thus the final model contained the following independent variables; sex (X_2), Access to credit (X_3), IGA (X_4), household size (X_6) and land holding size (X_9).

RESULTS AND DISCUSSION

The logistic regression coefficients for the factors influencing people to become fishermen are found in the Table (1). The results show that sex, access to credit and land holding size were significant factors that influenced people's decision to become fisherman. The regression coefficients for the final model are shown in the table (1)

Table 1: Logistic Regression Coefficients of the Factors Influencing People's Decision to go into Fishing

Variable	×i	Coefficient	t-value
Constant		1.791	0.087
Gender	×2	-2.299	0.008*
Access to credit	×3	1.391	0.011*
Income generating activities	×4	-0.512	0.112
Household size	×6	0.079	0.171
Land	×9	0.186	0.073**

* means significant at p=0.05 ** means significant at P= 0.10
-2 Log Likelihood = 228.942
Goodness of Fit = 191.399
Prediction of success = 65.95 %
Therefore, the model can be estimated as;
$Y = 1.791 + 0.186X_9 + 1.391X_3 - 2.299X_2 + 0.079X_6 - 0.512X_4$

Evaluation of the model: The logistic regression coefficients for the determinants of adoption of fishing are contained in the table above. The goodness of fit chi-square and -2 Log Likelihood shows that the model fits the data (significant at $p < 0.001$). Since the purpose of the model is to identify main factors that make people go into fishing, the model is appropriate for the purpose considering its highly significant goodness of fit chi-square and high predictive ability.

The influence of gender: On gender, the model implies that fishing is a male dominated occupation. This is witnessed by negative coefficient. Since 0 meant a respondent was male and 1 a respondent was female, then moving from 0 to 1 would result in reduction in the number of fishermen. Over 98% of the boat owners were male while 86.2% of those who did not own a boat but engaged in other activities like agriculture were female (Table 2).

The differences in gender between the two groups was statistically significant at $p = 0.05$. Therefore it can be said that if more male children are born, the probability of joining fishing industry is high (*ceteris paribus*).The results also show that women have very little control over economic activities as most of them are dominated by men. Involvement of women in economic activities would reduce the pressure on men as the sole bread winner.

Table 2: Proportion of respondents by their gender

Gender	Fisherman (%)	Non-fisherman (%)	Total
Male	97.8	86.2	95.5
Female	02.2	13.8	04.5

The influence of access to credit : The model suggests that access to credit in form of cash will result in having more fishermen and thus putting more pressure on the fishery. Overall about 87 % of the respondents did not

Table 3: Proportion of respondents by their ability to access credit

Access to credit	Fisherman (%)	Non-fisherman (%)	Total
Have access	19.8	07.2	13.5
No access	80.2	92.8	86.5

have access to any form of credit system (Table 3). However about 20% of the fishermen had access to credit compared to about 7% of the non-fishermen. This suggests that access to credit may influence people's decision to become a fisherman.

Of importance to note is the fact that over 80% of the non-fishermen indicated that they would invest in fishing if they had acquired enough capital. Therefore caution should be taken when introducing credit programs in the area it might increase fishing effort instead of reducing. The credit schemes that may be introduced in the area should not allow the communities to invest in fishing business as there already exists excess effort in fishing. Rather they should target other businesses to allow some fishermen to retire from the industry.

The influence of other income generating activities: The results show that people in the area would likely stop fishing if there are other profitable businesses in the area. This is shown by the negative coefficient in the table of results. This might relieve pressure on the fisheries, however this was not significant at p = 0.05. This suggests that people do not go into fishing because they have no alternative sources of income. Although this might be true for the crew members, who supply labor in the fishing activities, it does not hold for gear owners. Fishing remains the most lucrative business in the area. Due to high demand for fish with to low supply, the prices of fish have continued to increase and this might what is attracting new entrants into the business. The other income generating activities in the area include tailoring, carpentry, grocer, selling labor and selling vegetables. Lack of alternative use of the fishing equipment might also force the fishermen to continue their activities hoping for better catches in future. This is compounded by the open access nature of the resource. However, the introduction of other income generating activities might attract the crew members which might in turn reduce the frequency of fishing as they have to attend to other chores. Fishing is the highest employer of labor along the lake.

The influence of household size: Household size is found to be positively influencing people to venture into fishing. The more children one has, the higher the probability that the number of fisherman will increase. This is because of poverty the family may not be able to support all the children and some might venture into fishing as a way of making a living. It has been observed that in developing countries subject to high unemployment rate, fishing is one of the last remaining job opportunities for a labor force lacking training and capital (land)[9]. Over 70% of the respondents did not have formal education or skills training. Therefore it is not surprising that they end up being fisherman or crew member. The average number of children per family was 6 which were higher than the national figure of 5 children per household [10].

