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Research Article

Baseline Survey on the Fisheries of Tekeze Reservoir, Ethiopia

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Abstract

This baseline survey was aimed to: (1) assess the role of fisheries of Tekeze in improving fisher's livelihood; (2) assess household and individual involvement in fisheries and their inputs used; (3) recommend means of interventions for sustainable use of the fishery resource of Tekeze. Data was collected from September to October 2017 by preparing structured questionnaire and checklists. In addition, mixtures of purposive and random sampling methods were employed to collect the data from 302 sampled households. Finally, the collected data were analyzed by using both descriptive and inferential statistics. Fishing in the study area is the main source of immediate cash income for the household next to crop production. Because of this, 50.33% of the respondents involve in a part time basis and the remaining 32.78% and 16.89% involves in a full time and seasonal basis of fishing respectively. Fishing in the study area is practiced by using both monofilament and multifilament gill nets, hooks, and hook and lines. In addition, the fishing boat, which mostly used are steel boat and planked boat. Mostly, fishers actively participate in fishing starting from October to May and some fishers involves even up to June. A highly significant difference in fishing input ownership were also observed between zones (t = 12.5). Even though highly significant difference in total annual gain from fishing is observed between zones and regions (t = 8.8), fishing plays a considerably important role for fishers (80941.46 ETB per a year on average) including part-time seasonal fishers and crop producer. On the other hand, fishing in the study area is highly gender-biased activity, which makes women's participation negligible. However, destructive way of fishing by using 4cm stretched mesh sized monofilament gillnets; resource equity problem; poor infrastructure such as; road; and market competition problem are among the main problems in Tekeze fishery.

Key Words: livelihood, cash income, market competition, equity; fisheries of Tekeze; random sampling methods; fish production; agricultural activities; preservative methods

1. Introduction

Ethiopia is uniquely rich in water resources. It has numerous water bodies including ponds, lakes, rivers, reservoirs and wetlands [17]. As a landlocked country following the secession of Eritrea in 1993, fisheries in Ethiopia come exclusively from inland sources [1]. Therefore, the inland water body of Ethiopia is estimated to encompass about 7,400 km2 of lake area and a total river length of about 7,000 km [10,12,18,20].

Fish is an important food item that has significant socioeconomic contribution as a source of income, employment and cheap protein for marginal people in developing countries including Ethiopia [3]. Inland fisheries are particularly important for the food security of poor people, as most inland fish production goes for subsistence or local consumption [8]. It was estimated that more than 56 million people were directly involved in inland fisheries in the developing world in 2009 [5,19]. 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 [4,9,13].

1.1. Objectives of the Study

This baseline survey aimed to:

- Assess the role of fisheries of Tekeze reservoir in improving fisher's livelihood
- Assess household and individual involvement in fisheries and their inputs used
- Recommend means of interventions for sustainable use of the resource and enhance benefits from the fisheries of Tekeze reservoir.

2. Materials and Methods

Zones sampled	Frequency	Percentage
Tigray (TanquaAbergele)	53	17.5
N/Gonder (Tselemit)	42	13.9
Wag-Himera	207	68.5
Total	302	100.0

Table 1: *Sampled areas for the study*

2.1 Sampling Design and Procedure

This study was conducted at both Amhara and Tigray regions. Specifically, from Tigray; Tanqua Abergelle from North Gondar; Tselemit and from Waghimra; Abergelle, Ziquala and Sehala Seyemt districts that are beneficiary from fisheries of Tekeze reservoir fisheries were sampled. To collect the data from respondents that participate in the fisheries purposive sampling method were used. Totally, 302 sample of fishers were selected randomly based on proportional to the population size using Yemane (1967) formula. Accordingly, the required sample size at 95% confidence level with degree of variability of 5% and level of precision equal to 10% are recommended to obtain a sample size required which represent a true population.

$$n = \frac{N}{1+N(e^2)} = \mathbf{302\ fishers}$$

where, n = sample size, N= Population size and e = level of precision assumed 10%.

Finally, sampled respondents were interviewed using a pretested structured questionnaire and checklist.

