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Review in current problems of Ethiopian fishery: Incase of human and natural associated impacts on water bodies

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Abstract
This review paper was aimed to investigate the current fishery problems in Ethiopia. Different data sources were used including published and unpublished scientific papers. Ethiopian aquatic ecosystems provided more than 180 fish species and the country had the potential to produce 51,500 tonnes of fish per year. Based on the review the current problems of Ethiopian fishes and fishery were, impact of water hyacinth (mainly in observed Lake Tana and some other Ethiopian rift valley lakes), expansion of agriculture and industrialization, climate change and post harvest losses, using improper fishing gears and poison plants, immature fishing and overfishing, wetland degradation and fish diseases. Now a day the demand of fish is double increasing. Therefore, effective management of fishes is urgently required by encouraging the capture fishery and aquaculture to sustain the fish resources to meet the demand for fish and fishery products.

Keywords: Ethiopia, effective management, fishery problems, immature fishing, post-harvest losses

1. Introduction
The inland fishery of Africa is contributed about 2.1 million tonnes of fish per year, it represents (24%) of the total world fish production from inland water bodies (FAO, 2004) [20]. Fishery has significant role that contributes to the economy of the country (Mitike, 2015) [32]. It contributes a valuable asset in the economy of a given country (Felegeselam, 2003) [22]. The inland water body of Ethiopia is covered about 7,400 km^2 of the lakes and about 7,000 km a total length of the rivers (Felegeselam, 2003; Mitike, 2015) [22, 32]. More than 180 fish species were harbored in these water bodies (Temesgen and Getahun, 2016). The fish production potential is estimated for 51,500 tons per year in Ethiopia. However, only 30-38% of this potential is currently used (Mitike, 2015; Temesgen and Getahun, 2016) [32, 35]. According to Temesgen and Getahun (2016) [35] the exploitation of fish is depending on the socio-economic factors, resource accessibility and religious causes on fish utilization that integrates into human diet. Major challenges of fishes and fishery in water bodies of Ethiopia are suffered from human impacts, illegal fishing activities like using narrow mesh size nets and poisonous plant seeds that causes toxic to the fish, lack of awareness of the community in fisheries management, no fish stock assessment has been done so far, limited institutional, technical and financial capacity and low research and development capacities (Mitike, 2015; Desta *et al*., 2017) [18, 32]. The degree of the problem varied from place to place in the country. Tesfay and Teferi (2017) [39] documented that a significant amount of fish annually wasted due to post-harvest losses. Moreover, fish supply is considerably affected by gender, access to market, lack of infrastructure to market and size of fishing gears (Keno and Zewudie, 2016; Temesgen and Getahun, 2016) [27, 35] and the extent of heavy immature fishing in given water bodies (de Graaf *et al*., 2003; Muluye *et al*., 2016; Tesfahun, 2011) [14, 33, 37]. Moreover, fish production has faced serious problem like fish post-harvest losses due to poor post-harvest handling, storage and management problems are reported (Tesfay and Teferi, 2017) [39]. Several studies conducted in relation to fish production, constraints and its associated mitigations in Ethiopian water bodies (Asmare *et al*., 2016; Awoke, 2017; Awoke and Melaku, 2017; de Graaf *et al*., 2003; Desta *et al*., 2017; Gebretsadik and Merke, 2017; Kebtieneh *et al*., 2016; Mitike, 2015; Muluye *et al*., 2016; Tewabe, 2013; Tewabe *et al*., 2016; Tesfay and Teferi, 2017; Tilahun *et al*., 2016) [4, 7, 8,14, 18, 24, 26, 32-33, 39, 41-43]. However, all of them reported that a particular water

bodies of Ethiopia. This review paper gives the general perception on the status of fish, fishery and associated draw backs of the fishes in the country. Accordingly, there is little compiled information on the challenges of Ethiopian fishery, Therefore, the purpose of this review paper is aimed to fill this gap by assessing current constraints of Ethiopian inland fishery for continued fishing.

