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Socio-economic assessment of the fishery in Blue Nile River, Blue Nile basin, Ethiopia

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Abstract
Socio-economic data of fishes from upper part of Blue Nile River were collected from October 2010 to March, 2011. The objectives of the study were to assess the current fish composition, common fishing practices, post harvest handling of fishes and the major problems of fishing practices in this river and recommend possible fishery management option to fishermen around this river. Structured questionnaires and Checklist were used to collect the necessary socio-economic data. Univariate and Descriptive analysis were used to analyse the collected data. There were 100 fishermen in Sefania, Abenaze and Woteto Mider kebeles that engaged in Upper part of Blue Nile River fishery, among these 20 was permanent and they were fully depend on fishery as their source of income and 80 were seasonal. Most of the fishermen in upper part of Blue Nile River dependent on river fishery as source of additional income because they have main activities are crop and livestock farming. The main fishing season in the study area were starting from November to May. Fish species recorded in upper part of Blue Nile River were *Clarias gariepinus*, *Labeobarbus intermedius*, *Labeobarbus crassibarbis*, *Labeobarbus nedgia Labeobarbus forskalii*, *Mormyrus kannume*, *Bagrus docmak* and *Oriochromus niloticus*. However, farmer prefer to consume *L. intermedius* and *L. forskalii* because of they assume high quality and the fishes are attractive there appearance. In addition to fish fauna used as a habitat of other vertebrate animals found in the river such as Nile crocodile, Snakes, "Arjano" (Monitor lizard) Cattle egrets(Bulbulcus ibis), Great white pelican (Pelecanus onocrotalus), Grey heron (Ardea cindered), Sacred ibis (Threskiornis aethiopicus) and African Jacana (Actophilornis Africana). There was significant variation in income from fishing between fishermen around Upper part of Blue Nile River ($P<0.05$). The fishermen in Blue Nile River do not have the knowledge of fish processing. Therefore there should be training in fishery management and fish processing in these rivers.

Keywords: assessment, blue nile basin, fishery, rivers, socio-economic

Introduction
Fisheries play a very important role in the socio economic development of a country. These inland fisheries contribute about 25 percent to the world production of fish (Sugunan, Welcomme, Bene, Brummett& Beveridge, 2007) [18]. It has been recognized as a powerful source of income and employment generator. It is also the source of the cheapest and most easily digestible animal protein besides being a foreign exchange earner. Most importantly, it is the source of livelihood for a large section of economically backward population of the country. According to (Sewmehon Demssie, 2003) [16] report stated the fishery resource has significant socio-economic contribution through generating income, employment and used as a cheap protein sources for local people in developing countries including Ethiopia. Ethiopia is endowed with sizable amount of lotic (running) and lentic (stagnant water) environments whose fishery potential has not yet been fully realized (Brook Lemma, 1987) [2]. The inland water body of the county is estimated at about 7,400 km^2 of lake area and about 7,000 km total length of rivers (Shibru Tedla, 1973) [17]. These water bodies harbor more than a hundred edible fish species, and the annual potential fish yield of the main lakes is roughly between 30,000 and 40,000 metric tons (FAO, 1995) [6]. Fish are particularly important source of protein in developing countries, where protein intake is low (Thorpe *et al*., 2006). In general, fish provide over 20 % of total animal protein intake for more than 2.6 billion people in developing countries, and specifically in Africa the number of people directly dependent on income from fisheries is estimated to be 50–60 million (Heck *et al.*, 2007).

Even though no systematic survey and assessment of the potential of all water bodies have been made, the rough potential harvest estimated from seven main lakes, two small lakes and one reservoir covering a total area of 7,005 km^2 was about 51,500 tons of fish per year (Eshete Dejen, 2008) [4].

The fishery industry in our country has many limitations as indicated in different sources of materials done by scholars, especially in post harvest technologies. These studies showed that post harvesting of fish require careful handling, processing and preservation in order to provide quality and quantity products to the market (cite the studies). In the process of handling these products more than 50% of the total catch has been estimated as post harvest losses in some developing countries (FAO, 1981) [5]. According to Sewmehon Demssie (2003) [16] some 50% of the total landing was discarded and lost due to poor handling and distributing and this accounts for high economical loss. Hence, the objectives of the study were to assess the current composition, common fishing practice, post harvest handling of fishes and the major problems of fish production in upper part of Blue Nile River and recommend possible fishery management options to fishermen around this river to improve food security and reduce malnutrition.

