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Full Length Research Paper

Challenges and Mitigations of Fisheries in Tana – Sub Basin, Ethiopia.

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The study of challenges and mitigations of fisheries in Tana-Sub basin was conducted in 2014 for ten months. Sampling sites (154) were identified and selected based on Agro-Climatic Zone using Geographic Information System and key informant discussions were conducted. There are 5472 fishermen. At present, fisheries system is at risk because of over fishing, bad fishing season, fishing tools (mono filaments, fences, poising chemicals and small mesh size) and unnecessary activities are also taking place. Tana Beles filters allow much fish to enter to the turbine, which can kill almost all of them. Fishing, processing and transportation are very traditional. Developmental projects may possibly pose serious problems on the water level, water quality and biodiversity of Lake Tana and the Feeder Rivers. Fishing is taking place in breeding season and spawning ground of each species. As a result, from interviewed, 81.35% reported that fish supply decreased in the last ten years. Because of the traditional production system and poor management practice, the fishermen as a whole in this area are getting low income from the resource. Among the fisheries management awareness creations, restocking, prevention of destructive fishing methods/ tools, licensing of fishers and enforcing the control of illegal fishing, enforcement of management measures, participatory management approach, institutional capacity and linkage, managing pollution and the likes are important.

Keywords: Fisheries, natural resource, sustainable development, Tana Sub-basin

INTRODUCTION

Fish is an inexpensive source of protein and an important cash crop in many regions of the world, and water is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion (Bronmark and Hansson, 2005).

Even though the country is land-locked, there are a number of lakes and rivers with important fish resources in Ethiopia. The lakes cover a total area of about 7400 km2 and the rivers cover a total length of about 7700 km (Wood and Talling, 1988). Lake Tana, which is the largest lake in the country, constitutes almost half of the freshwater bodies of the country (Reyntjes *et al*., 1998; de Graaf *et al*., 2004).

These endemic fish species attracts the attention of world scientists. According to Abebe Getahun and Eshete Dejen (2012, Lake Tana has an annual maximum sustainable yield, which is about 7000- 15000 tons of fish. If the Lake is well managed, with no doubt its potential will be higher than this.

Sustainable utilization of aquatic resources, especially the fishery resource as a cheap source of animal protein, is mandatory to alleviate the severe suffering of people due to recurring drought and increasing human population in Ethiopia (Tesfaye, 1998). With the rapid increase in population and continuing expectations of growth in the standard of living, pressures on natural resources have become intense. In addition to these pressures, inappropriate fishing tools and fishing time are used. According to de Graaf *et al*. (2006) from Lake Tana, in the commercial catch large specimens of African catfish (>50 cm) and Nile tilapia (>20 cm) decreased significantly over the last ten years time. During the same period, the commercial catch of riverine spawning *Labeobarbus spp*. declined by 75%. In the experimental fishery a similar decrease was observed and the populations of juvenile *Labeobarbus* in the littoral (length range: 5-18 cm) decreased even by more than 85%. Therefore, this study was conducted to identify challenges of fisheries and set mitigations for sustainable utilization and socio-economic development in this sub basin.

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MATERIALS AND METHODS

General Descriptions of the Study Area

The Tana sub- basin is found in the Amhara region. Geographically, the basin is located between North latitude 1210669m - 1411084m and East longitude 254549 - 416363 m. Its elevation is ranging 1327 - 4109 meter above sea level. The basin has a total area of 1,589,654.98 hectares. The largest lake in Ethiopia, Lake Tana is found in the sub basin (Fig.1).

