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RESEARCH ARTICLE

DETERMINING FACTORS FOR FISHERS' INCOME: THE CASE OF LAKE TANA, ETHIOPIA

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ABSTRACT

The study was conducted from June 2011 to November 2012. We investigated the contribution of Lake Tana fisheries to the livelihoods of the people living around the lake. Random sampling techniques were used to select respondents. In total 145 respondents were drawn. The data were analyzed using descriptive statistics, one way ANOVA and correlation analyzes. We found that there were significant income difference between fishers using modern and traditional boats ($P<0.01$); perform fishing daily and occasionally ($P<0.01$); and fishing in groups and fishing alone ($F=23.71$; $P<0.01$). Fisheries contributed 48% to the total annual income of the fishers'. Age ($R = 0.372$), fishing gears ($R = 0.613$), fishing experience ($R = 0.466$) and fishing frequency ($R = 0.326$) were associated positively with fishers income and correlations were significant ($P < 0.01$). However, distance from market ($R = -0.457$) and catch per unit effort ($R = -0.342$) were negatively associated with fishers income ($P < 0.01$). We conclude that, fisheries are a vital means of livelihood for fishers living in villages surrounding the lake. Therefore, the government, none governmental organizations and the community themselves should give due attention to fisheries.

INTRODUCTION

Fisheries are one of livelihood strategies that have contributed much to people in developing countries. It is one of the vital strategies for the poor to achieve food, income and other social benefits. For instance, it serves as an important source of diet for over one billion people (Manasi *et al*., 2009) and provides employment for about 38 million people around the world (FAO, 2003). For centuries fishing on Lake Tana was subsistence reed boat fishery, but after the introduction of a commercial motorized gillnet fishery in the late 1980s fishing pressure increased progressively (Wudneh, 1998). This created new opportunities for the fishers, extending their fishing area from the shore to deeper, offshore waters and more importantly to distant river mouths. Moreover, with the increase in catch, fish processing, marketing and net making activities emerged as job opportunities to the surrounding communities. The three main species groups targeted by commercial gillnet fishery are the large *Labeobarbus* spp., African catfish (*Clarias gariepinus*) and Nile tilapia (*Oreochromis niloticus*). The commercial gill net fishery on *Labeobarbus* spp. is highly seasonal and mainly targets the spawning aggregations, as more than 50% of the annual catch is obtained in the river mouths during August and September (de Graaf *et al.*, 2006). This selective fishing was the most likely cause of the drastic decrease in abundance by ca. 75% of the migratory riverine spawning *Labeobarbus* species during 1990–2010 (Wudneh 1998; de Graaf *et al*. 2006; Mohammed *et al*., 2011). On the moment the Lake Tana fisheries contributes annually ca. 65 million Ethiopian Birr to the economy of the Amhara region (Amhara National Regional State Livestock Resources Development and Promotion Agency, 2011). Approximately ca. 20% of the catch (14 million Ethiopian Birr's) is exported to Sudan.

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The objective of this paper is to investigate the economic contribution of fisheries to the fishers' communities around Lake Tana and to analyze the factors determining the height of the income of the individual fishermen. We addressed the following research questions: (1) What is the effect of demographic and household factors such as age, sex, marital status, education and household size on the income of the fishers, (2) What is the effect of physical factors such as fishing gears used, fishing frequency, distance from the market and catch per unit effort on the income of fishers, (3) what is the effect of fishing experience on the income on the fishers and (4) What is the economic contribution of fisheries to the fishers' communities around Lake Tana.

MATERIAL AND METHODS

Study Area

Lake Tana is the largest lake in Ethiopia with an area of about 3200 km^2 and is situated in the northwestern part of the country in the highlands at an altitude of about 1800 m and has a catchment area of 16,500 km^2. It is shallow lake with an average depth of 8 m and maximum depth of 14 m and it is turbid, well-mixed (Vijverberg *et al*., 2009). Three zones (South Gonder, North Gonder and West Gojjam) surround Lake Tana. From these zones, ten districts (Woreda's) border the lake. Of which six were included in this study: Bahir Dar Zuria, Bahir Dar Town, Fogera, Gonder Zuria, Dembia, and surrounding Lake Tana.