2.2 Methods of Data Collection

Most of the data were collected by preparing a structured questionnaire. Data related to personal profiles; fishing input used and amount, benefit gained from fishing, preference for fish species, challenges for the fisheries of Tekeze reservoir and gender were collected by using structured questionnaire.

2.3 Methods of Data Analysis

Descriptive statistics such as frequency, mean, percentage, standard deviations were used for the analysis of the data. In addition, t-test and chi-square test (to test the significances of continuous and discrete variables respectively) were also used to summarize and compare the information between fishers and regions.

3. Results and Discussion

3.1. Demographic Characteristics of the Households

The average age of the respondents were 29.47 with the minimum and the maximum age of 18 and 72 (Table 2). This implies that fisheries of Tekeze reservoir contribute as a means of creating employment opportunities for landless and jobless for both youths and elders regardless of what their age is. The average distance from the landing site to the main vehicle road and fish marketing town is 142.66 and 235.19 minutes of walk respectively. In addition, the average distance from home to landing is138.05 in minute of walk. This shows fisher travels for more than one hour to sell their catch or processed fish to the nearest fish-marketing site. The sampled households have four family size on average; therefore, fisheries of Tekeze reservoir contribute to the household by giving cash income and nutrition from home consumption.

Attribute	Minimum	Maximum	Mean	Std. Dev.
Age	18	72	29.47	6.92
Total family size	1	10	4.12	1.96
Distance to landing*	1	600	138.05	97.28
Distance to road**	3	540	142.66	174.83
Distance to market***	3	820	235.19	165.33

*Distance from home to landing in minute of walk

** Distance from the landing site to the main vehicle road in minute of walk

*** Distance from landing site to the nearest fish-marketing town in minute of walk

Table 2: *Age, family size and distance to the main road and market*

The educational status indicates about 36% of the respondents were illiterate; about 36% attended literacy classes while around 28% had attended informal education. The marital status of the respondent's shows that majority of the respondents (80.5%) are married except a small percentage of single, divorced and widowed households (table 3).

Attributes		Frequency	%
Education	Illiterate	103	36
	Read and write	80	28
	Primary (grade 1-8)	86	30.1
	Secondary (grade 9-120	17	5.9
	Total	286	100
Marital status	Single	53	17.8
	Married	240	80.5
	widowed	4	1.3
	Divorced	1	0.3
	Total	298	100
Sex	Male	299	99.3
	Female	2	0.3
	Total	301	100

Table 3: *Education level, marital status and sex of sample households in the fishery sector*

The main means of livelihood in the study area are agricultural crop production and fishery-related activities. Of the total sampled households, 26.6% of them depending totally on fishing activities. The remaining participates in fishing, crop production, and livestock rearing activities in a variety of ways. This infers that fishing is the best means of income generating mechanism besides cropping production and livestock rearing (table 4).

Major means of livelihood		Frequency	%
Primary source of income	Crop cultivation	150	58.6
	Animal rearing	28	10.9
	Fishing and related activities	68	26.6
	Petty trade and seasonal labour	10	3.9
	Total	256	100
Types of participation in the fishery	Full time	99	32.78
	Part time	152	50.33
	Seasonal	51	16.89
	Total	302	100

Table 4: *Means of livelihood of the households and types of involvement in the fisheries*

3.2. Fishing practices and methods around Tekeze reservoir

In the study area, crop cultivation in line with animal rearing is a predominantly practiced agricultural activity but it does not mean that the role of fishery is negligible. Rather, it is the main source of immediate cash income for the household next to crop production. Sampled households in the study are involves in fishery related activities in a variety of ways, i.e. 50.33% involves in a part time basis and the remaining 32.78% and 16.89% involves in a full time and seasonal basis respectively. All this shows how fishing plays a vital role in livelihood diversification and means of risk reduction in agricultural crop failure in such a drought prone area (table 5).