2. Materials and Methods

Data sources were collected from September, 2017 through January, 2018. The different literature sources were used for this review including journal articles, books and book chapters, workshop proceedings, FAO reports, bulletins, legal documents and unpublished reports including PhD dissertations as well as M.sc. thesis. The documents were collected from Addis Ababa University library, Hawassa University library, Ethiopian Ministry of Livestock and fishery, from different fishery research centers, from the individual researchers and Internet.

3. Human activity and natural associated impacts on Ethiopian fishery

Fisheries are an important part of food security and nutrition, particularly for many poor people in developing countries (Adewolu and Adoti, 2010; Tesfay and Teferi, 2017) [2, 39]. However, the Ethiopian fishery is under several constraints due to different factors (Temesgen and Getahun, 2016) [35]. Some of the current problems of the Ethiopian fishery were discussed below.

3.1 Impact of water hyacinth on fishing activity

Water hyacinth (*Eichhornia crassipses*) have been considered as the worst invasive weeds in relation to its negative impacts on aquatic ecosystems, agriculture, fisheries, transportation, living conditions and social structures (Bhattacharya *et al*., 2015) [10]. Moreover, fish kills caused by oxygen depletion as a major impact of water hyacinth infestation which also impacted negatively on their socio- economic status (Waithaka, 2013) [45]. The current fish production in Lake Tana has declined due to the impact of this weed it had blocked many fishing grounds. According to Wassie *et al*. (2014) [46] reported that water hyacinth infestation has been covered about 34,500 ha (15% of the Northern shore of the Lake Tana). Consequently, all the fishers changed their landing site because of water hyacinth expansion obstructs their fishing activities (Asmare, 2017) [6]. Therefore, if the expansion of water hyacinth continues in this trend, it can negatively affect the livelihood of fishers in both directions by increasing costs of fishing and reducing the amount of fish caught in Lake Tana (Asmare *et al*., 2017) [6]. As a result, the decline of large barbs has been observed presently in Lake Tana, which is got shallower and shallower due to the worst weed (water hyacinth). Furthermore, the catch Per Unit of Effort (CPUE) of *Labeobarbus* in 2010 had sharply declined to 6 kg/trip in comparison with 28 kg/trip in 2001 and 63 kg/trip in 1991-1993 (63 kg/trip) (Asmare *et al*., 2017) [6]. In connection to this, a high infestation level of water hyacinth was also reported in some other Ethiopian rift valley lakes mainly in Aba-Samuel Dam, Lake Ellen, Lake Koka and Lake Wonji (Frehun *et al*., 2014) [23] and studies revealed that a rapid increase in water hyacinth was observed time to time. In summary, to continued fishing the resource managers and stakeholders strive to eradicate the proliferation of the water hyacinth in order to create a viable condition for fishery production as well as ensuring the healthy the lake's ecosystem.

3.2 Immature fish landing and overfishing by the fishermen

According to the FAO (1984) [19], report to conserve sustainable fish resource, commercial catching of fishes should be considered after reaching length at first sexual maturity. Therefore, length at first maturity of fishes is assumed as a minimum harvestable size of a given fish species (FAO, 1984) [19]. Because of, the number of fishes attaining recruitment depends on sexually matured fishes in the water bodies for the next fish production (LFDP, 1997; Muluye *et al*., 2016) [28, 33]. However, fishes are caught before reaching sexual maturity in Ethiopian water bodies. For instance, high proportions of *Labeobarbus intermedius* caught (38.34%) were below length at first maturity (immature fish) in Lake Koka (Tesfahun, 2011) [37]. Similarirly, there was immature fishing of (77.6%) for *Clarias gariepinus* and (23.0%) for *Oreochromis niloticus* in Lake Hawassa (Muluye *et al*., 2016) and (15%) for *Labeobarbus* species in Lake Tana (de Graaf *et al*., 2003) [14]. This might be the awareness of fishermen on the length at first sexual maturity is very limited in different water bodies. For instance, very few fishermen (1.3%) know the correct length at first sexual maturity of fish and (50.6%) of the fishermen did not know whether the catch fish is mature or immature as documented in Lake Hawassa (Muluye *et al*., 2016) [33]. This leads to overfishing towards the sustainable use of the fish resource for the future generation to poverty alleviation. In similar way, in Lake Ziway (74%) respondents were having poor knowledge towards Lake Fishery management and (26%) were having no good skill about the lake fishery management (Mitike, 2015) [32]. Overfishing might be the cause the losses of some fish species in the water bodies. The study conducted in Lake Zeway revealed that the most serious problems was using narrow mesh sizes which (43.33%) it resulted over exploiting of the fish stock in the lake. The current major problem creators on fishery were fishermen (71.33%) in the Lake Ziway (Mitike, 2015) [32].