Materials and Methods

Description of the study area

Study area of Blue Nile basin has three main catchments, upper, middle and lower Blue Nile. The Blue Nile River flows the Eastern outskirts of the city of Bahir Dar at the Southern end of the Lake Tana flows down approximately 35 km in a southeast direction where it forms the famous Blue Nile Fall to drop in to a gorge having a depth of about 45 m (Yihun Dile, 2009). Blue Nile River basin lies in the west of Ethiopia between latitude 7°45' and 12°45' N, and longitude 34° 05' and 39°45' E (MoWR, 2010) [13]. The total area of the basin is 199,812 km^2 including Lake Tana which has an area of about 3200km^2. About 46, 31 and 23% of the total basin area falls in Amhara, Oromia and Benshangul-Gumuz, respectively (MoWR, 2002) [12]. The River basin's elevation ranges from 500 m to 4261 m and the total mean annual flow from the River basin is estimated to be 54.8 billion m^3 (Seleshi Bekele *et al*., 2007) [15]. The present study was conducted in below the famous Blue Nile Fall of the Blue Nile River to the border between East and West Gojjam. It lies between West Gojjam (Yelimana Densa and Gonge Kolela districts) and South Gondar zones (Simada District), specifically the sites are Sefiana (10km after the Blue Nile fall), Abenaze (30km) and Wotetomider (60km) (Figure 1).

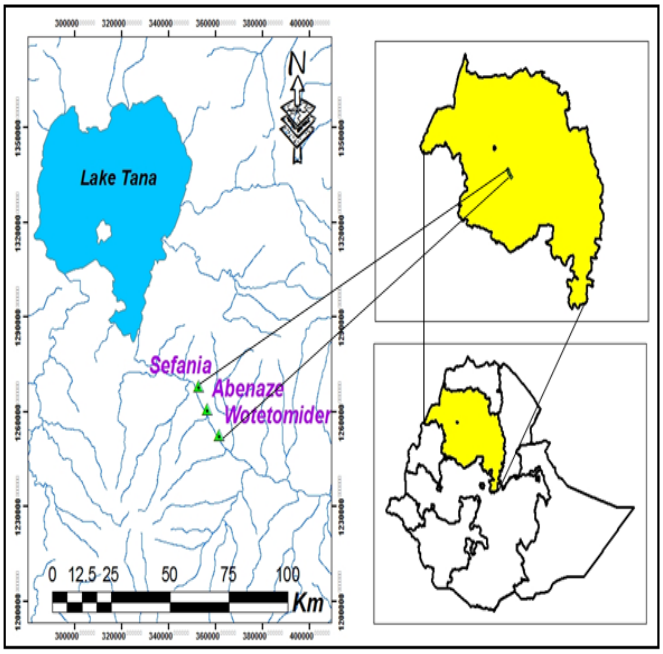

Fig. 1: Map of the study area and sampling sites

Method of Data Collection

Structured questionnaires, personal observation and checklists were administered in kebeles near to Blue Nile River. There were 30 fisheries mean in the study area that were selected and interviewed. Fishermen in these kebeles were randomly selected for data generation. Moreover, two focus groups were considered for additional information about the fishery status in the river by consulting key informants using participatory rural appraisal (PRA). The information collected include number of fishermen and their family dependants, family size, type of fishing gears used, type of fish caught, number of fish caught per week, fish consumption habits and preference etc.

Statistical analysis

Descriptive statistics and univariate analysis were used to analyze the collected data using SPSS software.

Results and Discussion

Fauna

Fish species recorded in upper part of Blue Nile River were *Clarias gariepinus*, *Labeobarbus intermedius*, *Labeobarbus crassibarbis*, *Labeobarbus nedgia Labeobarbus forskalii*, *Mormyrus kannume*, *Bagrus docmak* and *Oriochromus niloticus*. Blue Nile River below the Tisisat fall besides fishes the rivers used as a habitat of other vertebrate animals found in the river. These are Nile crocodile, Snakes, "Arjano" (Monitor lizard) and different species of amphibians and birds. Species of birds observed during the study period were Cattle egrets (Bulbulcus ibis), Great white pelican (Pelecanus onocrotalus), Grey heron (Ardea cinerea), Sacred ibis (Threskiornis aethiopicus) and African Jacana (Actophilornis Africana).