Data collection

Woreda's and sampling sites were selected on basis of the number of active fishers present (at least 180) and the presence of fishery inspectors (Table 1, Figure 1). Within each Woreda respondents for

interviews were selected randomly and the number selected were proportional to the number of fishers present, this corresponded to 6% of the fishers' population (National Audit Office Design Group, 2001). In total 145 fishers were interviewed. Data was collected using structured interviews. Before conducting the interview, three enumerators familiar with the culture and local language were recruited and trained in each site. The interview questionnaire was pre-tested among six non-sampled respondents two by each enumerator and adjustments were made accordingly. Data was not only collected from structured interviews, but also from focus groups discussions and interview with key informants. In each Woreda focus groups discussions were held with 8-12 participants. Additionally, interviews with local fisheries experts, elders and local administrators were conducted at each sampling site.

Table 1. Description of sampling sites. Fishers population estimates based on the data of Amhara National Regional State Livestock Resources Development and Promotion Agency (2011)

Zone	Village (Woreda)	Fishers population (indiv. per village)	Fishing Site	Samples taken
South Gonder	Fogera	479	Nabega	30
North Gonder	Dembia	605	Gorgora	38
	Takusa	188	Delgi	12
	Gonder Zuria	328	Mitreha Abawarka	21
West Gojjam	Bahir Dar Town	341	Bahir Dar	21
	Bahir Dar Zuria	371	Woramit	23

Table 2. Number and percentage of respondents according to their age group, household size, educational level and marital status

Age range	Number	Percentage	Educational level	Frequency	Percentage
18-27	36	25.5	Illiterate	62	44.0
28-37	41	29.1	Elementary (1-5)	43	30.5
38-47	39	27.7	Primary (6-8)	22	15.6
48-57	15	10.6	Secondary (9-10	13	9.2
58-68	10	7.1	Diploma	1	0.7
Total	141	100	Total	141	100
Household size			Marital status		
1-4	66	46.8	Married	114	80.9
5-8	66	46.8	Single	26	18.4
9-12	9	6.4	Widowed	1	0.7
Total	141	100	Total	141	100

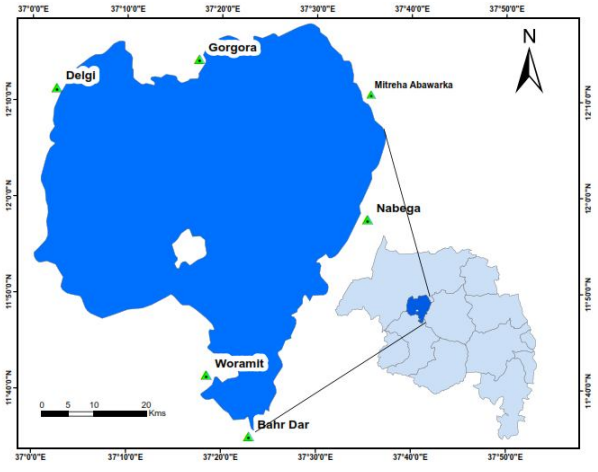

Figure 1. Map of the study area indicating sampling sites. See also Table 1

Data Analyses

SPSS (Statistical Package for Social Science) and Microsoft Excel were used for data management and analysis. We analyzed the data using descriptive statistics, one way ANOVA, and correlation analyses. One way ANOVA was run to test the income difference between fishers owned modern and traditional boat, those carried out fishing activities alone and in-groups and those which performed fishing daily and occasionally. Correlation analysis was run to test the association of fishers' income with variables of demographic and household characteristics, fishing equipment, fishing activities, fishing experience and distance from market. Fishing frequency was converted to a dichotomous variable coded as "1" daily fishers and "0" for occasional fishers, whereas catch per unit of effort was converted to an ordinal variable coded as "1" very much decreased, "2" decreased, "3" no change, "4" increased, and "5" very much increased. Pearson's correlation coefficient (R) was computed with the formula as given below (Yount, 2006):

$$R_{xy} = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

RESULTS

Demographic and household characteristics

Most respondents (82%) were 18-47 years old; the average age was 36.7 years (Table 2). The maximum and minimum age of the respondents was 68 and 18 years. Household size of the respondents ranged from one to eleven members, households with 1-4 and 5-8 members were most often observed (Table 2). The average household size of the respondents was 4.8. Majority of the respondents (80.9%) were married and the remaining 18.4% and 0.7% were single or widowed. The educational status revealed that 44% were illiterate, the remaining 56% were literate at different levels of education (Table 2), and all of the respondents were males. Not all the fishers' were engaged in fisheries all the time. Of the 141 respondent 51 (36.2%) were full time fishers, 90 (63.8%) were besides fishing also active with e.g., farming, petty trading and daily labor.