The 'Gancho' fishing gear caused the over-exploitation of the target fish stock particularly the Nile perch stocks in Lake Chamo (Gebretsadik and Mereke, 2017) [24]. The Ethiopian fishery is predominantly targeted on Nile tilapia (*Oreochromis niloticus*) (Bjørkli, 2004; Vijverberg *et al*., 2012) [44]. In other way, in Lake Tana, the *Labeobarbus* species are heavily fished during a seasonal fishery (de Graaf *et al*., 2006) [16]. According to Vijverberg *et al*. (2012) [44] 15-20 years ago Nile perch contributed (20%) of the commercial fish landings in Abaya and Chamo Lakes. However, now a day the fish stock has been depleted due to overfishing and poor fisheries management (Reyntjens *et al*., 1998; Vijverberg *et al*., 2012) [34, 44]. In Lake Tana migrating *Labeobarbus* species are overfished by a seasonal fishery during the peak spawning season (de Graaf *et al*., 2004; Vijverberg *et al*., 2012) [15, 44]. Currently, there is overfishing of the targeted fish species like Nile tilapia in Lakes Chamo, Abaya, Awassa, Langano and Ziway (Vijverberg *et al*., 2012) [44]. Desta *et al*. (2017) [18] documented big challenges due to uncontrolled and excess fishing practices (54%), increasing fishers over time (86%); using narrow mesh sized nets (53%), Lack of government control over fishing (31%) and lack of community involvement and sense of ownership in Lake Ziway (26%).

However, Dadebo *et al*. (2012) [12] reported as no overfishing was observed this is due to the mesh size was good used by the fishermen in Lake Hawassa. This is because of variations in length at first maturity on Nile tilapia (Bjørkli, 2004) [11]. Similarly, fishers using scientifically recommended sizes of fishing gears increased by (20.7%) in Fincha Amarti Nashe Reservoir (Keno and Zewudie, 2016) [27] and it is save for sustainable fish resource utilization. In conclusion, overfishing is resulted by poorly regulated high fishing effort by the commercial gillnet fishing (de Graaf *et al*., 2003) [14]. Therefore, mesh size of the fishing gears needs to be widened and avoid fishing during the spawning season for protecting juveniles and mega spawners for sustainable fish resource utilization in different water bodies (de Graaf *et al*., 2003; Tesfaye *et al*., 2016) [14, 38].

3.3 Wetland degradation associated impacts

In Ethiopia, wetlands covered about (22,600 km^2) surface area of the total land (Awoke and Melaku, 2017) [8]. Wetlands have provided habitat for fishes. For instance, Chefa wetland supports a potential fish production such as *Clarias gariepinus, Gara dembecha, Labeobarbus intermedius* and *Labeobarbus nedgia* (Tessema *et al.*, 2014) [40]. However, over-exploitation of wetland's resource is now a major problem in Ethiopia. Excessive exploitation of resources can also lead in some cases to a direct collapse of the wetland. In Afar, many areas of wetland have been lost during 1960's due to the increase of irrigation practice in the area (Gebretsadik and Mereke, 2017) [24]. Wetlands are mostly used for pastoralists during the dry season. For this reason, many of the wetlands have lost (Gebretsadik and Mereke, 2017) [24]. Although wetlands are capable of absorbing pollutants from the surface water, the primary pollutants; sediment, fertilizer, human sewage, animal waste, pesticides, heavy metals (Gebretsadik and Mereke, 2017) [24]. Evidence is the drained of Lake Haramaya due to an excessive water withdrawal by human induced factors (Meko *et al*., 2017) [29]. Year round over grazing around the wetlands causes loss of biodiversity and in turn affecting the hydrological system and balance of the wetland itself (Gebretsadik and Mereke, 2017) [24]. Moreover, wetland ecosystems are impacted the climate change. Globally, the impacts of climate change on freshwater systems are expected to exceed the benefits. Climate change is increasing uncertainty in water management and making it difficult to close the gap between water demand and supply (Gebretsadik and Mereke, 2017) [24].