Flora

There is high deforestation in the Blue Nile River basin below the Tissisat fall mainly hill side farming is devastating the forest and soil. Farmers in this area cultivate crops twice a year and perennial crop farming is practiced. The changes in vegetation patterns result from land degradation along the Blue Nile basin below the Tisisat fall that may lead to unexpected abnormal floods and reducing soil nutrients of the basin. The other factors that a lead to deforestation is because of all of the residents do not have access to the electricity. The people use kerosene lamp and fuel wood as a source of light and for cooking. Therefore, the villagers continue to denude the remaining shrubs and trees for their daily consumption. Vegetations on either side of the riverbank are mainly covered by shrubs and trees. The dominant trees are Syzygium guineanse ("Dokma"), Mimusops kummel ("Eshe"), Oleaeuropaea ("Woyira") and Ficus ("Shola").

Species composition

A total of eight species were identified, namely: *Labeobarbus intermedius*, *Labeobarbus nedgia*, *Labeobarbus forskalii*, *Labeobarbus crassibarbis*, *Bagrus docmak Mormyrus kannume*, *Clarias gariepinus* and, and *Oriochromus niloticus* (Table 1). Farmers identify some of the fish species with their local names: "Nech Assa" (*L. intermedius*), "Teyemate" (*L. forskalii*), "Source" (*L. crassibarbis*), "Mota" (*L. nedgia*), "Ayitoshe" (*M. kannume*),"Fergus" (*B. docmak*), "Ambaza" (*C. gariepinus*), "Koroso" (*O. niloticus*, Nile tilapia)(Table 1). They are represented by a single class Actinopeterygii (ray-finned fishes), 4 orders (Cypriniformes, Osteoglossiformes, Siluriformes and Perciformes), 5 families (Cyprinidae, Cichlidae, Bagridae, Clariidae and Mormyridae) and 6 genera (Table 1). The Cyprinidae were the dominant families. The freshwater fish fauna of upper part of Blue Nile River contains a mixture of Nilo-Sudanic (e.g., *M. kannume*, *B. docmak* and *L. forskalii*) and highland East African (e.g., *L. intermedius*, *L. nedgia*, *L. crassibarbis*, *C. gariepinus* and *O. niloticus*). *Labeobarbus intermedius*, *L. nedgia*, *L. crassibarbis*, *L. forskalii*, *B. docmak* and *M.kannume* were present in all the sampling sites. However, *C. gariepinus* was found in Sefania and Abenaze sampling sites but *O. niloticus* was found only in Sefania site.

Table 1: Fish species composition and Local name in Amharic according to the local people

Species	Local name	Family name	Order
Labeobarbus intermedius	Nechi Asa	Cyprinidae	Cypriniformes
Labeobarbus forskalii	Teyemate	Cyprinidae	Cypriniformes
Labeobarbus nedgia	Source	Cyprinidae	Cypriniformes
Labeobarbus crassibarbis	Mota	Cyprinidae	Cypriniformes
Mormyrus kannume	Ayitoshe	Mormyridae	Osteoglossiformes
Bagrus docmak	Fergus	Bagridae	Siluriformes
Clarias gariepinus	Ambaza	Clariidae	Siluriformes
Oriochromus niloticus	Keroso	Cichlidae	Perciformes

The fish species diversity in upper part of the Blue Nile River was low as compared to 27 species in Guang, Ayima, Gendwuha and Shinfa Rivers (Dereje, 2008) [3], 23 species from Beles and Gilgel Beles (Zeleke,2007). Similarly the number of economically important fish species in these river was much less (8) than the number (17) of species reported from head of Blue Nile River (Mohammed *et al*., 2011) [11], 10 species reported from Sanja, and Angered rivers (Genanaw, 2006) [8], 17 species from Beshilo, Dura and Ardi Rivers (Moges, 2007) [10] and (19) of species reported from rivers in Gambella region by Gashaw *et al*. (2011) [7]. Flow variability has an effect on fish assemblage, sometimes high flows for instance can destroy fish habitat and can wash the eggs of the fish that have been already laid. On the other hand during the dry season when the flow is low and when the water is reduced, the fishes are trapped in very small shallow pools that cause stress on fish and make very visible. Fishermen categories and practices According to Berihun Tefera *et al*. (2009) [1] there are four categories of fishermen involved in Lake Tana and rivers around lake Tana, these are:- full time fishermen, seasonal fishermen, contractual fishermen and part-time fishermen. In upper part of Blue Nile River unlike the case mentioned above, there are only two types of fishermen, seasonal and full time fishermen participating in river fishery. There were about 100 fishermen in Yeliman densa and Gonge kollela districts who are engaged on upper part of Blue Nile River, among these 20 were full time fishers and fully depend on fishery as their source of income. The remaining 80 were seasonal (OARDY, 2011). Most of the fishermen in upper part of Blue Nile River were seasonally dependent on river fishery as source of additional source of income because they have farm land to grow crop or raise animals are primary sources of income. Fishing gears used by the fishermen are based on the preferred fish type demanded both by consumer and fishers. The most common fish gears used Castnet, gillnet and hook. There was no introducing any modern fishing gear in the area. Most local fishermen use hook and line (Local name is mekatine) and Castnet (Local name is mereab) for catching fish. Some of the local fishermen used locally made gill nets with mesh size of approximately 12 cm stretch mesh size. When the volume of the river is becoming low there is high fishing intensity by local community and the fish prey by other aquatic animals such as birds and crocodiles. Most of the respondents are willing to cooperate in any measures that would lead to sustainable utilization of the fish resources. They are also eager to get modem fishing gear like gillnets.