Fishing gear

Fishers owned various tools, which were used to carry out fishing and fish processing. Lake Tana fishers have different fishing gears like different types and mesh sizes of gillnets, hook and line, cast net, fish-traps and different locally made fish gutting and flitting tools (i.e. knife and scissors). The fishers owned on average 11 different kind of fishing gears. Most fishers owned monofilament gillnets with different mesh sizes, imported from Sudan. We found that 21% and 79% of respondents owned modern and traditional boat, respectively. The average income, for those, who owned modern and traditional boats were 14000 and 5442 Birr's per year during the research period

(June 2011 to November 2012), respectively (Table 3). This income difference was highly significant (Table 4).

Table 3. Descriptive statistics of income of fishers owned traditional and modern boat. Mean annual income in Ethiopian Birr's over research period (June 2011 to November 2012), S.E. = Standard Error

Boat	N	Mean	S.E.
Modern	30	14000	1245.7
Traditional	111	5442	280.7
Total	141	7256	451.7

Table 4. Statistical test of income difference between fishers owned traditional and modern boat (One way ANOVA). Mean annual income in Ethiopian Birr's over research period

	Sum of Squares	Df	Mean Square	F	P-value.
Between Groups	1.716×10^{9}	1	1.716×10^{9}	103.2	0.000
Within Groups	2.312×10^{9}	139	1.663×10^{7}		
Total	4.028×10^{9}	140			

Seasonality of catch

We found that the catch for *O. niloticus* was highest from December to April, whereas the highest catch of *Labeobarbus* species was from July to September and of *C. gariepinus* was from June to July (Figure 2).

Table 5. Descriptive statistics of fishers' income by different fishing frequency and activities. Mean annual income in Ethiopian Birr's over research period, S.E = Standard Error

		N	Mean	S.E
Fishing frequency	Otherwise	39	4435.3	427.3
	Daily	102	8334.1	568.4
	Total	141	7255.7	451.7
Fishing activities	Alone	89	5696.2	312.9
	Group	52	9925.0	1004.2
	Total	141	7255.7	451.7

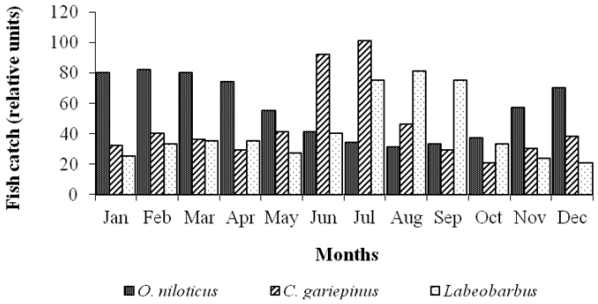

Figure 2. Monthly variation in fish catch (relative units) of *Labeobarbus* spp., *O. niloticus* and *C. gariepinus* in Lake Tana by the respondents over the period June 2011 – November 2012

Fishing frequency and income

From the total 141 respondents 102 were fishing daily, the rest fished only occasionally (Table 5). The average annual income for daily and occasional fishers was 8334 and 4435 Ethiopian Birr's, respectively (Table 5). There was income difference between daily and occasional fishers and the difference was statistically significant ($P< 0.01$) (Table 6). The minimum and maximum annual income of fishers were 1020 and 30,000, respectively, and the average was 7256 Ethiopian Birr's.

Fishing and other activities

Majority of the respondents (89) fish alone, whereas the remaining (52) fished in groups. Fishers who fished alone and those in groups had an average income of 5696 and 9925 Ethiopian Birr's, respectively (Table 5). This difference is significant (Table 6). From the annual income of occasional fishers, 48% of their income was from fishing activities, whereas, the rest came from other activities such as farming, daily labour and petty trade.