3.4 Expansion of agriculture, urbanization and industrialization

Farmers and investors growing their crops in Ethiopian water bodies without doing the impact assessment (Mitike, 2015) [32]. Nearly 6 million people live in the Abaya, Chamo, Hawassa and Chew-Bahir catchments and the population density is more than 160 people/km^2. Cultivation of teff *(Eragrostis tef),* chickpea, grass pea and maize practices has been impacted around the shore in LakeTana (Asmare *et al*, 2016) [4]. Demographic pressure resulted in increases agricultural growth, deforestation, municipal and industrial effluents and human activities on the shoreline nutrient loadings into the water bodies. For instance, farmers (21.33%) and factories (5.34%) had polluted Lake Ziway (Mitike, 2015) [32]. Ethiopian water bodies (Meko *et al*., 2017) [29]. Moreover, most of the investors prefer the rift valley for flower production in Ethiopia. For instance, one large company in Ethiopia now occupies about 300 hectares in Ziway around the lake (Gebretsadik and Mereke, 2017) [24].The reason is water availability and transport links to provide suitable conditions.

Furthermore, deforestation and overgrazing are big factors that increase the rate of degradation of the environment in Ethiopia (Awoke and Melaku, 2017) [8]. This resulted in a depletion of fish biodiversity in different drainage basins and the rift valley lakes (Getahun and Stiassny, 1998) [25]. The rift valley water bodies contain a high sediment load it reduces light penetration and in turn results the decline of the primary production and the fish production. This impact is associated with deforestation of the surrounding catchments of a given lakes (Getahun and Stiassny, 1998) [25]. Similarly, in Lake Tana sediment load and siltation are current problems (Aweke and Melaku, 2017) [8]. Similarly, in Lake Ziway the volume of the water reduction is due to water abstraction for irrigation and water supply (72%), Siltation of the lake through soil erosion due to deforestation (71%), chemical pollution due to runoff from irrigated lands (65%) (Desta *et al*., 2017) [18]. Mitike (2015) [32] also reported wetland and landscape degradation and sedimentation (36.34%) and water contamination by industrial/municipal wastes (20.33%) in the same lake and therefore, all these phenomena have direct or indirect impact on fish diversity in a given water bodies.

3.5 Climate change and post-harvest losses of fish product

Climate change seriously causes depletion of fishery activities in a certain country (Temesegen and Getahun, 2016) [35]. Higher inland water temperatures decline the availability of fish stocks by altering water quality and the trophic status of a given aquatic ecosystems. Ethiopia is facing a massive drought and food insecurity crisis as a result of shortage rains and droughts that have been resulted worse due to climate change by El Nino in 2015 (FAO, 2016) [21]. It affects fishers' livelihood in many ways. The climate change can also increase vulnerability of fishing households the severity of the impacts from climate change because of the agricultural crops were seriously affected for this reason the only option is to catch any size of fish and the fish population got over-exploited in Lake Langeno (Temesgen, 2017) [36]. In conclusion, based on the climate change impact (51.4%) respondents were reported that the impact was medium. However, (42.9%) of the respondents were reported that the impact is severe in Lake Tana (Asmare *et al*, 2016) [5]. Global climatic changes such as increase in mean air temperature, shifting precipitation patterns and an increase in extreme weather events are resulted in the depletion of fish stock (Meko *et al*., 2017) [29].