Fish consumption and production potential

The fish catch data from upper part of the Blue Nile River was not documented. The farmers fishing activity were preferred during late afternoon and night. However, rough estimates can be made from the observations I had and interviews made with the farmers. Accordingly, fishing activity takes place at about three sites along the stretch of the river. It takes place for about six months (15 November to end of May) sometimes and July. The main reason starting from June up October and mid of November, the river has increased the volume and affected the fishing activities, in addition to that the fishery men has totally engaged in crop cultivation and animal rising during that season.

Almost all of the respondents said that more than, 90% of the catch is composed of *L. forskalii*, *L. nedgia*, *M. kannume*, *L. intermedius*, and *B. docmak*. Among the above fish, species the farmer prefer to consume *L. intermedius* and *L. forskalii*. They prefer the two species because they assume high quality and the fishes are attractive when seen externally. Therefore Sefania, Abenaze and Wotton mider kebeles were the highest L. *intermedius* producer in kg per week, 39.8, 35 and 28 respectively (Table,2)

Table 2: Weekly fish production in kg from Blue Nile River

Villages Kebeles	Mean fish in kg per week	Mean fish in kg per year
Sefania	40.5	
Abenaze	36	
Woteto Mider	28	

Price of *L. forskalii*, *L.nedgia*, *M. kannume*, *B. docmak* and *C. gariepinus* was significantly different between the study area ($P<0.05$). Even though, there was high potential of B.docmak, M. kannume and Labeobarbus species, the people and the fishermen lack the skill of fish processing (Fletting, gutting and avoiding tiny bones) these fish. The people in upper part Blue Nile River have good feeding habit of *L. intermedius* as the result the price of this fish is higher than in Tiss Abay. Fishermen and the people in upper part of Blue Nile have better knowledge of fish processing in all type of fish species (*Labeobarbus*, *B.docmak* and *M. kannume*) have better price (Table 3).The people around the river prefer to consume *L. intermedius* and *L. forskalii*. They prefer the two species because they assume high quality and the fishes are attractive when seen externally. All of the respondents do not have storage facilities but they have tried to improve the shelf life

of the fish by sun drying methods by making a strip of the flesh of catfish and *Bagrus docmak*. In addition they use the fish as spice for making fish wote, especially during weeding ceremony.

Table 3: Mean price of highly preferred fish species

Village/ Kebela	Price in (ETB) birr by fish species				
	L. intermedius	***L. forskalii***	***L. nedgia***	***M.kannum***	***B.docmak***
Sefania	7	5	4.50	4	4.50
Abenaze	5.50	4.20	3.50	3.0	3.50
Woteto Mider	4.50	3.20	3.0	3.50	2.50

The riverine fish potential of Blue Nile River was better associated with high biodiversity supported by the Riverine wetland. However there is higher catchment degradation associated with deforestation and improper agricultural activity leads to soil erosion by farmers that come every year. In addition to this there is high completion to use the water of Lake Tana for Tana Beles hydro power and irrigation to harvest sugar cane production. This intensive withdrawal of water from the lake is becoming problem for fishery production in upper part of Blue Nile River.