Income determinant factors

We ran Pierson's correlation analysis to show the association of fishers' income with demographic, household, physical, fishing and

Table 6. One way ANOVA test for fishers' income by different fishing frequency and fishing activities

		Sum of squares	df	Mean Square	F	P-value
Fishing Frequency	Between Groups	4.288×10^{8}	1	4.288×10^{8}	16.56	0.000
	Within Groups	3.599×10^{9}	139	2.589×10^{7}		
	Total	4.028×10^{9}	140			
Fishing Activities	Between Groups	5.870×10^{8}	1	5.870×10^{8}	23.71	0.000
	Within Groups	3.441×10^{9}	139	2.476×10^{7}		
	Total	4.028×10^{9}	140			

Table 7. Pearson's correlation analysis (R) of income with explanatory variables. Significance levels (2-tailed): ** P ≤ 0.01, * P ≤ 0.05, ns not significant

Explanatory variables	1	2	3	4	5	6	7	8	9	10
Income (1)	1.00									
Age (2)	0.372^{**}	1.00								
Education (3)	0.089^{ns}	0.027	1.00							
Household size (4)	0.131^{ns}	0.704^{**}	0.047	1.00						
Marital status (5)	0.154^{ns}	-0.449^{**}	-0.068	-0.486^{**}	1.00					
Fishing gears (6)	0.613^{**}	0.416^{**}	-0.113	0.307^{**}	-0.298^{**}	1.00				
Fishing Experience (7)	0.466^{**}	0.714^{**}	-0.069	0.503^{**}	-0.324^{**}	0.507^{**}	1.00			
Fishing frequency (8)	0.326^{**}	0.064	-0.164	0.065	-0.045	0.298^{**}	0.142	1.00		
Distance from market (9)	-0.457^{**}	-0.319^{**}	0.193^{*}	-0.146	0.274^{**}	-0.457^{**}	-0.262^{**}	-0.076	1.00	
Catch Per Unit of Effort (10)	-0.342^{**}	-0.329^{**}	0.031	-0.176^{*}	0.149	-0.331^{**}	-0.337^{**}	-0.107	0.294^{**}	1.00

distance to market variables (Table 7). In total we investigated 10 variables. The total number of cells in the correlation matrix is 45, of which 30% was significantly associated with each other. Age of respondents ($R = 0.372$, $P < 0.01$), fishing experience ($R = 0.466$, $P < 0.01$), fishing frequency ($R = 0.326$, $P < 0.01$) and fishing gears ($R = 0.613$, $P < 0.01$) were positively associated with fishers income. However, distance from market ($R = -0.457$, $P < 0.01$) and catch per unit of effort ($R = -0.342$, $P < 0.01$), were negatively associated with fishers income.

Key informant interviews and group discussions

During June 2011 to November 2012 we conducted both key informant interviews and focus group discussions in each sampling site to complement the data we collected from household interviews. We found that, in the past fishers had been using multifilament gill nets with mesh sizes (stretched mesh) ranging from 10-14 cm. However, currently they shifted to monofilament gill nets, imported from Sudan, to compensate for the lower fish production and smaller fish size. Fishers owned on average 6 monofilament nets of approximately 100 m length and a depth of 2.5 m. The majority of fishers, except in the Southern part of the lake (i.e. around Bahir Dar), used traditional reed boats and they didn't have well organized cooperatives. As a result, most of fishers perform their fishing activities alone. According to the fishermen their annual income ranged between 7200 and 10800 Ethiopian birr. At the group discussions the fishermen generally agreed that the government and other concerned stakeholders should pay due attention to establish new cooperatives and strengthen existing ones, should control fishing with illegal fish gears, should provide training to improve their fishing ability and should supply credit to enable them to buy better boats and better fishing gear.