Attributes		N	%
Active months	October to May	73	36.5
	October to March	68	34
	October to June	59	29.5
Passive months	June to September	102	51
	March to April	30	15
	August to September	68	34
Where the net set	Open water	110	45.8
	River mouth	94	39.2
	Shoreline	36	15

Table 5: *Fishing season and ways of fishing*

As table 6 depicts, the main fishing gear type used for fishing is both monofilament and multifilament gill net, hook, and hook and line. In addition, the fishing boat, which mostly used is steel boat and planked boat. According to the result, most of fishing activities are performed around river mouth, shoreline and open water in their order of response. Regarding the level of involvement in fishing activities by season, most of the fishers in the area actively participate from October to May and some of them involves even up to June (table 5). This might be strongly associated with the level of workload on other agricultural activities like crop production and closed season for fishing.

In most cases, on the pre-rainy, rainy and post-rainy seasons, crop production is a main labor consuming activity. At this season, fishing related activities become relatively low when compared with the dry season. On the other hand, fishery regulation that prohibits fishing activities during breeding seasons may have an implication on the level of fishers' participation on fishing. Based on the above reasons, fishers passively participate in the fishing activities starting from June to September. In addition, fishers go to fishing 21 days per a month on average and one trip of fishing take an average of 3 hours.

3.3. Types of Fishing Equipment used and possession level

The most commonly used fishing boat is steel boat but there are certain fishers who use the planked and raft one. Regarding the amount of fishing boat possessed there is no significant difference in level of possession among fishers. As the fishing gear census shows, fishers owned 13.5 and 12.9 multi and monofilament gillnet respectively with a total length of 129 meter on average. In addition, fishers have about 21.98, 42.28 hooks, and hook and line respectively. These results shows that gillnet, hook, hook and line are the most fishing gear predominantly used in the study area. However, the standard deviation of number of gillnet owned and length of gillnet in meter is higher than the mean. This shows how the level of ownership of these fishing gears and their relative size are highly dispersed between individual fishers and study areas.

In addition, the paired t-test result shows that there is a highly significant difference in number of gillnet ownership between Zones ($t = 12.5$). This differences might resulted from difference in type and level of participation in the fishing activities, distance from home to the dam, and other demographic characteristics like, primary livelihood strategy, family size, land size and so on. On the other hand, the mesh size, which is important in the process of fishing, is below the recommended level because of most of the respondent use 4 cm mesh size gillnet on average.

Amount of input owned per HH	N	Min	Max	Mean	Std. Dev
Steel boat	113	1	11	1.17	.98
Raft (boffofe boat)	1	1	1	1.00	.
Planked boat	82	1	3	1.04	.25
Multifilament gillnet	6	6	20	13.50	4.85
Monofilament gillnet	114	2	50	12.92	7.44
Total length of the gillnet in meter	297	4	5750	129.80	405.96
Lateral line length in meter	301	2.0	25.0	4.159	3.98
Mesh size of the gillnet	298	1	16	4.26	1.52
Number of hooks	123	1	110	21.98	19.86
Hook size in number	23	5	30	9.91	7.54
Average number of hook and line	100	1	200	42.28	45.51
Size of hooks	4	10	20	15.00	4.08
Number of crew members per boat	173	1	66	8.18	14.03
Average fishing day per a month	298	3	150	21.55	14.178
Hour per trip of fishing	282	0	30	3.81	4.941

Table 6: *Possession of fishing equipment*

3.4. Inputs Used and Associated Costs of Fishing

Fishing activity is extensively a labor consuming activity, which takes 3.8 hours on average per a trip. However, it is difficult to conclude based on this data because of the data is taken from different places the fishing hour is different from place to palace. For this particular example, fishing in Tanqua Abergele takes 3 hours on average but it take about 20.8 hours on average at Abergele per trip. Costs of fishing are determined based on the level of fishing frequency, fishing equipment, labor (own or crew) and time invested on it. Based on this principle, fishers invest 3.8 hour per a day per trip on average and most of the fishers practice fishing for 21 days per month on average.

In the study area, fishers employ up to eight crews per boat for operating the fishing activities. As presented in the below table, the remaining costs which may be considered as a fixed fishing costs are fishing boat, fishing gear and their estimated cost is presented below. The fishing input costs are significantly different from woreda to woreda this might be resulted from difference in distance to input marketing place and transport and transaction costs (table 7).