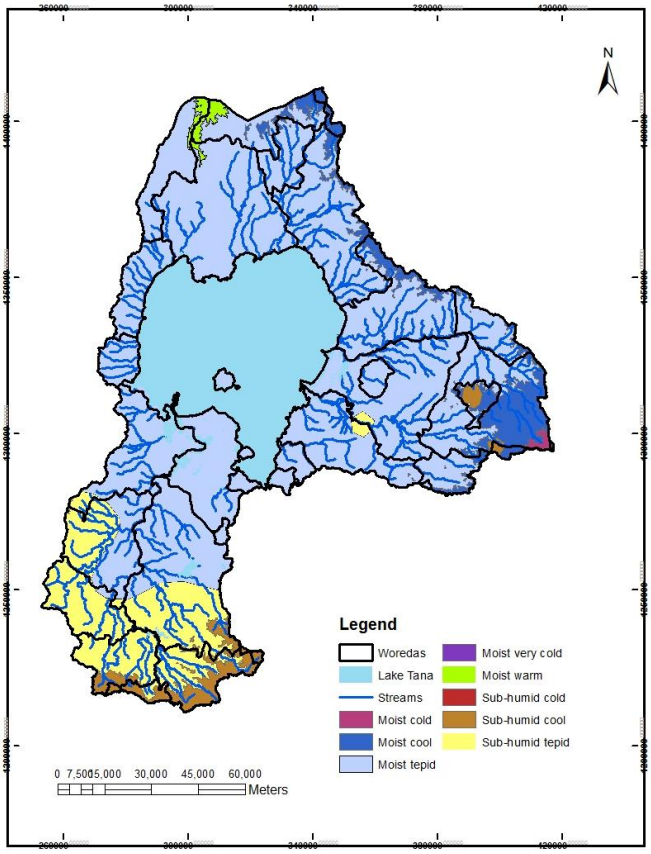

Fig.1. Map of the study area

In this sub basin, there are 28 fish species out of which 21 are endemic to the Country. Three of the fish families of Lake Tana, each represented by single species are Cichlidae, Clariidae (*Oreochromis niloticus* and *Clarias gariepinus,* respectively) (Vijverberg *et al*., 2009) and Balitoridae (*Afronemacheilus abyssinicus)* (Abebe and Eshete, 2012).

Cyprinidae is the largest family of fish in Lake Tana, and is represented by four genera: *Barbus, Varicorhinus, Garra* and *Labeobarbus*. *Barbus* is represented by three species: *B. humilis*, *B. pleurogramma* and *B. tanapelagius* (Eshete, 2003). *Varicorhinus* is represented only by *V. beso*; the genus *Garra* is represented by four species: *G. dembecha*, *G. tana*, *G. regressus* and *Garra* sp. (unidentified species with small mouth) (Akewake, 2007). *Labeobarbus* is the most abundant genus of the family and consists of 15 species (*L. acutirostris*, *L. brevicephalus*, *L. macrophtalmus*, *L. megastoma*, *L. platydorsus*, *L. truttiformis*, *L. tsanensis, L. dainellii, L. surkis, L. gorgorensis, L. crassibarbis, L. gorguari, L. nedgia, L. longissimus* and *L. intermedius)* forming a unique species flock in Lake Tana (Nagelkerke, 1997).

The sub basin is endowed with eight different agro-climatic zones namely, moist tepid, sub-humid tepid, moist cool, moist warm, moist cold, moist very cold, sub-humid cool and sub-humid cold. Most of the project area (79.4%) is found in moist tepid agro climatic zone followed by sub-humid tepid, moist cool and sub-humid cool which account for 12%, 5% and 3% , respectively. The area is dominated by one main rainy season, from June to September and one dry season for the rest months.

Sampling Methods

Sampling sites (154) were identified and selected based on Agro-Climatic Zone by using Geographic Information System (GIS) (Fig. 2). In addition to this, some important sites such as irrigations Dams (Mitsili,Selamiko, Rib, Megech and Megech Serava), harvested fish storages(Woreta, Enfiranze, Chuait, Delgi and Gorgora), illegal(monofilaments) fishing gear making places(Delgi), fishing activities and dominant wetlands were observed based on the local source (Figure2). Secondary data were also collected from woredas (21 woredas) (Agriculture office and Environmental protection and Land use Administration offices) and zonal sectors (North Gondar, Bahir Dar Liyu and South Gondar) department of Agriculture and EPLUA, by having developed formats in 2014 for about ten months. Primary data were also collected from key informants (57) were interviewed in the same year.