DISCUSSION

Due to the culture of the community, i.e. gender based labour division; all of the respondents were males. Their age ranged from 18 until 68 years (average 37 years), this is in agreement with what Ajala (2008) reported earlier for Lake Tana. In average, the household size of the respondents was 4.8, which, is slightly greater than regional average household size i.e. 4.3 (FDRE population census commission, 2008). However, it was less than the average household size reported for the southern Rift Valley Lake Chamo (5.3) (Shado, 2006). The fishers' livelihood activities in Lake Tana revolved around fishing, but for the majority of the fishermen fishing was a part-time activity in combination with other types of work. In contrast, in Lake Chamo the majority of the fishers (86%) engaged in fishing alone, whereas, only a few (14%) were engaged in part-time fishing (Shado, 2006). This difference is probably mainly due to the relatively scarcity of farmland around Lake Chamo as compared to the Lake Tana region, but the higher income per fisherman from fisheries in Lake Chamo may also play a role. Most of the fishers use monofilament gill nets which included mesh sizes below the legal allowed size. Monofilament nets are more efficient than the previously used multifilament nets. Both trends may lead to recruitment overfishing, especially in the seasonally migrating *Labeobarbus* spp. (de Graaf *et al*., 2004). A majority of the fishers owned traditional boats, which agrees with what Ameha (2001) reported previously for Lake Tana. The number of fishing equipments that a fisherman owns determines the level of his income. For instance in Lake Tana, those who owned a modern boat earned almost three times more gross income than those who owned a traditional boat. This is due to the fact that modern boat owners could more easily access areas which higher fish stocks and they could also reduce their post-harvest loss by landing their fish sooner than the traditional fishermen. This was also reported by Shado (2006) for Lake Chamo. *O .niloticus*, *Labeobarbus* species, and *C. gariepinus* are the commercially most important species in Lake Tana. Fishing activities are carried out throughout the year, though there is a high catch season for each species at different times of the year. Catch of *O. niloticus* were highest from December to April, whereas, it is was low from June to October (rainy season). This is due to the abundant growth of macrophytes growing during the rainy season in the littoral zone of the lake, to which the Nile tilapia move for breeding and hiding from predators. As it is very difficult to set gill nets in this habitat, fishers could not harvest them. The highest catch of *Labeobarbus* species was observed during July to September. This was due to their spawning migration behavior; this species aggregate at the river mouths of the tributaries of the lake before they ascend to the upstream areas for breeding (Palstra *et al*., 2004; de Graaf *et al*., 2005; Anteneh *et al*., 2008; Gebremedhin, 2011*)*. During these period fishers set gillnets near to the river mouth which resulted in high catches of *Labeobarbus*. Similar results were reported by Dejen (2005) and Gebremedhin (2011). Furthermore, there is slight increment in market price for Nile tilapia during these months (Gebremedhin, pers. comm. with fishers) which may have increased the fishing effort. The highest yield of *C. gariepinus* was observed during June and July, during its peak breeding time (June and July). The species breed in flooded areas so that fishers can easily access them during that time.

Fishers in Lake Tana perform their fishing activities at different frequencies, the majority of them fish daily, while some of them fish occasionally. Those who perform daily fishing activities earn almost twice as much income than occasional fishers. This is clearly a result of differences in effort. Most fishers were fishing alone, only in the Southern part of the lake (i.e. around Bahir Dar) fishing in groups was common practice. The main reason for this difference seems to be the presence of cooperatives, either initiated by the Ethiopian government or by NGO's. In the Southern part most fishermen had joined fisheries cooperatives, whereas the fishermen in the North and East didn't have well organized cooperatives. Fishing in groups had many benefits above fishing alone, such as: respect for their fishing rights by other fishers who were not part of their cooperative, receiving training in fishing techniques and fish handling, supporting each other by sharing fishing gear and efforts, getting access for credit and saving and getting more easily access to markets. As the result fishers who performed fishing activities in groups earned more income. Correlation analysis was conducted to show the association degree of fishers' income with variables of demographic variables, physical assets, fishing activities, and infrastructure. Age and experience of respondents was positively associated with fishers' income. As age of the fishers increased, their physical assets, their knowledge and skill of fishing (experience) increased. In Nigeria, Ugwumba and Okoh (2010) and Ayotunde and Oniah (2012) also reported a positive association of age and experience with fishers' income. Fishing frequency is positively associated with the total income of the fisherman in the study area. Those fishers who carried out fishing activity daily have more income than those who perform occasionally. Distance from market was negatively associated with fishers' income. This is probably due to higher fish post harvest loss when the distance to the market is longer. To our surprise, catch per unit of effort of fishers were negatively associated with fishers' income. This indicates that, as the catch of fish per unit of effort increased, income of fishers decreased. Because, as catch increased, the market demand and price of fish per unit weight generally decreased. This information was confirmed by the participants in focus group discussions. We conclude that fisheries are a vital means of living for Lake Tana fishers. Because, fishers achieve income, food and different social benefits from it. However, the income that they earn from fisheries is determined by various factors such as: fishing equipments, fishing experience, fishing activities, fishing frequency, distance from market and their age. Therefore, the government, non governmental organizations and the community themselves should work in integration by giving due emphasis on the factors that determine fishers income.

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