Estimated costs in ETB per unit	N	Min	Max	Mean	Std. Dev.
Raft boat	2	6000	20000	13000	9899.49
Planked boat	81	1200	13000	7030.86	2021.86
Steel boat	113	3500	330000	34526.55	33514.51
Gill net in	207	125	28750	340.46	1986.46
Long line	124	10	360	29.83	35.24
Hook	110	10	400	34.74	56.63

Table 7: *Cost of inputs*

3.5. Benefit Gained From Fishing at Tekezie reservoir

Fishing is overwhelmingly the most important activities for fishers for income generation in the study area. In particular, the poorest, landless and unemployed rural youths rely in a larger proportion on fishing activities while those who have land mainly rely on crop production. The study shows clearly that fishing is of considerable importance for people living in the study area including crop producer and part-time/ seasonal fishers. According to Moni & Khan, (2014), fisheries has an important implication for ensuring emergency cash flow in terms of urgent medical expenses, financing children's education and supporting household economy in times of maintaining social and family occasions. It also alters households' protein consumption level and income, expenditure and savings pattern of the households.

Andersson and Ngazi (1998) also reported that fisheries can provide an important contribution to household cash income [2]. This cash income gives access to other benefits such as education, health services, clothing, other foodstuffs etc. It also allows investment in other assets or enterprises such as land, livestock or fishing gear. In fisheries of Tekeze reservoir, people often turn to fishing when they finish their agricultural activities, thereby, it reduces their vulnerability to hunger by providing a complementary food source as part of diversified livelihood strategies and therefore, fisheries of Tekeze reservoir can act as a 'safety net' for the poor. This study is also supported by [4]. For example; people who have not agricultural lands could participate in fishing to meet their basic needs.

Even though fishing activities have associated with different fixed and variable costs, fishing gives a remarkable return for the farmers/fishers as a cash income. In the study area, most of the fishers caught five main fish species namely, Tilapia spp., Catfish spp., Labeo spp., Labeobarbus spp and Bagrus spp. As table eight shows, fishers generate an income ranging from 96 to 720,000 ETB and on average, they get about 80941.46 ETB per a year. However, the standard deviation as raised above tells us something about resource distribution and equity. The high standard deviation from the mean shows how the total gain from fishing are dispersed among fishers. In addition, there is significant difference between total annual gain from fishing between zones and regions ($t = 8.77$), which means some zones/ regions extensively participated and benefited from fishing while others are not invest more on fishing and become scarified.

Even though genus Bagrus is not as preferred fish species for home consumption by the fishers compared to tilapia, it contributes a lot for the annual gain than other fish species even above tilapia. The table 8 shows, how fishing at Tekeze reservoir contribute for the improvement of livelihood and poverty reduction by giving them a direct cash income at a time they want. Therefore, fishing plays a critical role as a 'bank in the

water' for the fishers and other actors that largely rely on this activity to access cash quickly. Hence, farming and fishing are overwhelmingly the most important activities for household food supply and means of income generation.

Annual gain ETB	N	Minimum	Maximum	Mean	Std. Dev.
Tilapia	82	24	132000	13182.51	27013.46
Catfish	225	24	720000	55221.64	95469.02
Labeo and Labeobarbus	112	12	216000	7982.30	24056.58
Bagrus	41	48	576000	118639.40	217549.89
Total	238	96	720000	80941.46	133486.78

Table 8: *Annual gain from fishing in 2016/2017 season*

3.6. Fish Consumption, Preference and Marketing Mechanisms

Fisheries provide a crucial source of animal protein and essential micronutrients for local communities. The contribution of fish to household food and nutrition security depends on availability, access and cultural and personal preferences. The household uses their catches for both home consumption and generating income by selling their caught. In the area the main fish type consumed by the community are *Tilapia, Catfish* fish *and* Bagrus species. According to the study, demand for fish showing an increasing rate year after year. On the same fashion, the price of fish is increase every year except seasonal variation in some seasons (table 9).