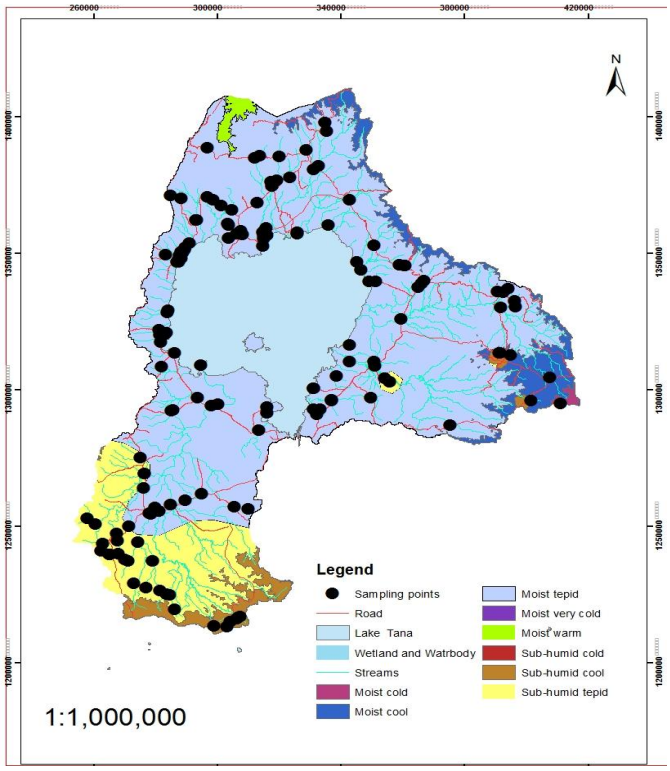

Fig.1. Map of observations and sampling sites of the study area

Data Analysis

Data which were normally distributed was analyzed by using parametric methods otherwise non-parametric method was conducted and some data were transformed. These collected data were done and analyzed by using SAS (Statistical Analysis System), SPSS (Statistical Package for Social Studies) and Excel software.

RESULTS AND DISCUSSION

Existing Situation of Capture Fisheries

The existing fisheries production is traditional. Because of traditional production system and poor management practice, the fishermen as a whole in this area are getting low income from these fisheries, failed for problems. Post harvesting system (Fig. 3) and the transportation system of this harvested fish, dried fish are traditional (Fig.4). Market technologies and system are also too poor. There is high fish demand in the market, particularly in Addis Ababa and North Sudan. Because of this demand, these dried fish are transported to North Sudan and semi processed ones are transported to Bahir Dar, Gondar and the most is to Addis Ababa. Some dried fishes are also demanded and consumed by local once (woredas which are found in the western parts of North Gondar Zone).

Fig. 3. Traditional post harvesting of fish in Alefa Woreda left) and Dembia Woreda (right)

Fig. 4. Harvested fish transportation (poor) to consumers in Gondar Zaria Woreda

General Problems of fisheries

Tana- Sub basin is considered growth corridor by the Government. Hence, several development projects (dam building and irrigation projects) are being studied and/or implemented. These include, among others, the Tana Beles inter-basin water transfer, Koga, Ribb, Megech dams, irrigation projects and there will be additional small dams. Almost all of them block the Feeder Rivers to store water, some pump water through tunnels and some pump water directly from the lake for irrigation purposes. These projects may possibly pose serious problems on the water level, water quality and biodiversity of Lake Tana and the Feeder Rivers in the basin. These dams, most of which lack fish ladder, blocks fish migration for spawning purpose, as a result *Labeobarbus* fish species are highly at risk, planned dams are feared to block this vital migration of fishes and this may ultimately lead to the demise of this unique group of fishes and decline in fish stock of Lake Tana. There were environmental impact assessment (EIA) studies conducted for the different projects, but which did not consider fish migration route in some. If the development projects are undertaken, the migration measures and the management plan suggested in the various EIAs need to be strictly followed and implemented. Experiences to date, however, indicate that this measures and plans are not properly adhered. According to local fishers thought, in Tana Beles there is a filter which tries not to allow inlet the fish to water canal. These filters allow much fish to enter to the turbine, which can kill almost all of them and which can result high loss. More are killed by turbine and some will pass it and are found at the outlet where there is high fish mortality.