According to the respondent's point of view the fish production potential of Blue Nile River is decreasing from time to time due to high intensity of fishing and reduction of pooling areas due to decreasing water volume. This might be due to the catchments degradation and pollution released from Bahirdar Tannery. Fishing intensity in the study area was higher starting from January to May (Fig 2). Fish potential of the river is decline from time to time due to environmental fluctuation (personal communication). According to Gebru Asrate (personal communication), report few species extinct from the river for example, *L. horie* in local language "Assa Nebarie"due to the reduction of volume of river. According to Golubtsov and Mina (2003) [9] recorded *M. hasslequistii* and *R. senegalensis* fish species but it was not recorded in Tadlo (2015) [19] reported. However, M. kannume was recorded in the present study but Golubtsov and Mina (2003) [9] had not recorded it. There might be variation in sampling habitats, fishing effort, type of gear used and gill net efficiency, sampling seasons and altitude difference that contributed the variation in the catches. In other ways that may be extinct the species due to increased pollution of the river as well as extreme reduction the volume of the river during dry period. Fishing income univariate analysis showed that income generated from fishing showed significant variations among kebeles with fishing activities ($P<0.05$) (Table 4). This is because of the higher *Labeobarbus* species in production from Blue Nile River and higher price of the fish around Tiss Abay town. The mean income generated from fishing has direct relation with fishing experience. Because fishermen knowledge in fishing and fishing site selection will be improved though experience.

Table 4: Monthly income from fishing from two rivers

Village/ Kebela	Income in Et. Birr (Mean±SD)	Fishing experience in years (Mean±SD)
Sefania	670±130.4	10± 4.6
Abenaze	540.33 ± 211.2	8± 8.2
Woteto Mider	570 ± 320.5	7.5 ± 9.4

Farmers catch fish on average four day per week and 17 days per month. They estimated their daily catch up on average five fish / night/ person (about 10 kg/night/person). From each site 204kg of fish harvest per six months per person per site.

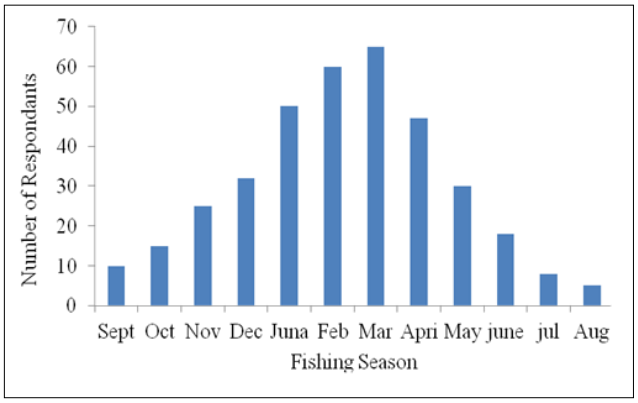

Fig 2: Farmers fishing time in the study area

Post-harvest and Handling Practices

There is no surplus fish production in study areas. Market areas are far apart to the production and even the price that they sold kg of fish is better than Lake Tana and Tributary Rivers. The fishermen in Blue Nile have no experience in processing Labeobarbus and other small fish species which are economically important fish in West Gojjam, Blue Nile Rivers. Preservation is commonly practiced study area due to lack of market accessibility and good price for fresh fish in the surrounding markets. Almost all of the respondents said that more than, 90% of the catch is composed of *L. forskalii*, *M. kannume*, *L. intermedius*, and *B. docmak* (this especially used after drying). Among the above fish, species the farmer prefer to consume *L. intermedius* and *L. forskalii.*

Fishing activities Problem

Main problems mentioned by fishermen in the study area were lack of effective fishing gears for river fishery, lack of knowledge of fishing, fish processing, lack of infrastructure and market, lack of post-harvest technology in case of fish excess production, As a result, the fishermen catch fish mostly for household consumption purposes. There is no extension service that assists fishery activities. In addition to the above problems reduction in water volume and pollution during dry season leads to extinction of some fish species. There was preliminary survey done by Golubtsov and Mina (2003) [9],

about 4-5km downstream from Tiss Issat falls that recorded four typical Niloticus species: *Mormyrus hasslequistii*, *L. forskalii*, *Raiamas senegalensis* and *B. docmak*. There was species composition variation between the present study and Golubtsov and Mina (2003) [9], reported. Golubtsov and Mina (2003) [9] recorded M. hasslequistii and R. senegalensis fish species but it was not found in the present study. M. kannume was recorded in the present study but Golubtsov and Mina (2003) [9] had not recorded it. The main reason will be reduction of the volume of water and pollution contributes to extinct such type of fish species**.**

Conclusions and Recommendations

Labeobarbus intermedius and L. forskalii is economically the most important fish species in study area. They prefer the two species because they assume high quality and the fishes are attractive when seen externally. However, do not have storage facilities but they have tried to improve the shelf life of the fish by sun drying methods by making a strip of the flesh of catfish and *Bagrus docmak*. The people around Blue Nile River should get training on how to process Labeobarbus efficiently and economically. Socioeconomic aspect of fishing in Blue Nile Rivers should be studied in detailed. Training on reducing post harvest loss and preservation methods should be given for fishermen in Blue Nile Rivers.

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