Attribute		Freq.	%
preferred fish	Tilapia	237	82.3
	Catfish	33	11.5
	Bagrus	18	6.2
Trend of demand for fish	Increase	246	82.8
	Decrease	46	15.5
	In different	5	1.7
Trend of price of fish	Increase	212	89.8
	Decrease	15	6.4
	In different	9	3.8
To whom do you sale	consumers	83	27.9
	cooperative	26	8.7
	processors	12	4
	hotels	12	4
	fish traders	165	55.4
Who set price	Fisher	78	28.5
	Through negotiation	91	33.2
	Traders	81	29.6
	cooperatives	24	8.7
Mode of transportation	Labour	79	34.3
	Car	25	10.9
	Back of donkey	30	13.1
	Boat	96	41.7

Table 9: *Fish consumption, preference for fish species and marketing mechanisms*

In addition, fisher sales their fish catch mostly for traders, consumers, and cooperatives based on negotiation with their buyers. Even though the fishers reported that they sold their caught based on negotiation between two parties, there are a tendencies that traders abuse fishers or producers through different mechanisms like, making collusion for price fixing. In addition, due to imperfect nature of the fish market in the area and poorly

developed infrastructures like road, storage facilities and electricity to search for fair fish markets, the price negotiation is held only for formality. Therefore, in most cases and in reality fishers in the study area are price taker and most of the traders who acts as an oligopolistic are price maker either directly or indirectly.

The mode of transportation is based on the accessibility of transport and its distance to the marketing site. Therefore, the main modes of transportation in the fisheries of Tekeze reservoir are boat, labour, back of donkey, and car in the order of response. In addition, respondents pay 33ETB on average per trip if they choose transportation through car.

3.7. Major Challenges in the Fisheries of Tekeze reservoir

This destructive way of fishing by using illegal mesh size and monofilament gillnet is one of the threat for the sustainability of the dam's fish resource. Weak implementation of fishery related bylaws/ regulation and inadequate training on fishery management, fishery proclamation and post-harvest loss reduction methods. Resource use conflict and governance/ administration problems on fair use of fish resource between the two regions are considered as a main problem in the fisheries of Tekeze reservoir.

Specifically, the fishery cooperatives in the Amhara region are not active and competitive to make the price fair and road problem makes fishers disadvantaged. The other problems raised by the respondent were: road, transport, electricity market competition problem, extension support, and resource use conflict. Specially, lack of market competition makes most fishers paralyzed consequently they feel that they only work for (servant of) the big traders. This type of market monopolization increases profit margin of the traders with the scarification of producers or fishers gain (table 10).

Attribute	Response	N	%
Is there any bylaw for fishery	Yes	179	89.5
	No	21	10.5
Implementation of the regulation?	Yes	106	38.1
	No	172	61.9
Training available	Yes	79	33.9
	No	154	66.1

Table 10: *Major challenges for Tekeze reservoir fisheries*

Furthermore, a previous study conducted by Kindye and Asmiro (2017, Unpublished) also confirmed that resource equity problem as a main bottleneck for Tekeze reservoir fishery. According to their finding, due to absence of policy framework, rules and regulation on the use fish resources there was a dispute in the use of fish resources between the two regions (Amhara and Tigray region). Moreover, both regions exploit the fish resource in a computational manner with no limitation of boundary, which leads diminish in diversity of species and stock.

3.8. Fisheries of Tekeze reservoir from gender perspective

Gender and sex are not the same thing. Sex refers to a biological difference between women and men. In addition, the role between men and women are permanent and universal, which could not be changed over time through education, technology, economics, and sudden crises like war and famine. On the other hand, gender is defined as a socially constructed roles and responsibilities of women and men, in a given culture or location. The roles are influenced by perceptions and expectations arising from cultural, political, environmental, economic, social, and religious factors. Gender roles, attitudes and behaviours are learned and can be changed over time through education, technology, economics, and sudden crises like war and famine.

According to Ogato G.S., *et al*., (2009) gender could be defined as "the rules, norms, customs and practices by which biological differences between males and females are translated into socially constructed differences between men and women and boys and girls." Similarly, Douglas Lucas Kivoi (2014) defined sex and gender as, "sex and gender are not the same since sex is the biological difference between male and female and gender entails roles constructed through different socialization of males and females. Gender roles keep changing and evolving with time."