State of the Threats

In this study it was possible to understand fisheries in Tana Sub- basin are failed for different illegal activities, which can result in total collapse of fisheries which is agreed to Abebe and Eshete' (2012) results. Therefore, implementing all necessary management measures is vital for the sustainability of the lake, rivers and wetlands and wise use of its resources. Currently, almost all fishers both reed boat and motorized boat are mainly concentrated on breeding season and spawning ground of each species. Tilapia fishing is carried out in littoral regions; Catfish at littoral flooded area and *Labeobarbus* is mainly targeted at river mouths and more distance towards upstream.

The most surprising fishing activity that will probably lead to over all collapse of Lake Tana fishery resource is using undersized monofilament gillnet imported from Sudan (Gelabat Town) since 2008 and now days this monofilament gillnet is made by fishermen around the lake for example, Bahir Dar, Esey Debir and Delgi (Fig. 6), Chuait, Gorgora and others. During peak spawning season at pre-rainy season, peak rainy season and post rainy season at all spawning grounds setting 4cm up to 7cm stretched mesh by all fishers has become common practice even cooperatives use this.

Fish Production in Tana Sub- Basin

According to Abebe and Eshete (2012), fish species, mainly *Labeobarbus*, Tilapia, and Catfish and V. beso are commercially important and have a potential to give good production.

Tana Sub- basin fisheries are means of the livelihood for many fishers. Currently, 5472 fishers are found, from these landless fishermen are 905. Harvesting of fish in Lake Tana increases from time to time, particularly staring from 2002(E.C) (Fig.5). This is because of increasing fishers and fishing tools from time to time.

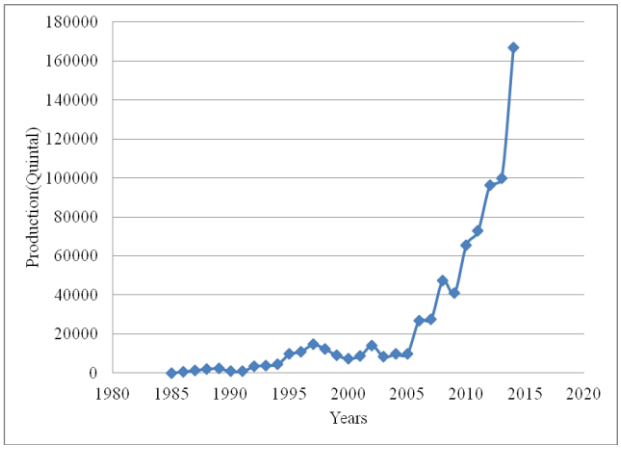

Fig. 5. Fish production from Lake Tana (1995-2014)

From household survey and key informant 81.35% said that, the fish availability from the catch, in the last ten years has been dramatically decreased (Table1).

Table 1. Fish supply status for the last years in Tana Sub- basin

Items	Frequency	Percent
Fish availability in the catch is increasing in the last ten years	220	15.14
Fish availability in the catch has decreased in the last ten years	1182	81.35
Fish availability in the catch has no changed in the last ten years	51	3.51
Total	1453	100

Influx of Affluent

Small scale agricultural activities are taking place around in this sub basin. These agricultural activities lead to introduction of agricultural inputs, such as fertilizers, pesticides and herbicides in to the lake, which are serious problems. Although the use of these amount inputs by farmers is small quantities so far, but the unregulated manner in which they are used is a threat to the health of the water. In addition, wastes from the different sections of Bahir Dar City (e. g .Hotels, Hospitals, Residents, etc) are, in most cases, discharged in to Lake Tana directly.