Fishes are perishable products they spoil very quickly by intrinsic and extrinsic factors. High temperatures hurry up fish spoilage in turn the high temperatures increases the activities of bacteria and enzymes in fish flesh and therefore, these are resulted post-harvest fish losses i.e. nutrient or economic losses of fish and fishery products. Losses are grouped into physical, quality and market oriented loss (Tesfay and Teferi, 2017) [39]. For instance, (42.9%) of the respondents reported the loss about 20 kg out of 200 kg of a catch was spoiled before landing. Moreover, (46.5%) of the respondents reported the highest proportion of fish loads damaged when arriving the market in Tekeze dam due to high temperature (22.25 to 31.15 °C) and (84.3%) respondents were responded that throwing the fish away. On the other hand, in Lake Hashenge the post harvest losses relatively small due to

relatively cold air temperature (13 to 19 °C). Out of the total respondents (52.62%) replied that limited access to market and this is associated with lack of consideration for the sector by the administration of the district regarding on fish supply in the country (Meko *et al*., 2017) [29]. Generally the post-harvest losses obtained by due to limited infrastructure facilities and fishing equipments, marketing constraints (Meko *et al*., 2017) [29].

3.6 Using improper fishing gears and poison plants

Fishers used improper fishing gears which are locally made like fike net traditionally called 'Kefo'. Fishermen put bait material inside the fyke net to impress the entrance of the fish and this system is non size selective, it depends on the size choice of the fishermen in Jemma and Wonchit Rivers (Tewabe *et al*., 2016) [43] and therefore, it causes over fishing. Comparably, more than 15 traditional fishing gear types were employed in Gambella region water bodies (Abegaz, 2010) [1]. Fishermen simply made a trap from locally available rope materials, and operated by themselves manually to set it down towards streams flow in Jemma and Wonchit Rivers (Tewabe *et al*., 2016) [43]. *Millettia ferruginea* is plant poisoning material used as fishing gear and its seed produced at high altitudes. The seed of *M. ferruginea* contains a highly toxic material that can cause mass destruction on the Barbus fish species in Gumara River (Ameha, 2004) [3]. The minimum concentration of water solution of powders of seeds of *M. ferruginea* can kill nearly (100%) fish population when exposed. Within an hour exposure and (0.04 g/L) concentration the large barbs were killed in Gumera River (Lake Tana) (Ameha, 2004) [3]. The fish exhibited stressful behaviors such as unusual swimming and loss of balance which is due to the bark damage the nervous system and general metabolism of the fish. As a result, the body cavity of the fish becomes bad smell and changed its normal color to black color in North Shewa Zone, Ethiopia (Asmare *et al*., 2016) [4]. Therefore, giving training for the fishermen is strongly recommended to use legalized fishing gears and to ban the poison plant seeds as fishing gear to sustain continued fishing.

3.7 Fish diseases

Meko *et at*. (2017) [29] noted that fish diseases are one of the problems of the fishery sector in the country. Parasites and disease associated conditions of the fish reduces fish production. Disease is globally recognized as one of the most serious threats to the commercial success of capture fishery and aquaculture. Fish diseases may lead to mass mortalities, and as the culture of fish becomes more intensive and widely spread, fish parasites infection will be more liable to become more serious economic and health issues. For instance, recently *L. intermedius* is declined due to overfishing and parasitic infection has result the less accessibility of the fish on the local fish markets (Desta *et al*., 2006; Mengesha, 2009; Dadebo *et al.*, 2013) [13, 17, 30]. In addition, *Contracaecum* was the most serious parasite that affecting of fish in Lake Ziway (Bekele and Hussien, 2015) [9]. Parasites like nematodes were also contributed (8.60%) for *Oreochromis niloticus* and (19.02%) for *Clarias gariepinus* in the gastrointestinal tract of the fish.

4. Conclusions

More than 180 fish species dwelled in lotic and lentic aquatic ecosystems of Ethiopia. The country has the potential to produce 51,500 tonnes of fish per year. However, less than 30% is currently utilized due to human induced and natural limiting factors including infestation of aquatic weed (serious problem in Tana and Koka Lakes), shortage of infrastructure and fishing gears, problems of market access, climate change, expansion of agriculture and industries, overfishing practices, lack of government attention were current challenges encountered in this review. Generally, based on the review it can be conclude that the human intervention is considered as the current problem of fish and fishery in the country and further study is needed to sustain the fish stock for the next utilization.

5. Conflict of interest

The author declares that there is no conflict of interests.

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