Surprisingly, the term "fisher" and "fisherman" are interchangeably used to represent those men who engaged in fishing activities and they don't consider women. This is also suggested by Medard M., et al., (2001) that descriptive nouns such as "Fishermen", is a stereotyping noun that tends to exclude women from the sector. This perception affects the way the fishing industry is supported. There is therefore a need for a conscious choice of gender sensitive words like "fish worker/fish traders", "fishers" as opposed to the term "fishermen". Such terms if consciously used, would make it clear that although there is a sexual division of labor between men and women in the fisheries, they are all fish workers.

3.8.1. Fishing and Fishing Gear Preparation

Most of the men in the study area (81%) fully involving in fishing activity and it is predominantly considered as only men's work (Table 11). On the other hand, participation of the women in the fishing activities is still stagnant and they are perceived as "fisher-man's wives" if their husbands engage in all fisheries-related activities. However, women in the fisheries of Tekeze reservoir have a significant role in preparation of net. In agreement with this study, Howell L.A., (2001) argued the most traditional is that of a fisherman's wife and plays with a very defined role. Similarly, the finding of Pereira G., (2001) showed that a woman linked to an artisanal fishing community is generally the wife of a small-scale fisher and she plays a relatively passive role. Generally, women in the fisheries of Tekeze reservoir have negligible role from fishing to selling.

3.8.2. Control Over Productive Resources

The power to decide on utilization and management of fishing equipment, caught fish and income from productive resources are predominately vested under men. In addition, men have full control over purchasing or selling of fishing equipment and who has access these productive resources. Fishing in Tekeze is performed by using the fishing boat with a net; hence, access to fishing equipment and way of fishing have been controlled by men. For some men, income from fishing is theirs to spend as they wish, while the income of women from fish supports the household (table 11).

Livelihood activities	Men	Women	Boys	girls
Prepare fishing net	82%	11%	6%	1%
*Wutwota	80%	7%	11%	2%
Maintain (repair) fishing net	84%	12%	4%	0%
Fishing	81%	13%	4%	3%
Washing and cleaning the caught fish	53%	37%	4%	5%
Gutting	61%	16%	7%	15%
salting	62%	14%	6%	18%
Filleting	80%	9%	5%	5%
Drying	86%	3%	6%	6%
Communicate with traders	95%	0%	5%	0%
Sale catch	96%	0%	4%	0%
Control over fishing net	92%	2%	7%	0%
Control over fishing boat	92%	0%	8%	0%
Control over caught fish	91%	0%	8%	0%

*Wutwota: arranging the net before and after catch

Table 11: *Men and women's role in the pre-fishing and fishing activities*

Conclusion and Recommendations

Most of the fishers in the area actively participate from October to May and passively participate from June to September. Highly significant difference in fishing input ownership and gain distribution between fishers and zones is observed, which indicates some zones extensively participated and benefited from fishing while others are not invest more on fishing. In addition, fisher sales their fish catch to consumers, cooperatives and fish traders based on negotiation on price with their buyers but the negotiation is for formality. The main mode of transportation in the fisheries of Tekeze reservoir is boat, labour, back of donkey and car. Based on our findings, fishing plays a vital role in livelihood diversification and means of risk reduction in agricultural crop failure in such a drought prone area. However, fisheries of Tekeze reservoir needs a critical intervention because of: destructive way of fishing by using 4cm stretched mesh sized monofilament gillnet; resource equity problem; poor infrastructure like road, transportation, electricity, and fish preservation equipment; market competition problem (semi monopolized or oligopoly); weak capacity building; and resource use conflict.

In order to secure the sustainability of Tekeze reservoir fishery and enhance fishers' benefits the following recommendations needs due attention:

- ✓ Mesh size regulation
- ✓ Improve infrastructure like road, transport, electricity and other fish processing equipment in order to make beneficiary
- ✓ The variation in costs of fishing inputs might be due to distant market for input therefore, encourage traders to supply important fish inputs and equipment at local market
- ✓ Capacity building and training about appropriate fishing methods, minimize post-harvest loss, alternative fish preservative methods, and ways of keeping post-harvest hygiene
- ✓ Strong market intervention in order to avoid market monopolization and price fixing, which undermine fishers
- ✓ Intervene in the resource use and management before **'tragedy of the commons'** occurred from such unregulated competition

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