By-catch

Some types of fishing equipment such as nets with small mesh sizes, Monofilaments, trawlers, and long lines collect both the desired species (catch) and many non-target species (by-catch) as information obtained from key informants. By-catch includes unwanted or undersized animals. These animals are culled and returned to the water body or elsewhere, often dead or dying; the populations of many non-target species are dropping as a result. In many cases, the discarded fish are juveniles, which increase the rate of population collapse.

Toxic Substances

Based on key informants discussion and field observation, toxic substances, such as Crushed seeds of Birbira with little Malathion is used in tributaries of Lake Tana so as to catch fish, which can result to fish mass kill.

Habitat Destruction

Lake Tana, wetlands and feeder rivers are exposed to various forms of environmental degradation such as drainage for agriculture, over grazing, upper catchment lands degradation, Eucalyptus encroachment or plantation, invasion of alien species or weeds, over harvesting of their resources, settlement and urban expansion, pollution and water diversion .These things affect the production and productivity of fish and also it affects even the existence of species, because of change of water chemistry and physical environment.

Management of Fisheries

Awareness Creation

Before doing anything, provide basic information and/or awareness for stakeholders, particularly fishers about the fisheries. Of course at the movement, knowledge about the fish resources is quite high for some fishers. They are aware that fish resources are a limited resource. They are also aware that

the size of their catch is getting smaller from year to year. However, only some of the fishers are aware that the government has laws, rules and regulations with regard to fisheries resources management. They have no idea about the content of these laws. It is, therefore, vital to design awareness creation programs for fishers as well as for extension workers about the law, regulations and directives.

Restocking

Because of the aquatic habitat changes due to natural (drought, flood, habitat destruction) or human (over-harvest, pollution, habitat lost to development and dam construction) influences, the natural production of fish declines, this is true in this sub basin.

It looks and approved from fishers there is a decline in the population of fish in the sub- basin over the past years. While all the reasons for the decline are not entirely known, it is agreed that a combination including loss of habitat, drying of rivers because of over utilization for irrigation, over fishing, illegal fishing tools and time and various forms of pollution are all contributing and interwoven factors. Therefore, stocking of fish is one of the many management strategies to help replenish the population for years to come. The need for mass production of quality fish seed can only be satisfied by artificial propagation methods. These methods permit the incubation and hatching of eggs and the rearing of seed under well protected conditions.

Prevention of Destructive Fishing Methods/ Tools

Illegal fishing activities like use of monofilaments (Fig. 6), Seeds of Birbirra tree (*Milletia ferruginea*) with Malathion and fencing as well as fishing practices that can hinder the free movement of spawning stocks, such as fencing the rivers, beach seines and trawls should be strictly forbidden. And there should be fish inspectors that can have the duty to check any of these destructive fishing methods.

Fig.6. Monofilaments are made by fishers at Takusa (the right) and Esey Debir, Alefa (left) woredas

In addition to illegal fishing activities, mesh size regulations also should be implemented seriously which can allow immature fish to escape from being caught by gill nets. The regulation allows 8cm and above stretched mesh size of gillnet for fishing.

Licensing of Fishers and Enforcing the Control of Illegal Fishing

Currently, there are about 5152 fishers around this sub- basin who are fishing most of them for commercial purpose and few are for home consumption. First, all of them need to be licensed without considering any new ones. Then, according to Abebe and Eshete (2012), monitor the resources status for two years. The decision whether or not to provide new license will be dependent on the resource base. It is not advisable at all to give fishing license for river fishery. Licensed can be issued, however, for reservoir fishery. The license will limit the number of gillnets per boat and number of fishing days per week. For commercial motorized boat 25 gillnet of 100m per boat is recommended. For reed boat fishers a maximum of 3 gillnets per boat is proposed. They should fish only 3 times per week during the non-restricted fishing season.

Participatory Management Approach

Established Kebele fisheries regulatory committee should be functional. It is also essential to establish in the rest, each of the bordering kebeles. The committee will monitor any activity around the water bodies from in any time particularly, in breeding season/time and sites/place with assistance of fish inspectors. This kebele regulatory committee and the inspector, thus, take full responsibility to monitor the resource and bring unlawful fishers to the respective woreda Judge for their actions.