The influence of land holding size: The land holding size for agriculture around Lake Malombe is very small. The average land holding size around the lake was 0.6 ha and could not support the large household sizes. Additionally, most of the soils along the lake are not suitable for agriculture because they are sandy [11].

Of importance to note is the fact that those were fishermen had larger land holding size than non fishers. Usually fishermen had money which they could use to rent land. Some fishermen had good relationship with traditional leaders and could easily get bigger than non fishermen. The fishermen sometimes pay labor in their field in kind (through fish) and therefore have no labor shortage. Therefore those with no land or small holding will work as crew members or will start fishing using traditional methods in order to get income to buy food for their families. This means that pressure will continue to be exerted on natural resources since the land will not provide all the food and income requirements.

Table 4: Landing holding size for Fishermen and Non-fishermen

Land holding size	Fisherman (%)	Non-fisherman (%)	Total
< 1 ha	38.6	54.2	46.4
1-2 ha	25.3	25.3	25.3
2-3 ha	07.2	08.4	07.8
2-4 ha	14.5	04.8	09.7
> 4 ha	14.4	07.2	10.8

RESULTS AND DISCUSSIONS

The study has described a wide range of socio-economic characteristics of the fishing communities around Lake Malombe with particular emphasis on those who invested their capital in boats and gears. The study has revealed that fisheries have been under pressure due to some socio-economic factors that affect their communities. The results of logit analysis has shown that sex, access to credit, land holding size were the main factors that influence people to join the fishing industries. In Malawi, just like in many developing countries, population pressure, limited alternative employment opportunities and effect of other socio-economic factors, have resulted in severely over fished coastal and inland

resources and increased threats to the livelihoods of fishermen.

The study has also been revealed that if people had more access to credit the number of fishermen would increase. Therefore caution should be given to credit programs that are being initiated in the area as they may increase the number of fishermen instead of reducing. The credit facilities should target the unemployed youth who usually sell their labor in the fishing industry. The credit programs must focus on other enterprises other than fishing and should be in form of inputs and not cash. This is because many respondents indicated that they would invest in fisheries if they had access to capital.

Having other income generating activities reduces the number of fisherman and thus reduces effort. This would help the lake to recover. Therefore, there is need to explore the viability of other income generating activities which are as profitable as fishing. People should be trained in other business ventures so that they should not only look at fishing as the only income generating activity. Skills training in other areas would empower the people economically than just selling their labor.

Land is, and will always be a constraint to agriculture production. Therefore, concerted effort should be placed on how to increase the productivity of the already existing land in order to meet the demands of the people. This involves encouraging the use of new technologies like the hybrids and extension services on the recommended agricultural practices. Since water might not be a problem, irrigation should be introduced to maximize production on small piece of land available.

It must also be recognized that the solution to the management of fisheries resources might not lie within the fisheries sector alone as the real causes of the problems might lie outside the fisheries sector. Not all fisheries problems can be solved with reference to fisheries alone. Efforts to improve incomes and living standards of people in fishing communities involve development of alternative economic opportunities. An integrated development approach which has been widely advocated since 1980's could be tried in the area. Such an approach must also address the problems of rapid population growth that is seen as a fundamental threat to the sustained exploitation of fisheries resources and a major constraint to effective management. In order to reduce effort in the lake there is need to have a multi-sectoral approach as it involves setting up of adult literacy institutions, have family planning clinics to reduce the population growth rate, increasing agricultural productivity and having the business entrepreneurs operating in the area. In this respect, the Fisheries Department should try to work with other organizations in solving the communities' problems. The Fisheries Department should consult with other government ministries like Agriculture and Community Development as they too have a greater role to play if the management of the resources is to be sustainable.

Participatory approach to fisheries management would help to gain acceptance in the community. Community involvement in management would help bring in ownership and help the communities analyze their problems and try to find solutions. However it must be realized that community based management is unlikely to be panacea to all the problems of small-scale fisheries management However, considering the substantial problems reportedly faced by the Fisheries Department, any alternative approach that increases the legitimacy of regulation and has potential for reducing enforcement costs is worth considering. The fishing communities must be actively involved at all stages of decision making and must clearly understand the implications of the decisions made. Therefore the fishermen could organize themselves into cooperatives to have a better bargaining power.

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