Institutional Capacity and Linkage

There is an obvious need for strong implementing agencies for regulations, policy issue and EIA study results to be implemented properly. One of the major implementing agencies is the Environmental Impact Authority. It is imperative that this authority needs to be strengthened with the essential finance and manpower at the federal and regional levels for proper monitoring and evaluation of project proceedings and management plans. It also appears that there is redundancy and repetition of efforts by different government and non-government institutions on the different projects that are taking place and around the lake. There should be a concerted action by all stakeholders towards mitigating the actual and potential environmental hazards facing the lake. Tana Sub- basin Authority with the collaboration of Bureau of Agriculture should coordinate all activities in an option to solve these problems.

Closing the Fishery during the Spawning Months

Cyprinids are riverine in their origin and they are adapted to live in lakes or lacustrine environments, most of the species migrate upstream to spawn in tributary rivers (Tomasson *et al*., 1984; Skelton *et al*., 1991) which indicates that they are not still fully adapted to the lake environment (Skelton *et al.* 1991). Studies which was conducted in major inflowing rivers of Lake Tana such as Gelda and Gumara (Nagelkerke and Sibbing, 1996; Palstra *et al*., 2004; de Graaf *et al*., 2005), Ribb (Abebe Getahun *et al*., 2008) and Dirma Megech (Wassie Anteneh, 2005), Arno-Garno River (Shewit Gebremedhin, 2011) and Gilgel Abay River and its Tributaries (Dagnew *et al*., 2014) approves this study, indicated the upstream spawning migration of some lacustrine *Labeobarbus* species. Also these studies approved that, *Labeobarbus* fish species breeding time is from July up to the beginning of November, most in the rivers and some are in the lake itself. According to Abebe and Eshete (2012), the littoral areas of Lake Tana with a radius of 5kms from the shore should be closed from any fishing activities for two months (June and July) every year so as to conserve fish species.

Rivers Buffering

Riparian buffers are vegetated zones of land adjacent to water sources. Preservation and reestablishment of these zones can have many environmental benefits. The most important function of these zones is to act as a filter for water flowing into the water source, and studies show that they greatly reduce water pollution. The vegetation and soil absorb runoff water that is often laden with pollutants, sediments and nutrients that are harmful to the water supply, especially if the buffer zone is over 9.14 m wide (Belt and Merril*,* 1992; Johnson and Ryba,1992). The absorption of runoff water has other benefits: it recharges the ground water supply, and can regulate water flow in rivers and therefore, reduces and prevents flooding. Having vegetation immediately adjacent to a water source also helps control erosion, as the roots of the plants help hold soil in place. Zones of land adjacent to water sources are often flourishing wildlife habitats, with many species depending on them for survival (Hawes *et al.* 2005). Therefore, to sustain spawning of migratory fish species in addition to many other benefits, buffing of the rivers is very important and urgent in this sub basin.

RECOMMENDATIONS

- Federal and Regional (Amhara Region) fisheries policies should be seriously implemented (proclamations No 315/2003 and 92/2003 on Fisheries Development, Protection and Utilization, respectively);
- Illegal fishing activities (like use of monofilaments, Seeds of Birbirra tree (*Milletia ferruginea*) with Malathion and fencing) must be totally prohibited both during spawning and non-spawning seasons in Tana sub- basin. The Kebele fisheries regulatory committee should be functional/ alerted in such situations;
- Basic information or awareness creation about fish species for the local people or users should be given to encourage conservation of fish species and their habitats;
- There must be an appropriate or urgent need of conservation of natural valuable resources, especially the lake, wetlands and breeding sites (rivers) of *Labeobarbus fish* species;
- Stock assessment of fisheries resource must be done in this area for proper management and
- In dams, there should be allowance fish path/ fish ladder of natural fish production by enhancing free movements of fish from natural water bodies to dams, lower to the upper parts of the dam.

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